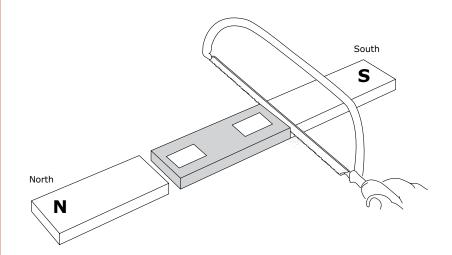
| Content Domain | Main Topic | Cognitive Domain |
|----------------|---------------------------|--------------------------|
| PHYSICS | Electricity and Magnetism | Conceptual Understanding |

Poles on cut magnet

The diagram shows a bar magnet which is cut into three pieces with a hacksaw.



Write an "N" or an "S" in each box on the diagram to show the polarity of each end of the center piece.

Item Number: S022035

SCORING

Note: To receive credit, the polarity of BOTH ends of the center piece must be indicated. Answer is correct if polarity is indicated correctly (N-S), but letters are shown above, below, or outside the boxes, as long as the polarity of both ends of the center piece is clear.

Correct Response

• N-S

Incorrect Response

- S-N
- Pole of cut ends of outer pieces are indicated (S N) instead of poles on center piece.
- · Other incorrect (including crossed out/erased, stray marks, illegible, or off task).

Overall Percent Correct

| Japan 64 A Singapore 62 A Macedonia, Republic of 62 A Korea, Republic of 59 A Bahrain 58 A Sweden 58 A Lithuania 56 A Belgium (Flemish) 55 A Cyprus 53 |
|--|
| Macedonia, Republic of 62 Korea, Republic of 59 Bahrain 58 Sweden 58 Lithuania 56 Belgium (Flemish) 55 |
| Korea, Republic of 59 Bahrain 58 Sweden 58 Lithuania 56 Belgium (Flemish) 55 |
| Bahrain 58 A Sweden 58 A Lithuania 56 A Belgium (Flemish) 55 A |
| Sweden 58 A Lithuania 56 A Belgium (Flemish) 55 A |
| Lithuania 56 ▲ Belgium (Flemish) 55 ▲ |
| Belgium (Flemish) 55 |
| Belgium (Flemish) 55 |
| |
| Cypius 35 |
| Russian Federation 52 |
| New Zealand 51 🔺 |
| Australia 51 🔺 |
| United States 51 |
| Estonia 51 🔺 |
| Serbia and Montenegro 51 🔺 |
| Israel 51 |
| Netherlands 49 O |
| Bulgaria 48 O |
| Italy 48 O |
| Morocco 47 O |
| Scotland 47 O |
| Moldova, Rep. of 46 O |
| Romania 46 O |
| England 46 O |
| Latvia 45 O |
| Slovenia 45 O |
| International average 44 |
| Chinese Taipei 44 O |
| Slovak Republic 43 0 |
| Hungary 43 O |
| Malaysia 43 O |
| Norway 41 O |
| Hong Kong, SAR 40 ▼ |
| Tiong Rong, SAN 40 V |
| Potowana 20 V |
| Botswana 39 V |
| Botswana 39 ▼ Jordan 38 ▼ Saudi Arabia |
| Botswana 39 V Jordan 38 V Saudi Arabia 37 V |
| Botswana 39 V Jordan 38 V Saudi Arabia 37 V Lebanon 36 V |
| Jordan 38 ▼ Saudi Arabia 37 ▼ Lebanon 36 ▼ Chile 35 ▼ |
| Jordan 38 ▼ Saudi Arabia 37 ▼ Lebanon 36 ▼ Chile 35 ▼ Philippines 34 ▼ |
| Jordan 38 ▼ Saudi Arabia 37 ▼ Lebanon 36 ▼ Chile 35 ▼ Philippines 34 ▼ Tunisia 33 ▼ |
| Jordan 38 ▼ Saudi Arabia 37 ▼ Lebanon 36 ▼ Chile 35 ▼ Philippines 34 ▼ Tunisia 33 ▼ Indonesia 32 ▼ |
| Jordan 38 ▼ Saudi Arabia 37 ▼ Lebanon 36 ▼ Chile 35 ▼ Philippines 34 ▼ Tunisia 33 ▼ Indonesia 32 ▼ Iran, Islamic Republic of 32 ▼ |
| Jordan 38 V Saudi Arabia 37 V Lebanon 36 V Chile 35 V Philippines 34 V Tunisia 33 V Indonesia 32 V Iran, Islamic Republic of 32 V Egypt 30 V |
| Jordan 38 V Saudi Arabia 37 V Lebanon 36 V Chile 35 V Philippines 34 V Tunisia 33 V Indonesia 32 V Iran, Islamic Republic of 32 V Egypt 30 V Palestinian Nat'l Auth. 27 |
| Jordan 38 V Saudi Arabia 37 V Lebanon 36 V Chile 35 V Philippines 34 V Tunisia 33 V Indonesia 32 V Iran, Islamic Republic of 32 V Egypt 30 V Palestinian Nat'l Auth. 27 V Armenia 25 V |
| Jordan 38 V Saudi Arabia 37 V Lebanon 36 V Chile 35 V Philippines 34 V Tunisia 33 V Indonesia 32 V Iran, Islamic Republic of 32 V Egypt 30 V Palestinian Nat'l Auth. 27 V Armenia 25 V Ghana 19 V |
| Jordan 38 V Saudi Arabia 37 V Lebanon 36 V Chile 35 V Philippines 34 V Tunisia 33 V Indonesia 32 V Iran, Islamic Republic of 32 V Egypt 30 V Palestinian Nat'l Auth. 27 V Armenia 25 V |

Country average vs. International average:

| Higher | |
|---------------|----------------|
| Not different | 0 |
| Lower | \blacksquare |

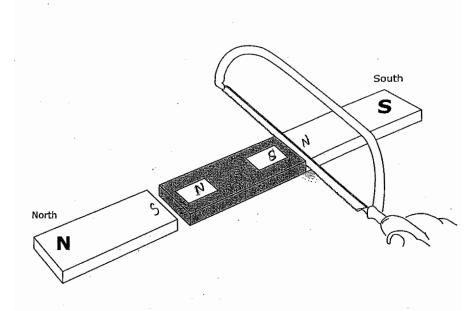
Poles on cut magnet (continued)

Item Number: S022035

Student Responses

Correct Response:

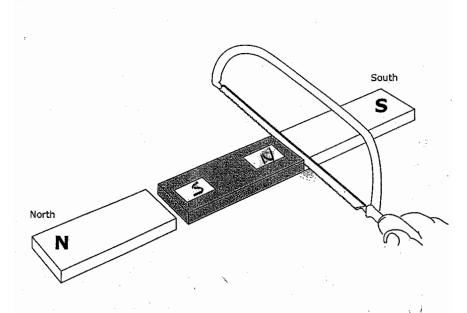
The diagram shows a bar magnet which is cut into three pieces with a hacksaw.



Write an "N" or an "S" in each box on the diagram to show the polarity of each end of the center piece.

Incorrect Response:

The diagram shows a bar magnet which is cut into three pieces with a hacksaw.

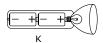


Write an "N" or an "S" in each box on the diagram to show the polarity of each end of the center piece.

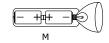
| Content Domain | Main Topic | Cognitive Domain |
|----------------|---------------------------|-------------------|
| PHYSICS | Electricity and Magnetism | Factual Knowledge |

Diagram of batteries in a flashlight

The diagrams show a flashlight and three ways to put batteries in it.







In order to make the flashlight work, which way must the batteries be placed?

- (A) Only as in K
- (B) Only as in L
- (C) Only as in M
- (D) None of these ways would work.

Item Number: S012037

Correct Response:

Δ

Overall Percent Correct

| England 95 A Korea, Republic of 93 A | |
|---|--|
| Korea, Republic of 93 | |
| | |
| Japan 93 ▲ | |
| Hong Kong, SAR 93 ▲ | |
| Russian Federation 93 🔺 | |
| Slovak Republic 93 🔺 | |
| Estonia 93 🔺 | |
| Chinese Taipei 92 🔺 | |
| Malaysia 91 ▲ | |
| Romania 91 🔺 | |
| Latvia 91 ▲ | |
| Hungary 91 ▲ | |
| Bulgaria 91 ▲ | |
| Bahrain 90 🔺 | |
| Lithuania 90 🔺 | |
| Moldova, Rep. of 90 🔺 | |
| Sweden 89 ▲ | |
| United States 89 | |
| Armenia 88 🔺 | |
| New Zealand 88 O | |
| Slovenia 87 🔺 | |
| Lebanon 86 O | |
| Netherlands 86 O | |
| Australia 85 O | |
| Belgium (Flemish) 85 O | |
| Cyprus 85 O | |
| International average 85 | |
| Scotland 84 O | |
| Indonesia 84 O | |
| Serbia and Montenegro 84 O | |
| Macedonia, Republic of 84 0 | |
| Italy 83 O | |
| Iran, Islamic Republic of 83 O | |
| Chile 82 0 | |
| Israel 82 O Norway 81 ▼ | |
| | |
| Botswana 81 ▼ Morocco 81 0 | |
| | |
| Jordan 78 ▼ Saudi Arabia 78 ▼ | |
| Palestinian Nat'l Auth. 78 | |
| Philippines 77 | |
| Egypt 67 | |
| Egypt 67 ▼ Tunisia 59 ▼ | |
| Ghana 55 V | |
| South Africa 52 V | |
| Journal J2 | |

Country average vs. International average:

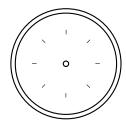
Higher △ Not different ○ Lower ▼

| Content Domain | Main Topic | Cognitive Domain |
|----------------|---------------------------|------------------------|
| PHYSICS | Electricity and Magnetism | Reasoning and Analysis |

Compass placed next to a magnet/draw



The diagram above shows a compass needle with its North and South poles labeled (N and S). It is placed next to a strong magnet as shown in the diagram below.





- A. Draw the compass needle in the circle on the diagram above. Label the North (N) and South (S) poles of the needle.
- B. Explain your answer using your knowledge of magnets.

Item Number: S032625A

SCORING

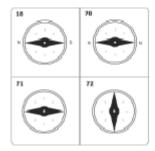
Correct Response

• Draws a "horizontal" needle with N to the left and S to the right. [See diagram below.]

Note: Credit should be given even if one label is missing (N to the left OR S to the right shown).

