

Staple Here

Student Name: _____



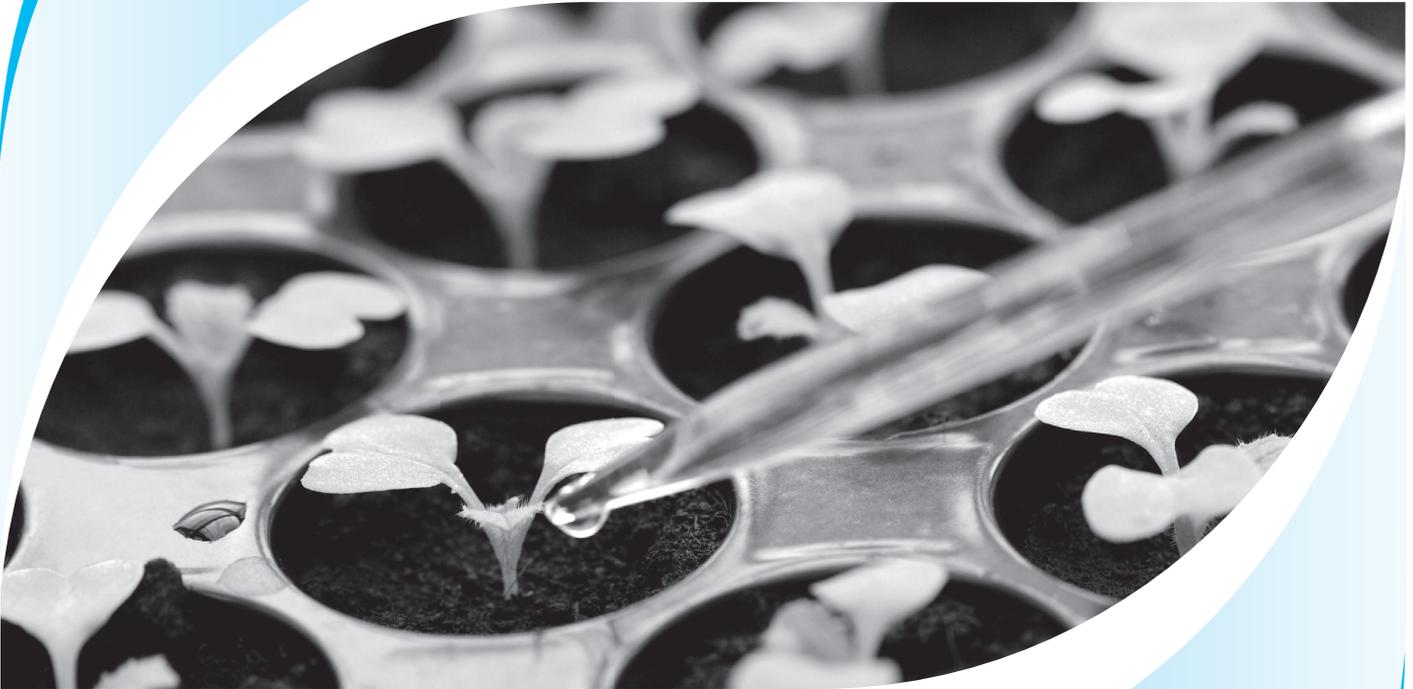
Missouri

DEPARTMENT OF ELEMENTARY & SECONDARY

EDUCATION™

End-of-Course Assessment

Physical Science



Practice Test

Acknowledgements:

Photo of Frozen Soap Bubble. This image is in the public domain under Creative Commons Attribution. Source: Pixabay. <https://pixabay.com/en/frost-bubble-ice-bubble-soap-bubble-3189252/>

Directions to the Student

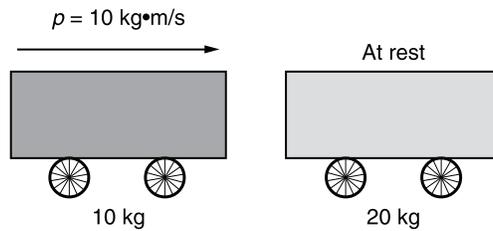
Today you will be taking the Missouri Physical Science Test. This is a test of how well you understand the course level expectations for Physical Science.

