Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Acids and Bases	Conceptual Understanding

Litmus test

A solution of hydrochloric acid (HCl) in water will turn blue litmus paper red. A solution of the base sodium hydroxide (NaOH) in water will turn red litmus paper blue. If the acid and base solutions above are mixed in the right proportion, the resulting solution will cause neither red nor blue litmus paper to change color.

Explain why the litmus paper does not change color in the mixed solution.

Item Number: S032057

SCORING

Note: To receive credit, responses must refer to neutralization or a chemical reaction that results in products that do not react with litmus paper.

Correct Response

- Explanation refers explicitly to the formation of **water** (and salt) from the neutralization reaction.
  Examples: *Hydrochloric acid and sodium hydroxide will mix together to form water and salt, which is neutral.*
  The hydrogen ions combine with the hydroxide ions to form water, so the litmus paper does not change color.
- Explanation refers explicitly to **neutralization** (or equivalent), but the specific reaction is not mentioned.
  Examples: *When you mix acid and alkali, the mixture becomes neutral and has a pH of 7.*
  The HCl neutralizes the NaOH, and the NaOH neutralizes the HCl.
  The mixed solution is neutral, so litmus paper does not react.
  Acid + base = neutral solution
  There is a neutralization reaction.
- Explanation refers to a chemical reaction taking place (implicitly or explicitly) to form products that do not react with litmus paper (or similar). [Neutralization is not explicitly mentioned.]
  Examples: *The acid and base react, and the new chemicals do not react with litmus paper.*
  The chemicals that change the litmus paper must have a chemical reaction to each other. Therefore they will not change the color of the paper anymore.
  They form a new solution that has different properties and doesn't react with litmus.
- Other correct.

Incorrect Response

- Mentions **only** that acid and base are "balanced", "opposites", "cancel each other", or similar.
  Examples: *The acid and base are opposites and counteract so they cancel each other out.*
  The acid tries to turn it red and the base just turns it blue again at the same time. Because they're balanced out and equal.
- Other incorrect (including crossed out/erased, stray marks, illegible, or off task).

Overall Percent Correct

Chinese Taipei	73	▲
Hong Kong, SAR	66	▲
Japan	64	▲
Singapore	56	▲
Malaysia	50	▲
Hungary	46	▲
England	39	▲
Korea, Republic of	39	▲
Sweden	34	▲
Egypt	31	▲
Scotland	25	O
Estonia	25	O
Norway	25	O
Russian Federation	23	O
Slovak Republic	22	O
Bulgaria	21	O
International average	**21**	
Moldova, Rep. of	21	O
Jordan	20	O
Armenia	20	O
Palestinian Nat'l Auth.	20	O
Romania	18	O
United States	17	▼
Israel	16	▼
Lithuania	15	▼
Cyprus	15	▼
Macedonia, Republic of	14	▼
Slovenia	14	▼
New Zealand	13	▼
Bahrain	13	▼
Latvia	13	▼
Australia	13	▼
Italy	12	▼
Iran, Islamic Republic of	12	▼
Serbia and Montenegro	12	▼
Lebanon	9	▼
Chile	7	▼
Netherlands	7	▼
Belgium (Flemish)	5	▼
Ghana	4	▼
Morocco	4	▼
Philippines	3	▼
South Africa	3	▼
Indonesia	3	▼
Saudi Arabia	2	▼
Tunisia	2	▼
Botswana	2	▼

Country average vs. International average:

Higher	▲
Not different	O
Lower	▼

Litmus test (continued)

Item Number: S032057

Student Responses

Correct Response:

A solution of hydrochloric acid (HCl) in water will turn blue litmus paper red. A solution of the base sodium hydroxide (NaOH) in water will turn red litmus paper blue. If the acid and base solutions above are mixed in the right proportion, the resulting solution will cause neither red nor blue litmus paper to change color.

Explain why the litmus paper does not change color in the mixed solution.

The chemicals have combined a new solution

Incorrect Response:

A solution of hydrochloric acid (HCl) in water will turn blue litmus paper red. A solution of the base sodium hydroxide (NaOH) in water will turn red litmus paper blue. If the acid and base solutions above are mixed in the right proportion, the resulting solution will cause neither red nor blue litmus paper to change color.

Explain why the litmus paper does not change color in the mixed solution.

Because both acids are formed as one mean that no color will show up

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Chemical Change	Conceptual Understanding

Fanning a wood fire

Fanning can make a wood fire burn hotter because the fanning

Ⓐ makes the wood hot enough to burn

Ⓑ adds more oxygen needed for burning

Ⓒ increases the amount of wood there is to burn

Ⓓ provides the energy needed to keep the fire going

Item Number: S012003

Correct Response: B

Overall Percent Correct

Japan	94	▲
Sweden	93	▲
Hungary	91	▲
Hong Kong, SAR	90	▲
Chinese Taipei	88	▲
Netherlands	87	▲
Estonia	86	▲
Norway	85	▲
New Zealand	84	▲
Australia	84	▲
England	83	▲
Italy	83	▲
Scotland	82	▲
Russian Federation	82	▲
Belgium (Flemish)	82	▲
Singapore	81	▲
United States	80	▲
Bulgaria	80	▲
Latvia	79	▲
Malaysia	78	▲
Slovak Republic	78	▲
Korea, Republic of	76	▲
Israel	76	▲
Slovenia	76	▲
Romania	73	O
Lithuania	72	O
International average	**70**	
Moldova, Rep. of	67	O
Iran, Islamic Republic of	66	O
Serbia and Montenegro	64	▼
Jordan	64	▼
Cyprus	62	▼
Macedonia, Republic of	61	▼
Chile	60	▼
Armenia	58	▼
Indonesia	57	▼
Bahrain	56	▼
Palestinian Nat'l Auth.	55	▼
Egypt	53	▼
Morocco	50	▼
Tunisia	49	▼
Lebanon	46	▼
Saudi Arabia	43	▼
Ghana	38	▼
Philippines	35	▼
Botswana	34	▼
South Africa	33	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Chemical Change	Conceptual Understanding

Reactions releasing energy

Some chemical reactions absorb energy, while others release energy. Of the chemical reactions in burning coal and exploding fireworks, which will release energy?

Ⓐ Burning coal only

Ⓑ Exploding fireworks only

Ⓒ Both burning coal and exploding fireworks

Ⓓ Neither burning coal nor exploding fireworks

Item Number: S022188

Correct Response: C

Overall Percent Correct

Chinese Taipei	77	▲
Hong Kong, SAR	74	▲
Singapore	68	▲
Scotland	65	▲
United States	65	▲
Estonia	64	▲
England	62	▲
Tunisia	61	▲
Palestinian Nat'l Auth.	59	▲
Israel	59	▲
Iran, Islamic Republic of	59	▲
Malaysia	58	▲
Slovak Republic	58	▲
Australia	57	▲
Cyprus	57	▲
New Zealand	56	O
Chile	56	▲
Philippines	55	▲
Jordan	54	O
Hungary	53	O
Latvia	53	O
Russian Federation	52	O
International average	**52**	
Sweden	51	O
Slovenia	50	O
Egypt	50	O
Norway	49	O
Lithuania	49	O
Romania	47	▼
Ghana	47	▼
Belgium (Flemish)	47	▼
Lebanon	47	O
Italy	47	▼
Macedonia, Republic of	46	▼
Armenia	46	▼
Saudi Arabia	45	▼
Bahrain	44	▼
Moldova, Rep. of	44	▼
Netherlands	42	▼
Botswana	42	▼
Japan	41	▼
Indonesia	40	▼
Serbia and Montenegro	39	▼
Korea, Republic of	38	▼
South Africa	36	▼
Bulgaria	36	▼
Morocco	35	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Chemical Change	Conceptual Understanding

Chemical change involving elements

Which is a chemical change?

