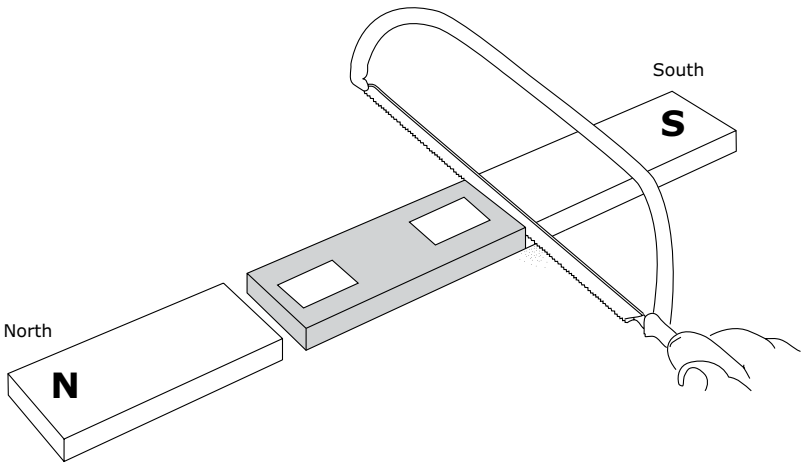
Content Domain	Main Topic	Cognitive Domain
PHYSICS	Electricity and Magnetism	Conceptual Understanding

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	▲
Singapore	62	▲
Macedonia, Republic of	62	▲
Korea, Republic of	59	▲
Bahrain	58	▲
Sweden	58	▲
Lithuania	56	▲
Belgium (Flemish)	55	▲
Cyprus	53	▲
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	O
Hungary	43	O
Malaysia	43	O
Norway	41	O
Hong Kong, SAR	40	▼
Botswana	39	▼
Jordan	38	▼
Saudi Arabia	37	▼
Lebanon	36	▼
Chile	35	▼
Philippines	34	▼
Tunisia	33	▼
Indonesia	32	▼
Iran, Islamic Republic of	32	▼
Egypt	30	▼
Palestinian Nat'l Auth.	27	▼
Armenia	25	▼
Ghana	19	▼
South Africa	17	▼

Country average vs. International average:

Higher	▲
Not different	O
Lower	▼

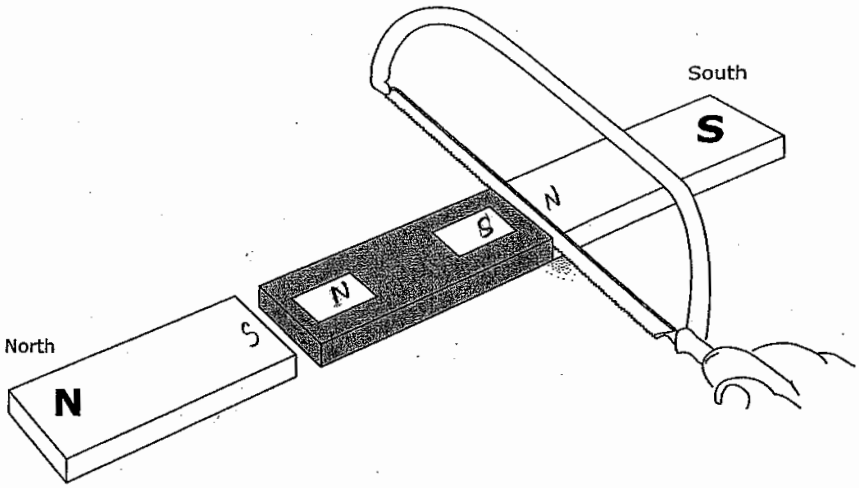
Poles on cut magnet (continued)

Item Number: S022035

Student Responses

Correct Response:

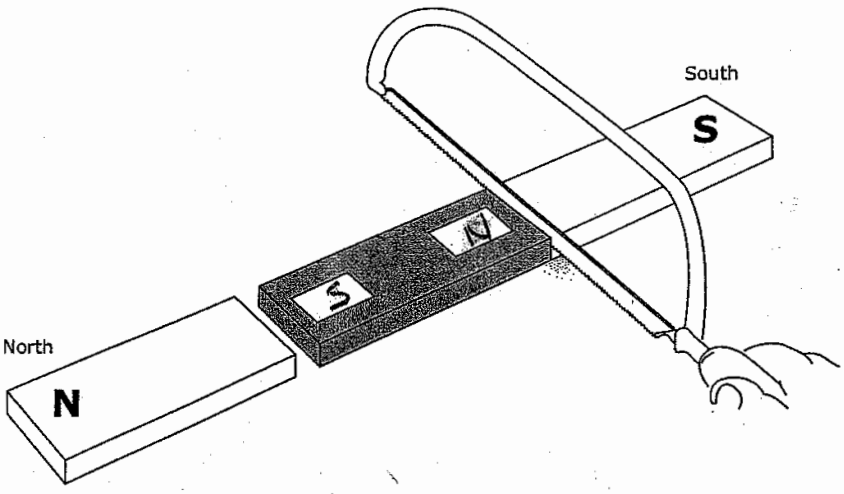
The diagram shows a bar magnet which is cut into three pieces with a hacksaw.



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.

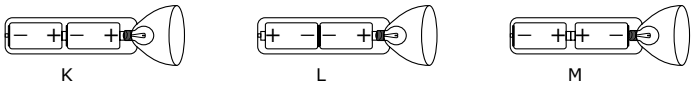


Write an "N" or an "S" in each box on the diagram to show the polarity of each end of the center piece.

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?

Ⓐ Only as in K

Ⓑ Only as in L

Ⓒ Only as in M

Ⓓ None of these ways would work.

Item Number: S012037

Correct Response: A

Overall Percent Correct

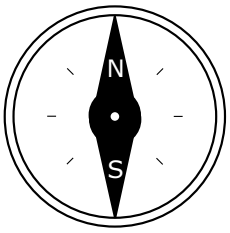
Singapore	97	▲
England	95	▲
Korea, Republic of	93	▲
Japan	93	▲
Hong Kong, SAR	93	▲
Russian Federation	93	▲
Slovak Republic	93	▲
Estonia	93	▲
Chinese Taipei	92	▲
Malaysia	91	▲
Romania	91	▲
Latvia	91	▲
Hungary	91	▲
Bulgaria	91	▲
Bahrain	90	▲
Lithuania	90	▲
Moldova, Rep. of	90	▲
Sweden	89	▲
United States	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	O
Italy	83	O
Iran, Islamic Republic of	83	O
Chile	82	O
Israel	82	O
Norway	81	▼
Botswana	81	▼
Morocco	81	O
Jordan	78	▼
Saudi Arabia	78	▼
Palestinian Nat'l Auth.	78	▼
Philippines	77	▼
Egypt	67	▼
Tunisia	59	▼
Ghana	55	▼
South Africa	52	▼

Country average vs. International average:

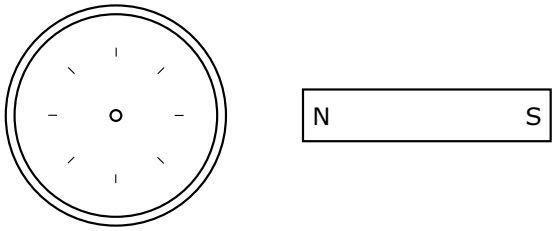
Higher ▲
Not different O
Lower ▼

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

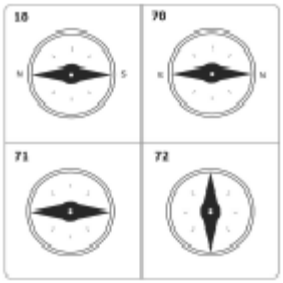
Correct Response

- 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	▲
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	▲
United States	45	▲
Netherlands	44	O
Iran, Islamic Republic of	43	O
Scotland	41	O
International average	**40**	
Jordan	38	O
Moldova, Rep. of	37	O
Italy	33	▼
Macedonia, Republic of	33	▼
Palestinian Nat'l Auth.	33	▼
Lebanon	31	▼
New Zealand	31	▼
Norway	30	▼
Estonia	29	▼
Morocco	28	▼
Israel	27	▼
Indonesia	26	▼
Egypt	26	▼
Slovenia	25	▼
Belgium (Flemish)	25	▼
Tunisia	24	▼
Latvia	23	▼
Lithuania	21	▼
Cyprus	20	▼
Philippines	17	▼
Saudi Arabia	16	▼
Chile	15	▼
Botswana	14	▼
South Africa	5	▼
Ghana	2	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