There are several important things to remember:

- 1** Read each question carefully and think about the answer. Then choose the answer that you think is best.
- 2** Make sure you clearly mark the correct choice in your test book.
- 3** If you do not know the answer to a question, skip it and go on. You may return to it later if you have time.
- 4** If you finish the test early, you may check over your work.

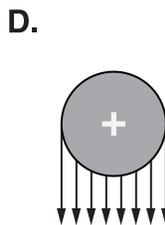
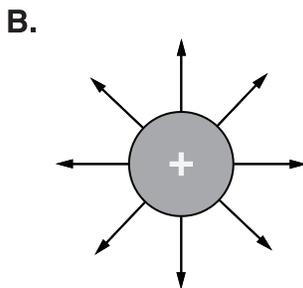
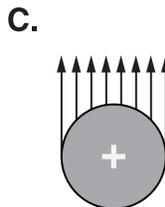
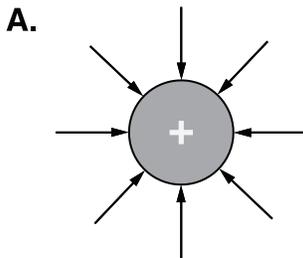
Physical Science

1. A 10 kg cart with a momentum of $10 \text{ kg} \cdot \text{m/s}$ hits a 20 kg cart at rest. Momentum is calculated by using the formula $p = mv$, where m is the mass of an object and v is the velocity of an object.



What is the momentum of the system after the collision?

- A. $2 \text{ kg} \cdot \text{m/s}$
B. $10 \text{ kg} \cdot \text{m/s}$
C. $20 \text{ kg} \cdot \text{m/s}$
D. $30 \text{ kg} \cdot \text{m/s}$
2. Which model shows electric field lines surrounding a positively charged object?



3. Jesse is curious about what happens when liquids of different temperatures are mixed.

Select the boxes to identify the equipment Jesse needs to conduct this investigation.

	Beaker	Thermometer	Stopwatch	Warm water	Two containers of water at the same temperature	Cold water	Mass scale
Equipment needed							

4. A 4 kg object is traveling to the right at a constant velocity of 16 m/s across a surface. The formula for momentum is $p = mv$, where “ m ” is mass and “ v ” is velocity. Calculate the momentum if the mass of the object (4 kg) was held constant but the velocity was half as much (8 m/s).

Enter the answer in the box.

	kg•m/s
--	--------

Go On ►

Physical Science

5. Sometimes it is helpful to describe light as a wave, while other times describing light as a particle is more helpful.

Match the model with each aspect of light that it best suits.

<input type="checkbox"/>	<input type="checkbox"/>	Bends at entry of a new medium
<input type="checkbox"/>	<input type="checkbox"/>	Pulls into a new medium with force
<input type="checkbox"/>	<input type="checkbox"/>	Produces a shadow
<input type="checkbox"/>	<input type="checkbox"/>	Creates an interference pattern

Wave Model	<input type="checkbox"/>
Particle Model	<input type="checkbox"/>

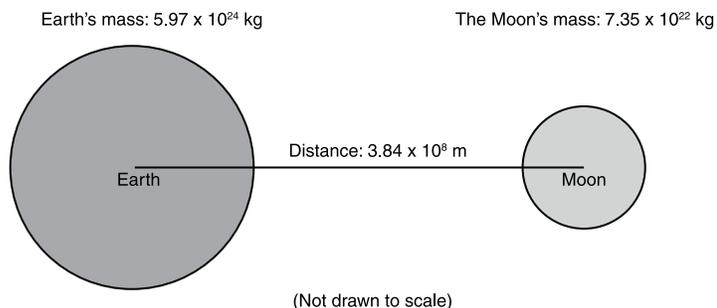
6. Use the formula $F = G \frac{m_1 m_2}{d^2}$, where

- F = the force of gravity
- G = universal gravitational constant
- m_1 and m_2 = masses of the two objects
- d = the distance between the centers of the two objects

What would result in the greatest gravitational force between two objects?

