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X-Ray Wavelengths and X-Ray Atomic Energy Levels

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Foreword

The National Standard Reference Data System is a government-wide effort to give to the technical community of the United States optimum access to the quantitative data of physical science, critically evaluated and compiled for convenience. This program was established in 1963 by the President's Office of Science and Technology, acting upon the recommendation of the Federal Council for Science and Technology. The National Bureau of Standards has been assigned responsibility for administering the effort. The general objective of the System is to coordinate and integrate existing data evaluation and compilation activities into a systematic, comprehensive program, supplementing and expanding technical coverage when necessary, establishing and maintaining standards for the output of the participating groups, and providing mechanisms for the dissemination of the output as required.

The NSRDS is conducted as a decentralized operation of nation-wide scope with central coordination by NBS. It comprises a complex of data centers and other activities, carried on in government agencies, academic institutions, and nongovernmental laboratories. The independent operational status of existing critical data projects is maintained and encouraged. Data centers that are components of the NSRDS produce compilations of critically evaluated data, critical reviews of the state of quantitative knowledge in specialized areas, and computations of useful functions derived from standard reference data.

For operational purposes, NSRDS compilation activities are organized into seven categories as listed below. The data publications of the NSRDS, which may consist of monographs, loose-leaf sheets, computer tapes, or any other useful product, will be classified as belonging to one or another of these categories. An additional "General" category of NSRDS publications will include reports on detailed classification schemes, lists of compilations considered to be Standard Reference Data, status reports, and similar material. Thus, NSRDS publications will appear in the following eight categories:

<i>Category</i>	<i>Title</i>
1	General
2	Nuclear Properties
3	Atomic and Molecular Properties
4	Solid State Properties
5	Thermodynamic and Transport Properties
6	Chemical Kinetics
7	Colloid and Surface Properties
8	Mechanical Properties of Materials

The Present compilation is in category 3 of the above list. It constitutes the 14th publication in the new NBS series known as the National Standard Reference Data Series.

A. V. ASTIN,
Director.

Preface

The publication philosophy of the National Standard Reference Data System recognizes that data compilations will be most useful if all available channels of publishing and disseminating the information are employed. Selection of a specific channel—Government Printing Office, a scientific journal, or a commercial publishing house—is determined by the circumstances for the individual document concerned. The goal is to reach all of the appropriate audience most readily at minimum expense.

The two compilations which follow were first published in "Reviews of Modern Physics." The authors and the editors felt that journal would reach the intended readers, and the Office of Standard Reference Data agreed. However, all concerned underestimated the demand for reprints, and the supply was exhausted soon after publication.

With the generous permission of the editors of "Reviews of Modern Physics," and the approval of the authors, the Office of Standard Reference Data has undertaken to reprint the articles as a part of the National Standard Reference Data System—National Bureau of Standards series.

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X-Ray Wavelengths

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Inconsistencies in accepted values (in x units) of x-ray reference lines have recently been demonstrated, although all are supposedly based on "good" calcite crystals. Factors supporting the selection of the $W K\alpha_1$ line as the *X-Ray Wavelength Standard* are critically discussed. A review is given of the experimental measurements which are used to establish the wavelength of this line on an absolute angstrom basis. Its value is $\lambda W K\alpha_1 = (0.2090100 \pm 5 \text{ ppm}) \text{ \AA}$. This may be used to define a new unit, denoted by \AA^* , such that the $W K\alpha_1$ wavelength is exactly 0.2090100 \AA^* ; hence $1 \text{ \AA}^* = 1 \text{ \AA} \pm 5 \text{ ppm}$. The wavelengths of the $Ag K\alpha_1$, $Mo K\alpha_1$, $Cu K\alpha_1$, and the $Cr K\alpha_2$ have been established as secondary standards with probable error of approximately one part per million. Sixty-one additional x-ray lines have been used as reference values in a comprehensive review and reevaluation of more than 2700 emission and absorption wavelengths. The recommended wavelength values are listed in \AA^* units together with probable errors; corresponding energies are given in keV. A second table lists the wavelengths in numerical order, and likewise includes their energies in keV.

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INTRODUCTION

The higher energy emission and absorption x-ray wavelengths provide energy reference standards for nuclear β - and γ -ray spectroscopy. Crystallographic dimensions are usually measured with the $Mo K\alpha_1$, $Cu K\alpha_1$, and other longer x-ray wavelengths. Accurate relative values of the occupied atomic energy levels have been calculated¹ by the use of all the emission x-ray wavelengths of an element, and the absolute scale can be derived from the wavelength of the absorption edge, or more accurately from x-ray emission wavelengths, and electron energy measurements from photoionization experiments.²

Wavelength values for more than twenty-seven hundred x-ray emission lines and absorption edges have been measured and remeasured over the last fifty years. Reviewers have published many critical surveys, listing recommended values for x-ray wave-

lengths. The best known reviews are those of Siegbahn,³ Cauchois and Hulubei,⁴ and Sandström.⁵

A very serious discrepancy exists in each of these tabulations (and all others): The shorter and longer wavelengths are not on the same relative energy scale. In general wavelengths less than 1.0 \AA are consistent with a $Mo K\alpha_1 = 707.831 \text{ xu}$ scale, and those of longer wavelength with a $Cu K\alpha_1 = 1537.400 \text{ xu}$ scale. Recent higher precision measurements⁶ of the $Mo K\alpha_1$ and $Cu K\alpha_1$ wavelengths, with carefully selected diffraction crystals of various materials shows that the above values are in disagreement by almost 20 parts per million (ppm) or approximately twenty times the previous estimates⁷ of the probable error. If we assume the xu defined by the first-order grating constant of calcite ($d_1 = 3029.04 \text{ xu}$) the new measurements are consistent with a $Cu K\alpha_1$ value of 1537.400 xu . The cause of the apparent errors in the $Mo K\alpha_1$ and other short wavelengths is still unknown.

In addition to the above discrepancy in the relative values of the wavelengths, the xu,⁸ which was intended to be 10^{-8} \AA , differs from this absolute scale by more than 200 ppm. Early measurements of x-ray wavelengths were made with NaCl crystals whose grating constant $d = 2.814 \text{ \AA}$ was calculated⁹ from the crystal geometry, molecular weight, density, and Avogadro's number. The latter was evaluated from the Faraday and the oil-drop value of the electronic charge which was in error by more than 600 ppm. Siegbahn⁸ noted the superiority of calcite crystals to NaCl for spectro-

¹ M. Siegbahn, *Spektroskopie der Röntgenstrahlen* (Julius Springer-Verlag, Berlin, 1931), 2nd ed.

² Y. Cauchois and H. Hulubei, *Longueurs d'onde des Emissions X et des Discontinuités d'Absorption X* (Hermann et Cie., Paris, 1947).

³ A. E. Sandström, *Handbuch der Physik*, S. Flügge, Ed. (Springer-Verlag, Berlin, 1957), Vol. 30, p. 164.

⁴ J. A. Bearden, A. Henins, J. G. Marzolf, W. C. Sauder, and J. S. Thomsen, *Phys. Rev.* **135**, 899 (1964).

⁵ See Ref. 5, p. 161.

⁶ M. Siegbahn and A. Leide, *Phil. Mag.* **33**, 647 (1919); M. Siegbahn, *Arkiv Mat. Astron. Fys.* **14**, Nr. 9 (1920).

⁷ H. G. S. Moseley, *Phil. Mag.* **26**, 1024 (1913).

¹ J. A. Bearden and A. F. Burr, *Rev. Mod. Phys.* **39**, 125 (1967), following article.

² S. Hagström, C. Nordling, and K. Siegbahn, *Alpha-, Beta-, Gamma-ray Spectroscopy*, Kai Siegbahn, Ed. (North-Holland Publishing Co., Amsterdam, 1965), Vol. 1, p. 845.

scopic measurements, and therefore determined the ratio of their grating constants. He assumed $d_1 = 2814.00$ xu for NaCl and obtained for calcite $d_1 = 3029.04$ xu, which has been the accepted definition¹⁰ of the xu. Thus the wavelength values in all previous tables are neither self-consistent nor are on an absolute Å scale.

In practice most x-ray wavelengths have been measured relative to convenient lines whose values had been established on an x-unit scale by other experimenters. Beginning in 1960, work in the x-ray laboratory of The Johns Hopkins University was undertaken on a precise remeasurement of the most used reference lines relative to a selected primary standard¹¹ wavelength, and also on new measurements to establish the selected primary x-ray wavelength standard on an absolute Angstrom scale. A further part of the work was to make a critical review of all x-ray wavelength papers and recalculate the published values on a single absolute scale with explicitly estimated probable errors for all adopted wavelength values. In the complete report¹² on that work, original published values are listed, changes due to reevaluation of reference lines, and weighting with respect to other values is indicated and recommended wavelength values obtained. Since most of the review and analysis on the shorter wavelengths had been completed on a Mo $K\alpha_1 = 707.831$ xu reference scale before the discrepancy between the Mo $K\alpha_1$ and Cu $K\alpha_1$ wavelengths was realized, the working data in the appendices of the above report¹² was continued on a Mo $K\alpha_1 = 707.83$ or its equivalent W $K\alpha_1 = 208.5770$ xu scale. The final recommended wavelength values of that report were readjusted to a W $K\alpha_1 = 0.2090100$ Å* scale. These are the values (except for minor corrected errors and a few new wavelengths) listed in the present review.

A PRIMARY X-RAY WAVELENGTH STANDARD

Inadequacy of the Calcite xu Standard

The x unit of length introduced by Siegbahn⁸ contains one serious flaw: it assumes that every good calcite crystal has the same grating constant. This was recognized as a possible limitation by Siegbahn⁸ in 1919 and has been under intermittent criticism ever since. Double-crystal¹³ spectrometer measurements in 1930 indicated a variation of 6 ppm between different samples of the best crystals then available. A more recent investigation¹⁴ on a wider selection of clear so-called "perfect" calcites gave a variation of approximately 20 ppm. A good calcite used by Merrill and

DuMond¹⁵ gave a value of the Mo $K\alpha_1$ 25 ppm greater than the accepted value of 707.831 xu reported by Sandström.⁷

This flaw has been particularly criticized by DuMond,¹⁶ who suggested that an emission line or lines would form a much better basis for defining a unit of length than a species of crystal. He suggested the use of the Mo $K\alpha_1$ line or, alternatively, an average of five x-ray wavelengths. Bergvall¹⁷ also voiced a similar opinion and stated that the Mo $K\alpha_1$ line had indeed become the working standard at Upsala. However, recent measurements⁸ have shown that their adopted value for the Mo $K\alpha_1 = 707.831$ xu is in serious disagreement with the calcite $d_1 = 3029.04$ xu definition and also as noted above with the xu value of Cu $K\alpha_1 = 1537.400$. Thus we have two xu standards and a third, the Angstrom used in crystallography. Any attempt to redefine the xu for use as a primary standard would certainly lead to further confusion in the x-ray wavelength and crystallographic literature.

CONSIDERATIONS IN THE SELECTION OF A WAVELENGTH STANDARD

In principle any x-ray line could be chosen and assigned an arbitrary value; for example, Cu $K\alpha_1 = 1.000000$ Cu unit. Then in every calculation of the properties of matter involving knowledge of atomic dimensions, a conversion factor would be required. Since the vast majority of such calculations do not attain an accuracy better than 10 ppm, this procedure appears to be unnecessary, provided, however, an absolute wavelength standard can be defined whose wavelength in centimeters or Angstroms is known within a few ppm. Of course, for the most precise calculations, e.g., atomic constants, a conversion factor differing from unity by a few ppm will be required, and this factor will change slightly as the accuracy of absolute x-ray wavelength measurements is increased.

Wavelength Defined by Peak Intensity of Line

X-ray spectra are recorded by photographic, counter, and ionization techniques. It would appear that the asymmetry of a line would influence the measurement of its wavelengths by these different techniques. However, this was not observed in the measurements¹⁸ made on the K-series elements from titanium to germanium. Increased precision in the measuring techniques may make such effects observable, and hence only highly symmetrical lines have been considered for a wavelength standard.

¹⁰ M. Siegbahn, *Nature* **151**, 502 (1943), and Ref. 3, pp. 42-47.

¹¹ J. A. Bearden, *Phys. Rev.* **137**, 455 (1965).

¹² J. A. Bearden, *X-Ray Wavelengths*, NYO-10586 (Fed. Sci. and Tech. Inf., U.S. Dept. of Commerce, Springfield, Va., 1964).

¹³ J. A. Bearden, *Phys. Rev.* **38**, 2089 (1931).

¹⁴ J. A. Bearden, *Phys. Rev.* **137**, 181 (1964).

¹⁵ J. J. Merrill and J. W. M. DuMond, *Phys. Rev.* **110**, 84 (1958).

¹⁶ J. W. M. DuMond, *Proc. Natl. Acad. Sci. (U.S.)* **45**, 1052 (1959).

¹⁷ P. Bergvall, O. Hörnfeldt, and C. Nordling, *Arkiv Fysik* **17**, 113 (1960).

¹⁸ J. A. Bearden and C. H. Shaw, *Phys. Rev.* **48**, 18 (1935).

For a symmetrical line, it is immaterial whether the wavelength is defined by the peak (obtained by division of chords¹⁹) or the mean, i.e., centroid. In general the peak position has been accepted as the wavelength criterion for both symmetrical and asymmetrical lines, and has been so employed in all measurements in the Johns Hopkins x-ray laboratory. In the designation of a wavelength standard the peak of the line has been recommended as the most precise indicator of its wavelength. It should be noted that the use of a symmetrical line as a standard does not eliminate all problems involving different methods of measurement; a great many lines are themselves asymmetric or have been measured in terms of asymmetric lines.

Selection of a Wavelength Region

In selecting the wavelength to be used as a standard, primary consideration should be given to the researches which require the highest precision and are most affected by errors arising in making the relative measurements. The energy scale for the highly important β - and γ -ray spectrum is very dependent²⁰ on the use of short x-ray wavelengths. The most precise γ -ray measurements have been those of Knowles,²¹ who has measured the ratio of the third-order positron annihilation radiation to the first order of a γ ray of Ta¹⁸², and then compared the third order of this radiation relative to the W K α_1 line. In this work the angles were measured to the order of 0.01 sec, indicating the precision that can be attained in the measurement of narrow, symmetrical lines where the diffraction angle is only of the order of a few degrees. Another recent problem²² which required high accuracy in the short-wavelength region was the location of the lead absorption edge for use in the μ -meson mass determination. In x-ray spectroscopy, shorter wavelengths have frequently been used as reference wavelengths²³ for the measurement of weak spectral lines.

It should be emphasized that the designation of a particular wavelength as the x-ray standard does not imply that all crystals and spectrometers must be calibrated by direct comparison to this wavelength. Convenient secondary standards⁶ with probable errors of the order of 1 ppm are available which are adequate for general use. The designated primary wavelength will be of most value in the highly precise researches whose objective is the establishment of new or better secondary standards.

¹⁹ J. A. Bearden, Phys. Rev. **43**, 94 (1933).

²⁰ J. W. M. DuMond, Ann. Phys. (N.Y.) **2**, 283 (1957); E. L. Chupp, A. F. Clark, J. W. M. DuMond, F. J. Gordon, and H. Mark, Phys. Rev. **107**, 745 (1957).

²¹ J. W. Knowles, Can. J. Phys. **40**, 237 (1962). International Conference on Nuclear Physics with Reactor Neutrons (AEC) ANL-6797. F. E. Throw, Ed., p. 165.

²² A. J. Bearden, Phys. Rev. Letters **4**, 240 (1960).

²³ E. Angelstam, Nova Acta Reg. Soc. Sci., Upsala **10**, Nr. 5 (1937).

Width and Symmetry Effects

The width of a line ($E/\Delta E$) is of prime importance in the precision with which its wavelength can be measured. Gamma-ray sources, with narrow symmetrical lines (10^{-6} – 10^{-10} eV), would make ideal standards if they could be produced at an intrinsic intensity comparable to that available from x-ray tubes. The width of an x-ray line (in wavelength units) is approximately proportional to its wavelength. In recent γ -ray²¹ and x-ray⁶ measurements, the centers of the observed symmetrical line profiles were located to within 0.001 of the observed width (not, of course the natural width of the γ -ray line). Thus in principle the peak of a narrow [e.g., W K α_1 in (2, +5) is 30 sec] short-wavelength line can be located with a higher precision than its angular position can be read on the divided circle. The error in the reading of the divided circle (approximately 0.1 sec) is constant and hence its error in ppm decreases with increased Bragg angle (the precision of the interferometer angle measuring method²⁴ is 1 ppm for angles from 3° to 30°). Disregarding other considerations, this would suggest that the long-wavelength symmetrical lines (e.g., Cr K α_2) would be measured more accurately with a divided circle than the short wavelengths. However, this advantage is offset by errors in large corrections due to index of refraction and anomalous dispersion,²⁵ the effect of surface treatment on the index of refraction correction,²⁶ single-crystal diffraction pattern asymmetry,²⁷ geometrical imperfection of crystals,²⁸ and the very important shift in wavelength due to the chemical state of the x-ray tube anode. These conclusions are completely substantiated⁶ in the precision evaluation of the wavelength ratio of five x-ray lines, W K α_1 , Ag K α_1 , Mo K α_1 , Cu K α_1 , and Cr K α_2 , with five selected crystals. A least-squares analysis of the measurements showed that each of the wavelengths had been measured with a probable error of approximately 1 ppm.

Source Requirements

The x-ray wavelength should be independent of chemical and isotope effects in the source. The K α_1 lines of the elements of high atomic number are much less affected by chemical combination than those of low Z . Rogosa and Schwarz²⁹ were unable to observe any shift in the wavelength peak of the Mo K α_1 for separated isotopes of Mo⁹², Mo⁹⁶, and Mo¹⁰⁰ greater than 10 ppm. Shortly afterwards Wertheim and Igo³⁰

²⁴ J. G. Marzolf, Rev. Sci. Instr. **35**, 1212 (1964).

²⁵ See Ref. 5, p. 143.

²⁶ J. A. Bearden, Bull. Am. Phys. Soc. **7**, 339 (1962).

²⁷ M. Renninger, Acta Cryst. **13**, 1067 (1960); J. G. Marzolf, S. J., Bull. Am. Phys. Soc. **8**, 313 (1963); also thesis, Dept. of Physics, The Johns Hopkins University, 1963.

²⁸ J. A. Bearden and A. Henins, Rev. Sci. Instr. **36**, 334 (1965).

²⁹ G. L. Rogosa and G. Schwarz, Phys. Rev. **92**, 1434 (1953).

³⁰ M. S. Wertheim and G. Igo, Phys. Rev. **98**, 1 (1955).

TABLE I. Fe^{57} Mössbauer wavelength in \AA^* and keV units measured with calcite and quartz crystals.

Date	Crystals	Order	d (\AA^* 25°C)	Wavelength \AA^*	keV
12/26/63	Calcite <i>A, B</i>	(1, ± 1)	3.035528	0.860239	14.41239
2/24/64	Calcite <i>A, B</i>	(2, ± 2)	3.035835	0.860241	14.41235
2/26/64	Calcite <i>A, B</i>	(2, ± 2)	3.035835	0.860238	14.41240
8/7/64	Quartz V_a, V_{14}	(1, ± 1)	3.336009	0.860223	14.41254
8/11/64	Quartz V_a, V_{14}	(2, ± 2)	3.336412	0.860227	14.41259
			Average	0.860234	14.41247

studied the problem and showed from theory that the expected shift for $Mo K\alpha_1$ was of the order of 5 ppm, about half the minimum value detectible by Rogosa and Schwarz. The shift for $W K\alpha_1$ should be substantially greater. However, as long as "natural abundances" of the W or Mo isotopes remain constant within 1%, either line should furnish a satisfactory standard.

A high-activity concentrated γ -ray source of dimensions comparable to an x-ray focal spot yields intensities of the order of 10^4 smaller than that emitted by an x-ray tube. The use of a 200-mCi Fe^{57} Mössbauer source as a wavelength standard has been evaluated³¹ by measurement of the wavelength of the 14.4-keV Fe^{57} γ ray with calcite and quartz crystals in the (1, ± 1) and (2, ± 2) orders. The area of the source was approximately 10 mm \times 10 mm, positioned such that its projected area was approximately 2 mm \times 10 mm. The adjustment of the spectrometer on the low-intensity γ -ray line was much more difficult than in the case of an intense x-ray line. The recorded intensities at peaks ranged from approximately 0.1 counts sec^{-1} to approximately 0.6 counts sec^{-1} , requiring the utmost precaution to reduce the background to less than 0.01 counts sec^{-1} . Two independent alignments of the spectrometer crystals and γ -ray source were made. The results in the (1, ± 1) and (2, ± 2) with each crystal were in excellent agreement, but the results with the two crystals differed by approximately 20 ppm. Between the two sets of measurements, which were several months apart, the spectrometer, crystals, and source were completely realigned. The results are listed in Table I. Because of the large difference in the two sets of measurements, no probable errors are calculated.

From the experience with these measurements, it could be seen that the source strength would have to be increased by at least a factor of ten or one hundred to make a γ -ray standard experimentally feasible. Imperfections present in most crystals would also require that the source dimensions be even smaller than those used. These experimental considerations

eliminate, at least for the present, the use of a γ -ray wavelength standard.

Crystal Considerations

The index of refraction correction for all crystals used in the first diffraction order (most used in previous wavelength measurements) is of the order of 160 ppm. Very few refraction measurements have been made which are of sufficient accuracy to be the basis for precise correction of wavelengths in low orders. Theories³² are available for calculating the index of refraction, but each leads to a significantly different value. Anomalous dispersion effects²⁵ may introduce errors of the order of 20 to 30 ppm in the regions of crystal absorption edges. In establishing a primary standard or relating secondary standards to it, refraction effects seriously limit the use of crystals of high atomic number and also wavelengths greater than one or two angstroms.

The index of refraction correction is reduced by the square of the order of diffraction.³³ $W K\alpha_1$ can be easily recorded in the 5th to 7th orders with calcite or silicon crystals; the refraction correction is thus reduced to 3 to 6 ppm. An error of 10% in the measured value of the index then introduces an error in the wavelength of less than one ppm. The short wavelength of the $W K\alpha_1$ permits its use in transmission, and by proper cutting of the crystal with respect to the atomic plane such that the incident and diffracted beams make equal angles with the crystal surfaces, the index of refraction effect is zero.

Asymmetry in the Darwin-Prins²⁷ single-crystal rocking curve affects the measured x-ray wavelength to a much smaller degree than the index of refraction. Its effect is wavelength-dependent and can be neglected for low atomic weight crystals used at the shorter (e.g., $W K\alpha_1$) wavelengths.

A more serious limitation to the accuracy of x-ray wavelength measurements is due to the large scale

³¹ J. A. Bearden, Bull. Am. Phys. Soc. 9, 387 (1964).

³² H. Kallmann and H. Mark, Ann. Physik 82, 585 (1927); J. A. Prins, Z. Physik 47, 479 (1928); H. Honl, Z. Physik 84, 1 (1933); J. A. Wheeler and J. A. Bearden, Phys. Rev. 46, 755 (1934).

³³ Reference 5, p. 138.

imperfection²⁸ of all natural and most synthetic crystals. Large single crystals approaching geometrical perfection are exceedingly rare and, even in the best examples, sharply bounded volumes occur whose planes differ from the average orientation by as much as a second of arc. Since all wavelength measurements, except those made in transmission, require a rotation of the crystal by $(180^\circ \pm 2\theta)$, failure of the x-ray beam to be diffracted from exactly the same crystal volume in both positions may introduce an appreciable error in the wavelength measurement. Grinding and etching a crystal surface parallel to the atomic planes, precise alignment of the crystal parallel to and on the rotation axis of the spectrometer, and the use of a narrowly defined x-ray beam minimize this error. The present availability of good synthetic crystals of silicon alleviates many of these difficulties.

THE W $K\alpha_1$ WAVELENGTH STANDARD

A wavelength standard should possess characteristics which permit its ready redetermination in other laboratories by different techniques. Considering all of the factors involved in the selection of a wavelength standard, the W $K\alpha_1$ line is superior to any other x-ray or γ -ray wavelength. Its advantages as the x-ray wavelength standard are:

(1) In diffraction measurements with W $K\alpha_1$ in transmission, the correction for index of refraction μ is negligible (0 for equal incident and emergent angles). The anomalous dispersion correction is negligible (less than 1 ppm) at this wavelength for either reflection or transmission in crystals of low atomic number.

(2) The W $K\alpha_1$ line is highly symmetrical, and any wavelength dependence on chemical effects or variations in the natural isotopic abundance of tungsten is well below present experimental errors.

(3) The measurement of the diffraction angle for the W $K\alpha_1$ line in transmission is affected by crystal imperfections and asymmetries in the single-crystal diffraction patterns considerably less than for lines of longer wavelengths.

(4) The interferometer method²⁴ of measuring angles is ideally suited to the transmission method; the requirement of a high-precision divided circle is unnecessary.

(5) The short wavelength of the W $K\alpha_1$ can be used directly to calibrate γ -ray lines if the latter are taken in high orders. Hence nuclear energy level systems can be calibrated.

(6) By secondary standards⁶ (already determined) x-ray wavelengths and parameters of individual crystal samples can be placed on a precise scale relative to the W $K\alpha_1$ with probable errors of approximately 1 ppm.

The W $K\alpha_1$ Wavelength

In order to complete the discussion of the W $K\alpha_1$ wavelength standard, use will be made of the result

obtained in a following section on the ratio of the absolute wavelength of the Cu $K\alpha_1\alpha_2$ (and to some extent the Cr and Al $K\alpha_1\alpha_2$) lines to their xu value or $\Lambda = \lambda_o/\lambda_e = 1.002056 \times 10^{-3}$. In the section on the inadequacy of the calcite xu standard, it was pointed out that a value of Cu $K\alpha_1 = 1537.400$ xu was consistent with the calcite definition $d_1 = 3029.04$ xu. Hence the absolute wavelength of the Cu $K\alpha_1$ is

$$\text{Cu } K\alpha_1 = 1.540562 \text{ \AA} \pm 5 \text{ ppm.}$$

The precision (five crystals) measurement⁶ of the ratio of the Cu $K\alpha_1$ wavelength to the W $K\alpha_1$ gave 7.370757 ± 1.2 ppm. Dividing the Cu $K\alpha_1$ wavelength by this factor yields the wavelength in angstroms of the W $K\alpha_1$ line or

$$\lambda \text{ W } K\alpha_1 = 0.2090100 \text{ \AA} \pm 5 \text{ ppm.}$$

This numerical value of the wavelength of the W $K\alpha_1$ line is used to define the x-ray wavelength standard by the relation

$$\lambda (\text{W } K\alpha_1) = 0.2090100 \text{ \AA}^*.$$

This is a new unit of length which may differ from the angstrom by ± 5 ppm (probable error), *but as a wavelength standard it has no error*. In order to clearly indicate that this unit is not exactly an angstrom, it has been designated \AA^* and has been used for all wavelength values appearing in this review. When higher accuracy is attained in the absolute measurement of the W $K\alpha_1$ line, a conversion factor slightly different from unity will then be required for the extremely precise calculations, for example in atomic constants.

SECONDARY STANDARDS

Secondary standards of wavelength are desirable to provide suitable reference lines for various portions of the x-ray spectrum. The recent study by Bearden *et al.*⁶ was designed to establish a group of such standards to the highest precision presently attainable. This investigation consisted of a long series of high precision measurements using a spectrometer with a graduated circle calibrated by means of an angular interferometer.²⁴ The lines studied were: Cr $K\alpha_2$, Cu $K\alpha_1$, Mo $K\alpha_1$, Ag $K\alpha_1$, and W $K\alpha_1$. Five different crystals (one calcite, two quartz, two silicon) were used, some in all wavelength measurements, giving a

TABLE II. Secondary standards.

Primary standard λ W $K\alpha_1 = 0.2090100 \text{ \AA}^*$
λ Ag $K\alpha_1 = (0.5594075 \pm 1.1 \text{ or } 5.2 \text{ ppm}) \text{ \AA}^*$
λ Mo $K\alpha_1 = (0.709300 \pm 1.3 \text{ or } 5.2 \text{ ppm}) \text{ \AA}^*$
λ Cu $K\alpha_1 = (1.540562 \pm 1.3 \text{ or } 5.2 \text{ ppm}) \text{ \AA}^*$
λ Cr $K\alpha_2 = (2.293606 \pm 1.3 \text{ or } 5.2 \text{ ppm}) \text{ \AA}^*$

TABLE III. New experimental values of emission lines in Å* units. The probable error is that of the last digit. The α_1 of 47 Ag is a secondary standard.

	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb
α_2 KL_{II}	0.647404±4	0.617630±4	0.589820±4	0.563799±3	0.539422±3	0.516544±4	0.495052±3	0.474827±3
α_1 KL_{III}	0.643083±4	0.613278±4	0.585449±4	0.5594075	0.535001±3	0.512112±4	0.490599±3	0.470358±3
β_3 KM_{II}	0.573067±4	0.546200±4	0.521123±4	0.497685±4	0.574728±7	0.455185±4	0.435871±5	0.417737±4
β_1 KM_{III}	0.572482±4	0.545605±4	0.520520±4	0.497069±4	0.574106±7	0.454550±4	0.435231±5	0.417086±3
β_5 $KM_{IV,V}$				0.49306±2				
β_2 $KN_{II,III}$		0.53503±2	0.510228±4	0.487032±4	0.465319±7			
β_1 $L_{II}M_{IV}$	4.62058±3	4.37414±4	4.14622±5	3.93473±3	3.73823±4	3.55530±4		3.22567±4
γ_1 $L_{II}N_{IV}$				3.52260±4		3.16213±4		2.85159±3
α_1 $L_{III}M_V$	4.84575±3		4.36767±5	4.15443±3	3.95635±4	3.77192±4	3.59994±3	3.43940±4
$\beta_{2,15}$ $L_{III}N_{IV,V}$			3.90887±4	3.70335±3	3.51408±4	3.33838±3	3.17505±3	3.02335±3

total of twenty different combinations, each one yielding a value of λ/d . There then resulted twenty equations for nine unknown quantities (four wavelengths and five grating constants). This system of overdetermined linear equations was solved by a least-squares adjustment on an IBM 7094 computer.

The resulting wavelength values are given in Table II. Two probable errors in ppm are given; the first is relative to the $W K\alpha_1$ as the *primary standard*, and the second takes into account the probable error of ± 5 ppm in the conversion factor Λ and hence is the probable error of the wavelength in absolute angstroms. These probable errors are borne out by the internal consistency of the data in a χ^2 test.

Additional Reference Standards

It was pointed out in the Introduction that most x-ray wavelengths have been measured relative to a few conveniently located lines whose values had been determined directly. About sixty of these lines have been remeasured in order to be able to reevaluate the published values on a consistent wavelength scale. These new values are the basis on which many wavelengths have been recomputed and hence are listed for convenience in Table III.

The instrumentation and method of measurement were basically the same as in the determination of reference wavelengths.⁶ Naturally less time and effort were devoted to each individual wavelength. In most cases only one crystal was used for each line and only one or two "runs" were taken. Each run consisted of about six curves taken alternately in the $(m+n)$ and $(m-n)$ positions of the double-crystal spectrometer.

The K -series measurements were carried out with the same calcite crystal used in the previous study⁶; its grating constant was known to about 1 ppm from the least-squares computation. In the L -series work a helium atmosphere was used to minimize absorption; physical limitations of the apparatus then dictated the use of two smaller calcite crystals. These were cali-

brated against reference wavelengths and grating constants of standard crystals determined in the least-squares evaluation. The resulting grating constants for the small calcite crystals involved probable errors of about 5 ppm.

Probable errors of the measurements in the K series were determined by the statistical fluctuation of the data and by the average systematic error associated with a single series of runs; the latter was estimated as about 4 ppm. In most cases the resulting wavelength errors ranged from 6 to 8 ppm. Errors in the L -series determinations were slightly greater, due to higher statistical fluctuations and less accurately known grating constants. For the most part probable errors ranged from 8 to 10 ppm.

In many instances, these values were considered sufficiently superior to all previous measurements to be adopted without change. However, there were also numerous instances in which these results were averaged with other high-precision data to obtain a "recommended" value.

X-RAY WAVELENGTH CONVERSION FACTOR $\Lambda(\lambda_g/\lambda_e)$

Two methods have been used for determining the x-ray wavelength conversion factor: (a) the absolute wavelengths of x-ray lines have been measured with a ruled grating and divided by their known value in x units; and (b) it has also been determined by computing the absolute grating constant of crystals from their density, molecular weight, and Avogadro's number.

Two ruled-grating measurements have been made with an accuracy sufficient to be used in a precision evaluation of the conversion factor: the early measurements²⁴ on the α and β lines of Cu and Cr, and the remeasurement of the Al $K\alpha$ plates of Tyren by Edlen and Svensson.²⁵ The value of the Al $K\alpha$ line in xu was

²⁴ J. A. Bearden, Phys. Rev. **37**, 1210 (1931).

²⁵ B. Edlen and L. A. Svensson, Arkiv Fysik **28**, 427 (1965).

taken from the work of Nordfors,³⁶ who used the L lines of Ag as references. The Ag L series was, in turn measured by Haglund³⁷ with respect to the Cu $K\alpha_1$. The resulting values of Λ are shown in Table III.

Unless there is a serious error (greater than 50 ppm) in Avogadro's number as listed in a recent analysis of atomic constants,³⁸ the measurement of crystal properties affords the most accurate method of evaluating the conversion factor. There is some question as to the constancy of isotopic abundances in nature³⁹ which needs further study. Precision density and x-ray measurements⁴⁰ have been made on eighteen high-purity silicon crystals obtained from various sources. The results were highly consistent, and a careful analysis of the errors in atomic weight, isotopic abundance, density, and Avogadro's number gave a final probable error of less than 5 ppm. In another experiment⁴¹ nine selected calcite crystals were used and corrections made for the known chemical impurities in each crystal. The results were in excellent agreement with the silicon values, giving some indication that the isotopic abundance question may not be serious. Smakula *et al.*⁴² have measured the density of seven crystals, Al, CaF₂, CsI, Ge, TiCl, TiBr, and Si. Powdered samples of these were then used to measure the diffraction angles for Cu $K\alpha_1$ x rays and hence to determine Λ . Several older and less accurate measurements⁴³ have been made with Mo $K\alpha_1$ radiation and are included with the other values in Table IV.

The high-frequency limit of the continuous x-ray spectrum $Ve = h\nu$ may be rewritten

$$\Lambda = (\hbar/e)c^2/V\lambda_s \text{ \AA-kxu}^{-1},$$

where Λ is the conversion factor, \hbar/e the ratio of Planck's constant to the electronic charge, c the velocity of light, V the x-ray tube voltage, and λ_s the wavelength of the limit in xu. $V\lambda_s$ has been measured⁴⁴ using a mercury gas target x-ray tube in order to avoid solid state fine structure at the high-frequency limit. The resulting value of Λ is lower than any of the others in Table IV but there is no reason for rejecting this value or increasing its probable error.

The final recommended value from Table IV (based

on Cu $K\alpha_1 = 1537.400$ xu) is

$$\Lambda = (1.002056 \pm 0.000005) \text{ \AA-kxu}^{-1}.$$

RECOMPUTATION OF X-RAY WAVELENGTHS

Literature Data

In addition to the comparatively few measurements described above, a vast amount of other x-ray wavelength data covering a period of over forty years has been reconsidered. Most of the measurements have employed one of five experimental methods⁴⁵—the single-crystal spectrometer, the tube spectrometer, the double-crystal spectrometer, the curved-crystal spectrometer, and the ruled grating (primarily in the soft x-ray region). In general, the double-crystal and tube-spectrometer results are considered more accurate, along with a few of the curved-crystal measurements.

If one measurement seemed clearly superior to all others by a significant margin, it was adopted without change. When two or more values of comparable accuracy were available, an average was taken. Such an average can be computed on a rigorous basis in comparatively few cases. This really requires a thorough

TABLE IV. Values of Λ based on Cu $K\alpha_1 = 1.537400$ kxu. The mean value was calculated with statistical weighting and the p.e. 4 is by internal consistency.

Experiment	Λ	p.e. (ppm)
Crystal constants		
Henins ^a (Si)	1.002057	5
Bearden ^b (CaCO ₃)	1.002055	9
Smakula ^c (Al, Si, Ge, CaF ₂ , CsI, TiCl, and TiBr)	1.00207	15
Various ^a Mo $K\alpha_1\lambda$ (CaCO ₃ , Qz, C)		
	1.00205	20
Ruled grating		
Bearden ^d —plain	1.00203	30
Edlen ^e —Tyren—concave	1.002060	20
"h/e exptl."		
Spijkerman ^f	1.00201	26
Mean	1.002056	4

Note: Atomic constants needed in calculation of the above values of Λ are taken from E. R. Cohen and J. W. M. DuMond, *Rev. Mod. Phys.* **37**, 537 (1965).

^a I. Henins and J. A. Bearden, *Phys. Rev.* **135**, 890 (1964).

^b J. A. Bearden, *Phys. Rev.* **137**, 181 (1965).

^c A. Smakula and J. Kalnajs, *Nuovo Cimento Suppl.* **6**, 214 (1957); *Phys. Rev.* **99**, 1737 (1955); A. Smakula and V. Sils, *Phys. Rev.* **99**, 1744 (1955); A. Smakula, J. Kalnajs, and V. Sils, *Phys. Rev.* **99**, 1747 (1955); see also Ref. a.

^d J. A. Bearden, *Phys. Rev.* **37**, 1210 (1931).

^e B. Edlen and L. A. Svensson, *Arkiv Fysik* **28**, 427 (1965).

^f J. J. Spijkerman and J. A. Bearden, *Phys. Rev.* **134**, A871 (1964).

⁴⁵ See Ref. 5, pp. 94 to 129.

³⁶ B. Nordfors, *Arkiv Fysik* **10**, 279 (1956).

³⁷ Ph. Haglund, *Z. Physik* **94**, 369 (1935).

³⁸ E. R. Cohen and J. W. M. DuMond, *Rev. Mod. Phys.* **37**, 590 (1965).

³⁹ R. J. Allenby, *Geochim. Cosmochim. Acta* **5**, 40 (1954); K. Rankama, *Isotope Geology* (McGraw-Hill Book Co., Inc., New York, 1954), p. 272.

⁴⁰ I. Henins and J. A. Bearden, *Phys. Rev.* **135**, 890 (1964); and I. Henins, *J. Res. Natl. Bur. Std. (U.S.)* **68**, 529 (1964).

⁴¹ J. A. Bearden, *Phys. Rev.* **137**, 181 (1965).

⁴² A. Smakula and J. Kalnajs, *Nuovo Cimento Suppl.* **6**, 214 (1957); *Phys. Rev.* **99**, 1737 (1955); A. Smakula and V. Sils, *Phys. Rev.* **99**, 1744 (1955); A. Smakula, J. Kalnajs, and V. Sils, *Phys. Rev.* **99**, 1747 (1955).

⁴³ See Ref. 40, p. 897.

⁴⁴ J. J. Spijkerman and J. A. Bearden, *Phys. Rev.* **134**, 871 (1964).

discussion of both systematic and statistical errors (the latter preferably supported by detailed data on individual runs) by each of the workers involved. In addition, it is desirable to have several measurements, say four or more, so that the external consistency of the data is subject to a meaningful check; it is particularly helpful if the workers involved have all measured a whole series of lines rather than an isolated one. In such instances, one can form a weighted average with reasonable confidence. In the case of spin doublets, a check of the consistency of the doublet wavelength separation was helpful in estimating the accuracy of the measurements.

However, for the majority of measurements, the available information is less than complete. There are often just two precision measurements, both with inadequate error discussion or with error estimates which are clearly overly optimistic. In such cases one has to combine intelligent guesswork and indirect evidence. The latter may include error estimates obtained from comparison with other lines measured by a given worker in the same report, or simply from those errors normally encountered with the same general design of instrument.

Two other types of indirect evidence have been used in many instances. One is energy-level data, which give a measure of the same energy difference by an indirect series of transitions between the two levels involved. This procedure rests on a rigorous basis, although the indirect values are often less precise than the direct ones. The second method is based on the familiar Moseley diagram. Reasonably adequate data are usually available to use this approach profitably.

In a few instances directly measured values have been rejected entirely, and interpolated values, based on the same line for neighboring elements, have been adopted. Interpolated values are also given for some cases where no direct measurements have been reported.

Conventions

Wavelengths tabulated normally refer to the pure element in its solid form. However, there are many instances in which such data are not available. For example, rare gases are of necessity almost always used in the gaseous form, while the rare-earth elements were customarily used in the form of salts. In many instances the data are sufficiently crude or the particular lines are so insensitive to chemical effects that the distinction becomes of no practical importance.

In high precision work there is some ambiguity as to exactly what feature of a line profile should be taken to be the "true wavelength." In double-crystal work the line peak is usually employed. In crystallography the centroid is widely used; in photographic work with visual observation of the plates, there is involved some subjective criterion of the observer which it is difficult to define precisely. In this survey the peak of

the line profile has been adopted as the standard criterion. This is one reason for giving preference to double-crystal values in most cases. Of course for the majority of lines the data are not sufficiently precise and well-defined to make the distinction between the various criteria at all meaningful.

The above criterion has been followed as consistently as possible even in the case of rather broad emission bands. In cases where the peak value could not be established with any degree of certainty, a value near the center of the band has been chosen and assigned a rather large probable error. In such cases the peak is usually not the best-defined feature of the band. The short-wavelength limit is often much sharper and more reproducible. In such cases the original experimental paper should be consulted to obtain a better-detailed picture of the band structure.

Errors

Previously published x-ray wavelength tables have usually not included any error estimates, except as these were implied by the number of significant figures stated. However, in order to give the maximum information on any experimentally determined quantity, it should be accompanied by a statement of estimated error. Hence it has been decided to list a probable error with each emission line in the accompanying tables.

The error criterion used is that of *probable error*. This term must emphatically not be misinterpreted as a limit of error. It is merely a rather crude estimate such that, in the judgment of the author, roughly half the true wavelength values lie within the assigned errors. In most cases there is no implication of a Gaussian error distribution. In particular, the probability of large deviations may be substantially greater than implied by Gaussian distributions; for example, it is likely that the chance of a discrepancy exceeding five probable errors is substantially greater than one in a thousand. As mentioned in the preceding section, there are a few instances in which experimental errors are fully discussed in the papers involved and in which there are a sufficient number of measurements by different workers to obtain a good check by external consistency. In such cases a probable error can be assigned on a reasonably rigorous basis. The greater majority of cases fall short of this ideal. However, it was considered more desirable to estimate probable errors and risk some serious mistakes in judgment than to omit this important information entirely.

WAVELENGTH TABLES V AND VI

In Table V all the emission lines of an element are listed under the element heading. The line and level designation are shown in the first column. The wavelengths in the second column are in \AA^* units (i.e., relative to the primary x-ray wavelength standard

TABLE V. X-ray wavelengths in Å* units and in keV. The probable error (p.e.) is the error in the last digit of wavelength. Designation indicates both conventional Siegbahn notation (if applicable) and transition, e.g., $\beta_1 L_{III}M_{IV}$ denotes a transition between the L_{III} and M_{IV} levels, which is the $L\beta_1$ line in Siegbahn notation.

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV		
3 Lithium				4 Beryllium				19 Potassium (Cont.)				20 Calcium (Cont.)			
αKL	228.	1	0.0543	114.	1	0.1085	$\eta L_{II}M_I$	47.24	2	0.2625	40.46	2	0.3064		
5 Boron				6 Carbon				β_1			35.94	2	0.3449		
αKL	67.6	3	0.1833	44.7	3	0.277	$l L_{III}M_I$	47.74	1	0.25971	40.96	2	0.3027		
7 Nitrogen				8 Oxygen				$\alpha_{1,2} L_{III}M_{IV,V}$			36.33	2	0.3413		
αKL	31.6	4	0.3924	23.62	3	0.5249	$M_{II,III}N_I$	692	9	0.0179	525.	9	0.0236		
9 Fluorine				10 Neon				21 Scandium				22 Titanium			
$\alpha_{1,2} KL_{II,III}$	18.32	2	0.6768	14.610	3	0.8486	$\alpha_2 KL_{II}$	3.0342	1	4.0861	2.75216	2	4.50486		
βKM				14.452	5	0.8579	$\alpha_1 KL_{III}$	3.0309†	1	4.0906	2.74851	2	4.51084		
11 Sodium				12 Magnesium				$\beta_{1,2} KM_{II,III}$	2.7796	2	4.4605	2.51391	2	4.93181	
$\alpha_{1,2} KL_{II,III}$	11.9101	9	1.0410	9.8900	2	1.25360	$\beta_3 KM_{IV,V}$	2.7634	3	4.4865	2.4985	2	4.9623		
βKM	11.575	2	1.0711	9.521	2	1.3022	$\eta L_{II}M_I$	35.13	2	0.3529	30.89	3	0.4013		
$L_{II,III}M$	407.1	5	0.03045	251.5	5	0.0493	$\beta_1 L_{II}M_{IV}$	31.02	2	0.3996	27.05	2	0.4584		
$L_1L_{II,III}$	376	1	0.0330	317	1	0.0392	$l L_{III}M_I$	35.59	3	0.3483	31.36	2	0.3953		
13 Aluminum				14 Silicon				$\alpha_{1,2} L_{III}M_{IV,V}$	31.35	3	0.3954	27.42	2	0.4522	
$\alpha_2 KL_{II}$	8.34173	9	1.48627	7.12791	9	1.73938	23 Vanadium				24 Chromium				
$\alpha_1 KL_{II}$	8.33934	9	1.48670	7.12542	9	1.73998	$\alpha_2 KL_{II}$	2.50738	2	4.94464	2.293606	3	5.40551		
βKM	7.960	2	1.5574	6.753	1	1.8359	$\alpha_1 KL_{III}$	2.50356	2	4.95220	2.28970	2	5.41472		
$L_{II,III}$	171.4	5	0.0724	135.5	4	0.0915	$\beta_{1,2} KM_{II,III}$	2.28440	2	5.42729	2.08487	2	5.94671		
$L_1L_{II,III}$	290.	1	0.0428				$\beta_3 KM_{IV,V}$	2.26951	6	5.4629	2.07087	6	5.9869		
15 Phosphorus				16 Sulfur				$\beta_{3,4} L_1M_{II,III}$	21.19†	9	0.585	18.96	2	0.654	
$\alpha_2 KL_{II}$	6.160†	1	2.0127	5.37496	8	2.30664	$\eta L_{II}M_I$	27.34	3	0.4535	24.30	3	0.5102		
$\alpha_1 KL_{II}$	6.157†	1	2.0137	5.37216	7	2.30784	$\beta_1 L_{II}M_{IV}$	23.88	4	0.5192	21.27	1	0.5828		
βKM	5.796	2	2.1390				$l L_{III}M_I$	27.77	1	0.4465	24.78	1	0.5003		
$\beta_1 KM$				5.0316	2	2.4640	$\alpha_{1,2} L_{III}M_{IV,V}$	24.25	3	0.5113	21.64	3	0.5728		
$\beta_2 KM$				5.0233	3	2.4681	$M_{II,III}M_{IV,V}$	337.	9	0.037	309.	9	0.040		
$L_{II,III}M$	103.8	4	0.1194				25 Manganese				26 Iron				
$l, \eta L_{II,III}M_I$				83.4	3	0.1487	$\alpha_2 KL_{II}$	2.10578	2	5.88765	1.939980	9	6.39084		
17 Chlorine				18 Argon				$\alpha_1 KL_{III}$	2.101820	9	5.89875	1.936042	9	6.40384	
$\alpha_2 KL_{II}$	4.7307	1	2.62078	4.19474	5	2.95563	$\beta_{1,2} KM_{II,III}$	1.91021	2	6.49045	1.75661	2	7.05798		
$\alpha_1 KL_{II}$	4.7278	1	2.62239	4.19180	5	2.95770	$\beta_3 KM_{IV,V}$	1.8971	1	6.5352	1.7442	1	7.1081		
βKM	4.4034	3	2.8156				$\beta_{3,4} L_1M_{II,III}$	17.19	2	0.721	15.65	2	0.792		
$\beta_{1,2} KM_{II,III}$				3.8860	2	3.1905	$\eta L_{II}M_I$	21.85	2	0.5675	19.75	4	0.628		
$\eta L_{II}M_I$	67.33	9	0.1841	55.9†	1	0.2217	$\beta_1 L_{II}M_{IV}$	19.11	2	0.6488	17.26	1	0.7185		
$l L_{III}M_I$	67.90	9	0.1826	56.3†	1	0.2201	$l L_{III}M_I$	22.29	1	0.5563	20.15	1	0.6152		
19 Potassium				20 Calcium				$\alpha_{1,2} L_{III}M_{IV,V}$	19.45	1	0.6374	17.59	2	0.7050	
$\alpha_2 KL_{II}$	3.7445	2	3.3111	3.36166	3	3.68809	$M_{II,III}M_{IV,V}$	273.	6	0.045	243.	5	0.051		
$\alpha_1 KL_{II}$	3.7414	2	3.3138	3.35839	3	3.69168	27 Cobalt				28 Nickel				
$\beta_{1,2} KM_{II,III}$	3.4539	2	3.5896	3.0897	2	4.0127	$\alpha_2 KL_{II}$	1.792850	9	6.91530	1.661747	8	7.46089		
$\beta_3 KM_{IV,V}$	3.4413	4	3.6027	3.0746	3	4.0325	$\alpha_1 KL_{III}$	1.788965	9	6.93032	1.657910	8	7.47815		
								$\beta_{1,2} KM_{II,III}$	1.62079	2	7.64943	1.500135	8	8.26466	
								$\beta_3 KM_{IV,V}$	1.60891	3	7.7059	1.48862	4	8.3286	
								$\beta_{3,4} L_1M_{II,III}$	14.31	3	0.870	13.18	1	0.941	
								$\eta L_{II}M_I$	17.87	3	0.694	16.27	3	0.762	
								$\beta_1 L_{II}M_{IV}$	15.666	8	0.7914	14.271	6	0.8688	
								$l L_{III}M_I$	18.292	8	0.6778	16.693	9	0.7427	
								$\alpha_{1,2} L_{III}M_{IV,V}$	15.972	6	0.7762	14.561	3	0.8515	
								$M_{II,III}M_{IV,V}$	214.	6	0.058	190.	2	0.0651	

TABLE V (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV										
29 Copper						30 Zinc						35 Bromine (Cont.)						36 Krypton (Cont.)					
$\alpha_2 KL_{II}$	1.544390	2	8.02783	1.439000	8	8.61578	$\beta_{3,4} L_{II}M_{II,III}$	7.767 [†]	9	1.596													
$\alpha_1 KL_{III}$	1.540562	2	8.04778	1.435155	7	8.63886	$\eta L_{II}M_{II}$	9.255	1	1.3396													
$\beta_2 KM_{II}$	1.3926	1	8.9029				$\beta_1 L_{II}M_{IV}$	8.1251	5	1.52590			7.576 [†] 3 1.6366										
$\beta_{1,2} KM_{II,III}$	1.392218	9	8.90529	1.29525	2	9.5720	γ_5						7.279 5 1.703										
$\beta_2 KN_{II,III}$				1.28372	2	9.6580	$\downarrow L_{III}M_{II}$	9.585	1	1.2935													
$\beta_5 KM_{IV,V}$	1.38109	3	8.9770	1.2848	1	9.6501	$\alpha_{1,2} L_{III}M_{IV,V}$	8.3746	5	1.48043			7.817 [†] 3 1.5860										
$\beta_{3,4} L_{II}M_{II,III}$	12.122	8	1.0228	11.200	7	1.1070	β_6						7.510 4 1.6510										
$\eta L_{II}M_{II}$	14.90	2	0.832	13.68	2	0.906	$L_{II}N_{III}$						7.250 5 1.710										
$\beta_1 L_{II}M_{IV}$	13.053	3	0.9498	11.983	3	1.0347	$M_{II}M_{II}$	184.6	3	0.0672													
$\downarrow L_{III}M_{II}$	15.286	9	0.8111	14.02	2	0.884	$M_{II}M_{III}$	164.7	3	0.0753													
$\alpha_{1,2} L_{III}M_{IV,V}$	13.336	3	0.9297	12.254	3	1.0117	$M_{III}M_{IV}$	109.4	3	0.1133													
$M_{II,III}M_{IV,V}$	173.	3	0.072	157.	3	0.079	$M_{II}N_{II}$	76.9	2	0.1613													
31 Gallium						32 Germanium						$M_{III}M_{IV,V}$											
							$\zeta_2 M_{IV}N_{II}$	79.8	3	0.1554													
							$\zeta_2 M_{IV}N_{II}$	191.1	2	0.06488													
							$M_{IV}N_{III}$	189.5	3	0.0654													
							$\zeta_1 M_{IV}N_{III}$	192.6	2	0.06437													
							37 Rubidium						38 Strontium										
$\alpha_2 KL_{II}$	1.34399	1	9.22482	1.258011	9	9.85532	$\alpha_2 KL_{II}$	0.92969	1	13.3358	0.87943	1	14.0979										
$\alpha_1 KL_{III}$	1.340083	9	9.25174	1.254054	9	9.88642	$\alpha_1 KL_{III}$	0.925553	9	13.3953	0.87526	1	14.1650										
$\beta_2 KM_{II}$	1.20835	5	10.2603	1.12936	9	10.9780	$\beta_2 KM_{II}$	0.82921	3	14.9517	0.78345	3	15.8249										
$\beta_1 KM_{III}$	1.20789	2	10.2642	1.12894	2	10.9821	$\beta_1 KM_{III}$	0.82868	2	14.9613	0.78292	2	15.8357										
$\beta_2 KN_{II,III}$	1.19600	2	10.3663	1.11686	2	11.1008	$\beta_2 KN_{II,III}$	0.81645	3	15.1854	0.77081	3	16.0846										
$\beta_5 KM_{IV,V}$	1.1981	2	10.348	1.1195	1	11.0745	$\beta_5 KM_{IV,V}$	0.8219	1	15.085	0.7764	1	15.969										
$\beta_4 L_{II}M_{II}$				9.640	2	1.2861	$\beta_4 KN_{IV,V}$	0.8154	2	15.205	0.76989	5	16.104										
$\beta_3 L_{II}M_{III}$				9.581	2	1.2941	$\beta_1 L_{II}M_{II}$	6.8207	3	1.81771	6.4026	3	1.93643										
$\beta_{3,4} L_{II}M_{II,III}$	10.359 [†]	8	1.197				$\beta_2 L_{II}M_{III}$	6.7876	3	1.82659	6.3672	3	1.94719										
$\eta L_{II}M_{II}$	12.597	2	0.9842	11.609	2	1.0680	$\gamma_{2,3} L_{II}N_{II,III}$	6.0458	3	2.0507	5.6445	3	2.1965										
$\beta_1 L_{II}M_{IV}$	11.023	2	1.1248	10.175	1	1.2185	$\eta L_{II}M_{II}$	8.0415	4	1.54177	7.5171	3	1.64933										
$\downarrow L_{III}M_{II}$	12.953	2	0.9572	11.965	4	1.0362	$\beta_1 L_{II}M_{IV}$	7.0759	3	1.75217	6.6239	3	1.87172										
$\alpha_{1,2} L_{III}M_{IV,V}$	11.292	1	1.09792	10.4361	8	1.18800	$\gamma_5 L_{II}N_{IV}$	6.7553	3	1.83532	6.2961	3	1.96916										
33 Arsenic						34 Selenium						$\downarrow L_{III}M_{II}$											
							$\alpha_2 L_{III}M_{IV}$	7.3251	3	1.69256	6.8697	3	1.80474										
							$\alpha_1 L_{III}M_{IV}$	7.3183	2	1.69413	6.8628	2	1.80656										
							$\beta_0 L_{III}N_{II}$	6.9842	3	1.77517	6.5191	3	1.90181										
							$M_{II}M_{III}$	144.4	3	0.0859													
							$M_{II}M_{IV}$	91.5	2	0.1355	85.7	2	0.1447										
							$M_{III}N_{II}$	57.0	2	0.2174	51.3	1	0.2416										
							$M_{III}M_{IV,V}$	96.7	2	0.1282	91.4	2	0.1357										
							$M_{III}N_{II}$	59.5	2	0.2083	53.6	1	0.2313										
							$\zeta_2 M_{IV}N_{II}$	127.8	2	0.0970													
							$M_{IV}N_{III}$	126.8	2	0.0978													
							$\zeta_2 M_{IV}N_{II,III}$				108.0	2	0.1148										
							$\zeta_1 M_{IV}N_{III}$	128.7	2	0.0964	108.7	1	0.1140										
							39 Yttrium						40 Zirconium										
							$\alpha_2 KL_{II}$	0.83305	1	14.8829	0.79015	1	15.6909										
							$\alpha_1 KL_{III}$	0.82884	1	14.9584	0.78593	1	15.7751										
							$\beta_2 KM_{II}$	0.74126	3	16.7258	0.70228	4	17.654										
							$\beta_1 KM_{III}$	0.74072	2	16.7378	0.70173	3	17.6678										
							$\beta_2 KN_{II,III}$	0.72864	4	17.0154	0.68993	4	17.970										
							$\beta_5 KM_{IV,V}$	0.7345	1	16.879	0.6959	1	17.815										
							35 Bromine						36 Krypton										
							$\alpha_2 KL_{II}$	1.04382	2	11.8776	0.9841	1	12.598										
							$\alpha_1 KL_{III}$	1.03974	2	11.9242	0.9801	1	12.649										
							$\beta_2 KM_{II}$	0.93327	5	13.2845	0.8790	1	14.104										
							$\beta_1 KM_{III}$	0.93279	2	13.2914	0.8785	1	14.112										
							$\beta_2 KN_{II,III}$	0.92046	2	13.4695	0.8661	1	14.315										
							$\beta_5 KM_{IV,V}$	0.9255	1	13.396	0.8708	2	14.238										
							$\beta_4 KN_{IV,V}$				0.8653	2	14.328										
							$\beta_4 L_{II}M_{II}$				7.304	5	1.697										
							$\beta_3 L_{II}M_{III}$				7.264	5	1.707										