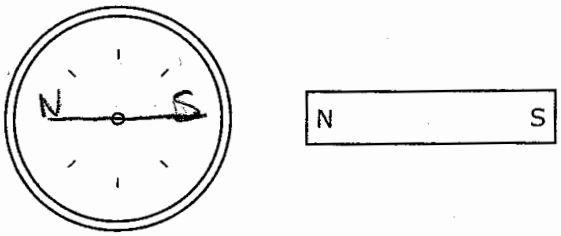
Compass placed next to a magnet/draw (continued)

Item Number: S032625A

Student Responses

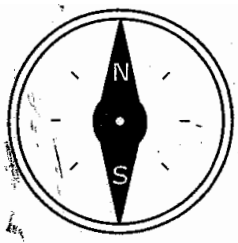
Correct Response:

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.

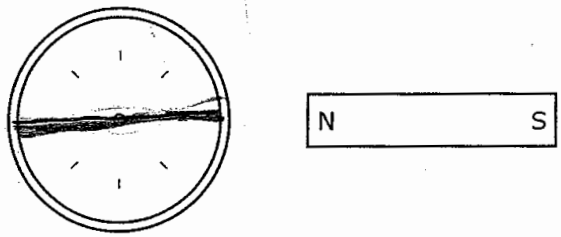


A. Draw the compass needle in the circle on the diagram above. Label the North (N) and South (S) poles of the needle.

Incorrect Response:



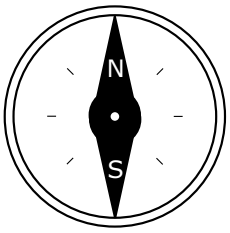
The diagram above shows a compass needle with its North and South poles labeled (N and S). It is placed next to a strong magnet as shown in the diagram below.



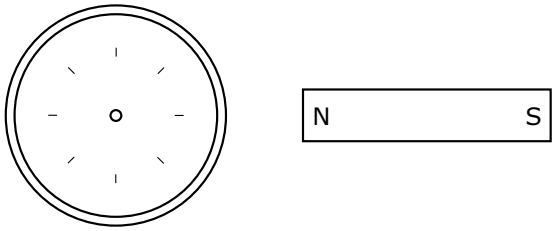
A. Draw the compass needle in the circle on the diagram above. Label the North (N) and South (S) poles of the needle.

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	O
Netherlands	31	O
Jordan	30	O
Palestinian Nat'l Auth.	30	O
International average	**29**	
Russian Federation	29	O
Moldova, Rep. of	28	O
Scotland	28	O
Macedonia, Republic of	21	▼
Italy	20	▼
Indonesia	20	▼
Egypt	17	▼
New Zealand	17	▼
Israel	16	▼
Lebanon	16	▼
Morocco	14	▼
Estonia	13	▼
Norway	13	▼
Botswana	11	▼
Belgium (Flemish)	11	▼
Slovenia	10	▼
Saudi Arabia	9	▼
Tunisia	9	▼
Philippines	8	▼
Latvia	8	▼
Chile	5	▼
Lithuania	5	▼
South Africa	4	▼
Cyprus	4	▼
Ghana	2	▼

Country average vs. International average:

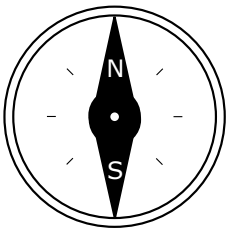
Higher ▲
Not different O
Lower ▼

Compass placed next to a magnet/explain (continued)

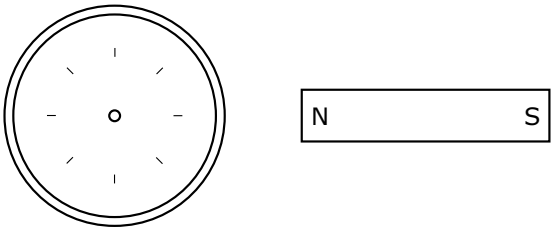
Item Number: S032625B

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.

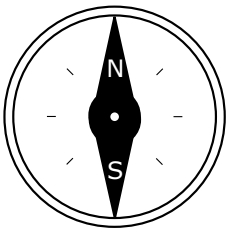
opposites attract and the north side of the magnet is facing the compass so the needle with south on it will point to the magnet

Compass placed next to a magnet/explain (continued)

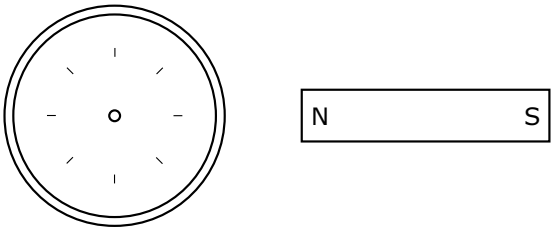
Item Number: S032625B

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.