Ⓐ Element 1 is polished to form a smooth surface.

Ⓑ Element 2 is heated and evaporates.

Ⓒ Element 3 develops a white, powdery surface after standing in air.

Ⓓ Element 4 is separated from a mixture by filtration.

Item Number: S022198

Correct Response: C

Overall Percent Correct

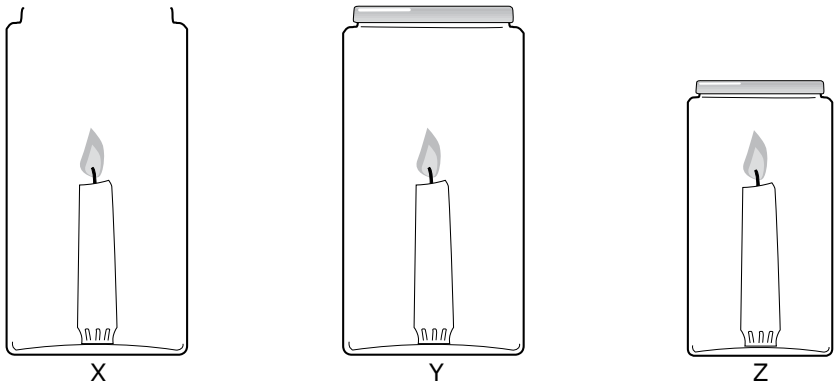
Chinese Taipei	73	▲
Singapore	60	▲
Hong Kong, SAR	52	▲
Malaysia	51	▲
Hungary	48	▲
Jordan	47	▲
Iran, Islamic Republic of	47	▲
England	46	▲
Japan	45	▲
Korea, Republic of	44	▲
Netherlands	43	▲
Palestinian Nat'l Auth.	41	▲
Armenia	40	▲
Russian Federation	39	▲
Bulgaria	39	O
Australia	39	▲
Belgium (Flemish)	38	O
Slovenia	36	O
New Zealand	34	O
Italy	34	O
International average	**34**	
Scotland	33	O
United States	33	O
Moldova, Rep. of	33	O
Estonia	32	O
Cyprus	32	O
Israel	30	▼
Tunisia	30	▼
Lebanon	30	▼
Serbia and Montenegro	30	▼
Macedonia, Republic of	30	▼
Norway	29	▼
South Africa	28	▼
Philippines	28	▼
Egypt	28	▼
Botswana	27	▼
Latvia	27	▼
Bahrain	25	▼
Romania	24	▼
Indonesia	24	▼
Saudi Arabia	22	▼
Sweden	22	▼
Slovak Republic	21	▼
Ghana	19	▼
Lithuania	19	▼
Morocco	15	▼
Chile	15	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Chemical Change	Reasoning and Analysis

Candles burning in 3 jars



Three identical candles are placed in the three jars shown above and lit at the same time. Jars Y and Z are then sealed with lids, and Jar X is left open.

Which candle flame will go out first (X, Y, or Z)? _____

Explain your answer.

Item Number: S022191

SCORING

Note: For full credit, responses must identify **Z** and include an explanation that explicitly mentions the need for **oxygen** (for combustion or burning). Responses may also mention that the supply runs out faster in the smaller sealed jar, but it is not required for full credit. Responses referring to the need for air (explicitly or using non-scientific language) are given partial credit. Responses mentioning **only** smoke (fumes, carbon dioxide, etc.) build-up or **heat** should be scored as incorrect.

Correct Response

- Z. Explanation refers to the need for oxygen (for burning).
  Examples: Z. The flame in the smaller jar will go out first since it has the least oxygen in it.
  Z. Oxygen is needed for the candle to burn.
  Z. It has less oxygen.
- Other fully correct.

Overall Percent Correct

Netherlands	82	▲
Estonia	79	▲
Sweden	78	▲
Singapore	78	▲
Lithuania	75	▲
Hungary	72	▲
Norway	72	▲
Belgium (Flemish)	71	▲
Russian Federation	69	▲
Japan	69	▲
England	66	▲
Italy	64	▲
Hong Kong, SAR	62	▲
Slovenia	62	▲
Chinese Taipei	60	▲
Israel	58	▲
Latvia	57	▲
Australia	57	▲
Slovak Republic	55	▲
Scotland	54	▲
New Zealand	53	▲
Korea, Republic of	52	▲
United States	48	O
Serbia and Montenegro	48	O
International average	**47**	
Malaysia	45	O
Macedonia, Republic of	44	O
Lebanon	44	O
Bulgaria	43	O
Cyprus	43	▼
Romania	42	▼
Tunisia	41	▼
Jordan	38	▼
Egypt	34	▼
Chile	32	▼
Bahrain	31	▼
Armenia	30	▼
Moldova, Rep. of	29	▼
Morocco	28	▼
Palestinian Nat'l Auth.	27	▼
Saudi Arabia	23	▼
Iran, Islamic Republic of	20	▼
Indonesia	12	▼
South Africa	9	▼
Philippines	5	▼
Botswana	3	▼
Ghana	1	▼

Country average vs. International average:

Higher	▲
Not different	O
Lower	▼

Candles burning in 3 jars (continued)

Item Number: S022191

SCORING (continued)

Partially Correct Response

- Z. Explanation refers to lack of air (gas) explicitly or using non-scientific language (e.g. suffocation, smothering, choking, etc.). (No explicit mention of oxygen.)
  Examples: Z. The flame in the smallest jar will be suffocated first.
  Z. It does not have enough air to breath.
  Since Z is the smallest jar, it will have less air in order to burn.
  Z. It gets smothered as the carbon dioxide increases.
- Indicates both Y AND Z (Y, Z; Y or Z; Y/Z etc.). Explanation based on the need for oxygen or air.
  Examples: Y and Z. The flame needs oxygen for it to burn, and both of these jars will run out of it.
  Y, Z. The closed jars do not get any air.
  Y or Z. They do not get any oxygen.
- Other partially correct.