TABLE V (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV						
39 Yttrium (Cont.)						40 Zirconium (Cont.)						43 Technetium				44 Ruthenium			
$\beta_4 KN_{IV,V}$	0.72776	5	17.036	0.68901	5	17.994	$\alpha_2 KL_{II}$	0.67932 [†]	3	18.2508	0.647408	5	19.1504						
$\beta_4 L_1M_{II}$	6.0186	3	2.0600	5.6681	3	2.1873	$\alpha_1 KL_{III}$	0.67502 [†]	3	18.3671	0.643083	4	19.2792						
$\beta_3 L_1M_{III}$	5.9832	3	2.0722	5.6330	3	2.2010	$\beta_3 KM_{II}$	0.60188 [†]	4	20.599	0.573067	4	21.6346						
$\gamma_{2,3} L_1N_{II,III}$	5.2830	3	2.3468	4.9536	3	2.5029	$\beta_1 KM_{III}$	0.60130 [†]	4	20.619	0.572482	4	21.6568						
ηL_1M_1	7.0406	3	1.76095	6.6069	3	1.87654	$\beta_2 KN_{II,III}$	0.59024 [†]	5	21.005	0.56166	3	22.074						
$\beta_1 L_{III}M_{IV}$	6.2120	3	1.99584	5.8360	3	2.1244	$\beta_5^{II} KM_{IV}$				0.5680	2	21.829						
$\gamma_6 L_{II}N_1$	5.8754	3	2.1102	5.4977	3	2.2551	$\beta_5^I KM_V$				0.56785	9	21.834						
$\gamma_1 L_{II}N_{IV}$				5.3843	3	2.3027	β_4				0.56089	9	22.104						
$l L_{III}M_1$	7.3563	3	1.68536	6.9185	3	1.79201	$\beta_4 L_{II}M_{IV}$				4.5230	2	2.7411						
$\alpha_2 L_{III}M_{IV}$	6.4558	3	1.92047	6.0778	3	2.0399	$\beta_2 L_1M_{III}$				4.4866	3	2.7634						
$\alpha_1 L_{III}M_V$	6.4488	2	1.92256	6.0705	2	2.04236	$\gamma_{2,3} L_1N_{II,III}$				3.8977	2	3.1809						
$\beta_3 L_{III}N_1$	6.0942	3	2.0344	5.7101	3	2.1712	$\eta L_{II}M_1$				5.2050	2	2.38197						
$\beta_{2,15}$				5.5863	3	2.2194	$\beta_1 L_{II}M_{IV}$	4.8873 [†]	8	2.5368	4.62058	3	2.68323						
$M_{II}M_{IV}$	81.5	2	0.1522	76.7	2	0.1617	$\gamma_6 L_{II}N_1$				4.2873	2	2.8918						
$M_{II}N_1$	46.48	9	0.267				$\gamma_1 L_{II}N_{IV}$				4.1822	2	2.9645						
$M_{III}M_V$				80.9	3	0.1533	$l L_{III}M_1$				5.5035	3	2.2528						
$M_{III}N_1$	48.5	2	0.256				$\alpha_2 L_{III}M_{IV}$				4.85381	7	2.55431						
$M_{III}M_{IV,V}$	86.5	2	0.1434				$\alpha_1 L_{III}M_V$	5.1148 [†]	3	2.4240	4.84575	5	2.55855						
$\zeta M_{IV,V}N_{II,III}$	93.4	2	0.1328	82.1	2	0.1511	$\beta_3 L_{III}N_1$				4.4866	3	2.7634						
$M_{IV,V}O_{II,III}$				70.0	4	0.177	$\beta_{2,15} L_{III}N_{IV,V}$				4.3718	2	2.8360						
							$M_{II}M_{IV}$				62.2	1	0.1992						
							$M_{II}N_1$				32.3	2	0.384						
							$M_{II}N_{IV}$				25.50	9	0.486						
							$M_{III}M_V$				68.3	1	0.1814						
							$\gamma M_{III}N_{IV,V}$				26.9	1	0.462						
							$\zeta M_{IV,V}N_{II,III}$				52.34	7	0.2369						
							$M_{IV,V}O_{II,III}$				44.8	1	0.2768						
41 Niobium						42 Molybdenum						45 Rhodium				46 Palladium			
$\alpha_2 KL_{II}$	0.75044	1	16.5210	0.713590	6	17.3743	$\alpha_2 KL_{II}$	0.617630	4	20.0737	0.589821	3	21.0201						
$\alpha_1 KL_{III}$	0.74620	1	16.6151	0.709300	1	17.47934	$\alpha_1 KL_{III}$	0.613279	4	20.2161	0.585448	3	21.1771						
$\beta_2 KM_{II}$	0.66634	3	18.6063	0.632872	9	19.5903	$\beta_3 KM_{II}$	0.546200	4	22.6989	0.521123	4	23.7911						
$\beta_1 KM_{III}$	0.66576	2	18.6225	0.632288	9	19.6083	$\beta_1 KM_{III}$	0.545605	4	22.7236	0.520520	4	23.8187						
β_2^{II}				0.62107	5	19.963	$\beta_2^{II} KN_{II}$	0.53513	5	23.168									
$\beta_2 KN_{II,III}$	0.65416	4	18.953	0.62099	2	19.9652	$\beta_2 KN_{II,III}$	0.53503	2	23.1728	0.510228	4	24.2991						
$\beta_4 KN_{IV,V}$	0.65318	5	18.981				$\beta_5^{II} KM_{IV}$	0.54118	9	22.909									
$\beta_5^{II} KM_{IV}$				0.62708	5	19.771	$\beta_5^I KM_V$	0.54101	9	22.917									
$\beta_5^I KM_V$				0.62692	5	19.776	$\beta_4 KN_{IV,V}$	0.53401	9	23.217	0.5093	2	24.346						
$\beta_4 KN_{IV,V}$				0.62001	9	19.996	$\beta_5 KM_{IV,V}$				0.51670	9	23.995						
$\beta_4 L_1M_{II}$	5.3455	3	2.3194	5.0488	3	2.4557	$\beta_4 L_1M_{II}$	4.2888	2	2.8908	4.0711	2	3.0454						
$\beta_3 L_1M_{III}$	5.3102	3	2.3348	5.0133	3	2.4730	$\beta_2 L_1M_{III}$	4.2522	2	2.9157	4.0346	2	3.0730						
$\gamma_{2,3} L_1N_{II,III}$	4.6542	2	2.6638	4.3800	2	2.8306	$\gamma_{2,3} L_1N_{II,III}$	3.6855	2	3.3640	3.4892	2	3.5533						
$\eta L_{II}M_1$	6.2109	3	1.99620	5.8475	3	2.1202	$\eta L_{II}M_1$	4.9217	2	2.5191	4.6605	2	2.6603						
$\beta_1 L_{II}M_{IV}$	5.4923	3	2.2574	5.17708	8	2.39481	$\beta_1 L_{II}M_{IV}$	4.37414	4	2.83441	4.14622	5	2.99022						
$\gamma_6 L_{II}N_1$	5.1517	3	2.4066	4.8369	2	2.5632	$\gamma_6 L_{II}N_1$	4.0451	2	3.0650	3.8222	2	3.2437						
$\gamma_1 L_{II}N_{IV}$	5.0361	3	2.4618	4.7258	2	2.6235	$\gamma_1 L_{II}N_{IV}$	3.9437	2	3.1438	3.7246	2	3.3287						
$l L_{III}M_1$	6.5176	3	1.90225	6.1508	3	2.01568	$l L_{III}M_1$	5.2169	3	2.3765	4.9525	3	2.5034						
$\alpha_2 L_{III}M_{IV}$	5.7349	3	2.1630	5.41437	8	2.28985	$\alpha_2 L_{III}M_{IV}$	4.60545	9	2.69205	4.37588	7	2.83329						
$\alpha_1 L_{III}M_V$	5.7243	2	2.16589	5.40655	8	2.29316	$\alpha_1 L_{III}M_V$	4.59743	9	2.69674	4.36767	5	2.83861						
$\beta_3 L_{III}N_1$	5.3613	3	2.3125	5.0488	5	2.4557	$\beta_3 L_{III}N_1$	4.2417	2	2.9229	4.0162	2	3.0870						
$\beta_{2,15} L_{III}N_{IV,V}$	5.2379	3	2.3670	4.9232	2	2.5183	$\beta_{2,15} L_{III}N_{IV,V}$	4.1310	2	3.0013	3.90887	4	3.17179						
$M_{II}M_{IV}$	72.1	3	0.1718	68.9	2	0.1798	$\beta_{10} L_1M_{IV}$				3.7988	2	3.2637						
$M_{II}N_1$	38.4	3	0.323	35.3	3	0.351													
$M_{II}N_{IV}$	33.1	2	0.375																
$M_{III}M_V$	78.4	2	0.1582	74.9	1	0.1656													
$M_{III}N_1$	40.7	2	0.305	37.5	2	0.331													
$\gamma M_{III}N_{IV,V}$	34.9	2	0.356																
$\zeta M_{IV,V}N_{II,III}$	72.19	9	0.1717	64.38	7	0.1926													
$M_{IV,V}O_{II,III}$	61.9	2	0.2002	54.8	2	0.2262													

TABLE V (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV		
45 Rhodium (Cont.)				46 Palladium (Cont.)				49 Indium (Cont.)				50 Tin (Cont.)			
$\beta_3 L_2M_V$				3.7920	2	3.2696	$\beta_1 KM_{III}$	0.454545	4	27.2759	0.435236	5	28.4860		
$M_{II}N_{II,III}$				20.1	2	0.616	$\beta_2 KN_{II,III}$	0.44500	1	27.8608	0.425915	8	29.1093		
$M_{II}M_{IV}$	59.3	1	0.2090	56.5	1	0.2194	$KO_{II,III}$	0.44374	3	27.940	0.42467	3	29.195		
$M_{II}N_I$	28.1	2	0.442	26.2	2	0.474	$\beta_2^{II} KM_{IV}$	0.45098	2	27.491	0.43184	3	28.710		
$M_{II}N_{IV}$				22.1	1	0.560	$\beta_2^I KM_V$	0.45086	2	27.499	0.43175	3	28.716		
$M_{II}M_V$	65.5	1	0.1892	62.9	1	0.1970	$\beta_2 KN_{IV,V}$	0.44393	4	27.928	0.42495	3	29.175		
$M_{II}^I N_I$	29.8	1	0.417	27.9	1	0.445	$\beta_2 L_2M_{II}$	3.50697	9	3.5353	3.34335	9	3.7083		
$\gamma M_{III}N_{IV,V}$	25.01	9	0.496	23.3 [†]	1	0.531	$\beta_2 L_2M_{III}$	3.46984	9	3.5731	3.30585	3	3.7500		
$\zeta M_{IV,V}N_{II,III}$	47.67	9	0.2601	43.6	1	0.2844	$\gamma_{2,3} L_2N_{II,III}$	2.9800	2	4.1605	2.8327	2	4.3768		
$M_{IV,V}O_{II,III}$	40.9	2	0.303	37.4	2	0.332	$\gamma_4 L_2O_{II,III}$	2.9264	2	4.2367	2.7775	2	4.4638		
							$\eta L_{II}M_I$	3.98327	9	3.11254	3.78876	9	3.27234		
47 Silver				48 Cadmium				$\beta_1 L_{II}M_{IV}$	3.55531	4	3.48721	3.38487	3	3.66280	
$\alpha_2 KL_{II}$	0.563798	4	21.9903	0.539422	3	22.9841	$\gamma_6 L_{II}N_I$	3.24907	9	3.8159	3.08475	9	4.0192		
$\alpha_1 KL_{III}$	0.5594075	6	22.16292	0.535010	3	23.1736	$\gamma_7 L_{II}N_{IV}$	3.16213	4	3.92081	3.00115	3	4.13112		
$\beta_3 KM_{II}$	0.497685	4	24.9115	0.475730	5	26.0612	$l L_{III}M_I$	4.26873	9	2.90440	4.07165	9	3.04499		
$\beta_1 KM_{III}$	0.497069	4	24.9424	0.475105	6	26.0955	$\alpha_2 L_{III}M_{IV}$	3.78073	6	3.27929	3.60891	4	3.43542		
$\beta_2 KN_{II,III}$	0.487032	4	25.4564	0.465328	7	26.6438	$\alpha_1 L_{III}M_V$	3.77192	4	3.28694	3.59994	3	3.44398		
$\beta_5 KM_{IV,V}$	0.49306	2	25.145				$\beta_2 L_{III}N_I$	3.43606	9	3.60823	3.26901	9	3.7926		
$\beta_4 KN_{IV,V}$	0.48598	3	25.512				$\beta_{2,15} L_{III}N_{IV,V}$	3.33838	3	3.71381	3.17505	3	3.90486		
$\beta_4 L_1M_{II}$	3.87023	5	3.20346	3.68203	9	3.36719	$\beta_7 L_{III}O_I$	3.324	4	3.730	3.1564	3	3.9279		
$\beta_3 L_1M_{III}$	3.83313	9	3.23446	3.64495	9	3.40145	$\beta_{10} L_1M_{IV}$	3.27404	9	3.7868	3.12170	9	3.9716		
$\gamma_2 L_2N_{II}$	3.31216	9	3.7432	3.1377	2	3.9513	$\beta_9 L_1M_V$	3.26763	9	3.7942	3.11513	9	3.9800		
$\gamma_2 L_2N_{III}$	3.30635	9	3.7498				$M_{II}M_{IV}$				47.3	1	0.2621		
$\eta L_{II}M_I$	4.4183	2	2.8061	4.19315	9	2.95675	$M_{II}N_I$				20.0	1	0.619		
$\beta_1 L_2M_{IV}$	3.93473	3	3.15094	3.73823	4	3.31657	$M_{II}N_{IV}$				16.93	5	0.733		
$\gamma_8 L_{II}N_I$	3.61638	9	3.42832	3.42551	9	3.61935	$M_{III}M_V$				54.2	1	0.2287		
$\gamma_1 L_{III}N_{IV}$	3.52260	4	3.51959	3.33564	6	3.71686	$M_{III}N_I$				21.5	1	0.575		
$l L_{III}M_I$	4.7076	2	2.6337	4.48014	9	2.76735	$\gamma M_{III}N_{IV,V}$				17.94	5	0.691		
$\alpha_2 L_{III}M_{IV}$	4.16294	5	2.97821	3.96496	6	3.12691	$M_{IV}O_{II,III}$				25.3	1	0.491		
$\alpha_1 L_{III}M_V$	4.15443	3	2.98431	3.95635	4	3.13373	$\zeta M_{IV,V}N_{II,III}$				31.24	9	0.397		
$\beta_6 L_{III}N_I$	3.80774	9	3.25603	3.61467	9	3.42994	M_VO_{III}				25.7	1	0.483		
$\beta_{2,16} L_{III}N_{IV,V}$	3.70335	3	3.34781	3.51408	4	3.52812									
$\beta_{10} L_1M_{IV}$	3.61158	9	3.43287	3.4367	2	3.6075	51 Antimony				52 Tellurium				
$\beta_9 L_1M_V$	3.60497	9	3.43917	3.43015	9	3.61445	$\alpha_2 KL_{II}$	0.474827	3	26.1108	0.455784	3	27.2017		
$M_{II}N_{II,III}$	18.8	2	0.658				$\alpha_1 KL_{III}$	0.470354	3	26.3591	0.451295	3	27.4723		
$M_{II}M_{IV}$	54.0	1	0.2295	52.0	2	0.2384	$\beta_2 KM_{II}$	0.417737	4	29.6792	0.400659	4	30.9443		
$M_{II}N_I$				22.9	2	0.540	$\beta_1 KM_{III}$	0.417085	3	29.7256	0.399995	5	30.9957		
$M_{II}N_{IV}$	20.66	7	0.600	19.40	7	0.639	$\beta_2 KN_{II,III}$	0.407973	5	30.3895	0.391102	6	31.7004		
$M_{III}M_V$	60.5	1	0.2048	58.7	2	0.2111	$KO_{II,III}$	0.40666	1	30.4875	0.38974	1	31.8114		
$M_{III}N_I$	26.0	1	0.478	24.5	1	0.507	$\beta_2^{II} KM_{IV}$	0.41388	1	29.9560					
$\gamma M_{III}N_{IV,V}$	21.82	7	0.568	20.47	7	0.606	$\beta_2^I KM_V$	0.41378	1	29.9632					
$M_{IV}O_{II,III}$				30.4	1	0.408	$\beta_2 KN_{IV,V}$	0.40702	1	30.4604					
$\zeta M_{IV,V}N_{II,III}$	39.77	7	0.3117	36.8	1	0.3371	$\beta_2 L_1M_{II}$	3.19014	9	3.8864	3.04661	9	4.0695		
M_VN_I	24.4	2	0.509				$\beta_2 L_1M_{III}$	3.15258	9	3.9327	3.00893	9	4.1204		
M_VO_{III}				30.8	1	0.403	$\gamma_{2,3} L_1N_{II,III}$	2.6953	2	4.5999	2.5674	2	4.8290		
$M_{IV,V}O_{II,III}$	33.5	3	0.370				$\gamma_4 L_1O_{II,III}$	2.6398	2	4.6967	2.5113	2	4.9369		
49 Indium				50 Tin				$\eta L_{II}M_I$	3.60765	9	3.43661	3.43832	9	3.60586	
$\alpha_2 KL_{II}$	0.516544	3	24.0020	0.495053	3	25.0440	$\beta_1 L_{II}M_{IV}$	3.22567	4	3.84357	3.07677	6	4.02958		
$\alpha_1 KL_{III}$	0.512113	3	24.2097	0.490599	3	25.2713	$\gamma_8 L_{II}N_I$	2.93187	9	4.2287	2.79007	9	4.4437		
$\beta_2 KM_{II}$	0.455181	4	27.2377	0.435877	5	28.4440	$\gamma_7 L_{II}N_{IV}$	2.85159	3	4.34779	2.71241	6	4.5709		
							$l L_{III}M_I$	3.88826	9	3.18860	3.71696	9	3.33555		
							$\alpha_2 L_{III}M_{IV}$	3.44840	6	3.59532	3.29846	9	3.7588		

TABLE V (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV		
57 Lanthanum (Cont.)				58 Cerium (Cont.)				61 Promethium (Cont.)				62 Samarium (Cont.)			
$M_{V}O_{II,III}$				14.39	5	0.862	$\alpha_2 L_{III}M_{IV}$	2.2926	4	5.4078	2.21062	3	5.6084		
$N_{IV,V}O_{II,III}$	152.6	6	0.0812	144.4	6	0.0859	$\alpha_1 L_{III}M_{IV}$	2.2822	3	5.4325	2.1998	2	5.6361		
59 Praseodymium				60 Neodymium				$\beta_6 L_{III}N_I$			1.94643	3	6.3697		
$\alpha_2 K L_{II}$	0.348749	2	35.5502	0.336472	2	36.8474	$\beta_{2,15} L_{III}N_{IV,V}$	1.9559	6	6.339	1.88221	3	6.5870		
$\alpha_1 K L_{III}$	0.344140	2	36.0263	0.331846	2	37.3610	$\beta_7 L_{III}O_I$			1.85626	3	6.6791			
$\beta_3 K M_{II}$	0.304975	5	40.6529	0.294027	3	42.1665	$\beta_5 L_{III}O_{IV,V}$			1.84700	9	6.7126			
$\beta_1 K M_{III}$	0.304261	4	40.7482	0.293299	2	42.2713	$\beta_{10} L_I M_{IV}$			1.86990	3	6.6304			
$\beta_2 K N_{II,III}$	0.29679	2	41.773	0.2861 [†]	1	43.33	$\beta_9 L_I M_V$			1.86166	3	6.6597			
$\beta_4 L_I M_{II}$	2.2550	4	5.4981	2.1669	3	5.7216	$\gamma M_{III}N_{IV,V}$			9.600	9	1.291			
$\beta_5 L_I M_{III}$	2.2172	3	5.5918	2.1268	2	5.8294	$\beta M_{IV}N_{VI}$			11.27	1	1.0998			
$\gamma_2 L_I N_{II}$	1.8791	4	6.598	1.8013	4	6.883	$\zeta M_{V}N_{III}$			14.91	4	0.831			
$\gamma_3 L_I N_{III}$	1.8740	4	6.616	1.7964	4	6.902	$\alpha M_{V}N_{VI,VII}$			11.47	3	1.081			
$\gamma_4 L_I O_{II,III}$	1.8193	4	6.815	1.7445	4	7.107	$N_{IV,V}N_{VI,VII}$			98.	1	0.126			
$\eta L_{II}M_I$	2.512	3	4.935	2.4094	4	5.1457	$N_{IV,V}O_{II,III}$			117.4	4	0.1056			
$\beta_1 L_{II}M_{IV}$	2.2588	3	5.4889	2.1669	2	5.7216	63 Europium				64 Gadolinium				
$\gamma_8 L_{II}N_I$	2.0205	4	6.136	1.9355	4	6.406	$\alpha_2 K L_{II}$	0.303118	2	40.9019	0.293038	2	42.3089		
$\gamma_1 L_{II}N_{IV}$	1.9611	3	6.3221	1.8779	2	6.6021	$\alpha_1 K L_{III}$	0.298446	2	41.5422	0.288353	2	42.9962		
$\gamma_8 L_{II}O_I$	1.9362	4	6.403	1.8552	5	6.683	$\beta_3 K M_{II}$	0.264332	5	46.9036	0.25534	2	48.555		
$l L_{III}M_I$	2.7841	4	4.4532	2.6760	4	4.6330	$\beta_1 K M_{III}$	0.263577	5	47.0379	0.25460	2	48.697		
$\alpha_2 L_{III}M_{IV}$	2.4729	3	5.0135	2.3807	3	5.2077	$\beta_2 K N_{II,III}$	0.256923	8	48.256	0.24816	3	49.959		
$\alpha_1 L_{III}M_V$	2.4630	2	5.0337	2.3704	2	5.2304	$K O_{II,III}$	0.255645	7	48.497	0.24687	3	50.221		
$\beta_3 L_{III}N_I$	2.1906	4	5.660	2.1039	3	5.8930	$\beta_5 K M_{IV,V}$			0.25275	3	49.052			
$\beta_{2,15} L_{III}N_{IV,V}$	2.1194	4	5.850	2.0360	3	6.0894	$\beta_4 L_I M_{II}$	1.9255	2	6.4389	1.8540	2	6.6871		
$\beta_7 L_{III}O_I$	2.0919	4	5.927	2.0092	3	6.1708	$\beta_8 L_I M_{III}$	1.8867	2	6.5713	1.8150	2	6.8311		
$\beta_{10} L_I M_{IV}$	2.1071	4	5.884	2.0237	3	6.1265	$\gamma_2 L_I N_{II}$	1.5961	2	7.7677	1.5331	2	8.087		
$\beta_9 L_I M_V$	2.1004	4	5.903	2.0165	3	6.1484	$\gamma_3 L_I N_{III}$	1.5903	2	7.7961	1.5297	2	8.105		
$\gamma M_{III}N_{IV,V}$	10.998	9	1.1273	10.505	9	1.180	$\gamma_4 L_I O_{II,III}$	1.5439	1	8.0304	1.4839	2	8.355		
$\beta M_{IV}N_{VI}$	13.06	2	0.950	12.44	2	0.997	$\eta L_{II}M_I$	2.1315	2	5.8166	2.0494	1	6.0495		
$\zeta M_{V}N_{III}$	17.38	4	0.714	16.46	4	0.753	$\beta_1 L_{II}M_{IV}$	1.9203	2	6.4564	1.8468	2	6.7132		
$\alpha M_{V}N_{VI,VII}$	13.343	5	0.9292	12.68	2	0.978	$\gamma_5 L_{II}N_I$	1.7085	2	7.2566	1.6412	2	7.5543		
$N_{IV,V}N_{VI,VII}$	113.	1	0.1095	107.	1	0.116	$\gamma_1 L_{II}N_{IV}$	1.6574	2	7.4803	1.5924	2	7.7858		
$N_{IV,V}O_{II,III}$	136.5	4	0.0908	128.9	7	0.0962	$\gamma_8 L_{II}O_I$	1.6346	2	7.5849	1.5707	2	7.894		
61 Promethium				62 Samarium				$\gamma_8 L_{II}O_{IV}$	1.6282	2	7.6147	1.5644	2	7.925	
$\alpha_2 K L_{II}$	0.324803	4	38.1712	0.313698	2	39.5224	$l L_{III}M_I$	2.3948	2	5.1772	2.3122	2	5.3621		
$\alpha_1 K L_{III}$	0.320160	4	38.7247	0.309040	2	40.1181	$\alpha_2 L_{III}M_{IV}$	2.1315	2	5.8166	2.0578	2	6.0250		
$\beta_3 K M_{II}$	0.28363 [†]	4	43.713	0.27376	2	45.289	$\alpha_1 L_{III}M_V$	2.1209	2	5.8457	2.0468	2	6.0572		
$\beta_1 K M_{III}$	0.28290 [†]	3	43.826	0.27301	2	45.413	$\beta_6 L_{III}N_I$	1.8737	2	6.6170	1.8054	2	6.8671		
$\beta_2 K N_{II,III}$	0.2759 [†]	1	44.94	0.2662	1	46.58	$\beta_{2,15} L_{III}N_{IV,V}$	1.8118	2	6.8432	1.7455	2	7.1028		
$K O_{II,III}$				0.26491	3	46.801	$\beta_7 L_{III}O_I$	1.7851	2	6.9453	1.7203	2	7.2071		
$\beta_3 K M_{IV,V}$				0.27111	3	45.731	$\beta_5 L_{III}O_{IV,V}$	1.7772	2	6.9763	1.7130	2	7.2374		
$\beta_4 L_I M_{II}$				2.00095	6	6.1963	$\beta_{10} L_I M_{IV}$	1.7993	3	6.890	1.7315	3	7.160		
$\beta_5 L_I M_{III}$	2.0421	4	6.071	1.96241	3	6.3180	$\beta_9 L_I M_V$	1.7916	3	6.920	1.7240	3	7.192		
$\gamma_2 L_I N_{II}$				1.66044	6	7.4668	$L_I O_{IV,V}$			1.4807	3	8.373			
$\gamma_3 L_I N_{III}$				1.65601	3	7.4867	$\gamma M_{III}N_{IV,V}$	9.211	9	1.346	8.844	9	1.402		
$\gamma_4 L_I O_{II,III}$				1.60728	3	7.7137	$\beta M_{IV}N_{VI}$	10.750	7	1.1533	10.254	6	1.2091		
$\eta L_{II}M_I$				2.21824	3	5.5892	$\zeta M_{V}N_{III}$	14.22	2	0.872	13.57	2	0.914		
$\beta_1 L_{II}M_{IV}$	2.0797	4	5.961	1.99806	3	6.2051	$\alpha M_{V}N_{VI,VII}$	10.96	3	1.131	10.46	3	1.185		
$\gamma_6 L_{II}N_I$				1.77934	3	6.9678	$N_{IV,V}O_{II,III}$	112.0	6	0.1107	65 Terbium				
$\gamma_1 L_{II}N_{IV}$	1.7989	9	6.892	1.72724	3	7.1780	$\alpha_2 K L_{II}$	0.283423	2	43.7441	0.274247	2	45.2078		
$\gamma_6 L_{II}O_{IV}$				1.6966	9	7.3076	$\alpha_1 K L_{III}$	0.278724	2	44.4816	0.269533	2	45.9984		
$l L_{III}M_I$				2.4823	4	4.9945	$\beta K M_{II}$	0.24683	2	50.229	0.23862	2	51.957		
								66 Dysprosium							

TABLE V (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV				
65 Terbium (Cont.)						66 Dysprosium (Cont.)						67 Holmium (Cont.)			68 Erbium (Cont.)		
$\beta_1 KM_{III}$	0.24608	2	50.382	0.23788	2	52.119	$\beta_{10} L_2M_{IV}$	1.5486	3	8.006	1.4941	3	8.298				
$\beta_2 KN_{II,III}$	0.2397 [†]	2	51.72	0.2317 [†]	2	53.51	$L_1O_{IV,V}$	1.3208	3	9.387							
$KO_{II,III}$	0.23858	3	51.965	0.23056	3	53.774	$\beta_8 L_2M_V$				1.4855	5	8.346				
$\beta_3 KM_{IV,V}$				0.23618	3	52.494	$M_{III}N_{IV}$				7.60	1	1.632				
$\beta_4 L_2M_{II}$	1.7864	2	6.9403	1.72103	7	7.2039	$\gamma M_{III}N_{IV,V}$	7.865	9	1.576							
$\beta_5 L_2M_{III}$	1.7472	2	7.0959	1.6822	2	7.3702	$\gamma M_{III} V$				7.546	8	1.643				
$\gamma_2 L_2N_{II}$	1.4764	2	8.398	1.42278	7	8.7140	$\beta M_{IV}N_{VI}$	8.965	4	1.3830	8.592	3	1.4430				
$\gamma_3 L_2N_{III}$	1.4718	2	8.423	1.41640	7	8.7532	ζM_VN_{III}	11.86	1	1.0450	11.37	1	1.0901				
$\gamma_4 L_1O_{II,III}$	1.4276	2	8.685	1.37459	7	9.0195	$\alpha M_VN_{VI,VII}$	9.20	2	1.348	8.82	1	1.406				
$\eta L_{III}M_I$	1.9730	2	6.2839	1.89743	7	6.5342	$N_{IV}N_{VI}$				72.7	9	0.171				
$\beta_1 L_{III}M_{IV}$	1.7768	3	6.978	1.71062	7	7.2477	$N_VN_{VI,VII}$				76.3	7	0.163				
$\gamma_2 L_{III}N_I$	1.5787	2	7.8535	1.51824	7	8.1661											
$\gamma_1 L_{III}N_{IV}$	1.5303	2	8.102	1.47266	7	8.4188	69 Thulium			70 Ytterbium							
$\gamma_3 L_{III}O_I$	1.5097	2	8.212				$\alpha_2 KL_{II}$	0.249095	2	49.7726	0.241424	2	51.3540				
$\gamma_6 L_{III}O_{IV}$	1.5035	2	8.246	1.44579	7	8.5753	$\alpha_1 KL_{III}$	0.244338	2	50.7416	0.236655	2	52.3889				
$l L_{III}M_I$	2.2352	2	5.5467	2.15877	7	5.7431	$\beta_2 KM_{II}$	0.21636	2	57.304	0.2096 [†]	1	59.14				
$\alpha_2 L_{III}M_{IV}$	1.9875	2	6.2380	1.91991	3	6.4577	$\beta_1 KM_{III}$	0.21556	2	57.517	0.20884	8	59.37				
$\alpha_1 L_{III}M_V$	1.9765	2	6.2728	1.90881	3	6.4952	$\beta_3 KM_{II,III}$	0.2098 [†]	2	59.09	0.2033 [†]	2	60.98				
$\beta_6 L_{III}N_I$	1.7422	2	7.1163	1.68213	7	7.3705	$KO_{II,III}$	0.20891	2	59.346	0.20226	2	61.298				
$\beta_{2,15} L_{III}N_{IV,V}$	1.6830	2	7.3667	1.62369	7	7.6357	$\beta_6 KM_{IV,V}$	0.21404	2	57.923	0.20739	2	59.782				
$\beta_7 L_{III}O_I$	1.6585	2	7.4753	1.60447	7	7.7272	$\beta_4 L_2M_{II}$	1.5448	2	8.026	1.49138	3	8.3132				
$\beta_8 L_{III}O_{IV,V}$	1.6510	2	7.5094	1.58837	7	7.8055	$\beta_5 L_2M_{III}$	1.5063	2	8.231	1.45233	5	8.5367				
$\beta_{10} L_2M_{IV}$	1.6673	3	7.436	1.60743	9	7.7130	$\gamma_2 L_2N_{II}$	1.2742	2	9.730	1.22879	7	10.0897				
$\beta_9 L_2M_V$				1.59973	9	7.7501	$\gamma_3 L_2N_{III}$	1.2678	2	9.779	1.22232	5	10.1431				
$L_3O_{IV,V}$	1.4228	3	8.714				$\gamma_4 L_1O_{II,III}$	1.2294	2	10.084	1.1853	1	10.4603				
$\gamma M_{III}N_{IV,V}$	8.486	9	1.461	8.144	9	1.522	$\eta L_{III}M_I$	1.6963	2	7.3088	1.63560	5	7.5802				
$\beta M_{IV}N_{VI}$	9.792	6	1.2661	9.357	6	1.3250	$\beta_1 L_{III}M_{IV}$	1.5304	2	8.101	1.47565	5	8.4018				
ζM_VN_{III}	12.98	2	0.955	12.43	2	0.998	$\gamma_5 L_{III}N_I$	1.3558	2	9.144	1.3063	1	9.4910				
$\alpha M_VN_{VI,VII}$	10.00	2	1.240	9.59	2	1.293	$\gamma_1 L_{III}N_{IV}$	1.3153	2	9.426	1.26769	5	9.8701				
$N_{IV,V}N_{VI,VII}$	86.	1	0.144	83.	1	0.149	$\gamma_3 L_{III}O_I$				1.24923	5	9.9246				
$N_{IV,V}O_{II,III}$	102.2	4	0.1213	97.2	8	0.128	$\gamma_5 L_{III}O_{IV}$	1.2905	2	9.607	1.24271	3	9.9766				
67 Holmium						68 Erbium						71 Lutetium			72 Hafnium		
$\alpha_2 KL_{II}$	0.265486	2	46.6997	0.257110	2	48.2211	$l L_{III}M_I$	1.9550	2	6.3419	1.89415	5	6.5455				
$\alpha_1 KL_{III}$	0.260756	2	47.5467	0.252365	2	49.1277	$\alpha_2 L_{III}M_{IV}$	1.7381	2	7.1331	1.68285	5	7.3673				
$\beta_2 KM_{II}$	0.23083	2	53.711	0.22341	2	55.494	$\alpha_1 L_{III}M_V$	1.7268 [†]	2	7.1799	1.67189	4	7.4156				
$\beta_1 KM_{III}$	0.23012	2	53.877	0.22266	2	55.681	$\beta_6 L_{III}N_I$	1.5162	2	8.177	1.4661	1	8.4563				
$\beta_3 KN_{II,III}$	0.2241 [†]	2	55.32	0.2167 [†]	2	57.21	$\beta_{2,15} L_{III}N_{IV,V}$	1.4640	2	8.468	1.41550	5	8.7588				
$KO_{II,III}$	0.22305	3	55.584	0.21581	3	57.450	$\beta_7 L_{III}O_I$				1.3948	1	8.8889				
$\beta_6 KM_{IV,V}$	0.22855	3	54.246	0.22124	3	56.040	$\beta_8 L_{III}O_{IV,V}$	1.4349	2	8.641	1.38696	7	8.9390				
$\beta_4 L_2M_{II}$	1.6595	2	7.4708	1.6007	1	7.7453	$\beta_{10} L_2M_{IV}$	1.4410	3	8.604	1.3915	1	8.9100				
$\beta_5 L_2M_{III}$	1.6203	2	7.6519	1.5616	1	7.9392	$\beta_9 L_2M_V$	1.4336	3	8.648	1.3838	1	8.9597				
$\gamma_2 L_2N_{II}$	1.3698	2	9.051	1.3210	2	9.385	L_1O_I				1.1886	1	10.4312				
$\gamma_3 L_2N_{III}$	1.3643	2	9.087	1.3146	1	9.4309	$L_1O_{IV,V}$	1.2263	3	10.110	1.1827	1	10.4833				
$\gamma_4 L_1O_{II,III}$	1.3225	2	9.374	1.2752	2	9.722	$L_{II}M_{II}$				1.58844	9	7.8052				
$\eta L_{III}M_I$	1.8264	2	6.7883	1.7566	1	7.0579	$L_{III}O_{II,III}$				1.2453	1	9.9561				
$\beta_1 L_{III}M_{IV}$	1.6475	2	7.5253	1.5873	1	7.8109	$l L_{III}M_{II}$				1.83091	9	6.7715				
$\gamma_6 L_2N_I$	1.4618	2	8.481	1.4067	3	8.814	$L_{III}O_{II,III}$				1.3898	1	8.9209				
$\gamma_1 L_2N_{IV}$	1.4174	2	8.747	1.3641	2	9.089	$M_{III}N_I$				8.470	9	1.464				
$\gamma_3 L_{II}O_I$	1.3983	2	8.867				$\gamma M_{III}N_V$				7.024	8	1.765				
$\gamma_5 L_2O_{IV}$	1.3923	2	8.905	1.3397	3	9.255	$\beta M_{IV}N_{VI}$	8.249	7	1.503	7.909	2	1.5675				
$l L_{III}M_I$	2.0860	2	5.9434	2.015	1	6.152	ζM_VN_{III}				10.48	1	1.183				
$\alpha_2 L_{III}M_{IV}$	1.8561	2	6.6795	1.7955	2	6.9050	$\alpha M_VN_{VI,VII}$	8.48	1	1.462	8.149	5	1.5214				
$\alpha_1 L_{III}M_V$	1.8450	2	6.7198	1.78425	9	6.9487	$N_{IV}N_{VI}$				65.1	7	0.190				
$\beta_8 L_{III}N_I$	1.6237	2	7.6359	1.5675	2	7.909	$N_VN_{VI,VII}$				69.3	5	0.179				
$\beta_{2,15} L_{III}N_{IV,V}$	1.5671	2	7.911	1.51399	9	8.1890											
$\beta_7 L_{III}O_I$				1.4941	3	8.298	71 Lutetium			72 Hafnium							
$\beta_9 L_{III}O_{IV,V}$	1.5378	2	8.062	1.4848	3	8.350	$\alpha_2 KL_{II}$	0.234081	2	52.9650	0.227024	3	54.6114				
							$\alpha_1 KL_{III}$	0.229298	2	54.0698	0.222227	3	55.7902				
							$\beta_3 KM_{II}$	0.20309 [†]	4	61.05	0.19686 [†]	4	62.98				

TABLE V (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV		
71 Lutetium (Cont.)				72 Hafnium (Cont.)				73 Tantalum (Cont.)				74 Tungsten (Cont.)			
$\beta_1 KM_{III}$	0.20231 [†]	3	61.283	0.19607 [†]	3	63.234	$KO_{II,III}$	0.184031	7	67.370	0.178444	5	69.479		
$\beta_2 KN_{II,III}$	0.1969 [†]	2	62.97	0.1908 [†]	2	64.98	KL_I				0.21592	4	57.42		
$KO_{II,III}$	0.19589	2	63.293				$\beta_5^{II} KM_{IV}$	0.188920	6	65.626	0.183264	5	67.652		
$\beta_5 KM_{IV,V}$	0.20084	2	61.732				$\beta_5^I KM_V$	0.188757	6	65.683	0.183092	7	67.715		
$\beta_4 L_{II}M_{II}$	1.44056	5	8.6064	1.39220	5	8.9054	$\beta_4 KN_{IV,V}$	0.18451	1	67.194	0.17892	2	69.294		
$\beta_3 L_{II}M_{III}$	1.40140	5	8.8469	1.35300	5	9.1634	$\beta_4 L_{II}M_{II}$	1.34581	3	9.2124	1.30162	5	9.5252		
$\gamma_2 L_{II}N_{II}$	1.1853	2	10.460	1.14442	5	10.8335	$\beta_3 L_{II}M_{III}$	1.30678	3	9.4875	1.26269	5	9.8188		
$\gamma_3 L_{II}N_{III}$	1.17953	4	10.5110	1.13841	5	10.8907	$\gamma_2 L_{II}N_{II}$	1.1053	1	11.217	1.06806	3	11.6080		
$\gamma_4 L_{II}O_{II}$				1.10376	5	11.2326	$\gamma_3 L_{II}N_{III}$	1.09936	4	11.2776	1.06200	6	11.6743		
$\gamma_5 L_{II}O_{II,III}$	1.1435	1	10.8425	1.10303	5	11.2401	$\gamma_4 L_{II}O_{II}$	1.06544	3	11.6366	1.02863	3	12.0530		
$\eta L_{II}M_I$	1.5779	1	7.8575	1.52325	5	8.1393	$\gamma_4 L_{II}O_{III}$	1.06467	3	11.6451	1.02775	3	12.0634		
$\beta_1 L_{II}M_{IV}$	1.42359	3	8.7090	1.37410	5	9.0227	$\eta L_{II}M_I$	1.47106	5	8.4280	1.42110	3	8.7243		
$\gamma_6 L_{II}N_I$	1.2596	1	9.8428	1.21537	5	10.2011	$\beta_1 L_{II}M_{IV}$	1.32698	3	9.3431	1.281809	9	9.67235		
$\gamma_1 L_{II}N_{IV}$	1.22228	4	10.1434	1.17900	5	10.5158	$\gamma_6 L_{II}N_I$	1.1729	1	10.5702	1.13235	3	10.9490		
$\gamma_8 L_{II}O_I$	1.2047	1	10.2915	1.16138	5	10.6754	$\gamma_1 L_{II}N_{IV}$	1.13794	3	10.8952	1.09855	3	11.2859		
$\gamma_5 L_{II}O_{IV}$	1.1987	1	10.3431	1.15519	5	10.7325	$\gamma_8 L_{II}O_I$	1.1205	1	11.0646	1.08113	4	11.4677		
$l L_{III}M_I$	1.8360	1	6.7528	1.78145	5	6.9596	$\gamma_6 L_{II}O_{IV}$	1.11388	3	11.1306	1.07448	5	11.5387		
$\alpha_2 L_{III}M_{IV}$	1.63029	5	7.6049	1.58046	5	7.8446	$l L_{III}M_I$	1.72841	5	7.1731	1.6782	1	7.3878		
$\alpha_1 L_{III}M_{IV}$	1.61951	3	7.6555	1.56958	5	7.8990	$\alpha_2 L_{III}M_{IV}$	1.53293	2	8.0879	1.48743	2	8.3352		
$\beta_5 L_{III}N_I$	1.4189	1	8.7376	1.37410	5	9.0227	$\alpha_1 L_{III}M_{IV}$	1.52197	2	8.1461	1.47639	2	8.3976		
$\beta_{15} L_{III}N_{IV}$	1.3715	1	9.0395	1.32783	5	9.3371	$\beta_6 L_{III}N_I$	1.33094	8	9.3153	1.28989	7	9.6117		
$\beta_2 L_{III}N_V$	1.37012	3	9.0489	1.32639	5	9.3473	$\beta_{15} L_{III}N_{IV}$	1.28619	5	9.6394	1.24631	3	9.9478		
$\beta_7 L_{III}O_I$	1.34949	5	9.1873	1.30564	5	9.4958	$\beta_2 L_{III}N_V$	1.28454	2	9.6518	1.24460	3	9.9615		
$\beta_8 L_{III}O_{IV,V}$	1.34183	7	9.2397	1.29761	5	9.5546	$\beta_7 L_{III}O_I$	1.26385	5	9.8098	1.22400	4	10.1292		
$L_{II}M_I$				1.43025	9	8.6685	$\beta_6 L_{III}O_{IV,V}$	1.2555	1	9.8750	1.21545	3	10.2004		
$\beta_{10} L_{II}M_{IV}$	1.3430	2	9.232	1.29819	9	9.5503	$L_{II}M_I$				1.3365	3	9.277		
$\beta_9 L_{II}M_V$	1.3358	1	9.2816	1.29025	9	9.6090	$\beta_{10} L_{II}M_{IV}$	1.2537	2	9.889	1.21218	3	10.2279		
$L_{II}N_{IV}$	1.16227	9	10.6672	1.12250	9	11.0451	$\beta_9 L_{II}M_V$	1.2466	2	9.946	1.20479	7	10.2907		
$\gamma_{11} L_{II}N_V$	1.16107	9	10.6782	1.12146	9	11.0553	$L_{II}N_I$	1.11521	9	11.1173					
$L_{II}O_I$				1.10664	9	11.2034	$L_{II}N_{IV}$	1.08377	7	11.4398	1.0468	2	11.844		
$L_{II}O_{IV}$				1.10086	9	11.2622	$\gamma_{11} L_{II}N_V$	1.08205	7	11.4580	1.0458	1	11.856		
$L_{II}M_{II}$	1.53333	9	8.0858	1.48064	9	8.3735	$L_{II}N_{VI,VII}$	1.06357	9	11.6570					
$\beta_{17} L_{II}M_{III}$				1.43643	9	8.6312	$L_{II}O_I$	1.06771	9	11.6118	1.0317	3	12.017		
$L_{II}N_V$				1.17788	9	10.5258	$L_{II}O_{IV,V}$	1.06192	9	11.6752	1.0250	2	12.095		
$v L_{II}N_{VI}$				1.15830	9	10.7037	$L_{II}M_{II}$	1.43048	9	8.6671					
$L_{II}O_{II,III}$	1.2014	1	10.3198				$\beta_{17} L_{II}M_{III}$	1.3864	1	8.9428	1.3387	2	9.261		
$t L_{III}M_{II}$	1.7760	1	6.9810	1.72305	9	7.1954	$L_{II}M_V$	1.31897	9	9.3998	1.2728	2	9.741		
$s L_{III}M_{III}$				1.66346	9	7.4532	$L_{II}N_{II}$	1.1600	2	10.688	1.1218	3	11.052		
$L_{III}N_{II}$				1.35887	9	9.1239	$L_{II}N_{III}$	1.1553	1	10.7316	1.1149	2	11.120		
$L_{III}N_{III}$				1.35053	9	9.1802	$L_{II}N_V$	1.13687	9	10.9055					
$u L_{III}N_{VI,VII}$				1.30165	9	9.5249	$v L_{II}N_{VI}$	1.1158	1	11.1113	1.0771	1	11.510		
$L_{III}O_{II,III}$	1.34524	9	9.2163				$L_{II}O_{II}$	1.11789	9	11.0907					
$M_{III}N_I$				7.887	9	1.572	$L_{II}O_{III}$	1.11693	9	11.1001	1.0792	2	11.488		
$\gamma M_{III}N_V$	6.768	6	1.832	6.544	4	1.895	$l L_{III}M_{II}$	1.67265	9	7.4123	1.6244	3	7.632		
ζ_2				9.686	7	1.2800	$s L_{III}M_{III}$	1.61264	9	7.6881	1.5642	3	7.926		
$\beta M_{IV}N_{VI}$	7.601	2	1.6312	7.303	1	1.6976	$L_{III}N_{II}$	1.3167	1	9.4158	1.2765	2	9.712		
ζ_1				9.686	7	1.2800	$L_{III}N_{III}$	1.3086	1	9.4742	1.2672	2	9.784		
$\alpha M_V N_{VI,VII}$	7.840	2	1.5813	7.539	1	1.6446	$v L_{III}N_{VI}$	1.25778	4	9.8572	1.21868	5	10.1733		
$N_{IV}N_{VI}$	63.0	5	0.197				$L_{III}O_{II,III}$	1.2601	3	9.839	1.2211	2	10.153		
$N_V N_{VI,VII}$	65.7	2	0.1886				$M_{I}N_{III}$	5.40	2	2.295	5.172	9	2.397		
73 Tantalum				74 Tungsten				$M_{I}O_{II,III}$			4.44	2	2.79		
$\alpha_2 KL_{II}$	0.220305	8	56.277	0.213828	2	57.9817	$M_{II}N_I$				6.28	2	1.973		
$\alpha_1 KL_{III}$	0.215497	4	57.532	0.2090100	Std	59.31824	$M_{II}N_{IV}$	5.570	4	2.226	5.357	4	2.314		
$\beta_6 KM_{II}$	0.190890	2	64.9488	0.185181	2	66.9514	$M_{III}N_I$	7.612	9	1.629	7.360	8	1.684		
$\beta_1 KM_{III}$	0.190089	4	65.223	0.184374	2	67.2443	$M_{III}N_{IV}$	6.353	5	1.951	6.134	4	2.021		
$\beta_2^{II} KN_{II}$	0.185188	9	66.949	0.17960	1	69.031	$\gamma M_{III}N_V$	6.312	4	1.964	6.092	3	2.035		
$\beta_2^I KN_{III}$	0.185011	8	67.013	0.179421	7	69.101	$M_{III}O_I$	5.83	2	2.126	5.628	8	2.203		
							$M_{III}O_{IV,V}$	5.67	3	2.19					

TABLE V (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV										
73 Tantalum (Cont.)						74 Tungsten (Cont.)						75 Rhenium (Cont.)						76 Osmium (Cont.)					
$\zeta_2 M_{IV}N_{II}$	9.330	5	1.3288	8.993	5	1.3787	$L_{II}M_V$	1.2305	1	10.0753	1.18977	7	10.4205										
$M_{IV}N_{III}$	8.90	2	1.393	8.573	8	1.446	$L_{II}N_{II}$	1.0839	1	11.438													
$\beta M_{IV}N_{VI}$	7.023	1	1.7655	6.757	1	1.8349	$L_{II}N_{III}$	1.0767	1	11.515	1.03973	5	11.9243										
$M_{IV}O_{II}$	7.09	2	1.748	6.806	9	1.822	$\nu L_{II}N_{VI}$	1.0404	1	11.917	1.0050	2	12.337										
$\zeta_1 M_V N_{III}$	9.316	4	1.3308	8.962	4	1.3835	$L_{II}O_{III}$	1.0397	1	11.925	1.0047	2	12.340										
$\alpha M_V N_{VI, VII}$	7.252	1	1.7096				$l L_{III}M_{II}$	1.5789	1	7.8525	1.5347	2	8.079										
$\alpha_2 M_V N_{VI}$				6.992	2	1.7731	$s L_{III}M_{III}$	1.5178	1	8.1682	1.4735	2	8.414										
$\alpha_1 M_V N_{VII}$				6.983	1	1.7754	$L_{III}N_I$				1.20086	7	10.3244										
$M_V O_{III}$	7.30	2	1.700	7.005	9	1.770	$L_{III}N_{III}$	1.2283	1	10.0933													
$N_{II}N_{IV}$				54.0	2	0.2295	$\nu L_{III}N_{VI, VII}$	1.1815	1	10.4931	1.14537	7	10.8245										
$N_{IV}N_{VI}$	58.2	1	0.2130	55.8	1	0.2221	$M_{II}N_{III}$				4.79	2	2.59										
$N_V N_{VI, VII}$	61.1	2	0.2028				$M_{II}N_I$				5.81	2	2.133										
$N_V N_{VI}$				59.5	3	0.208	$M_{II}N_{IV}$				4.955	4	2.502										
$N_V N_{VII}$				58.4	1	0.2122	$M_{III}N_I$				6.89	2	1.798										
							$M_{III}N_{IV}$	5.931	5	2.090	5.724	5	2.166										
75 Rhenium						76 Osmium						77 Iridium						78 Platinum					
$\alpha_2 K L_{II}$	0.207611	1	59.7179	0.201639	2	61.4867	$\gamma M_{III}N_V$	5.885	2	2.1067	5.682	4	2.182										
$\alpha_1 K L_{III}$	0.202781	2	61.1403	0.196794	2	63.0005	$\zeta_2 M_{IV}N_{II}$	8.664	5	1.4310	8.359	5	1.4831										
$\beta_8 K M_{II}$	0.179697	3	68.994	0.174431	3	71.077	$M_{IV}N_{III}$	8.239	8	1.505													
$\beta_1 K M_{III}$	0.178880	3	69.310	0.173611	3	71.413	$\beta M_{IV}N_{VI}$	6.504	1	1.9061	6.267	1	1.9783										
$\beta_2^{II} K N_{II}$	0.17425	1	71.151	0.16910	1	73.318	$\zeta_1 M_V N_{III}$	8.629	4	1.4368	8.310	4	1.4919										
$\beta_2^I K N_{III}$	0.174054	6	71.232	0.168906	6	73.402	$\alpha M_V N_{VI, VII}$	6.729	1	1.8425	6.490	1	1.9102										
$K O_{II, III}$	0.17308	1	71.633	0.16798	1	73.808	$N_{IV}N_{VI}$				51.9	1	0.2388										
$\beta_3^{II} K M_{IV}$	0.17783	1	69.719	0.17262	1	71.824	$N_V N_{VI, VII}$				54.7	2	0.2266										
$\beta_8^I K M_V$	0.17766	1	69.786	0.17245	1	71.895																	
$\beta_2 K N_{IV, V}$	0.17362	2	71.410	0.16842	2	73.615																	
$\beta_4 L_I M_{II}$	1.25917	5	9.8463	1.21844	5	10.1754	$\alpha_2 K L_{II}$	0.195904	2	63.2867	0.190381	4	65.122										
$\beta_3 L_I M_{III}$	1.22031	5	10.1598	1.17955	7	10.5108	$\alpha_1 K L_{III}$	0.191047	2	64.8956	0.185511	4	66.832										
$\gamma_2 L_I N_{II}$	1.03233	5	12.0098	0.99805	5	12.4224	$\beta_2 K M_{II}$	0.169367	2	73.2027	0.164501	3	75.368										
$\gamma_3 L_I N_{III}$	1.02613	7	12.0824	0.99186	5	12.4998	$\beta_1 K M_{III}$	0.168542	2	73.5608	0.163675	3	75.748										
$\gamma^4 L_I O_{II}$	0.99334	5	12.4813	0.96033	8	12.910	$\beta_2^{II} K N_{II}$	0.16415	1	75.529	0.15939	1	77.785										
$\gamma_4 L_I O_{III}$	0.99249	5	12.4920	0.95938	8	12.923	$\beta_2^I K N_{III}$	0.163956	7	75.619	0.15920	1	77.878										
$\eta L_{II} M_I$	1.37342	5	9.0272	1.32785	7	9.3370	$K O_{II, III}$	0.163019	5	76.053	0.15826	1	78.341										
$\beta_1 L_{II} M_{IV}$	1.23858	2	10.0100	1.19727	7	10.3553	$\beta_6^{II} K M_{IV}$	0.16759	2	73.980	0.16271	2	76.199										
$\gamma_6 L_{II} N_I$	1.09388	5	11.3341	1.05693	5	11.7303	$\beta_6^I K M_V$	0.167373	9	74.075	0.16255	3	76.27										
$\gamma_1 L_{II} N_{IV}$	1.06099	5	11.6854	1.02503	5	12.0953	$\beta_4 K N_{IV, V}$	0.16352	2	75.821	0.15881	2	78.069										
$\gamma_5 L_{II} O_I$	1.04398	5	11.8758	1.00788	5	12.3012	$\beta_4 L_I M_{II}$	1.17958	3	10.5106	1.14223	5	10.8543										
$\gamma_6 L_{II} O_{IV}$	1.03699	9	11.956	1.00107	5	12.3848	$\beta_3 L_I M_{III}$	1.14085	3	10.8674	1.10394	5	11.2308										
$l L_{III} M_I$	1.63056	5	7.6036	1.58498	7	7.8222	$\gamma_2 L_I N_{II}$	0.96545	3	12.8418	0.93427	5	13.2704										
$\alpha_2 L_{III} M_{IV}$	1.44396	5	8.5862	1.40234	5	8.8410	$\gamma_3 L_I N_{III}$	0.95931	5	12.9240	0.92791	5	13.3613										
$\alpha_1 L_{III} M_V$	1.43290	4	8.6525	1.39121	5	8.9117	$\gamma^4 L_I O_{II}$	0.92831	3	13.3555	0.89747	4	13.8145										
$\beta_6 L_{III} N_I$	1.25100	5	9.9105	1.21349	5	10.2169	$\gamma_4 L_I O_{III}$	0.92744	3	13.3681	0.89659	4	13.8281										
$\beta_{16} L_{III} N_{IV}$	1.20819	5	10.2617	1.17167	5	10.5816	$\eta L_{II} M_I$	1.28448	3	9.6522	1.2429	2	9.975										
$\beta_2 L_{III} N_V$	1.20660	4	10.2752	1.16979	8	10.5985	$\beta_1 L_{II} M_{IV}$	1.15781	3	10.7083	1.11990	2	11.0707										
$\beta_7 L_{III} O_I$	1.18610	5	10.4529	1.14933	8	10.7872	$\gamma_6 L_{II} N_I$	1.02175	5	12.1342	0.9877	2	12.552										
$\beta_{10} L_{III} O_{IV, V}$	1.17721	5	10.5318	1.1405	1	10.8711	$\gamma_1 L_{II} N_{IV}$	0.99085	3	12.5126	0.95797	3	12.9420										
$\beta_9 L_I M_V$	1.16487	4	10.6433	1.13353	5	10.9376	$\gamma_8 L_{II} O_I$	0.97409	3	12.7279	0.9411	1	13.173										
$L_I N_I$	1.0420	1	11.899	1.12637	6	11.0071	$\gamma_6 L_{II} O_{IV}$	0.96708	4	12.8201	0.9342	2	13.271										
$L_I N_{IV}$	1.0119	1	12.252	0.9772	3	12.687	$l L_{III} M_I$	1.54094	3	8.0458	1.4995	2	8.268										
$\gamma_{11} L_I N_V$	1.0108	1	12.266	0.9765	3	12.696	$\alpha_2 L_{III} M_{IV}$	1.36250	5	9.0995	1.32432	2	9.3618										
$L_I O_I$	0.9965	1	12.442	0.96318	7	12.8721	$\alpha_1 L_{III} M_V$	1.35128	3	9.1751	1.31304	3	9.4423										
$L_I O_{IV, V}$	0.9900	1	12.524	0.95603	5	12.9683	$\beta_6 L_{III} N_I$	1.17796	3	10.5251	1.14355	5	10.8418										
$L_{II} M_{II}$	1.3366	1	9.2761	1.2934	2	9.586	$\beta_{16} L_{III} N_{IV}$	1.13707	3	10.9036													
$\beta_{17} L_{II} M_{III}$	1.2927	1	9.5910	1.2480	2	9.934	$\beta_2 L_{III} N_V$	1.13532	3	10.9203	1.10200	3	11.2505										
							$\beta_7 L_{III} O_I$	1.11489	3	11.1205	1.08168	3	11.4619										