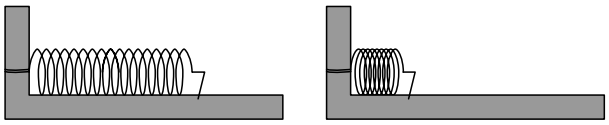
B. Explain your answer using your knowledge of magnets.

As the magnet contacts the magnet moves the opposite way.

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.



1 2

Which spring has more stored energy?

Ⓐ Spring 1

Ⓑ Spring 2

Ⓒ Both springs have the same energy.

Ⓓ You cannot tell unless you know what the springs are made of.

Item Number: S012002

Correct Response: B

Overall Percent Correct

Singapore	84	▲
England	84	▲
Korea, Republic of	84	▲
United States	83	▲
New Zealand	83	▲
Japan	81	▲
Netherlands	79	▲
Australia	78	▲
Scotland	78	▲
Estonia	77	▲
Hungary	75	▲
Italy	75	▲
Norway	74	▲
Lithuania	74	▲
Russian Federation	73	▲
Belgium (Flemish)	71	▲
Sweden	71	▲
Israel	70	▲
Hong Kong, SAR	69	▲
Slovenia	68	▲
Malaysia	67	▲
Latvia	64	O
Chinese Taipei	64	O
Lebanon	63	O
Jordan	63	O
International average	**62**	
Bulgaria	61	O
Armenia	60	O
Chile	59	O
Cyprus	58	O
Indonesia	57	▼
Iran, Islamic Republic of	56	▼
Macedonia, Republic of	56	▼
Serbia and Montenegro	55	▼
Botswana	52	▼
Palestinian Nat'l Auth.	50	▼
Philippines	48	▼
Slovak Republic	47	▼
Morocco	46	▼
Romania	39	▼
South Africa	39	▼
Egypt	39	▼
Moldova, Rep. of	38	▼
Saudi Arabia	37	▼
Ghana	36	▼
Bahrain	35	▼
Tunisia	28	▼

Country average vs. International average:

Higher ▲
Not different O
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	▲
Slovak Republic	78	▲
England	75	▲
Hong Kong, SAR	74	▲
Japan	74	▲
United States	73	▲
Russian Federation	72	▲
Lithuania	72	▲
Netherlands	71	▲
Australia	71	▲
Korea, Republic of	70	▲
Latvia	68	▲
Singapore	67	▲
Estonia	66	▲
Scotland	66	▲
Armenia	66	▲
Belgium (Flemish)	64	▲
Romania	64	▲
Malaysia	63	▲
Moldova, Rep. of	62	▲
Bulgaria	61	▲
New Zealand	57	O
Slovenia	54	O
International average	**52**	
Iran, Islamic Republic of	52	O
Sweden	51	O
Israel	48	O
Norway	47	▼
Jordan	44	▼
Cyprus	44	▼
Serbia and Montenegro	44	▼
Macedonia, Republic of	41	▼
Palestinian Nat'l Auth.	40	▼
Italy	40	▼
Chile	40	▼
Indonesia	39	▼
Bahrain	33	▼
Morocco	27	▼
Tunisia	27	▼
Saudi Arabia	26	▼
Philippines	24	▼
Lebanon	22	▼
Egypt	20	▼
Botswana	11	▼
South Africa	11	▼
Ghana	5	▼

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:

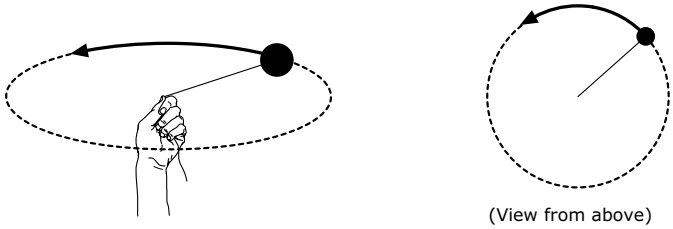
When a nail is pulled out of a wooden board, the nail becomes warm. Explain why.