Incorrect Response

- Draws a "horizontal" needle with poles reversed (N to the right and/or S to the left).
 [See diagram below.]
- Draws a "horizontal" needle with no poles indicated. [See diagram below.]
- Draws a "vertical" needle with or without poles indicated. [See diagram below.]
- · Other incorrect (including crossed out/erased, stray marks, illegible, or off task).



Overall Percent Correct

| Japan | 88 | _ |
|---|--|---------------------------------------|
| Korea, Republic of | 87 | <u> </u> |
| Chinese Taipei | 86 | |
| Singapore | 76 | |
| Slovak Republic | 74 | |
| Hungary | 67 | |
| England | 65 | |
| Hong Kong, SAR | 61 | |
| Malaysia | 58 | |
| Bulgaria | 57 | |
| Bahrain | 56 | |
| Armenia | 54 | |
| Sweden | 52 | |
| Australia | 50 | |
| Russian Federation | 48 | |
| Romania | 45 | |
| Serbia and Montenegro | 45 | A |
| United States | 45 | • |
| Netherlands | 44 | 0 |
| Iran, Islamic Republic of | 43 | 0 |
| Scotland | 41 | 0 |
| International average | 40 | |
| Jordan | 38 | 0 |
| Moldova, Rep. of | 37 | 0 |
| | | |
| Italy | 33 | \blacksquare |
| ' ' | 33 33 | V |
| Italy | | ▼ ▼ |
| Italy Macedonia, Republic of | 33 | \blacksquare |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. | 33 33 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand | 33 33 31 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon | 33 33 31 31 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway | 33 33 31 31 30 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia | 33 33 31 31 30 29 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco | 33 33 31 31 30 29 28 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco Israel | 33 33 31 31 30 29 28 27 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco Israel Indonesia | 33 33 31 31 30 29 28 27 26 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco Israel Indonesia Egypt | 33 33 31 31 30 29 28 27 26 26 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco Israel Indonesia Egypt Slovenia | 33 33 31 31 30 29 28 27 26 26 25 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco Israel Indonesia Egypt Slovenia Belgium (Flemish) | 33 33 31 31 30 29 28 27 26 26 25 25 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco Israel Indonesia Egypt Slovenia Belgium (Flemish) Tunisia | 33 33 31 31 30 29 28 27 26 26 25 25 24 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco Israel Indonesia Egypt Slovenia Belgium (Flemish) Tunisia Latvia | 33 33 31 31 30 29 28 27 26 26 25 25 24 23 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco Israel Indonesia Egypt Slovenia Belgium (Flemish) Tunisia Latvia Lithuania | 33 33 31 31 30 29 28 27 26 26 25 25 24 23 21 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco Israel Indonesia Egypt Slovenia Belgium (Flemish) Tunisia Latvia Lithuania Cyprus | 33 33 31 31 30 29 28 27 26 25 25 24 23 21 20 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco Israel Indonesia Egypt Slovenia Belgium (Flemish) Tunisia Latvia Lithuania Cyprus Philippines | 33 33 31 31 30 29 28 27 26 26 25 25 24 23 21 20 17 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco Israel Indonesia Egypt Slovenia Belgium (Flemish) Tunisia Latvia Lithuania Cyprus Philippines Saudi Arabia | 33 33 31 31 30 29 28 27 26 26 25 25 24 23 21 20 17 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco Israel Indonesia Egypt Slovenia Belgium (Flemish) Tunisia Latvia Lithuania Cyprus Philippines Saudi Arabia Chile | 33 33 31 31 30 29 28 27 26 26 25 25 24 23 21 20 17 16 | * * * * * * * * * * * * * * * * * * * |
| Italy Macedonia, Republic of Palestinian Nat'l Auth. Lebanon New Zealand Norway Estonia Morocco Israel Indonesia Egypt Slovenia Belgium (Flemish) Tunisia Latvia Lithuania Cyprus Philippines Saudi Arabia Chile Botswana | 33 33 31 31 30 29 28 27 26 26 25 25 24 23 21 20 17 16 15 | * * * * * * * * * * * * * * * * * * * |

Country average vs. International average:

| Higher | |
|---------------|---|
| Not different | 0 |
| Lower | |

Compass placed next to a magnet/draw (continued)

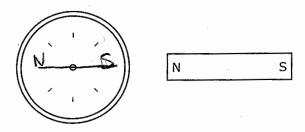
Item Number: S032625A

Student Responses

Correct Response:



The diagram above shows a compass needle with its North and South poles labeled (N and S). It is placed next to a strong magnet as shown in the diagram below.

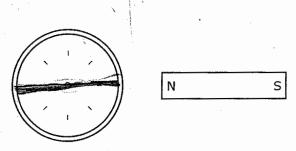


A. Draw the compass needle in the circle on the diagram above. Label the North (N) and South (S) poles of the needle.

Incorrect Response:



The diagram above shows a compass needle with its North and South poles labeled (N and S). It is placed next to a strong magnet as shown in the diagram below.



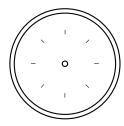
A. Draw the compass needle in the circle on the diagram above. Label the North (N) and South (S) poles of the needle.

| Content Domain | Main Topic | Cognitive Domain |
|----------------|---------------------------|------------------------|
| PHYSICS | Electricity and Magnetism | Reasoning and Analysis |

Compass placed next to a magnet/explain



The diagram above shows a compass needle with its North and South poles labeled (N and S). It is placed next to a strong magnet as shown in the diagram below.





- A. Draw the compass needle in the circle on the diagram above. Label the North (N) and South (S) poles of the needle.
- B. Explain your answer using your knowledge of magnets.

Item Number: S032625B

Scoring for Explanation

Correct Response

• Explains that opposite poles attract (N toward S, etc.) or like poles repel (or similar).

Examples: The south point of the compass is attracted to the north pole of the magnet.

North and south attract together.

The magnets which have different poles attract one another.

The N pole on the magnet will attract the S pole on the compass.

Opposites attract and likes repel.

The magnet pushes the N pole of the compass away.

· Other correct.

Incorrect Response

· Refers to magnetic attraction/repulsion but with an incorrect application.

Examples: Because the same pole will be attracted.

The magnet is closer to the compass and will have a stronger attraction to the N end. The needle of the compass is metal, so it is attracted to the magnet and turns. It attracts the needle to North and South poles.

• Explains that the compass needle always points North, or similar.

Examples: The needle of North always goes to the magnetic North.

North always goes toward North.

· Other incorrect (including crossed out/erased, stray marks, illegible, or off task).

Overall Percent Correct

| Korea, Republic of | 81 | |
|--|--|---|
| Japan | 77 | |
| Chinese Taipei | 70 | |
| Singapore | 67 | |
| Hungary | 59 | |
| England | 59 | |
| Slovak Republic | 56 | |
| Hong Kong, SAR | 47 | |
| Armenia | 45 | |
| Bahrain | 43 | |
| Malaysia | 43 | |
| Bulgaria | 42 | |
| Australia | 41 | |
| Iran, Islamic Republic of | 40 | |
| Sweden | 39 | |
| United States | 37 | |
| Serbia and Montenegro | 37 | |
| Romania | 33 | 0 |
| Netherlands | 31 | 0 |
| Jordan | 30 | 0 |
| Palestinian Nat'l Auth. | 30 | 0 |
| International average | 29 | |
| Russian Federation | 29 | 0 |
| Moldova, Rep. of | 28 | 0 |
| | | |
| Scotland | 28 | |
| Scotland Macedonia Republic of | 28 21 | 0 |
| Macedonia, Republic of | 21 | O ▼ |
| Macedonia, Republic of Italy | 21 20 | ○▼ |
| Macedonia, Republic of Italy Indonesia | 21 20 20 | ○▼▼ |
| Macedonia, Republic of Italy Indonesia Egypt | 21 20 20 17 | ○▼▼▼ |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand | 21 20 20 17 17 | ○▼▼▼ |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel | 21 20 20 17 17 16 | ○▼▼▼ |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon | 21 20 20 17 17 16 16 | ○▼▼▼ |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco | 21 20 20 17 17 16 16 | <!--</td--> |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia | 21 20 20 17 17 16 16 14 | O V |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia Norway | 21 20 20 17 17 16 16 14 13 | O V |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia Norway Botswana | 21 20 20 17 17 16 16 14 13 13 | O V |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia Norway Botswana Belgium (Flemish) | 21 20 20 17 17 16 16 14 13 13 | O V |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia Norway Botswana Belgium (Flemish) Slovenia | 21 20 20 17 17 16 16 14 13 13 11 11 | <!--</td--> |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia Norway Botswana Belgium (Flemish) Slovenia Saudi Arabia | 21 20 20 17 17 16 16 14 13 13 11 11 | O V |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia Norway Botswana Belgium (Flemish) Slovenia Saudi Arabia Tunisia | 21 20 20 17 17 16 16 14 13 13 11 11 10 9 | · · · · · · · · · · · · · · · · · · · |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia Norway Botswana Belgium (Flemish) Slovenia Saudi Arabia Tunisia Philippines | 21 20 20 17 17 16 16 14 13 11 11 10 9 | · · · · · · · · · · · · · · · · · · · |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia Norway Botswana Belgium (Flemish) Slovenia Saudi Arabia Tunisia Philippines Latvia | 21 20 20 17 17 16 16 14 13 11 11 10 9 8 8 | · · · · · · · · · · · · · · · · · · · |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia Norway Botswana Belgium (Flemish) Slovenia Saudi Arabia Tunisia Philippines Latvia Chile | 21 20 20 17 17 16 16 14 13 11 11 10 9 8 8 5 | · · · · · · · · · · · · · · · · · · · |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia Norway Botswana Belgium (Flemish) Slovenia Saudi Arabia Tunisia Philippines Latvia Chile Lithuania | 21 20 20 17 17 16 16 14 13 11 11 10 9 8 8 5 5 | · · · · · · · · · · · · · · · · · · · |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia Norway Botswana Belgium (Flemish) Slovenia Saudi Arabia Tunisia Philippines Latvia Chile Lithuania South Africa | 21 20 20 17 17 16 16 14 13 11 11 10 9 8 8 5 5 | · · · · · · · · · · · · · · · · · · · |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia Norway Botswana Belgium (Flemish) Slovenia Saudi Arabia Tunisia Philippines Latvia Chile Lithuania South Africa Cyprus | 21 20 20 17 17 16 16 14 13 11 11 10 9 8 8 5 4 4 | <!--</td--> |
| Macedonia, Republic of Italy Indonesia Egypt New Zealand Israel Lebanon Morocco Estonia Norway Botswana Belgium (Flemish) Slovenia Saudi Arabia Tunisia Philippines Latvia Chile Lithuania South Africa | 21 20 20 17 17 16 16 14 13 11 11 10 9 8 8 5 5 | · · · · · · · · · · · · · · · · · · · |

Country average vs. International average:

Higher △
Not different ○
Lower ▼

Compass placed next to a magnet/explain (continued)

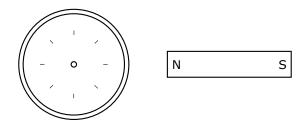
Item Number: S032625B

Student Responses

Correct Response:



The diagram above shows a compass needle with its North and South poles labeled (N and S). It is placed next to a strong magnet as shown in the diagram below.



