



National Institute of Standards & Technology

# Certificate of Analysis

## Standard Reference Material<sup>®</sup>

Potassium Dihydrogen Phosphate (186-I-f)

Disodium Hydrogen Phosphate (186-II-f)

### pH Primary Standards

These Standard Reference Materials (SRMs) are intended for use in preparing an admixture in solution for calibrating pH measuring systems. SRMs 186-I-f Potassium Dihydrogen Phosphate ( $\text{KH}_2\text{PO}_4$ ) and 186-II-f Disodium Hydrogen Phosphate ( $\text{Na}_2\text{HPO}_4$ ) were selected to meet high purity and uniformity requirements; however, these SRMs are certified with respect to pH(S) values only. SRMs 186-I-f and 186-II-f are supplied as crystalline materials, each in a 30 g unit.

**Certified Values and Uncertainty:** The certified pH(S) values listed in Table 1 were derived from emf measurements of cells without liquid junction using platinum, hydrogen gas (corrected to 101.325 kPa) electrodes and Ag/AgCl electrodes by the method of calculation described in References [1,2]. The pH(S) values correspond to  $-\log a_{\text{H}}$ , where  $a_{\text{H}}$  is the activity of the hydrogen ion referred to the standard state on the molality scale. **NOTE:** The values for pH(S) apply only to solutions prepared from the current lot (f) of these SRMs. Small differences in pH(S) values, typically less than 0.01, can occur between SRM lots.

A solution with a molality of 0.025 mol/kg with respect to both  $\text{KH}_2\text{PO}_4$  and  $\text{Na}_2\text{HPO}_4$  is recommended for the calibration of pH measuring systems (see Preparation of 0.025 Molal Solution). The certified pH(S) values of this solution as a function of temperature are given in Table 1.

For pH measurements in the physiologically important range pH 7 to pH 8, a solution with a molality of 0.008695 mol/kg with respect to  $\text{KH}_2\text{PO}_4$  and a molality of 0.03043 mol/kg with respect to  $\text{Na}_2\text{HPO}_4$  is also useful (see Preparation of Physiological Buffer Solution). The certified pH(S) values of this solution as a function of temperature are given in Table 1.

The uncertainty of the certified values of pH(S) is estimated not to exceed  $\pm 0.005$  unit for the temperature range 0 °C to 50 °C. The expanded uncertainty at the 95 % confidence level is less than  $\pm 0.005$  for all temperatures listed as determined according to the procedure described in the ISO Guide [3]. However, to allow for extrathermodynamic assumptions, an uncertainty of  $\pm 0.005$  is assigned. The expanded uncertainty includes Type B components due to measurements of temperature, atmospheric pressure, electrode potential, molality of HCl used to standardize electrodes, and the gravimetric preparation of standards. The Type A uncertainty is obtained from the standard deviation of the pH(S) values after smoothing with respect to temperature as described in Reference [2].

**Expiration of Certification:** The certification of this SRM lot is valid until **31 December 2003**, within the measurement uncertainties specified, provided the SRM is handled and stored in accordance with the instructions given in this certificate. However, the certification is invalid if the SRM is damaged, contaminated, or modified.

**Maintenance of SRM Certification:** NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification before expiration of this certificate, NIST will notify the purchaser. Return of the attached registration card will facilitate notification.

The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the NIST Standard Reference Materials Program by J.C. Colbert.

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*See Certificate Revision History on Last Page*  
SRMs 186If & 186IIf

The certification measurements were performed by P.A. Berezansky of the NIST Analytical Chemistry Division, Hou Chuan Jia, Guest Scientist from the People's Republic of China, and Maritza Torres-Lozano, Guest Scientist from CENAM, Mexico. Stability analysis was performed by K.W. Pratt of the NIST Analytical Chemistry Division.

Statistical consultation was provided by K.R. Eberhardt of the NIST Statistical Engineering Division.

#### NOTICE AND WARNINGS TO USERS

**Source of Material:** The  $\text{KH}_2\text{PO}_4$  and the  $\text{Na}_2\text{HPO}_4$  were specially prepared by GFS Chemicals, Powell, OH. These lots meet the specifications of the American Chemical Society for reagent grade materials [4].

**Drying:** Each salt should be dried for two hours at 110 °C before use.

**Storage:** SRMs 186-I-f and 186-II-f should be stored, as received, in their original containers with the caps tightly closed in a dry environment and under normal laboratory temperatures.