TABLE V (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV										
77 Iridium (Cont.)						78 Platinum (Cont.)						79 Gold (Cont.)						80 Mercury (Cont.)					
$\beta_5 L_{III}O_{IV,V}$	1.10585	3	11.2114	1.0724	2	11.561	$\gamma_2 L_2N_{II}$	0.90434	3	13.7095	0.87544	7	14.162										
L_2M_I	1.2102	2	10.245	1.16962	9	10.6001	$\gamma_3 L_2N_{III}$	0.89783	5	13.8090	0.86915	7	14.265										
$\beta_{10} L_2M_{IV}$	1.09702	4	11.3016	1.06183	7	11.6762	$\gamma'_4 L_2O_{II}$	0.86816	4	14.2809	0.84013	7	14.757										
$\beta_9 L_2M_V$	1.08975	5	11.3770	1.05446	5	11.7577	$\gamma_4 L_2O_{III}$	0.86703	4	14.2996	0.83894	7	14.778										
L_2N_I	0.9766	2	12.695	0.9455	2	13.113	$\eta L_{II}M_I$	1.20273	3	10.3083	1.1640	1	10.6512										
L_2N_{IV}	0.9459	2	13.108				$\beta_1 L_{II}M_{IV}$	1.08353	3	11.4423	1.04868	5	11.8226										
$\gamma_{II} L_2N_V$	0.9446	2	13.126	0.9143	2	13.560	$\gamma_5 L_{II}N_I$	0.95559	3	12.9743	0.92453	7	13.410										
$L_2O_{IV,V}$	0.9243	3	13.413				$\gamma_{II} L_{II}N_{IV}$	0.92650	3	13.3817	0.89646	5	13.8301										
L_2O_I				0.8995	2	13.784	$\gamma_5 L_{II}O_I$	0.90989	5	13.6260	0.87995	7	14.090										
L_2O_{IV}				0.8943	1	13.864	$\gamma_6 L_{II}O_{IV}$	0.90297	3	13.7304	0.87319	7	14.199										
L_2O_V				0.8934	1	13.878	$\delta L_{III}M_I$	1.45964	9	8.4939	1.4216	1	8.7210										
$L_{II}M_{II}$	1.2502	3	9.917	1.213	1	10.225	$\alpha_2 L_{III}M_{IV}$	1.28772	3	9.6280	1.25264	7	9.8976										
$\beta_{17} L_{II}M_{III}$	1.2069	2	10.273	1.1667	1	10.6265	$\alpha_1 L_{III}M_V$	1.27640	3	9.7133	1.24120	5	9.9888										
$L_{II}M_V$	1.1489	2	10.791	1.1129	2	11.140	$\beta_5 L_{III}N_I$	1.11092	3	11.1602	1.07975	7	11.4824										
$L_{II}N_{II}$	1.0120	2	12.251	0.9792	2	12.661	$\beta_5 L_{III}N_{IV}$	1.07188	5	11.5667	1.04151	7	11.9040										
$L_{II}N_{III}$	1.0054	3	12.332	0.97173	4	12.7588	$\beta_2 L_{III}N_V$	1.07022	3	11.5847	1.03975	7	11.9241										
$\nu L_{II}N_{VI}$	0.97161	6	12.7603	0.93931	5	13.1992	$\beta_7 L_{III}O_I$	1.04974	8	11.8106	1.01937	7	12.1625										
$L_{II}O_{III}$	0.96979	5	12.7843				$\beta_5 L_{III}O_{IV,V}$	1.04044	3	11.9163	1.00987	7	12.2769										
$\delta L_{III}M_{II}$	1.4930	3	8.304	1.4530	2	8.533	L_2M_I	1.13525	5	10.9210	1.0999	2	11.272										
$s L_{III}M_{III}$	1.4318	2	8.659	1.3895	2	8.923	$\beta_{10} L_2M_{IV}$	1.02789	7	12.0617	0.9962	2	12.446										
$L_{III}N_{II}$	1.16545	5	10.6380	1.1310	2	10.962	$\beta_9 L_2M_V$	1.02063	7	12.1474	0.9871	2	12.560										
$L_{III}N_{III}$	1.1560	3	10.725	1.1226	2	11.044	L_2N_I	0.9131	1	13.578	0.8827	2	14.045										
$u L_{III}N_{VI,VII}$	1.11145	4	11.1549	1.07896	5	11.4908	L_2N_{IV}	0.88563	7	13.999													
$L_{III}O_{II,III}$	1.10923	6	11.1772	1.0761	3	11.521	$\gamma_{II} L_2N_V$	0.88433	7	14.020	0.85657	7	14.474										
M_2N_{III}	4.631 [†]	9	2.677	4.460	9	2.780	L_2O_I	0.87074	5	14.2385	0.8452	2	14.670										
$M_{II}N_{IV}$	4.780	4	2.594	4.601	4	2.695	$L_2O_{IV,V}$	0.86400	5	14.3497	0.8350	2	14.847										
$M_{III}N_I$	6.669	9	1.859	6.455	9	1.921	$L_{II}M_{II}$	1.1708	1	10.5892	1.1387	5	10.888										
$M_{III}N_{IV}$	5.540	5	2.238	5.357	5	2.314	$\beta_{17} L_{II}M_{III}$	1.12798	5	10.9915	1.0916	5	11.358										
$\gamma M_I N_V$	5.500	4	2.254	5.319	4	2.331	$L_{II}M_V$	1.0756	2	11.526													
$M_{III}O_I$				4.876	9	2.543	$L_{II}N_{III}$	0.9402	2	13.186	0.90894	7	13.640										
$M_{III}O_{IV,V}$	4.869	9	2.546	4.694	8	2.641	$\nu L_{II}N_{VI}$	0.90837	5	13.6487	0.87885	7	14.107										
$\zeta_2 M_{IV}N_{II}$	8.065	5	1.5373	7.790	5	1.592	$L_{II}O_{II}$	0.90746	7	13.662	0.8784	1	14.114										
$M_{IV}N_{III}$	7.645	8	1.622	7.371	8	1.682	$L_{II}O_{III}$	0.90638	7	13.679	0.8758	1	14.156										
$\beta M_{IV}N_{VI}$	6.038	1	2.0535	5.828	1	2.1273	$\delta L_{III}M_{II}$	1.41366	7	8.7702	1.3746	2	9.019										
$\zeta_1 M_V N_{III}$	8.021	4	1.5458	7.738	4	1.6022	$s L_{III}M_{III}$	1.35131	7	9.1749	1.3112	2	9.455										
$\alpha_2 M_V N_{VI}$	6.275	3	1.9758	6.058	3	2.047	$L_{III}N_{II}$	1.09968	7	11.2743	1.0649	2	11.642										
$\alpha_1 M_V N_{VII}$	6.262	1	1.9799	6.047	1	2.0505	$L_{III}N_{III}$	1.09026	7	11.3717	1.0585	1	11.713										
$M_V O_{III}$				5.987	9	2.071	$u L_{III}N_{VI,VII}$	1.04752	5	11.8357													
$N_{IV}N_{VI}$	50.2	1	0.2470	48.1	2	0.258	$u' L_{III}N_{VI}$				1.01769	7	12.1826										
$N_V N_{VI,VII}$	52.8	1	0.2348	50.9	1	0.2436	$u L_{III}N_{VII}$				1.01674	7	12.1940										
79 Gold						80 Mercury																	
$\alpha_2 K L_{II}$	0.185075	2	66.9895	0.179958	3	68.895	$L_{III}O_{II,III}$	1.0450	2	11.865													
$\alpha_1 K L_{III}$	0.180195	2	68.8037	0.175068	3	70.819	$L_{III}O_{II}$				1.01558	7	12.2079										
$\beta_2 K M_{II}$	0.159810	2	77.580	0.155321	3	79.822	$L_{III}O_{III}$				1.01404	7	12.2264										
$\beta_1 K M_{III}$	0.158982	3	77.984	0.154487	3	80.253	$L_{III}P_{II,III}$	1.03876	7	11.9355													
$\beta_2^{II} K N_{II}$	0.15483	2	80.08	0.15040	2	82.43	$M_I N_{III}$	4.300	9	2.883													
$\beta_2^I K N_{III}$	0.154618	9	80.185	0.15020	2	82.54	$M_{II}N_{IV}$	4.432	4	2.797													
$K O_{II,III}$	0.153694	7	80.667	0.14931	2	83.04	$M_{III}N_I$	6.259	9	1.981	6.09	2	2.036										
$K L_I$	0.18672	4	66.40				$M_{III}N_{IV}$	5.186	5	2.391													
$\beta_5^{II} K M_{IV}$	0.158062	7	78.438				$\gamma M_{III}N_V$	5.145	4	2.410	4.984 [†]	2	2.4875										
$\beta_5^I K M_V$	0.157880	5	78.529				$M_{III}O_I$	4.703	9	2.636													
$\beta_5 K M_{IV,V}$				0.15353	2	80.75	$M_{III}O_{IV,V}$	4.522	6	2.742													
$\beta_4 K N_{IV,V}$	0.154224	5	80.391	0.14978	2	82.78	$\zeta_2 M_{IV}N_{II}$	7.523	5	1.648													
$\beta_4 L_2M_{II}$	1.10651	3	11.2047	1.07222	7	11.5630	$M_{IV}N_{III}$	7.101	8	1.746	6.87	2	1.805										
$\beta_3 L_2M_{III}$	1.06785	9	11.6103	1.03358	7	11.9953	$\beta M_{IV}N_{VI}$	5.624	1	2.2046	5.4318 [†]	9	2.2825										
							$\zeta_1 M_V N_{III}$	7.466	4	1.6605													
							$\alpha_2 M_V N_{VI}$	5.854	3	2.118													

TABLE V (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV										
79 Gold (Cont.)						80 Mercury (Cont.)						81 Thallium (Cont.)						82 Lead (Cont.)					
$\alpha_1 M_V N_{VII}$	5.840	1	2.1229	5.6476 [†]	9	2.1953	$L_{II} N_{III}$	0.87996	5	14.0893	0.85192	7	14.553										
$M_V O_{III}$	5.767	9	2.150				$L_{II} N_V$				0.8382	2	14.791										
$N_{IV} N_{VI}$	46.8	2	0.265	45.2 [†]	3	0.274	$\nu L_{II} N_{VI}$	0.85048	5	14.5777	0.82327	7	15.060										
$N_V N_{VI, VII}$	49.4	1	0.2510	47.9 [†]	3	0.259	$L_{II} O_{II}$	0.8490	1	14.604													
81 Thallium						82 Lead																	
$\alpha_2 K L_{II}$	0.175036	2	70.8319	0.170294	2	72.8042	$L_{II} O_{III}$				0.8200	1	15.120										
$\alpha_1 K L_{III}$	0.170136	2	72.8715	0.165376	2	74.9694	$t L_{III} M_{II}$	1.34154	5	9.2417	1.30767	7	9.4811										
$\beta_2 K M_{II}$	0.150980	6	82.118	0.146810	4	84.450	$s L_{III} M_{III}$	1.27807	5	9.7007	1.24385	7	9.9675										
$\beta_1 K M_{III}$	0.150142	5	82.576	0.145970	6	84.936	$L_{III} N_{II}$				1.01040	7	12.2705										
$\beta_2^{II} K N_{II}$	0.14614	1	84.836	0.14212	2	87.23	$L_{III} N_{III}$	1.0286	1	12.053	1.0005	1	12.392										
$\beta_2^I K N_{III}$	0.14595	1	84.946	0.14191	1	87.364	$u L_{III} N_{VI, VII}$	0.9888	1	12.538	0.96133	7	12.8968										
$K O_{II, III}$	0.14509	1	85.451	0.141012	8	87.922	$L_{III} O_{II}$	0.98738	5	12.5566	0.9586	1	12.934										
$K P$				0.1408	1	88.06	$L_{III} O_{III}$	0.98538	5	12.5820	0.9578	1	12.945										
$\beta_3 K M_{IV, V}$	0.14917	1	83.114				$L_{III} P_{II, III}$	0.97926	5	12.6607	0.95118	7	13.0344										
$\beta_3^{II} K M_{IV}$				0.14512	2	85.43	$M_{II} N_{III}$	4.013	9	3.089	3.872	9	3.202										
$\beta_3^I K M_V$				0.14495	3	85.53	$M_{II} N_I$				4.655	8	2.664										
$\beta_4 K N_{IV, V}$	0.14553	2	85.19	0.14155	3	87.59	$M_{III} N_{IV}$	4.116	4	3.013	3.968	5	3.124										
$\beta_4 L_I M_{II}$	1.03918	3	11.9306	1.0075	1	12.306	$M_{III} N_I$	5.884	8	2.107	5.704	8	2.174										
$\beta_4 L_I M_{III}$	1.00062	3	12.3904	0.96911	7	12.7933	$M_{III} N_{IV}$	4.865	5	2.548	4.715	3	2.630										
$\gamma_2 L_I N_{II}$	0.84773	5	14.6251	0.8210	2	15.101	$\gamma M_{III} N_V$	4.823	4	2.571	4.674	1	2.6527										
$\gamma_2 L_I N_{III}$	0.84130	4	14.7368	0.8147	1	15.218	$M_{III} O_I$				4.244	9	2.921										
$\gamma_4 L_I O_{II}$	0.81308	5	15.2482	0.78706	7	15.752	$M_{II} O_{IV, V}$	4.216	6	2.941	4.069	6	3.047										
$\gamma_4 L_I O_{III}$	0.81184	5	15.2716	0.7858	1	15.777	$\zeta_3 M_{IV} N_{II}$	7.032	5	1.763	6.802	5	1.823										
$\eta L_{II} M_I$	1.12769	3	10.9943	1.09241	7	11.3493	$M_{IV} N_{III}$				6.384	7	1.942										
$\beta_1 L_{II} M_{IV}$	1.01513	4	12.2133	0.98291	3	12.6137	$\beta M_{IV} N_{VI}$	5.249	1	2.3621	5.076	1	2.4427										
$\gamma_5 L_{II} N_I$	0.89500	4	13.8526	0.86655	5	14.3075	$M_{IV} O_{II}$	5.196	9	2.386	5.004	9	2.477										
$\gamma_1 L_{II} N_{IV}$	0.86752	3	14.2915	0.83973	3	14.7644	$\zeta_1 M_V N_{III}$	6.974	4	1.778	6.740	3	1.8395										
$\gamma_1 L_{II} O_I$	0.8513	2	14.564	0.82365	5	15.0527	$\alpha_2 M_V N_{VI}$	5.472	2	2.2656	5.299	2	2.3397										
$\gamma_6 L_{II} O_{IV}$	0.8442	2	14.685	0.81683	5	15.1783	$\alpha_1 M_V N_{VII}$	5.460	1	2.2706	5.286	1	2.3455										
$L_{II} P_I$				0.81583	5	15.1969	$M_V O_{III}$				5.168	9	2.399										
$l L_{III} M_I$	1.38477	3	8.9532	1.34990	7	9.1845	$N_{IV} N_{VI}$				42.3	2	0.293										
$\alpha_2 L_{III} M_{IV}$	1.21875	3	10.1728	1.18648	5	10.4495	$N_V N_{VI, VII}$	46.5	2	0.267	45.0	1	0.2756										
$\alpha_1 L_{III} M_V$	1.20739	4	10.2685	1.17501	2	10.5515	$N_{VI} O_{IV}$	115.3	2	0.1075	102.4	1	0.1211										
$\beta_2 L_{III} N_I$	1.04963	5	11.8118	1.0210	1	12.143	$N_{VI} O_V$	113.0	1	0.10968	100.2	2	0.1237										
$\beta_{15} L_{III} N_{IV}$	1.01201	3	12.2510	0.98389	7	12.6011	$N_{VII} O_V$	117.7	1	0.10530	104.3	1	0.1189										
$\beta_2 L_{III} N_V$	1.01031	3	12.2715	0.98221	7	12.6226	83 Bismuth						84 Polonium										
$\beta_1 L_{III} O_I$	0.99017	5	12.5212	0.9620	1	12.888	$\alpha_2 K L_{II}$	0.165717	2	74.8148	0.16130 [†]	1	76.862										
$\beta_5 L_{III} O_{IV, V}$	0.98058	3	12.6436	0.9526	1	13.015	$\alpha_1 K L_{III}$	0.160789	2	77.1079	0.15636 [†]	1	79.290										
$L_I M_I$	1.0644	2	11.648	1.0323	2	12.010	$\beta_2 K M_{II}$	0.142779	7	86.834	0.13892 [†]	2	89.25										
$\beta_{10} L_I M_{IV}$	0.96389	7	12.8626	0.9339	2	13.275	$\beta_1 K M_{III}$	0.141948	3	87.343	0.13807 [†]	2	89.80										
$\beta_9 L_I M_V$	0.95675	7	12.9585	0.9268	1	13.377	$\beta_2^{II} K N_{II}$	0.13817	1	89.733	0.13438 [†]	2	92.26										
$L_I N_I$	0.8549	1	14.503	0.82859	7	14.963	$\beta_2^I K N_{III}$	0.13797	1	89.864	0.13418 [†]	2	92.40										
$L_I N_{IV}$	0.83001	7	14.937	0.80364	7	15.427	$K O_{II, III}$	0.13709	1	90.435													
$\gamma_{11} L_I N_V$	0.82879	5	14.9593	0.80233	9	15.453	$\beta_6 K M_{IV, V}$	0.14111	1	87.860													
$L_I N_{VI, VII}$				0.7884	1	15.725	$\beta_4 K N_{IV, V}$	0.13759	2	90.11													
$L_I O_I$	0.8158	1	15.198	0.7897	1	15.699	$\beta_4 L_I M_{II}$	0.97690	4	12.6912	0.9475	3	13.086										
$L_I O_{IV, V}$	0.80861	5	15.3327	0.78257	7	15.843	$\beta_2 L_I M_{III}$	0.93855	3	13.2098	0.9091	3	13.638										
$L_{II} M_{II}$	1.0997	1	11.274	1.0644	2	11.648	$\gamma_2 L_I N_{II}$	0.79565	3	15.5824	0.772	1	16.07										
$\beta_{11} L_{II} M_{III}$	1.05609	7	11.7397	1.0223	1	12.127	$\gamma_2 L_I N_{III}$	0.78917	5	15.7102													
$L_{II} M_V$	1.00722	5	12.3093	0.9747	1	12.720	$\gamma_4 L_I O_{II}$	0.76198	3	16.2709													
$L_{II} N_{II}$	0.882	2	14.057	0.8585	3	14.442	$\gamma_4 L_I O_{III}$	0.76087	3	16.2947													
							$\gamma_{15} L_I P_{II, III}$	0.75690	3	16.3802													
							$\eta L_{II} M_I$	1.05856	3	11.7122													
							$\beta_1 L_{II} M_{IV}$	0.951978	9	13.0235	0.9220	2	13.447										
							$\gamma_6 L_{II} N_I$	0.83923	5	14.7732													

TABLE V (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV										
83 Bismuth (Cont.)						84 Poenonium (Cont.)						85 Astatine						86 Radon					
$\gamma_1 L_{II}N_{IV}$	0.81311	2	15.2477	0.78748	9	15.744	$\alpha_2 KL_{II}$	0.15705 [†]	2	78.95	0.15294 [†]	3	81.07										
$\gamma_2 L_{II}O_I$	0.7973	1	15.551				$\alpha_1 KL_{III}$	0.15210 [†]	2	81.52	0.14798 [†]	3	83.78										
$\gamma_6 L_{II}O_{IV}$	0.79043	3	15.6853	0.7645	2	16.218	$\beta_3 KM_{II}$	0.13517 [†]	4	91.72	0.13155 [†]	5	94.24										
$l L_{III}M_I$	1.31610	7	9.4204	1.2829	5	9.664	$\beta_1 KM_{III}$	0.13432 [†]	4	92.30	0.13069 [†]	5	94.87										
$\alpha_2 L_{III}M_{IV}$	1.15536	1	10.73091	1.12548 [†]	5	11.0158	$\beta_2^{II} KN_{II}$	0.13072 [†]	4	94.84	0.12719 [†]	5	97.47										
$\alpha_1 L_{III}M_V$	1.14386	2	10.8388	1.11386	4	11.1308	$\beta_2^I KN_{III}$	0.13052 [†]	4	94.99	0.12698 [†]	5	97.64										
$\beta_6 L_{III}N_I$	0.99331	3	12.4816	0.9672	2	12.819	$\beta_8 L_I M_{III}$	0.88135 [†]	9	14.067	0.85436 [†]	9	14.512										
$\beta_{16} L_{III}N_{IV}$	0.95702	5	12.9549	0.9312	2	13.314	$\beta_1 L_{II}M_{IV}$	0.89349 [†]	9	13.876	0.86605 [†]	9	14.316										
$\beta_2 L_{III}N_V$	0.95518	4	12.9799	0.92937	5	13.3404	$\gamma_1 L_{II}N_{IV}$	0.76289 [†]	9	16.251	0.73928 [†]	9	16.770										
$\beta_7 L_{III}O_I$	0.93505	5	13.2593				$\alpha_2 L_{III}M_{IV}$	1.09671 [†]	5	11.3048	1.06899 [†]	5	11.5979										
$\beta_8 L_{III}O_{IV,V}$	0.92556	3	13.3953	0.8996	2	13.782	$\alpha_1 L_{III}M_V$	1.08500 [†]	5	11.4268	1.05723 [†]	5	11.7270										
$L_I M_I$	1.0005	9	12.39				87 Francium						88 Radium										
$\beta_{10} L_I M_{IV}$	0.90495	4	13.7002				$\alpha_2 KL_{II}$	0.14896 [†]	3	83.23	0.14512 [†]	2	85.43										
$\beta_9 L_I M_V$	0.89791	3	13.8077				$\alpha_1 KL_{III}$	0.14399 [†]	3	86.10	0.14014 [†]	2	88.47										
$L_I N_I$	0.8022	1	15.456				$\beta_3 KM_{II}$	0.12807 [†]	5	96.81	0.12469 [†]	3	99.43										
$L_I N_{IV}$	0.7795	5	15.904				$\beta_1 KM_{III}$	0.12719 [†]	5	97.47	0.12382 [†]	3	100.13										
$\gamma_{11} L_I N_V$	0.77728	5	15.951				$\beta_2^{II} KN_{II}$	0.12379 [†]	5	100.16	0.12050 [†]	3	102.89										
$L_I N_{VI,VII}$	0.7641	5	16.23				$\beta_2^I KN_{III}$	0.12358 [†]	5	100.33	0.12029 [†]	3	103.07										
$L_I O_{IV,V}$	0.75791	5	16.358				$\beta_4 L_I M_{II}$				0.84071	5	14.7472										
$L_{II}M_{II}$	1.0346	9	11.98				$\beta_8 L_I M_{III}$	0.82789 [†]	9	14.976	0.80273	5	15.4449										
$\beta_{17} L_{II}M_{III}$	0.98913	5	12.5344				$\gamma_2 L_I N_{II}$				0.68199	5	18.179										
$L_{II}M_V$	0.94419	5	13.1310				$\gamma_2 L_I N_{III}$				0.67538	5	18.357										
$L_{II}N_{II}$	0.8344	9	14.86				$\gamma_4 L_I O_{II}$				0.65131	5	19.036										
$L_{II}N_{III}$	0.8248	1	15.031				$\gamma_4 L_I O_{III}$				0.64965	5	19.084										
$\nu L_{II}N_{VI}$	0.79721	9	15.552				$\gamma_{18} L_I P_{II,III}$				0.64513	5	19.218										
$L_{II}O_{III}$	0.79384	5	15.6178				$\eta L_{II}M_I$				0.90742	5	13.6630										
$l L_{III}M_{II}$	1.2748	1	9.7252				$\beta_1 L_{II}M_{IV}$	0.83940 [†]	9	14.770	0.81375	5	15.2358										
$s L_{III}M_{III}$	1.2105	1	10.2421				$\gamma_6 L_{II}N_I$				0.71774	5	17.274										
$L_{III}N_{II}$	0.98280	5	12.6151				$\gamma_1 L_{II}N_{IV}$	0.71652 [†]	9	17.303	0.69463	5	17.849										
$L_{III}N_{III}$	0.97321	5	12.7394				γ_8				0.6801	1	18.230										
$u L_{III}N_{VI,VII}$	0.93505	5	13.2593				$\gamma_6 L_{II}O_{IV}$				0.67328	5	18.414										
$L_{III}O_{II}$	0.9323	2	13.298				$L_{II}P_I$				0.6724	1	18.439										
$L_{III}O_{III}$	0.9302	2	13.328				$l L_{III}M_I$				1.16719	5	10.6222										
$L_{III}P_{II,III}$	0.92413	4	13.4159				$\alpha_2 L_{III}M_{IV}$	1.04230	5	11.8950	1.01656	5	12.1962										
$M_I N_{II}$	3.892	9	3.185				$\alpha_1 L_{III}M_V$	1.03049	5	12.0313	1.00473	5	12.3397										
$M_I N_{III}$	3.740	9	3.315				$\beta_8 L_{III}N_I$				0.87083	5	14.2362										
$M_{II}N_{IV}$	3.834	4	3.234				$\beta_{16} L_{III}N_{IV}$				0.83722	5	14.8086										
$M_{III}N_I$	5.537	8	2.239				$\beta_2 L_{III}N_V$	0.858	2	14.45	0.83537	5	14.8414										
$M_{III}N_{IV}$	4.571	5	2.712				$\beta_1 L_{III}O_I$				0.8162	1	15.190										
$\gamma M_{III}N_V$	4.532	2	2.735				$\beta_8 L_{III}O_{IV,V}$				0.80627	5	15.3771										
$M_{III}O_I$	4.105	9	3.021				$L_{III}P_I$				0.8050	1	15.402										
$M_{III}O_{IV,V}$	3.932	6	3.153				$\beta_{10} L_I M_{IV}$				0.77546	5	15.988										
$\zeta_2 M_{IV}N_{II}$	6.585	5	1.883				$\beta_9 L_I M_V$				0.76857	5	16.131										
$M_{IV}N_{III}$	6.162	8	2.012				$L_I N_I$				0.6874	1	18.036										
$\beta M_{IV}N_{VI}$	4.909	1	2.5255				$L_I N_{IV}$				0.6666	1	18.600										
$M_{IV}O_{II}$	4.823	3	2.571				$\gamma_{11} L_I N_V$				0.6654	1	18.633										
$M_{IV}P_{II,III}$	4.59	2	2.70				$L_I O_{IV,V}$				0.6468	1	19.167										
$\zeta_1 M_V N_{III}$	6.521	4	1.901				$\beta_{17} L_{II}M_{III}$				0.8438	1	14.692										
$\alpha_2 M_V N_{VI}$	5.130	2	2.4170				$L_{II}N_{III}$				0.7043	1	17.604										
$\alpha_1 M_V N_{VII}$	5.118	1	2.4226				$L_{II}N_V$				0.6932	1	17.884										
$N_I P_{II,III}$	13.30	6	0.932				$L_{II}O_{II}$				0.6780	1	18.286										
$N_{VI}O_{IV}$	91.6	1	0.1354																				
$N_{VII}O_V$	93.2	1	0.1330																				

TABLE V (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV										
87 Francium (Cont.)						88 Radium (Cont.)						89 Actinium (Cont.)						90 Thorium (Cont.)					
$L_{II}O_{III}$				0.6764	1	18.330	$v L_{II}N_{VI}$				0.64064	9	19.353										
$L_{III}P_{II,III}$				0.6714	1	18.466	$L_{II}O_{II}$				0.6369	1	19.466										
$L_{III}N_{II}$				0.8618	1	14.387	$L_{II}O_{III}$				0.6356	1	19.506										
$L_{III}N_{III}$				0.8512	1	14.566	$L_{II}P_{II,III}$				0.6312	1	19.642										
$u L_{III}N_{VI,VII}$				0.8186	1	15.146	$t L_{III}M_I$				1.08009	9	11.4788										
$L_{III}P_{II,III}$				0.8038	1	15.425	$s L_{III}M_{II}$				1.0112	1	12.261										
89 Actinium						90 Thorium						89 Actinium (Cont.)						90 Thorium (Cont.)					
$\alpha_2 K L_{II}$	0.14141 [†]	2	87.67	0.137829	2	89.953	$L_{III}N_{II}$				0.8190	2	15.138										
$\alpha_1 K L_{III}$	0.136417 [†]	8	90.884	0.132813	2	93.350	$L_{III}N_{III}$				0.8082	1	15.341										
$\beta_2 K M_{II}$	0.12143 [†]	2	102.10	0.118268	3	104.831	$u L_{III}N_{VI,VII}$				0.77661	5	15.964										
$\beta_1 K M_{III}$	0.12055 [†]	2	102.85	0.117396	9	105.609	$L_{III}O_{II}$				0.7713	1	16.074										
$\beta_2^{II} K N_{II}$	0.11732 [†]	2	105.67	0.11426	1	108.511	$L_{III}O_{III}$				0.7690	1	16.123										
$\beta_2^I K N_{III}$	0.11711 [†]	2	105.86	0.114040	9	108.717	$L_{III}P_{II,III}$				0.7625	2	16.260										
$K O_{II,III}$				0.11322	1	109.500	$M_I N_{III}$				2.934	8	4.23										
$\beta_3 K M_{IV,V}$				0.116667	9	106.269	$M_I O_{III}$				2.442	9	5.08										
$\beta_4 K N_{IV,V}$				0.11366	2	109.08	$M_{II} N_I$				3.537	9	3.505										
$\beta_4 L_I M_{II}$				0.79257	4	15.6429	$M_{II} N_{IV}$				3.011	2	4.117										
$\beta_3 L_I M_{III}$	0.77822 [†]	9	15.931	0.75479	3	16.4258	$M_{II} O_{IV}$				2.618	5	4.735										
$\gamma_2 L_{II} N_{II}$				0.64221	4	19.305	$M_{III} N_I$				4.568	5	2.714										
$\gamma_3 L_I N_{III}$				0.63559	4	19.507	$M_{III} N_{IV}$				3.718	3	3.335										
$\gamma^4 L_I O_{II}$				0.61251	4	20.242	$\gamma M_{II} N_V$				3.679	2	3.370										
$\gamma^4 L_I O_{III}$				0.61098	4	20.292	$M_{III} O_I$				3.283	9	3.78										
$\gamma_{12} L_I P_{II,III}$				0.60705	8	20.424	$M_{III} O_{IV,V}$				3.131	3	3.959										
$\eta L_{II} M_I$				0.85446	4	14.5099	$\zeta_2 M_V N_{II}$				5.340	5	2.322										
$\beta_1 L_{II} M_{IV}$	0.78903 [†]	9	15.713	0.765210	9	16.2022	$M_{IV} N_{III}$				4.911	5	2.524										
$\gamma_6 L_{II} N_I$				0.67491	4	18.370	$\beta M_{IV} N_{VI}$				3.941	1	3.1458										
$\gamma_1 L_{II} N_{IV}$	0.67351 [†]	9	18.408	0.65313	3	18.9825	$M_{IV} O_{II}$				3.808	4	3.256										
$\gamma_3 L_{II} O_I$				0.63898	5	19.403	$\zeta_1 M_V N_{III}$				5.245	5	2.364										
$\gamma_6 L_{II} O_{IV}$				0.63258	4	19.599	$\alpha_2 M_V N_{VI}$				4.151	2	2.987										
$L_{II} P_I$				0.6316	1	19.629	$\alpha_1 M_V N_{VII}$				4.1381	9	2.9961										
$L_{II} P_{IV}$				0.62991	9	19.682	$M_V P_{III}$				3.760	9	3.298										
$l L_{III} M_I$				1.11508	4	11.1186	$N P_{II}$				9.44	7	1.313										
$\alpha_2 L_{III} M_{IV}$	0.99178 [†]	5	12.5008	0.96788	2	12.8096	$N P_{III}$				9.40	7	1.1319										
$\alpha_1 L_{III} M_V$	0.97993 [†]	5	12.6520	0.95600	3	12.9687	$N_{II} O_{IV}$				11.56	5	1.072										
$\beta_3 L_{III} N_I$				0.82790	8	14.975	$N_I P_I$				11.07	7	1.120										
$\beta_{15} L_{III} N_{IV}$				0.79539	5	15.5875	$N_{III} O_V$				13.8	1	0.897										
$\beta_2 L_{III} N_V$				0.79354	3	15.6237	$N_{IV} N_{VI}$				33.57	9	0.3693										
$\beta_1 L_{III} O_I$				0.77437	4	16.0105	$N_V N_{VI,VII}$				36.32	9	0.3414										
$\beta_3 L_{III} O_{IV,V}$				0.76468	5	16.213	$N_{VI} O_{IV}$				49.5	1	0.2505										
$L_{III} P_I$				0.76338	5	16.241	$N_{VII} O_V$				48.2	1	0.2572										
$L_{III} P_{IV,V}$				0.76087	9	16.295	$O_{III} P_{IV,V}$				50.0	1	0.2479										
$\beta_{10} L_I M_{IV}$				0.7301	1	16.981	$O_{IV,V} O_{II,III}$				68.2	3	0.1817										
$\beta_3 L_I M_V$				0.7234	1	17.139				181.	5	0.068											
$L_I N_I$				0.64755	5	19.146	91 Protactinium						92 Uranium										
$L_I N_{IV}$				0.6276	1	19.755	$\alpha_2 K L_{II}$	0.134343 [†]	9	92.287	0.130968	4	94.665										
$\gamma_{11} L_I N_V$				0.62636	9	19.794	$\alpha_1 K L_{III}$	0.129325 [†]	3	95.868	0.125947	3	98.439										
$L_I N_{VI,VII}$				0.6160	1	20.128	$\beta_2 K M_{II}$	0.11523 [†]	2	107.60	0.112296	4	110.406										
$L_I O_I$				0.6146	1	20.174	$\beta_1 K M_{III}$	0.114345 [†]	8	108.427	0.111394	5	111.300										
$L_I O_{IV,V}$				0.6083	1	20.383	$\beta_2^{II} K N_{II}$	0.11129 [†]	2	111.40	0.10837	1	114.40										
$L_{II} M_{II}$				0.8338	1	14.869	$\beta_2^I K N_{III}$	0.11107 [†]	2	111.62	0.10818	1	114.60										
$\beta_{17} L_{II} M_{III}$				0.79257	4	15.6429	$K O_{II,III}$				0.10744	1	115.39										
$L_{II} M_V$				0.7579	1	16.359	$\beta_3 K M_{IV,V}$				0.11069	1	112.01										
$L_{II} N_{III}$				0.6620	1	18.729	$\beta_4 K N_{IV,V}$				0.10780	2	115.01										
$L_{II} N_V$				0.6521	1	19.014	$\beta_4 L_I M_I$	0.7699	1	16.104	0.747985	9	16.5753										
							$\beta_3 L_I M_{III}$	0.73230	5	16.930	0.71029	2	17.4550										

TABLE V (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV										
91 Protactinium (Cont.)						92 Uranium (Cont.)						91 Protactinium (Cont.)						92 Uranium (Cont.)					
$\gamma_2 L_{II}N_{II}$	0.6239	1	19.872	0.605237	9	20.4847	$M_{IV}O_{II}$	3.691	2	3.359	3.576	1	3.4666										
$\gamma_3 L_{II}N_{III}$	0.6169	1	20.098	0.598574	9	20.7127	$\xi_1 M_{V}N_{III}$	5.092	2	2.4350	4.946	2	2.507										
$\gamma'_4 L_{II}O_{II}$				0.576700	9	21.4984	$\alpha_2 M_{V}N_{VI}$	4.035	3	3.072	3.924	1	3.1595										
$\gamma_4 L_{II}O_{II,III}$	0.5937	1	20.882	0.57499	9	21.562	$\alpha_1 M_{V}N_{VII}$	4.022	1	3.0823	3.910	1	3.1708										
γ_{13}				0.5706	1	21.729	$N_{I}O_{III}$				10.09	7	1.229										
$\eta L_{II}M_I$	0.8295	1	14.946	0.80509	2	15.3997	$N_{I}P_{II}$				8.81	7	1.41										
$\beta_1 L_{II}M_{IV}$	0.74232	5	16.702	0.719984	8	17.2200	$N_{II}P_{III}$				8.76	7	1.42										
$\gamma_5 L_{II}N_I$	0.6550	1	18.930	0.63557	2	19.5072	$N_{II}P_I$				10.40	7	1.192										
$\gamma_1 L_{II}N_{IV}$	0.63358 [†]	9	19.568	0.614770	9	20.1671	$N_{III}O_V$				12.90	9	0.961										
$\gamma_3 L_{II}O_I$				0.60125	5	20.621	$N_{IV}N_{VI}$				31.8	1	0.390										
$\gamma_5 L_{II}O_{IV}$	0.6133	1	20.216	0.594845	9	20.8426	$N_{V}N_{VI,VII}$				34.8	1	0.357										
$L_{III}P_{IV}$				0.59203	5	20.942	$N_{IV}O_V$				43.3	2	0.286										
$l L_{III}M_I$	1.0908	1	11.366	1.06712	2	11.6183	$N_{VI}O_V$				42.1	2	0.295										
$\alpha_2 L_{III}M_{IV}$	0.94482 [†]	5	13.1222	0.922558	9	13.4388	$N_{I}P_{IV,V}$				8.60	7	1.44										
$\alpha_1 L_{III}M_V$	0.93284	5	13.2907	0.910639	9	13.6147																	
$\beta_3 L_{III}N_I$	0.8079	1	15.347	0.78838	2	15.7260	93 Neptunium						94 Plutonium										
$\beta_{15} L_{III}N_{IV}$				0.756642	9	16.3857	$\beta_4 L_{II}M_{II}$	0.72671	2	17.0607	0.70620	2	17.5560										
$\beta_2 L_{III}N_V$	0.7737	1	16.024	0.754681	9	16.4283	$\beta_3 L_{II}M_{III}$	0.68920 [†]	9	17.989	0.66871	2	18.5405										
$\beta_7 L_{III}O_I$	0.7546	2	16.431	0.73602	6	16.845	$\gamma_2 L_{II}N_{II}$	0.5873	5	21.11	0.57068	2	21.7251										
$\beta_5 L_{III}O_{IV,V}$	0.7452	2	16.636	0.726305	9	17.0701	$\gamma_2 L_{II}N_{III}$	0.5810	5	21.34	0.564001	9	21.9824										
$L_{III}P_I$				0.72521	5	17.096	$\gamma'_4 L_{II}O_{II}$				0.5432	1	22.823										
$L_{III}P_{IV,V}$				0.72240	5	17.162	$\gamma_4 L_{II}O_{II,III}$	0.5585	5	22.20	0.5416	1	22.891										
$\beta_{16} L_{II}M_V$	0.7088	2	17.492	0.68760	5	18.031	$\eta L_{II}M_I$	0.7809	2	15.876	0.7591	1	16.333										
$\beta_9 L_{II}M_V$	0.7018	1	17.667	0.681014	8	18.2054	$\beta_1 L_{II}M_{IV}$	0.698478	9	17.7502	0.67772	2	18.2937										
$L_{II}N_{IV}$				0.59096	5	20.979	$\gamma_5 L_{II}N_I$	0.616	1	20.12	0.5988	1	20.704										
$\gamma_{11} L_{II}N_V$				0.58986	5	21.019	$\gamma_1 L_{II}N_{IV}$	0.596498	9	20.7848	0.578882	9	21.4173										
$L_{I}O_{IV,V}$				0.5725	1	21.657	γ_8				0.5658	1	21.914										
$\beta_{17} L_{II}M_{III}$				0.74503	5	16.641	$\gamma_3 L_{II}O_{IV}$	0.57699	5	21.488	0.55973	2	22.1502										
$L_{II}N_{III}$				0.6228	1	19.907	$l L_{III}M_I$	1.0428	6	11.890	1.0226	1	12.124										
$v L_{II}N_{VI}$				0.6031	1	20.556	$\alpha_2 L_{III}M_{IV}$	0.901045	9	13.7597	0.88028	2	14.0842										
$L_{III}O_{III}$				0.59728	5	20.758	$\alpha_1 L_{III}M_V$	0.889128	9	13.9441	0.86830	2	14.2786										
$L_{II}P_{II,III}$				0.5930	2	20.906	$\beta_6 L_{III}N_I$	0.769	1	16.13	0.75148	2	16.4983										
$l L_{III}M_{II}$				1.0347	1	11.982	$\beta_{15} L_{III}N_{IV}$				0.7205	1	17.208										
$s L_{III}M_{III}$				0.9636	1	12.866	$\beta_2 L_{III}N_V$	0.736230	9	16.8400	0.71851	2	17.2553										
$L_{III}N_{II}$				0.78017	9	15.892	$\beta_7 L_{III}O_I$				0.7003	1	17.705										
$L_{III}N_{III}$				0.7691	1	16.120	$\beta_5 L_{III}O_{IV,V}$	0.70814	2	17.5081	0.69068	2	17.9506										
$u L_{III}N_{VI,VII}$				0.738603	9	16.7859	$\beta_{10} L_{II}M_{IV}$				0.6482	1	19.126										
$L_{III}O_{II}$				0.7333	1	16.907	$\beta_3 L_{II}M_V$				0.6416	1	19.323										
$L_{III}O_{III}$				0.7309	1	16.962	$u L_{III}N_{VI,VII}$				0.7031	1	17.635										
$L_{III}P_{II,III}$				0.72426	5	17.118	95 Americium																
$M_I N_{II}$				2.92	2	4.25	$\beta_4 L_{II}M_{II}$	0.68639	2	18.0627													
$M_I N_{III}$				2.753	8	4.50	$\beta_3 L_{II}M_{III}$	0.64891	2	19.1059													
$M_I O_{III}$				2.304	7	5.38	$\gamma_2 L_{II}N_{II}$	0.5544	2	22.361													
$M_I P_{III}$				2.253	6	5.50	$\beta_1 L_{II}M_{IV}$	0.657655	9	18.8520													
$M_{II}N_I$	3.441	5	3.603	3.329	4	3.724	$\gamma_1 L_{II}N_{IV}$	0.561886	9	22.0652													
$M_{II}N_{IV}$	2.910	2	4.260	2.817	2	4.401	$\gamma_3 L_{II}O_{IV}$	0.54311	2	22.8282													
$M_{II}O_V$	2.527	4	4.906	2.443	4	5.075	$l L_{III}M_I$	1.0012	6	12.384													
$M_{III}N_I$	4.450	4	2.786	4.330	2	2.863	$\alpha_2 L_{III}M_{IV}$	0.860266	9	14.4119													
$M_{III}N_{IV}$	3.614	2	3.430	3.521	2	3.521	$\alpha_1 L_{III}M_V$	0.848187	9	14.6172													
$\gamma M_{III}N_V$	3.577	1	3.4657	3.479	1	3.563	$\beta_6 L_{III}N_I$	0.73418	2	16.8870													
$M_{III}O_I$	3.245	9	3.82	3.115	7	3.980	$\beta_{15} L_{III}N_{IV}$	0.70341	2	17.6258													
$M_{III}O_{IV,V}$	3.038	2	4.081	2.948	2	4.205	$\beta_2 L_{III}N_V$	0.701390	9	17.6765													
$\xi_2 M_{IV}N_{II}$	5.193	2	2.3876	5.050	2	2.4548	$\beta_3 L_{III}O_{IV,V}$	0.67383	2	18.3996													
$M_{IV}N_{III}$				4.625	5	2.681																	
$\beta M_{IV}N_{VI}$	3.827	1	3.2397	3.716	1	3.3367																	

TABLE VI. Wavelengths in numerical order of the emission lines and absorption edges.

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
0.10723	1 92 U	K	Abs. Edge	115.62	0.1408	1 82 Pb	KP	88.06	
0.10744	1 92 U	KO _{II,III}	115.39	0.140880	5 82 Pb	K	Abs. Edge	88.005	
0.10780	2 92 U	Kβ ₄	KN _{IV,V}	115.01	0.141012	8 82 Pb	KO _{II,III}	87.922	
0.10818	1 92 U	Kβ ₂ ^I	KN _{III}	114.60	0.14111	1 83 Bi	Kβ ₅	KM _{IV,V}	87.860
0.10837	1 92 U	Kβ ₂ ^{II}	KN _{II}	114.40	0.14141	2 89 Ac	Kα ₂	KL _{II}	87.67
0.11069	1 92 U	Kβ ₅	KM _{IV,V}	112.01	0.14155	3 82 Pb	Kβ ₄	KN _{IV,V}	87.59
0.11107	2 91 Pa	Kβ ₂ ^I	KN _{III}	111.62	0.14191	1 82 Pb	Kβ ₂ ^I	KN _{III}	87.364
0.11129	2 91 Pa	Kβ ₂ ^{II}	KN _{II}	111.40	0.141948	3 83 Bi	Kβ ₁	KM _{III}	87.343
0.111394	5 92 U	Kβ ₁	KM _{III}	111.300	0.14212	2 82 Pb	Kβ ₂ ^{II}	Kβ ₂ ^{II}	87.23
0.112296	4 92 U	Kβ ₃	KM _{II}	110.406	0.142779	7 83 Bi	Kβ ₂	KM _{II}	86.834
0.11307	1 90 Th	K	Abs. Edge	109.646	0.14399	3 87 Fr	Kα ₁	KL _{III}	86.10
0.11322	1 90 Th	KO _{II,III}	109.500	0.14495	1 81 Tl	K	Abs. Edge	85.533	
0.11366	2 90 Th	Kβ ₄	KN _{IV,V}	109.08	0.14495	3 82 Pb	Kβ ₅ ^I	KM _V	85.53
0.114040	9 90 Th	Kβ ₂ ^I	KN _{III}	108.717	0.14509	1 81 Tl	KO _{II,III}	85.451	
0.11426	1 90 Th	Kβ ₂ ^{II}	KN _{II}	108.511	0.14512	2 82 Pb	Kβ ₅ ^{II}	KM _{IV}	85.43
0.114345	8 91 Pa	Kβ ₁	KM _{III}	108.427	0.14512	2 88 Ra	Kα ₂	KL _{II}	85.43
0.11523	2 91 Pa	Kβ ₂	KM _{II}	107.60	0.14553	2 81 Tl	Kβ ₄	KN _{IV,V}	85.19
0.116667	9 90 Th	Kβ ₅	KM _{IV,V}	106.269	0.14595	1 81 Tl	Kβ ₂ ^I	KN _{III}	84.946
0.11711	2 89 Ac	Kβ ₂ ^I	KN _{III}	105.86	0.145970	6 82 Pb	Kβ ₁	KM _{III}	84.936
0.11732	2 89 Ac	Kβ ₂ ^{II}	KN _{II}	105.67	0.14614	1 81 Tl	Kβ ₂ ^{II}	KN _{II}	84.836
0.117396	9 90 Th	Kβ ₁	KM _{III}	105.609	0.146810	4 82 Pb	Kβ ₅	KM _{II}	84.450
0.118268	3 90 Th	Kβ ₂	KM _{II}	104.831	0.14798	3 86 Rn	Kα ₁	KL _{III}	83.78
0.12029	3 88 Ra	Kβ ₂ ^I	KN _{III}	103.07	0.14896	3 87 Fr	Kα ₂	KL _{II}	83.23
0.12050	3 88 Ra	Kβ ₂ ^{II}	KN _{II}	102.89	0.14917	1 81 Tl	Kβ ₅	KM _{IV,V}	83.114
0.12055	2 89 Ac	Kβ ₁	KM _{III}	102.85	0.14918	1 80 Hg	K	Abs. Edge	83.109
0.12143	2 89 Ac	Kβ ₅	KM _{II}	102.10	0.14931	2 80 Hg	KO _{II,III}	83.04	
0.12358	5 87 Fr	Kβ ₂ ^I	KN _{III}	100.33	0.14978	2 80 Hg	Kβ ₄	KN _{IV,V}	82.78
0.12379	5 87 Fr	Kβ ₂ ^{II}	KN _{II}	100.16	0.150142	5 81 Tl	Kβ ₁	KM _{III}	82.576
0.12382	3 88 Ra	Kβ ₁	KM _{III}	100.13	0.15020	2 80 Hg	Kβ ₂ ^I	KN _{III}	82.54
0.12469	3 88 Ra	Kβ ₃	KM _{II}	99.43	0.15040	2 80 Hg	Kβ ₂ ^{II}	KN _{II}	82.43
0.125947	3 92 U	Kα ₁	KL _{III}	98.439	0.150980	6 81 Tl	Kβ ₂	KM _{II}	82.118
0.12698	5 86 Rn	Kβ ₂ ^I	KN _{III}	97.64	0.15210	2 85 At	Kα ₁	KL _{III}	81.52
0.12719	5 86 Rn	Kβ ₂ ^{II}	KN _{II}	97.47	0.15294	3 86 Rn	Kα ₂	KL _{II}	81.07
0.12719	5 87 Fr	Kβ ₁	KM _{III}	97.47	0.15353	2 80 Hg	Kβ ₅	KM _{IV,V}	80.75
0.12807	5 87 Fr	Kβ ₃	KM _{II}	96.81	0.153593	5 79 Au	K	Abs. Edge	80.720
0.129325	3 91 Pa	Kα ₁	KL _{III}	95.868	0.153694	7 79 Au	KO _{II,III}	80.667	
0.13052	4 85 At	Kβ ₂ ^I	KN _{III}	94.99	0.154224	5 79 Au	Kβ ₄	KN _{IV,V}	80.391
0.13069	5 86 Rn	Kβ ₁	KM _{III}	94.87	0.154487	3 80 Hg	Kβ ₁	KM _{III}	80.253
0.13072	4 85 At	Kβ ₂ ^{II}	KN _{II}	94.84	0.154618	9 79 Au	Kβ ₂ ^I	KN _{III}	80.185
0.130968	4 92 U	Kα ₂	KL _{II}	94.665	0.15483	2 79 Au	Kβ ₂ ^{II}	KN _{II}	80.08
0.13155	5 86 Rn	Kβ ₂	KM _{II}	94.24	0.155321	3 80 Hg	Kβ ₂	KM _{II}	79.822
0.132813	2 90 Th	Kα ₁	KL _{III}	93.350	0.15636	1 84 Po	Kα ₁	KL _{III}	79.290
0.13418	2 84 Po	Kβ ₂ ^I	KN _{III}	92.40	0.15705	2 85 At	Kα ₂	KL _{II}	78.95
0.13432	4 85 At	Kβ ₁	KM _{III}	92.30	0.157880	5 79 Au	Kβ ₅ ^I	KM _V	78.529
0.134343	9 91 Pa	Kα ₂	KL _{II}	92.287	0.158062	7 79 Au	Kβ ₅ ^{II}	KM _{IV}	78.438
0.13438	2 84 Po	Kβ ₂ ^{II}	KN _{II}	92.26	0.15818	1 78 Pt	K	Abs. Edge	78.381
0.13517	4 85 At	Kβ ₃	KM _{II}	91.72	0.15826	1 78 Pt	KO _{II,III}	78.341	
0.136417	8 89 Ac	Kα ₁	KL _{III}	90.884	0.15881	2 78 Pt	Kβ ₄	KN _{IV,V}	78.069
0.13694	1 83 Bi	K	Abs. Edge	90.534	0.158982	3 79 Au	Kβ ₁	KM _{III}	77.984
0.13709	1 83 Bi	KO _{II,III}	90.435	0.15920	1 78 Pt	Kβ ₂ ^I	KN _{III}	77.878	
0.13759	2 83 Bi	Kβ ₄	KN _{IV,V}	90.11	0.15939	1 78 Pt	Kβ ₂ ^{II}	KN _{II}	77.785
0.137829	2 90 Th	Kα ₂	KL _{II}	89.953	0.159810	2 79 Au	Kβ ₅	KM _{II}	77.580
0.13797	1 83 Bi	Kβ ₂ ^I	KN _{III}	89.864	0.160789	2 83 Bi	Kα ₁	KL _{III}	77.1079
0.13807	2 84 Po	Kβ ₁	KM _{III}	89.80	0.16130	1 84 Po	Kα ₂	KL _{II}	76.862
0.13817	1 83 Bi	Kβ ₂ ^{II}	KN _{II}	89.733	0.16255	3 78 Pt	Kβ ₅ ^I	KM _V	76.27
0.13892	2 84 Po	Kβ ₅	KM _{II}	89.25	0.16271	2 78 Pt	Kβ ₅ ^{II}	KM _{IV}	76.199
0.14014	2 88 Ra	Kα ₁	KL _{III}	88.47	0.16292	1 77 Ir	K	Abs. Edge	76.101