B. Explain your answer using your knowledge of magnets.

OPPOSITED OFFICE AND THE NORTH IS FACING THE COMPOSED SO THE NEEDLE WITH SOUTH ON IT WILL POINT TO THE MOCKET

Compass placed next to a magnet/explain (continued)

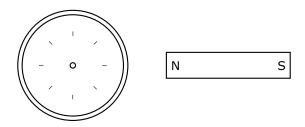
Item Number: S032625B

Student Responses (continued)

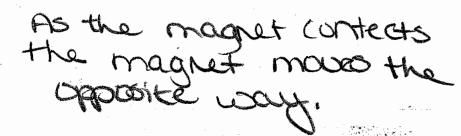
Incorrect Response:



The diagram above shows a compass needle with its North and South poles labeled (N and S). It is placed next to a strong magnet as shown in the diagram below.



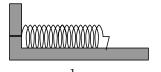
B. Explain your answer using your knowledge of magnets.



| Content Domain | Main Topic | Cognitive Domain |
|----------------|---------------------------------------|--------------------------|
| PHYSICS | Energy Types, Sources and Conversions | Conceptual Understanding |

Stored energy in two springs

Spring 1 and Spring 2 were the same. Then, Spring 1 was pushed together a little and clamped in place. Spring 2 was pushed together a lot and clamped.





 2

Which spring has more stored energy?

- (A) Spring 1
- (B) Spring 2
- © Both springs have the same energy.
- (D) You cannot tell unless you know what the springs are made of.

Item Number: S012002

Correct Response:

В

Overall Percent Correct

| Singapore | 84 | A |
|---|--|---|
| England | 84 | |
| Korea, Republic of | 84 | <u> </u> |
| United States | 83 | <u> </u> |
| New Zealand | 83 | • |
| Japan | 81 | <u> </u> |
| Netherlands | 79 | |
| Australia | 78 | A |
| Scotland | 78 | <u> </u> |
| Estonia | 77 | <u> </u> |
| Hungary | 75 | <u> </u> |
| Italy | 75 75 | <u> </u> |
| Norway | 74 | <u> </u> |
| Lithuania | 74 | <u> </u> |
| Russian Federation | 73 | <u> </u> |
| Belgium (Flemish) | 71 | <u> </u> |
| Sweden | 71 | <u> </u> |
| Israel | 70 | _ _ |
| Hong Kong, SAR | 69 | <u> </u> |
| Slovenia | 68 | <u> </u> |
| Malaysia | 67 | <u> </u> |
| Latvia | 64 | 0 |
| Chinese Taipei | 64 | 0 |
| Lebanon | 63 | 0 |
| | | |
| Jordan | 63 | |
| Jordan | | 0 |
| | 63 | |
| Jordan International average | 63 62 | 0 |
| Jordan International average Bulgaria | 63 62 61 | 0 |
| Jordan International average Bulgaria Armenia | 63 62 61 60 | 0 0 |
| Jordan International average Bulgaria Armenia Chile | 63 62 61 60 59 | 0 0 0 0 |
| Jordan International average Bulgaria Armenia Chile Cyprus | 63 62 61 60 59 58 | 0 0 0 0 |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia | 63 62 61 60 59 58 57 | 0 0 0 0 |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of | 63 62 61 60 59 58 57 56 | 0 0 0 0 |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of Macedonia, Republic of | 63 62 61 60 59 58 57 56 56 | 0 0 0 0 |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of Macedonia, Republic of Serbia and Montenegro | 63 62 61 60 59 58 57 56 56 55 | 0 0 0 0 |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of Macedonia, Republic of Serbia and Montenegro Botswana | 63 62 61 60 59 58 57 56 56 55 52 | 0 0 0 0 V |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of Macedonia, Republic of Serbia and Montenegro Botswana Palestinian Nat'l Auth. | 63 62 61 60 59 58 57 56 56 55 52 50 | 0 0 0 0 V |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of Macedonia, Republic of Serbia and Montenegro Botswana Palestinian Nat'l Auth. Philippines | 63 62 61 60 59 58 57 56 56 55 52 50 48 | 0 0 0 0 |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of Macedonia, Republic of Serbia and Montenegro Botswana Palestinian Nat'l Auth. Philippines Slovak Republic | 63 62 61 60 59 58 57 56 56 55 52 50 48 47 | 0 0 0 0 V |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of Macedonia, Republic of Serbia and Montenegro Botswana Palestinian Nat'l Auth. Philippines Slovak Republic Morocco | 63 62 61 60 59 58 57 56 56 55 52 50 48 47 46 | 0 0 0 0 V |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of Macedonia, Republic of Serbia and Montenegro Botswana Palestinian Nat'l Auth. Philippines Slovak Republic Morocco Romania | 63 62 61 60 59 58 57 56 56 55 52 50 48 47 46 39 | 0 0 0 0 0 0 0 0 0 0 0 |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of Macedonia, Republic of Serbia and Montenegro Botswana Palestinian Nat'l Auth. Philippines Slovak Republic Morocco Romania South Africa | 63 62 61 60 59 58 57 56 56 55 52 50 48 47 46 39 39 | 0 0 0 0 0 0 0 0 0 0 0 |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of Macedonia, Republic of Serbia and Montenegro Botswana Palestinian Nat'l Auth. Philippines Slovak Republic Morocco Romania South Africa Egypt | 63 62 61 60 59 58 57 56 56 55 52 50 48 47 46 39 39 | 0 0 0 0 0 0 0 0 0 0 0 |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of Macedonia, Republic of Serbia and Montenegro Botswana Palestinian Nat'l Auth. Philippines Slovak Republic Morocco Romania South Africa Egypt Moldova, Rep. of | 63 62 61 60 59 58 57 56 56 55 52 50 48 47 46 39 39 39 38 | 0 0 0 0 0 0 0 0 0 0 0 |
| International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of Macedonia, Republic of Serbia and Montenegro Botswana Palestinian Nat'l Auth. Philippines Slovak Republic Morocco Romania South Africa Egypt Moldova, Rep. of Saudi Arabia | 63 62 61 60 59 58 57 56 56 55 52 50 48 47 46 39 39 39 38 37 | 0 0 0 0 V |
| Jordan International average Bulgaria Armenia Chile Cyprus Indonesia Iran, Islamic Republic of Macedonia, Republic of Serbia and Montenegro Botswana Palestinian Nat'l Auth. Philippines Slovak Republic Morocco Romania South Africa Egypt Moldova, Rep. of Saudi Arabia Ghana | 63 62 61 60 59 58 57 56 56 55 52 50 48 47 46 39 39 39 38 37 36 | 0 0 0 0 0 0 0 0 0 0 0 |

Country average vs. International average:

Higher △
Not different ○
Lower ▼

| Content Domain | Main Topic | Cognitive Domain |
|----------------|---------------------------------------|--------------------------|
| PHYSICS | Energy Types, Sources and Conversions | Conceptual Understanding |

Nail pulled out of a wooden board

When a nail is pulled out of a wooden board, the nail becomes warm. Explain why.

Item Number: S032131

SCORING

Correct Response

· Explanation refers to friction (implicitly or explicitly).

Examples: Because it is rubbed against the wood.

Nail resists when you pull it out.

Because of the force on the nail to pull it out.

Because of friction.

There is friction between the nail and the wooden board.

· Explanation refers to energy change.

Examples: There is more energy in the nail after the transition.

Because energy is used to get it out.

Kinetic energy changes to heat energy when you pull it out.

· Other correct.

Incorrect Response

• Explanation refers only to the nail or the action taken with inadequate connection to friction or energy.

Examples: It is hard to get it out.

You must pull hard.

Because it was in the wood for too long.

· Other incorrect (including crossed out/erased, stray marks, illegible, or off task).