Incorrect Response

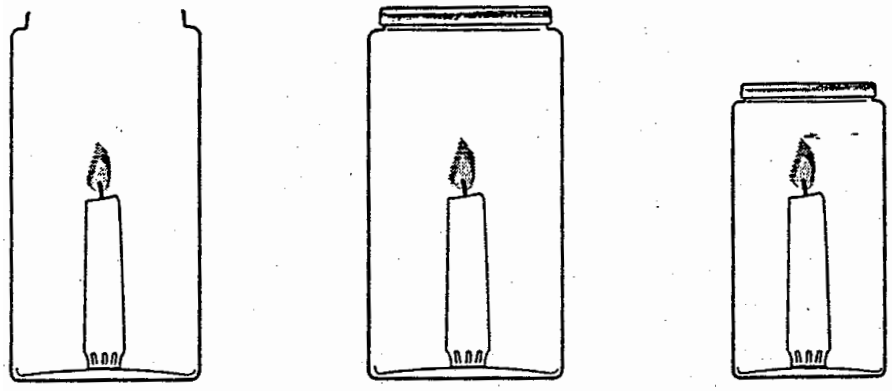
- Z with no explanation or an incorrect explanation.
  Examples: Z. This jar will have the smallest flame since it is in the smallest jar.
  Z. The smoke cannot escape, so the flame dies.
  Z. The carbon dioxide level builds up too much.
  Z. The candle wants to let off heat, so it bursts.
- X. Explanation based on the candle being blown out (or similar).
  Examples: X. A person walking past the candle might cause it to blow out.
  X. If the jar is not closed, it goes out from the wind.
- X OR Y with no explanation or any other incorrect explanation.
- Other incorrect (including crossed out/erased, stray marks, illegible, or off task).

Candles burning in 3 jars (continued)

Item Number: S022191

Student Responses

Correct Response:



Three identical candles are placed in the three jars shown above and lit at the same time. Jars Y and Z are then sealed with lids, and jar X is left open.

Which candle will go out first (X, Y, or Z)? Z

Explain your answer.

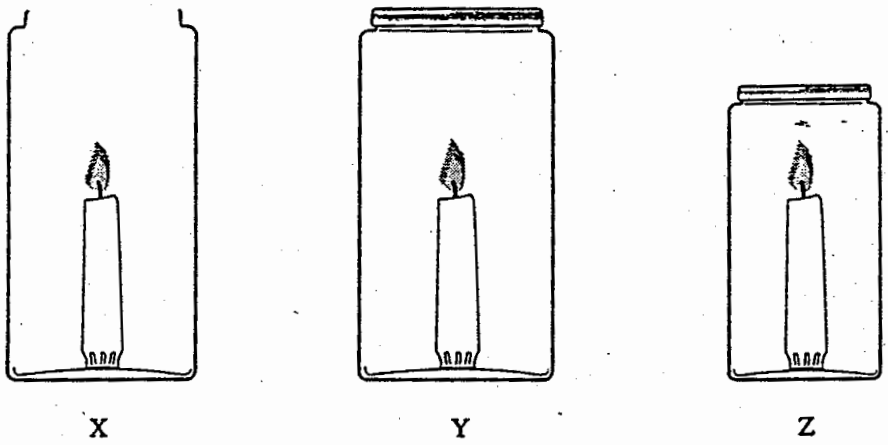
Z because fire needs oxygen to stay lit with the lid being sealed no oxygen can get in. There is a little bit of air in there for it to stay lit. Since Z is the smaller than Y, Z would go out first

Candles burning in 3 jars (continued)

Item Number: S022191

Student Responses (continued)

Partial Response:



Three identical candles are placed in the three jars shown above and lit at the same time. Jars Y and Z are then sealed with lids, and jar X is left open.

Which candle will go out first (X, Y, or Z)? Z

Explain your answer.

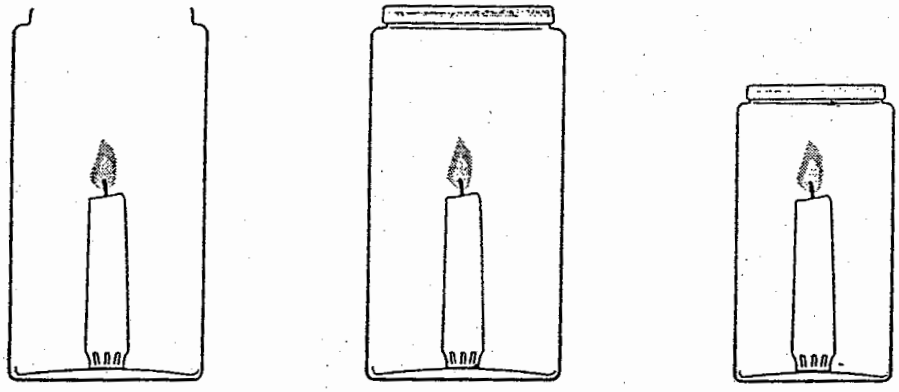
Fire needs Air to burn without it, it will go out. Since it is the smallest jar it has less air. Once the air is burned up the the fire will go out.

Candles burning in 3 jars (continued)

Item Number: S022191

Student Responses (continued)

Incorrect Response:



Three identical candles are placed in the three jars shown above and lit at the same time. Jars Y and Z are then sealed with lids, and jar X is left open.

Which candle will go out first (X, Y. or Z)? Y, Z

Explain your answer.

because they are both closed and the oxygen is trapped so then they will both go out.

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Classification and Composition of Matter	Conceptual Understanding

NOT a mixture

Which of the following is NOT a mixture?

Ⓐ Smoke

Ⓑ Sugar

Ⓒ Milk

Ⓓ Paint

Item Number: S022187

Correct Response: B

Overall Percent Correct

Chinese Taipei	64	▲
Sweden	58	▲
Estonia	57	▲
Jordan	56	▲
Netherlands	56	▲
Korea, Republic of	56	▲
Singapore	55	▲
Slovak Republic	53	▲
Hungary	51	▲
Slovenia	51	▲
Australia	50	▲
Palestinian Nat'l Auth.	50	▲
New Zealand	49	▲
Norway	49	▲
Russian Federation	48	▲
Belgium (Flemish)	48	▲
Japan	48	▲
Israel	47	▲
United States	46	▲
Lithuania	45	▲
England	45	▲
Italy	43	O
Scotland	40	O
International average	**40**	
Serbia and Montenegro	40	O
Moldova, Rep. of	40	O
Bahrain	39	O
Bulgaria	37	O
Saudi Arabia	36	▼
Latvia	35	▼
Lebanon	35	▼
Hong Kong, SAR	34	▼
Malaysia	34	▼
Armenia	33	▼
Romania	33	▼
Indonesia	30	▼
Iran, Islamic Republic of	30	▼
Macedonia, Republic of	30	▼
Tunisia	29	▼
Cyprus	28	▼
Morocco	27	▼
Chile	26	▼
Egypt	25	▼
Philippines	18	▼
Ghana	16	▼
Botswana	16	▼
South Africa	15	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Classification and Composition of Matter	Conceptual Understanding

Solution half as concentrated

David makes a solution by dissolving 10 grams of salt in 100 ml of water. He wants a solution that is half as concentrated. What should he add to the original solution to obtain a solution that is about half as concentrated?