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
0.163019	5 77 Ir	$KO_{II,III}$	76.053	0.190381	4 78 Pt	$K\alpha_2$	KL_{II}	65.122	
0.16352	2 77 Ir	$K\beta_4$	75.821	0.1908	2 72 Hf	$K\beta_2$	$KN_{II,III}$	64.98	
0.163675	3 78 Pt	$K\beta_1$	75.748	0.190890	2 73 Ta	$K\beta_3$	KM_{II}	64.9488	
0.163956	7 77 Ir	$K\beta_2^I$	KN_{III}	75.619	0.191047	2 77 Ir	$K\alpha_1$	KL_{III}	64.8956
0.16415	1 77 Ir	$K\beta_2^{II}$	KN_{II}	75.529	0.19585	5 71 Lu	K	Abs. Edge	63.31
0.164501	3 78 Pt	$K\beta_3$	KM_{II}	75.368	0.19589	2 71 Lu		$KO_{II,III}$	63.293
0.165376	2 82 Pb	$K\alpha_1$	KL_{III}	74.9694	0.195904	2 77 Ir	$K\alpha_2$	KL_{II}	63.2867
0.165717	2 83 Bi	$K\alpha_2$	KL_{II}	74.8148	0.19607	3 72 Hf	$K\beta_1$	KM_{III}	63.234
0.167373	9 77 Ir	$K\beta_3^I$	KM_V	74.075	0.196794	2 76 Os	$K\alpha_1$	KL_{III}	63.0005
0.16759	2 77 Ir	$K\beta_3^{II}$	KM_{IV}	73.980	0.19686	4 72 Hf	$K\beta_3$	KM_{II}	62.98
0.16787	1 76 Os	K	Abs. Edge	73.856	0.1969	2 71 Lu	$K\beta_2$	$KN_{II,III}$	62.97
0.16798	1 76 Os		$KO_{II,III}$	73.808	0.20084	2 71 Lu	$K\beta_5$	$KM_{IV,V}$	61.732
0.16842	2 76 Os	$K\beta_4$	$KN_{IV,V}$	73.615	0.201639	2 76 Os	$K\alpha_2$	KL_{II}	61.4867
0.168542	2 77 Ir	$K\beta_1$	KM_{III}	73.5608	0.20224	5 70 Yb	K	Abs. Edge	61.30
0.168906	6 76 Os	$K\beta_2^I$	KN_{III}	73.402	0.20226	2 70 Yb		$KO_{II,III}$	61.298
0.16910	1 76 Os	$K\beta_2^{II}$	KN_{II}	73.318	0.20231	3 71 Lu	$K\beta_1$	KM_{III}	61.283
0.169367	2 77 Ir	$K\beta_5$	KM_{II}	73.2027	0.202781	2 75 Re	$K\alpha_1$	KL_{III}	61.1403
0.170136	2 81 Tl	$K\alpha_1$	KL_{III}	72.8715	0.20309	4 71 Lu	$K\beta_3$	KM_{II}	61.05
0.170294	2 82 Pb	$K\alpha_2$	KL_{II}	72.8042	0.2033	2 70 Yb	$K\beta_2$	$KN_{II,III}$	60.89
0.17245	1 76 Os	$K\beta_5^I$	KM_V	71.895	0.20739	2 70 Yb	$K\beta_5$	$KM_{IV,V}$	59.782
0.17262	1 76 Os	$K\beta_5^{II}$	KM_{IV}	71.824	0.207611	1 75 Re	$K\alpha_2$	KL_{II}	59.7179
0.17302	1 75 Re	K	Abs. Edge	71.658	0.20880	5 69 Tm	K	Abs. Edge	59.38
0.17308	1 75 Re		$KO_{II,III}$	71.633	0.20884	8 70 Yb	$K\beta_1$	KM_{III}	59.37
0.173611	3 76 Os	$K\beta_1$	KM_{III}	71.413	0.20891	2 69 Tm		$KO_{II,III}$	59.346
0.17362	2 75 Re	$K\beta_4$	$KN_{IV,V}$	71.410	0.2090100	Std. 74 W	$K\alpha_1$	KL_{III}	59.31824
0.174054	6 75 Re	$K\beta_2^I$	KN_{III}	71.232	0.2096	1 70 Yb	$K\beta_3$	KM_{II}	59.14
0.17425	1 75 Re	$K\beta_2^{II}$	KN_{II}	71.151	0.2098	2 69 Tm	$K\beta_2$	$KN_{II,III}$	59.09
0.174431	3 76 Os	$K\beta_3$	KM_{II}	71.077	0.213828	2 74 W	$K\alpha_2$	KL_{II}	57.9817
0.175036	2 81 Tl	$K\alpha_2$	KL_{II}	70.8319	0.21404	2 69 Tm	$K\beta_5$	$KM_{IV,V}$	57.923
0.175068	3 80 Hg	$K\alpha_1$	KL_{III}	70.819	0.215497	4 73 Ta	$K\alpha_1$	KL_{III}	57.532
0.17766	1 75 Re	$K\beta_1^I$	KM_V	69.786	0.21556	2 69 Tm	$K\beta_1$	KM_{III}	57.517
0.17783	1 75 Re	$K\beta_1^{II}$	KM_{IV}	69.719	0.21567	1 68 Er	K	Abs. Edge	57.487
0.17837	1 74 W	K	Abs. Edge	69.508	0.21581	3 68 Er		$KO_{II,III}$	57.450
0.178444	5 74 W		$KO_{II,III}$	69.479	0.21592	4 74 W		KL_I	57.42
0.178880	3 75 Re	$K\beta_1$	KM_{III}	69.310	0.21636	2 69 Tm	$K\beta_3$	KM_{II}	57.304
0.17892	2 74 W	$K\beta_4$	$KN_{IV,V}$	69.294	0.2167	2 68 Er	$K\beta_2$	$KN_{II,III}$	57.21
0.179421	7 74 W	$K\beta_2^I$	KN_{III}	69.101	0.220305	8 73 Ta	$K\alpha_2$	KL_{II}	56.277
0.17960	1 74 W	$K\beta_2^{II}$	KN_{II}	69.031	0.22124	3 68 Er	$K\beta_5$	$KM_{IV,V}$	56.040
0.179697	3 75 Re	$K\beta_3$	KM_{II}	68.994	0.222227	3 72 Hf	$K\alpha_1$	KL_{III}	55.7902
0.179958	3 80 Hg	$K\alpha_2$	KL_{II}	68.895	0.22266	2 68 Er	$K\beta_1$	KM_{III}	55.681
0.180195	2 79 Au	$K\alpha_1$	KL_{III}	68.8037	0.22291	1 67 Ho	K	Abs. Edge	55.619
0.183092	7 74 W	$K\beta_1^I$	KM_V	67.715	0.22305	3 67 Ho		$KO_{II,III}$	55.584
0.183264	5 74 W	$K\beta_1^{II}$	KM_{IV}	67.652	0.22341	2 68 Er	$K\beta_5$	KM_{II}	55.494
0.18394	1 73 Ta	K	Abs. Edge	67.403	0.2241	2 67 Ho	$K\beta_2$	$KN_{II,III}$	55.32
0.184031	7 73 Ta		$KO_{II,III}$	67.370	0.227024	3 72 Hf	$K\alpha_2$	KL_{II}	54.6114
0.184374	2 74 W	$K\beta_1$	KM_{III}	67.2443	0.22855	3 67 Ho	$K\beta_5$	$KM_{IV,V}$	54.246
0.18451	1 73 Ta	$K\beta_4$	$KN_{IV,V}$	67.194	0.229298	2 71 Lu	$K\alpha_1$	KL_{III}	54.0698
0.185011	8 73 Ta	$K\beta_2^I$	KN_{III}	67.013	0.23012	2 67 Ho	$K\beta_1$	KM_{III}	53.877
0.185075	2 79 Au	$K\alpha_2$	KL_{II}	66.9895	0.23048	1 66 Dy	K	Abs. Edge	53.793
0.185181	2 74 W	$K\beta_3$	KM_{II}	66.9514	0.23056	3 66 Dy		$KO_{II,III}$	53.774
0.185188	9 73 Ta	$K\beta_2^{II}$	KN_{II}	66.949	0.23083	2 67 Ho	$K\beta_3$	KM_{II}	53.711
0.185511	4 78 Pt	$K\alpha_1$	KL_{III}	66.832	0.2317	2 66 Dy	$K\beta_2$	$KN_{II,III}$	53.47
0.18672	4 79 Au		KL_I	66.40	0.234081	2 71 Lu	$K\alpha_2$	KL_{II}	52.9650
0.188757	6 73 Ta	$K\beta_1^I$	KM_V	65.683	0.23618	3 66 Dy	$K\beta_5$	$KM_{IV,V}$	52.494
0.188920	6 73 Ta	$K\beta_1^{II}$	KM_{IV}	65.626	0.236655	2 70 Yb	$K\alpha_1$	KL_{III}	52.3889
0.18982	5 72 Hf	K	Abs. Edge	65.31	0.23788	2 66 Dy	$K\beta_1$	KM_{III}	52.119
0.190089	4 73 Ta	$K\beta_1$	KM_{III}	65.223	0.23841	1 65 Tb	K	Abs. Edge	52.002

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV
0.23858	3 65 Tb	$KO_{II,III}$	51.965	0.315816	2 58 Ce	$K\beta_1$ KM_{III}	39.2573
0.23862	2 66 Dy	$K\beta_2$ KM_{II}	51.957	0.316520	4 58 Ce	$K\beta_2$ KM_{II}	39.1701
0.2397	2 65 Tb	$K\beta_1$ $KN_{II,III}$	51.68	0.31844	5 57 La	K Abs. Edge	38.934
0.241424	2 70 Yb	$K\alpha_2$ KL_{II}	51.3540	0.31864	2 57 La	$KO_{II,III}$	38.909
0.244338	2 69 Tm	$K\alpha_1$ KL_{III}	50.7416	0.31931	2 57 La	$K\beta_4^I$ $KN_{IV,V}$	38.828
0.24608	2 65 Tb	$K\beta_1$ KM_{III}	50.382	0.320117	7 57 La	$K\beta_2$ $KN_{II,III}$	38.7299
0.24681	1 64 Gd	K Abs. Edge	50.233	0.320160	4 61 Pm	$K\alpha_1$ KL_{III}	38.7247
0.24683	2 65 Tb	$K\beta_2$ KM_{II}	50.229	0.324803	4 61 Pm	$K\alpha_2$ KL_{II}	38.1712
0.24687	3 64 Gd	$KO_{II,III}$	50.221	0.32546	2 57 La	$K\beta_5^I$ KM_V	38.094
0.24816	3 64 Gd	$K\beta_2$ $KN_{II,III}$	49.959	0.32563	2 57 La	$K\beta_5^{II}$ KM_{IV}	38.074
0.249095	2 69 Tm	$K\alpha_2$ KL_{II}	49.7726	0.327983	3 57 La	$K\beta_1$ KM_{III}	37.8010
0.252365	2 68 Er	$K\alpha_1$ KL_{III}	49.1277	0.328686	4 57 La	$K\beta_3$ KM_{II}	37.7202
0.25275	3 64 Gd	$K\beta_6$ $KM_{IV,V}$	49.052	0.33104	1 56 Ba	K Abs. Edge	37.452
0.25460	2 64 Gd	$K\beta_1$ KM_{III}	48.697	0.33127	2 56 Ba	$KO_{II,III}$	37.426
0.25534	2 64 Gd	$K\beta_2$ KM_{II}	48.555	0.331846	2 60 Nd	$K\alpha_1$ KL_{III}	37.3610
0.25553	1 63 Eu	K Abs. Edge	48.519	0.33229	2 56 Ba	$K\beta_4^{II}$ KN_{IV}	37.311
0.255645	7 63 Eu	$KO_{II,III}$	48.497	0.33277	1 56 Ba	$K\beta_2$ $KN_{II,III}$	37.257
0.256923	8 63 Eu	$K\beta_2^I$ $KN_{II,III}$	48.256	0.336472	2 60 Nd	$K\alpha_2$ KL_{II}	36.8474
0.257110	2 68 Er	$K\alpha_2$ KL_{II}	48.2211	0.33814	2 56 Ba	$K\beta_5^I$ KM_V	36.666
0.260756	2 67 Ho	$K\alpha_1$ KL_{III}	47.5467	0.33835	2 56 Ba	$K\beta_5^{II}$ KM_{IV}	36.643
0.263577	5 63 Eu	$K\beta_1$ KM_{III}	47.0379	0.340811	3 56 Ba	$K\beta_1$ KM_{III}	36.3782
0.264332	5 63 Eu	$K\beta_2$ KM_{II}	46.9036	0.341507	4 56 Ba	$K\beta_2$ KM_{II}	36.3040
0.26464	5 62 Sm	K Abs. Edge	46.849	0.344140	2 59 Pr	$K\alpha_1$ KL_{III}	36.0263
0.26491	3 62 Sm	$KO_{II,III}$	46.801	0.34451	1 55 Cs	K Abs. Edge	35.987
0.265486	2 67 Ho	$K\alpha_2$ KL_{II}	46.6997	0.34611	2 55 Cs	$K\beta_2$ $KN_{II,III}$	35.822
0.2662	1 62 Sm	$K\beta_2$ $KN_{II,III}$	46.57	0.348749	2 59 Pr	$K\alpha_2$ KL_{II}	35.5502
0.269533	2 66 Dy	$K\alpha_1$ KL_{III}	45.9984	0.354364	7 55 Cs	$K\beta_1$ KM_{III}	34.9869
0.27111	3 62 Sm	$K\beta_5$ $KM_{IV,V}$	45.731	0.355050	4 55 Cs	$K\beta_3$ KM_{II}	34.9194
0.27301	2 62 Sm	$K\beta_1$ KM_{III}	45.413	0.357092	2 58 Ce	$K\alpha_1$ KL_{III}	34.7197
0.27376	2 62 Sm	$K\beta_2$ KM_{II}	45.289	0.3584	5 54 Xe	K Abs. Edge	34.59
0.274247	2 66 Dy	$K\alpha_2$ KL_{II}	45.2078	0.36026	3 54 Xe	$K\beta_2$ $KN_{II,III}$	34.415
0.27431	5 61 Pm	K Abs. Edge	45.198	0.361683	2 58 Ce	$K\alpha_2$ KL_{II}	34.2789
0.2759	1 61 Pm	$K\beta_2$ $KN_{II,III}$	44.93	0.36872	2 54 Xe	$K\beta_1$ KM_{III}	33.624
0.278724	2 65 Tb	$K\alpha_1$ KL_{III}	44.4816	0.36941	2 54 Xe	$K\beta_2$ KM_{II}	33.562
0.28290	3 61 Pm	$K\beta_1$ KM_{III}	43.826	0.370737	2 57 La	$K\alpha_1$ KL_{III}	33.4418
0.283423	2 65 Tb	$K\alpha_2$ KL_{II}	43.7441	0.37381	1 53 I	K Abs. Edge	33.1665
0.28363	4 61 Pm	$K\beta_2$ KM_{II}	43.713	0.37523	2 53 I	$K\beta_2$ $KN_{II,III}$	33.042
0.28453	5 60 Nd	K Abs. Edge	43.574	0.375313	2 57 La	$K\alpha_2$ KL_{II}	33.0341
0.2861	1 60 Nd	$K\beta_2$ $KN_{II,III}$	43.32	0.383905	4 53 I	$K\beta_1$ KM_{III}	32.2947
0.288353	2 64 Gd	$K\alpha_1$ KL_{III}	42.9962	0.384564	4 53 I	$K\beta_3$ KM_{II}	32.2394
0.293038	2 64 Gd	$K\alpha_2$ KL_{II}	42.3089	0.385111	4 56 Ba	$K\alpha_1$ KL_{III}	32.1936
0.293299	2 60 Nd	$K\beta_1$ KM_{III}	42.2713	0.389668	5 56 Ba	$K\alpha_2$ KL_{II}	31.8171
0.294027	3 60 Nd	$K\beta_2$ KM_{II}	42.1665	0.38974	1 52 Te	$KO_{II,III}$	31.8114
0.29518	5 59 Pr	K Abs. Edge	42.002	0.38974	1 52 Te	K Abs. Edge	31.8114
0.29679	2 59 Pr	$K\beta_2$ $KN_{II,III}$	41.773	0.391102	6 52 Te	$K\beta_2$ $KN_{II,III}$	31.7004
0.298446	2 63 Eu	$K\alpha_1$ KL_{III}	41.5422	0.399995	5 52 Te	$K\beta_1$ KM_{III}	30.9957
0.303118	2 63 Eu	$K\alpha_2$ KL_{II}	40.9019	0.400290	4 55 Cs	$K\alpha_1$ KL_{III}	30.9728
0.304261	4 59 Pr	$K\beta_1$ KM_{III}	40.7482	0.400659	4 52 Te	$K\beta_3$ KM_{II}	30.9443
0.304975	5 59 Pr	$K\beta_2$ KM_{II}	40.6529	0.404835	4 55 Cs	$K\alpha_2$ KL_{II}	30.6251
0.30648	5 58 Ce	K Abs. Edge	40.453	0.40666	1 51 Sb	$KO_{II,III}$	30.4875
0.30668	2 58 Ce	$KO_{II,III}$	40.427	0.40668	1 51 Sb	K Abs. Edge	30.4860
0.30737	2 58 Ce	$K\beta_4^I$ $KN_{IV,V}$	40.337	0.40702	1 51 Sb	$K\beta_4^I$ $KN_{IV,V}$	30.4604
0.30816	1 58 Ce	$K\beta_2$ $KN_{II,III}$	40.233	0.407973	5 51 Sb	$K\beta_2$ $KN_{II,III}$	30.3895
0.309040	2 62 Sm	$K\alpha_1$ KL_{III}	40.1181	0.41378	1 51 Sb	$K\beta_5^I$ KM_V	29.9632
0.31342	2 58 Ce	$K\beta_5^I$ KM_V	39.558	0.41388	1 51 Sb	$K\beta_5^{II}$ KM_{IV}	29.9560
0.31357	2 58 Ce	$K\beta_5^{II}$ KM_{IV}	39.539	0.41634	2 54 Xe	$K\alpha_1$ KL_{III}	29.779
0.313698	2 62 Sm	$K\alpha_2$ KL_{II}	39.5224	0.417085	3 51 Sb	$K\beta_1$ KM_{III}	29.7256

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
0.417737	4 51 Sb	$K\beta_3$	KM_{II}	29.6792	0.546200	4 45 Rh	$K\beta_3$	KM_{II}	22.6989
0.42087	2 54 Xe	$K\alpha_2$	KL_{II}	29.458	0.5544	2 95 Am	$L\gamma_2$	$L_I N_{II}$	22.361
0.42467	3 50 Sn		$KO_{II,III}$	29.195	0.5572	1 94 Pu	L_{II}	Abs. Edge	22.253
0.42467	1 50 Sn	K	Abs. Edge	29.1947	0.5585	5 93 Np	$L\gamma_4$	$L_I O_{II,III}$	22.20
0.42495	3 50 Sn	$K\beta_4^I$	$KN_{IV,V}$	29.175	0.5594075	6 47 Ag	$K\alpha_1$	KL_{III}	22.16292
0.425915	8 50 Sn	$K\beta_2$	$KN_{II,III}$	29.1093	0.55973	2 94 Pu	$L\gamma_5$	$L_{II} O_{IV}$	22.1502
0.43175	3 50 Sn	$K\beta_5^I$	KM_V	28.716	0.56051	1 44 Ru	K	Abs. Edge	22.1193
0.43184	3 50 Sn	$K\beta_5^{II}$	KM_{IV}	28.710	0.56089	9 44 Ru	$K\beta_4$	$KN_{IV,V}$	22.104
0.433318	5 53 I	$K\alpha_1$	KL_{II}	28.6120	0.56166	3 44 Ru	$K\beta_2$	$KN_{II,III}$	22.074
0.435236	5 50 Sn	$K\beta_1$	KM_{III}	28.4860	0.561886	9 95 Am	$L\gamma_1$	$L_{II} N_{IV}$	22.0652
0.435877	5 50 Sn	$K\beta_3$	KM_{II}	28.4440	0.563798	4 47 Ag	$K\alpha_2$	KL_{II}	21.9903
0.437829	7 53 I	$K\alpha_2$	KL_{II}	28.3172	0.564001	9 94 Pu	$L\gamma_2$	$L_I N_{III}$	21.9824
0.44371	1 49 In	K	Abs. Edge	27.9420	0.5658	1 94 Pu	$L\gamma_3$	$L_{II} O_I$	21.914
0.44374	3 49 In		$KO_{II,III}$	27.940	0.56785	9 44 Ru	$K\beta_5^I$	KM_V	21.834
0.44393	4 49 In	$K\beta_4^I$	$KN_{IV,V}$	27.928	0.5680	2 44 Ru	$K\beta_5^{II}$	KM_{IV}	21.829
0.44500	1 49 In	$K\beta_2$	$KN_{II,III}$	27.8608	0.5695	1 92 U	L_I	Abs. Edge	21.771
0.45086	2 49 In	$K\beta_5^I$	KM_V	27.499	0.5706	1 92 U	$L\gamma_{13}$	$L_I P_{II,III}$	21.729
0.45098	2 49 In	$K\beta_5^{II}$	KM_{IV}	27.491	0.57068	2 94 Pu	$L\gamma_2$	$L_I N_{II}$	21.1251
0.451295	3 52 Te	$K\alpha_1$	KL_{III}	27.4723	0.572482	4 44 Ru	$K\beta_1$	KM_{III}	21.6568
0.454545	4 49 In	$K\beta_1$	KM_{III}	27.2759	0.5725	1 92 U		$L_I O_{IV,V}$	21.657
0.455181	4 49 In	$K\beta_3$	KM_{II}	27.2377	0.573067	4 44 Ru	$K\beta_3$	KM_{II}	21.6346
0.455784	3 52 Te	$K\alpha_2$	KL_{II}	27.2017	0.57499	9 92 U	$L\gamma_4$	$L_I O_{III}$	21.562
0.46407	1 48 Cd	K	Abs. Edge	26.7159	0.576700	9 92 U	$L\gamma_4'$	$L_I O_{II}$	21.4984
0.465328	7 48 Cd	$K\beta_2$	$KN_{II,III}$	26.6438	0.57699	5 93 Np	$L\gamma_5$	$L_{II} O_{IV}$	21.488
0.470354	3 51 Sb	$K\alpha_1$	KL_{III}	26.3591	0.578882	9 94 Pu	$L\gamma_1$	$L_{II} N_{IV}$	21.4173
0.474827	3 51 Sb	$K\alpha_2$	KL_{II}	26.1108	0.5810	5 93 Np	$L\gamma_3$	$L_I N_{III}$	21.34
0.475105	6 48 Cd	$K\beta_1$	KM_{III}	26.0955	0.585448	3 46 Pd	$K\alpha_1$	KL_{III}	21.1771
0.475730	5 48 Cd	$K\beta_3$	KM_{II}	26.0612	0.5873	5 93 Np	$L\gamma_2$	$L_I N_{II}$	21.11
0.48589	1 47 Ag	K	Abs. Edge	25.5165	0.58906	1 43 Te	K	Abs. Edge	21.0473
0.4859	9 47 Ag	$K\beta_4$	$KN_{IV,V}$	25.512	0.589821	3 46 Pd	$K\alpha_2$	KL_{II}	21.0201
0.487032	4 47 Ag	$K\beta_2$	$KN_{II,III}$	25.4564	0.58986	5 92 U	$L\gamma_{11}$	$L_I N_V$	21.019
0.490599	3 50 Sn	$K\alpha_1$	KL_{III}	25.2713	0.59024	5 43 Tc	$K\beta_2$	$KN_{II,III}$	21.005
0.49306	2 47 Ag	$K\beta_5$	$KM_{IV,V}$	25.145	0.59096	5 92 U		$L_I N_{IV}$	20.979
0.495053	3 50 Sn	$K\alpha_2$	KL_{II}	25.0440	0.5919	1 92 U	L_{II}	Abs. Edge	20.945
0.497069	4 47 Ag	$K\beta_1$	KM_{III}	24.9424	0.59203	5 92 U		$L_{II} P_{IV}$	20.942
0.497685	4 47 Ag	$K\beta_3$	KM_{II}	24.9115	0.5930	2 92 U		$L_{II} P_{II,III}$	20.906
0.5092	1 46 Pd	K	Abs. Edge	24.348	0.5937	1 91 Pa	$L\gamma_4$	$L_I O_{II,III}$	20.882
0.5093	2 46 Pd	$K\beta_4$	$KN_{IV,V}$	24.346	0.594845	9 92 U	$L\gamma_5$	$L_{II} O_{IV}$	20.8426
0.510228	4 46 Pd	$K\beta_2$	$KN_{II,III}$	24.2991	0.596498	9 93 Np	$L\gamma_1$	$L_{II} N_{IV}$	20.7848
0.512113	3 49 In	$K\alpha_1$	KL_{III}	24.2097	0.59728	5 92 U		$L_{II} O_{III}$	20.758
0.516544	3 49 In	$K\alpha_2$	KL_{II}	24.0020	0.598574	9 92 U	$L\gamma_3$	$L_I N_{III}$	20.7127
0.51670	9 46 Pd	$K\beta_5$	$KM_{IV,V}$	23.995	0.5988	1 94 Pu	$L\gamma_5$	$L_{II} N_I$	20.704
0.520520	4 46 Pd	$K\beta_1$	KM_{III}	23.8187	0.60125	5 92 U	$L\gamma_3$	$L_{II} O_I$	20.621
0.521123	4 46 Pd	$K\beta_3$	KM_{II}	23.7911	0.60130	4 43 Tc	$K\beta_1$	KM_{III}	20.619
0.53395	1 45 Rh	K	Abs. Edge	23.2198	0.60188	4 43 Tc	$K\beta_3$	KM_{II}	20.599
0.53401	9 45 Rh	$K\beta_4^I$	$KN_{IV,V}$	23.217	0.6031	1 92 U	L_V	$L_{II} N_{VI}$	20.556
0.535010	3 48 Cd	$K\alpha_1$	KL_{III}	23.1736	0.605237	9 92 U	$L\gamma_2$	$L_I N_{II}$	20.4847
0.53503	2 45 Rh	$K\beta_2$	$KN_{II,III}$	23.1728	0.6059	1 90 Th	L_I	Abs. Edge	20.464
0.53513	5 45 Rh	$K\beta_5^{II}$	KN_{II}	23.168	0.60705	8 90 Th	$L\gamma_{13}$	$L_I P_{II,III}$	20.424
0.5365	1 94 Pu	L_I	Abs. Edge	23.109	0.6083	1 90 Th		$L_I O_{IV,V}$	20.383
0.539422	3 48 Cd	$K\alpha_2$	KL_{II}	22.9841	0.61098	4 90 Th	$L\gamma_4$	$L_I O_{III}$	20.292
0.54101	9 45 Rh	$K\beta_5^I$	KM_V	22.917	0.61251	4 90 Th	$L\gamma_4'$	$L_I O_{II}$	20.242
0.54118	9 45 Rh	$K\beta_5^{II}$	KM_{IV}	22.909	0.6133	1 91 Pa	$L\gamma_5$	$L_{II} O_{IV}$	20.216
0.5416	1 94 Pu	$L\gamma_4$	$L_I O_{III}$	22.891	0.613279	4 45 Rh	$K\alpha_1$	KL_{III}	20.2161
0.54311	2 95 Am	$L\gamma_5$	$L_{II} O_{IV}$	22.8282	0.6146	1 90 Th		$L_I O_I$	20.174
0.5432	1 94 Pu	$L\gamma_4'$	$L_I O_{II}$	22.823	0.614770	9 92 U	$L\gamma_1$	$L_{II} N_{IV}$	20.1671
0.545605	4 45 Rh	$K\beta_1$	KM_{III}	22.7236	0.6160	1 90 Th		$L_I N_{VI,VII}$	20.128

TABLE VI (Continued)

Wavelength					Wavelength						
\AA^*	p.e.	Element	Designation	keV	\AA^*	p.e.	Element	Designation	keV		
0.616	1	93 Np	$L\gamma_5$	$L_{II}N_I$	20.12	0.67383	2	95 Am	$L\beta_5$	$L_{III}O_{IV,V}$	18.3996
0.6169	1	91 Pa	$L\gamma_3$	$L_{II}N_{III}$	20.098	0.67491	4	90 Th	$L\gamma_6$	$L_{II}N_I$	18.370
0.617630	4	45 Rh	$K\alpha_2$	KL_{II}	20.0737	0.67502	3	43 Tc	$K\alpha_1$	KL_{III}	18.3671
0.61978	1	42 Mo	K	Abs. Edge	20.0039	0.67538	5	88 Ra	$L\gamma_3$	$L_{II}N_{III}$	18.357
0.62001	9	42 Mo	$K\beta_1^I$	$KN_{IV,V}$	19.996	0.6764	1	88 Ra		$L_{II}O_{III}$	18.330
0.62099	2	42 Mo	$K\beta_2$	$KN_{II,III}$	19.9652	0.67772	2	94 Pu	$L\beta_1$	$L_{II}M_{IV}$	18.2937
0.62107	5	42 Mo	$K\beta_2^{II}$	KN_{II}	19.963	0.6780	1	88 Ra		$L_{II}O_{II}$	18.286
0.6228	1	92 U		$L_{II}N_{III}$	19.907	0.67932	3	43 Tc	$K\alpha_2$	KL_{II}	18.2508
0.6239	1	91 Pa	$L\gamma_2$	$L_{II}N_{II}$	19.872	0.6801	1	88 Ra	$L\gamma_8$	$L_{II}O_I$	18.230
0.62636	9	90 Th	$L\gamma_{II}$	$L_{II}N_V$	19.794	0.681014	8	92 U	$L\beta_3$	$L_{II}M_V$	18.2054
0.62692	5	42 No	$K\beta_3^I$	KM_V	19.776	0.68199	5	88 Ra	$L\gamma_2$	$L_{II}N_{II}$	18.179
0.62708	5	42 Mo	$K\beta_3^{II}$	KM_{IV}	19.771	0.68639	2	95 Am	$L\beta_4$	$L_{II}M_{II}$	18.0627
0.6276	1	90 Th		$L_{II}N_{IV}$	19.755	0.6867	1	94 Pu	L_{III}	Abs. Edge	18.054
0.6299	1	90 Th	L_{II}	Abs. Edge	19.683	0.6874	1	88 Ra		$L_{II}N_I$	18.036
0.62991	9	90 Th		$L_{II}P_{IV}$	19.682	0.68760	5	92 U	$L\beta_{10}$	$L_{II}M_{IV}$	18.031
0.6312	1	90 Th		$L_{II}P_{II,III}$	19.642	0.68883	1	40 Zr	K	Abs. Edge	17.9989
0.6316	1	90 Th		$L_{II}P_I$	19.629	0.68901	5	40 Zr	$K\beta_4$	$KN_{IV,V}$	17.994
0.632288	9	42 Mo	$K\beta_1$	KM_{III}	19.6083	0.68920	9	93 Np	$L\beta_3$	$L_{II}M_{III}$	17.989
0.63258	4	90 Th	$L\gamma_6$	$L_{II}O_{IV}$	19.599	0.68993	4	40 Zr	$K\beta_2$	$KN_{II,III}$	17.970
0.632872	2	42 Mo	$K\beta_3$	KM_{II}	19.5903	0.69068	2	94 Pu	$L\beta_5$	$L_{III}O_{IV,V}$	17.9506
0.63358	9	91 Pa	$L\gamma_1$	$L_{II}N_{IV}$	19.568	0.6932	1	88 Ra		$L_{II}N_V$	17.884
0.63557	2	92 U	$L\gamma_5$	$L_{II}N_I$	19.5072	0.69463	5	88 Ra	$L\gamma_1$	$L_{II}N_{IV}$	17.849
0.63559	4	90 Th	$L\gamma_3$	$L_{II}N_{III}$	19.507	0.6959	1	40 Zr	$K\beta_5$	$KM_{IV,V}$	17.815
0.6356	1	90 Th		$L_{II}O_{III}$	19.506	0.698478	9	93 Np	$L\beta_1$	$L_{II}M_{IV}$	17.7502
0.6369	1	90 Th		$L_{II}O_{II}$	19.466	0.7003	1	94 Pu	$L\beta_7$	$L_{III}O_I$	17.705
0.63898	5	90 Th	$L\gamma_8$	$L_{II}O_I$	19.403	0.701390	9	95 Am	$L\beta_2$	$L_{III}N_V$	17.6765
0.64064	9	90 Th	$L\gamma$	$L_{II}N_{VI}$	19.353	0.70173	3	40 Zr	$K\beta_1$	KM_{III}	17.6678
0.6416	1	94 Pu	$L\beta_9$	$L_{II}M_V$	19.323	0.7018	1	91 Pa	$L\beta_9$	$L_{II}M_V$	17.667
0.64221	4	90 Th	$L\gamma_2$	$L_{II}N_{II}$	19.305	0.70228	4	40 Zr	$K\beta_3$	KM_{II}	17.654
0.643083	4	44 Ru	$K\alpha_1$	KL_{III}	19.2792	0.7031	1	94 Pu	$L\gamma$	$L_{III}N_{VI,VII}$	17.635
0.6445	1	88 Ra	L_I	Abs. Edge	19.236	0.70341	2	95 Am	$L\beta_{15}$	$L_{III}N_{IV}$	17.6258
0.64513	5	88 Ra	$L\gamma_{13}$	$L_I P_{II,III}$	19.218	0.7043	1	88 Ra		$L_{II}N_{III}$	17.604
0.6468	1	88 Ra		$L_I O_{IV,V}$	19.167	0.70620	2	94 Pu	$L\beta_4$	$L_{II}M_{II}$	17.5560
0.647408	5	44 Ru	$K\alpha_2$	KL_{II}	19.1504	0.70814	2	93 Np	$L\beta_5$	$L_{III}O_{IV,V}$	17.5081
0.64755	5	90 Th		$L_{II}N_I$	19.146	0.7088	2	91 Pa	$L\beta_{10}$	$L_{II}M_{IV}$	17.492
0.6482	1	94 Pu	$L\beta_{10}$	$L_{II}M_{IV}$	19.126	0.709300	1	42 Mo	$K\alpha_1$	KL_{III}	17.47934
0.64891	2	95 Am	$L\beta_3$	$L_{II}M_{III}$	19.1059	0.71029	2	92 U	$L\beta_3$	$L_{II}M_{III}$	17.4550
0.64965	5	88 Ra	$L\gamma_4$	$L_I O_{III}$	19.084	0.713590	6	42 Mo	$K\alpha_2$	KL_{II}	17.3743
0.65131	5	88 Ra	$L\gamma_4'$	$L_I O_{II}$	19.036	0.71652	9	87 Fr	$L\gamma_1$	$L_{II}N_{IV}$	17.303
0.6521	1	90 Th		$L_{II}N_V$	19.014	0.71774	5	88 Ra	$L\gamma_6$	$L_{II}N_I$	17.274
0.65298	1	41 Nb	K	Abs. Edge	18.9869	0.71851	2	94 Pu	$L\beta_2$	$L_{III}N_V$	17.2553
0.65313	3	90 Th	$L\gamma_1$	$L_{II}N_{IV}$	18.9825	0.719984	8	92 U	$L\beta_1$	$L_{II}M_{IV}$	17.2200
0.65318	5	41 Nb	$K\beta_4$	$KN_{IV,V}$	18.981	0.7205	1	94 Pu	$L\beta_{15}$	$L_{III}N_{IV}$	17.208
0.65416	4	41 Nb	$K\beta_2$	$KN_{II,III}$	18.953	0.7223	1	92 U	L_{III}	Abs. Edge	17.165
0.6550	1	91 Pa	$L\gamma_5$	$L_{II}N_I$	18.930	0.72240	5	92 U		$L_{III}P_{IV,V}$	17.162
0.657655	9	95 Am	$L\beta_1$	$L_{II}M_{IV}$	18.8520	0.7234	1	90 Th	$L\beta_9$	$L_{II}M_V$	17.139
0.6620	1	90 Th		$L_{II}N_{III}$	18.729	0.72426	5	92 U		$L_{III}P_{II,III}$	17.118
0.6654	1	88 Ra	$L\gamma_{11}$	$L_{II}N_V$	18.633	0.72521	5	92 U		$L_{III}P_I$	17.096
0.66576	2	41 Nb	$K\beta_1$	KM_{III}	18.6225	0.726305	9	92 U	$L\beta_2$	$L_{III}O_{IV,V}$	17.0701
0.66634	3	41 Nb	$K\beta_3$	KM_{II}	18.6063	0.72671	2	93 Np	$L\beta_4$	$L_{II}M_{II}$	17.0607
0.6666	1	88 Ra		$L_{II}N_{IV}$	18.600	0.72766	5	39 Y	K	Abs. Edge	17.038
0.66871	2	94 Pu	$L\beta_3$	$L_{II}M_{III}$	18.5405	0.72776	5	39 Y	$K\beta_4$	$KN_{IV,V}$	17.036
0.6707	1	88 Ra	L_{II}	Abs. Edge	18.486	0.72864	4	39 Y	$K\beta_2$	$KN_{II,III}$	17.0154
0.6714	1	88 Ra		$L_{II}P_{II,III}$	18.466	0.7301	1	90 Th	$L\beta_{10}$	$L_{II}M_{IV}$	16.981
0.6724	1	88 Ra		$L_{II}P_I$	18.439	0.7309	1	92 U		$L_{III}O_{III}$	16.962
0.67328	5	88 Ra	$L\gamma_6$	$L_{II}O_{IV}$	18.414	0.73230	5	91 Pa	$L\beta_3$	$L_{II}M_{III}$	16.930
0.67351	9	89 Ac	$L\gamma_1$	$L_{II}N_{IV}$	18.408	0.7333	1	92 U		$L_{III}O_{II}$	16.907

TABLE VI (Continued)

Wavelength \AA^*	p.e. Element	Designation	keV	Wavelength \AA^*	p.e. Element	Designation	keV		
0.73418	2 95 Am	$L\beta_6$	$L_{III}N_I$	16.8870	0.78292	2 38 Sr	$K\beta_1$	KM_{III}	15.8357
0.7345	1 39 Y	$K\beta_3$	$KM_{IV,V}$	16.879	0.78345	3 38 Sr	$K\beta_3$	KM_{II}	15.8249
0.73602	6 92 U	$L\beta_7$	$L_{III}O_I$	16.845	0.7858	1 82 Pb	$L\gamma_4$	$L_I O_{III}$	15.777
0.736230	9 93 Np	$L\beta_2$	$L_{III}N_V$	16.8400	0.78593	1 40 Zr	$K\alpha_1$	KL_{III}	15.7751
0.738603	9 92 U	$L\alpha$	$L_{III}N_{VI,VII}$	16.7859	0.78706	7 82 Pb	$L\gamma_4'$	$L_I O_{II}$	15.752
0.73928	9 86 Rn	$L\gamma_1$	$L_{II}N_{IV}$	16.770	0.78748	9 84 Po	$L\gamma_1$	$L_{II}N_{IV}$	15.744
0.74072	2 39 Y	$K\beta_1$	KM_{III}	16.7378	0.78838	2 92 U	$L\beta_6$	$L_{III}N_I$	15.7260
0.74126	3 39 Y	$K\beta_3$	KM_{II}	16.7258	0.7884	1 82 Pb		$L_{II}N_{VI,VII}$	15.725
0.74232	5 91 Pa	$L\beta_1$	$L_{II}M_{IV}$	16.702	0.7887	1 83 Bi	L_{II}	Abs. Edge	15.719
0.74503	5 92 U	$L\beta_{17}$	$L_{II}M_{III}$	16.641	0.78903	9 89 Ac	$L\beta_1$	$L_{II}M_{IV}$	15.713
0.7452	2 91 Pa	$L\beta_6$	$L_{III}O_{IV,V}$	16.636	0.78917	5 83 Bi	$L\gamma_3$	$L_I N_{III}$	15.7102
0.74620	1 41 Nb	$K\alpha_1$	KL_{III}	16.6151	0.7897	1 82 Pb		$L_I O_I$	15.699
0.747985	9 92 U	$L\beta_4$	$L_I M_{II}$	16.5753	0.79015	1 40 Zr	$K\alpha_2$	KL_{II}	15.6909
0.75044	1 41 Nb	$K\alpha_2$	KL_{II}	16.5210	0.79043	3 83 Bi	$L\gamma_5$	$L_{II}O_{IV}$	15.6853
0.75148	2 94 Pu	$L\beta_6$	$L_{III}N_I$	16.4983	0.79257	4 90 Th	$L\beta_4$	$L_I M_{II}$	15.6429
0.7546	2 91 Pa	$L\beta_7$	$L_{III}O_I$	16.431	0.79257	4 90 Th	$L\beta_{17}$	$L_{II}M_{III}$	15.6429
0.754681	9 92 U	$L\beta_2$	$L_{III}N_V$	16.4283	0.79354	3 90 Th	$L\beta_2$	$L_{III}M_V$	15.6237
0.75479	3 90 Th	$L\beta_3$	$L_I M_{III}$	16.4258	0.79384	5 83 Bi		$L_{II}O_{III}$	15.6178
0.756642	9 92 U	$L\beta_{16}$	$L_{III}N_{IV}$	16.3857	0.79539	5 90 Th	$L\beta_{16}$	$L_{III}N_{IV}$	15.5875
0.75690	3 83 Bi	$L\gamma_{13}$	$L_I P_{II,III}$	16.3802	0.79565	3 83 Bi	$L\gamma_2$	$L_I N_{II}$	15.5824
0.7571	1 83 Bi	L_I	Abs. Edge	16.376	0.79721	9 83 Bi	$L\gamma$	$L_{II}N_{VI}$	15.552
0.7579	1 90 Th		$L_{II}M_V$	16.359	0.7973	1 83 Bi	$L\gamma_3$	$L_{II}O_I$	15.551
0.75791	5 83 Bi		$L_I O_{IV,V}$	16.358	0.8022	1 83 Bi		$L_I N_I$	15.456
0.7591	1 94 Pu	$L\eta$	$L_{II}M_I$	16.333	0.80233	9 82 Pb	$L\gamma_{11}$	$L_I N_V$	15.453
0.7607	1 90 Th	L_{III}	Abs. Edge	16.299	0.80273	5 88 Ra	$L\beta_5$	$L_I M_{III}$	15.4449
0.76087	9 90 Th		$L_{III}P_{IV,V}$	16.295	0.8028	1 88 Ra	L_{III}	Abs. Edge	15.444
0.76087	3 83 Bi	$L\gamma_4$	$L_I O_{III}$	16.2947	0.80364	7 82 Pb		$L_I N_{IV}$	15.427
0.76198	3 83 Bi	$L\gamma_4'$	$L_I O_{II}$	16.2709	0.8038	1 88 Ra		$L_{III}P_{II,III}$	15.425
0.7625	2 90 Th		$L_{III}P_{II,III}$	16.260	0.8050	1 88 Ra		$L_{III}P_I$	15.402
0.76289	9 85 At	$L\gamma_1$	$L_{II}N_{IV}$	16.251	0.80509	2 92 U	$L\eta$	$L_{II}M_I$	15.3997
0.76338	5 90 Th		$L_{III}P_I$	16.241	0.80627	5 88 Ra	$L\beta_6$	$L_{III}O_{IV,V}$	15.3771
0.7641	5 83 Bi		$L_I N_{VI,VII}$	16.23	0.8079	1 91 Pa	$L\beta_6$	$L_{III}N_I$	15.347
0.7645	2 84 Po	$L\gamma_6$	$L_{II}O_{IV}$	16.218	0.8081	1 81 Tl	L_I	Abs. Edge	15.343
0.76468	5 90 Th	$L\beta_5$	$L_{III}O_{IV,V}$	16.213	0.8082	1 90 Th		$L_{III}N_{III}$	15.341
0.765210	9 90 Th	$L\beta_1$	$L_{II}M_{IV}$	16.2022	0.80861	5 81 Tl		$L_I O_{IV,V}$	15.3327
0.76857	5 88 Ra	$L\beta_3$	$L_I M_V$	16.131	0.81163	9 90 Th		$L_I M_I$	15.276
0.769	1 93 Np	$L\beta_6$	$L_{III}N_I$	16.13	0.81184	5 81 Tl	$L\gamma_4$	$L_I O_{III}$	15.2716
0.7690	1 90 Th		$L_{III}O_{III}$	16.123	0.81308	5 81 Tl	$L\gamma_4'$	$L_I O_{II}$	15.2482
0.7691	1 92 U		$L_{III}N_{III}$	16.120	0.81311	2 83 Bi	$L\gamma_1$	$L_{II}N_{IV}$	15.2477
0.76973	5 38 Sr	K	Abs. Edge	16.107	0.81375	5 88 Ra	$L\beta_1$	$L_{II}M_{IV}$	15.2358
0.7699	1 91 Pa	$L\beta_4$	$L_I M_{II}$	16.104	0.8147	1 82 Pb	$L\gamma_3$	$L_I N_{III}$	15.218
0.76989	5 38 Sr	$K\beta_4$	$KN_{IV,V}$	16.104	0.81538	5 82 Pb	L_{II}	Abs. Edge	15.2053
0.77081	3 38 Sr	$K\beta_2$	$KN_{II,III}$	16.0846	0.8154	2 37 Rb	$K\beta_4$	$KN_{IV,V}$	15.205
0.7713	1 90 Th		$L_{III}O_{II}$	16.074	0.81554	5 37 Rb	K	Abs. Edge	15.2023
0.772	1 84 Po	$L\gamma_2$	$L_I N_{II}$	16.07	0.8158	1 81 Tl		$L_I O_I$	15.198
0.7737	1 91 Pa	$L\beta_2$	$L_{III}N_V$	16.024	0.81583	5 82 Pb		$L_{II}P_I$	15.1969
0.77437	4 90 Th	$L\beta_7$	$L_{III}O_I$	16.0105	0.8162	1 88 Ra	$L\beta_7$	$L_{III}O_I$	15.190
0.77546	5 88 Ra	$L\beta_{10}$	$L_I M_{IV}$	15.988	0.81645	3 37 Rb	$K\beta_2$	$KN_{II,III}$	15.1854
0.7764	1 38 Sr	$K\beta_5$	$KM_{IV,V}$	15.969	0.81683	5 82 Pb	$L\gamma_5$	$L_{II}O_{IV}$	15.1783
0.77661	5 90 Th	$L\alpha$	$L_{III}N_{VI,VII}$	15.964	0.8186	1 88 Ra	$L\alpha$	$L_{III}N_{VI,VII}$	15.146
0.77728	5 83 Bi	$L\gamma_{11}$	$L_I N_V$	15.951	0.8190	2 90 Th		$L_{III}N_{II}$	15.138
0.77822	9 89 Ac	$L\beta_3$	$L_I M_{III}$	15.931	0.8200	1 82 Pb		$L_{II}O_{III}$	15.120
0.77954	5 83 Bi		$L_I N_{IV}$	15.904	0.8210	2 82 Pb	$L\gamma_2$	$L_I N_{II}$	15.101
0.78017	9 92 U		$L_{III}N_{II}$	15.892	0.8219	1 37 Rb	$K\beta_5$	$KM_{IV,V}$	15.085
0.7809	2 93 Np	$L\eta$	$L_{II}M_I$	15.876	0.82327	7 82 Pb	$L\gamma$	$L_{II}N_{VI}$	15.060
0.78196	5 82 Pb	L_I	Abs. Edge	15.855	0.82365	5 82 Pb	$L\gamma_3$	$L_{II}O_I$	15.0527
0.78257	7 82 Pb		$L_I O_{IV,V}$	15.843	0.8248	1 83 Bi		$L_{II}N_{III}$	15.031

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
0.82789	9 87 Fr	$L\beta_3$	$L_{II}M_{III}$	14.976	0.87088	5 88 Ra	$L\beta_3$	$L_{III}N_I$	14.2362
0.82790	8 90 Th	$L\beta_3$	$L_{III}N_I$	14.975	0.8722	1 80 Hg	L_{II}	Abs. Edge	14.215
0.82859	7 82 Pb		$L_I N_I$	14.963	0.87319	7 80 Hg	$L\gamma_6$	$L_{II}O_{IV}$	14.199
0.82868	2 37 Rb	$K\beta_1$	KM_{III}	14.9613	0.87526	1 38 Sr	$K\alpha_1$	KL_{III}	14.1650
0.82879	5 81 Tl	$L\gamma_{11}$	$L_I N_V$	14.9593	0.87544	7 80 Hg	$L\gamma_2$	$L_I N_{II}$	14.162
0.82884	1 39 Y	$K\alpha_1$	KL_{III}	14.9584	0.8758	1 80 Hg		$L_{II}O_{III}$	14.156
0.82921	3 37 Rb	$K\beta_3$	KM_{II}	14.9517	0.8784	1 80 Hg		$L_{II}O_{II}$	14.114
0.8295	1 91 Pa	$L\eta$	$L_{II}M_I$	14.946	0.8785	1 36 Kr	$K\beta_1$	KM_{III}	14.112
0.83001	7 81 Tl		$L_I N_{IV}$	14.937	0.87885	7 80 Hg	$L\nu$	$L_{II}N_{VI}$	14.107
0.83305	1 39 Y	$K\alpha_2$	KL_{II}	14.8829	0.8790	1 36 Kr	$K\beta_3$	KM_{II}	14.104
0.8338	1 90 Th		$L_{II}M_{II}$	14.869	0.87943	1 38 Sr	$K\alpha_2$	KL_{II}	14.0979
0.8344	9 83 Bi		$L_{II}N_{II}$	14.86	0.87995	7 80 Hg	$L\gamma_3$	$L_{II}O_I$	14.090
0.8350	2 80 Hg		$L_I O_{IV,V}$	14.847	0.87996	5 81 Tl		$L_{II}N_{III}$	14.0893
0.8353	1 80 Hg	L_I	Abs. Edge	14.842	0.88028	2 94 Pu	$L\alpha_2$	$L_{III}M_{IV}$	14.0842
0.83537	5 88 Ra	$L\beta_2$	$L_{III}N_V$	14.8414	0.88135	9 85 At	$L\beta_3$	$L_I M_{III}$	14.067
0.83722	5 88 Ra	$L\beta_{13}$	$L_{III}N_{IV}$	14.8086	0.8827	2 80 Hg		$L_I N_I$	14.045
0.8382	2 82 Pb		$L_{II}N_V$	14.791	0.88433	7 79 Au	$L\gamma_{11}$	$L_I N_V$	14.020
0.83894	7 80 Hg	$L\gamma_4$	$L_I O_{III}$	14.778	0.88563	7 79 Au		$L_I N_{IV}$	13.999
0.83923	5 83 Bi	$L\gamma_5$	$L_{II}N_I$	14.7732	0.8882	2 81 Tl		$L_{II}M_{II}$	13.959
0.83940	9 87 Fr	$L\beta_1$	$L_{II}M_{IV}$	14.770	0.889128	9 93 Np	$L\alpha_1$	$L_{III}M_V$	13.9441
0.83973	3 82 Pb	$L\gamma_1$	$L_{II}N_{IV}$	14.7644	0.8931	1 78 Pt	L_I	Abs. Edge	13.883
0.84013	7 80 Hg	$L\gamma_4'$	$L_I O_{II}$	14.757	0.8934	1 78 Pt		$L_I O_V$	13.878
0.84071	5 88 Ra	$L\beta_4$	$L_I M_{II}$	14.7472	0.89349	9 85 At	$L\beta_1$	$L_{II}M_{IV}$	13.876
0.84130	4 81 Tl	$L\gamma_8$	$L_I N_{III}$	14.7368	0.8943	1 78 Pt		$L_I O_{IV}$	13.864
0.8434	1 81 Tl	L_{II}	Abs. Edge	14.699	0.89500	4 81 Tl	$L\gamma_3$	$L_{II}N_I$	13.8526
0.8438	1 88 Ra	$L\beta_{17}$	$L_{II}M_{III}$	14.692	0.89646	5 80 Hg	$L\gamma_1$	$L_{II}N_{IV}$	13.8301
0.8442	2 81 Tl	$L\gamma_6$	$L_{II}O_{IV}$	14.685	0.89659	4 78 Pt	$L\gamma_4$	$L_I O_{III}$	13.8281
0.8452	2 80 Hg		$L_I O_I$	14.670	0.89747	4 78 Pt	$L\gamma_4'$	$L_I O_{II}$	13.8145
0.84773	5 81 Tl	$L\gamma_2$	$L_I N_{II}$	14.6251	0.89783	5 79 Au	$L\gamma_2$	$L_I N_{III}$	13.8090
0.848187	9 95 Am	$L\alpha_1$	$L_{III}M_V$	14.6172	0.89791	3 83 Bi	$L\beta_3$	$L_I M_V$	13.8077
0.8490	1 81 Tl		$L_{II}O_{II}$	14.604	0.8995	2 78 Pt		$L_I O_I$	13.784
0.85048	5 81 Tl	$L\nu$	$L_{II}N_{VI}$	14.5777	0.8996	2 84 Po	$L\beta_3$	$L_{III}O_{IV,V}$	13.782
0.8512	1 88 Ra		$L_{III}N_{III}$	14.566	0.901045	9 93 Np	$L\alpha_2$	$L_{III}M_{IV}$	13.7597
0.8513	2 81 Tl	$L\gamma_8$	$L_{II}O_I$	14.564	0.90259	5 79 Au	L_{II}	Abs. Edge	13.7361
0.85192	7 82 Pb		$L_{II}N_{III}$	14.553	0.90297	3 79 Au	$L\gamma_6$	$L_{II}O_{IV}$	13.7304
0.85436	9 86 Rn	$L\beta_3$	$L_I M_{III}$	14.512	0.90434	3 79 Au	$L\gamma_2$	$L_I N_{II}$	13.7095
0.85446	4 90 Th	$L\eta$	$L_{II}M_I$	14.5099	0.90495	4 83 Bi	$L\beta_{10}$	$L_I M_{IV}$	13.7002
0.8549	1 81 Tl		$L_I N_I$	14.503	0.90638	7 79 Au		$L_{II}O_{III}$	13.679
0.85657	7 80 Hg	$L\gamma_{11}$	$L_I N_V$	14.474	0.90742	5 88 Ra	$L\eta$	$L_{II}M_I$	13.6630
0.858	2 87 Fr	$L\beta_2$	$L_{III}N_V$	14.45	0.90746	7 79 Au		$L_{II}O_{II}$	13.662
0.8585	3 82 Pb		$L_{II}N_{II}$	14.442	0.90837	5 79 Au	$L\nu$	$L_{II}N_{VI}$	13.6487
0.860266	9 95 Am	$L\alpha_2$	$L_{III}M_{IV}$	14.4119	0.90894	7 80 Hg		$L_{II}N_{III}$	13.640
0.8618	1 88 Ra		$L_{III}N_{II}$	14.387	0.9091	3 84 Po	$L\beta_3$	$L_I M_{III}$	13.638
0.86376	5 79 Au	L_I	Abs. Edge	14.3537	0.90989	5 79 Au	$L\gamma_3$	$L_{II}O_I$	13.6260
0.86400	5 79 Au		$L_I O_{IV,V}$	14.3497	0.910639	9 92 U	$L\alpha_1$	$L_{III}M_V$	13.6147
0.8653	2 36 Kr	$K\beta_4$	$KN_{IV,V}$	14.328	0.9131	1 79 Au		$L_I N_I$	13.578
0.86552	1 36 Kr	K	Abs. Edge	14.3244	0.9143	2 78 Pt	$L\gamma_{11}$	$L_I N_V$	13.560
0.86605	9 86 Rn	$L\beta_1$	$L_{II}M_{IV}$	14.316	0.9204	1 35 Br	K	Abs. Edge	13.470
0.8661	1 36 Kr	$K\beta_2$	$KN_{II,III}$	14.315	0.92046	2 35 Br	$K\beta_2$	$KN_{II,III}$	13.4695
0.86655	5 82 Pb	$L\gamma_3$	$L_{II}N_I$	14.3075	0.9220	2 84 Po	$L\beta_1$	$L_{II}M_{IV}$	13.447
0.86703	4 79 Au	$L\gamma_4$	$L_I O_{III}$	14.2996	0.922558	9 92 U	$L\alpha_2$	$L_{III}M_{IV}$	13.4388
0.86752	3 81 Tl	$L\gamma_1$	$L_{II}N_{IV}$	14.2915	0.9234	1 83 Bi	L_{III}	Abs. Edge	13.426
0.86816	4 79 Au	$L\gamma_4'$	$L_I O_{II}$	14.2809	0.9236	1 77 Ir	L_I	Abs. Edge	13.423
0.86830	2 94 Pu	$L\alpha_1$	$L_{III}M_V$	14.2786	0.92413	4 83 Bi		$L_{III}P_{II,III}$	13.4159
0.86915	7 80 Hg	$L\gamma_3$	$L_I N_{III}$	14.265	0.9243	3 77 Ir		$L_I O_{IV,V}$	13.413
0.87074	5 79 Au		$L_I O_I$	14.2385	0.92453	7 80 Hg	$L\gamma_5$	$L_{II}N_I$	13.410
0.8708	2 36 Kr	$K\beta_3$	$KM_{IV,V}$	14.238	0.9255	1 35 Br	$K\beta_3$	$KM_{IV,V}$	13.396