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

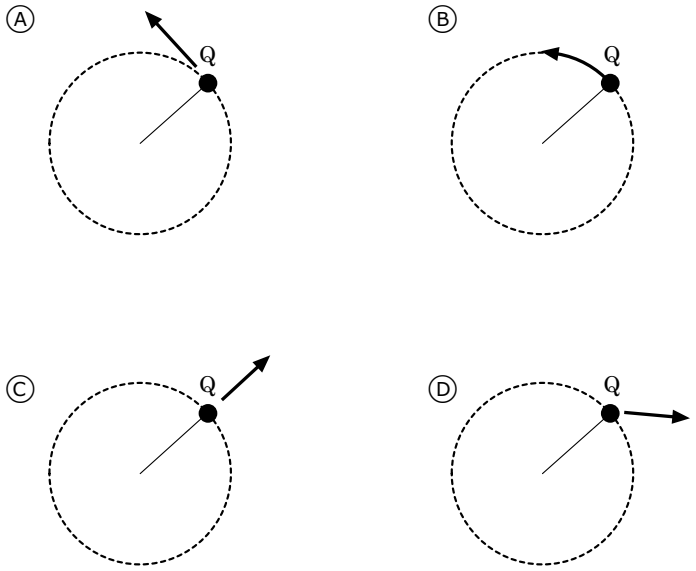
Content Domain	Main Topic	Cognitive Domain
PHYSICS	Forces and Motion	Conceptual Understanding

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	▲
Netherlands	82	▲
Estonia	80	▲
Singapore	79	▲
Australia	77	▲
Japan	77	▲
Hungary	77	▲
Scotland	77	▲
New Zealand	77	▲
Belgium (Flemish)	76	▲
United States	76	▲
Lithuania	75	▲
Malaysia	75	▲
Sweden	74	▲
England	74	▲
Russian Federation	74	▲
Slovak Republic	72	▲
Norway	72	▲
Latvia	71	▲
Slovenia	70	▲
Hong Kong, SAR	69	▲
Chinese Taipei	68	▲
Italy	61	O
Bulgaria	60	O
Serbia and Montenegro	60	O
International average	**60**	
Cyprus	59	O
Israel	58	O
Romania	58	O
Chile	58	O
Armenia	58	O
Macedonia, Republic of	54	▼
Moldova, Rep. of	52	▼
Iran, Islamic Republic of	48	▼
Jordan	47	▼
Indonesia	47	▼
Bahrain	44	▼
Philippines	42	▼
Saudi Arabia	38	▼
Palestinian Nat'l Auth.	36	▼
Morocco	33	▼
Tunisia	31	▼
Egypt	30	▼
Lebanon	30	▼
Botswana	30	▼
South Africa	22	▼
Ghana	22	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

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?

Ⓐ The density of helium is less than the density of air.

Ⓑ The air resistance lifts the balloon up.

Ⓒ There is no gravity acting on helium balloons.

Ⓓ The wind blows the balloon upward.

Item Number: S032281

Correct Response: A

Overall Percent Correct

Korea, Republic of	89	▲
Hungary	88	▲
Slovak Republic	86	▲
Chinese Taipei	86	▲
Estonia	83	▲
Singapore	81	▲
Slovenia	79	▲
Sweden	77	▲
Russian Federation	75	▲
Japan	74	▲
United States	72	▲
Hong Kong, SAR	71	▲
Malaysia	69	▲
Lithuania	69	▲
Norway	69	▲
Scotland	69	▲
Latvia	69	▲
New Zealand	67	▲
England	66	▲
Australia	66	▲
Serbia and Montenegro	65	▲
Romania	65	▲
Italy	61	O
Bulgaria	60	O
International average	**58**	
Netherlands	58	O
Jordan	56	O
Moldova, Rep. of	56	O
Armenia	56	O
Israel	54	▼
Chile	52	▼
Macedonia, Republic of	52	▼
Palestinian Nat'l Auth.	50	▼
Philippines	49	▼
Belgium (Flemish)	49	▼
Lebanon	47	▼
Egypt	45	▼
Bahrain	43	▼
Iran, Islamic Republic of	38	▼
Cyprus	35	▼
Saudi Arabia	33	▼
Indonesia	32	▼
Ghana	28	▼
Botswana	25	▼
South Africa	21	▼
Tunisia	21	▼
Morocco	19	▼