Ⓐ 50 ml of water

Ⓑ 100 ml of water

Ⓒ 5 grams of salt

Ⓓ 10 grams of salt

Item Number: S032564

Correct Response: B

Overall Percent Correct

Latvia	55	▲
Hungary	50	▲
Estonia	50	▲
Lithuania	46	▲
Chinese Taipei	46	▲
Japan	46	▲
Hong Kong, SAR	46	▲
Russian Federation	43	▲
Sweden	42	▲
Korea, Republic of	40	▲
Belgium (Flemish)	40	▲
Moldova, Rep. of	40	▲
Singapore	40	▲
Bulgaria	38	▲
Netherlands	38	▲
Slovenia	35	▲
Australia	33	O
England	32	O
New Zealand	32	O
Serbia and Montenegro	31	O
Romania	31	O
International average	**30**	
Norway	30	O
Italy	29	O
Slovak Republic	27	O
Scotland	27	O
United States	26	▼
South Africa	25	▼
Israel	24	▼
Egypt	23	▼
Cyprus	22	▼
Bahrain	21	▼
Lebanon	21	▼
Iran, Islamic Republic of	20	▼
Macedonia, Republic of	18	▼
Malaysia	18	▼
Ghana	18	▼
Philippines	18	▼
Saudi Arabia	17	▼
Morocco	16	▼
Botswana	15	▼
Indonesia	14	▼
Chile	13	▼
Tunisia	13	▼
Armenia	12	▼
Palestinian Nat'l Auth.	0	▼
Jordan	0	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Classification and Composition of Matter	Conceptual Understanding

Which substances are elements

Oxygen, hydrogen, and water are substances.
Which of these substances are elements?

Ⓐ oxygen, hydrogen and water

Ⓑ oxygen and hydrogen only

Ⓒ oxygen only

Ⓓ water only

Item Number: S032574

Correct Response: B

Overall Percent Correct

Slovak Republic	76	▲
Chinese Taipei	75	▲
Estonia	73	▲
Hungary	71	▲
Singapore	67	▲
Korea, Republic of	66	▲
Serbia and Montenegro	66	▲
Slovenia	66	▲
Israel	64	▲
Japan	64	▲
Lithuania	64	▲
Latvia	64	▲
Russian Federation	62	▲
Macedonia, Republic of	60	▲
Armenia	58	▲
Sweden	57	▲
Moldova, Rep. of	55	O
New Zealand	54	O
United States	54	▲
Romania	53	O
Morocco	50	O
International average	**49**	
Bulgaria	48	O
Jordan	48	O
England	45	O
Ghana	45	O
Cyprus	45	O
Malaysia	43	▼
Australia	42	▼
Palestinian Nat'l Auth.	41	▼
Scotland	40	▼
Hong Kong, SAR	38	▼
Italy	38	▼
Egypt	37	▼
Philippines	37	▼
Botswana	37	▼
Bahrain	36	▼
Netherlands	35	▼
Iran, Islamic Republic of	33	▼
Chile	32	▼
Indonesia	32	▼
South Africa	31	▼
Norway	31	▼
Lebanon	29	▼
Saudi Arabia	28	▼
Belgium (Flemish)	27	▼
Tunisia	0	▼

Country average vs. International average:

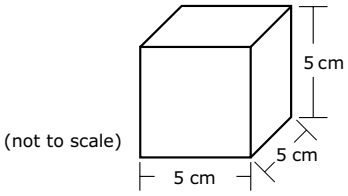
Higher ▲
Not different O
Lower ▼

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Classification and Composition of Matter	Conceptual Understanding

Metal crown: density of metal block

The scientists decided to compare the densities of the crown and a block of metal just like the original block. The density of a substance is the mass of a sample of the substance divided by its volume (density = mass/volume).

The scientists found the volume of the block and computed its density based on its known mass (2,400 g). The diagram below shows the dimensions of the block of metal that the scientists measured.



What is the density of the block of metal?

Answer: _____ g/cm^3

Item Number: S032709

SCORING

Correct Response

- 19.2 g/cm^3
- 19 g/cm^3 [Rounds to nearest whole unit.]

Incorrect Response

- Shows the set-up for density (mass/volume) but does not compute density or makes a computational error.
- 125 [Computes volume but not density.]
- 19.3 [No work shown ; indicates density copied from table.]
- Other incorrect (including crossed out/erased, stray marks, illegible or off task).

Overall Percent Correct

Singapore	64	▲
Hong Kong, SAR	53	▲
Japan	47	▲
Chinese Taipei	43	▲
Hungary	40	▲
Armenia	40	▲
Lithuania	39	▲
Estonia	38	▲
Korea, Republic of	33	▲
Russian Federation	33	▲
Belgium (Flemish)	31	▲
Italy	30	▲
Slovak Republic	29	▲
Latvia	28	▲
Netherlands	28	▲
England	26	O
Sweden	26	▲
United States	25	▲
Slovenia	23	O
Moldova, Rep. of	23	O
Romania	22	O
International average	**21**	
Australia	20	O
Scotland	20	O
Serbia and Montenegro	20	O
Malaysia	18	▼
Palestinian Nat'l Auth.	17	▼
New Zealand	17	O
Jordan	17	▼
Macedonia, Republic of	16	▼
Israel	16	▼
Bulgaria	11	▼
Cyprus	10	▼
Bahrain	10	▼
Norway	10	▼
Egypt	9	▼
Lebanon	9	▼
Chile	6	▼
Botswana	6	▼
Indonesia	6	▼
Philippines	5	▼
Tunisia	5	▼
Morocco	4	▼
Iran, Islamic Republic of	2	▼
South Africa	2	▼
Saudi Arabia	1	▼
Ghana	1	▼

Country average vs. International average:

Higher	▲
Not different	O
Lower	▼

Metal crown: density of metal block (continued)

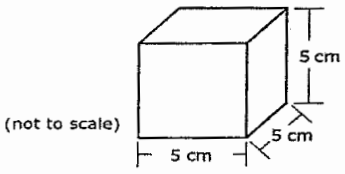
Item Number: S032709

Student Responses

Correct Response:

The scientists decided to compare the densities of the crown and a block of metal just like the original block. The density of a substance is the mass of a sample of the substance divided by its volume (density = mass/volume).

The scientists found the volume of the block and computed its density based on its known mass (2400g). The diagram below shows the dimensions of the block of metal that the scientists measured.



What is the density of the block of metal?

Answer: _____ g/cm^3

GIVEN:

$M = 2400$

$V = 5 * 5 \times 5$

$= 125\ cm^3$

FORMULA

$$D = \frac{M}{V} = \frac{2400\ g}{125\ cm^3} = 19.2\ g/cm^3$$

Metal crown: density of metal block (continued)

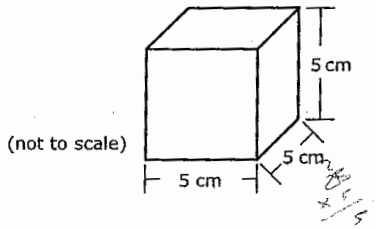
Item Number: S032709

Student Responses (continued)

Incorrect Response:

The scientists decided to compare the densities of the crown and a block of metal just like the original block. The density of a substance is the mass of a sample of the substance divided by its volume (density = mass/volume).

The scientists found the volume of the block and computed its density based on its known mass (2,400 g). The diagram below shows the dimensions of the block of metal that the scientists measured.



What is the density of the block of metal?