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
0.925553	9 37 Rb	$K\alpha_1$	KL_{III}	13.3953	0.96788	2 90 Th	$L\alpha_2$	$L_{III}M_{IV}$	12.8096
0.92556	3 83 Bi	$L\beta_8$	$L_{III}O_{IV,V}$	13.3953	0.96911	7 82 Pb	$L\beta_2$	L_2M_{III}	12.7933
0.92650	3 79 Au	$L\gamma_1$	$L_{II}N_{IV}$	13.3817	0.96979	5 77 Ir		$L_{II}O_{III}$	12.7843
0.9268	1 82 Pb	$L\beta_9$	L_2M_V	13.377	0.97161	6 77 Ir	$L\nu$	$L_{II}N_{VI}$	12.7603
0.92744	3 77 Ir	$L\gamma_4$	L_2O_{III}	13.3681	0.97173	4 78 Pt		$L_{II}N_{III}$	12.7588
0.92791	5 78 Pt	$L\gamma_3$	L_2N_{III}	13.3613	0.97321	5 83 Bi		$L_{III}N_{III}$	12.7394
0.92831	3 77 Ir	$L\gamma_1'$	L_1O_{II}	13.3555	0.97409	3 77 Ir	$L\gamma_8$	$L_{II}O_I$	12.7279
0.92937	5 84 Po	$L\beta_2$	$L_{III}N_V$	13.3404	0.9747	1 82 Pb		$L_{II}M_V$	12.720
0.92969	1 37 Rb	$K\alpha_2$	KL_{II}	13.3358	0.9765	3 76 Os	$L\gamma_{II}$	L_2N_V	12.696
0.9302	2 83 Bi		$L_{III}O_{III}$	13.328	0.9766	2 77 Ir		L_2N_I	12.695
0.9312	2 84 Po	$L\beta_{15}$	$L_{III}N_{IV}$	13.314	0.97690	4 83 Bi	$L\beta_4$	L_2M_{II}	12.6912
0.9323	2 83 Bi		$L_{III}O_{II}$	13.298	0.9772	3 76 Os		L_2N_{IV}	12.687
0.93279	2 35 Br	$K\beta_1$	KM_{III}	13.2914	0.9792	2 78 Pt		$L_{II}N_{II}$	12.661
0.93284	5 91 Pa	$L\alpha_1$	$L_{III}M_V$	13.2907	0.97926	5 81 Tl		$L_{III}P_{II,III}$	12.6607
0.93327	5 35 Br	$K\beta_2$	KM_{II}	13.2845	0.9793	1 81 Tl	L_{III}	Abs. Edge	12.660
0.9339	2 82 Pb	$L\beta_{10}$	L_2M_{IV}	13.275	0.97974	1 34 Se	K	Abs. Edge	12.6545
0.93414	5 78 Pt	L_{II}	Abs. Edge	13.2723	0.97992	5 34 Se	$K\beta_2$	$KN_{II,III}$	12.6522
0.9342	2 78 Pt	$L\gamma_6$	$L_{II}O_{IV}$	13.271	0.97993	5 89 Ac	$L\alpha_1$	$L_{III}M_V$	12.6520
0.93427	5 78 Pt	$L\gamma_2$	L_2N_{II}	13.2704	0.9801	1 36 Kr	$K\alpha_1$	KL_{III}	12.649
0.93505	5 83 Bi	$L\beta_7$	$L_{III}O_I$	13.2593	0.98058	3 81 Tl	$L\beta_6$	$L_{III}O_{IV,V}$	12.6436
0.93505	5 83 Bi	$L\nu$	$L_{III}N_{VI,VII}$	13.2593	0.98221	7 82 Pb	$L\beta_2$	$L_{III}N_V$	12.6226
0.93855	3 83 Bi	$L\beta_8$	L_2M_{III}	13.2098	0.98280	5 83 Bi		$L_{III}N_{II}$	12.6151
0.93931	5 78 Pt	$L\nu$	$L_{II}N_{VI}$	13.1992	0.98291	3 82 Pb	$L\beta_1$	$L_{II}M_{IV}$	12.6137
0.9402	2 79 Au		$L_{II}N_{III}$	13.186	0.98389	7 82 Pb	$L\beta_{15}$	$L_{III}N_{IV}$	12.6011
0.9411	1 78 Pt	$L\gamma_8$	$L_{II}O_I$	13.173	0.9841	1 36 Kr	$K\alpha_2$	KL_{II}	12.598
0.94419	5 83 Bi		$L_{II}M_V$	13.1310	0.9843	1 34 Se	$K\beta_5$	$KM_{IV,V}$	12.595
0.9446	2 77 Ir	$L\gamma_{II}$	L_2N_V	13.126	0.98538	5 81 Tl		$L_{III}O_{III}$	12.5820
0.94482	5 91 Pa	$L\alpha_2$	$L_{III}M_{IV}$	13.1222	0.9871	2 80 Hg	$L\beta_9$	L_2M_V	12.560
0.9455	2 78 Pt		L_2N_I	13.113	0.98738	5 81 Tl		$L_{II}O_{II}$	12.5566
0.9459	2 77 Ir		L_2N_{IV}	13.108	0.9877	2 78 Pt	$L\gamma_5$	$L_{II}N_I$	12.552
0.9475	3 84 Po	$L\beta_4$	L_2M_{II}	13.086	0.9888	1 81 Tl	$L\nu$	$L_{III}N_{VI,VII}$	12.538
0.95073	5 82 Pb	L_{III}	Abs. Edge	13.0406	0.98913	5 83 Bi	$L\beta_{17}$	$L_{II}M_{III}$	12.5344
0.95118	7 82 Pb		$L_{III}P_{II,III}$	13.0344	0.9894	1 75 Re	L_I	Abs. Edge	12.530
0.951978	9 83 Bi	$L\beta_1$	$L_{II}M_{IV}$	13.0235	0.9900	1 75 Re		$L_I O_{IV,V}$	12.524
0.9526	1 82 Pb	$L\beta_6$	$L_{III}O_{IV,V}$	13.015	0.99017	5 81 Tl	$L\beta_7$	$L_{III}O_I$	12.5212
0.95518	4 83 Bi	$L\beta_2$	$L_{III}N_V$	12.9799	0.99085	3 77 Ir	$L\gamma_1$	$L_{II}N_{IV}$	12.5126
0.95559	3 79 Au	$L\gamma_6$	$L_{II}N_I$	12.9743	0.99178	5 89 Ac	$L\alpha_2$	$L_{III}M_{IV}$	12.5008
0.9558	1 76 Os	L_I	Abs. Edge	12.972	0.99186	5 76 Os	$L\gamma_2$	L_2N_{III}	12.4998
0.95600	3 90 Th	$L\alpha_1$	$L_{III}M_V$	12.9687	0.99218	3 34 Se	$K\beta_1$	KM_{III}	12.4959
0.95603	5 76 Os		$L_1O_{IV,V}$	12.9683	0.99249	5 75 Re	$L\gamma_4$	L_1O_{III}	12.4920
0.95675	7 81 Tl	$L\beta_9$	L_2M_V	12.9585	0.99268	5 34 Se	$K\beta_3$	KM_{II}	12.4896
0.95702	5 83 Bi	$L\beta_{16}$	$L_{III}N_{IV}$	12.9549	0.99331	3 83 Bi	$L\beta_8$	$L_{III}N_I$	12.4816
0.9578	1 82 Pb		$L_{III}O_{III}$	12.945	0.99334	5 75 Re	$L\gamma_4'$	L_1O_{II}	12.4813
0.95797	3 78 Pt	$L\gamma_1$	$L_{II}N_{IV}$	12.9420	0.9962	2 80 Hg	$L\beta_{10}$	L_2M_{IV}	12.446
0.9586	1 82 Pb		$L_{III}O_{II}$	12.934	0.9965	1 75 Re		L_1O_I	12.442
0.95931	5 77 Ir	$L\gamma_3$	L_2N_{III}	12.9240	0.99805	5 76 Os	$L\gamma_2$	L_2N_{II}	12.4224
0.95938	8 76 Os	$L\gamma_4$	L_1O_{III}	12.923	1.0005	1 82 Pb		$L_{III}N_{III}$	12.392
0.96033	8 76 Os	$L\gamma_4'$	L_1O_{II}	12.910	1.0005	9 83 Bi		L_2M_I	12.39
0.96133	7 82 Pb	$L\nu$	$L_{III}N_{VI,VII}$	12.8968	1.00062	3 81 Tl	$L\beta_3$	L_2M_{III}	12.3904
0.9620	1 82 Pb	$L\beta_7$	$L_{III}O_I$	12.888	1.00107	5 76 Os	$L\gamma_6$	$L_{II}O_{IV}$	12.3848
0.96318	7 76 Os		L_1O_I	12.8721	1.0012	6 95 Am	L_I	$L_{III}M_I$	12.384
0.9636	1 92 U	L_5	$L_{III}M_{III}$	12.866	1.0014	1 76 Os	L_{II}	Abs. Edge	12.381
0.96389	7 81 Tl	$L\beta_{10}$	L_2M_{IV}	12.8626	1.0047	2 76 Os		$L_{II}O_{III}$	12.340
0.96545	3 77 Ir	$L\gamma_2$	L_2N_{II}	12.8418	1.00473	5 88 Ra	$L\alpha_1$	$L_{III}M_V$	12.3397
0.96708	4 77 Ir	$L\gamma_6$	$L_{II}O_{IV}$	12.8201	1.0050	2 76 Os	$L\nu$	$L_{II}N_{VI}$	12.337
0.9671	1 77 Ir	L_{II}	Abs. Edge	12.820	1.0054	3 77 Ir		$L_{II}N_{III}$	12.332
0.9672	2 84 Po	$L\beta_8$	$L_{III}N_I$	12.819	1.00722	5 81 Tl		$L_{II}M_V$	12.3093

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
1.0075	1 82 Pb	$L\beta_4$	$L_{II}M_{II}$	12.306	1.04500	3 33 As	$K\beta_2$	$KN_{II,III}$	11.8642
1.00788	5 76 Os	$L\gamma_3$	$L_{II}O_I$	12.3012	1.0458	1 74 W	$L\gamma_{II}$	$L_{II}N_V$	11.856
1.0091	1 80 Hg	L_{III}	Abs. Edge	12.286	1.0468	2 74 W		$L_{II}N_{IV}$	11.844
1.00987	7 80 Hg	$L\beta_5$	$L_{III}O_{IV,V}$	12.2769	1.04752	5 79 Au	Lu	$L_{III}N_{VI,VII}$	11.8357
1.01031	3 81 Tl	$L\beta_2$	$L_{III}N_V$	12.2715	1.04868	5 80 Hg	$L\beta_1$	$L_{III}M_{IV}$	11.8226
1.01040	7 82 Pb		$L_{III}N_{II}$	12.2705	1.0488	1 33 As	$K\beta_5$	$KM_{IV,V}$	11.822
1.0108	1 75 Re	$L\gamma_{II}$	$L_{II}N_V$	12.266	1.04963	5 81 Tl	$L\beta_5$	$L_{III}N_I$	11.8118
1.0112	1 90 Th	Ls	$L_{III}M_{III}$	12.261	1.04974	8 79 Au	$L\beta_7$	$L_{III}O_I$	11.8106
1.0119	1 75 Re		$L_{II}N_{IV}$	12.252	1.05446	5 78 Pt	$L\beta_5$	$L_{II}M_V$	11.7577
1.0120	2 77 Ir		$L_{II}N_{II}$	12.251	1.05609	7 81 Tl	$L\beta_{17}$	$L_{II}M_{III}$	11.7397
1.01201	3 81 Tl	$L\beta_{15}$	$L_{III}N_{IV}$	12.2510	1.05693	5 76 Os	$L\gamma_5$	$L_{II}N_I$	11.7303
1.01404	7 80 Hg		$L_{III}O_{III}$	12.2264	1.05723	5 86 Rn	$L\alpha_1$	$L_{III}M_V$	11.7270
1.01513	4 81 Tl	$L\beta_1$	$L_{III}M_{IV}$	12.2133	1.05730	2 33 As	$K\beta_1$	KM_{III}	11.7262
1.01558	7 80 Hg		$L_{III}O_{II}$	12.2079	1.05783	5 33 As	$K\beta_2$	KM_{II}	11.7203
1.01656	5 88 Ra	$L\alpha_2$	$L_{III}M_{IV}$	12.1962	1.0585	1 80 Hg		$L_{III}N_{III}$	11.713
1.01674	7 80 Hg	Lu	$L_{III}N_{VII}$	12.1940	1.05856	3 83 Bi	$L\eta$	$L_{II}M_I$	11.7122
1.01769	7 80 Hg	Lu'	$L_{III}N_{VI}$	12.1826	1.06099	5 75 Re	$L\gamma_1$	$L_{II}N_{IV}$	11.6854
1.01937	7 80 Hg	$L\beta_7$	$L_{III}O_I$	12.1625	1.0613	1 73 Ta	L_I	Abs. Edge	11.682
1.02063	7 79 Au	$L\beta_9$	$L_{II}M_V$	12.1474	1.06183	7 78 Pt	$L\beta_{10}$	$L_{II}M_{IV}$	11.6762
1.0210	1 82 Pb	$L\beta_6$	$L_{III}N_I$	12.143	1.06192	9 73 Ta		$L_I O_{IV,V}$	11.6752
1.02175	5 77 Ir	$L\gamma_5$	$L_{II}N_I$	12.1342	1.06200	6 74 W	$L\gamma_3$	$L_{II}N_{III}$	11.6743
1.0223	1 82 Pb	$L\beta_{17}$	$L_{II}M_{III}$	12.127	1.06357	9 73 Ta		$L_{II}N_{VI,VII}$	11.6570
1.0226	1 94 Pu	L_I	$L_{III}M_I$	12.124	1.0644	2 82 Pb		$L_{II}M_{II}$	11.648
1.02467	5 74 W	L_I	Abs. Edge	12.0996	1.0644	2 81 Tl		$L_{II}M_I$	11.648
1.0250	2 74 W		$L_I O_{IV,V}$	12.095	1.06467	3 73 Ta	$L\gamma_4$	$L_I O_{III}$	11.6451
1.02503	5 76 Os	$L\gamma_1$	$L_{II}N_{IV}$	12.0953	1.0649	2 80 Hg		$L_{III}N_{II}$	11.642
1.02613	7 75 Re	$L\gamma_2$	$L_{II}N_{III}$	12.0824	1.06544	3 73 Ta	$L\gamma_4'$	$L_I O_{II}$	11.6366
1.02775	3 74 W	$L\gamma_4$	$L_I O_{III}$	12.0634	1.06712	2 92 U	L_I	$L_{III}M_I$	11.6183
1.02789	7 79 Au	$L\beta_{10}$	$L_{II}M_{IV}$	12.0617	1.06771	9 73 Ta		$L_I O_I$	11.6118
1.0286	1 81 Tl		$L_{III}N_{III}$	12.053	1.06785	9 79 Au	$L\beta_2$	$L_{II}M_{III}$	11.6103
1.02863	3 74 W	$L\gamma_4'$	$L_I O_{II}$	12.0530	1.06806	3 74 W	$L\gamma_2$	$L_{II}N_{II}$	11.6080
1.03049	5 87 Fr	$L\alpha_1$	$L_{III}M_V$	12.0313	1.06899	5 86 Rn	$L\alpha_2$	$L_{III}M_{IV}$	11.5979
1.0317	3 74 W		$L_I O_I$	12.017	1.07022	3 79 Au	$L\beta_2$	$L_{III}N_V$	11.5847
1.03233	5 75 Re	$L\gamma_2$	$L_{II}N_{II}$	12.0098	1.07188	5 79 Au	$L\beta_{15}$	$L_{III}N_{IV}$	11.5667
1.0323	2 82 Pb		$L_{II}M_I$	12.010	1.07222	7 80 Hg	$L\beta_4$	$L_{II}M_{II}$	11.5630
1.03358	7 80 Hg	$L\beta_2$	$L_{II}M_{III}$	11.9953	1.0723	1 78 Pt	L_{III}	Abs. Edge	11.562
1.0346	9 83 Bi		$L_{II}M_{II}$	11.98	1.0724	2 78 Pt	$L\beta_5$	$L_{III}O_{IV,V}$	11.561
1.0347	1 92 U	L_I	$L_{III}M_{II}$	11.982	1.07448	5 74 W	$L\gamma_5$	$L_{II}O_{IV}$	11.5387
1.03699	9 75 Re	$L\gamma_5$	$L_{II}O_{IV}$	11.956	1.0745	1 74 W	L_{II}	Abs. Edge	11.538
1.0371	1 75 Re	L_{II}	Abs. Edge	11.954	1.0756	2 79 Au		$L_{II}M_V$	11.526
1.03876	7 79 Au		$L_{III}P_{II,III}$	11.9355	1.0761	3 78 Pt		$L_{III}O_{II,III}$	11.521
1.03918	3 81 Tl	$L\beta_4$	$L_{II}M_{II}$	11.9306	1.0767	1 75 Re		$L_{II}N_{III}$	11.515
1.0397	1 75 Re		$L_{II}O_{III}$	11.925	1.0771	1 74 W	$L\nu$	$L_{II}N_{VI}$	11.510
1.03973	5 76 Os		$L_{II}N_{III}$	11.9243	1.07896	5 78 Pt	Lu	$L_{III}N_{VI,VII}$	11.4908
1.03974	2 35 Br	$K\alpha_1$	KL_{III}	11.9242	1.0792	2 74 W		$L_{II}O_{III}$	11.488
1.03975	7 80 Hg	$L\beta_2$	$L_{III}N_V$	11.9241	1.07975	7 80 Hg	$L\beta_5$	$L_{III}N_I$	11.4824
1.04000	5 79 Au	L_{III}	Abs. Edge	11.9212	1.08009	9 90 Th	L_I	$L_{III}M_{II}$	11.4788
1.0404	1 75 Re	$L\nu$	$L_{II}N_{VI}$	11.917	1.08113	4 74 W	$L\gamma_5$	$L_{II}O_I$	11.4677
1.04044	3 79 Au	$L\beta_5$	$L_{III}O_{IV,V}$	11.9163	1.08168	3 78 Pt	$L\beta_7$	$L_{III}O_I$	11.4619
1.04151	7 80 Hg	$L\beta_{15}$	$L_{III}N_{IV}$	11.9040	1.08205	7 73 Ta	$L\gamma_{II}$	$L_{II}N_V$	11.4580
1.0420	1 75 Re		$L_{II}N_I$	11.899	1.08353	3 79 Au	$L\beta_1$	$L_{II}M_{IV}$	11.4423
1.04230	5 87 Fr	$L\alpha_2$	$L_{III}M_{IV}$	11.8950	1.08377	7 73 Ta		$L_{II}N_{IV}$	11.4398
1.0428	6 93 Np	L_I	$L_{III}M_I$	11.890	1.0839	1 75 Re		$L_{II}N_{II}$	11.438
1.04382	2 35 Br	$K\alpha_2$	KL_{II}	11.8776	1.08500	5 85 At	$L\alpha_1$	$L_{III}M_V$	11.4268
1.04398	5 75 Re	$L\gamma_5$	$L_{II}O_I$	11.8758	1.08975	5 77 Ir	$L\beta_5$	$L_{II}M_V$	11.3770
1.0450	2 79 Au		$L_{III}O_{II,III}$	11.865	1.09026	7 79 Au		$L_{III}N_{III}$	11.3717
1.0450	1 33 As	K	Abs. Edge	11.865	1.0908	1 91 Pa	L_I	$L_{III}M_I$	11.366

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
1.0916	5 80 Hg	$L\beta_{17}$	$L_{II}M_{III}$	11.358	1.13687	9 73 Ta	$L_{III}N_V$	10.9055	
1.09241	7 82 Pb	$L\eta$	$L_{II}M_I$	11.3493	1.13707	3 77 Ir	$L\beta_{16}$	$L_{III}N_{IV}$	10.9036
1.09388	5 75 Re	$L\gamma_5$	$L_{II}N_I$	11.3341	1.13794	3 73 Ta	$L\gamma_1$	$L_{II}N_{IV}$	10.8952
1.09671	5 85 At	$L\alpha_2$	$L_{III}M_{IV}$	11.3048	1.13841	5 72 Hf	$L\gamma_3$	$L_I N_{III}$	10.8907
1.09702	4 77 Ir	$L\beta_{10}$	$L_{II}M_{IV}$	11.3016	1.1387	5 80 Hg		$L_{II}M_{II}$	10.888
1.09855	3 74 W	$L\gamma_1$	$L_{II}N_{IV}$	11.2859	1.1402	1 71 Lu	L_I	Abs. Edge	10.8740
1.09936	4 73 Ta	$L\gamma_3$	$L_I N_{III}$	11.2776	1.1405	1 76 Os	$L\beta_5$	$L_{III}O_{IV,V}$	10.8711
1.0997	1 81 Tl		$L_{II}M_{II}$	11.274	1.1408	1 76 Os	L_{III}	Abs. Edge	10.8683
1.0997	1 72 Hf	L_I	Abs. Edge	11.274	1.14085	3 77 Ir	$L\beta_3$	$L_I M_{III}$	10.8674
1.09968	7 79 Au		$L_{III}N_{II}$	11.2743	1.14223	5 78 Pt	$L\beta_4$	$L_I M_{II}$	10.8543
1.0999	2 80 Hg		$L_I M_I$	11.272	1.1435	1 71 Lu	$L\gamma_4$	$L_I O_{II,III}$	10.8425
1.10086	9 72 Hf		$L_I O_{IV}$	11.2622	1.14355	5 78 Pt	$L\beta_6$	$L_{III}N_I$	10.8418
1.10200	3 78 Pt	$L\beta_2$	$L_{III}N_V$	11.2505	1.14386	2 83 Bi	$L\alpha_1$	$L_{III}M_V$	10.8388
1.10303	5 72 Hf	$L\gamma_3$	$L_I O_{III}$	11.2401	1.14442	5 72 Hf	$L\gamma_2$	$L_I N_{II}$	10.8335
1.10376	5 72 Hf	$L\gamma_4'$	$L_I O_{II}$	11.2326	1.14537	7 76 Os	Lu	$L_{III}N_{VI,VII}$	10.8245
1.10394	5 78 Pt	$L\beta_3$	$L_I M_{III}$	11.2308	1.1489	2 77 Ir		$L_{II}M_V$	10.791
1.10477	2 34 Se	$K\alpha_1$	KL_{III}	11.2224	1.14933	8 76 Os	$L\beta_7$	$L_{III}O_I$	10.7872
1.1053	1 73 Ta	$L\gamma_2$	$L_I N_{II}$	11.217	1.1548	1 72 Hf	L_{II}	Abs. Edge	10.7362
1.1058	1 77 Ir	L_{III}	Abs. Edge	11.212	1.15519	5 72 Hf	$L\gamma_6$	$L_{II}O_{IV}$	10.7325
1.10585	3 77 Ir	$L\beta_5$	$L_{III}O_{IV,V}$	11.2114	1.1553	1 73 Ta		$L_{II}N_{III}$	10.7316
1.10651	3 79 Au	$L\beta_4$	$L_I M_{II}$	11.2047	1.15536	1 83 Bi	$L\alpha_2$	$L_{III}M_{IV}$	10.73091
1.10664	9 72 Hf		$L_I O_I$	11.2034	1.1560	3 77 Ir		$L_{III}N_{III}$	10.725
1.10882	2 34 Se	$K\alpha_2$	KL_{II}	11.1814	1.15781	3 77 Ir	$L\beta_1$	$L_{II}M_{IV}$	10.7083
1.10923	6 77 Ir		$L_{III}O_{II,III}$	11.1772	1.15830	9 72 Hf	$L\nu$	$L_{II}N_{VI}$	10.7037
1.11092	3 79 Au	$L\beta_6$	$L_{III}N_I$	11.1602	1.1600	2 73 Ta		$L_{II}N_{II}$	10.688
1.11145	4 77 Ir	Lu	$L_{III}N_{VI,VII}$	11.1549	1.16107	9 71 Lu	$L\gamma_{11}$	$L_I N_V$	10.6782
1.1129	2 78 Pt		$L_{II}M_V$	11.140	1.16138	5 72 Hf	$L\gamma_3$	$L_{II}O_I$	10.6754
1.1137	1 73 Ta	L_{II}	Abs. Edge	11.132	1.16227	9 71 Lu		$L_I N_{IV}$	10.6672
1.11386	4 84 Po	$L\alpha_1$	$L_{III}M_V$	11.1308	1.1640	1 80 Hg	$L\eta$	$L_{II}M_I$	10.6512
1.11388	3 73 Ta	$L\gamma_5$	$L_{II}O_{IV}$	11.1306	1.16487	4 75 Re	$L\beta_9$	$L_I M_V$	10.6433
1.11489	3 77 Ir	$L\beta_7$	$L_{III}O_I$	11.1205	1.16545	5 77 Ir		$L_{III}N_{II}$	10.6380
1.1149	2 74 W		$L_{II}N_{III}$	11.120	1.1667	1 78 Pt	$L\beta_{17}$	$L_{II}M_{III}$	10.6265
1.11508	4 90 Th	L_I	$L_{III}M_I$	11.1186	1.16719	5 88 Ra	L_I	$L_{III}M_I$	10.6222
1.11521	9 73 Ta		$L_I N_I$	11.1173	1.16962	9 78 Pt		$L_I M_I$	10.6001
1.1158	1 73 Ta	$L\nu$	$L_{II}N_{VI}$	11.1113	1.16979	8 76 Os	$L\beta_2$	$L_{III}N_V$	10.5985
1.11658	5 32 Ge	K	Abs. Edge	11.1036	1.1708	1 79 Au		$L_{II}M_{II}$	10.5892
1.11686	2 32 Ge	$K\beta_2$	$KN_{II,III}$	11.1008	1.17167	5 76 Os	$L\beta_{15}$	$L_{III}N_{IV}$	10.5816
1.11693	9 73 Ta		$L_{II}O_{III}$	11.1001	1.17218	5 75 Re	$L\beta_{10}$	$L_I M_{IV}$	10.5770
1.11789	9 73 Ta		$L_{II}O_{II}$	11.0907	1.1729	1 73 Ta	$L\gamma_6$	$L_{II}N_I$	10.5702
1.1195	1 32 Ge	$K\beta_5$	$KM_{IV,V}$	11.0745	1.17501	2 82 Pb	$L\alpha_1$	$L_{III}M_V$	10.5515
1.11990	2 78 Pt	$L\beta_1$	$L_{II}M_{IV}$	11.0707	1.17588	1 33 As	$K\alpha_1$	KL_{III}	10.54372
1.1205	1 73 Ta	$L\gamma_3$	$L_{II}O_I$	11.0646	1.17721	5 75 Re	$L\beta_5$	$L_{III}O_{IV,V}$	10.5318
1.12146	9 72 Hf	$L\gamma_{11}$	$L_I N_V$	11.0553	1.1773	1 75 Re	L_{III}	Abs. Edge	10.5306
1.1218	3 74 W		$L_{II}N_{II}$	11.052	1.17788	9 72 Hf		$L_{II}N_V$	10.5258
1.12250	9 72 Hf		$L_I N_{IV}$	11.0451	1.17796	3 77 Ir	$L\beta_5$	$L_{III}N_I$	10.5251
1.1226	2 78 Pt		$L_{III}N_{III}$	11.044	1.17900	5 72 Hf	$L\gamma_1$	$L_{II}N_{IV}$	10.5158
1.12548	5 84 Po	$L\alpha_2$	$L_{III}M_{IV}$	11.0158	1.17953	4 71 Lu	$L\gamma_3$	$L_I N_{III}$	10.5110
1.12637	6 76 Os	$L\beta_9$	$L_I M_V$	11.0071	1.17955	7 76 Os	$L\beta_3$	$L_I M_{III}$	10.5108
1.12769	3 81 Tl	$L\eta$	$L_{II}M_I$	10.9943	1.17958	3 77 Ir	$L\beta_4$	$L_I M_{II}$	10.5106
1.12798	5 79 Au	$L\beta_{17}$	$L_{II}M_{III}$	10.9915	1.17987	1 33 As	$K\alpha_2$	KL_{II}	10.50799
1.12894	2 32 Ge	$K\beta_1$	KM_{III}	10.9821	1.1815	1 75 Re	Lu	$L_{III}N_{VI,VII}$	10.4931
1.12936	9 32 Ge	$K\beta_3$	KM_{II}	10.9780	1.1818	1 70 Yb	L_I	Abs. Edge	10.4904
1.1310	2 78 Pt		$L_{III}N_{II}$	10.962	1.1827	1 70 Yb		$L_I O_{IV,V}$	10.4833
1.13235	3 74 W	$L\gamma_5$	$L_{II}N_I$	10.9490	1.1853	1 70 Yb	$L\gamma_4$	$L_I O_{II,III}$	10.4603
1.13353	5 76 Os	$L\beta_{10}$	$L_I M_{IV}$	10.9376	1.1853	2 71 Lu	$L\gamma_2$	$L_I N_{II}$	10.460
1.13525	5 79 Au		$L_I M_I$	10.9210	1.18610	5 75 Re	$L\beta_7$	$L_{III}O_I$	10.4529
1.13532	3 77 Ir	$L\beta_2$	$L_{III}N_V$	10.9203	1.18648	5 82 Pb	$L\alpha_2$	$L_{III}M_{IV}$	10.4495

TABLE VI (Continued)

Wavelength \AA^*	p.e. Element	Designation	keV	Wavelength \AA^*	p.e. Element	Designation	keV
1.1886	1 70 Yb	$L_I O_I$	10.4312	1.254054	9 32 Ge	$K\alpha_1$ KL_{III}	9.88642
1.18977	7 76 Os	$L_{II} M_V$	10.4205	1.2553	1 73 Ta	L_{III} Abs. Edge	9.8766
1.1958	1 31 Ga	K Abs. Edge	10.3682	1.2555	1 73 Ta	$L\beta_5$ $L_{III} O_{IV,V}$	9.8750
1.19600	2 31 Ga	$K\beta_2$ $KN_{II,III}$	10.3663	1.25778	4 73 Ta	Lu $L_{III} N_{VI,VII}$	9.8572
1.19727	7 76 Os	$L\beta_1$ $L_{II} M_{IV}$	10.3553	1.258011	9 32 Ge	$K\alpha_2$ KL_{II}	9.85532
1.1981	2 31 Ga	$K\beta_3$ $KM_{IV,V}$	10.348	1.25917	5 75 Re	$L\beta_4$ $L_I M_{II}$	9.8463
1.1985	1 71 Lu	L_{II} Abs. Edge	10.3448	1.2596	1 71 Lu	$L\gamma_5$ $L_{II} N_I$	9.8428
1.1987	1 71 Lu	$L\gamma_6$ $L_{II} O_{IV}$	10.3431	1.2601	3 73 Ta	$L_{III} O_{II,III}$	9.839
1.20086	7 76 Os	$L_{III} N_{II}$	10.3244	1.26269	5 74 W	$L\beta_3$ $L_I M_{III}$	9.8188
1.2014	1 71 Lu	$L_{II} O_{II,III}$	10.3198	1.26385	5 73 Ta	$L\beta_7$ $L_{III} O_I$	9.8098
1.20273	3 79 Au	$L\eta$ $L_{II} M_I$	10.3083	1.2672	2 74 W	$L_{III} N_{III}$	9.784
1.2047	1 71 Lu	$L\gamma_8$ $L_{II} O_I$	10.2915	1.26769	5 70 Yb	$L\gamma_1$ $L_{II} N_{IV}$	9.7801
1.20479	7 74 W	$L\beta_3$ $L_I M_V$	10.2907	1.2678	2 69 Tm	$L\gamma_3$ $L_I N_{III}$	9.779
1.20660	4 75 Re	$L\beta_2$ $L_{III} N_V$	10.2752	1.2706	1 68 Er	L_I Abs. Edge	9.7574
1.2069	2 77 Ir	$L\beta_{17}$ $L_{II} M_{III}$	10.273	1.2728	2 74 W	$L_{II} M_V$	9.741
1.20739	4 81 Tl	$L\alpha_1$ $L_{III} M_V$	10.2685	1.2742	2 69 Tm	$L\gamma_2$ $L_I N_{II}$	9.730
1.20789	2 31 Ga	$K\beta_1$ KM_{III}	10.2642	1.2748	1 83 Bi	L_I $L_{III} M_{II}$	9.7252
1.20819	5 75 Re	$L\beta_{16}$ $L_{III} N_{IV}$	10.2617	1.2752	2 68 Er	$L\gamma_4$ $L_I O_{II,III}$	9.722
1.20835	5 31 Ga	$K\beta_3$ KM_{II}	10.2603	1.27640	3 79 Au	$L\alpha_1$ $L_{III} M_V$	9.7133
1.2102	2 77 Ir	$L_I M_I$	10.245	1.2765	2 74 W	$L_{III} N_{II}$	9.712
1.2105	1 83 Bi	L_S $L_{III} M_{III}$	10.2421	1.27807	5 81 Tl	L_S $L_{III} M_{III}$	9.7007
1.21218	3 74 W	$L\beta_{10}$ $L_{II} M_{IV}$	10.2279	1.281809	9 74 W	$L\beta_1$ $L_{II} M_{IV}$	9.67235
1.213	1 78 Pt	$L_{II} M_{II}$	10.225	1.2829	5 84 Po	L_I $L_{III} M_I$	9.664
1.21349	5 76 Os	$L\beta_5$ $L_{III} N_I$	10.2169	1.2834	1 30 Zn	K Abs. Edge	9.6607
1.21537	5 72 Hf	$L\gamma_5$ $L_{II} N_I$	10.2011	1.28372	2 30 Zn	$K\beta_2$ $KN_{II,III}$	9.6580
1.21545	3 74 W	$L\beta_6$ $L_{III} O_{IV,V}$	10.2004	1.28448	3 77 Ir	$L\eta$ $L_{II} M_I$	9.6522
1.2155	1 74 W	L_{III} Abs. Edge	10.1999	1.28454	2 73 Ta	$L\beta_2$ $L_{III} N_V$	9.6518
1.21844	5 76 Os	$L\beta_4$ $L_I M_{II}$	10.1754	1.2848	1 30 Zn	$K\beta_3$ $KM_{IV,V}$	9.6501
1.21868	5 74 W	Lu $L_{III} N_{VI,VII}$	10.1733	1.28619	5 73 Ta	$L\beta_{18}$ $L_{III} N_{IV}$	9.6394
1.21875	3 81 Tl	$L\alpha_2$ $L_{III} M_{IV}$	10.1728	1.28772	3 79 Au	$L\alpha_2$ $L_{III} M_{IV}$	9.6280
1.22031	5 75 Re	$L\beta_3$ $L_I M_{III}$	10.1598	1.2892	1 69 Tm	L_{II} Abs. Edge	9.6171
1.2211	2 74 W	$L_{III} O_{II,III}$	10.153	1.28989	7 74 W	$L\beta_6$ $L_{III} N_I$	9.6117
1.22228	4 71 Lu	$L\gamma_1$ $L_{II} N_{IV}$	10.1434	1.29025	9 72 Hf	$L\beta_9$ $L_I M_V$	9.6090
1.22232	5 70 Yb	$L\gamma_3$ $L_I N_{III}$	10.1431	1.2905	2 69 Tm	$L\gamma_6$ $L_I O_{IV}$	9.607
1.22400	4 74 W	$L\beta_7$ $L_{III} O_I$	10.1292	1.2927	1 75 Re	$L\beta_{17}$ $L_{II} M_{III}$	9.5910
1.2250	1 69 Tm	L_I Abs. Edge	10.1206	1.2934	2 76 Os	$L_{II} M_{II}$	9.586
1.2263	3 69 Tm	$L_I O_{IV,V}$	10.110	1.29525	2 30 Zn	$K\beta_{1,2}$ $KM_{II,III}$	9.5720
1.2283	1 75 Re	$L_{III} N_{III}$	10.0933	1.2972	1 72 Hf	L_{III} Abs. Edge	9.5577
1.22879	7 70 Yb	$L\gamma_2$ $L_I N_{II}$	10.0897	1.29761	5 72 Hf	$L\beta_5$ $L_{III} O_{IV,V}$	9.5546
1.2294	2 69 Tm	$L\gamma_4$ $L_I O_{II,III}$	10.084	1.29819	9 72 Hf	$L\beta_{10}$ $L_I M_{IV}$	9.5503
1.2305	1 75 Re	$L_{II} M_V$	10.0753	1.30162	5 74 W	$L\beta_4$ $L_I M_{II}$	9.5252
1.23858	2 75 Re	$L\beta_1$ $L_{II} M_{IV}$	10.0100	1.30165	9 72 Hf	Lu $L_{III} N_{VI,VII}$	9.5249
1.24120	5 80 Hg	$L\alpha_1$ $L_{III} M_V$	9.9888	1.30564	5 72 Hf	$L\beta_7$ $L_{III} O_I$	9.4958
1.24271	3 70 Yb	$L\gamma_5$ $L_{II} O_{IV}$	9.9766	1.3063	1 70 Yb	$L\gamma_5$ $L_{II} N_I$	9.4910
1.2428	1 70 Yb	L_{II} Abs. Edge	9.9761	1.30678	3 73 Ta	$L\beta_8$ $L_I M_{III}$	9.4875
1.2429	2 78 Pt	$L\eta$ $L_{II} M_I$	9.975	1.30767	7 82 Pb	L_I $L_{III} M_{II}$	9.4811
1.24385	7 82 Pb	L_S $L_{III} M_{III}$	9.9675	1.3086	1 73 Ta	$L_{III} N_{III}$	9.4742
1.24460	3 74 W	$L\beta_2$ $L_{III} N_V$	9.9615	1.3112	2 80 Hg	L_S $L_{III} M_{III}$	9.455
1.2453	1 70 Yb	$L_{II} O_{II,III}$	9.9561	1.31304	3 78 Pt	$L\alpha_1$ $L_{III} M_V$	9.4423
1.24631	3 74 W	$L\beta_{15}$ $L_{III} N_{IV}$	9.9478	1.3146	1 68 Er	$L\gamma_3$ $L_I N_{III}$	9.4309
1.2466	2 73 Ta	$L\beta_5$ $L_I M_V$	9.946	1.3153	2 69 Tm	$L\gamma_1$ $L_{II} N_{IV}$	9.426
1.2480	2 76 Os	$L\beta_{17}$ $L_{II} M_{III}$	9.934	1.31610	7 83 Bi	L_I $L_{III} M_I$	9.4204
1.24923	5 70 Yb	$L\gamma_6$ $L_{II} O_I$	9.9246	1.3167	1 73 Ta	$L_{III} N_{II}$	9.4158
1.2502	3 77 Ir	$L_{II} M_{II}$	9.917	1.31897	9 73 Ta	$L_{II} M_V$	9.3998
1.25100	5 75 Re	$L\beta_5$ $L_{III} N_I$	9.9105	1.3190	1 67 Ho	L_I Abs. Edge	9.3994
1.25264	7 80 Hg	$L\alpha_2$ $L_{III} M_{IV}$	9.8976	1.3208	3 67 Ho	$L_I O_{IV,V}$	9.387
1.2537	2 73 Ta	$L\beta_{10}$ $L_I M_{IV}$	9.889	1.3210	2 68 Er	$L\gamma_2$ $L_I N_{II}$	9.385

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
1.3225	2 67 Ho	$L\gamma_4$	$L_I O_{II,III}$	9.374	1.3948	1 70 Yb	$L\beta_7$	$L_{III} O_I$	8.8889
1.32432	2 78 Pt	$L\alpha_2$	$L_{III} M_{IV}$	9.3618	1.3983	2 67 Ho	$L\gamma_8$	$L_{II} O_I$	8.867
1.32639	5 72 Hf	$L\beta_2$	$L_{III} N_V$	9.3473	1.40140	5 71 Lu	$L\beta_8$	$L_I M_{III}$	8.8469
1.32698	3 73 Ta	$L\beta_1$	$L_{III} M_{IV}$	9.3431	1.40234	5 76 Os	$L\alpha_2$	$L_{III} M_{IV}$	8.8410
1.32783	5 72 Hf	$L\beta_{16}$	$L_{III} N_{IV}$	9.3371	1.4067	3 68 Er	$L\gamma_6$	$L_{II} N_I$	8.814
1.32785	7 76 Os	$L\eta$	$L_{II} M_I$	9.3370	1.41366	7 79 Au	L_I	$L_{III} M_{II}$	8.7702
1.33094	8 73 Ta	$L\beta_6$	$L_{III} N_I$	9.3153	1.41550	5 70 Yb	$L\beta_{2,15}$	$L_{III} N_{IV,V}$	8.7588
1.3358	1 71 Lu	$L\beta_9$	$L_I M_V$	9.2816	1.41640	7 66 Dy	$L\gamma_2$	$L_I N_{III}$	8.7532
1.3365	3 74 W		$L_I M_I$	9.277	1.4174	2 67 Ho	$L\gamma_1$	$L_{II} N_{IV}$	8.747
1.3366	1 75 Re		$L_{II} M_{II}$	9.2761	1.4189	1 71 Lu	$L\beta_6$	$L_{III} N_I$	8.7376
1.3386	1 68 Er	L_{II}	Abs. Edge	9.2622	1.42110	3 74 W	$L\eta$	$L_{II} M_I$	8.7243
1.3387	2 74 W	$L\beta_{17}$	$L_{II} M_{III}$	9.261	1.4216	1 80 Hg	L_I	$L_{III} M_I$	8.7210
1.3397	3 68 Er	$L\gamma_8$	$L_{II} O_{IV}$	9.255	1.4223	1 65 Tb	L_I	Abs. Edge	8.7167
1.340083	9 31 Ga	$K\alpha_1$	KL_{III}	9.25174	1.42278	7 66 Dy	$L\gamma_2$	$L_I N_{II}$	8.7140
1.3405	1 71 Lu	L_{III}	Abs. Edge	9.2490	1.4228	3 65 Tb		$L_I O_{IV,V}$	8.714
1.34154	5 81 Tl	L_I	$L_{III} M_{II}$	9.2417	1.42359	3 71 Lu	$L\beta_1$	$L_{II} M_{IV}$	8.7090
1.34183	7 71 Lu	$L\beta_6$	$L_{III} O_{IV,V,*}$	9.2397	1.4276	2 65 Tb	$L\gamma_4$	$L_I O_{II,III}$	8.685
1.3430	2 71 Lu	$L\beta_{10}$	$L_I M_{IV}$	9.232	1.43025	9 72 Hf		$L_I M_I$	8.6685
1.34399	1 31 Ga	$K\alpha_2$	KL_{II}	9.22482	1.43048	9 73 Ta		$L_{II} M_{II}$	8.6671
1.34524	9 71 Lu		$L_{III} O_{II,III}$	9.2163	1.4318	2 77 Ir	L_S	$L_{III} M_{III}$	8.659
1.34581	3 73 Ta	$L\beta_8$	$L_I M_{II}$	9.2124	1.43290	4 75 Re	$L\alpha_1$	$L_{II} M_V$	8.6525
1.34949	5 71 Lu	$L\beta_7$	$L_{III} O_I$	9.1873	1.4334	1 69 Tm	L_{III}	Abs. Edge	8.6496
1.34990	7 82 Pb	L_I	$L_{III} M_I$	9.1845	1.4336	3 69 Tm	$L\beta_9$	$L_I M_V$	8.648
1.35053	9 72 Hf		$L_{III} N_{III}$	9.1802	1.4349	2 69 Tm	$L\beta_8$	$L_{III} O_{IV,V}$	8.641
1.35128	3 77 Ir	$L\alpha_1$	$L_{III} M_V$	9.1751	1.435155	7 30 Zn	$K\alpha_1$	KL_{III}	8.63886
1.35131	7 79 Au	L_S	$L_{III} M_{III}$	9.1749	1.43643	9 72 Hf	$L\beta_{17}$	$L_{II} M_{III}$	8.6312
1.35300	5 72 Hf	$L\beta_8$	$L_I M_{III}$	9.1634	1.439000	8 30 Zn	$K\alpha_2$	KL_{II}	8.61578
1.3558	2 69 Tm	$L\gamma_8$	$L_{II} N_I$	9.144	1.44056	5 71 Lu	$L\beta_4$	$L_I M_{II}$	8.6064
1.35887	9 72 Hf		$L_{III} N_{II}$	9.1239	1.4410	3 69 Tm	$L\beta_{10}$	$L_I M_{IV}$	8.604
1.36250	5 77 Ir	$L\alpha_2$	$L_{III} M_{IV}$	9.0995	1.44396	5 75 Re	$L\alpha_2$	$L_{III} M_{IV}$	8.5862
1.3641	2 68 Er	$L\gamma_1$	$L_{II} N_{IV}$	9.089	1.4445	1 66 Dy	L_{II}	Abs. Edge	8.5830
1.3643	2 67 Ho	$L\gamma_3$	$L_I N_{III}$	9.087	1.44579	7 66 Dy	$L\gamma_8$	$L_{II} O_{IV}$	8.5753
1.3692	1 66 Dy	L_I	Abs. Edge	9.0548	1.45233	5 70 Yb	$L\beta_8$	$L_I M_{III}$	8.5367
1.3698	2 67 Ho	$L\gamma_2$	$L_I N_{II}$	9.051	1.4530	2 78 Pt	L_I	$L_{III} M_{II}$	8.533
1.37012	3 71 Lu	$L\beta_2$	$L_{III} N_V$	9.0489	1.45964	9 79 Au	L_I	$L_{III} M_I$	8.4939
1.3715	1 71 Lu	$L\beta_{15}$	$L_{III} N_{IV}$	9.0395	1.4618	2 67 Ho	$L\gamma_8$	$L_{II} N_I$	8.481
1.37342	5 75 Re	$L\eta$	$L_{II} M_I$	9.0272	1.4640	2 69 Tm	$L\beta_{2,13}$	$L_{III} N_{IV,V}$	8.468
1.37410	5 72 Hf	$L\beta_1$	$L_{II} M_{IV}$	9.0227	1.4661	1 70 Yb	$L\beta_8$	$L_{III} N_I$	8.4563
1.37410	5 72 Hf	$L\beta_6$	$L_{III} N_I$	9.0227	1.47106	5 73 Ta	$L\eta$	$L_{II} M_I$	8.4280
1.37459	7 66 Dy	$L\gamma_3$	$L_I O_{II,III}$	9.0195	1.4718	2 65 Tb	$L\gamma_8$	$L_I N_{III}$	8.423
1.3746	2 80 Hg	L_I	$L_{II} M_{II}$	9.019	1.47266	7 66 Dy	$L\gamma_1$	$L_{II} N_{IV}$	8.4188
1.38059	5 29 Cu	K	Abs. Edge	8.9803	1.4735	2 76 Os	L_S	$L_{III} M_{III}$	8.414
1.38109	3 29 Cu	$K\beta_2$	$K M_{IV,V}$	8.9770	1.47565	5 70 Yb	$L\beta_1$	$L_{II} M_{IV}$	8.4018
1.3838	1 70 Yb	$L\beta_9$	$L_I M_V$	8.9597	1.4764	2 65 Tb	$L\gamma_2$	$L_I N_{II}$	8.398
1.38477	3 81 Tl	L_I	$L_{III} M_I$	8.9532	1.47639	2 74 W	$L\alpha_1$	$L_{III} M_V$	8.3976
1.3862	1 70 Yb	L_{III}	Abs. Edge	8.9441	1.4784	1 64 Gd	L_I	Abs. Edge	8.3864
1.3864	1 73 Ta	$L\beta_{17}$	$L_{II} M_{III}$	8.9428	1.48064	9 72 Hf		$L_{II} M_{II}$	8.3735
1.38696	7 70 Yb	$L\beta_5$	$L_{III} O_{IV,V}$	8.9390	1.4807	3 64 Gd		$L_I O_{IV,V}$	8.373
1.3895	2 78 Pt	L_S	$L_{III} M_{III}$	8.923	1.4835	1 68 Er	L_{III}	Abs. Edge	8.3575
1.3898	1 70 Yb		$L_{III} O_{II,III}$	8.9209	1.4839	2 64 Gd	$L\gamma_4$	$L_I O_{II,III}$	8.355
1.3905	1 67 Ho	L_{II}	Abs. Edge	8.9164	1.4848	3 68 Er	$L\beta_8$	$L_{III} O_{IV,V}$	8.350
1.39121	5 76 Os	$L\alpha_1$	$L_{III} M_V$	8.9117	1.4855	5 68 Er	$L\beta_9$	$L_I M_V$	8.346
1.3915	1 70 Yb	$L\beta_{10}$	$L_I M_{IV}$	8.9100	1.48743	2 74 W	$L\alpha_2$	$L_{III} M_{IV}$	8.3352
1.39220	5 72 Hf	$L\beta_4$	$L_I M_{II}$	8.9054	1.48807	1 28 Ni	K	Abs. Edge	8.33165
1.392218	9 29 Cu	$K\beta_{1,3}$	$K M_{II,III}$	8.90529	1.48862	4 28 Ni	$K\beta_8$	$K M_{IV,V}$	8.3286
1.3923	2 67 Ho	$L\gamma_6$	$L_{II} O_{IV}$	8.905	1.49138	3 70 Yb	$L\beta_4$	$L_I M_{II}$	8.3132
1.3926	1 29 Cu	$K\beta_2$	$K M_{II}$	8.9029	1.4930	3 77 Ir	L_I	$L_{III} M_{II}$	8.304

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
1.4941	3 68 Er	$L\beta_1$	$L_{III}O_1$	8.298	1.60891	3 27 Co	$K\beta_5$	$KM_{IV,V}$	7.7059
1.4941	3 68 Er	$L\beta_{10}$	$L_{II}M_{IV}$	8.298	1.61264	9 73 Ta	L_5	$L_{III}M_{III}$	7.6881
1.4995	2 78 Pt	L_1	$L_{III}M_I$	8.268	1.61951	3 71 Lu	$L\alpha_1$	$L_{III}M_V$	7.6555
1.500135	8 28 Ni	$K\beta_{1,3}$	$KM_{II,III}$	8.26466	1.6203	2 67 Ho	$L\beta_3$	$L_{II}M_{III}$	7.6519
1.5023	1 65 Tb	L_{II}	Abs. Edge	8.2527	1.62079	2 27 Co	$K\beta_{1,3}$	$KM_{II,III}$	7.64943
1.5035	2 65 Tb	$L\gamma_6$	$L_{II}O_{IV}$	8.246	1.6237	2 67 Ho	$L\beta_3$	$L_{III}N_I$	7.6359
1.5063	2 69 Tm	$L\beta_3$	$L_{II}M_{III}$	8.231	1.62369	7 66 Dy	$L\beta_{7,16}$	$L_{III}N_{IV,V}$	7.6357
1.5097	2 65 Tb	$L\gamma_6$	$L_{II}O_I$	8.212	1.6244	3 74 W	L_1	$L_{III}M_{II}$	7.6324
1.51399	9 68 Er	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	8.1890	1.6271	1 63 Eu	L_{II}	Abs. Edge	7.6199
1.5162	2 69 Tm	$L\beta_3$	$L_{III}N_I$	8.177	1.6282	2 63 Eu	$L\gamma_6$	$L_{II}O_{IV}$	7.6147
1.5178	1 75 Re	L_5	$L_{III}M_{III}$	8.1682	1.63029	5 71 Lu	$L\alpha_2$	$L_{III}M_{IV}$	7.6049
1.51824	7 66 Dy	$L\gamma_6$	$L_{II}N_I$	8.1661	1.63056	5 75 Re	L_1	$L_{III}M_I$	7.6036
1.52197	2 73 Ta	$L\alpha_1$	$L_{III}M_V$	8.1461	1.6346	2 63 Eu	$L\gamma_8$	$L_{III}O_I$	7.5849
1.52325	5 72 Hf	$L\eta$	$L_{II}M_I$	8.1393	1.63560	5 70 Yb	$L\eta$	$L_{II}M_I$	7.5802
1.5297	2 64 Gd	$L\gamma_2$	$L_I N_{III}$	8.105	1.6412	2 64 Gd	$L\gamma_6$	$L_{II}N_2$	7.5543
1.5303	2 65 Tb	$L\gamma_1$	$L_{II}N_{IV}$	8.102	1.6475	2 67 Ho	$L\beta_1$	$L_{II}M_{IV}$	7.5253
1.5304	2 69 Tm	$L\beta_1$	$L_{II}M_{IV}$	8.101	1.6497	1 65 Tb	L_{III}	Abs. Edge	7.5153
1.53293	2 73 Ta	$L\alpha_2$	$L_{III}M_{IV}$	8.0879	1.6510	2 65 Tb	$L\beta_5$	$L_{III}O_{IV,V}$	7.5094
1.5331	2 64 Gd	$L\gamma_2$	$L_I N_{II}$	8.087	1.65601	3 62 Sm	$L\gamma_2$	$L_I N_{III}$	7.487
1.53333	9 71 Lu		$L_{II}M_{II}$	8.0858	1.6574	2 63 Eu	$L\gamma_1$	$L_{II}N_{IV}$	7.4803
1.5347	2 76 Os	L_1	$L_{III}M_{II}$	8.079	1.657910	8 28 Ni	$K\alpha_1$	KL_{III}	7.47815
1.5368	1 67 Ho	L_{III}	Abs. Edge	8.0676	1.6585	2 65 Tb	$L\beta_1$	$L_{III}O_I$	7.4753
1.5378	2 67 Ho	$L\beta_5$	$L_{III}O_{IV,V}$	8.062	1.6595	2 67 Ho	$L\beta_4$	$L_I M_{II}$	7.4708
1.5381	1 63 Eu	L_1	Abs. Edge	8.0607	1.66044	6 62 Sm	$L\gamma_2$	$L_I N_{II}$	7.467
1.540562	2 29 Cu	$K\alpha_1$	KL_{III}	8.04778	1.661747	8 28 Ni	$K\alpha_2$	KL_{II}	7.46089
1.54094	3 77 Ir	L_1	$L_{III}M_I$	8.0458	1.66346	9 72 Hf	L_5	$L_{III}M_{III}$	7.4532
1.5439	1 63 Eu	$L\gamma_6$	$L_I O_{II,III}$	8.0304	1.6673	3 65 Tb	$L\beta_{10}$	$L_I M_{IV}$	7.436
1.544390	9 29 Cu	$K\alpha_2$	KL_{II}	8.02783	1.6674	5 61 Pm	L_1	Abs. Edge	7.436
1.5448	2 69 Tm	$L\beta_4$	$L_I M_{II}$	8.026	1.67189	4 70 Yb	$L\alpha_1$	$L_{III}M_V$	7.4156
1.5486	3 67 Ho	$L\beta_{10}$	$L_I M_{IV}$	8.006	1.67265	9 73 Ta	L_1	$L_{III}M_{II}$	7.4123
1.5616	1 68 Er	$L\beta_3$	$L_I M_{III}$	7.9392	1.6782	1 74 W	L_1	$L_{III}M_I$	7.3878
1.5632	1 64 Gd	L_{II}	Abs. Edge	7.9310	1.68213	7 66 Dy	$L\beta_6$	$L_{III}N_I$	7.3705
1.5642	3 74 W	L_5	$L_{III}M_{III}$	7.926	1.6822	2 66 Dy	$L\beta_3$	$L_I M_{III}$	7.3702
1.5644	2 64 Gd	$L\gamma_6$	$L_{II}O_{IV}$	7.925	1.68285	5 70 Yb	$L\alpha_2$	$L_{III}M_{IV}$	7.3673
1.5671	2 67 Ho	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	7.911	1.6830	2 65 Tb	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	7.3667
1.5675	2 68 Er	$L\beta_5$	$L_{III}N_I$	7.909	1.6953	1 62 Sm	L_{II}	Abs. Edge	7.3132
1.56958	5 72 Hf	$L\alpha_1$	$L_{III}M_V$	7.8990	1.6963	2 69 Tm	$L\eta$	$L_{II}M_I$	7.3088
1.5707	2 64 Gd	$L\gamma_8$	$L_{II}O_I$	7.894	1.6966	9 62 Sm	$L\gamma_6$	$L_{II}O_{IV}$	7.308
1.5779	1 71 Lu	$L\eta$	$L_{II}M_I$	7.8575	1.7085	2 63 Eu	$L\gamma_6$	$L_{II}N_I$	7.2566
1.5787	2 65 Tb	$L\gamma_6$	$L_{II}N_I$	7.8535	1.71062	7 66 Dy	$L\beta_1$	$L_{II}M_{IV}$	7.2477
1.5789	1 75 Re	L_1	$L_{III}M_{II}$	7.8525	1.7117	1 64 Gd	L_{III}	Abs. Edge	7.2430
1.58046	5 72 Hf	$L\alpha_2$	$L_{III}M_{IV}$	7.8446	1.7130	2 64 Gd	$L\beta_5$	$L_{III}O_{IV,V}$	7.2374
1.58498	7 76 Os	L_1	$L_{III}M_I$	7.8222	1.7203	2 64 Gd	$L\beta_7$	$L_{III}O_I$	7.2071
1.5873	1 68 Er	$L\beta_1$	$L_{II}M_{IV}$	7.8109	1.72103	7 66 Dy	$L\beta_4$	$L_I M_{II}$	7.2039
1.58837	7 66 Dy	$L\beta_5$	$L_{III}O_{IV,V}$	7.8055	1.72305	9 72 Hf	L_1	$L_{III}M_{II}$	7.1954
1.58844	9 70 Yb		$L_{III}M_{II}$	7.8052	1.7240	3 64 Gd	$L\beta_8$	$L_I M_V$	7.192
1.5903	2 63 Eu	$L\gamma_8$	$L_I N_{III}$	7.7961	1.72724	3 62 Sm	$L\gamma_1$	$L_{II}N_{IV}$	7.178
1.5916	1 66 Dy	L_{III}	Abs. Edge	7.7897	1.7268	2 69 Tm	$L\alpha_1$	$L_{III}M_V$	7.1799
1.5924	2 64 Gd	$L\gamma_1$	$L_{II}N_{IV}$	7.7858	1.72841	5 73 Ta	L_1	$L_{III}M_I$	7.1731
1.5961	2 63 Eu	$L\gamma_8$	$L_I N_{II}$	7.7677	1.7315	3 64 Gd	$L\beta_{10}$	$L_I M_{IV}$	7.160
1.59973	9 66 Dy	$L\beta_5$	$L_I M_V$	7.7501	1.7381	2 69 Tm	$L\alpha_2$	$L_{III}M_{IV}$	7.1331
1.6002	1 62 Sm	L_1	Abs. Edge	7.7478	1.7390	1 60 Nd	L_1	Abs. Edge	7.1294
1.6007	1 68 Er	$L\beta_4$	$L_I M_{II}$	7.7453	1.7422	2 65 Tb	$L\beta_5$	$L_{III}N_I$	7.1163
1.60447	7 66 Dy	$L\beta_7$	$L_{III}O_I$	7.7272	1.74346	1 26 Fe	K	Abs. Edge	7.1120
1.60728	3 62 Sm	$L\gamma_6$	$L_I O_{II,III}$	7.714	1.7442	1 26 Fe	$K\beta_5$	$KM_{IV,V}$	7.1081
1.60743	9 66 Dy	$L\beta_{10}$	$L_I M_{IV}$	7.7130	1.7445	4 60 Nd	$L\gamma_4$	$L_I O_{II,III}$	7.107
1.60815	1 27 Co	K	Abs. Edge	7.70954	1.7455	2 64 Gd	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	7.1028