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 (cm^3)	Density of Crown (g/cm^3)
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/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	O
England	34	O
Netherlands	33	O
Israel	33	O
International average	**30**	
Moldova, Rep. of	30	O
Latvia	29	O
Egypt	29	O
Russian Federation	26	▼
Serbia and Montenegro	23	▼
Norway	22	▼
Hungary	22	▼
Cyprus	21	▼
Morocco	21	▼
Tunisia	19	▼
Iran, Islamic Republic of	18	▼
Bahrain	17	▼
Macedonia, Republic of	15	▼
Indonesia	15	▼
Italy	15	▼
Romania	14	▼
Bulgaria	13	▼
Armenia	11	▼
Botswana	10	▼
Philippines	8	▼
Chile	6	▼
Lebanon	6	▼
South Africa	6	▼
Ghana	5	▼
Saudi Arabia	1	▼

Country average vs. International average:

Higher ▲
Not different O
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 (cm^3)	Density of Crown (g/cm^3)
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?

To test more than once to see if their answers are close to the other answers.

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 (cm^3)	Density of Crown (g/cm^3)
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?

To see if they got a different answer, or they might of used a different object to measure,

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 (cm^3)	Density of Crown (g/cm^3)
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/cm^3. 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	O
Norway	14	O
Slovenia	14	O
International average	**14**	
Israel	13	O
Moldova, Rep. of	13	O
Hungary	12	▼
Serbia and Montenegro	11	▼
Slovak Republic	10	▼
Russian Federation	10	O
Cyprus	9	▼
Bulgaria	9	▼
Romania	7	▼
Jordan	7	▼
Macedonia, Republic of	7	▼
Armenia	6	▼
Italy	6	▼
Lebanon	6	▼
Indonesia	4	▼
Tunisia	4	▼
Philippines	4	▼
Egypt	4	▼
Bahrain	3	▼
Palestinian Nat'l Auth.	3	▼
Chile	3	▼
Morocco	3	▼
Botswana	2	▼
Iran, Islamic Republic of	2	▼
South Africa	1	▼
Ghana	1	▼
Saudi Arabia	0	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

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

Item Number: S032712B

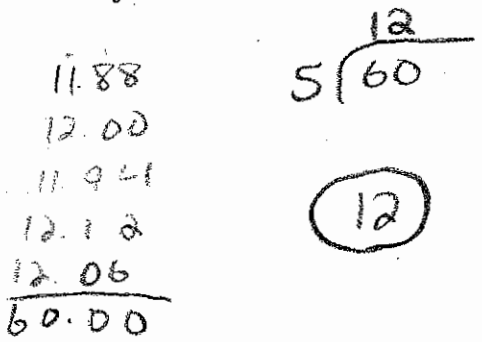
Student Responses

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 (cm^3)	Density of Crown (g/cm^3)
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/cm^3. 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 (cm^3)	Density of Crown (g/cm^3)
1	202	11.88
2	200	12.00
3	201	11.94
4	198	12.12
5	199	12.06

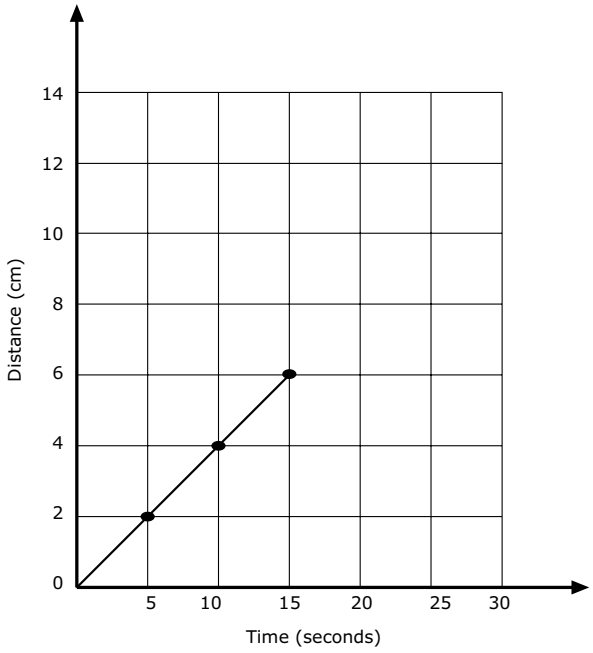
B. The scientists reported to the king that the density of the crown was 12.0 g/cm^3. Show how the scientists used their results to obtain this value for the density.