- A. halving the mass of object 1
- B. doubling the mass of object 1
- C. halving the distance between the two objects
- D. doubling the distance between the two objects

7. Earth has a mass of 5.97×10^{24} kg and Earth's moon has a mass of 7.35×10^{22} kg. The distance between the center of Earth and the center of Earth's moon is 3.84×10^8 m.



The formula for gravitational force of attraction is $F_g = G \frac{m_1 m_2}{d^2}$, where

- F_g is the force of gravity
- G is the universal gravitational constant (6.67×10^{-11} N \cdot m² / kg²)
- m_1 and m_2 are the masses of the two objects, and
- d is the distance between the centers of two objects

Which represents the gravitational force of attraction between Earth and Earth's moon?

- A. 1.98×10^{20} N
- B. 3.81×10^{20} N
- C. 7.62×10^{28} N
- D. 2.97×10^{30} N

8. Observe the chemical reaction.



Select the phrase to complete the sentence.

To create more reactants,

- | |
|---|
| <input type="radio"/> apply heat to the reactants. |
| <input type="radio"/> double the amount of product. |
| <input type="radio"/> double the amount of reactants. |

9. A student is asked to develop a model to illustrate the life span of our sun. Which factors must be included in the model?

Select all that apply.

- A. size
- B. color
- C. time scale
- D. composition
- E. location of the sun in the universe
- F. distance between the sun and other stars

10. The following question has two parts. First, answer Part A. Then, answer Part B.

You may use the Periodic Table Reference Sheet to answer this question.

Part A

Sodium chloride, commonly known as table salt, is made of sodium (Na) ions and chloride (Cl) ions. Which of the following is the simplest formula unit for sodium chloride?

- A. NaCl
- B. Na₂Cl
- C. NaCl₂
- D. Na₃Cl₂

Part B

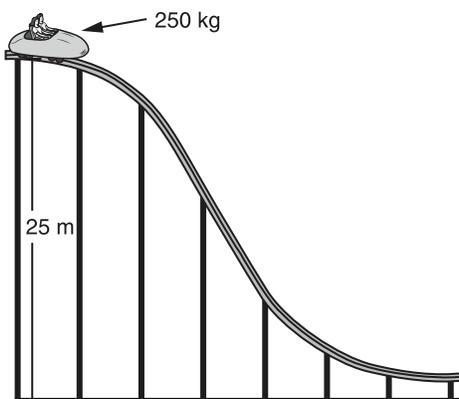
Enter the correct number into each box to complete the sentences.

This formula is best because a sodium atom has valence electron(s) and a chlorine atom has valence electron(s). Sodium forms an ion with a charge and chlorine forms an ion with a charge.

Go On ►

Physical Science

11. A roller coaster car has a mass of 250 kg. The car is sitting on top of a 25 m hill. The gravitational potential energy of the car at the highest point of the track is 61,250 J.



Kinetic energy can be modeled by the formula $KE = \frac{1}{2}mv^2$, where m is the mass of an object and v is the velocity of an object.

What is the maximum velocity of the roller coaster car at the lowest point of the track? Round the answer to the nearest whole number.

- A. 22 m/s
- B. 175 m/s
- C. 490 m/s
- D. 30,625 m/s

12. The balanced chemical equation for the synthesis of water is shown.



Explain how this balanced chemical equation supports the claim that mass/matter is conserved during a chemical reaction.

Enter the answer in the box.

13. Which statement is evidence that supports the Big Bang theory?

- A. There are uniform cosmic gravitational forces in the universe.
- B. There is uniform cosmic background radiation in the universe.
- C. The observable long wavelengths of light indicate that galaxies are moving toward us.
- D. The observable short wavelengths of light indicate that galaxies are moving away from us.

14. Which factors could increase reaction rate?

Select all that apply.

- A. introducing an inhibitor
- B. increasing the temperature of the system
- C. increasing the surface area of a solid reactant
- D. increasing the concentration of one of the reactants
- E. increasing the size of the container in which the reaction occurs

Go On ►

Physical Science

15. Select the words to correctly complete each sentence.

It takes Earth approximately 365 days to orbit the sun. When Earth moves away

from the sun, its acceleration

increases.

decreases.

remains constant.

Earth's velocity is fastest

when it is

closest to the sun.