Answer: 160 g/cm^3

$D = \frac{m}{V} = \frac{2400\text{g}}{15}$

160
15|2400
-2 400
0

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Classification and Composition of Matter	Factual Knowledge

Substance type of black/white powder

A powder made up of both white specks and black specks is likely to be

Ⓐ a solution

Ⓑ a pure compound

Ⓒ a mixture

Ⓓ an element

Item Number: S012016

Correct Response: C

Overall Percent Correct

Lithuania	92	▲
Hungary	90	▲
Estonia	90	▲
Slovenia	88	▲
Slovak Republic	88	▲
Latvia	84	▲
Netherlands	84	▲
Sweden	84	▲
Japan	83	▲
Bulgaria	82	▲
United States	82	▲
Romania	81	▲
Singapore	80	▲
Israel	79	▲
Moldova, Rep. of	79	▲
Chinese Taipei	79	▲
Belgium (Flemish)	78	▲
England	77	▲
Australia	77	▲
Korea, Republic of	77	▲
Russian Federation	77	▲
Hong Kong, SAR	75	▲
Macedonia, Republic of	74	O
Serbia and Montenegro	74	O
Armenia	74	O
International average	**72**	
Italy	70	O
New Zealand	70	O
Malaysia	69	O
Scotland	68	O
Tunisia	67	▼
Jordan	67	▼
Palestinian Nat'l Auth.	66	▼
Norway	65	▼
Chile	65	▼
Botswana	64	▼
Egypt	63	▼
Lebanon	63	▼
Bahrain	63	▼
Morocco	60	▼
Iran, Islamic Republic of	60	▼
Saudi Arabia	59	▼
Philippines	58	▼
Cyprus	57	▼
Ghana	52	▼
Indonesia	50	▼
South Africa	48	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Classification and Composition of Matter	Factual Knowledge

Reaction of chlorine and sodium

When chlorine gas reacts with sodium metal, what type of substance is formed?

Ⓐ A mixture
Ⓑ A compound
Ⓒ An element
Ⓓ An alloy
Ⓔ A solution

Item Number: S022206

Correct Response: B

Overall Percent Correct

Bulgaria	68	▲
Cyprus	63	▲
Bahrain	60	▲
Lithuania	59	▲
Chinese Taipei	59	▲
Slovenia	59	▲
Singapore	58	▲
Japan	56	▲
Hungary	56	▲
Estonia	55	▲
Sweden	55	▲
Armenia	55	▲
Egypt	53	▲
Russian Federation	53	▲
Latvia	51	▲
Jordan	50	▲
Lebanon	50	▲
Slovak Republic	50	▲
Serbia and Montenegro	50	▲
Israel	49	▲
Korea, Republic of	49	▲
England	47	▲
Scotland	47	▲
Palestinian Nat'l Auth.	45	▲
Macedonia, Republic of	44	O
United States	42	O
International average	**41**	
Moldova, Rep. of	37	▼
Italy	36	▼
Saudi Arabia	35	▼
New Zealand	34	▼
Romania	33	▼
Chile	33	▼
Hong Kong, SAR	32	▼
Malaysia	32	▼
Australia	32	▼
Indonesia	30	▼
Tunisia	28	▼
Ghana	26	▼
Belgium (Flemish)	24	▼
Iran, Islamic Republic of	23	▼
Philippines	23	▼
South Africa	18	▼
Botswana	13	▼
Morocco	13	▼
Netherlands	13	▼
Norway	11	▼

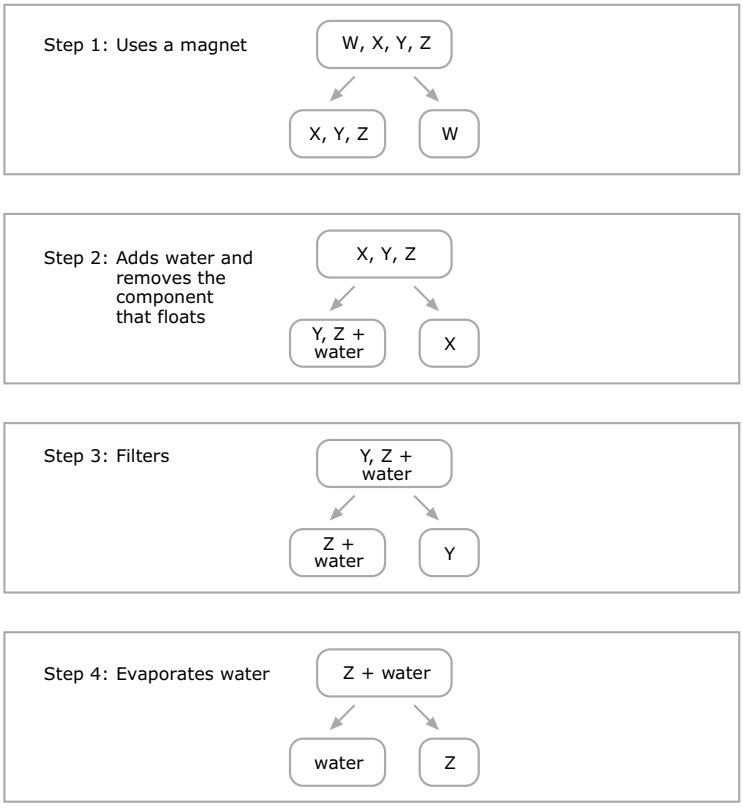
Country average vs. International average:

Higher ▲
Not different O
Lower ▼

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Classification and Composition of Matter	Reasoning and Analysis

Separation of salt/sand/iron filings mixture

Teresa is given a mixture of salt, sand, iron filings, and small pieces of cork. She separates the mixture using a 4-step procedure as shown in the diagram. The letters W, X, Y, and Z are used to stand for the four components but do not indicate which letter stands for which component.



Identify what each component is by writing *salt, sand, iron,* or *cork* in the correct spaces below

Component W is: _____

Component X is: _____

Component Y is: _____

Component Z is: _____

Item Number: S032562

Overall Percent Correct

Singapore	68	▲
Chinese Taipei	67	▲
Japan	58	▲
Hong Kong, SAR	58	▲
Estonia	56	▲
Korea, Republic of	54	▲
Hungary	51	▲
Slovak Republic	51	▲
Latvia	49	▲
England	48	▲
Scotland	48	▲
Netherlands	47	▲
Sweden	47	▲
Lithuania	47	▲
New Zealand	46	▲
Malaysia	46	▲
Russian Federation	45	▲
Australia	44	▲
Belgium (Flemish)	44	▲
Armenia	42	▲
Slovenia	41	O
Italy	39	O
United States	35	O
Jordan	35	O
Romania	35	O
International average	**34**	
Moldova, Rep. of	34	O
Israel	33	O
Norway	26	▼
Lebanon	26	▼
Chile	26	▼
Iran, Islamic Republic of	25	▼
Bahrain	23	▼
Egypt	22	▼
Bulgaria	21	▼
Palestinian Nat'l Auth.	20	▼
Serbia and Montenegro	20	▼
Cyprus	19	▼
Tunisia	15	▼
Saudi Arabia	14	▼
Macedonia, Republic of	14	▼
Indonesia	12	▼
Philippines	11	▼
South Africa	8	▼
Botswana	7	▼
Morocco	6	▼
Ghana	6	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

Separation of salt/sand/iron filings mixture (continued)

Item Number: S032562

SCORING

Note: To receive full credit, responses must correctly identify all four components. Partial credit is given for responses that list at least two components correctly. If a component is listed more than once, none of the entries for that component will be considered as correct. For example, a response that lists Iron, Salt, Salt, Salt is incorrect.

Correct Response

- Identifies all four components correctly: W = iron; X = cork; Y = sand; Z = salt.