Overall Percent Correct

| Chinese Taipei | 84 | |
|---|--|---|
| Hungary | 84 | A |
| Slovak Republic | 78 | A |
| England | 75 | |
| Hong Kong, SAR | 74 | |
| Japan | 74 | |
| United States | 73 | A |
| Russian Federation | 72 | A |
| Lithuania | 72 | A |
| Netherlands | 71 | A |
| Australia | 71 | A |
| Korea, Republic of | 70 | A |
| Latvia | 68 | A |
| Singapore | 67 | A |
| Estonia | 66 | A |
| Scotland | 66 | |
| Armenia | 66 | A |
| Belgium (Flemish) | 64 | A |
| Romania | 64 | A |
| Malaysia | 63 | A |
| Moldova, Rep. of | 62 | A |
| Bulgaria | 61 | A |
| New Zealand | 57 | 0 |
| Slovenia | 54 | 0 |
| the annual conditions and | F2 | |
| International average | 52 | |
| Iran, Islamic Republic of | 52 | 0 |
| | | 0 |
| Iran, Islamic Republic of | 52 | |
| Iran, Islamic Republic of Sweden | 52 51 | 0 0 |
| Iran, Islamic Republic of Sweden Israel | 52 51 48 | 0 0 |
| Iran, Islamic Republic of Sweden Israel Norway | 52 51 48 47 | 0 0 |
| Iran, Islamic Republic of Sweden Israel Norway Jordan | 52 51 48 47 44 | 0 0 |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus | 52 51 48 47 44 44 | 0 0 |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro | 52 51 48 47 44 44 | 0 0 |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro Macedonia, Republic of | 52 51 48 47 44 44 44 | 0 0 |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro Macedonia, Republic of Palestinian Nat'l Auth. | 52 51 48 47 44 44 44 41 | 0 0 |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro Macedonia, Republic of Palestinian Nat'l Auth. Italy | 52 51 48 47 44 44 44 41 40 | 0 0 |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro Macedonia, Republic of Palestinian Nat'l Auth. Italy Chile | 52 51 48 47 44 44 41 40 40 | 0 0 |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro Macedonia, Republic of Palestinian Nat'l Auth. Italy Chile Indonesia | 52 51 48 47 44 44 41 40 40 40 39 | 0 |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro Macedonia, Republic of Palestinian Nat'l Auth. Italy Chile Indonesia Bahrain | 52 51 48 47 44 44 41 40 40 40 39 33 | 0 0 |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro Macedonia, Republic of Palestinian Nat'l Auth. Italy Chile Indonesia Bahrain Morocco | 52 51 48 47 44 44 41 40 40 40 39 33 27 | 0 0 |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro Macedonia, Republic of Palestinian Nat'l Auth. Italy Chile Indonesia Bahrain Morocco Tunisia | 52 51 48 47 44 44 41 40 40 40 39 33 27 27 | 0 0 |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro Macedonia, Republic of Palestinian Nat'l Auth. Italy Chile Indonesia Bahrain Morocco Tunisia Saudi Arabia | 52 51 48 47 44 44 41 40 40 40 39 33 27 27 26 | O |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro Macedonia, Republic of Palestinian Nat'l Auth. Italy Chile Indonesia Bahrain Morocco Tunisia Saudi Arabia Philippines | 52 51 48 47 44 44 41 40 40 40 39 33 27 27 26 24 | O |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro Macedonia, Republic of Palestinian Nat'l Auth. Italy Chile Indonesia Bahrain Morocco Tunisia Saudi Arabia Philippines Lebanon | 52 51 48 47 44 44 41 40 40 40 39 33 27 27 26 24 22 | O |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro Macedonia, Republic of Palestinian Nat'l Auth. Italy Chile Indonesia Bahrain Morocco Tunisia Saudi Arabia Philippines Lebanon Egypt | 52 51 48 47 44 44 41 40 40 39 33 27 26 24 22 20 | O |
| Iran, Islamic Republic of Sweden Israel Norway Jordan Cyprus Serbia and Montenegro Macedonia, Republic of Palestinian Nat'l Auth. Italy Chile Indonesia Bahrain Morocco Tunisia Saudi Arabia Philippines Lebanon Egypt Botswana | 52 51 48 47 44 44 41 40 40 39 33 27 27 26 24 22 20 11 | 0 0 |

Country average vs. International average:

| Higher | |
|---------------|---|
| Not different | O |
| Lower | |

Nail pulled out of a wooden board (continued)

Item Number: S032131

Student Responses

Correct Response:

When a nail is pulled out of a wooden board, the nail becomes warm. Explain why.

the nail becomes warm because of the energy that was in it as it was pulled out

Incorrect Response:

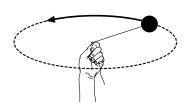
When a nail is pulled out of a wooden board, the nail becomes warm. Explain why.

Because the inside of the board is warmer than it is on the outside

| Content Domain | Main Topic | Cognitive Domain |
|----------------|-------------------|--------------------------|
| PHYSICS | Forces and Motion | Conceptual Understanding |

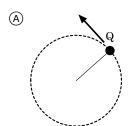
Path of ball released from orbit

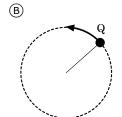
The diagram on the left shows a ball on the end of a string being whirled in a circle. The diagram on the right shows the whirling ball as viewed from above.

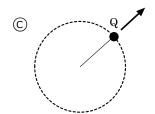


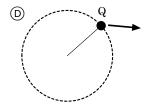


After several whirls, the string is released when the ball is at Q. Which of these diagrams shows the direction in which the ball will fly the instant the string is released?









Item Number: S022040

Correct Response:

A

Overall Percent Correct

| Korea, Republic of | 87 | A |
|--|--|---|
| Netherlands | 82 | |
| Estonia | 80 | A |
| Singapore | 79 | <u> </u> |
| Australia | 77 | • |
| Japan | 77 | <u> </u> |
| Hungary | 77 | |
| Scotland | 77 | A |
| New Zealand | 77 | A |
| Belgium (Flemish) | 76 | <u> </u> |
| United States | 76 | <u> </u> |
| Lithuania | 75 | <u> </u> |
| Malaysia | 75 | <u> </u> |
| Sweden | 74 | <u> </u> |
| England | 74 | <u> </u> |
| Russian Federation | 74 | <u> </u> |
| Slovak Republic | 72 | A |
| Norway | 72 | <u> </u> |
| Latvia | 71 | A |
| Slovenia | 70 | A |
| Hong Kong, SAR | 69 | A |
| Chinese Taipei | 68 | A |
| Italy | 61 | 0 |
| Bulgaria | 60 | 0 |
| | | |
| 9 | | |
| Serbia and Montenegro International average | 60 60 | 0 |
| Serbia and Montenegro | 60 | |
| Serbia and Montenegro International average | 60 60 | 0 |
| Serbia and Montenegro International average Cyprus | 60 60 59 | 0 |
| Serbia and Montenegro International average Cyprus Israel | 60 60 59 58 | 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania | 60 60 59 58 58 | 0 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile | 60 60 59 58 58 58 | 0 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia | 60 60 59 58 58 58 58 | 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of | 60 60 59 58 58 58 58 54 | 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of Moldova, Rep. of | 60 60 59 58 58 58 58 54 52 | 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of Moldova, Rep. of Iran, Islamic Republic of | 60 60 59 58 58 58 58 54 52 48 | 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of Moldova, Rep. of Iran, Islamic Republic of Jordan | 60 60 59 58 58 58 54 52 48 47 | 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of Moldova, Rep. of Iran, Islamic Republic of Jordan Indonesia | 60 59 58 58 58 54 52 48 47 47 | 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of Moldova, Rep. of Iran, Islamic Republic of Jordan Indonesia Bahrain | 60 59 58 58 58 54 52 48 47 47 44 | 0 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of Moldova, Rep. of Iran, Islamic Republic of Jordan Indonesia Bahrain Philippines | 60 59 58 58 58 54 52 48 47 47 44 42 | 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of Moldova, Rep. of Iran, Islamic Republic of Jordan Indonesia Bahrain Philippines Saudi Arabia | 59 58 58 58 58 54 52 48 47 47 44 42 38 | 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of Moldova, Rep. of Iran, Islamic Republic of Jordan Indonesia Bahrain Philippines Saudi Arabia Palestinian Nat'l Auth. | 59 58 58 58 58 54 52 48 47 47 44 42 38 36 | 0 0 0 0 0 0 0 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of Moldova, Rep. of Iran, Islamic Republic of Jordan Indonesia Bahrain Philippines Saudi Arabia Palestinian Nat'l Auth. Morocco | 59 58 58 58 58 54 52 48 47 47 44 42 38 36 33 | 0 0 0 0 0 0 0 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of Moldova, Rep. of Iran, Islamic Republic of Jordan Indonesia Bahrain Philippines Saudi Arabia Palestinian Nat'l Auth. Morocco Tunisia | 59 58 58 58 58 54 52 48 47 47 44 42 38 36 33 | 0 0 0 0 0 0 0 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of Moldova, Rep. of Iran, Islamic Republic of Jordan Indonesia Bahrain Philippines Saudi Arabia Palestinian Nat'l Auth. Morocco Tunisia Egypt | 59 58 58 58 58 54 52 48 47 47 44 42 38 36 33 31 30 | 0 0 0 0 0 0 0 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of Moldova, Rep. of Iran, Islamic Republic of Jordan Indonesia Bahrain Philippines Saudi Arabia Palestinian Nat'l Auth. Morocco Tunisia Egypt Lebanon | 59 58 58 58 58 54 52 48 47 47 44 42 38 36 33 31 30 30 | 0 0 0 0 |
| Serbia and Montenegro International average Cyprus Israel Romania Chile Armenia Macedonia, Republic of Moldova, Rep. of Iran, Islamic Republic of Jordan Indonesia Bahrain Philippines Saudi Arabia Palestinian Nat'l Auth. Morocco Tunisia Egypt Lebanon Botswana | 59 58 58 58 58 54 52 48 47 47 44 42 38 36 33 31 30 30 | 0 0 0 0 0 0 0 0 0 0 0 |

Country average vs. International average:

| Higher | |
|---------------|----------------|
| Not different | 0 |
| Lower | \blacksquare |

| Content Domain | Main Topic | Cognitive Domain |
|----------------|-------------------|--------------------------|
| PHYSICS | Forces and Motion | Conceptual Understanding |

Why helium balloon moves upward

A balloon filled with helium gas is set free and starts to move upward. Which of the following best explains why the helium balloon moves upward?

- (A) The density of helium is less than the density of air.
- (B) The air resistance lifts the balloon up.
- (C) There is no gravity acting on helium balloons.
- (D) The wind blows the balloon upward.

Item Number: S032281

Correct Response:

Δ

Overall Percent Correct

| Korea, Republic of | 89 | A |
|---|--|---|
| Hungary | 88 | |
| Slovak Republic | 86 | <u> </u> |
| Chinese Taipei | 86 | <u> </u> |
| Estonia | 83 | A |
| Singapore | 81 | <u> </u> |
| Slovenia | 79 | <u> </u> |
| Sweden | 77 | <u> </u> |
| Russian Federation | 75 | <u> </u> |
| Japan | 74 | <u> </u> |
| United States | 72 | <u> </u> |
| Hong Kong, SAR | 71 | <u> </u> |
| Malaysia | 69 | <u> </u> |
| Lithuania | 69 | <u> </u> |
| Norway | 69 | <u> </u> |
| Scotland | 69 | <u> </u> |
| Latvia | 69 | <u> </u> |
| New Zealand | 67 | <u> </u> |
| England | 66 | <u> </u> |
| Australia | 66 | <u> </u> |
| Serbia and Montenegro | 65 | <u> </u> |
| Romania | 65 | <u> </u> |
| Italy | 61 | 0 |
| Bulgaria | 60 | 0 |
| | | |
| | 58 | |
| International average Netherlands | 58 58 | 0 |
| International average | | 0 |
| International average Netherlands Jordan | 58 | |
| International average Netherlands | 58 56 | 0 |
| International average Netherlands Jordan Moldova, Rep. of | 58 56 56 | 0 0 0 |
| International average Netherlands Jordan Moldova, Rep. of Armenia | 58 56 56 56 | O O O ▼ |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel | 58 56 56 56 54 | O O O ▼ |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile | 58 56 56 56 54 52 | O O O ▼ |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of | 58 56 56 56 54 52 52 | O O O ▼ |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of Palestinian Nat'l Auth. Philippines | 58 56 56 56 54 52 52 50 | O O O ▼ |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of Palestinian Nat'l Auth. | 58 56 56 56 54 52 52 50 49 | O O O ▼ |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of Palestinian Nat'l Auth. Philippines Belgium (Flemish) | 58 56 56 56 54 52 52 50 49 | 0 0 0 • • • • |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of Palestinian Nat'l Auth. Philippines Belgium (Flemish) Lebanon | 58 56 56 54 52 52 50 49 49 | 0 0 0 • • • • |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of Palestinian Nat'l Auth. Philippines Belgium (Flemish) Lebanon Egypt | 58 56 56 54 52 52 50 49 49 47 | O O O ▼ |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of Palestinian Nat'l Auth. Philippines Belgium (Flemish) Lebanon Egypt Bahrain | 58 56 56 54 52 52 50 49 49 47 45 | 0 0 0 • • • • |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of Palestinian Nat'l Auth. Philippines Belgium (Flemish) Lebanon Egypt Bahrain Iran, Islamic Republic of | 58 56 56 54 52 52 50 49 47 45 43 | 0 0 0 • • • • |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of Palestinian Nat'l Auth. Philippines Belgium (Flemish) Lebanon Egypt Bahrain Iran, Islamic Republic of Cyprus | 58 56 56 54 52 52 50 49 47 45 43 38 35 | O |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of Palestinian Nat'l Auth. Philippines Belgium (Flemish) Lebanon Egypt Bahrain Iran, Islamic Republic of Cyprus Saudi Arabia | 58 56 56 54 52 52 50 49 47 45 43 38 35 33 | O |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of Palestinian Nat'l Auth. Philippines Belgium (Flemish) Lebanon Egypt Bahrain Iran, Islamic Republic of Cyprus Saudi Arabia Indonesia | 58 56 56 54 52 52 50 49 47 45 43 38 35 33 | O |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of Palestinian Nat'l Auth. Philippines Belgium (Flemish) Lebanon Egypt Bahrain Iran, Islamic Republic of Cyprus Saudi Arabia Indonesia Ghana | 58 56 56 54 52 52 50 49 47 45 43 38 35 33 32 28 | O |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of Palestinian Nat'l Auth. Philippines Belgium (Flemish) Lebanon Egypt Bahrain Iran, Islamic Republic of Cyprus Saudi Arabia Indonesia Ghana Botswana | 58 56 56 54 52 52 50 49 47 45 43 38 35 33 32 28 | 0 0 0 • • • • |
| International average Netherlands Jordan Moldova, Rep. of Armenia Israel Chile Macedonia, Republic of Palestinian Nat'l Auth. Philippines Belgium (Flemish) Lebanon Egypt Bahrain Iran, Islamic Republic of Cyprus Saudi Arabia Indonesia Ghana Botswana South Africa | 58 56 56 54 52 52 50 49 47 45 43 38 35 33 32 28 25 21 | O |

Country average vs. International average:

Higher △ Not different O Lower ▼

| Content Domain | Main Topic | Cognitive Domain |
|----------------|-------------------|--------------------------|
| PHYSICS | Forces and Motion | Conceptual Understanding |

Metal crown: why scientists repeated measurement

The scientists measured the volume of the crown five times. They computed the density for each volume measurement. Their results are shown in the table below.

| Trial | Volume of Crown (cm³) | Density of Crown (g/cm³) |
|-------|-----------------------|--------------------------|
| 1 | 202 | 11.88 |
| 2 | 200 | 12.00 |
| 3 | 201 | 11.94 |
| 4 | 198 | 12.12 |
| 5 | 199 | 12.06 |

A. Why did the scientists measure the volume five times?

B. The scientists reported to the king that the density of the crown was $12.0~\rm g/cm^3$. Show how the scientists used their results to obtain this value for the density.

Item Number: S032712A

Overall Percent Correct

| Chinese Taipei | 76 | |
|-------------------------|----|---|
| Korea, Republic of | 67 | |
| Estonia | 60 | |
| Singapore | 58 | |
| Hong Kong, SAR | 56 | |
| Japan | 53 | |
| Malaysia | 53 | |
| Lithuania | 53 | |
| Belgium (Flemish) | 47 | |
| United States | 47 | |
| Australia | 44 | |
| Jordan | 44 | |
| Slovenia | 42 | |
| Sweden | 42 | |
| Scotland | 41 | |
| New Zealand | 40 | |
| Palestinian Nat'l Auth. | 38 | |
| Slovak Republic | 34 | 0 |
| England | 34 | 0 |
| Netherlands | 33 | 0 |
| Israel | 33 | 0 |
| International average | 30 | |

| international average | 30 | |
|---------------------------|----|---------------------------------------|
| Moldova, Rep. of | 30 | 0 |
| Latvia | 29 | 0 |
| Egypt | 29 | O |
| Russian Federation | 26 | \blacksquare |
| Serbia and Montenegro | 23 | \blacksquare |
| Norway | 22 | \blacksquare |
| Hungary | 22 | \blacksquare |
| Cyprus | 21 | \blacksquare |
| Morocco | 21 | \blacksquare |
| Tunisia | 19 | \blacksquare |
| Iran, Islamic Republic of | 18 | * * * * * * * * * * * * * * * * * * * |
| Bahrain | 17 | \blacksquare |
| Macedonia, Republic of | 15 | \blacksquare |
| Indonesia | 15 | \blacksquare |
| Italy | 15 | \blacksquare |
| Romania | 14 | \blacksquare |
| Bulgaria | 13 | \blacksquare |
| Armenia | 11 | \blacksquare |
| Botswana | 10 | \blacksquare |
| Philippines | 8 | * * * * * * * * * * * * * * * * * * * |
| Chile | 6 | |
| Lebanon | 6 | |
| South Africa | 6 | \blacksquare |
| Ghana | 5 | \blacksquare |
| Saudi Arabia | 1 | \blacksquare |
| | | |

Country average vs. International average:

Higher
Not different
Lower

Metal crown: why scientists repeated measurement (continued)

Item Number: S032712A

SCORING

Why Scientists Repeat Measurements

Correct Response

 Refers to accuracy, precision, reliability, experimental uncertainty, estimation of measurement error (or similar).

Examples: Because there is experimental error. So measuring it 5 times you can calculate

the average to know how much error there is.

Each time they measure the volume it is close but not exactly the same. So, it's better

to measure it a few times to be sure. They want a more exact answer.

To get an accurate measure of the volume.

It's more reliable.

· Refers only to computing an average or mean value (or median or range).

Examples: To find the average volume.

To work out the mean.

· Other correct.

Incorrect Response

 Refers only to 'mistakes' or changes in the measurements (or similar); no explicit mention of accuracy, precision, experimental uncertainty, etc.

Examples: In case mistakes happen.

To make sure it wasn't changing.

To make sure the answer was right and he did not make a mistake.

To make sure they did it right.

To check if it was correct.

 Refers only to a 'fair test' or similar; no explicit mention of computation of average, accuracy, precision, experimental uncertainty, etc.

Examples: To make sure it was a fair test.

To ensure a fair test.

• Other incorrect (including crossed out/erased, stray marks, illegible or off task).

Metal crown: why scientists repeated measurement (continued)

Item Number: S032712A

Student Responses

Correct Response:

The scientists measured the volume of the crown five times. They computed the density for each volume measurement. Their results are shown in the table below.

| Trial | Volume of Crown (cm³) | Density of Crown (g/cm³) |
|-------|-----------------------|--------------------------|
| 1 | 202 | 11.88 |
| 2 | 200 | 12.00 |
| 3 | 201 | 11.94 |
| 4 | 198 | 12.12 |
| 5 | 199 | 12.06 |

A. Why did the scientists measure the volume five times?

Incorrect Response:

The scientists measured the volume of the crown five times. They computed the density for each volume measurement. Their results are shown in the table below.

| Trial | Volume of Crown (cm³) | Density of Crown (g/cm³) |
|-------|-----------------------|--------------------------|
| 1 | 202 | 11.88 |
| 2 | 200 | 12.00 |
| 3 | 201 | 11.94 |
| 4 | 198 | 12.12 |
| 5 | 199 | 12.06 |

A. Why did the scientists measure the volume five times?

| Content Domain | Main Topic | Cognitive Domain | |
|----------------|-------------------|--------------------------|--|
| PHYSICS | Forces and Motion | Conceptual Understanding | |

Metal crown: determination of average/median value

The scientists measured the volume of the crown five times. They computed the density for each volume measurement. Their results are shown in the table below.

| Trial | Volume of Crown (cm³) | Density of Crown (g/cm³) |
|-------|-----------------------|--------------------------|
| 1 | 202 | 11.88 |
| 2 | 200 | 12.00 |
| 3 | 201 | 11.94 |
| 4 | 198 | 12.12 |
| 5 | 199 | 12.06 |

A. Why did the scientists measure the volume five times?

B. The scientists reported to the king that the density of the crown was 12.0 g/cm³. Show how the scientists used their results to obtain this value for the density.

Item Number: S032712B

SCORING

Correct Response

• Shows (or describes) a correct method for computing the average (mean) value.

Examples: (11.88+12.00+11.94+12.12+12.06) = 60. 60/5=12.0 (202+200+201+198+199)/5 = 200. 2400/200=12.0

They added together all of the densities and then divided by 5 to get the average.

• Shows (or describes) a correct method for determining the median value.

Examples: 202, 201, 200, 198, 199. 200 is the median volume, so 2400/200 is the median density (12).

12 is the middle value when placed in order (12.12, 12.06, 12.00, 11.94, 11.88).

· Other correct

Incorrect Response

- States that it is the average, mean or median value with no or incorrect work shown.
- Shows a computation of density (mass/volume). [No determination of average or median included.] Examples: They did mass divided by volume.

2400g/200cc = 12 g/cc

· Other incorrect (including crossed out/erased, stray marks, illegible, or off task).