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
1.7472	2 65 Tb	$L\beta_2$	$L_{III}M_{III}$	7.0959	1.9255	2 63 Eu	$L\beta_4$	$L_{II}M_{II}$	6.4389
1.75661	2 26 Fe	$K\beta_{1,3}$	$KM_{II,III}$	7.05798	1.9255	5 59 Pr	L_{II}	Abs. Edge	6.439
1.7566	1 68 Er	$L\eta$	$L_{II}M_I$	7.0579	1.9355	4 60 Nd	$L\gamma_5$	$L_{II}N_I$	6.406
1.7676	5 61 Pm	L_{II}	Abs. Edge	7.014	1.936042	9 26 Fe	$K\alpha_1$	KL_{III}	6.40384
1.7760	1 71 Lu	$L\zeta$	$L_{III}M_{II}$	6.9810	1.9362	4 59 Pr	$L\gamma_8$	$L_{II}O_I$	6.403
1.7761	1 63 Eu	L_{III}	Abs. Edge	6.9806	1.939980	9 26 Fe	$K\alpha_2$	KL_{II}	6.39084
1.7768	3 65 Tb	$L\beta_1$	$L_{II}M_{IV}$	6.978	1.94643	3 62 Sm	$L\beta_5$	$L_{III}N_I$	6.3693
1.7772	2 63 Eu	$L\beta_5$	$L_{III}O_{IV,v}$	6.9763	1.9550	2 69 Tm	$L\zeta$	$L_{III}M_I$	6.3419
1.77934	3 62 Sm	$L\gamma_6$	$L_{II}N_I$	6.968	1.9553	3 58 Ce	$L\gamma_3$	$L_I N_{III}$	6.3409
1.78145	5 72 Hf	$L\zeta$	$L_{III}M_I$	6.9596	1.9559	6 61 Pm	$L\beta_{2,15}$	$L_{III}N_{IV,v}$	6.339
1.78425	9 68 Er	$L\alpha_1$	$L_{III}M_V$	6.9487	1.9602	3 58 Ce	$L\gamma_2$	$L_I N_{II}$	6.3250
1.7851	2 63 Eu	$L\beta_7$	$L_{III}O_I$	6.9453	1.9611	3 59 Pr	$L\gamma_1$	$L_{II}N_{IV}$	6.3221
1.7864	2 65 Tb	$L\beta_4$	$L_{II}M_{II}$	6.9403	1.96241	3 62 Sm	$L\beta_2$	$L_{II}M_{III}$	6.318
1.788965	9 27 Co	$K\alpha_1$	KL_{III}	6.93032	1.9730	2 65 Tb	$L\eta$	$L_{II}M_I$	6.2839
1.7916	3 63 Eu	$L\beta_3$	$L_{II}M_V$	6.920	1.9765	2 65 Tb	$L\alpha_1$	$L_{III}M_V$	6.2728
1.792850	9 27 Co	$K\alpha_2$	KL_{II}	6.91530	1.9780	5 57 La	L_I	Abs. Edge	6.268
1.7955	2 68 Er	$L\alpha_2$	$L_{III}M_{IV}$	6.9050	1.9830	4 57 La	$L\gamma_4$	$L_I O_{II,III}$	6.252
1.7964	4 60 Nd	$L\gamma_5$	$L_I N_{III}$	6.902	1.9875	2 65 Tb	$L\alpha_2$	$L_{III}M_{IV}$	6.2380
1.7989	9 61 Pm	$L\gamma_1$	$L_{II}N_{IV}$	6.892	1.9967	1 60 Nd	L_{III}	Abs. Edge	6.2092
1.7993	3 63 Eu	$L\beta_{10}$	$L_{II}M_{IV}$	6.890	1.99806	3 62 Sm	$L\beta_1$	$L_{II}M_{IV}$	6.2051
1.8013	4 60 Nd	$L\gamma_2$	$L_I N_{II}$	6.883	2.00095	6 62 Sm	$L\beta_4$	$L_I M_{II}$	6.196
1.8054	2 64 Gd	$L\beta_5$	$L_{III}N_I$	6.8671	2.0092	3 60 Nd	$L\beta_7$	$L_{II}O_I$	6.1708
1.8118	2 63 Eu	$L\beta_{2,15}$	$L_{III}N_{IV,v}$	6.8432	2.0124	5 58 Ce	L_{II}	Abs. Edge	6.161
1.8141	5 59 Pr	L_I	Abs. Edge	6.834	2.015	1 68 Er	$L\zeta$	$L_{III}M_I$	6.152
1.8150	2 64 Gd	$L\beta_3$	$L_{II}M_{III}$	6.8311	2.0165	3 60 Nd	$L\beta_9$	$L_I M_{III}$	6.1484
1.8193	4 59 Pr	$L\gamma_4$	$L_I O_{II,III}$	6.815	2.0205	4 59 Pr	$L\gamma_5$	$L_{II}N_I$	6.136
1.8264	2 67 Ho	$L\eta$	$L_{II}M_I$	6.7883	2.0237	4 58 Ce	$L\gamma_8$	$L_{II}O_I$	6.126
1.83091	9 70 Yb	$L\zeta$	$L_{III}M_{II}$	6.7715	2.0237	3 60 Nd	$L\beta_{10}$	$L_{II}M_{IV}$	6.1265
1.8360	1 71 Lu	$L\zeta$	$L_{III}M_I$	6.7528	2.0360	3 60 Nd	$L\beta_{2,15}$	$L_{III}N_{IV,v}$	6.0894
1.8440	1 60 Nd	L_{II}	Abs. Edge	6.7234	2.0410	4 57 La	$L\gamma_3$	$L_I N_{III}$	6.074
1.8450	2 67 Ho	$L\alpha_1$	$L_{III}M_V$	6.7198	2.0421	4 61 Pm	$L\beta_3$	$L_{II}M_{III}$	6.071
1.8457	1 62 Sm	L_{III}	Abs. Edge	6.7172	2.0460	4 57 La	$L\gamma_2$	$L_I N_{II}$	6.060
1.8468	2 64 Gd	$L\beta_1$	$L_{II}M_{IV}$	6.7132	2.0468	2 64 Gd	$L\alpha_1$	$L_{III}M_V$	6.0572
1.84700	9 62 Sm	$L\beta_5$	$L_{III}O_{IV,v}$	6.7126	2.0487	4 58 Ce	$L\gamma_1$	$L_{II}N_{IV}$	6.052
1.8540	2 64 Gd	$L\beta_4$	$L_I M_{II}$	6.6871	2.0494	1 64 Gd	$L\eta$	$L_{II}M_I$	6.0495
1.8552	5 60 Nd	$L\gamma_8$	$L_{II}O_I$	6.683	2.0578	2 64 Gd	$L\alpha_2$	$L_{III}M_{IV}$	6.0250
1.8561	2 67 Ho	$L\alpha_2$	$L_{III}M_{IV}$	6.6795	2.0678	5 56 Ba	L_I	Abs. Edge	5.996
1.85626	3 62 Sm	$L\beta_7$	$L_{III}O_I$	6.679	2.07020	5 24 Cr	K	Abs. Edge	5.9888
1.86166	3 62 Sm	$L\beta_3$	$L_I M_V$	6.660	2.07087	6 24 Cr	$K\beta_5$	$KM_{IV,v}$	5.9869
1.86990	3 62 Sm	$L\beta_{10}$	$L_{II}M_{IV}$	6.634	2.0756	3 56 Ba	$L\gamma_4$	$L_I O_{II,III}$	5.9733
1.8737	2 63 Eu	$L\beta_5$	$L_{III}N_I$	6.6170	2.0791	5 59 Pr	L_{III}	Abs. Edge	5.963
1.8740	4 59 Pr	$L\gamma_2$	$L_I N_{III}$	6.616	2.0797	4 61 Pm	$L\beta_1$	$L_{II}M_{IV}$	5.961
1.8779	2 60 Nd	$L\gamma_1$	$L_{II}N_{IV}$	6.6021	2.08487	2 24 Cr	$K\beta_{1,3}$	$KM_{II,III}$	5.94671
1.8791	4 59 Pr	$L\gamma_2$	$L_I N_{II}$	6.598	2.0860	2 67 Ho	$L\zeta$	$L_{III}M_I$	5.9434
1.8821	3 62 Sm	$L\beta_{2,15}$	$L_{III}N_{IV,v}$	6.586	2.0919	4 59 Pr	$L\beta_7$	$L_{III}O_I$	5.927
1.8867	2 63 Eu	$L\beta_3$	$L_I M_{III}$	6.5713	2.1004	4 59 Pr	$L\beta_2$	$L_I M_V$	5.903
1.8934	5 58 Ce	L_I	Abs. Edge	6.548	2.101820	9 25 Mn	$K\alpha_1$	KL_{III}	5.89875
1.89415	5 70 Yb	$L\zeta$	$L_{III}M_I$	6.5455	2.1039	3 60 Nd	$L\beta_5$	$L_{III}N_I$	5.8930
1.89643	5 25 Mn	K	Abs. Edge	6.5376	2.1053	5 57 La	L_{II}	Abs. Edge	5.889
1.8971	1 25 Mn	$K\beta_6$	$KM_{IV,v}$	6.5352	2.10578	2 25 Mn	$K\alpha_2$	KL_{II}	5.88765
1.89743	7 66 Dy	$L\eta$	$L_{II}M_I$	6.5342	2.1071	4 59 Pr	$L\beta_{10}$	$L_I M_{IV}$	5.884
1.8991	4 58 Ce	$L\gamma_4$	$L_I O_{II,III}$	6.528	2.1103	3 58 Ce	$L\gamma_5$	$L_{II}N_I$	5.8751
1.90881	3 66 Dy	$L\alpha_1$	$L_{III}M_V$	6.4952	2.1194	4 59 Pr	$L\beta_{2,15}$	$L_{III}N_{IV,v}$	5.850
1.91021	2 25 Mn	$K\beta_{1,3}$	$KM_{II,III}$	6.49045	2.1209	2 63 Eu	$L\alpha_1$	$L_{III}M_{IV}$	5.8457
1.9191	1 61 Pm	L_{III}	Abs. Edge	6.4605	2.1268	2 60 Nd	$L\beta_2$	$L_{II}M_{III}$	5.8294
1.91991	3 66 Dy	$L\alpha_2$	$L_{III}M_{IV}$	6.4577	2.1315	2 63 Eu	$L\eta$	$L_{II}M_I$	5.8166
1.9203	2 63 Eu	$L\beta_1$	$L_{II}M_{IV}$	6.4564	2.1315	2 63 Eu	$L\alpha_2$	$L_{III}M_{IV}$	5.8166

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
2.1342	2 56 Ba	$L\gamma_3$	$L_{II}N_{III}$	5.8092	2.3913	2 53 I	$L\gamma_4$	$L_{II}O_{II,III}$	5.1848
2.1387	2 56 Ba	$L\gamma_2$	$L_{II}N_{II}$	5.7969	2.3948	2 63 Eu	L_I	$L_{III}M_I$	5.1772
2.1418	3 57 La	$L\gamma_1$	$L_{III}N_{IV}$	5.7885	2.40435	6 56 Ba	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	5.1565
2.15877	7 66 Dy	L_I	$L_{III}M_I$	5.7431	2.4094	4 60 Nd	$L\eta$	$L_{II}M_I$	5.1457
2.166	1 58 Ce	L_{III}	Abs. Edge	5.723	2.4105	3 57 La	$L\beta_3$	$L_{II}M_{III}$	5.1434
2.1669	3 60 Nd	$L\beta_4$	$L_{II}M_{II}$	5.7216	2.4174	2 55 Cs	$L\gamma_5$	$L_{II}N_I$	5.1287
2.1669	2 60 Nd	$L\beta_1$	$L_{II}M_{IV}$	5.7216	2.4292	1 54 Xe	L_{II}	Abs. Edge	5.1037
2.1673	5 55 Cs	L_I	Abs. Edge	5.721	2.442	9 90 Th		$M_{II}O_{III}$	5.08
2.1701	2 58 Ce	$L\beta_7$	$L_{III}O_I$	5.7132	2.443	4 92 U		$M_{II}O_{IV}$	5.075
2.1741	2 55 Cs	$L\gamma_4$	$L_I O_{II,III}$	5.7026	2.4475	2 53 I	$L\gamma_{2,3}$	$L_{II}N_{II,III}$	5.0657
2.1885	3 58 Ce	$L\beta_9$	$L_{II}M_V$	5.6650	2.4493	3 57 La	$L\beta_4$	$L_{II}M_{II}$	5.0620
2.1906	4 59 Pr	$L\beta_6$	$L_{III}N_I$	5.660	2.45891	5 57 La	$L\beta_1$	$L_{II}M_{IV}$	5.0421
2.1958	5 58 Ce	$L\beta_{10}$	$L_{II}M_{IV}$	5.646	2.4630	2 59 Pr	$L\alpha_1$	$L_{III}M_V$	5.0337
2.1998	2 62 Sm	$L\alpha_1$	$L_{III}M_V$	5.6361	2.4729	3 59 Pr	$L\alpha_2$	$L_{III}M_{IV}$	5.0135
2.2048	1 56 Ba	L_{II}	Abs. Edge	5.6233	2.4740	1 55 Cs	L_{III}	Abs. Edge	5.0113
2.2056	4 57 La	$L\gamma_6$	$L_{II}N_I$	5.621	2.4783	2 55 Cs	$L\beta_9$	$L_{II}M_V$	5.0026
2.2087	2 58 Ce	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	5.6134	2.4823	4 62 Sm	L_I	$L_{III}M_I$	4.9945
2.21062	3 62 Sm	$L\alpha_2$	$L_{III}M_{IV}$	5.6090	2.4826	2 56 Ba	$L\beta_5$	$L_{III}N_I$	4.9939
2.2172	3 59 Pr	$L\beta_3$	$L_{II}M_{III}$	5.5918	2.4849	2 55 Cs	$L\beta_7$	$L_{III}O_I$	4.9893
2.21824	3 62 Sm	$L\eta$	$L_{II}M_I$	5.589	2.4920	2 55 Cs	$L\beta_{10}$	$L_{II}M_{IV}$	4.9752
2.2328	2 55 Cs	$L\gamma_3$	$L_{II}N_{III}$	5.5527	2.49734	5 22 Ti	K	Abs. Edge	4.96452
2.2352	2 65 Tb	L_I	$L_{III}M_I$	5.5467	2.4985	2 22 Ti	$K\beta_5$	$KM_{IV,V}$	4.9623
2.2371	2 55 Cs	$L\gamma_2$	$L_{II}N_{II}$	5.5420	2.50356	2 23 V	$K\alpha_1$	KL_{III}	4.95220
2.2415	2 56 Ba	$L\gamma_1$	$L_{II}N_{IV}$	5.5311	2.50738	2 23 V	$K\alpha_2$	KL_{II}	4.94464
2.253	6 92 U		$M_{II}P_{III}$	5.50	2.5099	1 52 Te	L_I	Abs. Edge	4.9397
2.2550	4 59 Pr	$L\beta_4$	$L_{II}M_{II}$	5.4981	2.5113	2 52 Te	$L\gamma_4$	$L_I O_{II,III}$	4.9369
2.2588	3 59 Pr	$L\beta_1$	$L_{II}M_{IV}$	5.4889	2.5118	2 55 Cs	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	4.9359
2.261	1 57 La	L_{III}	Abs. Edge	5.484	2.512	3 59 Pr	$L\eta$	$L_{II}M_I$	4.935
2.2691	1 23 V	K	Abs. Edge	5.4639	2.51391	2 22 Ti	$K\beta_{1,2}$	$KM_{II,III}$	4.93181
2.26951	6 23 V	$K\beta_6$	$KM_{IV,V}$	5.4629	2.5164	2 56 Ba	$L\beta_3$	$L_{II}M_{III}$	4.9269
2.2737	1 54 Xe	L_I	Abs. Edge	5.4528	2.527	4 91 Pa		$M_{II}O_{IV}$	4.906
2.275	3 57 La	$L\beta_7$	$L_{III}O_I$	5.450	2.5542	5 53 I	L_{II}	Abs. Edge	4.8540
2.282	3 57 La	$L\beta_9$	$L_{II}M_V$	5.434	2.5553	2 56 Ba	$L\beta_4$	$L_{II}M_{II}$	4.8519
2.2818	3 58 Ce	$L\beta_6$	$L_{III}N_I$	5.4334	2.5615	2 58 Ce	$L\alpha_1$	$L_{III}M_V$	4.8402
2.2822	3 61 Pm	$L\alpha_1$	$L_{III}M_V$	5.4325	2.5674	2 52 Te	$L\gamma_{2,3}$	$L_{II}N_{II,III}$	4.8290
2.28440	2 23 V	$K\beta_{1,2}$	$KM_{II,III}$	5.42729	2.56821	5 56 Ba	$L\beta_1$	$L_{II}M_{IV}$	4.82753
2.28970	2 24 Cr	$K\alpha_1$	KL_{III}	5.41472	2.5706	3 58 Ce	$L\alpha_2$	$L_{III}M_{IV}$	4.8230
2.290	3 57 La	$L\beta_{10}$	$L_{II}M_{IV}$	5.415	2.58244	8 53 I	$L\gamma_1$	$L_{II}N_{IV}$	4.8009
2.2926	4 61 Pm	$L\alpha_2$	$L_{III}M_{IV}$	5.4078	2.5926	1 54 Xe	L_{III}	Abs. Edge	4.7822
2.293606	3 24 Cr	$K\alpha_2$	KL_{II}	5.405509	2.5932	2 55 Cs	$L\beta_6$	$L_{III}N_I$	4.7811
2.3030	3 57 La	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	5.3835	2.618	5 90 Th		$M_{II}O_{IV}$	4.735
2.304	7 92 U		$M_{II}O_{III}$	5.38	2.6203	4 58 Ce	$L\eta$	$L_{II}M_I$	4.7315
2.3085	3 56 Ba	$L\gamma_5$	$L_{II}N_I$	5.3707	2.6285	2 55 Cs	$L\beta_3$	$L_{II}M_{III}$	4.7167
2.3109	3 58 Ce	$L\beta_3$	$L_{II}M_{III}$	5.3651	2.6388	1 51 Sb	L_I	Abs. Edge	4.6984
2.3122	2 64 Gd	L_I	$L_{III}M_I$	5.3621	2.6398	2 51 Sb	$L\gamma_6$	$L_I O_{II,III}$	4.6967
2.3139	1 55 Cs	L_{II}	Abs. Edge	5.3581	2.65710	9 53 I	$L\gamma_5$	$L_{II}N_I$	4.6660
2.3480	2 55 Cs	$L\gamma_1$	$L_{II}N_{IV}$	5.2804	2.66570	5 57 La	$L\alpha_1$	$L_{III}M_V$	4.65097
2.3497	4 58 Ce	$L\beta_4$	$L_{II}M_{II}$	5.2765	2.6666	2 55 Cs	$L\beta_4$	$L_{II}M_{II}$	4.6494
2.3561	3 58 Ce	$L\beta_1$	$L_{II}M_{IV}$	5.2622	2.67533	5 57 La	$L\alpha_2$	$L_{III}M_{IV}$	4.63423
2.3629	1 56 Ba	L_{III}	Abs. Edge	5.2470	2.6760	4 60 Nd	L_I	$L_{III}M_I$	4.6330
2.3704	2 60 Nd	$L\alpha_1$	$L_{III}M_V$	5.2304	2.6837	2 55 Cs	$L\beta_1$	$L_{II}M_{IV}$	4.6198
2.3764	2 56 Ba	$L\beta_9$	$L_{II}M_V$	5.2171	2.6879	1 52 Te	L_{II}	Abs. Edge	4.6126
2.3790	4 57 La	$L\beta_6$	$L_{III}N_I$	5.2114	2.6953	2 51 Sb	$L\gamma_{2,3}$	$L_{II}N_{II,III}$	4.5999
2.3806	2 56 Ba	$L\beta_7$	$L_{III}O_I$	5.2079	2.71241	6 52 Te	$L\gamma_1$	$L_{II}N_{IV}$	4.5709
2.3807	3 60 Nd	$L\alpha_2$	$L_{III}M_{IV}$	5.2077	2.71352	9 53 I	$L\beta_3$	$L_{II}M_V$	4.5690
2.3869	2 56 Ba	$L\beta_{10}$	$L_{II}M_{IV}$	5.1941	2.7196	5 53 I	L_{III}	Abs. Edge	4.5587
2.3880	5 53 I	L_I	Abs. Edge	5.192	2.72104	9 53 I	$L\beta_{10}$	$L_{II}M_{IV}$	4.5564

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
2.7288	3 53 I	$L\beta_3$	$L_{III}O_I$	4.5435	3.04661	9 52 Te	$L\beta_4$	$L_{II}M_{II}$	4.0695
2.740	3 57 La	$L\eta$	$L_{II}M_I$	4.525	3.068	5 90 Th	M_{III}	Abs. Edge	4.041
2.74851	2 22 Ti	$K\alpha_1$	KL_{III}	4.51084	3.0703	1 20 Ca	K	Abs. Edge	4.0381
2.75053	8 53 I	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	4.5075	3.0746	3 20 Ca	$K\beta_5$	$KM_{IV,V}$	4.0325
2.75216	2 22 Ti	$K\alpha_2$	KL_{II}	4.50486	3.07677	6 52 Te	$L\beta_1$	$L_{II}M_{IV}$	4.02958
2.753	8 92 U		$M_{II}N_{III}$	4.50	3.08475	9 50 Sn	$L\gamma_5$	$L_{II}N_I$	4.0192
2.762	1 21 Sc	K	Abs. Edge	4.489	3.0849	1 48 Cd	L_I	Abs. Edge	4.0190
2.7634	3 21 Sc	$K\beta_5$	$KM_{IV,V}$	4.4865	3.0897	2 20 Ca	$K\beta_{1,3}$	$KM_{II,III}$	4.0127
2.77595	5 56 Ba	$L\alpha_1$	$L_{III}M_V$	4.46626	3.094	5 83 Bi	M_I	Abs. Edge	4.007
2.7769	1 50 Sn	L_I	Abs. Edge	4.4648	3.11513	9 50 Sn	$L\beta_5$	$L_I M_V$	3.9800
2.7775	2 50 Sn	$L\gamma_4$	$L_I O_{II,III}$	4.4638	3.11513	9 51 Sb	$L\beta_6$	$L_{III}N_I$	3.9800
2.7796	2 21 Sc	$K\beta_{1,3}$	$KM_{II,III}$	4.4605	3.115	7 92 U		$M_{III}O_I$	3.980
2.7841	4 59 Pr	L_I	$L_{III}M_I$	4.4532	3.12170	9 50 Sn	$L\beta_{10}$	$L_I M_{IV}$	3.9716
2.78553	5 56 Ba	$L\alpha_2$	$L_{III}M_{IV}$	4.45090	3.131	3 90 Th		$M_{III}O_{IV,V}$	3.959
2.79007	9 52 Te	$L\gamma_5$	$L_{II}N_I$	4.4437	3.1355	2 56 Ba	L_I	$L_{II}M_I$	3.9541
2.817	2 92 U		$M_{II}N_{IV}$	4.401	3.1377	2 48 Cd	$L\gamma_2$	$L_I N_{II}$	3.9513
2.8294	5 51 Sb	L_{II}	Abs. Edge	4.3819	3.1473	1 49 In	L_{II}	Abs. Edge	3.9393
2.8327	2 50 Sn	$L\gamma_{2,3}$	$L_I N_{II,III}$	4.3768	3.14860	6 53 I	$L\alpha_1$	$L_{III}M_V$	3.93765
2.83672	9 53 I	$L\beta_5$	$L_{III}N_I$	4.3706	3.15258	9 51 Sb	$L\beta_5$	$L_I M_{III}$	3.9327
2.83897	9 52 Te	$L\beta_5$	$L_I M_V$	4.3671	3.1557	1 50 Sn	L_{III}	Abs. Edge	3.9288
2.84679	9 52 Te	$L\beta_{10}$	$L_I M_{IV}$	4.3551	3.1564	3 50 Sn	$L\beta_7$	$L_{III}O_I$	3.9279
2.85159	3 51 Sb	$L\gamma_1$	$L_{II}N_{IV}$	4.34779	3.15791	6 53 I	$L\alpha_2$	$L_{III}M_{IV}$	3.92604
2.8555	1 52 Te	L_{III}	Abs. Edge	4.3418	3.16213	4 49 In	$L\gamma_1$	$L_{II}N_{IV}$	3.92081
2.8627	3 56 Ba	$L\eta$	$L_{II}M_I$	4.3309	3.17505	3 50 Sn	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	3.90486
2.8634	3 52 Te	$L\beta_7$	$L_{III}O_I$	4.3298	3.19014	9 51 Sb	$L\beta_8$	$L_I M_{II}$	3.8364
2.87429	9 53 I	$L\beta_2$	$L_I M_{III}$	4.3134	3.217	5 82 Pb	M_I	Abs. Edge	3.854
2.88217	8 52 Te	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	4.3017	3.22567	4 51 Sb	$L\beta_1$	$L_{II}M_{IV}$	3.84357
2.884	5 92 U		M_{III}	4.299	3.245	9 91 Pa		$M_{III}O_I$	3.82
2.8917	4 58 Ce	L_I	$L_{III}M_I$	4.2875	3.24907	9 49 In	$L\gamma_5$	$L_{II}N_I$	3.8159
2.8924	2 55 Cs	$L\alpha_1$	$L_{III}M_V$	4.2865	3.2564	1 47 Ag	L_I	Abs. Edge	3.8072
2.9020	2 55 Cs	$L\alpha_2$	$L_{III}M_{IV}$	4.2722	3.2670	2 55 Cs	L_I	$L_{III}M_I$	3.7950
2.910	2 91 Pa		$M_{II}N_{IV}$	4.260	3.26763	9 49 In	$L\beta_3$	$L_I M_V$	3.7942
2.91207	9 53 I	$L\beta_4$	$L_I M_{II}$	4.2575	3.26901	9 50 Sn	$L\beta_6$	$L_{III}N_I$	3.7926
2.92	2 92 U		$M_{II}N_{II}$	4.25	3.27404	9 49 In	$L\beta_{10}$	$L_I M_{IV}$	3.7868
2.9260	1 49 In	L_I	Abs. Edge	4.2373	3.27979	9 53 I	$L\eta$	$L_{II}M_I$	3.7801
2.9264	2 49 In	$L\gamma_4$	$L_I O_{II,III}$	4.2367	3.283	9 90 Th		$M_{III}O_I$	3.78
2.93187	9 51 Sb	$L\gamma_5$	$L_{II}N_I$	4.2287	3.28920	6 52 Te	$L\alpha_1$	$L_{III}M_V$	3.76933
2.934	8 90 Th		$M_{II}N_{III}$	4.23	3.29846	9 52 Te	$L\alpha_2$	$L_{III}M_{IV}$	3.7588
2.93744	6 53 I	$L\beta_1$	$L_{II}M_{IV}$	4.22072	3.30585	3 50 Sn	$L\beta_2$	$L_I M_{III}$	3.7500
2.948	2 92 U		$M_{III}O_{IV,V}$	4.205	3.30635	9 47 Ag	$L\gamma_2$	$L_I N_{III}$	3.7498
2.97088	9 52 Te	$L\beta_5$	$L_{III}N_I$	4.1732	3.31216	9 47 Ag	$L\gamma_3$	$L_I N_{II}$	3.7432
2.97261	9 51 Sb	$L\beta_5$	$L_I M_V$	4.1708	3.3237	1 49 In	L_{III}	Abs. Edge	3.7302
2.97917	9 51 Sb	$L\beta_{10}$	$L_I M_{IV}$	4.1616	3.324	4 49 In	$L\beta_7$	$L_{III}O_I$	3.730
2.9800	2 49 In	$L\gamma_{2,3}$	$L_I N_{II,III}$	4.1605	3.3257	1 48 Cd	L_{II}	Abs. Edge	3.7280
2.9823	1 50 Sn	L_{II}	Abs. Edge	4.1573	3.329	4 92 U		$M_{II}N_I$	3.724
2.9932	2 55 Cs	$L\eta$	$L_{II}M_I$	4.1421	3.333	5 92 U	M_{IV}	Abs. Edge	3.720
3.0003	1 51 Sb	L_{III}	Abs. Edge	4.1323	3.33564	6 48 Cd	$L\gamma_1$	$L_{II}N_{IV}$	3.71686
3.00115	3 50 Sn	$L\gamma_1$	$L_{II}N_{IV}$	4.13112	3.33838	3 49 In	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	3.71381
3.0052	3 51 Sb	$L\beta_7$	$L_{III}O_I$	4.1255	3.34335	9 50 Sn	$L\beta_4$	$L_I M_{II}$	3.7083
3.006	3 57 La	L_I	$L_{III}M_I$	4.124	3.346	5 81 Tl	M_I	Abs. Edge	3.705
3.00893	9 52 Te	$L\beta_2$	$L_I M_{III}$	4.1204	3.35839	3 20 Ca	$K\alpha_1$	KL_{III}	3.69168
3.011	2 90 Th		$M_{II}N_{IV}$	4.117	3.359	5 83 Bi	M_{II}	Abs. Edge	3.691
3.0166	2 54 Xe	$L\alpha_1$	$L_{III}M_V$	4.1099	3.36166	3 20 Ca	$K\alpha_2$	KL_{II}	3.68809
3.02335	3 51 Sb	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	4.10078	3.36487	3 50 Sn	$L\beta_1$	$L_{II}M_{IV}$	3.66280
3.0309	1 21 Sc	$K\alpha_1$	KL_{III}	4.0906	3.42551	9 48 Cd	$L\gamma_5$	$L_{II}N_I$	3.61935
3.0342	1 21 Sc	$K\alpha_2$	KL_{II}	4.0861	3.43015	9 48 Cd	$L\beta_9$	$L_I M_V$	3.61445
3.038	2 91 Pa		$M_{III}O_{IV,V}$	4.081	3.43606	9 49 In	$L\beta_6$	$L_{III}N_I$	3.60823

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
3.4365	1 19 K	<i>K</i>	Abs. Edge	3.6078	4 49 In	<i>Lα₁</i>	<i>L_{III}M_V</i>	3.28694	
3.4367	2 48 Cd	<i>Lβ₁₀</i>	<i>L_IM_{IV}</i>	3.6075	6 49 In	<i>Lα₂</i>	<i>L_{III}M_{IV}</i>	3.27929	
3.437	1 46 Pd	<i>L_I</i>	Abs. Edge	3.607	5 80 Hg	<i>M_{II}</i>	Abs. Edge	3.277	
3.43832	9 52 Te	<i>Lη</i>	<i>L_{II}M_I</i>	3.78876	9 50 Sn	<i>Lη</i>	<i>L_{II}M_I</i>	3.27234	
3.43941	4 51 Sb	<i>Lα₁</i>	<i>L_{III}M_V</i>	3.60472	3.7920	2 46 Pd	<i>Lβ₉</i>	<i>L_IM_V</i>	3.2696
3.441	5 91 Pa		<i>M_{III}N_I</i>	3.603	3.7988	2 46 Pd	<i>Lβ₁₀</i>	<i>L_{II}M_{IV}</i>	3.2637
3.4413	4 19 K	<i>Kβ₈</i>	<i>KM_{IV,V}</i>	3.6027	3.80774	9 47 Ag	<i>Lβ₆</i>	<i>L_{III}N_I</i>	3.25603
3.44840	6 51 Sb	<i>Lα₂</i>	<i>L_{III}M_{IV}</i>	3.59532	3.808	4 90 Th		<i>M_{IV}O_{II}</i>	3.256
3.4539	2 19 K	<i>Kβ_{1,3}</i>	<i>KM_{II,III}</i>	3.5896	3.8222	2 46 Pd	<i>Lγ₅</i>	<i>L_{II}N_I</i>	3.2437
3.46984	9 49 In	<i>Lβ₈</i>	<i>L_IM_{III}</i>	3.57311	3.827	1 91 Pa	<i>Mβ</i>	<i>M_{IV}N_{VI}</i>	3.2397
3.478	5 80 Hg	<i>M_I</i>	Abs. Edge	3.565	3.83313	9 47 Ag	<i>Lβ₂</i>	<i>L_IM_{III}</i>	3.23446
3.479	1 92 U	<i>Mγ</i>	<i>M_{III}N_V</i>	3.563	3.834	4 83 Bi		<i>M_{II}N_{IV}</i>	3.234
3.4892	2 46 Pd	<i>Lγ_{2,3}</i>	<i>L_IN_{II,III}</i>	3.5533	3.835	5 44 Ru	<i>L_I</i>	Abs. Edge	3.233
3.492	5 82 Pb	<i>M_{II}</i>	Abs. Edge	3.550	3.87023	5 47 Ag	<i>Lβ₄</i>	<i>L_IM_{II}</i>	3.20346
3.497	5 92 U	<i>M_V</i>	Abs. Edge	3.545	3.87090	5 18 A	<i>K</i>	Abs. Edge	3.20290
3.5047	1 48 Cd	<i>L_{III}</i>	Abs. Edge	3.5376	3.872	9 82 Pb		<i>M_IN_{III}</i>	3.202
3.50697	9 49 In	<i>Lβ₄</i>	<i>L_IM_{II}</i>	3.53528	3.8860	2 18 A	<i>Kβ_{1,3}</i>	<i>KM_{II,III}</i>	3.1905
3.51408	4 48 Cd	<i>Lβ_{2,15}</i>	<i>L_{III}N_{IV,V}</i>	3.52812	3.88826	9 51 Sb	<i>L_I</i>	<i>L_{III}M_I</i>	3.18860
3.5164	1 47 Ag	<i>L_{II}</i>	Abs. Edge	3.5258	3.892	9 83 Bi		<i>M_IN_{II}</i>	3.185
3.521	2 92 U		<i>M_{III}N_{IV}</i>	3.521	3.8977	2 44 Ru	<i>Lγ_{2,3}</i>	<i>L_IN_{II,III}</i>	3.1809
3.52260	4 47 Ag	<i>Lγ₁</i>	<i>L_{II}N_{IV}</i>	3.51959	3.904	5 83 Bi	<i>M_{III}</i>	Abs. Edge	3.176
3.537	9 90 Th		<i>M_{II}N_I</i>	3.505	3.9074	1 46 Pd	<i>L_{III}</i>	Abs. Edge	3.17298
3.55531	4 49 In	<i>Lβ₁</i>	<i>L_{II}M_{IV}</i>	3.48721	3.90887	4 46 Pd	<i>Lβ_{2,15}</i>	<i>L_{III}N_{IV,V}</i>	3.17179
3.557	5 90 Th	<i>M_{IV}</i>	Abs. Edge	3.485	3.910	1 92 U	<i>Mα₁</i>	<i>M_VN_{VII}</i>	3.1708
3.55754	9 53 I	<i>L_I</i>	<i>L_{III}M_I</i>	3.48502	3.915	5 77 Ir	<i>M_I</i>	Abs. Edge	3.167
3.576	1 92 U		<i>M_{IV}O_{II}</i>	3.4666	3.924	1 92 U	<i>Mα₂</i>	<i>M_VN_{VI}</i>	3.1595
3.577	1 91 Pa	<i>Mγ</i>	<i>M_{III}N_V</i>	3.4657	3.932	6 83 Bi		<i>M_{III}O_{IV,V}</i>	3.153
3.59994	3 50 Sn	<i>Lα₁</i>	<i>L_{III}M_V</i>	3.44398	3.93473	3 47 Ag	<i>Lβ₁</i>	<i>L_{II}M_{IV}</i>	3.15094
3.60497	9 47 Ag	<i>Lβ₉</i>	<i>L_IM_V</i>	3.43917	3.936	5 79 Au	<i>M_{II}</i>	Abs. Edge	3.150
3.60765	9 51 Sb	<i>Lη</i>	<i>L_{II}M_I</i>	3.43661	3.941	1 90 Th	<i>Mβ</i>	<i>M_{IV}N_{VI}</i>	3.1458
3.60891	4 50 Sn	<i>Lα₂</i>	<i>L_{III}M_{IV}</i>	3.43542	3.9425	5 45 Rh	<i>L_{II}</i>	Abs. Edge	3.1448
3.61158	9 47 Ag	<i>Lβ₁₀</i>	<i>L_IM_{IV}</i>	3.43287	3.9437	2 45 Rh	<i>Lγ₁</i>	<i>L_{II}N_{IV}</i>	3.1438
3.614	2 91 Pa		<i>M_{III}N_{IV}</i>	3.430	3.95635	4 48 Cd	<i>Lα₁</i>	<i>L_{III}M_V</i>	3.13373
3.61467	9 48 Cd	<i>Lβ₆</i>	<i>L_{III}N_I</i>	3.42994	3.96496	6 48 Cd	<i>Lα₂</i>	<i>L_{III}M_{IV}</i>	3.12691
3.61638	9 47 Ag	<i>Lγ₅</i>	<i>L_{II}N_I</i>	3.42832	3.968	5 82 Pb		<i>M_{II}N_{IV}</i>	3.124
3.616	5 79 Au	<i>M_I</i>	Abs. Edge	3.428	3.98327	9 49 In	<i>Lη</i>	<i>L_{II}M_I</i>	3.11254
3.629	5 45 Rh	<i>L_I</i>	Abs. Edge	3.417	4.013	9 81 Tl		<i>M_IN_{III}</i>	3.089
3.634	5 81 Tl	<i>M_{II}</i>	Abs. Edge	3.412	4.0162	2 46 Pd	<i>Lβ₆</i>	<i>L_{III}N_I</i>	3.0870
3.64495	9 48 Cd	<i>Lβ₂</i>	<i>L_IM_{III}</i>	3.40145	4.022	1 91 Pa	<i>Mα₁</i>	<i>M_VN_{VII}</i>	3.0823
3.679	2 90 Th	<i>Mγ</i>	<i>M_{III}N_V</i>	3.370	4.0346	2 46 Pd	<i>Lβ₃</i>	<i>L₂M_{III}</i>	3.0730
3.68203	9 48 Cd	<i>Lβ₄</i>	<i>L_IM_{II}</i>	3.36719	4.035	3 91 Pa	<i>Mα₂</i>	<i>M_VN_{VI}</i>	3.072
3.6855	2 45 Rh	<i>Lγ_{2,3}</i>	<i>L_IN_{II,III}</i>	3.3640	4.0451	2 45 Rh	<i>Lγ₅</i>	<i>L_{II}N_I</i>	3.0650
3.691	2 91 Pa		<i>M_{IV}O_{II}</i>	3.359	4.047	1 82 Pb	<i>M_{III}</i>	Abs. Edge	3.0632
3.6999	1 47 Ag	<i>L_{III}</i>	Abs. Edge	3.35096	4.058	5 43 Te	<i>L_I</i>	Abs. Edge	3.055
3.70335	3 47 Ag	<i>Lβ_{2,15}</i>	<i>L_{III}N_{IV,V}</i>	3.34781	4.069	6 82 Pb		<i>M_{III}O_{IV,V}</i>	3.047
3.716	1 92 U	<i>Mβ</i>	<i>M_{IV}N_{VI}</i>	3.3367	4.0711	2 46 Pd	<i>Lβ₄</i>	<i>L_IM_{II}</i>	3.0454
3.71696	9 52 Te	<i>L_I</i>	<i>L_{III}M_I</i>	3.33555	4.071	5 76 Os	<i>M_I</i>	Abs. Edge	3.045
3.718	3 90 Th		<i>M_{III}N_{IV}</i>	3.335	4.07165	9 50 Sn	<i>L_I</i>	<i>L_{III}M_I</i>	3.04499
3.7228	1 46 Pd	<i>L_{II}</i>	Abs. Edge	3.33031	4.093	5 78 Pt	<i>M_{II}</i>	Abs. Edge	3.029
3.7246	2 46 Pd	<i>Lγ₁</i>	<i>L_{II}N_{IV}</i>	3.3287	4.105	9 83 Bi		<i>M_{III}O_I</i>	3.021
3.729	5 90 Th	<i>Mγ</i>	Abs. Edge	3.325	4.116	4 81 Tl		<i>M_{II}N_{IV}</i>	3.013
3.73823	4 48 Cd	<i>Lβ₁</i>	<i>L_{II}M_{IV}</i>	3.31657	4.1299	5 45 Rh	<i>L_{III}</i>	Abs. Edge	3.0021
3.740	9 83 Bi		<i>M_IN_{III}</i>	3.315	4.1310	2 45 Rh	<i>Lβ_{2,15}</i>	<i>L_{III}N_{IV,V}</i>	3.0013
3.7414	2 19 K	<i>Kα₁</i>	<i>KL_{III}</i>	3.3138	4.1381	9 90 Th	<i>Mα₁</i>	<i>M_VN_{VII}</i>	2.9961
3.7445	2 19 K	<i>Kα₂</i>	<i>KL_{II}</i>	3.3111	4.14622	5 46 Pd	<i>Lβ₁</i>	<i>L_{II}M_{IV}</i>	2.99022
3.760	9 90 Th		<i>M_VP_{III}</i>	3.298	4.151	2 90 Th	<i>Mα₂</i>	<i>M_VN_{VI}</i>	2.987
3.762	5 78 Pt	<i>M_I</i>	Abs. Edge	3.296	4.15443	3 47 Ag	<i>Lα₁</i>	<i>L_{III}M_V</i>	2.98431

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
4.16294	5 47 Ag	$L\alpha_2$	$L_{III}M_{IV}$	2.97821	4.6542	2 41 Nb	$L_{\gamma_{2,3}}$	$L_{II}N_{II,III}$	2.6638
4.180	1 44 Ru	L_{II}	Abs. Edge	2.9663	4.655	8 82 Pb		$M_{II}N_I$	2.664
4.1822	2 44 Ru	L_{γ_1}	$L_{II}N_{IV}$	2.9645	4.6605	2 46 Pd	L_{η}	$L_{II}M_I$	2.6603
4.19180	5 18 A	$K\alpha_1$	KL_{III}	2.95770	4.674	1 82 Pb	M_{γ}	$M_{III}N_V$	2.6527
4.19315	9 48 Cd	L_{η}	$L_{II}M_I$	2.95675	4.686	1 78 Pt	M_{III}	Abs. Edge	2.6459
4.19474	5 18 A	$K\alpha_2$	KL_{II}	2.95563	4.694	8 78 Pt		$M_{III}O_{IV,V}$	2.641
4.198	1 81 Tl	M_{III}	Abs. Edge	2.9535	4.703	9 79 Au		$M_{III}O_I$	2.636
4.216	6 81 Tl		$M_{III}O_{IV,V}$	2.941	4.7076	2 47 Ag	L_I	$L_{III}M_I$	2.6337
4.236	5 75 Re	M_I	Abs. Edge	2.927	4.715	3 82 Pb		$M_{III}N_{IV}$	2.630
4.2417	2 45 Rh	$L\beta_6$	$L_{III}N_I$	2.9229	4.719	1 42 Mo	L_{II}	Abs. Edge	2.6274
4.244	9 82 Pb		$M_{III}O_I$	2.921	4.7258	2 42 Mo	L_{γ_1}	$L_{II}N_{IV}$	2.6235
4.2522	2 45 Rh	$L\beta_5$	$L_I M_{III}$	2.9157	4.7278	1 17 Cl	$K\alpha_1$	KL_{III}	2.62239
4.260	5 77 Ir	M_{II}	Abs. Edge	2.910	4.7307	1 17 Cl	$K\alpha_2$	KL_{II}	2.62078
4.26873	9 49 In	L_I	$L_{III}M_I$	2.90440	4.757	5 82 Pb	M_{IV}	Abs. Edge	2.606
4.2873	2 44 Ru	L_{γ_5}	$L_{II}N_I$	2.8918	4.764	5 83 Bi	M_V	Abs. Edge	2.603
4.2888	2 45 Rh	$L\beta_4$	$L_I M_{II}$	2.8908	4.780	4 77 Ir		$M_{III}N_{IV}$	2.594
4.300	9 79 Au		$M_I N_{III}$	2.883	4.79	2 76 Os		$M_I N_{III}$	2.59
4.304	5 42 Mo	L_I	Abs. Edge	2.881	4.815	5 74 W	M_{II}	Abs. Edge	2.575
4.330	2 92 U		$M_{III}N_I$	2.863	4.823	3 83 Bi		$M_{IV}O_{II}$	2.571
4.355	1 80 Hg	M_{III}	Abs. Edge	2.8469	4.823	4 81 Tl	M_{γ}	$M_{III}N_V$	2.571
4.36767	5 46 Pd	$L\alpha_1$	$L_{III}M_V$	2.83861	4.8369	2 42 Mo	L_{γ_5}	$L_{II}N_I$	2.5632
4.369	1 44 Ru	L_{III}	Abs. Edge	2.8377	4.84575	5 44 Ru	$L\alpha_1$	$L_{III}M_V$	2.55855
4.3718	2 44 Ru	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	2.8360	4.85381	7 44 Ru	$L\alpha_2$	$L_{III}M_{IV}$	2.55431
4.37414	4 45 Rh	$L\beta_1$	$L_{II}M_{IV}$	2.83441	4.861	1 77 Ir	M_{III}	Abs. Edge	2.5505
4.37588	7 46 Pd	$L\alpha_2$	$L_{III}M_{IV}$	2.83329	4.865	5 81 Tl		$M_{III}N_{IV}$	2.548
4.3800	2 42 Mo	$L_{\gamma_{2,3}}$	$L_I N_{II,III}$	2.8306	4.869	9 77 Ir		$M_{III}O_{IV,V}$	2.546
4.3971	1 17 Cl	K	Abs. Edge	2.81960	4.876	9 78 Pt		$M_{III}O_I$	2.543
4.4034	3 17 Cl	$K\beta$	KM	2.8156	4.879	5 40 Zr	L_I	Abs. Edge	2.541
4.407	5 74 W	M_I	Abs. Edge	2.813	4.8873	8 43 Tc	$L\beta_1$	$L_{II}M_{IV}$	2.5368
4.4183	2 47 Ag	L_{η}	$L_{II}M_I$	2.8061	4.909	1 83 Bi	$M\beta$	$M_{IV}N_{VI}$	2.5255
4.432	4 79 Au		$M_{II}N_{IV}$	2.797	4.911	5 90 Th		$M_{IV}N_{III}$	2.524
4.433	5 76 Os	M_{II}	Abs. Edge	2.797	4.913	1 42 Mo	L_{III}	Abs. Edge	2.5234
4.436	1 43 Te	L_{II}	Abs. Edge	2.7948	4.9217	2 45 Rh	L_{η}	$L_{II}M_I$	2.5191
4.44	2 74 W		$M_I O_{II,III}$	2.79	4.9232	2 42 Mo	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	2.5183
4.450	4 91 Pa		$M_{III}N_I$	2.786	4.946	2 92 U	M_{ζ_1}	$M_V N_{III}$	2.507
4.460	9 78 Pt		$M_I N_{III}$	2.780	4.952	5 81 Tl	M_{IV}	Abs. Edge	2.504
4.48014	9 48 Cd	L_I	$L_{III}M_I$	2.76735	4.9525	3 46 Pd	L_I	$L_{III}M_I$	2.5034
4.4866	3 44 Ru	$L\beta_3$	$L_I M_{III}$	2.7634	4.9536	3 40 Zr	$L_{\gamma_{2,3}}$	$L_I N_{II,III}$	2.5029
4.4866	3 44 Ru	$L\beta_5$	$L_{III}N_I$	2.7634	4.955	4 76 Os		$M_{II}N_{IV}$	2.502
4.518	1 79 Au	M_{III}	Abs. Edge	2.7439	4.955	5 82 Pb	M_V	Abs. Edge	2.502
4.522	6 79 Au		$M_{III}O_{IV,V}$	2.742	4.984	2 80 Hg	M_{γ}	$M_{III}N_V$	2.4875
4.5230	2 44 Ru	$L\beta_4$	$L_I M_{II}$	2.7411	5.004	9 82 Pb		$M_{IV}O_{II}$	2.477
4.532	2 83 Bi	M_{γ}	$M_{III}N_V$	2.735	5.0133	3 42 Mo	$L\beta_3$	$L_I M_{III}$	2.4730
4.568	5 90 Th		$M_{III}N_I$	2.714	5.0185	1 16 S	K	Abs. Edge	2.47048
4.571	5 83 Bi		$M_{III}N_{IV}$	2.712	5.020	5 73 Ta	M_{II}	Abs. Edge	2.470
4.572	5 83 Bi	M_{IV}	Abs. Edge	2.711	5.0233	3 16 S	$K\beta_x$	KM	2.4681
4.575	5 41 Nb	L_I	Abs. Edge	2.710	5.031	1 41 Nb	L_{II}	Abs. Edge	2.4641
4.585	5 73 Ta	M_I	Abs. Edge	2.704	5.0316	2 16 S	$K\beta_1$	KM	2.46404
4.59	2 83 Bi		$M_{IV}P_{II,III}$	2.70	5.0361	3 41 Nb	L_{γ_1}	$L_{II}N_{IV}$	2.4618
4.59743	9 45 Rh	$L\alpha_1$	$L_{III}M_V$	2.69674	5.043	5 76 Os	M_{III}	Abs. Edge	2.458
4.601	4 78 Pt		$M_{II}N_{IV}$	2.695	5.0488	3 42 Mo	$L\beta_4$	$L_I M_{II}$	2.4557
4.60545	9 45 Rh	$L\alpha_2$	$L_{III}M_{IV}$	2.69205	5.0488	5 42 Mo	$L\beta_5$	$L_{III}N_I$	2.4557
4.620	5 75 Re	M_{II}	Abs. Edge	2.684	5.050	2 92 U	M_{ζ_2}	$M_{IV}N_{II}$	2.4548
4.62058	3 44 Ru	$L\beta_1$	$L_{II}M_{IV}$	2.68323	5.076	1 82 Pb	$M\beta$	$M_{IV}N_{VI}$	2.4427
4.625	5 92 U		$M_{IV}N_{III}$	2.681	5.092	2 91 Pa	M_{ζ_1}	$M_V N_{III}$	2.4350
4.630	1 43 Tc	L_{III}	Abs. Edge	2.6780	5.1148	3 43 Tc	$L\alpha_1$	$L_{III}M_V$	2.4240
4.631	9 77 Ir		$M_I N_{III}$	2.677	5.118	1 83 Bi	$M\alpha_1$	$M_V N_{VII}$	2.4226

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
5.130	2 83 Bi	$M\alpha_2$	$M_{V}N_{VI}$	2.4170	5.6445	3 38 Sr	$L\gamma_{2,3}$	$L_{II}N_{II,III}$	2.1965
5.145	4 79 Au	$M\gamma$	$M_{III}N_{V}$	2.410	5.6476	9 80 Hg	$M\alpha_1$	$M_{V}N_{VII}$	2.1953
5.1517	3 41 Nb	$L\gamma_6$	$L_{II}N_I$	2.4066	5.650	5 73 Ta	M_{III}	Abs. Edge	2.194
5.153	5 81 Tl	M_V	Abs. Edge	2.406	5.6681	3 40 Zr	$L\beta_6$	$L_{II}M_{II}$	2.1873
5.157	5 80 Hg	M_{IV}	Abs. Edge	2.404	5.67	3 73 Ta		$M_{III}O_{IV,V}$	2.19
5.168	9 82 Pb		$M_{V}O_{III}$	2.399	5.682	4 76 Os	$M\gamma$	$M_{III}N_{V}$	2.182
5.172	9 74 W		$M_{II}N_{III}$	2.397	5.704	8 82 Pb		$M_{III}N_I$	2.174
5.17708	8 42 Mo	$L\beta_1$	$L_{III}M_{IV}$	2.39481	5.7101	3 40 Zr	$L\beta_6$	$L_{III}N_I$	2.1712
5.186	5 79 Au		$M_{III}N_{IV}$	2.391	5.724	5 76 Os		$M_{III}N_{IV}$	2.166
5.193	2 91 Pa	$M\zeta_2$	$M_{IV}N_{II}$	2.3876	5.7243	2 41 Nb	$L\alpha_1$	$L_{III}M_{V}$	2.16589
5.196	9 81 Tl		$M_{IV}O_{II}$	2.386	5.7319	3 41 Nb	$L\alpha_2$	$L_{III}M_{IV}$	2.1630
5.2050	2 44 Ru	$L\eta$	$L_{II}M_I$	2.38197	5.756	1 39 Y	L_{II}	Abs. Edge	2.1540
5.217	5 39 Y	L_I	Abs. Edge	2.377	5.767	9 79 Au		$M_{V}O_{III}$	2.150
5.2169	3 45 Rh	L_I	$L_{III}M_I$	2.3765	5.784	1 15 P	K	Abs. Edge	2.1435
5.230	1 41 Nb	L_{III}	Abs. Edge	2.3706	5.796	2 15 P	$K\beta$	KM	2.1391
5.234	5 75 Re	M_{III}	Abs. Edge	2.369	5.81	2 76 Os		$M_{II}N_I$	2.133
5.2379	3 41 Nb	$L\beta_{2,16}$	$L_{III}N_{IV,V}$	2.3670	5.81	1 78 Pt	M_V	Abs. Edge	2.133
5.245	5 90 Th	$M\zeta_1$	$M_{V}N_{III}$	2.364	5.828	1 78 Pt	$M\beta$	$M_{IV}N_{VI}$	2.1273
5.249	1 81 Tl	$M\beta$	$M_{IV}N_{VI}$	2.3621	5.83	2 73 Ta		$M_{III}O_I$	2.126
5.2830	3 39 Y	$L\gamma_{2,3}$	$L_{II}N_{II,III}$	2.3468	5.83	1 77 Ir	M_{IV}	Abs. Edge	2.126
5.286	1 82 Pb	$M\alpha_1$	$M_{V}N_{VII}$	2.3455	5.8360	3 40 Zr	$L\beta_1$	$L_{II}M_{IV}$	2.1244
5.299	2 82 Pb	$M\alpha_2$	$M_{V}N_{VI}$	2.3397	5.840	1 79 Au	$M\alpha_1$	$M_{V}N_{VII}$	2.1229
5.3102	3 41 Nb	$L\beta_8$	$L_{II}M_{III}$	2.3348	5.8475	3 42 Mo	$L\eta$	$L_{II}M_I$	2.1202
5.319	4 78 Pt	$M\gamma$	$M_{III}N_{V}$	2.331	5.854	3 79 Au	$M\alpha_2$	$M_{V}N_{VI}$	2.118
5.340	5 90 Th	$M\zeta_2$	$M_{IV}N_{II}$	2.322	5.8754	3 39 Y	$L\gamma_6$	$L_{II}N_I$	2.1102
5.3455	3 41 Nb	$L\beta_4$	$L_{II}M_{II}$	2.3194	5.884	8 81 Tl		$M_{III}N_I$	2.107
5.357	4 74 W		$M_{II}N_{IV}$	2.314	5.885	2 75 Re	$M\gamma$	$M_{III}N_{V}$	2.1067
5.357	5 78 Pt		$M_{III}N_{IV}$	2.314	5.931	5 75 Re		$M_{III}N_{IV}$	2.090
5.36	1 80 Hg	M_V	Abs. Edge	2.313	5.962	1 39 Y	L_{III}	Abs. Edge	2.0794
5.3613	3 41 Nb	$L\beta_6$	$L_{III}N_I$	2.3125	5.9832	3 39 Y	$L\beta_6$	$L_{II}M_{III}$	2.0722
5.37216	7 16 S	$K\alpha_1$	KL_{III}	2.30784	5.987	9 78 Pt		$M_{V}O_{III}$	2.071
5.374	5 79 Au	M_{IV}	Abs. Edge	2.307	6.008	5 37 Rb	L_I	Abs. Edge	2.063
5.37496	8 16 S	$K\alpha_2$	KL_{II}	2.30664	6.0186	3 39 Y	$L\beta_4$	$L_{II}M_{II}$	2.0600
5.378	1 40 Zr	L_{II}	Abs. Edge	2.3053	6.038	1 77 Ir	$M\beta$	$M_{IV}N_{VI}$	2.0535
5.3843	3 40 Zr	$L\gamma_1$	$L_{II}N_{IV}$	2.3027	6.0458	3 37 Rb	$L\gamma_{2,3}$	$L_{II}N_{II,III}$	2.0507
5.40	2 73 Ta		$M_{II}N_{III}$	2.295	6.047	1 78 Pt	$M\alpha_1$	$M_{V}N_{VII}$	2.0505
5.40655	8 42 Mo	$L\alpha_1$	$L_{III}M_{V}$	2.29316	6.05	1 77 Ir	M_V	Abs. Edge	2.048
5.41437	8 42 Mo	$L\alpha_2$	$L_{III}M_{IV}$	2.28985	6.058	3 78 Pt	$M\alpha_2$	$M_{V}N_{VI}$	2.047
5.4318	9 80 Hg	$M\beta$	$M_{IV}N_{VI}$	2.2825	6.0705	2 40 Zr	$L\alpha_1$	$L_{III}M_{V}$	2.04336
5.435	1 74 W	M_{III}	Abs. Edge	2.2811	6.073	5 76 Os	M_{IV}	Abs. Edge	2.042
5.460	1 81 Tl	$M\alpha_1$	$M_{V}N_{VII}$	2.2706	6.0778	3 40 Zr	$L\alpha_2$	$L_{III}M_{IV}$	2.0399
5.472	2 81 Tl	$M\alpha_2$	$M_{V}N_{VI}$	2.2656	6.09	2 80 Hg		$M_{III}N_I$	2.036
5.4923	3 41 Nb	$L\beta_1$	$L_{II}M_{IV}$	2.2574	6.092	3 74 W	$M\gamma$	$M_{III}N_{V}$	2.035
5.4977	3 40 Zr	$L\gamma_6$	$L_{II}N_I$	2.2551	6.0942	3 39 Y	$L\beta_6$	$L_{III}N_I$	2.0344
5.500	4 77 Ir	$M\gamma$	$M_{III}N_{V}$	2.254	6.134	4 74 W		$M_{III}N_{IV}$	2.021
5.5035	3 44 Ru	L_I	$L_{III}M_I$	2.2528	6.1508	3 42 Mo	L_I	$L_{III}M_I$	2.01568
5.537	8 83 Bi		$M_{III}N_I$	2.239	6.157	1 15 P	$K\alpha_1$	KL_{III}	2.0137
5.540	5 77 Ir		$M_{III}N_{IV}$	2.238	6.160	1 15 P	$K\alpha_2$	KL_{II}	2.0127
5.570	4 73 Ta		$M_{II}N_{IV}$	2.226	6.162	8 83 Bi		$M_{IV}N_{III}$	2.012
5.579	1 40 Zr	L_{III}	Abs. Edge	2.2225	6.173	1 38 Sr	L_{II}	Abs. Edge	2.0085
5.584	5 79 Au	M_V	Abs. Edge	2.220	6.2109	3 41 Nb	$L\eta$	$L_{II}M_I$	1.99620
5.5863	3 40 Zr	$L\beta_{2,16}$	$L_{III}N_{IV,V}$	2.2194	6.2120	3 39 Y	$L\beta_1$	$L_{II}M_{IV}$	1.99584
5.59	1 78 Pt	M_{IV}	Abs. Edge	2.217	6.259	9 79 Au		$M_{III}N_I$	1.981
5.592	5 38 Sr	L_I	Abs. Edge	2.217	6.262	1 77 Ir	$M\alpha_1$	$M_{V}N_{VII}$	1.9799
5.624	1 79 Au	$M\beta$	$M_{IV}N_{VI}$	2.2046	6.267	1 76 Os	$M\beta$	$M_{IV}N_{VI}$	1.9783
5.628	8 74 W		$M_{III}O_I$	2.203	6.275	3 77 Ir	$M\alpha_2$	$M_{V}N_{VI}$	1.9758
5.6330	3 40 Zr	$L\beta_3$	$L_{II}M_{III}$	2.2010	6.28	2 74 W		$M_{II}N_I$	1.973