Partially Correct Response

- Identifies iron and cork correctly (W and X); sand and/or salt are missing or incorrect.
  Examples: Iron, Cork, Salt, Sand
  Iron, Cork, Sand, Blank
- Identifies iron and salt correctly (W and Z); cork and/or sand are missing or incorrect.
  Examples: Iron, Sand, Cork, Salt
  Iron, Blank, Blank, Salt
- Identifies sand and salt correctly (Y and Z); iron and/or cork are missing or incorrect.
  Examples: Cork, Iron, Sand, Salt
  Blank, Blank, Sand, Salt
  Water, Cork, Sand, Salt
- Other partially correct (that identifies at least two components correctly).

Incorrect Response

- Identifies only iron correctly (W), all other components are missing or incorrect.
- Other incorrect (including crossed out/erased, stray marks, illegible or off task).

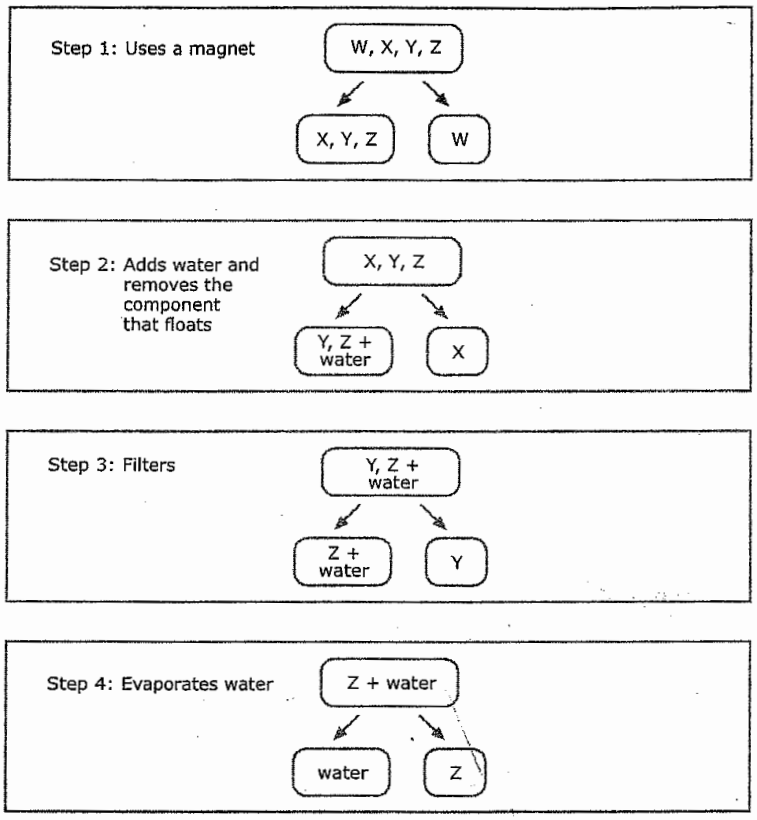
Separation of salt/sand/iron filings mixture (continued)

Item Number: S032562

Student Responses

Correct Response:

Teresa is given a mixture of salt, sand, iron filings, and small pieces of cork. She separates the mixture using a 4-step procedure as shown in the diagram. The letters W, X, Y, and Z are used to stand for the four components but do not indicate which letter stands for which component.



Identify what each component is by writing *salt, sand, iron,* or *cork* in the correct spaces below

Component W is: iron

Component X is: sand

Component Y is: Cork

Component Z is: Salt

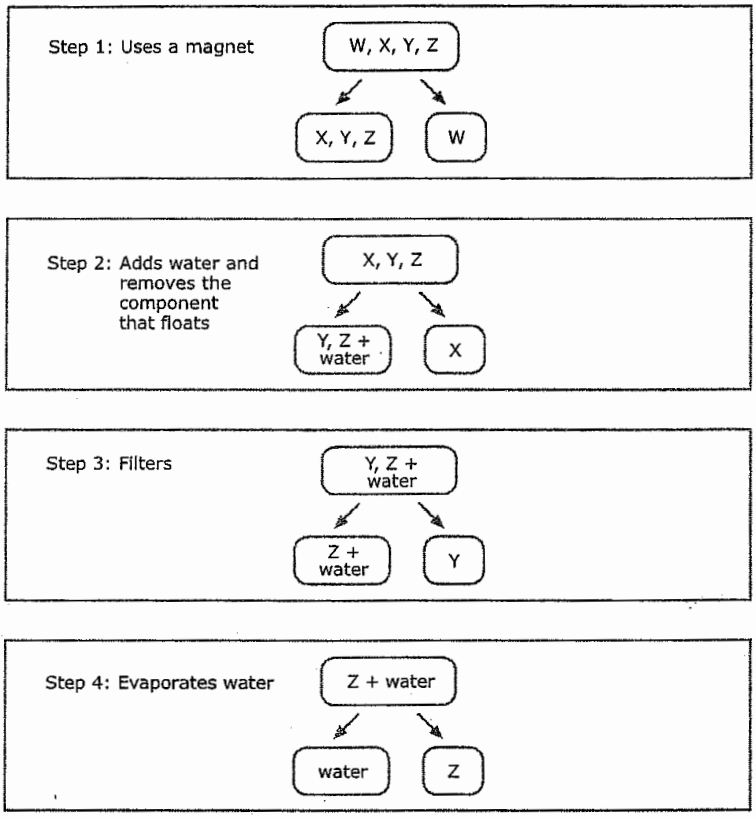
Separation of salt/sand/iron filings mixture (continued)

Item Number: S032562

Student Responses (continued)

Partially Correct Response:

Teresa is given a mixture of salt, sand, iron filings, and small pieces of cork. She separates the mixture using a 4-step procedure as shown in the diagram. The letters W, X, Y, and Z are used to stand for the four components but do not indicate which letter stands for which component.



Identify what each component is by writing *salt, sand, iron,* or *cork* in the correct spaces below

Component W is: water

Component X is: cork

Component Y is: sand

Component Z is: salt

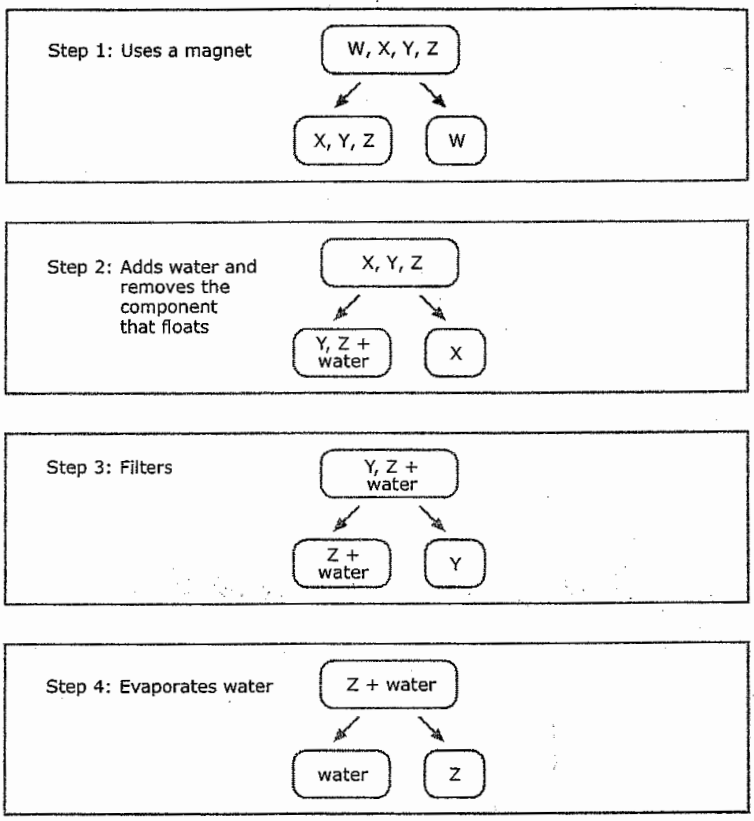
Separation of salt/sand/iron filings mixture (continued)