Overall Percent Correct

| Singapore | 47 | • |
|-----------------------|----|---|
| Japan | 44 | _ |
| Estonia | 36 | |
| | | |
| Lithuania | 31 | |
| United States | 29 | |
| Netherlands | 29 | |
| Chinese Taipei | 28 | |
| Scotland | 26 | |
| Sweden | 24 | |
| Hong Kong, SAR | 24 | |
| Australia | 23 | |
| England | 22 | |
| Latvia | 22 | |
| New Zealand | 21 | |
| Malaysia | 20 | |
| Belgium (Flemish) | 20 | |
| Korea, Republic of | 15 | 0 |
| Norway | 14 | 0 |
| Slovenia | 14 | 0 |
| International average | 14 | |

| International average | 14 | |
|---------------------------|----|---|
| Israel | 13 | 0 |
| Moldova, Rep. of | 13 | 0 |
| Hungary | 12 | \blacksquare |
| Serbia and Montenegro | 11 | \blacksquare |
| Slovak Republic | 10 | \blacksquare |
| Russian Federation | 10 | 0 |
| Cyprus | 9 | \blacksquare |
| Bulgaria | 9 | \blacksquare |
| Romania | 7 | \blacksquare |
| Jordan | 7 | \blacksquare |
| Macedonia, Republic of | 7 | \blacksquare |
| Armenia | 6 | \blacksquare |
| Italy | 6 | \blacksquare |
| Lebanon | 6 | \blacksquare |
| Indonesia | 4 | \blacksquare |
| Tunisia | 4 | \blacksquare |
| Philippines | 4 | \blacksquare |
| Egypt | 4 | \blacksquare |
| Bahrain | 3 | \blacksquare |
| Palestinian Nat'l Auth. | 3 | \blacksquare |
| Chile | 3 | \blacksquare |
| Morocco | 3 | \blacksquare |
| Botswana | 2 | \blacksquare |
| Iran, Islamic Republic of | 2 | \blacksquare |
| South Africa | 1 | \blacksquare |
| Ghana | 1 | O V |
| Saudi Arabia | 0 | • |

Country average vs. International average:

Higher △ Not different O Lower ▼

Metal crown: determination of average/median value (continued)

Item Number: S032712B

Student Responses

Correct Response:

The scientists measured the volume of the crown five times. They computed the density for each volume measurement. Their results are shown in the table below.

| Trial | Volume of Crown (cm³) | Density of Crown (g/cm³) |
|-------|-----------------------|--------------------------|
| 1 | 202 | 11.88 |
| 2 | 200 | 12.00 |
| 3 | 201 | 11.94 |
| 4 | 198 | 12.12 |
| 5 | 199 | 12.06 |

B. The scientists reported to the king that the density of the crown was 12.0 g/cm³. Show how the scientists used their results to obtain this value for the density.

Metal crown: determination of average/median value (continued)

Item Number: S032712B

Student Responses

Incorrect Response:

The scientists measured the volume of the crown five times. They computed the density for each volume measurement. Their results are shown in the table below.

| Trial | Volume of Crown (cm³) | Density of Crown (g/cm³) |
|-------|-----------------------|--------------------------|
| 1 | 202 | 11.88 |
| 2 | 200 | 12.00 |
| 3 | 201 | 11.94 |
| 4 | 198 | 12.12 |
| 5 | 199 | 12.06 |

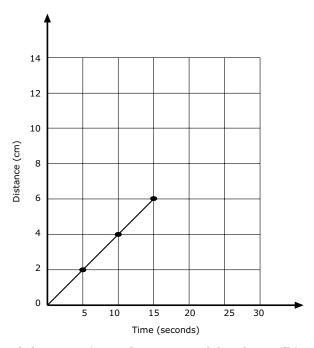
B. The scientists reported to the king that the density of the crown was 12.0 g/cm³. Show how the scientists used their results to obtain this value for the density.

He took the average and used that.

| Content Domain | Main Topic | Cognitive Domain |
|----------------|-------------------|------------------------|
| PHYSICS | Forces and Motion | Reasoning and Analysis |

Extrapolation of distance/time graph

The graph shows the progress made by a beetle moving along a straight line.



If the beetle keeps moving at the same speed, how long will it take to travel 10 cm?

- (A) 4 seconds
- (B) 6 seconds
- © 20 seconds
- (D) 25 seconds

Item Number: S022041

Correct Response:

D

Overall Percent Correct

| Singapore 90 ▲ Korea, Republic of 90 ▲ Japan 89 ▲ Malaysia 89 ▲ Belgium (Flemish) 89 ▲ Scotland 88 ▲ Australia 87 ▲ United States 87 ▲ Hungary 86 ▲ England 85 ▲ Sweden 84 ▲ Hong Kong, SAR 84 ▲ Lithuania 83 ▲ New Zealand 82 ▲ Estonia 82 ▲ Chinese Taipei 80 ▲ Slovenia 80 ▲ Latvia 79 ▲ Israel 79 ▲ Russian Federation 79 ▲ Norway 75 ▲ Italy 74 ○ Chile 73 ○ Moldova, Rep. of 73 ○ |
|---|
| Japan 89 ▲ Malaysia 89 ▲ Belgium (Flemish) 89 ▲ Scotland 88 ▲ Australia 87 ▲ United States 87 ▲ Hungary 86 ▲ England 85 ▲ Sweden 84 ▲ Hong Kong, SAR 84 ▲ Lithuania 83 ▲ New Zealand 82 ▲ Estonia 82 ▲ Chinese Taipei 80 ▲ Slovenia 80 ▲ Latvia 79 ▲ Israel 79 ▲ Russian Federation 79 ▲ Norway 75 ▲ Italy 74 ○ Chile 73 ○ Moldova, Rep. of 73 ○ Bulgaria 71 ○ Lebanon 70 ○ |
| Malaysia 89 ▲ Belgium (Flemish) 89 ▲ Scotland 88 ▲ Australia 87 ▲ United States 87 ▲ Hungary 86 ▲ England 85 ▲ Sweden 84 ▲ Hong Kong, SAR 84 ▲ Lithuania 83 ▲ New Zealand 82 ▲ Estonia 82 ▲ Chinese Taipei 80 ▲ Slovenia 80 ▲ Latvia 79 ▲ Israel 79 ▲ Russian Federation 79 ▲ Norway 75 ▲ Italy 74 O Chile 73 O Moldova, Rep. of 73 O Bulgaria 71 O Lebanon 70 O Cyprus 68 O Slovak Republic 68 O Romania 67 |
| Belgium (Flemish) 89 ▲ Scotland 88 ▲ Australia 87 ▲ United States 87 ▲ Hungary 86 ▲ England 85 ▲ Sweden 84 ▲ Hong Kong, SAR 84 ▲ Lithuania 83 ▲ New Zealand 82 ▲ Estonia 82 ▲ Chinese Taipei 80 ▲ Slovenia 80 ▲ Latvia 79 ▲ Israel 79 ▲ Russian Federation 79 ▲ Norway 75 ▲ Italy 74 ○ Chile 73 ○ Moldova, Rep. of 73 ○ Bulgaria 71 ○ Lebanon 70 ○ Cyprus 68 ○ Slovak Republic 68 ○ |
| Scotland 88 ▲ Australia 87 ▲ United States 87 ▲ Hungary 86 ▲ England 85 ▲ Sweden 84 ▲ Hong Kong, SAR 84 ▲ Lithuania 83 ▲ New Zealand 82 ▲ Estonia 82 ▲ Chinese Taipei 80 ▲ Slovenia 80 ▲ Latvia 79 ▲ Israel 79 ▲ Russian Federation 79 ▲ Norway 75 ▲ Italy 74 ○ Chile 73 ○ Moldova, Rep. of 73 ○ Bulgaria 71 ○ Lebanon 70 ○ Cyprus 68 ○ Slovak Republic 68 ○ Romania 67 ○ |
| Australia 87 |
| United States 87 |
| Hungary 86 ▲ England 85 ▲ Sweden 84 ▲ Hong Kong, SAR 84 ▲ Lithuania 83 ▲ New Zealand 82 ▲ Estonia 82 ▲ Chinese Taipei 80 ▲ Slovenia 80 ▲ Latvia 79 ▲ Israel 79 ▲ Russian Federation 79 ▲ Norway 75 ▲ Italy 74 ○ Chile 73 ○ Moldova, Rep. of 73 ○ Bulgaria 71 ○ International average 71 □ Lebanon 70 ○ Cyprus 68 ○ Slovak Republic 68 ○ Romania 67 ○ Botswana 64 ▼ Macedonia, Republic of 64 ▼ Morocco 61 ▼ |
| England 85 |
| Sweden 84 ▲ Hong Kong, SAR 84 ▲ Lithuania 83 ▲ New Zealand 82 ▲ Estonia 82 ▲ Chinese Taipei 80 ▲ Slovenia 80 ▲ Latvia 79 ▲ Israel 79 ▲ Russian Federation 79 ▲ Norway 75 ▲ Italy 74 ○ Chile 73 ○ Moldova, Rep. of 73 ○ Bulgaria 71 ○ Lebanon 70 ○ Cyprus 68 ○ Slovak Republic 68 ○ Romania 67 ○ Botswana 64 ▼ Macedonia, Republic of 64 ▼ Morocco 61 ▼ |
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| Lithuania 83 ▲ New Zealand 82 ▲ Estonia 82 ▲ Chinese Taipei 80 ▲ Slovenia 80 ▲ Latvia 79 ▲ Israel 79 ▲ Russian Federation 79 ▲ Norway 75 ▲ Italy 74 ○ Chile 73 ○ Moldova, Rep. of 73 ○ Bulgaria 71 ○ Lebanon 70 ○ Cyprus 68 ○ Slovak Republic 68 ○ Romania 67 ○ Botswana 64 ▼ Macedonia, Republic of 64 ▼ Morocco 61 ▼ |
| New Zealand 82 ▲ Estonia 82 ▲ Chinese Taipei 80 ▲ Slovenia 80 ▲ Latvia 79 ▲ Israel 79 ▲ Russian Federation 79 ▲ Norway 75 ▲ Italy 74 ○ Chile 73 ○ Moldova, Rep. of 73 ○ Bulgaria 71 ○ Lebanon 70 ○ Cyprus 68 ○ Slovak Republic 68 ○ Romania 67 ○ Botswana 64 ▼ Macedonia, Republic of 64 ▼ Morocco 61 ▼ |
| Estonia 82 |
| Chinese Taipei 80 Slovenia 80 Latvia 79 Israel 79 Russian Federation 79 Norway 75 Italy 74 Chile 73 Moldova, Rep. of 73 Bulgaria 71 Lebanon 70 Cyprus 68 Slovak Republic 68 Romania 67 Botswana 64 Macedonia, Republic of 64 Morocco 61 |
| Slovenia 80 ▲ Latvia 79 ▲ Israel 79 ▲ Russian Federation 79 ▲ Norway 75 ▲ Italy 74 ○ Chile 73 ○ Moldova, Rep. of 73 ○ Bulgaria 71 ○ International average 71 □ Lebanon 70 ○ Cyprus 68 ○ Slovak Republic 68 ○ Romania 67 ○ Botswana 64 ▼ Macedonia, Republic of 64 ▼ Morocco 61 ▼ |
| Latvia 79 ▲ Israel 79 ▲ Russian Federation 79 ▲ Norway 75 ▲ Italy 74 ○ Chile 73 ○ Moldova, Rep. of 73 ○ Bulgaria 71 ○ International average 71 ○ Cyprus 68 ○ Slovak Republic 68 ○ Romania 67 ○ Botswana 64 ▼ Macedonia, Republic of 64 ▼ Morocco 61 ▼ |
| Israel 79 ▲ Russian Federation 79 ▲ Norway 75 ▲ Italy 74 ○ Chile 73 ○ Moldova, Rep. of 73 ○ Bulgaria 71 ○ International average 71 □ Lebanon 70 ○ Cyprus 68 ○ Slovak Republic 68 ○ Romania 67 ○ Botswana 64 ▼ Macedonia, Republic of 64 ▼ Morocco 61 ▼ |
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| Italy |
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| Cyprus 68 0 Slovak Republic 68 0 Romania 67 0 Botswana 64 ▼ Macedonia, Republic of 64 Morocco 61 ▼ |
| Slovak Republic 68 0 Romania 67 0 Botswana 64 ▼ Macedonia, Republic of 64 ▼ Morocco 61 ▼ |
| Romania 67 O Botswana 64 ▼ Macedonia, Republic of 64 ▼ Morocco 61 ▼ |
| Botswana 64 ▼ Macedonia, Republic of 64 ▼ Morocco 61 ▼ |
| Macedonia, Republic of 64 ▼ Morocco 61 ▼ |
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| Indonesia 61 ▼ Bahrain 58 ▼ Iran, Islamic Republic of 56 ▼ Armenia 56 ▼ Serbia and Montenegro 55 ▼ |
| Bahrain 58 ▼ Iran, Islamic Republic of 56 ▼ Armenia 56 ▼ Serbia and Montenegro 55 ▼ |
| Iran, Islamic Republic of 56 ▼ Armenia 56 ▼ Serbia and Montenegro 55 ▼ |
| Armenia 56 ▼ Serbia and Montenegro 55 ▼ |
| Serbia and Montenegro 55 ▼ |
| |
| Tunisia 55 ▼ |
| Jordan 54 ▼ |
| Philippines 52 ▼ |
| |
| Egypt 51 ▼ |
| Egypt 51 ▼ Palestinian Nat'l Auth. 44 ▼ |
| Egypt 51 V Palestinian Nat'l Auth. 44 V Saudi Arabia 40 V |