TABLE VI (Continued)

Wavelength					Wavelength						
\AA^*	p.e.	Element	Designation	keV	\AA^*	p.e.	Element	Designation	keV		
6.2961	3	38 Sr	$L\gamma_5$	$L_{II}N_I$	1.96916	7.101	8	79 Au	$M_{IV}N_{III}$	1.746	
6.30	1	76 Os	M_V	Abs. Edge	1.967	7.11	1	73 Ta	M_V	Abs. Edge	1.743
6.312	4	73 Ta	M_γ	$M_{III}N_V$	1.964	7.12542	9	14 Si	$K\alpha_1$	KL_{III}	1.73998
6.33	1	75 Re	M_{IV}	Abs. Edge	1.958	7.12791	9	14 Si	$K\alpha_2$	KL_{II}	1.73938
6.353	5	73 Ta		$M_{III}N_{IV}$	1.951	7.168	1	36 Kr	L_{II}	Abs. Edge	1.7297
6.3672	3	38 Sr	$L\beta_3$	$L_I M_{III}$	1.94719	7.250	5	36 Kr		$L_{II}N_{III}$	1.710
6.384	7	82 Pb		$M_{IV}N_{III}$	1.942	7.252	1	73 Ta	$M\alpha$	$M_V N_{VI, VII}$	1.7096
6.387	1	38 Sr	L_{III}	Abs. Edge	1.9411	7.264	5	36 Kr	$L\beta_2$	$L_I M_{III}$	1.707
6.4026	3	38 Sr	$L\beta_4$	$L_I M_{II}$	1.93643	7.279	5	36 Kr	$L\gamma_6$	$L_{II}N_I$	1.703
6.4488	2	39 Y	$L\alpha_1$	$L_{III}M_V$	1.92256	7.30	2	73 Ta		$M_V O_{III}$	1.700
6.455	9	78 Pt		$M_{III}N_I$	1.921	7.303	1	72 Hf	$M\beta$	$M_{IV}N_{VI}$	1.6976
6.4558	3	39 Y	$L\alpha_2$	$L_{III}M_{IV}$	1.92047	7.304	5	36 Kr	$L\beta_3$	$L_I M_{II}$	1.697
6.47	1	36 Kr	L_I	Abs. Edge	1.915	7.3183	2	37 Rb	$L\alpha_1$	$L_{III}M_V$	1.69413
6.490	1	76 Os	$M\alpha$	$M_V N_{VI, VII}$	1.9102	7.3251	3	37 Rb	$L\alpha_2$	$L_{III}M_{IV}$	1.69256
6.504	1	75 Re	$M\beta$	$M_{IV}N_{VI}$	1.9061	7.3563	3	39 Y	L_I	$L_{III}M_I$	1.68536
6.5176	3	41 Nb	L_I	$L_{III}M_I$	1.90225	7.360	8	74 W		$M_{III}N_I$	1.684
6.5191	3	38 Sr	$L\beta_4$	$L_{III}N_I$	1.90181	7.371	8	78 Pt		$M_{IV}N_{III}$	1.682
6.521	4	83 Bi	$M\zeta_1$	$M_V N_{III}$	1.901	7.392	1	36 Kr	L_{III}	Abs. Edge	1.6772
6.544	4	72 Hf	M_γ	$M_{III}N_V$	1.895	7.466	4	79 Au	$M\zeta_1$	$M_V N_{III}$	1.6605
6.560	5	75 Re	M_V	Abs. Edge	1.890	7.503	1	34 Se	L_I	Abs. Edge	1.6525
6.585	5	83 Bi	$M\zeta_2$	$M_{IV}N_{II}$	1.883	7.510	4	36 Kr	$L\beta_5$	$L_{III}N_I$	1.6510
6.59	1	74 W	M_{IV}	Abs. Edge	1.880	7.5171	3	38 Sr	$L\eta$	$L_{II}M_I$	1.64933
6.6069	3	40 Zr	$L\eta$	$L_{II}M_I$	1.87654	7.523	5	79 Au	$M\zeta_2$	$M_{IV}N_{II}$	1.648
6.6239	3	38 Sr	$L\beta_1$	$L_{II}M_{IV}$	1.87172	7.539	1	72 Hf	$M\alpha$	$M_V N_{VI, VII}$	1.6446
6.644	1	37 Rb	L_{II}	Abs. Edge	1.8661	7.546	8	68 Er	M_γ	$M_{III}N_V$	1.643
6.669	9	77 Ir		$M_{III}N_I$	1.859	7.576	3	36 Kr	$L\beta_1$	$L_{II}M_{IV}$	1.6366
6.729	1	75 Re	$M\alpha$	$M_V N_{VI, VII}$	1.8425	7.60	1	68 Er		$M_{III}N_{IV}$	1.632
6.738	1	14 Si	K	Abs. Edge	1.8400	7.601	2	71 Lu	$M\beta$	$M_{IV}N_{VI}$	1.6312
6.740	3	82 Pb	$M\zeta_1$	$M_V N_{III}$	1.8395	7.612	9	73 Ta		$M_{III}N_I$	1.629
6.7530	1	14 Si	$K\beta$	KM	1.83594	7.645	8	77 Ir		$M_{IV}N_{III}$	1.622
6.755	3	37 Rb	$L\gamma_3$	$L_{II}N_{IV}$	1.83532	7.738	4	78 Pt	$M\zeta_1$	$M_V N_{III}$	1.6022
6.757	1	74 W	$M\beta$	$M_{IV}N_{VI}$	1.8349	7.753	5	35 Br	L_{II}	Abs. Edge	1.599
6.768	6	71 Lu	M_γ	$M_{III}N_V$	1.832	7.767	9	35 Br	$L\beta_{3,4}$	$L_I M_{II, III}$	1.596
6.7876	3	37 Rb	$L\beta_2$	$L_I M_{III}$	1.82659	7.790	5	78 Pt	$M\zeta_2$	$M_{IV}N_{II}$	1.592
6.802	5	82 Pb	$M\zeta_2$	$M_{IV}N_{II}$	1.823	7.817	3	36 Kr	$L\alpha_{1,2}$	$L_{III}M_{IV, V}$	1.5860
6.806	9	74 W		$M_{IV}O_{II}$	1.822	7.8362	3	38 Sr	L_I	$L_{III}M_I$	1.58215
6.8207	3	37 Rb	$L\beta_4$	$L_I M_{II}$	1.81771	7.840	2	71 Lu	$M\alpha$	$M_V N_{VI, VII}$	1.5813
6.83	1	74 W	M_V	Abs. Edge	1.814	7.865	9	67 Ho	M_γ	$M_{III}N_{IV, V}$	1.576
6.862	1	37 Rb	L_{III}	Abs. Edge	1.8067	7.887	9	72 Hf		$M_{III}N_I$	1.572
6.8628	2	38 Sr	$L\alpha_1$	$L_{III}M_V$	1.80656	7.909	2	70 Yb	$M\beta$	$M_{IV}N_{VI}$	1.5675
6.8697	3	38 Sr	$L\alpha_2$	$L_{III}M_{IV}$	1.80474	7.94813	5	13 Al	K	Abs. Edge	1.55988
6.87	1	73 Ta	M_{IV}	Abs. Edge	1.804	7.960	2	13 Al	$K\beta$	KM	1.55745
6.87	2	80 Hg	δ	$M_{IV}N_{III}$	1.805	7.984	5	35 Br	L_{III}	Abs. Edge	1.5530
6.89	2	76 Os		$M_{III}N_I$	1.798	8.021	4	77 Ir	$M\zeta_1$	$M_V N_{III}$	1.5458
6.9185	3	40 Zr	L_I	$L_{III}M_I$	1.79201	8.0415	4	37 Rb	$L\eta$	$L_{II}M_I$	1.54177
6.959	5	35 Br	L_I	Abs. Edge	1.781	8.065	5	77 Ir	$M\zeta_2$	$M_{IV}N_{II}$	1.5373
6.974	4	81 Tl	$M\zeta_1$	$M_V N_{III}$	1.778	8.107	1	33 As	L_I	Abs. Edge	1.5293
6.983	1	74 W	$M\alpha_1$	$M_V N_{VII}$	1.7754	8.1251	5	35 Br	$L\beta_1$	$L_{II}M_{IV}$	1.52590
6.9842	3	37 Rb	$L\beta_5$	$L_{III}N_I$	1.77517	8.144	9	66 Dy	M_γ	$M_{III}N_{IV, V}$	1.522
6.992	2	74 W	$M\alpha_2$	$M_V N_{VI}$	1.7731	8.149	5	70 Yb	$M\alpha$	$M_V N_{VI, VII}$	1.5214
7.005	9	74 W		$M_V O_{III}$	1.770	8.239	8	75 Re		$M_{IV}N_{III}$	1.505
7.023	1	73 Ta	$M\beta$	$M_{IV}N_{VI}$	1.7655	8.249	7	69 Tm	$M\beta$	$M_{IV}N_{VI}$	1.503
7.024	8	70 Yb	M_γ	$M_{III}N_V$	1.765	8.310	4	76 Os	$M\zeta_1$	$M_V N_{III}$	1.4919
7.032	5	81 Tl	$M\zeta_2$	$M_{IV}N_{II}$	1.763	8.321	9	34 Se	$L\beta_{3,4}$	$L_I M_{II, III}$	1.490
7.0406	3	39 Y	$L\eta$	$L_{II}M_I$	1.76095	8.33934	9	13 Al	$K\alpha_1$	KL_{III}	1.48670
7.0759	3	37 Rb	$L\beta_1$	$L_{III}M_{IV}$	1.75217	8.34173	9	13 Al	$K\alpha_2$	KL_{II}	1.48627
7.09	2	73 Ta		$M_{IV}O_{II, III}$	1.748	8.359	5	76 Os	$M\zeta_2$	$M_{IV}N_{II}$	1.4831

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV
8.3636	4 37 Rb	<i>L</i> _I	1.48238	10.254	6 64 Gd	<i>M</i> β	1.2091
8.3746	5 35 Br	<i>L</i> _{α_{1,2}}	1.48043	10.294	1 34 Se	<i>L</i> _I	1.2044
8.407	1 34 Se	Abs. Edge	1.4747	10.359	9 31 Ga	<i>L</i> β _{3,4}	1.197
8.470	9 70 Yb	<i>M</i> _{III} <i>N</i> _I	1.464	10.40	7 92 U	<i>N</i> _{II} <i>P</i> _I	1.192
8.48	1 69 Tm	<i>M</i> α	1.462	10.4361	8 32 Ge	<i>L</i> α _{1,2}	1.18800
8.486	9 65 Tb	<i>M</i> γ	1.461	10.46	3 64 Gd	<i>M</i> α	1.185
8.487	5 69 Tm	Abs. Edge	1.4609	10.48	1 70 Yb	<i>M</i> ξ	1.183
8.573	8 74 W	<i>M</i> _{IV} <i>N</i> _{III}	1.446	10.505	9 60 Nd	<i>M</i> γ	1.180
8.592	3 68 Er	<i>M</i> β	1.4430	10.711	5 63 Eu	<i>M</i> _{IV}	1.1575
8.60	7 92 U	<i>N</i> _I <i>P</i> _{IV,V}	1.44	10.734	1 33 As	<i>L</i> η	1.1550
8.601	5 68 Er	Abs. Edge	1.4415	10.750	7 63 Eu	<i>M</i> β	1.1533
8.629	4 75 Re	<i>M</i> ξ ₁	1.4368	10.828	5 31 Ga	<i>L</i> _{II}	1.1450
8.646	1 34 Se	<i>L</i> _{III}	1.4340	10.96	3 63 Eu	<i>M</i> α	1.131
8.664	5 75 Re	<i>M</i> ξ ₂	1.4310	10.998	9 59 Pr	<i>M</i> γ	1.1273
8.7358	5 34 Se	<i>L</i> β ₁	1.41923	11.013	5 63 Eu	<i>M</i> ν	1.1258
8.76	7 92 U	<i>N</i> _I <i>P</i> _{III}	1.42	11.023	2 31 Ga	<i>L</i> β ₁	1.1248
8.773	1 32 Ge	<i>L</i> _I	1.4132	11.072	1 33 As	<i>L</i> _I	1.1198
8.81	7 92 U	<i>N</i> _I <i>P</i> _{II}	1.41	11.07	7 90 Th	<i>N</i> _{II} <i>P</i> _I	1.120
8.82	1 68 Er	<i>M</i> α	1.406	11.100	1 31 Ga	<i>L</i> _{III}	1.1169
8.844	9 64 Gd	<i>M</i> γ	1.402	11.200	7 30 Zn	<i>L</i> β _{3,4}	1.1070
8.847	5 68 Er	Abs. Edge	1.4013	11.27	1 62 Sm	<i>M</i> β	1.0998
8.90	2 73 Ta	<i>M</i> _{IV} <i>N</i> _{III}	1.393	11.288	5 62 Sm	<i>M</i> _{IV}	1.0983
8.929	1 33 As	<i>L</i> β _{3,4}	1.3884	11.292	1 31 Ga	<i>L</i> α _{1,2}	1.09792
8.962	4 74 W	<i>M</i> ξ ₁	1.3835	11.37	1 68 Er	<i>M</i> ξ	1.0901
8.965	4 67 Ho	<i>M</i> β	1.3830	11.47	3 62 Sm	<i>M</i> α	1.081
8.9900	5 34 Se	<i>L</i> α _{1,2}	1.37910	11.53	1 58 Ce	<i>M</i> γ	1.0749
8.993	5 74 W	<i>M</i> ξ ₂	1.3787	11.552	5 62 Sm	<i>M</i> ν	1.0732
9.125	1 33 As	<i>L</i> _{II}	1.3587	11.56	5 90 Th	<i>N</i> _{II} <i>O</i> _{IV}	1.072
9.20	2 67 Ho	<i>M</i> α	1.348	11.569	1 11 Na	<i>K</i>	1.07167
9.211	9 63 Eu	<i>M</i> γ	1.346	11.575	2 11 Na	<i>K</i> β	1.0711
9.255	1 35 Br	<i>L</i> η	1.3396	11.609	2 32 Ge	<i>L</i> η	1.0680
9.316	4 73 Ta	<i>M</i> ξ ₁	1.3308	11.862	1 30 Zn	<i>L</i> _{II}	1.04523
9.330	5 73 Ta	<i>M</i> ξ ₂	1.3288	11.86	1 67 Ho	<i>M</i> ξ	1.0450
9.357	6 66 Dy	<i>M</i> β	1.3250	11.9101	9 11 Na	<i>K</i> α _{1,2}	1.04098
9.367	1 33 As	<i>L</i> _{III}	1.3235	11.965	2 32 Ge	<i>L</i> _I	1.0362
9.40	7 90 Th	<i>N</i> _I <i>P</i> _{III}	1.319	11.983	3 30 Zn	<i>L</i> β ₁	1.0347
9.4141	8 33 As	<i>L</i> β ₁	1.3170	12.08	4 57 La	<i>M</i> γ	1.027
9.44	7 90 Th	<i>N</i> _I <i>P</i> _{II}	1.313	12.122	3 29 Cu	<i>L</i> β _{3,4}	1.0228
9.5122	1 12 Mg	<i>K</i>	1.30339	12.131	1 30 Zn	<i>L</i> _{III}	1.02201
9.517	5 31 Ga	<i>L</i> _I	1.3028	12.254	3 30 Zn	<i>L</i> α _{1,2}	1.0117
9.521	2 12 Mg	<i>K</i> β	1.3022	12.43	2 66 Dy	<i>M</i> ξ	0.998
9.581	2 32 Ge	<i>L</i> β ₃	1.2941	12.44	2 60 Nd	<i>M</i> β	0.997
9.585	1 35 Br	<i>L</i> ξ	1.2935	12.459	5 60 Nd	<i>M</i> _{IV}	0.9951
9.59	2 66 Dy	<i>M</i> α	1.293	12.597	2 31 Ga	<i>L</i> η	0.9842
9.600	9 62 Sm	<i>M</i> γ	1.291	12.68	2 60 Nd	<i>M</i> α	0.978
9.640	2 32 Ge	<i>L</i> β ₂	1.2861	12.737	5 60 Nd	<i>M</i> ν	0.9734
9.6709	8 33 As	<i>L</i> α _{1,2}	1.2820	12.75	3 56 Ba	<i>M</i> γ	0.973
9.686	7 72 Hf	<i>M</i> ξ ₂	1.2800	12.90	9 92 U	<i>N</i> _{III} <i>O</i> _V	0.961
9.686	7 72 Hf	<i>M</i> ξ ₁	1.2800	12.953	2 31 Ga	<i>L</i> _I	0.9572
9.792	6 65 Tb	<i>M</i> β	1.2661	12.98	2 65 Tb	<i>M</i> ξ	0.955
9.8900	2 12 Mg	<i>K</i> α _{1,2}	1.25360	13.014	1 29 Cu	<i>L</i> _{II}	0.95268
9.924	1 32 Ge	<i>L</i> _{II}	1.2494	13.053	3 29 Cu	<i>L</i> β ₁	0.9498
9.962	1 34 Se	<i>L</i> η	1.2446	13.06	2 59 Pr	<i>M</i> β	0.950
10.00	2 65 Tb	<i>M</i> α	1.240	10.31	1 30 Zn	<i>L</i> _I	1.197
10.09	7 92 U	<i>N</i> _I <i>O</i> _{III}	1.229	13.122	5 59 Pr	<i>M</i> _{IV}	0.9448
10.175	1 32 Ge	<i>L</i> β ₁	1.2185	13.18	2 28 Ni	<i>L</i> β _{3,4}	0.941
10.187	1 32 Ge	<i>L</i> _{III}	1.2170	13.288	1 29 Cu	<i>L</i> _{III}	0.93306

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV	
13.30	6 83 Bi	$N_{I,II,III}$	0.932	18.8	2 47 Ag	$M_{I,II,III}$	0.658	
13.336	3 29 Cu	$L_{\alpha_{1,2}}$	0.9297	18.96	4 24 Cr	$L\beta_{3,4}$	0.654	
13.343	5 59 Pr	$M\alpha$	0.9292	19.11	2 25 Mn	$L\beta_1$	0.6488	
13.394	5 59 Pr	M_V	Abs. Edge	19.1	1 52 Te		0.648	
13.57	2 64 Gd	$M\zeta$	0.914	19.40	7 48 Cd		0.639	
13.68	2 30 Zn	$L\eta$	0.906	19.44	5 57 La	$M\zeta$	0.638	
13.75	4 58 Ce	$M\beta$	0.902	19.45	1 25 Mn	$L_{\alpha_{1,2}}$	0.6374	
13.8	1 90 Th	$N_{III,IV}$	0.897	19.66	5 53 I	$M_{IV,V}$	0.631	
14.02	2 30 Zn	L_I	0.884	19.75	4 26 Fe	$L\eta$	0.628	
14.04	2 58 Ce	$M\alpha$	0.883	20.0	1 50 Sn		0.619	
14.22	2 63 Eu	$M\zeta$	0.872	20.1	2 46 Pd		0.616	
14.242	5 28 Ni	L_{II}	Abs. Edge	20.15	1 26 Fe	L_I	0.6152	
14.271	6 28 Ni	$L\beta_1$	0.8688	20.2	1 51 Sb		0.612	
14.3018	1 10 Ne	K	0.866889	20.47	7 48 Cd	$M\gamma$	0.606	
14.31	3 27 Co	$L\beta_{3,4}$	0.870	20.64	4 56 Ba	$M\zeta$	0.601	
14.39	5 58 Ce	$M_{V,VI,III}$	0.862	20.66	7 47 Ag		0.600	
14.452	5 10 Ne	$K\beta$	0.8579	20.7	1 24 Cr	L_{III}	Abs. Edge	0.598
14.51	5 57 La	$M\beta$	0.854	21.19	5 23 Va	$L\beta_{3,4}$	0.585	
14.525	5 28 Ni	L_{III}	Abs. Edge	21.27	1 24 Cr	$L\beta_1$	0.5828	
14.561	3 28 Ni	$L_{\alpha_{1,2}}$	0.8515	21.34	5 52 Te		0.581	
14.610	3 10 Ne	$K\alpha_{1,2}$	0.8486	21.5	1 50 Sn		0.575	
14.88	5 57 La	$M\alpha$	0.833	21.64	3 24 Cr	$L_{\alpha_{1,2}}$	0.5728	
14.90	2 29 Cu	$L\eta$	0.832	21.78	5 52 Te		0.569	
14.91	4 62 Sm	$M\zeta$	0.831	21.82	7 47 Ag	$M\gamma$	0.568	
15.286	9 29 Cu	L_I	0.8111	21.85	2 25 Mn	$L\eta$	0.5675	
15.56	1 56 Ba	M_{IV}	Abs. Edge	22.1	1 46 Pd		0.560	
15.618	5 27 Co	L_{II}	Abs. Edge	22.29	1 25 Mn	L_I	0.5563	
15.65	4 26 Fe	$L\beta_{3,4}$	0.792	22.9	2 48 Cd		0.540	
15.666	8 27 Co	$L\beta_1$	0.7914	23.32	1 8 O	K	Abs. Edge	0.5317
15.72	9 56 Ba		0.789	23.3	1 46 Pd	$M\gamma$	0.531	
15.89	1 56 Ba	M_V	Abs. Edge	23.62	3 8 O	$K\alpha$	0.5249	
15.91	5 56 Ba	$M_{IV,III}$	0.779	23.88	4 23 Va	$L\beta_1$	0.5192	
15.915	5 27 Co	L_{III}	Abs. Edge	24.25	3 23 Va	$L_{\alpha_{1,2}}$	0.5113	
15.93	4 52 Te	$M\gamma$	0.778	24.28	5 50 Sn	$M_{IV,V}$	Abs. Edge	0.511
15.972	6 27 Co	$L_{\alpha_{1,2}}$	0.7762	24.30	3 24 Cr	$L\eta$	0.5102	
15.98	5 51 Sb		0.776	24.4	2 47 Ag		0.509	
16.20	5 56 Ba		0.765	24.5	1 48 Cd		0.507	
16.27	3 28 Ni	$L\eta$	0.762	24.78	1 24 Cr	L_I	0.5003	
16.46	4 60 Nd	$M\zeta$	0.753	25.01	9 45 Rh	$M\gamma$	0.496	
16.693	9 28 Ni	L_I	0.7427	25.3	1 50 Sn		0.491	
16.7	1 24 Cr	L_I	Abs. Edge	25.50	9 44 Ru		0.486	
16.92	4 51 Sb	$M\gamma$	0.733	25.7	1 50 Sn		0.483	
16.93	5 50 Sn		0.733	26.0	1 47 Ag		0.478	
17.19	4 25 Mn	$L\beta_{3,4}$	0.721	26.2	2 46 Pd		0.474	
17.202	5 26 Fe	L_{II}	Abs. Edge	26.72	9 52 Te	$M\zeta$	0.464	
17.26	1 26 Fe	$L\beta_1$	0.7185	26.9	1 44 Ru	$M\gamma$	0.462	
17.38	4 59 Pr	$M\zeta$	0.714	27.05	2 22 Ti	$L\beta_1$	0.4584	
17.525	5 26 Fe	L_{III}	Abs. Edge	27.29	1 22 Ti	$L_{II,III}$	Abs. Edge	0.4544
17.59	2 26 Fe	$L_{\alpha_{1,2}}$	0.7050	27.34	3 23 Va	$L\eta$	0.4535	
17.6	1 52 Te		0.703	27.42	2 22 Ti	$L_{\alpha_{1,2}}$	0.4522	
17.87	3 27 Co	$L\eta$	0.694	27.77	1 23 Va	L_I	0.4465	
17.94	5 50 Sn	$M\gamma$	0.691	27.9	1 46 Pd		0.445	
17.9	1 24 Cr	L_{II}	Abs. Edge	28.1	2 45 Rh		0.442	
18.292	8 27 Co	L_I	0.6778	28.13	5 48 Cd	$M_{IV,V}$	Abs. Edge	0.4408
18.32	2 9 F	$K\alpha$	0.6768	28.88	8 51 Sb	$M\zeta$	0.429	
18.35	4 58 Ce	$M\zeta$	0.676	29.8	1 45 Rh		0.417	
18.8	1 51 Sb		0.658	30.4	1 48 Cd		0.408	

TABLE VI (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV
30.8	1 48 Cd	$M_{V}O_{III}$	0.403	49.4	1 79 Au	$N_{V}N_{VI,VII}$	0.2510
30.82	5 47 Ag	M_{IV}	0.4022	49.5	1 90 Th	$N_{VI}O_{V}$	0.2505
30.89	3 22 Ti	L_{η}	0.4013	50.0	1 90 Th	$N_{VII}O_{V}$	0.2479
30.99	1 7 N	K	0.4000	50.2	1 77 Ir	$N_{IV}N_{VI}$	0.2470
31.02	2 21 Sc	$L\beta_1$	0.3996	50.3	1 52 Te	$M_{III}M_{V}$	0.2465
31.14	5 47 Ag	M_{V}	0.3981	50.9	1 78 Pt	$N_{V}N_{VI,VII}$	0.2436
31.24	9 50 Sn	M_{ζ}	0.397	51.3	1 38 Sr	$M_{II}N_{I}$	0.2416
31.35	3 21 Sc	$L\alpha_{1,2}$	0.3954	51.9	1 76 Os	$N_{IV}N_{VI}$	0.2388
31.36	2 22 Ti	Ll	0.3953	52.0	2 48 Cd	$M_{II}M_{IV}$	0.2384
31.60	4 7 N	$K\alpha$	0.3924	52.2	1 51 Sb	$M_{III}M_{V}$	0.2375
31.8	1 92 U		0.390	52.34	7 44 Ru	$M_{IV,V}N_{II,III}$	0.2369
32.3	2 44 Ru		0.384	52.8	1 77 Ir	$N_{V}N_{VI,VII}$	0.2348
33.1	2 41 Nb		0.375	53.6	1 38 Sr	$M_{III}N_{I}$	0.2313
33.5	3 47 Ag		0.370	54.0	2 74 W	$N_{II}N_{IV}$	0.2295
33.57	9 90 Th		0.3693	54.0	1 47 Ag	$M_{II}M_{IV}$	0.2295
34.8	1 92 U		0.357	54.2	1 50 Sn	$M_{III}M_{V}$	0.2287
34.9	2 41 Nb	M_{γ}	0.356	54.7	2 76 Os	$N_{V}N_{VI,VII}$	0.2266
35.13	2 21 Sc	L_{η}	0.3529	54.8	2 42 Mo	$M_{IV,V}O_{II,III}$	0.2262
35.13	1 20 Ca	L_{II}	0.3529	55.8	1 74 W	$N_{IV}N_{VI}$	0.2221
35.3	3 42 Mo		0.351	55.9	1 18 A	$L_{II}M_{I}$	0.2217
35.49	1 20 Ca	L_{III}	0.34931	56.3	1 18 A	$L_{III}M_{I}$	0.2201
35.59	3 21 Sc	Ll	0.3483	56.5	1 46 Pd	$M_{II}M_{IV}$	0.2194
35.63	1 20 Ca	$L_{II,III}$	0.34793	57.0	2 37 Rb	$M_{II}N_{I}$	0.2174
35.94	2 20 Ca	$L\beta_1$	0.3449	58.2	1 73 Ta	$N_{IV}N_{VI}$	0.2130
36.32	9 90 Th		0.3414	58.4	1 74 W	$N_{V}N_{VII}$	0.2122
36.33	2 20 Ca	$L\alpha_{1,2}$	0.3413	58.7	2 48 Cd	$M_{III}M_{V}$	0.2111
36.8	1 48 Cd	M_{ζ}	0.3371	59.3	1 45 Rh	$M_{II}M_{IV}$	0.2090
37.4	2 46 Pd		0.332	59.5	3 74 W	$N_{V}N_{VI}$	0.208
37.5	2 42 Mo		0.331	59.5	2 37 Rb	$M_{III}N_{I}$	0.2083
38.4	3 41 Nb		0.323	60.5	1 47 Ag	$M_{III}M_{V}$	0.2048
39.77	7 47 Ag	M_{ζ}	0.3117	61.1	2 73 Ta	$N_{V}N_{VI,VII}$	0.2028
40.46	2 20 Ca	L_{η}	0.3064	61.9	2 41 Nb	$M_{IV,V}O_{II,III}$	0.2002
40.7	2 41 Nb		0.305	62.2	1 44 Ru	$M_{II}M_{IV}$	0.1992
40.9	2 45 Rh		0.303	62.9	1 46 Pd	$M_{III}M_{V}$	0.1970
40.96	2 20 Ca	Ll	0.3027	63.0	5 71 Lu	$N_{IV}N_{VI}$	0.197
42.1	2 92 U		0.295	64.38	7 42 Mo	$M_{IV,V}N_{II,III}$	0.1926
42.1	1 19 K	$L_{II,III}$	0.2946	65.1	7 70 Yb	$N_{IV}N_{VI}$	0.190
42.3	2 82 Pb		0.293	65.5	1 45 Rh	$M_{III}M_{V}$	0.1892
43.3	2 92 U		0.286	65.7	2 71 Lu	$N_{V}N_{VI,VII}$	0.1886
43.6	1 46 Pd	M_{ζ}	0.2844	67.33	9 17 Cl	$L_{II}M_{I}$	0.1841
43.68	1 6 C	K	0.28384	67.6	3 5 B	$K\alpha$	0.1833
44.7	3 6 C	$K\alpha$	0.277	67.90	9 17 Cl	Ll	0.1826
44.8	1 44 Ru		0.2768	68.2	3 90 Th	$O_{III}P_{IV,V}$	0.1817
45.0	1 82 Pb		0.2756	68.3	1 44 Ru	$M_{III}M_{V}$	0.1814
45.2	3 80 Hg		0.274	68.9	2 42 Mo	$M_{II}M_{IV}$	0.1798
45.2	1 51 Sb		0.2743	69.3	5 70 Yb	$N_{V}N_{VI,VII}$	0.179
46.48	9 39 Y		0.267	70.0	4 40 Zr	$M_{IV,V}O_{II,III}$	0.177
46.5	2 81 Tl		0.267	72.1	3 41 Nb	$M_{II}M_{IV}$	0.1718
46.8	2 79 Au		0.265	72.19	9 41 Nb	$M_{IV,V}N_{II,III}$	0.1717
47.24	2 19 K	Ll	0.2625	72.7	9 68 Er	$N_{IV}N_{VI}$	0.171
47.3	1 50 Sn		0.2621	74.9	1 42 Mo	$M_{III}M_{V}$	0.1656
47.67	9 45 Rh	M_{ζ}	0.2601	76.3	7 68 Er	$N_{V}N_{VI,VII}$	0.163
47.74	1 19 K	Ll	0.25971	76.7	2 40 Zr	$M_{II}M_{IV}$	0.1617
47.9	3 80 Hg		0.259	76.9	2 35 Br	$M_{II}N_{I}$	0.1613
48.1	2 78 Pt		0.258	78.4	2 41 Nb	$M_{III}M_{V}$	0.1582
48.2	1 90 Th		0.2572	79.8	3 35 Br	$M_{III}N_{I}$	0.1554
48.5	2 39 Y		0.256	80.9	3 40 Zr	$M_{III}M_{V}$	0.1533

TABLE VI (Continued)

Wavelength \AA^*	p.e. Element	Designation	keV	Wavelength \AA^*	p.e. Element	Designation	keV	
81.5	2 39 Y	$M_{II}M_{IV}$	0.1522	157.	3 30 Zn	$M_{II,III}M_{IV,V}$	0.079	
82.1	2 40 Zr	$M_{IV,V}N_{II,III}$	0.1511	159.0	2 56 Ba	$N_{IV}O_{III}$	0.07796	
83.	1 66 Dy	$M_{IV,V}N_{VI,VII}$	0.149	159.5	5 29 Cu	Abs. Edge	0.0777	
83.4	3 16 S	$L_{II,III}M_I$	0.1487	163.3	2 56 Ba	$N_{IV}O_{II}$	0.07590	
85.7	2 38 Sr	$M_{II}M_{IV}$	0.1447	164.6	2 56 Ba	$N_{V}O_{III}$	0.07530	
86.	1 65 Tb	$N_{IV,V}N_{VI,VII}$	0.144	164.7	3 35 Br	$M_I M_{III}$	0.0753	
86.5	2 39 Y	$M_{III}M_{IV,V}$	0.1434	166.0	5 29 Cu	Abs. Edge	0.0747	
91.4	2 38 Sr	$M_{III}M_{IV,V}$	0.1357	170.4	1 13 Al	$L_{II,III}$	Abs. Edge	0.07278
91.5	2 37 Rb	$M_{II}M_{IV}$	0.1355	171.4	5 13 Al	$L_{II,III}M$	0.0724	
91.6	1 83 Bi	$N_{VI}O_{IV}$	0.1354	173.	3 29 Cu	$M_{II,III}M_{IV,V}$	0.072	
93.2	1 83 Bi	$N_{VII}O_V$	0.1330	181.	5 90 Th	$O_{IV,V}O_{II,III}$	0.068	
93.4	2 39 Y	$M_{IV,V}N_{II,III}$	0.1328	183.8	1 55 Cs	$N_{IV}O_{III}$	0.06746	
94.	1 15 P	Abs. Edge	0.132	184.6	3 35 Br	$M_I M_{II}$	0.0672	
96.7	2 37 Rb	$M_{III}M_{IV,V}$	0.1282	188.4	1 28 Ni	Abs. Edge	0.06581	
97.2	8 66 Dy	$N_{IV,V}O_{II,III}$	0.128	188.6	1 55 Cs	$N_{IV}O_{II}$	0.06574	
98.	1 62 Sm	$N_{IV,V}N_{VI,VII}$	0.126	189.5	3 35 Br	$M_{IV}N_{III}$	0.0654	
100.2	2 82 Pb	$N_{VI}O_V$	0.1237	190.3	1 55 Cs	$N_{V}O_{III}$	0.06515	
102.2	4 65 Tb	$N_{IV,V}O_{II,III}$	0.1213	190.	2 28 Ni	$M_{II,III}M_{IV,V}$	0.0651	
102.4	1 82 Pb	$N_{VI}O_{IV}$	0.1211	191.1	2 35 Br	$M_{IV}N_{II}$	0.06488	
103.8	4 15 P	$L_{II,III}M$	0.1194	192.6	2 35 Br	$M_{V}N_{III}$	0.06437	
104.3	1 82 Pb	$N_{VII}O_V$	0.1189	197.3	1 12 Mg	Abs. Edge	0.06284	
107.	1 60 Nd	$N_{IV,V}N_{VI,VII}$	0.116	202.	5 27 Co	Abs. Edge	0.061	
108.0	2 38 Sr	$M_{IV}N_{II,III}$	0.1148	203.	1 16 S	$L_I L_{II,III}$	0.061	
108.7	1 38 Sr	$M_{V}N_{III}$	0.1140	214.	6 27 Co	$M_{II,III}M_{IV,V}$	0.058	
109.4	3 35 Br	$M_{II}M_{IV}$	0.1133	224.	1 53 I	Abs. Edge	0.0552	
110.6	5 29 Cu	Abs. Edge	0.1121	226.5	1 3 Li	Abs. Edge	0.05475	
111.	1 4 Be	Abs. Edge	0.111	227.8	1 34 Se	Abs. Edge	0.05443	
112.0	6 63 Eu	$N_{IV,V}O_{II,III}$	0.1107	228.	1 3 Li	Abs. Edge	0.0543	
113.0	1 81 Tl	$N_{VI}O_V$	0.10968	230.	2 34 Se	$M_{V}N_{III}$	0.0538	
113.	1 59 Pr	$N_{IV,V}N_{VI,VII}$	0.1095	230.	1 26 Fe	Abs. Edge	0.0538	
113.8	3 35 Br	$M_{III}M_{IV,V}$	0.1089	243.	5 26 Fe	$M_{II,III}M_{IV,V}$	0.051	
114.	1 4 Be	KL	0.1085	249.3	1 12 Mg	Abs. Edge	0.04973	
115.3	2 81 Tl	$N_{VI}O_{IV}$	0.1075	250.7	1 12 Mg	Abs. Edge	0.04945	
117.4	4 62 Sm	$N_{IV,V}O_{II,III}$	0.1056	251.5	5 12 Mg	$L_{II,III}M$	0.04929	
117.7	1 81 Tl	$N_{VII}O_V$	0.10530	273.	6 25 Mn	$M_{II,III}M_{IV,V}$	0.045	
123.	1 14 Si	Abs. Edge	0.1006	290.	1 13 Al	$L_I L_{II,III}$	0.0428	
126.8	2 37 Rb	$M_{IV}N_{III}$	0.0978	309.	9 24 Cr	$M_{II,III}M_{IV,V}$	0.040	
127.8	2 37 Rb	$M_{IV}N_{II}$	0.0970	317.	1 12 Mg	$L_I L_{II,III}$	0.0392	
128.7	2 37 Rb	$M_{V}N_{III}$	0.0964	337.	9 23 V	$M_{II,III}M_{IV,V}$	0.0368	
128.9	7 60 Nd	$N_{IV,V}O_{II,III}$	0.0962	376.	1 11 Na	$L_I L_{II,III}$	0.03299	
135.5	4 14 Si	$L_{II,III}M$	0.0915	399.	5 35 Br	Abs. Edge	0.0311	
136.5	4 59 Pr	$N_{IV,V}O_{II,III}$	0.0908	405.	5 11 Na	Abs. Edge	0.0306	
137.0	5 30 Zn	Abs. Edge	0.0905	407.1	5 11 Na	$L_{II,III}M$	0.03045	
142.5	1 13 Al	Abs. Edge	0.08701	417.	5 17 Cl	Abs. Edge	0.0297	
143.9	5 30 Zn	Abs. Edge	0.0862	444.	5 53 I	Abs. Edge	0.0279	
144.4	6 58 Ce	$N_{IV,V}O_{II,III}$	0.0859	525.	9 20 Ca	$M_{II,III}N_I$	0.0236	
144.4	3 37 Rb	$M_I M_{III}$	0.0859	692.	9 19 K	$M_{II,III}N_I$	0.0179	
152.6	6 57 La	$N_{IV,V}O_{II,III}$	0.0812					

$W K\alpha_1=0.2090100 \text{ \AA}^*$) and the probable errors in the third column, which apply to the last listed figure, are based on the error in the wavelength relative to the $W K\alpha_1$ line. The probable error on an absolute scale (angstroms) can be easily calculated by converting the listed error into parts per million and adding statistically an error of five ppm which is due to the uncertainty in the wavelength of the primary $W K\alpha_1$ standard. In more than 98% of the listed wavelengths, the errors shown in the third column are so large that the added error due to the primary standard is insignificant. The energy of the lines in keV ($V\lambda=12398.10\pm 0.13 \text{ eV} - \text{\AA}^*$) are shown in column four. This probable error includes that of the primary wavelength standard, and hence this ten ppm error combined with that in the last figure in the wavelength values yields the absolute probable errors in the keV energy values. The values for a second element are likewise shown in columns five, six, and seven. Data for other elements follow in a similar format.

In the study of the x-ray literature, the wavelengths of a number of lines were noted which appeared inconsistent with the remaining data. A Moseley-type diagram was constructed, and if the value was clearly outside estimated probable error, it was assumed that an experimental or typographical error had occurred, and the interpolated value was listed in the table. Such cases are marked with a dagger[†] as a superscript to the wavelength. For elements of atomic number 85 through 89 and 91, there are no measured lines of the *K* series and very few of other series except for 88 radium and 91 protactinium. Likewise there are very few measurements for 43 technetium and 54 xenon. In these cases, interpolated values are listed for the more prominent lines and marked with a dagger[†]. More recent measurements⁴⁶ of the *L* lines of

⁴⁶ G. D. Deodhar and R. C. Karnatak, *J. Sci. Ind. Res.* **15B**, 615 (1956).

61 samarium have been brought to our attention. Since these appear to be substantially more accurate than all the *L* data previously used for samarium¹², they are listed in Tables V and VI (corrected to \AA^* units) in place of the former values. A few misprints and incorrect line designations, discussed in the appendices of Ref. 12 of the succeeding paper, have been corrected in Tables V and VI.

For the convenience of those interested in x-ray chemical analysis and nuclear conversion problems, the x-ray wavelengths of both the emission lines and absorption edges are listed in numerical order in Table VI. The wavelengths are given in \AA^* units, together with their energy equivalents in keV. The probable error applies to the last wavelength figure. The interpolated lines and edges have not been marked by a dagger[†] in this table.

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Reevaluation of X-Ray Atomic Energy Levels

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All of the x-ray emission wavelengths have recently been reevaluated and placed on a consistent Å* scale. For most elements these data give a highly overdetermined set of equations for energy level differences, which have been solved by least-squares adjustment for each case. This procedure makes "best" use of all x-ray wavelength data, and also permits calculation of the probable error for each energy difference. Photoelectron measurements of absolute energy levels are more precise than x-ray absorption edge data. These have been used to establish the absolute scale for eighty-one elements and, in many cases, to provide additional energy level difference data. The x-ray absorption wavelengths were used for eight elements and ionization measurements for two; the remaining five were interpolated by a Moseley diagram involving the output values of energy levels from adjacent elements. Probable errors are listed on an absolute energy basis. In the original source of the present data, a table of energy levels in Rydberg units is given. Difference tables in volts, Rydbergs, and milli-Å* wavelength units, with the respective probable errors, are also included there.

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INTRODUCTION

Manne Siegbahn^{1,2} developed the first extensive evaluation of atomic energy levels from x-ray absorption edges and emission lines. The energy of the well-defined L_{III} absorption edge was chosen as the fundamental reference level for most of the periodic system; K edges were used for the lower atomic numbers. Other levels of each element were determined from the wavelengths of the emission lines as suggested by Idei.³

As improved x-ray data have become available, several reviews have appeared.⁴⁻⁹ Different energy units have been used to facilitate use by special groups. Cauchois^{6,7} improved the consistency of the rare-earth evaluations by a series of controlled absorption measurements. Theoretical calculations of many parameters often require ionization energies. Slater⁹ has

calculated these for all atomic numbers less than 42. For the outer electrons he used optical data, for the inner electrons, x-ray data.

Magnetic spectrometer¹⁰ measurements of the kinetic energy of photoelectrons released by irradiation with x rays of known wavelength furnish a method for direct measurement of energy levels. Recently Kai Siegbahn¹¹ and co-workers have used a high-precision iron-free spectrometer to determine energy levels directly from x-ray photoelectron measurements. For elements where photoelectron values are not available and x-ray absorption edge values existed, the latter are used to help complete the table; in other instances, interpolated or extrapolated values are listed. All values are given to the nearest eV.

X-ray emission wavelengths provide accurate data for evaluating the atomic energy levels on a relative scale,³ but only recently¹² has full advantage been taken of all the information available. The number of available lines is usually considerably greater than the number of energy levels involved. For such problems, which yield an overdetermined set of linear equations, the method of least squares furnishes a convenient and consistent means of obtaining "best" values and also probable errors for each of the values. Recently reevaluated wavelengths¹³ of the x-ray emission lines provide most of the input data. In place of the x-ray absorption edge values, previously used to establish the absolute scale, photoelectron measurements are substituted, wherever available.

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¹ M. Siegbahn, *Spektroskopie der Röntgenstrahlen* (Julius Springer-Verlag, Berlin, 1931).

² D. L. Webster, W. W. Nicholas, and M. Siegbahn, *International Critical Tables*, E. W. Washburn, Ed. (McGraw-Hill Book Co., Inc., New York, 1929), Vol. 6, p.35.

³ S. Idei, *Sci. Rept. Tohoku Univ.* 19, 641 (1930).

⁴ E. Sauri, *Landolt-Börnstein*, A. Eucken, Ed. (Springer-Verlag, Berlin, 1950), 6th ed., Vol. 1, p. 226.

⁵ R. D. Hill, E. L. Church, and J. W. Mihelich, *Rev. Sci. Instr.* 23, 523 (1952).

⁶ Y. Cauchois, *J. Phys. Radium* 13, 113 (1952).

⁷ Y. Cauchois, *J. Phys. Radium* 16, 253 (1955).

⁸ A. E. Sandström, *Encyclopedia of Physics*, S. Flügge, Ed. (Springer-Verlag, Berlin, 1957), Vol. 30, p. 78.

⁹ J. C. Slater, *Phys. Rev.* 98, 1039 (1955).

¹⁰ H. R. Robinson, J. P. Andrews, and E. J. Irons, *Proc. Roy. Soc. (London)* A143, 48 (1933); H. R. Robinson: *Proc. Phys. Soc. (London)* 46, 693 (1934); *Phil. Mag.* 18, 1086 (1934); also see Kretschmar, *Phys. Rev.* 43, 417 (1933).

¹¹ S. Hagström, C. Nordling, and K. Siegbahn, *Alpha-, Beta-, and Gamma-Ray Spectroscopy*, K. Siegbahn, Ed. (North-Holland Publ. Co., Amsterdam, 1965), Vol. 1, p. 845.

¹² J. A. Bearden and A. F. Burr, *Atomic Energy Levels*, NYO 2543-1 (Federal Sci. and Tech. Inf., U.S. Dept. of Commerce, Springfield, Va. 122151).

¹³ J. A. Bearden, *Rev. Mod. Phys.* 39, 78 (1967), preceding article. J. A. Bearden, *X-Ray Wavelengths*, NYO 10586 (Federal Sci. and Tech. Inf., U.S. Dept. of Commerce, Springfield, Va. 122151).

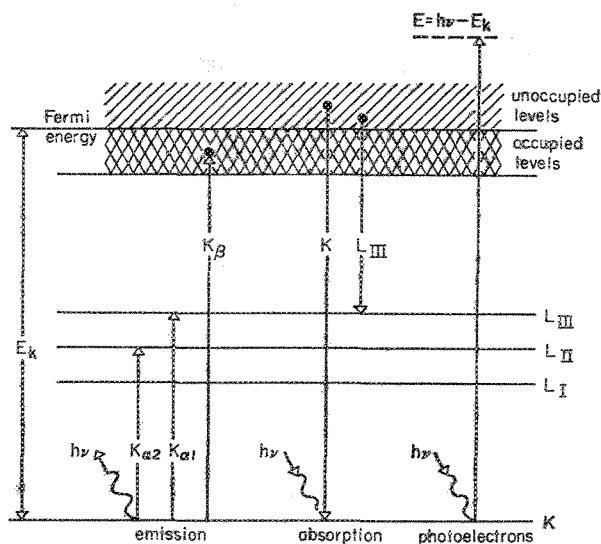


FIG. 1. Schematic of the principles involved in evaluating atomic energy levels.

METHODS OF EVALUATING ENERGY LEVELS

The principles involved in evaluating atomic energy levels are shown schematically in Fig. 1. The energy of a $K\alpha_1$ emission photon is just the difference between the K and L_{III} levels; similarly the $K\alpha_2$ corresponds to that difference between K and L_{II} . Usually the energy difference between a pair of levels can be obtained in two or more ways. For example, the difference between L_{II} and L_{III} can be evaluated from $K\alpha_1 - K\alpha_2$ (expressed in energy units). Alternatively it can be found from $L\beta_1 - L\alpha_2$, which represent the $L_{II}M_{IV}$ and $L_{III}M_{IV}$ transitions, respectively (omitted from Fig. 1 in the interest of simplicity). In the case of thorium, ninety-nine equations (including sixteen photoelectron measurements as discussed below) can be set up with only twenty-five unknown levels. A least-squares solution of this set yields the desired energy levels.

In order to determine these values on an absolute scale, the energy required to raise an electron from at least one energy state to the Fermi level energy (zero) must be included among the input data. In the center of Fig. 1 a K and an L_{III} absorption edge are indicated; experimental measurements of these edges give (approximately) the energy difference between the Fermi level and the K and L_{III} states, respectively. The theoretical corrections that must be made to these values for fine structure effects in the edges (due to differing transition probabilities and other causes) constitutes the principal uncertainty^{8,13} in the use of present x-ray absorption edge measurements.

The photoelectron method measures the energy of various states relative to the Fermi level. In this case the incident photon (usually originating from an x-ray spectral line) has an energy $h\nu$, normally much larger

¹⁴ L. G. Parratt, *Rev. Mod. Phys.* **31**, 616 (1959).

than that of the energy level under study. If, for example, the photoelectron comes from the K level, it emerges with an energy $(h\nu - E_K)$. To determine the exact kinetic energy, a work function correction is required. This is more amenable to analysis¹⁵ than the corrections to x-ray absorption measurements. This fact constitutes a major advantage of this method. This procedure is discussed in a later section.

EXPERIMENTAL MEASUREMENTS

X-Ray Measurements of Wavelengths and Absorption Edges

The principles of precise measurement of x-ray wavelengths have been summarized in the foregoing paper.¹⁵ Absorption edge wavelength measurements require the same techniques, but are subject to additional complications. The thickness^{14,16} of the absorber can displace the observed edge and, of course, the chemical state of the absorber is important. However, in spite of the uncertainty in the correction for fine-structure effects and difficulties of precise x-ray measurements, a number of the results are in excellent agreement with the photoelectron values. Thus it appears that with sufficient care the x-ray absorption measurements could be made competitive with the photoelectron method.

X-Ray Photoelectron Measurements

The precision β -ray spectrograph developed by Kai Siegbahn¹⁷ and his collaborators at Uppsala provides an instrument of high accuracy for the measurement of photoelectron energies. The precision of these measurements is approximately one hundred times that of the older magnetic spectrometer values¹⁰; for some elements they are an order of magnitude better than existing x-ray ones.

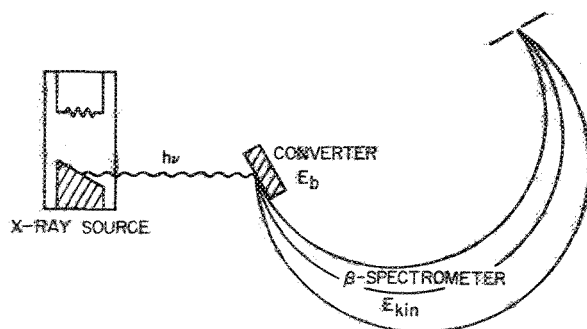


FIG. 2. Schematic of the use of a β -ray spectrometer for determining energy levels.

¹⁵ E. Sokolowski, *Arkiv Fysik* **15**, 1 (1959).

¹⁶ O. Beckman, B. Axelsson, and P. Bergvall, *Arkiv Fysik* **15**, 567 (1959).

¹⁷ K. Siegbahn, *Alpha-, Beta-, and Gamma-Ray Spectroscopy*, K. Siegbahn, Ed. (North-Holland Publ. Co., Amsterdam, 1965), Chap. III.

The use of a β -ray spectrometer for determining energy levels is shown schematically in Fig. 2. X rays strike the material under study (the converter) and release photoelectrons, whose kinetic energy is measured by the spectrometer. In its simplest form Einstein's photoelectric law states that $E_{pe} = h\nu - E_B$, where E_{pe} is the kinetic energy of the photoelectron, $h\nu$ that of the incident photon, and E_B the binding energy of the electron.

However, the measured photoelectron energy is decreased by the work function of the converter, ϕ . Since the converter and the slit are electrically connected, their Fermi levels are identical. Thus, if ϕ_s is the work function of the spectrometer slit system, there is an increase in kinetic energy, $\phi - \phi_s$, due to contact potential. With these corrections, the photoelectric equation becomes

$$E_{pe} = h\nu - E_B - \phi + (\phi - \phi_s) = h\nu - E_B - \phi_s.$$

Hence the net correction involves only the work function of the slits (oxidized Cu) and is independent of the work function of the converter.

In general, intense K lines were used to produce photoelectrons. Each x-ray line ejects photoelectrons from all levels whose energies are less than $h\nu - \phi$ in absolute value (e.g., photons energetic enough to remove K electrons also eject these from L_I , L_{II} , L_{III} , and other levels). The observed β -ray spectrum is composed of a number of lines due to the multiplicity in both the primary x-ray wavelengths and the energy levels of the converter. The resolution of the spectrometer was sufficient to exclude the influence of the α_2 lines on α_1 measurements.¹¹ Likewise the electrons undergoing discrete energy losses did not displace the observed spectra to lower energies.