Item Number: S032562

Student Responses (continued)

Incorrect Response:

Teresa is given a mixture of salt, sand, iron filings, and small pieces of cork. She separates the mixture using a 4-step procedure as shown in the diagram. The letters W, X, Y, and Z are used to stand for the four components but do not indicate which letter stands for which component.



Identify what each component is by writing *salt, sand, iron,* or *cork* in the correct spaces below

Component W is: Iron

Component X is: Sand

Component Y is: Salt

Component Z is: Cork

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Classification and Composition of Matter	Reasoning and Analysis

Metal crown: what metal block was made of

The table below lists the density for different metals.

Metal	Density (g/cm^3)
Platinum	21.4
Gold	19.3
Silver	10.5
Copper	8.9
Zinc	7.1
Aluminum	2.7

A. Look at the density you computed for the block of metal. What was the block of metal most likely made of?

Answer: _____

Explain your answer.

B. The density of the crown was found to be 12.0 g/cm^3. What would you report to the king about what metal or mixture of metals the jeweler used to make the crown?

Item Number: S032713A

Overall Percent Correct

Hungary	37	▲
Singapore	36	▲
Japan	36	▲
Chinese Taipei	29	▲
United States	28	▲
Russian Federation	27	▲
Estonia	27	▲
Lithuania	26	▲
Belgium (Flemish)	26	▲
Hong Kong, SAR	23	▲
England	23	▲
Australia	22	▲
Latvia	22	▲
Slovak Republic	21	▲
New Zealand	21	▲
Netherlands	20	▲
Sweden	18	O
Slovenia	18	O
Scotland	18	O
Korea, Republic of	18	O
Jordan	16	O
Norway	16	O
International average	**16**	
Romania	14	O
Moldova, Rep. of	13	O
Egypt	13	▼
Serbia and Montenegro	13	▼
Armenia	13	▼
Italy	12	▼
Malaysia	12	▼
Israel	11	▼
Macedonia, Republic of	11	▼
Palestinian Nat'l Auth.	11	▼
Morocco	10	▼
Bahrain	9	▼
Bulgaria	8	▼
Chile	8	▼
Cyprus	6	▼
Lebanon	6	▼
Indonesia	5	▼
Philippines	4	▼
Ghana	3	▼
Botswana	2	▼
South Africa	2	▼
Tunisia	2	▼
Iran, Islamic Republic of	1	▼
Saudi Arabia	1	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

Metal crown: what metal block was made of (continued)

Item Number: S032713A

SCORING

Codes for Identifying Metal in Block

Note: To receive credit, responses must identify gold AND give an explanation based on density. Responses that identify gold with no or incorrect explanation are incorrect. It is possible that a different metal or metal(s) may be identified based on an incorrect density computation in the previous question. These types of responses may scored as correct, provided the explanation is reasonable based on the computed density.

Correct Response

- GOLD with an explanation based on correct density computed in previous question (19.2 g/cm3).
  Examples: Gold. Because it had the closest density.
  Gold. The density is the same.
- Other correct.

Incorrect Response

- GOLD with no explanation or incorrect explanation that is NOT based on density.
  Examples: Gold. Because that is what crowns are always made of.
- SILVER (alone or mixed). [Confuses density of crown with density of the metal block.]
  Examples: It is mostly silver because the density is 12 and that's the closest one.
- Other incorrect (including crossed out/erased, stray marks, illegible, or off task).

Metal crown: what metal block was made of (continued)

Item Number: S032713A

Student Responses

Correct Response:

The table below lists the density for different metals.

Metal	Density (g/cm³)
Platinum	21.4
Gold	19.3
Silver	10.5
Copper	8.9
Zinc	7.1
Aluminum	2.7

A. Look at the density you computed for the block of metal. What was the block of metal most likely made of?

Answer: Gold

Explain your answer.

the block of metal was only 0,1 away from 19,3 which was gold so that is the closest thing to it

Incorrect Response:

The table below lists the density for different metals.

Metal	Density (g/cm³)
Platinum	21.4
Gold	19.3
Silver	10.5
Copper	8.9
Zinc	7.1
Aluminum	2.7

A. Look at the density you computed for the block of metal. What was the block of metal most likely made of?

Answer: Clay

Explain your answer.

Because everything listed under metal they are made out Clay.

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Classification and Composition of Matter	Reasoning and Analysis

Metal crown: what crown was made of

The table below lists the density for different metals.

Metal	Density (g/cm^3)
Platinum	21.4
Gold	19.3
Silver	10.5
Copper	8.9
Zinc	7.1
Aluminum	2.7

A. Look at the density you computed for the block of metal. What was the block of metal most likely made of?

Answer: _____

Explain your answer.

B. The density of the crown was found to be 12.0 g/cm^3. What would you report to the king about what metal or mixture of metals the jeweler used to make the crown?

Item Number: S032713B

Overall Percent Correct

Chinese Taipei	25	▲
Hong Kong, SAR	20	▲
Singapore	20	▲
Hungary	20	▲
Korea, Republic of	19	▲
Slovenia	18	▲
Estonia	15	▲
Norway	13	▲
Latvia	12	▲
Sweden	12	▲
Slovak Republic	12	▲
Jordan	11	▲
United States	11	▲
Netherlands	10	O
Russian Federation	10	O
Lithuania	10	O
Armenia	10	O
New Zealand	9	O
Scotland	9	O
Australia	9	O
Egypt	8	O
International average	**8**	
Romania	8	O
Malaysia	8	O
Moldova, Rep. of	8	O
Belgium (Flemish)	8	O
Macedonia, Republic of	6	▼
Cyprus	5	▼
England	5	▼
Israel	4	▼
Iran, Islamic Republic of	4	▼
Lebanon	4	▼
Indonesia	4	▼
Morocco	4	▼
Bulgaria	4	▼
Palestinian Nat'l Auth.	4	▼
Chile	3	▼
Bahrain	2	▼
South Africa	2	▼
Philippines	2	▼
Japan	1	▼
Saudi Arabia	1	▼
Tunisia	1	▼
Ghana	1	▼
Botswana	1	▼
Serbia and Montenegro	1	▼
Italy	1	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

Metal crown: what crown was made of (continued)

Item Number: S032713B

SCORING

Codes for Reporting Composition of Crown

Note: To receive credit, responses must indicate that the crown is composed of a mixture of metals (alloy) AND identify the metals that might be included based on the density (crown density between the densities of the pure metals). Responses that indicate that the crown is made of a mixture (alloy) or is not pure gold with no further information about what other metals are included are scored as incorrect. If responses indicate that the crown is made of Palladium (not in the table but with a density of 12 g/cm3), they should be scored as correct.