Country average vs. International average:

32

Ghana

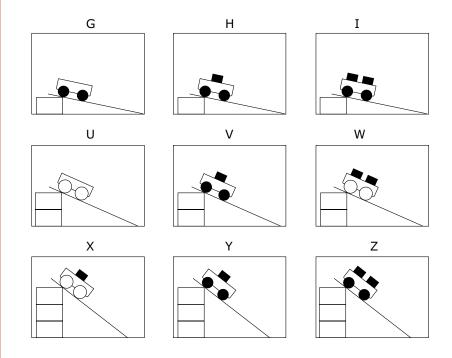
Higher Not different O
Lower

A

| Content Domain | Main Topic | Cognitive Domain | |
|----------------|-------------------|------------------------|--|
| PHYSICS | Forces and Motion | Reasoning and Analysis | |

Controlled experiment with cart

The diagrams show nine different trials Michael carried out using carts with wheels of two different sizes and different numbers of blocks of equal mass. He used the same ramp for all trials, starting the carts from different heights.



He wants to test this idea: The higher the ramp is placed, the faster the cart will travel at the bottom of the ramp. Which three trials should he compare?

- (A) G, H and I
- (B) I, W and Z
- (c) I, V and X
- (D) U, W and X
- (E) H, V and Y

Item Number: S022222

Correct Response:

Ε

Overall Percent Correct

| Singapore | 79 | A |
|-----------------------|----|----------|
| Japan | 78 | |
| Korea, Republic of | 75 | |
| Hong Kong, SAR | 66 | |
| England | 65 | |
| Chinese Taipei | 63 | |
| Netherlands | 59 | |
| Malaysia | 58 | |
| Australia | 58 | |
| Scotland | 58 | |
| United States | 57 | |
| Hungary | 56 | |
| Lithuania | 54 | |
| New Zealand | 54 | |
| Estonia | 51 | |
| Sweden | 48 | |
| Belgium (Flemish) | 48 | |
| Russian Federation | 47 | O |
| Slovenia | 45 | 0 |
| Armenia | 45 | 0 |
| Italy | 44 | 0 |
| International average | 43 | |
| CL LD LI | 40 | _ |

| reary | | |
|---------------------------|----|---|
| International average | 43 | |
| Slovak Republic | 43 | 0 |
| Latvia | 42 | 0 |
| Norway | 41 | 0 |
| Israel | 41 | 0 |
| Serbia and Montenegro | 39 | \blacksquare |
| Bahrain | 37 | \blacksquare |
| Romania | 36 | \blacksquare |
| Bulgaria | 36 | \blacksquare |
| Jordan | 35 | \blacksquare |
| Cyprus | 34 | \blacksquare |
| Chile | 33 | \blacksquare |
| Saudi Arabia | 32 | \blacksquare |
| Macedonia, Republic of | 31 | \blacksquare |
| Lebanon | 31 | \blacksquare |
| Iran, Islamic Republic of | 31 | O V |
| Moldova, Rep. of | 30 | \blacksquare |
| Philippines | 30 | \blacksquare |
| Palestinian Nat'l Auth. | 25 | \blacksquare |
| Indonesia | 25 | \blacksquare |
| Egypt | 23 | \blacksquare |
| Botswana | 23 | \blacksquare |
| Tunisia | 23 | \blacksquare |
| Morocco | 22 | \blacksquare |
| South Africa | 18 | \blacksquare |
| Ghana | 18 | • |
| | | |

Country average vs. International average:

Higher
Not different
Lower

| Content Domain | Main Topic | Cognitive Domain |
|----------------|-------------------|------------------------|
| PHYSICS | Forces and Motion | Reasoning and Analysis |

Data trend of masses on spring

The table below shows the results of an experiment to investigate how the length of a spring changes as different masses are hung from it.

| Mass (grams) | Length of Spring (cm) |
|--------------|-----------------------|
| 0 | 5 |
| 10 | 7 |
| 20 | 9 |
| 30 | 11 |
| 40 | 12 |
| 50 | 13 |
| 60 | 13 |

Describe how the length of the spring changed as different masses were hung from it. $\,$