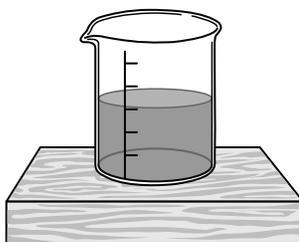
farthest from the sun.

halfway between the sun and the farthest point in orbit.

A science teacher set up a demonstration to study energy transfer using the following materials:

- beaker of water
- graduated cylinder, filled with 2 mL of water
- piece of wood
- barium hydroxide solid
- ammonium thiocyanate solid

Students were asked to feel the piece of wood and the beaker of water prior to the demonstration to determine relative temperature of each. Next, 2mL of water was placed onto the piece of wood and the beaker of water was placed on top of that. Then, the teacher added barium hydroxide and ammonium thiocyanate to the water in the beaker. Students were given the opportunity to feel the outside of the beaker again. When the teacher lifted the beaker, the piece of wood was stuck to the bottom of the beaker. Frost was observable along the edge between the glass and the wood.



Physical Science

16. Select the options to correctly complete each sentence.

After the completion of the reaction, the beaker's temperature was

at room temperature (25 degrees Celsius).

colder than room temperature (25 degrees Celsius).

warmer than room temperature (25 degrees Celsius).

We know this because

there was liquid in the beaker.

the water between the piece of wood and the beaker was frozen.

barium hydroxide and ammonium thiocyanate dissolved in the water.

17. Select the words to correctly complete the sentence.

The teacher asked the students to touch the beaker. The beaker felt

hot

cold

because thermal energy was transferred

to

from

the student's hand

to

from

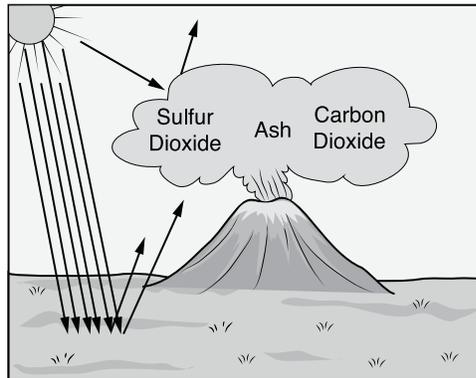
the beaker.

18. Which of the following objects have balanced forces acting upon them?

Select all that apply.

- A. one at rest on a table
- B. one that is accelerating
- C. one that is rolling to a stop
- D. one that is falling after being dropped
- E. one moving to the right at a constant velocity

19. A volcanic eruption can add carbon dioxide, sulfur dioxide, and ash to the atmosphere. The diagram represents a volcanic eruption.



In what way does a volcanic eruption most affect the climate?

- A. traps the sun's radiation and increases air temperatures
- B. reflects the sun's radiation and decreases air temperatures
- C. absorbs the sun's radiation and increases ocean temperatures
- D. transfers the sun's radiation and decreases ocean temperatures

Physical Science

20. Select the word or phrase to complete the sentence.

Use the formula $F = G \frac{m_1 m_2}{d^2}$, where

- F = force of gravity
- G = universal gravitational constant
- m_1 and m_2 = masses of the two objects
- d = distance between the centers of two objects

Scientists estimate that the moon gets farther away from Earth by 3.8 centimeters each year. As the distance increases over time, the gravitational

force between the two objects

<input type="radio"/> increases.
<input type="radio"/> decreases.
<input type="radio"/> stays the same.

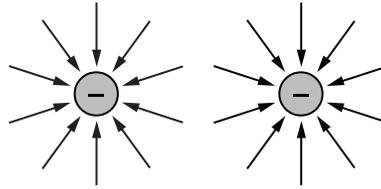
21. Physical science students conducted an investigation to compare the surface tension of three liquids. Some of the steps taken in the investigation were incorrect. Select the actions that made the investigation unsuccessful.

Select all that apply.

The students want to determine which liquid has the strongest surface tension by adding drops of three different liquids to the surface of a penny. Within a lab group, four students choose four different pennies to test the different liquids.