Calculation of the electron energy in terms of the observed current in the magnetic coils of the spectrometer requires an involved procedure which has been discussed in several papers and recently reviewed, in detail, by Kai Siegbahn.¹⁷ This treatise should be consulted for theory, procedures, and resulting reference standards, which are used for all subsequent measurements.

Hagström and Karlsson¹⁸ showed that the method is not limited to conductors or even semiconductors. They found that, if the sample under study was insulated with thin mylar from the aluminum backing plate, (which was electrically connected to the spectrometer slit), the intense ionization due to the direct x-ray beam kept the potential of the insulating sample constant. Hence, even in this case, the observed binding energies were still measured with respect to the zero or Fermi energy. Thus insulating compounds could be attached in thin layers directly to the aluminum backing plate and their level energies measured in this manner.

¹⁸ S. Hagström and S.-E. Karlsson, *Arkiv Fysik* **26**, 351 (1964); and S. Hagström, *Z. Physik* **178**, 82 (1964).

INPUT DATA USED IN EVALUATING ENERGY LEVEL VALUES

A separate least-squares evaluation was carried out on each element for which an overdetermined set of data was available. Wavelengths and probable errors of emission lines (all expressed in eV units) are taken from the previous paper.¹³ If photoelectron measurements are available for two or more levels, they are included in the least-squares adjustment for that element. If only a single level is determined by the photoelectron method, this establishes one energy level; the others are found from energy differences obtained by a least-squares adjustment of the emission line data.

Wavelength measurements¹⁵ of critical absorption edges are used to establish the absolute scale for eight elements for which no photoelectron measurements are available. In a few cases, where neither photoelectron nor x-ray measurements exist, a Moseley diagram of the final output values of adjacent elements is used to establish one level of the element. The remaining levels are then calculated with emission lines as above. If two or more absorption wavelengths are available for an element, these are also treated by the least-squares method.

The values of the x-ray photoelectron measurements used are listed in brackets in Table I, together with references to the original publications. The published values have been adjusted slightly to make them consistent with the new x-ray emission wavelengths¹³ and more recent values of the atomic constants.¹⁹ In the original data most of the errors are 2σ values; these have been changed to probable errors as shown in Table I. For comparison, all the more accurately measured x-ray absorption wavelengths (converted to eV by the factor $12398.1 \text{ \AA}^* - \text{eV}$) are listed in parentheses in Table I. The x-ray absorption data are used for establishing the absolute energy level scale in only eight elements; the other listed values are for comparison only.

EVALUATION OF THE ATOMIC ENERGY LEVELS

Since nearly all elements involve many emission line measurements interconnecting a lesser number of energy levels, an overdetermined set of equations results. As indicated above, a least-squares adjustment provides an appropriate way of solving this set of equations in order to obtain maximum information from the available data. Justification for this procedure and derivations of the equations involved have been presented in many sources.²⁰⁻²² A clear explanation of

¹⁹ E. R. Cohen and J. W. M. DuMond, *Rev. Mod. Phys.* **37**, 537 (1965).

²⁰ E. Whittaker and G. Robinson, *The Calculus of Observations* (New York, 1944), 4th ed., Chap. 9.

²¹ I. F. Sokolnikoff and R. M. Radheffer, *Mathematics of Physics and Modern Engineering* (McGraw-Hill Book Co., Inc., New York, 1958), Chap. IX, Sec. 11.

²² E. R. Cohen, *Rev. Mod. Phys.* **25**, 709 (1953).

TABLE I. Recommended values of the atomic energy levels, and probable errors in eV. Where available, photoelectron direct measurements are listed in brackets [] immediately under the recommended values. The measured values of the x-ray absorption energies (from Ref. 13) are shown in parentheses (). Interpolated values are enclosed in angle brackets $\langle \rangle$.

Level	1 H	2 He	3 Li	4 Be	5 B	6 C	7 N	8 O
<i>K</i>	13.59811 ^a	24.58678 ^b	54.75±0.02 (54.75)	111.0±1.0 (111.0)	188.0±0.4 [188.0] ^a	283.8±0.4 [283.8] ^a (283.8)	401.6±0.4 [401.6] ^a	532.0±0.4 [532.0] ^a
<i>L_I</i>								23.7±0.4 [23.7] ^a
<i>L_{II,III}</i>					4.7±0.9	6.4±1.9	9.2±0.6	7.1±0.8
	9 F	10 Ne	11 Na	12 Mg	13 Al	14 Si	15 P	16 S
<i>K</i>	685.4±0.4 [685.4] ^a	866.9±0.3 (866.9)	1072.1±0.4 [1072.1] ^a (1072.)	1305.0±0.4 [1305.0] ^a (1303.)	1559.6±0.4 [1559.6] ^a (1559.8)	1838.9±0.4 [1838.9] ^a	2145.5±0.4 [2145.5] ^a	2472.0±0.4 [2472.0] ^a (2470.)
<i>L_I</i>	\langle 31. \rangle	\langle 45. \rangle	63.3±0.4 [63.3] ^a	89.4±0.4 [89.4] ^a (63.)	117.7±0.4 [117.7] ^a (87.)	148.7±0.4 [148.7] ^a	189.3±0.4 [189.3] ^a	229.2±0.4 [229.2] ^a
<i>L_{II,III}</i>	8.6±0.8	18.3±0.4	31.1±0.4 (31.)	51.4±0.5 (50.)	73.1±0.5 (72.8)	99.2±0.5 (100.6)	132.2±0.5 (132.)	164.8±0.7
	17 Cl	18 Ar	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr
<i>K</i>	2822.4±0.3 [2822.4] ^a (2020.)	3202.9±0.3 (3202.9)	3607.4±0.4 [3607.4] ^a (3607.8)	4038.1±0.4 [4038.1] ^a (4038.1)	4492.8±0.4 [4492.8] ^a	4966.4±0.4 [4966.4] ^a (4964.5)	5465.1±0.3 [5465.1] ^a (5464.)	5989.2±0.3 [5989.2] ^a (5989.)
<i>L_I</i>	270.2±0.4 [270.2] ^a	320. (320.) ^a	377.1±0.4 [377.1] ^a	437.8±0.4 [437.8] ^a	500.4±0.4 [500.4] ^a	563.7±0.4 [563.7] ^a	628.2±0.4 [628.2] ^a	694.6±0.4 [694.6] ^a
<i>L_{II}</i>	201.6±0.3	247.3±0.3	296.3±0.4	350.0±0.4	406.7±0.4	461.5±0.4	520.5±0.3	583.7±0.3
<i>L_{III}</i>	200.0±0.3	245.2±0.3	293.6±0.4	346.4±0.4	402.2±0.4	455.5±0.4	512.9±0.3	574.5±0.3
<i>M_I</i>	17.5±0.4	25.3±0.4	33.9±0.4	43.7±0.4	53.8±0.4	60.3±0.4	66.5±0.4	74.1±0.4
<i>M_{II,III}</i>	6.8±0.4	12.4±0.3	17.8±0.4	25.4±0.4	32.3±0.5	34.6±0.4	37.8±0.3	42.5±0.3
<i>M_{IV,V}</i>					6.6±0.5	3.7	2.2±0.3	2.3±0.4

TABLE I (Continued)

	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge
<i>K</i>	6539.0±0.4 [6539.0] ^b (6538.)	7112.0±0.9 [7111.3] ^{b,c} (7111.2)	7708.9±0.3 [7708.9] ^b (7709.5)	8332.8±0.4 [8332.8] ^b (8331.6)	8978.9±0.4 [8978.9] ^{b,c} (8980.3)	9658.6±0.6 [9658.6] ^b (9660.7)	10367.1±0.5 [10367.1] ^b (10368.2)	11103.1±0.7 [11103.8] ^b (11103.6)
<i>L_I</i>	769.0±0.4 [769.0] ^a	846.1±0.4 [846.1] ^a	925.6±0.4 [925.6] ^a	1008.1±0.4 [1008.1] ^a	1096.1±0.4 [1096.0] ^a	1193.6±0.9	1297.7±1.1	1414.3±0.7 [1413.6] ^b
<i>L_{II}</i>	651.4±0.4	721.1±0.9	793.6±0.3	871.9±0.4	951.0±0.4 [950.0] ^b (953.)	1042.8±0.6	1142.3±0.5	1247.8±0.7
<i>L_{III}</i>	640.3±0.4	(720.8)	(793.8)	(870.6)	(953.)	(1045.)		(1249.)
<i>M_I</i>	83.9±0.5	708.1±0.9	778.6±0.3	854.7±0.4	931.1±0.4 [931.4] ^b (933.)	1019.7±0.6	1115.4±0.5	1216.7±0.7
<i>M_{II}</i>		(707.4)	(779.0)	(853.6)	(933.)	(1022.)	(1117.)	(1217.0)
<i>M_{III}</i>	48.6±0.4	54.0±0.9 (54.)	59.5±0.3 (61.)	68.1±0.4 (66.)	73.6±0.4 (75.)	86.6±0.6 (86.)	106.8±0.7	127.9±0.9
<i>M_{IV}</i>	3.3±0.5	3.6±0.9	2.9±0.3	3.6±0.4	1.6±0.4	8.1±0.6	17.4±0.5	28.7±0.7
	33 As	34 Se	35 Br	36 Kr	37 Rb	38 Sr	39 Y	40 Zr
<i>K</i>	11866.7±0.7 [11866.7] ^b (11865.)	12657.8±0.7 [12657.8] ^b (12654.5)	13473.7±0.4 (13470.)	14325.6±0.8 (14324.4)	15199.7±0.3 (15202.)	16104.6±0.3 (16107.)	17038.4±0.3 (17038.)	17997.6±0.4 (17999.)
<i>L_I</i>	1526.5±0.8 (1529.)	1653.9±3.5 (1652.5)	1782.0±0.4 [1782.0] ^b	1921.0±0.6 [1921.2] ^b (1730.)	2065.1±0.3 [2065.4] ^b	2216.3±0.3 [2216.2] ^b	2372.5±0.3 [2372.7] ^b	2531.6±0.3 [2531.6] ^b
<i>L_{II}</i>	1358.6±0.7 (1358.7)	1476.2±0.7 (1474.7)	1596.0±0.4 [1596.2] ^b	1727.2±0.5 [1727.2] ^b (1730.)	1863.9±0.3 [1863.4] ^b	2006.8±0.3 [2006.6] ^b (2008.5)	2155.5±0.3 [2155.0] ^b (2154.0)	2306.7±0.3 [2306.5] ^b (2305.3)
<i>L_{III}</i>	1323.1±0.7 (1323.5)	1435.8±0.7 (1434.0)	1549.9±0.4 [1549.7] ^b	1674.9±0.5 [1674.8] ^b (1677.)	1804.4±0.3 [1804.6] ^b	1939.6±0.3 [1939.9] ^b (1941.)	2080.0±0.3 [2080.2] ^b (2079.4)	2222.3±0.3 [2222.5] ^b (2222.5)
<i>M_I</i>	203.5±0.7	231.5±0.7	256.5±0.4	222.7±1.1	322.1±0.3	357.5±0.3	393.6±0.3	430.3±0.3
<i>M_{II}</i>	146.4±1.2	168.2±1.3	189.3±0.4	222.7±1.1	247.4±0.3	279.8±0.3	312.4±0.4	344.2±0.4

TABLE I (Continued)

	33 As	34 Se	35 Br	36 Kr	37 Rb	38 Sr	39 Y	40 Zr
M_{III}	140.5±0.8	161.9±1.0	181.5±0.4	213.8±1.1	238.5±0.3	269.1±0.3	300.3±0.4	330.5±0.4
M_{IV}	41.2±0.7	56.7±0.8	70.1±0.4	88.9±0.8	111.8±0.3	135.0±0.3	159.6±0.3	182.4±0.3
M_V								
N_I			27.3±0.5	24.0±0.8	29.3±0.3	37.7±0.3	45.4±0.3	51.3±0.3
N_{II}	2.5±1.0	5.6±1.3	5.2±0.4	10.6±1.9	14.8±0.4	19.9±0.3	25.6±0.4	28.7±0.4
N_{III}								
	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd
K	18985.6±0.4 (18987.)	19999.5±0.3 (20004.)	21044.0±0.7	22117.2±0.3 (22119.)	23219.9±0.3 (23219.8)	24350.3±0.3 (24348.)	25514.0±0.3 (25516.)	26711.2±0.3 (26716.)
L_I	2697.7±0.3 [2697.7] ⁱ	2865.5±0.3 [2866.0] ⁱ	3042.5±0.4 [3042.5] ⁱ	3224.0±0.3 [3224.3] ⁱ	3411.9±0.3 [3412.0] ⁱ (3417.)	3604.3±0.3 [3604.6] ⁱ (3607.)	3805.8±0.3 [3806.2] ^m (3807.)	4018.0±0.3 [4018.1] ^m (4019.)
L_{II}	2464.7±0.3 [2464.7] ⁱ	2625.1±0.3 [2624.5] ⁱ (2627.)	2793.2±0.4 [2973.2] ⁱ	2966.9±0.3 [2966.8] ⁱ (2966.3)	3146.1±0.3 [3146.3] ⁱ (3145.)	3330.3±0.3 [3330.3] ⁱ (3330.3)	3523.7±0.3 [3523.6] ^m (3526.)	3727.0±0.3 [3727.1] ^m (3728.)
L_{III}	2370.5±0.3 [2370.6] ⁱ	2520.2±0.3 [2520.2] ⁱ (2523.2)	2676.9±0.4 [2676.9] ⁱ	2837.9±0.3 [2837.7] ⁱ (2837.7)	3003.8±0.3 [3003.5] ^{s,i} (3002.)	3173.3±0.3 [3173.0] ^{s,i} (3173.0)	3351.1±0.3 [3350.8] ^s (3351.0)	3537.5±0.3 [3537.3] ^s (3537.6)
M_I	468.4±0.3	504.6±0.3		585.0±0.3	627.1±0.3	669.9±0.3	717.5±0.3	770.2±0.3
M_{II}	378.4±0.4	409.7±0.4	444.9±1.5	482.8±0.3	521.0±0.3	559.1±0.3	602.4±0.3	650.7±0.3
M_{III}	363.0±0.4	392.3±0.3	425.0±1.5	460.6±0.3	496.2±0.3	531.5±0.3	571.4±0.3	616.5±0.3
M_{IV}	207.4±0.3	230.3±0.3	256.4±0.5	283.6±0.3	311.7±0.3	340.0±0.3	372.8±0.3	410.5±0.3
M_V	204.6±0.3	227.0±0.3	252.9±0.4	279.4±0.3	307.0±0.3	334.7±0.3	366.7±0.3	403.7±0.3
N_I	58.1±0.3	61.8±0.3		74.9±0.3	81.0±0.3	86.4±0.3	95.2±0.3	107.6±0.3
N_{II}	33.9±0.4	34.8±0.4	38.9±1.9	43.1±0.4	47.9±0.4	51.1±0.4	62.6±0.3	66.9±0.4
N_{III}								
$N_{IV,V}$	3.2±0.3	1.8±0.3		2.0±0.3	2.5±0.4	1.5±0.3	3.3±0.3	9.3±0.3

TABLE I (Continued)

	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	55 Cs	56 Ba
K	27939.9±0.3	29200.1±0.4 (29195.)	30491.2±0.3 (30486.)	31813.8±0.3 (31811.)	33169.4±0.4 (33167.)	34561.4±1.1 (34590.)	35984.6±0.4 (35987.)	37440.6±0.4 (37452.)
L _I	4237.5±0.3 [4237.7] ^m (4237.3)	4464.7±0.3 [4464.5] ^k (4464.8)	4698.3±0.3 [4698.3] ^m (4698.4)	4939.2±0.3 [4939.3] ^m (4939.7)	5188.1±0.3 [5188.1] ^j	5452.8±0.4 (5452.8)	5714.3±0.4 [5712.7] ^j (5721.)	5988.8±0.4 [5986.8] ^j (5996.)
L _{II}	3938.0±0.3 [3937.8] ^m (3939.3)	4156.1±0.3 [4156.2] ^k (4157.)	4380.4±0.3 [4380.6] ^m (4382.)	4612.0±0.3 [4612.0] ^m (4612.6)	4852.1±0.3 [4852.0] ^j	5103.7±0.4 (5103.7)	5359.4±0.3 [5359.5] ^j (5358.)	5623.6±0.3 [5623.6] ^j (5623.3)
L _{III}	3730.1±0.3 [3730.0] ^k (3730.2)	3928.8±0.3 [3928.8] ^k (3928.8)	4132.2±0.3 [4132.2] ^k (4132.3)	4341.4±0.3 [4341.2] ^k (4341.8)	4557.1±0.3 [4557.1] ^j	4782.2±0.4 (4782.2)	5011.9±0.3 [5012.0] ^j (5011.3)	5247.0±0.3 [5247.3] ^j (5247.0)
M _I	825.6±0.3	883.8±0.3	943.7±0.3	1006.0±0.3	1072.1±0.3	1217.1±0.4	1292.8±0.4	
M _{II}	702.2±0.3	756.4±0.4	811.9±0.3	869.7±0.3	930.5±0.3	999.0±2.1	1065.0±0.5	1136.7±0.5
M _{III}	664.3±0.3	714.4±0.3	765.6±0.3	818.7±0.3	874.6±0.3	937.0±2.1	997.6±0.5	1062.2±0.5
M _{IV}	450.9±0.3	493.3±0.3	536.9±0.3	582.5±0.3	631.3±0.3	739.5±0.4	796.1±0.3	
M _V	443.1±0.3	484.8±0.3	527.5±0.3	572.1±0.3	619.4±0.3	672.3±0.5	725.5±0.5	780.7±0.3
N _I	121.9±0.3	136.5±0.4	152.0±0.3	168.3±0.3	186.4±0.3	230.8±0.4	253.0±0.5	
N _{II}	77.4±0.4	88.6±0.4	98.4±0.5	110.2±0.5	122.7±0.5	146.7±3.1	172.3±0.6	191.8±0.7
N _{III}							161.6±0.6	179.7±0.6
N _{IV}	16.2±0.3	23.9±0.3	31.4±0.3	39.8±0.3	49.6±0.3	78.8±0.5	92.5±0.5	
N _V							76.5±0.5	89.9±0.5
O _I	0.1±4.5	0.9±0.5	6.7±0.5	11.6±0.6	13.6±0.6	22.7±0.5	39.1±0.6	
O _{II}	0.8±0.4	1.1±0.5	2.1±0.4	2.3±0.5	3.3±0.5	13.1±0.5	16.6±0.5	
O _{III}						11.4±0.5	14.6±0.5	
	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd
K	38924.6±0.4 (38934.)	40443.0±0.4 (40453.)	41990.6±0.5 (42002.)	43568.9±0.4 (43574.)	45184.0±0.7 (45198.)	46834.2±0.5 (46849.)	48519.0±0.4 (48519.)	50239.1±0.5 (50233.)

TABLE I (Continued)

	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd
L_I	6266.3±0.5 [6266.3] ⁿ	6548.8±0.5 [6548.5] ⁿ	6834.8±0.5 [6834.9] ⁿ	7126.0±0.4 [7125.8] ⁿ (7129.)	7427.9±0.8 [7427.9] ⁿ	7736.8±0.5 [7736.2] ⁿ (7748.)	8052.0±0.4 [8051.7] ⁿ (8061.)	8375.6±0.5 [8375.4] ⁿ (8386.)
L_{II}	5890.6±0.4 [5890.7] ⁿ	6164.2±0.4 [6164.3] ⁿ	6440.4±0.5 [6440.2] ⁿ	6721.5±0.4 [6721.8] ⁿ (6723.)	7012.8±0.6 [7012.8] ⁿ	7311.8±0.4 [7312.0] ⁿ (7313.)	7617.1±0.4 [7617.6] ⁿ (7620.)	7930.3±0.4 [7930.5] ⁿ (7931.)
L_{III}	5482.7±0.4 [5482.6] ⁿ	5723.4±0.4 [5723.6] ⁿ	5964.3±0.4 [5964.3] ⁿ	6207.9±0.4 [6208.0] ⁿ (6209.)	6459.3±0.6 [6459.4] ⁿ	6716.2±0.5 [6716.8] ⁿ (6717.)	6976.9±0.4 [6976.7] ⁿ (6981.)	7242.8±0.4 [7242.8] ⁿ (7243.)
M_I	1361.3±0.3	1434.6±0.6	1511.0±0.8	1575.3±0.7	1722.8±0.8	1800.0±0.5	1880.8±0.5	
M_{II}	1204.4±0.6	1272.8±0.6	1337.4±0.7	1402.8±0.6	1471.4±6.2	1540.7±1.2	1613.9±0.7	1688.3±0.7
M_{III}	1123.4±0.5	1185.4±0.5	1242.2±0.6	1297.4±0.5	1356.9±1.4	1419.8±1.1	1480.6±0.6	1544.0±0.8
M_{IV}	848.5±0.4	901.3±0.6	951.1±0.6	999.9±0.6	1051.5±0.9	1106.0±0.8	1160.6±0.6	1217.2±0.6
M_V	831.7±0.4	883.3±0.5	931.0±0.6	977.7±0.6	1026.9±1.0	1080.2±0.6	1130.9±0.6	1185.2±0.6
N_I	270.4±0.8	289.6±0.7	304.5±0.9	315.2±0.8	345.7±0.9	360.2±0.7	375.8±0.7	
N_{II}	205.8±1.2	223.3±1.1	236.3±1.5	243.3±1.6	{ 242.±16. }		265.6±1.9	283.9±1.0
N_{III}	191.4±0.9	207.2±0.9	217.6±1.1	224.6±1.3	242.±16.	247.4±1.5	256.6±0.8	270.9±0.9
N_{IV}	98.9±0.8	110.0±0.6	113.2±0.7	117.5±0.7	120.4±2.0	129.0±1.2	133.2±0.6	140.5±0.8
$N_{VI, VII}$		0.1±1.2	2.0±0.6	1.5±0.9		5.5±1.1	0.0±3.2	0.1±3.5
O_I	32.3±7.2	37.8±1.3	37.4±1.0	37.5±0.9		37.4±1.5	31.8±0.7	36.1±0.8
$O_{II, III}$	14.4±1.2	19.8±1.2	22.3±0.7	21.1±0.8		21.3±1.5	22.0±0.6	20.3±1.2
	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	72 Hf
K	51995.7±0.5 (52002.)	53788.5±0.5 (53793.)	55617.7±0.5 (55619.)	57485.5±0.5 (57487.)	59389.6±0.5	61332.3±0.5 (61300.)	63313.8±0.5 (63310.)	65350.8±0.6 (65310.)
L_I	8708.0±0.5 [8707.6] ⁿ (8717.)	9045.8±0.5 [9046.5] ⁿ	9394.2±0.4 [9394.3] ⁿ (9399.)	9751.3±0.4 [9751.5] ⁿ (9757.)	10115.7±0.4 [10115.6] ⁿ (10121.)	10486.4±0.4 [10487.3] ⁿ (10490.)	10870.4±0.4 [10870.1] ⁿ (10874.)	11270.7±0.4 [11271.6] ⁿ (11274.)

TABLE I (Continued)

	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	72 Hf
L_{II}	8251.6±0.4 [8251.8] ⁿ (8253.)	8580.6±0.4 [8580.4] ⁿ (8583.)	8917.8±0.4 [8918.2] ⁿ (8916.)	9264.3±0.4 [9264.3] ⁿ (9262.)	9616.9±0.4 [9617.1] ⁿ (9617.1)	9978.2±0.4 [9977.9] ⁿ (9976.)	10348.6±0.4 [10349.0] ⁿ (10345.)	10739.4±0.4 [10738.9] ⁿ (10736.)
L_{III}	7514.0±0.4 [7514.2] ⁿ (7515.)	7790.1±0.4 [7789.6] ⁿ (7789.7)	8071.1±0.4 [8070.6] ⁿ (8068.)	8357.9±0.4 [8357.6] ⁿ (8357.5)	8648.0±0.4 [8647.8] ⁿ (8649.6)	8943.6±0.4 [8942.6] ⁿ (8944.1)	9244.1±0.4 [9243.8] ⁿ	9560.7±0.4 [9560.4] ⁿ (9558.)
M_I	1967.5±0.6	2046.8±0.4	2128.3±0.6	2206.5±0.6	2306.8±0.7	2398.1±0.4	2491.2±0.5	2600.9±0.4
M_{II}	1767.7±0.9	1841.8±0.5	1922.8±1.0	2005.8±0.6	2089.8±1.1	2173.0±0.4	2263.5±0.4	2365.4±0.4
M_{III}	1611.3±0.8	1675.6±0.9	1741.2±0.9	1811.8±0.6	1884.5±1.1	1949.8±0.5	2023.6±0.5	2107.6±0.4
M_{IV}	1275.0±0.6	1332.5±0.4	1391.5±0.7	1453.3±0.5	1514.6±0.7	1576.3±0.4	1639.4±0.4	1716.4±0.4
M_V	1241.2±0.7	1294.9±0.4	1351.4±0.8	1409.3±0.5	1467.7±0.9	1527.8±0.4	1588.5±0.4	1661.7±0.4
N_I	397.9±0.8	416.3±0.5	435.7±0.8	449.1±1.0	471.7±0.9	487.2±0.6	506.2±0.6	538.1±0.4
N_{II}	310.2±1.2	331.8±0.6	343.5±1.4	366.2±1.5	385.9±1.6	396.7±0.7	410.1±1.8	437.0±0.5
N_{III}	385.0±1.0	292.9±0.6	306.6±0.9	320.0±0.7	336.6±1.6	343.5±0.5	359.3±0.5	380.4±0.5
N_{IV}	147.0±0.8	154.2±0.5	161.0±1.0	176.7±1.2	179.6±1.2	198.1±0.5	204.8±0.5	223.8±0.4
N_V				167.6±1.5				
$N_{VI,VII}$	2.6±1.5	4.2±1.6	3.7±3.0	4.3±1.4	5.3±1.9	6.3±1.0	6.9±0.5	17.1±0.5
O_I	39.0±0.8	62.9±0.5	51.2±1.3	59.8±1.7	53.2±3.0	54.1±0.5	56.8±0.5	64.9±0.4
O_{II}	25.4±0.8	26.3±0.6	20.3±1.5	29.4±1.6	32.3±1.6	23.4±0.6	28.0±0.6	38.1±0.6
O_{III}								
	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg
K	67416.4±0.6 (67403.)	69525.0±0.3 (69508.)	71676.4±0.4 (71658.)	73870.8±0.5	76111.0±0.5	78394.8±0.7 (78381.)	80724.9±0.5 (80720.)	83102.3±0.8
L_I	11681.5±0.3 [11680.2] ^p (11682.)	12099.8±0.3 [12098.2] ^p (12099.6)	12526.7±0.4	12968.0±0.4	13418.5±0.3	13879.9±0.4	14352.8±0.4	14839.3±1.0 (14842.)

TABLE I (Continued)

	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg
L_{II}	11136.1±0.3 [11136.1] ^p (11132.)	11544.0±0.3 [11541.4] ^p (11538.)	11958.7±0.3 [11956.9] ^p (11954.)	12385.0±0.4 (12381.)	12824.1±0.3 [12824.0] ^{p,p} (12820.)	13272.6±0.3 [13272.6] ^{p,p} (13272.3)	13733.6±0.3 [13733.5] ^{p,p} (13736.)	14208.7±0.7 (14215.)
L_{III}	9881.1±0.3 [9880.3] ^p (9877.7)	10206.8±0.3 [10204.2] ^p (10200.)	10535.3±0.3 [10534.2] ^p (10531.)	10870.9±0.3 [10870.7] ^p (10868.)	11215.2±0.3 [11215.1] ^{p,p} (11212.)	11563.7±0.3 [11563.7] ^{p,p} (11562.)	11918.7±0.3 [11918.2] ^{p,p} (11921.)	12283.9±0.4 [12284.0] ^{p,p} (12286.)
M_I	2708.0±0.4	2819.6±0.4	2931.7±0.4	3048.5±0.4	3173.7±1.7	3296.0±0.9	3424.9±0.3 [3424.8] ^p	3561.6±1.1
M_{II}	2468.7±0.3 [2468.6] ^p	2574.9±0.3 [2575.0] ^p	2681.6±0.4	2792.2±0.3 [2791.9] ^p	2908.7±0.3 [2909.1] ^p	3026.5±0.4 [3026.5] ^p (3029.)	3147.8±0.4 [3149.5] ^p	3278.5±1.3
M_{III}	2194.0±0.3 [2194.1] ^p	2281.0±0.3 [2281.0] ^p	2367.3±0.3 [2367.3] ^p	2457.2±0.4 [2457.4] ^p	2550.7±0.3 [2550.5] ^p (2550.5)	2645.4±0.4 [2645.5] ^p (2645.9)	2743.0±0.3 [2743.1] ^p (2744.0)	2847.1±0.4 [2847.1] ^p
M_{IV}	1793.2±0.3 [1793.1] ^p	1871.6±0.3 [1871.4] ^p	1948.9±0.3 [1948.9] ^p	2030.8±0.3 [2031.0] ^p	2116.1±0.3 [2116.1] ^p	2201.9±0.3 [2201.9] ^p	2291.1±0.3 [2291.2] ^p (2307.)	2384.9±0.3 [2384.9] ^p
M_V	1735.1±0.3 [1735.2] ^p	1809.2±0.3 [1809.3] ^p	1882.9±0.3 [1882.9] ^p	1960.1±0.3 [1960.2] ^p	2040.4±0.3 [2040.5] ^p	2121.6±0.3 [2121.6] ^p	2205.7±0.3 [2206.1] ^p (2220.)	2294.9±0.3 [2294.9] ^p
N_I	565.5±0.5	595.0±0.4	625.0±0.4	654.3±0.5	690.1±0.4	722.0±0.6	758.8±0.4	800.3±1.0
N_{II}	464.8±0.5	491.6±0.4	517.9±0.5	546.5±0.5	577.1±0.4	609.2±0.6	643.7±0.5	676.9±2.4
N_{III}	404.5±0.4	425.3±0.5	444.4±0.5	468.2±0.6	494.3±0.6	519.0±0.6	545.4±0.5	571.0±1.4
N_{IV}	241.3±0.4	258.8±0.4	273.7±0.5	289.4±0.5	311.4±0.4	330.8±0.5	352.0±0.4	378.3±1.0
N_V	229.3±0.3	245.4±0.4	260.2±0.4	272.8±0.6	294.9±0.4	313.3±0.4	333.9±0.4	359.8±1.2
N_{VI}	25.0±0.4	36.5±0.4 33.6±0.4	40.6±0.4	46.3±0.6	63.4±0.4	74.3±0.4	86.4±0.4	102.2±0.5
N_{VII}								
O_I	71.1±0.5	77.1±0.4	82.8±0.5	83.7±0.6	95.2±0.4	101.7±0.4	107.8±0.7	120.3±1.3
O_{II}	44.9±0.4	46.8±0.5	45.6±0.7	58.0±1.1	63.0±0.6	65.3±0.7	71.7±0.7	80.5±1.3
O_{III}	36.4±0.4	35.6±0.5	34.6±0.6	45.4±1.0	50.5±0.6	51.7±0.7	53.7±0.7	57.6±1.3
O_{IV}	5.7±0.4	6.1±0.4	3.5±0.5		3.8±0.4	2.2±1.3	2.5±0.5	6.4±1.4

TABLE I (Continued)

	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn	87 Fr	88 Ra
<i>K</i>	85530.4±0.6	88004.5±0.7 (88005.)	90525.9±0.7 (90534.)	93105.0±3.8	95729.9±7.7	98404.±12.	101137.±13.	103921.9±7.2
<i>L_I</i>	15346.7±0.4 (15343.)	15860.8±0.5 (15855.)	16387.5±0.4 (16376.)	16939.3±9.8	17493.±29.	18049.±38.	18639.±40.	19236.7±1.5 (19236.0)
<i>L_{II}</i>	14697.9±0.3 [14697.3] ^p (14699.)	15200.0±0.4 (15205.)	15711.1±0.3 [15708.4] ^p (15719.)	16244.3±2.4	16784.7±2.5	17337.1±3.4	17906.5±3.5	18484.3±1.5 (18486.0)
<i>L_{III}</i>	13657.5±0.3 [12656.3] ^{p,p} (12660.)	13035.2±0.3 [13034.9] ^{p,p} (13041.)	13418.6±0.3 [13418.3] ^{p,p} (13426.)	13813.8±1.0 (13813.8)	14213.5±2.0 (14213.5)	14619.4±3.0 (14619.4)	15031.2±3.0 (15031.2)	15444.4±1.5 (15444.0)
<i>M_I</i>	3704.1±0.4	3850.7±0.5	3999.1±0.3 [3999.1] ^p	4149.4±3.9	⟨4317.⟩	⟨4482.⟩	⟨4652.⟩	4822.0±1.5
<i>M_{II}</i>	3415.7±0.3 [3415.7] ^p	3554.2±0.3 [3554.2] ^p	3696.3±0.3 [3696.4] ^p	3854.1±9.8	4008.±28.	4159.±38.	4327.±40.	4489.5±1.8
<i>M_{III}</i>	2956.6±0.3 [2956.5] ^p	3066.4±0.4 [3066.3] ^p	3176.9±0.3 [3176.8] ^p	3301.9±9.9	3426.±29.	3538.±38.	3663.±40.	3791.8±1.7
<i>M_{IV}</i>	2485.1±0.3 [2485.2] ^p	2585.6±0.3 [2585.5] ^p (2606.)	2687.6±0.3 [2687.4] ^p	2798.0±1.2	2908.7±2.1	3021.5±3.1	3136.2±3.1	3248.4±1.6
<i>M_V</i>	2389.3±0.3 [2389.4] ^p	2484.0±0.3 [2484.2] ^p (2502.)	2579.6±0.3 [2579.5] ^p	2683.0±1.1	2786.7±2.1	2892.4±3.1	2999.9±3.1	3104.9±1.6
<i>N_I</i>	845.5±0.5	893.6±0.7	938.2±0.3 [938.7] ^p	995.3±2.9	⟨1042.⟩	⟨1097.⟩	⟨1153.⟩	1208.4±1.6
<i>N_{II}</i>	721.3±0.8	763.9±0.8	805.3±0.3 [805.3] ^p	851.±12.	886.±30.	929.±40.	980±42.	1057.6±1.8
<i>N_{III}</i>	609.0±0.5	644.5±0.6	678.9±0.3 [678.9] ^p	705.±14.	740.±30.	768.±40.	810±43.	879.1±1.8
<i>N_{IV}</i>	406.6±0.4	435.2±0.5	463.6±0.3 [463.6] ^p	500.2±2.4	533.2±3.2	566.6±4.0	603.3±4.1	635.9±1.6
<i>N_V</i>	386.2±0.5	412.9±0.6	440.0±0.3 [440.1] ^p	473.4±1.3			577.±34.	602.7±1.7

TABLE I (Continued)

	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn	87 Fr	88 Ra
<i>N_{VI}</i>	122.8±0.4	142.9±0.4	161.9±0.5	}				298.9±2.4
<i>N_{VII}</i>	118.5±0.4	138.1±0.4	157.4±0.6					
<i>O_I</i>	136.3±0.7	147.3±0.8	159.3±0.7					254.4±2.1
<i>O_{II}</i>	99.6±0.6	104.8±1.0	116.8±0.7					200.4±2.0
<i>O_{III}</i>	75.4±0.6	86.0±1.0	92.8±0.6					152.8±2.0
<i>O_{IV}</i>	15.3±0.4	21.8±0.4	26.5±0.5	}				
<i>O_V</i>	13.1±0.4	19.2±0.4	24.4±0.6		31.4±3.2			
<i>P_I</i>		3.1±1.0						43.5±2.2
<i>P_{II,III}</i>		0.7±1.0	2.7±0.7					18.8±1.8

	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm
<i>K</i>	106755.3±5.3	109650.9±0.9	112601.4±2.4	115606.1±1.6	118678.±33.	121818.±44.	125027.±55.	128220
<i>L_I</i>	19840.±18.	20472.1±0.5	21104.6±1.8	21757.4±0.3	22426.8±0.9	23097.2±1.6	23772.9±2.0	24460
		(20464.)	(21128.)	(21771.)		(23109.)	(23772.9)	
<i>L_{II}</i>	19083.2±2.8	19693.2±0.4	20313.7±1.5	20947.6±0.3	21690.5±0.4	22266.2±0.7	22944.0±1.0	23779
		(19683.)	(20319.)	(20945.)		(22253.)		
<i>L_{III}</i>	15871.0±2.0	16300.3±0.3	16733.1±1.4	17166.3±0.3	17610.0±0.4	18056.8±0.6	18504.1±0.9	18930
	(15871.0)	[16299.6] ^a	(16733.)	[17168.5] ^r	(17606.2)	(18053.1)	(18504.1)	
		(16299.)		(17165.)				
<i>M_I</i>	(5002.)	5182.3±0.3	5366.9±1.6	5548.0±0.4	5723.2±3.6	5932.9±1.4	6120.5±7.5	6288
		[5182.3] ^a						
<i>M_{II}</i>	4656.±18.	4830.4±0.4	5000.9±2.3	5182.2±0.4	5366.2±0.7	5541.2±1.7	5710.2±2.1	5895
		[4830.6] ^a		[5180.9] ^r	[5366.4] ^r			
<i>M_{III}</i>	3909.±18.	4046.1±0.4	4173.8±1.8	4303.4±0.3	4434.7±0.5	4556.6±1.5	4667.0±2.1	4797
		[4046.1] ^a		[4303.6] ^r	[4434.6] ^r			
		(4041.)		(4299.)				
<i>M_{IV}</i>	3370.2±2.1	3490.8±0.3	3611.2±1.4	3727.6±0.3	3850.3±0.4	3972.6±0.6	4092.1±1.0	4227
		[3490.7] ^a		[3728.1] ^r	[3849.8] ^r	[3972.7] ^r		
		(3485.)		(3720.)				

TABLE I (Continued)

	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm
M_V	3219.0±2.1	3332.0±0.3 [3332.1] ^a (3325.)	3441.8±1.4 (3436.)	3551.7±0.3 [3551.7] ^f (3545.)	3665.8±0.4 [3664.2] ^g	3778.1±0.6 [3778.0] ^h	3886.9±1.0	3971
N_I	(1269.)	1329.5±0.4 [1329.8] ^a	1387.1±1.9	1440.8±0.4 [1441.3] ^f	1500.7±0.8 [1500.7] ^g	1558.6±0.8	1617.1±1.1	1643
N_{II}	1080. ±19.	1168.2±0.4 [1168.3] ^a	1224.3±1.6	1272.6±0.3 [1272.5] ^f	1327.7±0.8 [1327.7] ^g	1372.1±1.8	1411.8±8.3	1440
N_{III}	890. ±19.	967.3±0.4 [967.6] ^a	1006.7±1.7	1044.9±0.3 [1044.9] ^f	1086.8±0.7 [1086.8] ^g	1114.8±1.6	(1135.7)	1154
N_{IV}	674.9±3.7	714.1±0.4 [714.4] ^a	743.4±2.1	780.4±0.3 [779.7] ^f	815.9±0.5 [817.1] ^g	848.9±0.6 [848.9] ^h	878.7±1.0	
N_V		676.4±0.4 [676.4] ^a	708.2±1.8	737.7±0.3 [737.6] ^f	770.3±0.4 [773.2] ^g	801.4±0.6 [801.4] ^h	827.6±1.0	
N_{VI}		344.4±0.3 [344.2] ^a	371.2±1.6	391.3±0.6	415.0±0.8 [415.0] ^g	445.8±1.7		
N_{VII}		335.2±0.4 [335.0] ^a	359.5±1.6	380.9±0.9	404.4±0.5 [404.4] ^g	432.4±2.1		
O_I		290.2±0.8	309.6±4.3	323.7±1.1		351.9±2.4		385
O_{II}		229.4±1.1		259.3±0.5	283.4±0.8 [283.4] ^g	274.1±4.7		
O_{III}		181.8±0.4 [181.8] ^a	222.9±3.9	195.1±1.3	206.1±0.7 [206.1] ^g	206.5±4.7		
O_{IV}		94.3±0.4 [94.4] ^a		105.0±0.5	109.3±0.7 [108.8] ^g	116.0±1.2	115.8±1.3	
O_V		87.9±0.3 [88.1] ^a	94.1±2.8	96.3±1.4	101.3±0.5 [101.4] ^g	105.4±1.0	103.3±1.1	
P_I		59.5±1.1		70.7±1.2				
P_{II}		49.0±2.5		42.3±9.0				
P_{III}		43.0±2.5		32.3±9.0				

TABLE I (Continued)

	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lw
K	[131590±40] ^a	135960	139490	143090	146780	150540	154380
L _I	[25275±17] ^a	26110	26900	27700	28530	29380	30240
L _{II}	[24385±17] ^a	25250	26020	26810	27610	28440	29280
L _{III}	[19452±20] ^a	19930	20410	20900	21390	21880	22360
M _I	[6556±21] ^a	6754	6977	7205	7441	7675	7900
M _{II}	[6147±31] ^a	6339	6574	6793	7019	7245	7460
M _{III}	[4977±31] ^a	5109	5252	5397	5546	5688	5710
M _{IV}	4366	4497	4630	4766	4903	5037	5150
M _V	4132	4253	4374	4498	4622	4741	4860
N _I	[1755±22] ^a	1799	1868	1937	2010	2078	2140
N _{II}	1554	1616	1680	1747	1814	1876	1930
N _{III}	1235	1279	1321	1366	1410	1448	1480
O _I	[398±22] ^a	419	435	454	472	484	490

^a J. E. Mack, 1949, as given in C. E. Moore, *Atomic Energy Levels* (U. S. National Bureau of Standards, Washington, D. C., 1949), Vol. 1, p. 1.

^b G. Herzberg, 1937, as given in C. E. Moore, *Atomic Energy Levels* (U. S. National Bureau of Standards, Washington, D. C., 1938), Vol. 3, p. 239.

^c See Ref. 18.

^d A. Fahlman, D. Hamrin, R. Nordberg, C. Nordling, and K. Siegbahn, *Phys. Rev. Letters* **14**, 127 (1965).

See also Ref. 26.

^e See Ref. 15.

^f See Ref. 11.

^g C. Nordling, *Arkiv Fysik* **15**, 397 (1959).

^h E. Sokolowski, C. Nordling, and K. Siegbahn, *Arkiv Fysik* **12**, 301 (1957).

ⁱ C. Nordling and S. Hagström, *Arkiv Fysik* **16**, 515 (1960).

^j I. Anderson and S. Hagström, *Arkiv Fysik* **27**, 161 (1964).

^k M. O. Krause, *Phys. Rev.* **140**, A1845 (1965).

^l A. Fahlman, O. Hörnfeldt, and C. Nordling, *Arkiv Fysik* **23**, 75 (1962).

^m P. Bergvall, O. Hörnfeldt, and C. Nordling, *Arkiv Fysik* **17**, 113 (1960).

ⁿ P. Bergvall and S. Hagström, *Arkiv Fysik* **17**, 61 (1960).

^o S. Hagström, *Z. Physik* **178**, 82 (1964).

^p A. Fahlman and S. Hagström, *Arkiv Fysik* **27**, 69 (1964).

^q C. Nordling and S. Hagström, *Z. Physik* **178**, 418 (1964).

^r C. Nordling and S. Hagström, *Arkiv Fysik* **15**, 431 (1959).

^s S. Hagström, *Bull. Am. Phys. Soc.* **11**, 389 (1966).

^t A. Fahlman, K. Hamrin, R. Nordberg, C. Nordling, K. Siegbahn, and L. W. Holm, *Phys. Letters* **19**,

643 (1966).

^u J. M. Hollander, M. D. Holtz, T. Novakov, and R. L. Graham, *Arkiv Fysik* **28**, 375 (1965).

the procedure followed here is given by Bearden and Thomsen.²³

Two methods are used to check the consistency of the input data with the output data. The first is the use of the χ^2 test, where

$$\chi^2 = \sum (d_i/\sigma_i)^2, \quad (1)$$

with d_i representing the difference between the i th experimental input value and that computed from the adjusted energy levels, and σ_i representing the corresponding standard deviation. It is well known²³ that, in any least-squares adjustment of data with Gaussian error distribution, χ^2 can be expected to equal the number of degrees of freedom; that is, the difference between the number of equations and the number of unknowns which the system possesses. When all the data for all elements are considered as a group, the resultant system possesses about 1300 degrees of freedom and a χ^2 of approximately 3300.

The procedure discussed above is strictly applicable only when the errors are known to be Gaussian.²⁴ A second check is made by calculating the ratio, r , of the residuals, d_i , to the value to be expected from consideration of the input errors. This ratio can be estimated by following and extending the arguments presented by Cohen and DuMond.²⁵ Let y stand for a particular energy level difference and p stand for the corresponding probable error. Let a subscript 1 indicate the experimental input value, either an emission line or a photoelectric measurement, subscript 2 indicate the least-squares output value, and subscript 3 indicate the output value of a least-squares adjustment made *without* including the experimental datum y_1 . The probable error of the difference $y_1 - y_2$ is desired; however, this error cannot be found directly, since the fact that y_1 was included in the set of data which produced y_2 means that their errors are correlated. However, y_2 can also be obtained by an appropriate average of y_1 and y_3 . Since y_3 is obtained from a set of data which excludes y_1 , they are independent, and y_2 and p_2 can be computed by simply taking a weighted average of y_1 and y_3 , with weights inversely proportional to the squares of the probable errors. Hence the sum of the weights is

$$1/p_2^2 = 1/p_1^2 + 1/p_3^2 \quad (2)$$

and

$$y_2 = p_2^2 [(y_1/p_1^2) + (y_3/p_3^2)]. \quad (3)$$

From (2) one obtains

$$p_2^2 = p_1^2 p_3^2 / (p_1^2 + p_3^2) \quad (4)$$

and

$$p_3^2 = p_1^2 p_2^2 / (p_1^2 - p_2^2). \quad (5)$$

Since y_1 and y_3 are independent, the probable error squared of the difference $y_1 - y_3$ can be written down immediately as $p_1^2 + p_3^2$, but the probable error squared of the difference $y_1 - y_2$ must be computed by first expressing $y_1 - y_2$ in terms of y_1 and y_3 . By using (3) and (4) to express y_2 we obtain

$$y_1 - y_2 = [p_1^2 / (p_1^2 + p_3^2)] (y_1 - y_3). \quad (6)$$

hence p_{12}^2 , the probable error squared of $y_1 - y_2$, is

$$p_{12}^2 = [p_1^2 / (p_1^2 + p_3^2)]^2 (p_1^2 + p_3^2). \quad (7)$$

Substituting (5) into (7) to eliminate p_3^2 gives the desired probable error in the form

$$p_{12} = (p_1^2 - p_2^2)^{1/2}. \quad (8)$$

Thus the desired ratio r between the actual difference and its statistically expected value is given by

$$r = (y_1 - y_2) / (p_1^2 - p_2^2)^{1/2}. \quad (9)$$

A study of r as calculated for each input datum reveals the extent to which each datum fitted in with the data as a whole. If the input errors are chosen properly, then according to the definition of probable error, fifty percent of the ratios should be less than one. For all the elements as a group, the actual percentage of error ratios less than one is just 50; the extremely close agreement is doubtless partly fortuitous.

The conclusion from this percentage is that the errors assigned to the input data, including the data from the previous article, are substantially correct. On the other hand, from the fact that χ^2 exceeded the degrees of freedom, it would appear that there are a greater number of large deviations than would be expected from a Gaussian error distribution. The likelihood of this had been emphasized by the authors.

Not only are half the error ratios less than one for the whole mass of the data, but the figure for each element individually is usually close to 50%; hence output errors as calculated directly by the computer (on the basis of internal consistency) are used. In a few cases (32 Ge, 33 As, 34 Se, and 80 Hg) the percentages are unusually low; in order to avoid understating any errors, all errors for these elements are reported on the basis of external consistency.

The comparison of the residuals (differences between the input values and the corresponding values as calculated on the basis of the adjusted energy levels) with the statistically expected differences proved very useful in other ways. When this error ratio is very large, a renewed investigation of that input often revealed a misprint, misidentification, or other mistake. However, in some cases this ratio is uncomfortably large, and no specific reason can be found for rejecting that input item. Those items which have an error ratio greater than 5.0 are rejected.¹²

There appears to be no significant pattern in these rejected input data. Almost as many have negative

²³ J. A. Bearden and J. S. Thomsen, *Nuovo Cimento* **5**, 267 (1957).

²⁴ J. S. Thomsen, *Bull. Am. Phys. Soc.* **10**, 547 (1965).

²⁵ E. R. Cohen and J. W. M. DuMond, *Proc. of International Conference on Nuclidic Masses 1963*, W. H. Johnson, Jr., Ed. (Springer-Verlag, Wien, 1964).

error ratios as positive ones; no level or pair of levels predominates in the list. The rejected data are distributed among the *K*, *L*, and *M*, and photoelectron categories roughly in proportion to the amount of input data in each category. As one progresses up the periodic table, it seems that the initial measurement of various lines is often accompanied by high errors. This is not surprising, since these lines are weak and sometimes diffuse, making their identification and detection unusually difficult and subject to errors which are easy to underestimate.

It is interesting to note that no $K\alpha_1$, $K\alpha_2$, nor any of the best measured *L* lines appear in the rejected group, despite the fact that they had been assigned the lowest errors. Furthermore, in no case did the error ratio for these lines become suspiciously large. A few difficulties, particularly with the value of the L_I level in the light elements, did appear, and are discussed further in the detailed energy level report.¹²

ENERGY LEVEL TABLE

The adjusted values for the various energy levels, together with the respective probable errors, are listed in Table I. These errors are primarily due to three causes: (1) those due to the photoelectron measurements, which may be subdivided into two parts: (a) random variations introduced by counting statistics which affects *even* the spacing between levels of a single element, and (b) systematic errors in the main calibration line (usually common to a group of elements) and the spectrometer slit work function, which affect the absolute accuracy relative to the Fermi level energy and amount to approximately 0.3 eV for all elements; (2) the probable errors in the x-ray emission wavelengths relative to the $W K\alpha_1$ standard and that of the primary standard to the absolute angstrom scale (5 parts per million); (3) the probable error in the wavelength to energy ($\lambda = 12398.10 \pm 0.13 \text{ eV} \cdot \text{\AA}^*$) conversion factor.

Recently²⁶ photoelectron measurements of the L_I energy in the elements sodium ($Z=11$) to copper ($Z=29$) have been reported. The values from sodium ($Z=11$) to vanadium ($Z=23$) have been used to replace the interpolated values shown in our previous report.¹² The remaining new values have been used with the older *K*-level values to redetermine new level energies for the elements vanadium ($Z=23$) to copper ($Z=29$). The *K*-level energies of the elements from sodium to chromium were also redetermined. Agreement with previous values¹⁸ to within 0.5 eV was obtained for all elements except titanium. The new value for titanium is 1.2 eV higher than that of the earlier work, and while no explanation of the discrepancy is available, this new value has been substituted for the older value. This indicates a need for

further redeterminations of all the older values as a check on the estimated accuracies and on unsuspected experimental variations.

For some elements the *K* level alone has been used to determine the absolute values. In these cases when new photoelectron measurements are available, all the remaining levels can be adjusted by the difference in the new and old values for each element. However, three or more level energies have been measured for the heavier elements (sixteen for thorium) and when new measurements are available for these, a new least-squares readjustment will be necessary to obtain corrected energy level values for an element.

Some energy levels were obtained by interpolation or calculation. The interpolation was performed by passing a fourth order polynomial through the nearest fifteen energy values. The level for atomic numbers 96 and 98 through 103 were obtained from a relativistic self-consistent Slater-Dirac energy level calculation.²⁷ The results of an extrapolation vary greatly with the order of the polynomial used, and therefore should be considered rough values only.

The best of the x-ray absorption edge measurements, listed in parentheses (), are generally in good agreement with the photoelectron values. From these it would appear that the x-ray measurements have been made relative to the Fermi energy level with higher accuracy than previously estimated. New x-ray measurements with modern techniques should certainly be competitive with the photoelectron measurements.

ERROR CORRELATION AND ENERGY DIFFERENCES

The errors shown in Table I are not statistically independent and hence can not be combined without some knowledge of the correlation coefficients. For example, consider the $L_{II}-L_{III}$ energy difference of chromium. As in the case of other lighter elements, the *K* level energy was determined by the photoelectron method. The error involved in this measurement, item (1) in the first paragraph of the preceding section, is considerably greater than that in the emission line wavelengths, item (2); consequently all stated errors are strongly correlated through this common source. Thus, since in Table I the value of the L_{II} level is $(583.7 \pm 0.3) \text{ eV}$, and that for the L_{III} level is $(574.5 \pm 0.3) \text{ eV}$, one might erroneously conclude that the difference is $(9.2 \pm 0.4) \text{ eV}$, which would be true only if the major errors were uncorrelated. However, the wavelengths of chromium $K\alpha_1$ and $K\alpha_2$ emission lines which connect the L_{III} and L_{II} levels to the *K* level are known with probable errors of ten and one parts per million respectively; hence most of the errors in both the L_{II} and L_{III} levels come from the errors in the absolute value of the *K* level.

²⁶ R. Nordberg, K. Hamrin, A. Fahlman, C. Nordling, and K. Siegbahn, *Z. Physik* 192, 462 (1966).

²⁷ J. T. Waber (private communication, 1964); D. Liberman, J. T. Waber, and D. T. Cromer, *Phys. Rev.* 137, A27 (1965).

TABLE II. Examples of energy level differences and corresponding probable errors for the case of 24 chromium. Entries above the principal diagonal represent differences while those below give corresponding probable errors.

Energy level differences in electron volts							
24 Cr	K	L1	L2	L3	M1	M23	M45
K		5292.77	5405.51	5414.72	5915.09	5946.71	5986.93
L1	0.70		112.74	121.95	622.31	653.93	694.16
L2	0.05	0.69		9.21	509.58	541.20	581.42
L3	0.07	0.70	0.05		500.36	531.98	572.21
M1	0.21	0.72	0.20	0.19		31.62	71.85
M23	0.08	0.69	0.06	0.07	0.21		40.23
M45	0.18	0.71	0.17	0.17	0.26	0.18	
24 Cr	Energy level difference errors in electron volts						
Energy level differences in Rydberg units							
24 Cr	K	L1	L2	L3	M1	M23	M45
K		389.022	397.308	397.985	434.762	437.086	440.043
L1	131		8.286	8.963	45.740	48.064	51.021
L2	5.1	6152		0.677	37.454	39.778	42.735
L3	10	5700	5179		36.777	39.101	42.058
M1	33	1158	387	385		2.324	5.281
M23	10	1057	106	139	6497		2.957
M45	28	1028	289	304	3603	4403	
24 Cr	Energy level difference errors in ppm Rydberg units						
Energy level differences in wavelength (mÅ*)							
24 Cr	K	L1	L2	L3	M1	M23	M45
K		2342.459	2293.606	2289.703	2096.01	2084.86	2070.86
L1	131		109975	101666	19922	18959	17860
L2	1.3	6152		1345646	24330	22908	21323
L3	8.7	5700	5179		24778	23305	21667
M1	33	1158	387	385		392094	172564
M23	9.6	1057	106	139	6497		308210
M45	28	1028	289	304	3603	4403	
24 Cr	Energy level difference errors in ppm Å*						

Indeed the correlation coefficient between these two levels is almost unity. When this is taken into account, the value of the above difference becomes (9.21 ± 0.05) eV.

Thus energy level differences and corresponding errors can not in general be accurately obtained from the data in Table I alone. For this reason the original report included three tables of energy level differences, in units of electron-volts, Rydbergs, and equivalent wavelength in milli Å* (abbreviated mÅ*). Table II shows examples of each, presented in matrix form, for the specific case of chromium ($Z=24$).

For example, the $L_{II}L_{III}$ difference which was discussed above is found in the first matrix at the intersection of the L2 row and the L3 column, above the principal diagonal, and is 9.21 eV. The corresponding element in the lower half of the matrix gives the probable error (calculated with proper consideration of error correlation), viz. 0.05 eV. The last two matrices are similar in form, but errors are given in parts per million rather than absolute units.

It will be noted that the equivalent wavelength values in the mÅ* units carry the smallest probable errors. Since all the x-ray emission line input data used

in this report were given in \AA^* ; values on this scale involve little or no error due to conversion factor uncertainties. These energy level differences represent possible x-ray emission lines; therefore this table should be of value to investigators looking for new lines or seeking possible identification of observed lines. One should note, however, that all possible differences are listed, no matter how the transition may be forbidden by selection rules. The values in this table will differ slightly from the corresponding entries in the preceding article,¹² because the latter values are a weighted mean of the *actual* observations on a given *line*, while the former represent values based on all the available information for the given *element*. Usually any difference is within the experimental error; in the few cases where a definite disagreement arose, the value

based on direct observation was discarded in this work.

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