Correct Response

- Reports that the crown is made of a mixture (alloy) AND names specific metal(s) that might be included (reasonable composition based on density).
  Examples: The jeweler used some silver as well as gold.
  It might have had some copper mixed in because that would lower the density and the cost.
  The jeweler most likely used all silver except for a thin coat of gold to make it look pure gold even though it wasn't.
- Other correct.

Incorrect Response

- Reports only that the crown is made of a mixture or is NOT pure gold (or similar); NO specific metals are named.
  Examples: The jeweler didn't use the block of metal that the king gave him.
  The jeweler used four more metals to make the crown.
- Reports SILVER (density closest to 12 g/cm3).
  Examples: The metal used is silver.
- Reports an incorrect mixture of metals based on additive densities.
  Examples: It's silver and aluminum (10.5 + 2.7)
  Mixture of silver and aluminum as their density adds up to 12.0 approximately.
  Copper and aluminum.
- Other incorrect (including crossed out/erased, stray marks, illegible or off task).

Metal crown: what crown was made of (continued)

Item Number: S032713B

Student Responses

Correct Response:

The table below lists the density for different metals.

Metal	Density (g/cm³)
Platinum	21.4
Gold	19.3
Silver	10.5
Copper	8.9
Zinc	7.1
Aluminum	2.7

B. The density of the crown was found to be 12.0 g/cm³. What would you report to the king about what metal or mixture of metals the jeweler used to make the crown?

he used silver and gold

Incorrect Response:

The table below lists the density for different metals.

Metal	Density (g/cm³)
Platinum	21.4
Gold	19.3
Silver	10.5
Copper	8.9
Zinc	7.1
Aluminum	2.7

B. The density of the crown was found to be 12.0 g/cm³. What would you report to the king about what metal or mixture of metals the jeweler used to make the crown?

I would tell him that the man that used the crown he used Platinum, gold, copper, zinc and Aminium.

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Particulate Structure of Matter	Conceptual Understanding

Atoms removed from chair

If you took all of the atoms out of a chair, what would be left?

Ⓐ The chair would still be there, but it would weigh less.

Ⓑ The chair would be exactly the same as it was before.

Ⓒ There would be nothing left of the chair.

Ⓓ Only a pool of liquid would be left on the floor.

Item Number: S012040

Correct Response: C

Overall Percent Correct

Lithuania	78	▲
Sweden	73	▲
Singapore	69	▲
Estonia	68	▲
United States	68	▲
Hungary	67	▲
Korea, Republic of	66	▲
Japan	65	▲
England	64	▲
Armenia	64	▲
Latvia	62	▲
Slovenia	62	▲
Russian Federation	60	▲
Israel	60	▲
Slovak Republic	59	▲
Australia	59	▲
New Zealand	55	O
Scotland	55	O
Norway	54	O
Italy	53	O
Chinese Taipei	52	O
Bahrain	51	O
International average	**51**	
Romania	51	O
Palestinian Nat'l Auth.	51	O
Netherlands	50	O
Macedonia, Republic of	50	O
Bulgaria	48	O
Jordan	47	O
Hong Kong, SAR	47	O
Moldova, Rep. of	47	O
Egypt	46	▼
Chile	46	▼
Cyprus	45	▼
Serbia and Montenegro	44	▼
Lebanon	44	▼
Belgium (Flemish)	44	▼
Saudi Arabia	43	▼
Botswana	42	▼
Iran, Islamic Republic of	37	▼
South Africa	35	▼
Ghana	33	▼
Tunisia	30	▼
Malaysia	30	▼
Morocco	29	▼
Philippines	24	▼
Indonesia	13	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Particulate Structure of Matter	Factual Knowledge

Particles in nucleus of atom

The nucleus of MOST atoms consists of

Ⓐ neutrons only
Ⓑ protons and neutrons
Ⓒ protons and electrons
Ⓓ neutrons and electrons

Item Number: S012025

Correct Response: B

Overall Percent Correct

Macedonia, Republic of	79	▲
Slovak Republic	71	▲
Estonia	69	▲
Serbia and Montenegro	68	▲
Slovenia	67	▲
Armenia	66	▲
Singapore	65	▲
Chinese Taipei	63	▲
Russian Federation	62	▲
Romania	61	▲
Egypt	57	▲
United States	57	▲
Lithuania	56	▲
Lebanon	55	▲
Moldova, Rep. of	54	▲
Palestinian Nat'l Auth.	52	▲
Bulgaria	51	O
Iran, Islamic Republic of	48	O
New Zealand	48	O
International average	**47**	
Hungary	47	O
Italy	46	O
Jordan	46	O
Israel	45	O
Bahrain	45	O
Indonesia	44	O
England	43	O
Korea, Republic of	43	▼
Philippines	42	▼
Chile	42	▼
Australia	41	▼
Tunisia	40	▼
Ghana	40	▼
Cyprus	39	▼
Japan	37	▼
Latvia	36	▼
Netherlands	35	▼
Saudi Arabia	34	▼
Sweden	32	▼
Norway	32	▼
Scotland	32	▼
Morocco	31	▼
Hong Kong, SAR	31	▼
Botswana	30	▼
Malaysia	28	▼
Belgium (Flemish)	27	▼
South Africa	27	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼

Content Domain	Main Topic	Cognitive Domain
CHEMISTRY	Particulate Structure of Matter	Factual Knowledge

Neutral atom gains electron

What is formed when a neutral atom gains an electron?

Ⓐ A mixture

Ⓑ An ion

Ⓒ A molecule

Ⓓ A metal

Item Number: S022202

Correct Response: B

Overall Percent Correct

Singapore	79	▲
Bahrain	73	▲
Estonia	72	▲
Slovak Republic	71	▲
Armenia	71	▲
Lithuania	71	▲
Hungary	71	▲
Slovenia	69	▲
Lebanon	69	▲
Russian Federation	69	▲
Israel	64	▲
Serbia and Montenegro	61	▲
Egypt	61	▲
Iran, Islamic Republic of	60	▲
Sweden	60	▲
Romania	60	▲
Palestinian Nat'l Auth.	58	▲
Macedonia, Republic of	58	▲
Chile	58	▲
Jordan	58	▲
Bulgaria	56	▲
Chinese Taipei	54	▲
Hong Kong, SAR	51	O
Ghana	50	O
Latvia	49	O
Italy	49	O
Japan	48	O
International average	**47**	
United States	46	O
Moldova, Rep. of	44	O
Saudi Arabia	40	▼
England	32	▼
Australia	30	▼
Netherlands	29	▼
Philippines	28	▼
Malaysia	27	▼
Scotland	26	▼
New Zealand	24	▼
Morocco	22	▼
Belgium (Flemish)	22	▼
Cyprus	22	▼
Norway	22	▼
Korea, Republic of	21	▼
Botswana	19	▼
Tunisia	19	▼
South Africa	18	▼
Indonesia	18	▼

Country average vs. International average:

Higher ▲
Not different O
Lower ▼