Item Number: S022286

Overall Percent Correct

| Hungary 73 ▲ Slovak Republic 71 ▲ Korea, Republic of 68 ▲ Chinese Taipei 67 ▲ Estonia 66 ▲ New Zealand 65 ▲ Armenia 65 ▲ Chile 62 ▲ Italy 60 ▲ Japan 56 ▲ Norway 56 ▲ Australia 55 ▲ Hong Kong, SAR 55 ▲ Serbia and Montenegro 53 ▲ Lithuania 52 ▲ Sweden 50 ▲ Slovenia 49 ▲ Latvia 47 O Iran, Islamic Republic of 46 ▲ United States 45 O Netherlands 45 O Russian Federation 43 O Bulgaria 42 O International average | Singapore | 75 | A |
|--|---|--|----------|
| Korea, Republic of 68 ▲ Chinese Taipei 67 ▲ Estonia 66 ▲ New Zealand 65 ▲ Armenia 65 ▲ Chile 62 ▲ Italy 60 ▲ Japan 56 ▲ Norway 56 ▲ Australia 55 ▲ Hong Kong, SAR 55 ▲ Serbia and Montenegro 53 ▲ Lithuania 52 ▲ Sweden 50 ▲ Slovenia 49 ▲ Latvia 47 ○ Iran, Islamic Republic of 46 ▲ United States 45 ○ Netherlands 45 ○ Russian Federation 43 ○ Bulgaria 42 ○ International average 42 Israel 41 ○ Moldova, Rep. of 40 <td></td> <td>73</td> <td>A</td> | | 73 | A |
| Chinese Taipei 67 ▲ Estonia 66 ▲ New Zealand 65 ▲ Armenia 65 ▲ Chile 62 ▲ Italy 60 ▲ Japan 56 ▲ Norway 56 ▲ Australia 55 ▲ Hong Kong, SAR 55 ▲ Serbia and Montenegro 53 ▲ Lithuania 52 ▲ Sweden 50 ▲ Slovenia 49 ▲ Latvia 47 ○ Iran, Islamic Republic of 46 ▲ United States 45 ○ Netherlands 45 ○ Russian Federation 43 ○ Bulgaria 42 ○ International average 42 Israel 41 ○ Moldova, Rep. of 40 ○ Belgium (Flemish) 39< | Slovak Republic | 71 | A |
| Estonia 66 ▲ New Zealand 65 ▲ Armenia 65 ▲ Chile 62 ▲ Italy 60 ▲ Japan 56 ▲ Norway 56 ▲ Australia 55 ▲ Hong Kong, SAR 55 ▲ Serbia and Montenegro 53 ▲ Lithuania 52 ▲ Sweden 50 ▲ Slovenia 49 ▲ Latvia 47 ○ Iran, Islamic Republic of 46 ▲ United States 45 ○ Netherlands 45 ○ Russian Federation 43 ○ Bulgaria 42 ○ International average 42 Israel 41 ○ Moldova, Rep. of 40 ○ Belgium (Flemish) 39 ○ Jordan 36 | Korea, Republic of | 68 | |
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| Armenia 65 ▲ Chile 62 ▲ Italy 60 ▲ Japan 56 ▲ Norway 56 ▲ Australia 55 ▲ Hong Kong, SAR 55 ▲ Serbia and Montenegro 53 ▲ Lithuania 52 ▲ Sweden 50 ▲ Slovenia 49 ▲ Latvia 47 O Iran, Islamic Republic of 46 ▲ United States 45 O Netherlands 45 O Russian Federation 43 O Bulgaria 42 O International average 42 O International average 42 O Belgium (Flemish) 39 O Jordan 37 ▼ Macedonia, Republic of 36 ▼ Romania 36 ▼ Pale | Estonia | 66 | |
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| Italy 60 ▲ Japan 56 ▲ Norway 56 ▲ Australia 55 ▲ Hong Kong, SAR 55 ▲ Serbia and Montenegro 53 ▲ Lithuania 52 ▲ Sweden 50 ▲ Slovenia 49 ▲ Latvia 47 O Iran, Islamic Republic of 46 ▲ United States 45 O Netherlands 45 O Russian Federation 43 O Bulgaria 42 O International average 42 O International average 42 O Israel 41 O O Belgium (Flemish) 39 O Jordan 37 ▼ Macedonia, Republic of 36 ▼ Romania 36 ▼ Palestinian Nat'l Auth. 35 ▼ Scotland 34 ▼ Malaysia <t< td=""><td>Armenia</td><td>65</td><td>A</td></t<> | Armenia | 65 | A |
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| Norway 56 ▲ Australia 55 ▲ Hong Kong, SAR 55 ▲ Serbia and Montenegro 53 ▲ Lithuania 52 ▲ Sweden 50 ▲ Slovenia 49 ▲ Latvia 47 O Iran, Islamic Republic of 46 ▲ United States 45 O Netherlands 45 O Russian Federation 43 O Bulgaria 42 O International average 42 Image: Control of the cont | Italy | 60 | A |
| Australia 55 | Japan | 56 | |
| Hong Kong, SAR Serbia and Montenegro Lithuania Sweden Soweden Slovenia Latvia Iran, Islamic Republic of United States Netherlands Russian Federation Bulgaria International average Israel Moldova, Rep. of Belgium (Flemish) Jordan Macedonia, Republic of Romania Palestinian Nat'l Auth. Scotland Malaysia Egypt Saudi Arabia Cyprus Lebanon Indonesia Morocco Bahrain Tunisia Botswana Soweden Sowe | Norway | 56 | A |
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| United States45ONetherlands45ORussian Federation43OBulgaria42OInternational average42Israel41OMoldova, Rep. of40OBelgium (Flemish)39OJordan37VMacedonia, Republic of36VRomania36VPalestinian Nat'l Auth.35VScotland34VMalaysia33VEngland30VPhilippines29VSaudi Arabia27VCyprus26VLebanon20VIndonesia17VMorocco17VBahrain13VTunisia12VBotswana7VSouth Africa6V | Latvia | 47 | |
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| Russian Federation Bulgaria 42 International average Israel 41 Moldova, Rep. of Belgium (Flemish) 39 Jordan 37 Macedonia, Republic of Romania Palestinian Nat'l Auth. 35 Scotland Malaysia Egypt 33 Egypt 33 Fingland Philippines 29 Saudi Arabia 27 Cyprus Lebanon Indonesia Morocco 17 Bahrain Tunisia Botswana South Africa 42 O O O O O O O O O O O O O O O O O O | United States | 45 | |
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| Moldova, Rep. of Belgium (Flemish) Jordan Macedonia, Republic of Romania Palestinian Nat'l Auth. Scotland Malaysia Egypt Saudi Arabia Cyprus Lebanon Indonesia Morocco Bahrain Tunisia Botswana South Addination A to one of the missing of the miss | | | |
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| Jordan 37 ▼ Macedonia, Republic of 36 ▼ Romania 36 ▼ Palestinian Nat'l Auth. 35 ▼ Scotland 34 ▼ Malaysia 33 ▼ Egypt 33 ▼ England 30 ▼ Philippines 29 ▼ Saudi Arabia 27 ▼ Cyprus 26 ▼ Lebanon 20 ▼ Indonesia 17 ▼ Morocco 17 ▼ Bahrain 13 ▼ Tunisia 12 ▼ South Africa 6 ▼ | Israel | 41 | |
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| Lebanon 20 ▼ Indonesia 17 ▼ Morocco 17 ▼ Bahrain 13 ▼ Tunisia 12 ▼ Botswana 7 ▼ South Africa 6 ▼ | Israel Moldova, Rep. of Belgium (Flemish) Jordan Macedonia, Republic of Romania Palestinian Nat'l Auth. Scotland Malaysia Egypt | 41 40 39 37 36 36 35 34 33 | 0 0 |
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| Indonesia 17 ▼ Morocco 17 ▼ Bahrain 13 ▼ Tunisia 12 ▼ Botswana 7 ▼ South Africa 6 ▼ | Israel Moldova, Rep. of Belgium (Flemish) Jordan Macedonia, Republic of Romania Palestinian Nat'l Auth. Scotland Malaysia Egypt England Philippines Saudi Arabia | 41 40 39 37 36 36 35 34 33 30 29 27 | 0 0 |
| Morocco 17 ▼ Bahrain 13 ▼ Tunisia 12 ▼ Botswana 7 ▼ South Africa 6 ▼ | Israel Moldova, Rep. of Belgium (Flemish) Jordan Macedonia, Republic of Romania Palestinian Nat'l Auth. Scotland Malaysia Egypt England Philippines Saudi Arabia Cyprus | 41 40 39 37 36 36 35 34 33 30 29 27 26 | 0 0 |
| Bahrain13▼Tunisia12▼Botswana7▼South Africa6▼ | Israel Moldova, Rep. of Belgium (Flemish) Jordan Macedonia, Republic of Romania Palestinian Nat'l Auth. Scotland Malaysia Egypt England Philippines Saudi Arabia Cyprus Lebanon | 41 40 39 37 36 36 35 34 33 30 29 27 26 20 | 0 0 |
| Tunisia 12 ▼ Botswana 7 ▼ South Africa 6 ▼ | Israel Moldova, Rep. of Belgium (Flemish) Jordan Macedonia, Republic of Romania Palestinian Nat'l Auth. Scotland Malaysia Egypt England Philippines Saudi Arabia Cyprus Lebanon Indonesia | 41 40 39 37 36 36 35 34 33 30 29 27 26 20 17 | 0 0 |
| Botswana 7 ▼ South Africa 6 ▼ | Israel Moldova, Rep. of Belgium (Flemish) Jordan Macedonia, Republic of Romania Palestinian Nat'l Auth. Scotland Malaysia Egypt England Philippines Saudi Arabia Cyprus Lebanon Indonesia Morocco | 41 40 39 37 36 36 35 34 33 30 29 27 26 20 17 | 0 0 |
| South Africa 6 ▼ | Israel Moldova, Rep. of Belgium (Flemish) Jordan Macedonia, Republic of Romania Palestinian Nat'l Auth. Scotland Malaysia Egypt England Philippines Saudi Arabia Cyprus Lebanon Indonesia Morocco Bahrain | 41 40 39 37 36 36 35 34 33 30 29 27 26 20 17 17 | 0 0 |
| | Israel Moldova, Rep. of Belgium (Flemish) Jordan Macedonia, Republic of Romania Palestinian Nat'l Auth. Scotland Malaysia Egypt England Philippines Saudi Arabia Cyprus Lebanon Indonesia Morocco Bahrain Tunisia | 41 40 39 37 36 36 35 34 33 30 29 27 26 20 17 17 13 | 0 0 |
| Glidiid Z ▼ | Israel Moldova, Rep. of Belgium (Flemish) Jordan Macedonia, Republic of Romania Palestinian Nat'l Auth. Scotland Malaysia Egypt England Philippines Saudi Arabia Cyprus Lebanon Indonesia Morocco Bahrain Tunisia Botswana | 41 40 39 37 36 36 35 34 33 30 29 27 26 20 17 17 13 12 7 | 0 0 |
| | Israel Moldova, Rep. of Belgium (Flemish) Jordan Macedonia, Republic of Romania Palestinian Nat'l Auth. Scotland Malaysia Egypt England Philippines Saudi Arabia Cyprus Lebanon Indonesia Morocco Bahrain Tunisia Botswana South Africa | 41 40 39 37 36 36 35 34 33 30 29 27 26 20 17 17 13 12 7 6 | 0 0 |

Country average vs. International average:

Higher △
Not different ○
Lower ▼

Data trend of masses on spring (continued)

Item Number: S022286

SCORING

Note: To receive credit, responses must address two basic regions in the table to describe the trend in spring length as a function of the mass added:

- (i) initially, the spring increases in length (at a constant rate) as more mass is added.
- (ii) after a point (40 grams), the spring length starts to level off and then remains constant as more mass is added.

Responses may be quantitative or qualitative in nature. [No credit is lost for using wrong or no units in describing length or mass.]

Correct Response

· Response includes both regions (i) and (ii).

Examples: At low mass, it grew 2 for every 10 grams. Then it changed by 1 at 40g. Then at 50g, it did not grow any more.

It increases by 2's until 30, increases by 1's until 50, and increases by 0 at 60. The length increased steadily up to 40g, and then it increased just a little bit more until it was 13cm at 50 and 60 grams.

At first it got longer every time you added a mass, but then after a while, it did not get any longer.

· Other correct.

Incorrect Response

 Includes only region (i). Response references only an increase in length as more mass is added but discussion of leveling off is inadequate or missing.

Examples: The length increased as more mass was added.

The spring length got 2cm longer with each mass.

It increased by 2cm each time until 40 grams.

• Refers only to leveling off of spring length or decreasing increments at higher masses.

[Description of change in region (i) is inadequate or missing.]

Examples: It stretches but only up to 13 cm.

After 50 grams it did not change. It stretches less at higher masses.

• Other incorrect (including crossed out/erased, stray marks, illegible, or off task).

Data trend of masses on spring (continued)

Item Number: S022286

Student Responses

Correct Response:

The table below shows the results of an experiment to investigate how the length of a spring changes as different masses are hung from it.

| Mass (grams) | Length of Spring (cm) |
|--------------|-----------------------|
| 0 | 5 |
| 10 | 7 |
| 20 | 9 |
| 30 | 11 |
| 40 | 12 |
| 50 | 13 |
| 60 | 13 |

Describe how the length of the spring changed as different masses were hung

from it. The langth increased by 2 until it reached a mass of 30 grams it than increased by 1 and than sustained after a mass of 50.

Data trend of masses on spring (continued)

Item Number: S022286

Student Responses (continued)

Incorrect Response:

The table below shows the results of an experiment to investigate how the length of a spring changes as different masses are hung from it.

| Mass (grams) | Length of Spring (cm) |
|--------------|-----------------------|
| 0 | .5 |
| 10 | 7 |
| 20 | 9 |
| 30 | 11 |
| 40 | 12 |
| 50 | 13 |
| . 60 | 13 |

Describe how the length of the spring changed as different masses were hung from it.

Leave Himop from it.