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?

Ⓐ 4 seconds

Ⓑ 6 seconds

Ⓒ 20 seconds

Ⓓ 25 seconds

Item Number: S022041

Correct Response: D

Overall Percent Correct

Netherlands	91	▲
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	O
Chile	73	O
Moldova, Rep. of	73	O
Bulgaria	71	O
International average	**71**	
Lebanon	70	O
Cyprus	68	O
Slovak Republic	68	O
Romania	67	O
Botswana	64	▼
Macedonia, Republic of	64	▼
Morocco	61	▼
Indonesia	61	▼
Bahrain	58	▼
Iran, Islamic Republic of	56	▼
Armenia	56	▼
Serbia and Montenegro	55	▼
Tunisia	55	▼
Jordan	54	▼
Philippines	52	▼
Egypt	51	▼
Palestinian Nat'l Auth.	44	▼
Saudi Arabia	40	▼
South Africa	35	▼
Ghana	32	▼

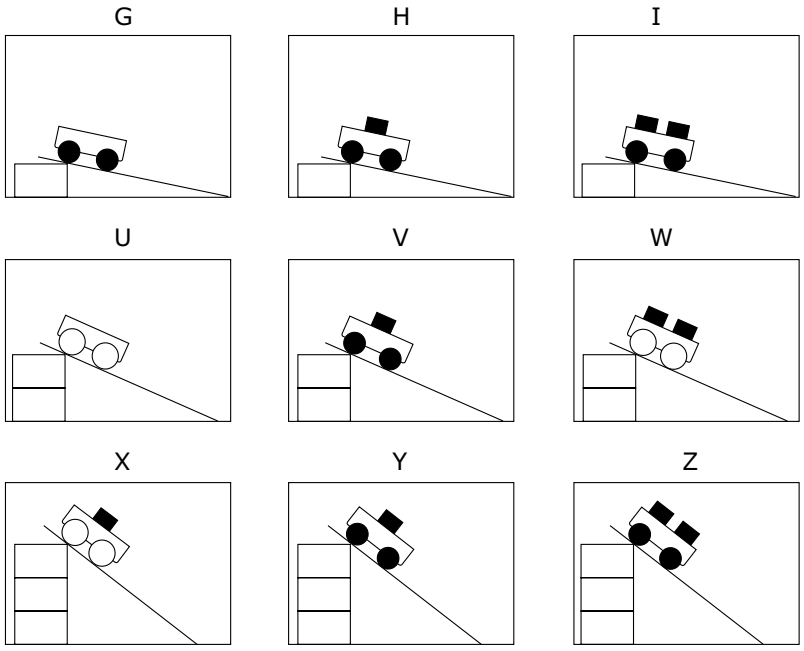
Country average vs. International average:

Higher ▲
Not different O
Lower ▼

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?

Ⓐ G, H and I
Ⓑ I, W and Z
Ⓒ I, V and X
Ⓓ U, W and X
Ⓔ H, V and Y

Item Number: S022222

Correct Response: E

Overall Percent Correct

Singapore	79	▲
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	O
Armenia	45	O
Italy	44	O
International average	**43**	
Slovak Republic	43	O
Latvia	42	O
Norway	41	O
Israel	41	O
Serbia and Montenegro	39	▼
Bahrain	37	▼
Romania	36	▼
Bulgaria	36	▼
Jordan	35	▼
Cyprus	34	▼
Chile	33	▼
Saudi Arabia	32	▼
Macedonia, Republic of	31	▼
Lebanon	31	▼
Iran, Islamic Republic of	31	▼
Moldova, Rep. of	30	▼
Philippines	30	▼
Palestinian Nat'l Auth.	25	▼
Indonesia	25	▼
Egypt	23	▼
Botswana	23	▼
Tunisia	23	▼
Morocco	22	▼
South Africa	18	▼
Ghana	18	▼

Country average vs. International average:

Higher ▲
Not different O
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

Singapore	75	▲
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	**42**	
Israel	41	O
Moldova, Rep. of	40	O
Belgium (Flemish)	39	O
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	▼
Botswana	7	▼
South Africa	6	▼
Ghana	2	▼

Country average vs. International average:

Higher ▲
Not different O
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 length 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. it got longer as you hung heavier things from it.