#### INSTRUCTIONS FOR USE

**Preparation of 0.025 Molal Solution:** Add 3.404 g of SRM 186-I-f,  $\text{KH}_2\text{PO}_4$  and 3.551 g of SRM 186-II-f,  $\text{Na}_2\text{HPO}_4$  to 1000.0 g of distilled water and mix thoroughly. The distilled water should not contain dissolved carbon dioxide and should have an electrolytic conductivity no greater than 2  $\mu\text{S}/\text{cm}$ . Carbon dioxide-free water can be prepared by boiling distilled water for 10 minutes and guarding it with a soda-lime tube while cooling. If volumetric apparatus is to be used, transfer 3.387 g of SRM 186-I-f,  $\text{KH}_2\text{PO}_4$  and 3.533 g of SRM 186-II-f,  $\text{Na}_2\text{HPO}_4$  to a calibrated, Class A 1 L volumetric flask. Dissolve and fill to the mark with distilled water at 25 °C and mix thoroughly. The mass values given have been pre-corrected for buoyancy in air.

Elaborate precautions to prevent contamination of the buffer solution with atmospheric carbon dioxide are not necessary; however, the container should be kept tightly stoppered at all times when a sample is not being removed. The solution should be replaced after two weeks or sooner, if molds or sediment appear, or if it has been exposed repeatedly to air containing carbon dioxide.

**Preparation of the Physiological Buffer Solution:** Add 1.184 g of SRM 186-I-f,  $\text{KH}_2\text{PO}_4$  and 4.322 g of SRM 186-II-f,  $\text{Na}_2\text{HPO}_4$  to 1000.0 g of distilled water in a manner similar to that used for the 0.025 molal solution. If volumetric apparatus is to be used, transfer 1.179 g of SRM 186-I-f and 4.303 g of SRM 186-II-f to a calibrated Class A 1 L volumetric flask, dissolving, and filling to the mark with water. The mass values given have been pre-corrected for buoyancy in air.

This buffer solution is more sensitive to contamination with carbon dioxide than is the 0.025 molal solution. If the solution is to maintain the assigned pH(S) for two weeks, precautions should be taken to exclude carbon dioxide.

Table 1. Certified pH(S) Values and Uncertainties

Temperature °C	0.025 Molal Solution pH(S)	Physiological Buffer Solution pH(S)
0	6.978 ± 0.005	7.534 ± 0.005
5	6.946 ± 0.005	7.500 ± 0.005
10	6.918 ± 0.005	7.472 ± 0.005
15	6.895 ± 0.005	7.448 ± 0.005
20	6.876 ± 0.005	7.429 ± 0.005
25	6.860 ± 0.005	7.414 ± 0.005
30	6.849 ± 0.005	7.403 ± 0.005
35	6.842 ± 0.005	7.395 ± 0.005
37	6.840 ± 0.005	7.392 ± 0.005
40	6.838 ± 0.005	7.390 ± 0.005
45	6.838 ± 0.005	7.388 ± 0.005
50	6.842 ± 0.005	7.388 ± 0.005

## REFERENCES

- [1] Wu, Y.C., Koch, W.F., and Marinenko, G., "A Report of the National Bureau of Standards pH Standards," *J. Res. Natl Bur. Stand.*, **Vol. 89**, p. 395, (1984).
- [2] Wu, Y.C., Koch, W.F., and Durst, R.A., "Standard Reference Materials: Standardization of pH Measurements," NBS SP 260-53, (February 1988).
- [3] *Guide to the Expression of Uncertainty in Measurement*, ISBN 92-67-10188-9, 1st Ed., ISO, Geneva, Switzerland, (1993); see also Taylor, B.N. and Kuyatt, C.E., "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results," NIST Technical Note 1297, U.S. Government Printing Office, Washington, DC, (1994).
- [4] Reagent Chemicals, 8th Ed., American Chemical Society, Washington, DC, (1993).

**Certificate Revision History:** 15 November 2001 (This technical revision reports an extension in the expiration date); 5 December 1996 (Original certificate date).

*Users of this SRM should ensure that the certificate in their possession is current. This can be accomplished by contacting the SRM Program at: telephone (301) 975-6776; fax (301) 926-4751; e-mail [srminfo@nist.gov](mailto:srminfo@nist.gov); or via the Internet <http://www.nist.gov/srm>.*