Two students decide to place their penny heads up and two students place their penny heads down. They all decide to test water first. They use the same type of droppers to drop similar size drops onto the penny. They find that they can drop an average of 44 drops of water onto the penny. Next they decide to test rubbing alcohol. They predict that they will not be able to get as many drops of rubbing alcohol on the penny because rubbing alcohol has weaker attractive forces than water. They find that they are able to drop an average of 19 drops of rubbing alcohol on the penny. Finally, they test vegetable oil and predict it will have the least number of drops because oil is nonpolar and has the weakest attractive forces. They find they are able to drop an average of 12 drops of oil before the oil runs over. They decide not to repeat the investigation, as they have 4 pieces of data from their 4 different pennies.

The diagram shows two negatively charged particles separated by a fixed distance.



22. Select the words or phrases to correctly complete the sentences.

The two charges

<input type="radio"/> repel one another.
<input type="radio"/> are attracted to one another.
<input type="radio"/> are not affected by one another.

 If the distance between the

two particles is increased, the energy stored in the field would

<input type="radio"/> increase.
<input type="radio"/> decrease.
<input type="radio"/> remain the same.

Physical Science

23. What will happen when the two particles are brought closer together?

Select the phrase to correctly complete the sentence.

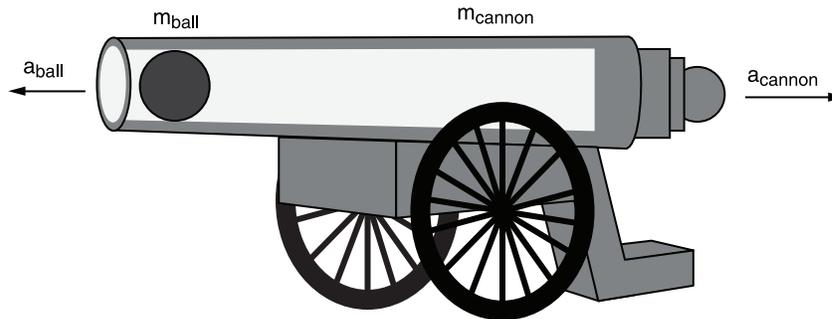
When two negatively charged objects are brought closer together, the objects will

lose energy.

gain energy.

have the same amount of energy as before.

24. The diagram shows a cannon as a cannon ball is being fired. In the diagram, a = acceleration and m = mass.



There are several forces acting on the cannon and the cannon ball. In the following statements, select whether the force pair is balanced or unbalanced.

When the cannon is fired, the cannon ball moves to the left, while the cannon

moves to the right, and the net force is

<input type="radio"/> balanced.
<input type="radio"/> unbalanced.

The cannon wheel moving to the right creates friction between the wheel and the

ground, and the net force on the cannon is

<input type="radio"/> balanced.
<input type="radio"/> unbalanced.

The cannon ball moves to the left and is met with air resistance, resulting in

<input type="radio"/> a balanced	net force on the cannon ball.
<input type="radio"/> an unbalanced	

25. The following question has two parts. First, answer Part A. Then, answer Part B.

Part A

A model of a nuclear process is shown.



What type of process is shown by the model?

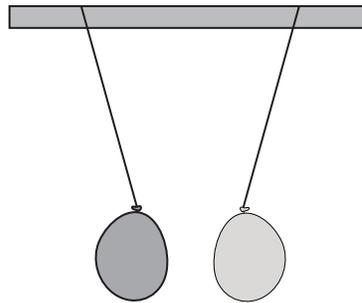
- A. nuclear fusion
- B. nuclear fission
- C. radioactive decay
- D. chemical reaction

Part B

What piece of evidence from the model supports the answer to Part A?

Enter the evidence in the box.

26. A student entered a science classroom and saw two balloons hanging from the ceiling. Instead of hanging straight down, the balloons were angled toward each other, exhibiting an attractive interaction.



Which conditions below could result in the balloons hanging as shown in the diagram?

Select all that apply.

- A. Neither balloon is charged.
- B. The balloons are oppositely charged.
- C. Both balloons are positively charged.
- D. Both balloons are negatively charged.
- E. One is charged and the other is neutral.

Physical Science

27. A 2,500 kg train car is traveling at 2 m/s. It then collides with and attaches to a 2,500 kg train car at rest.

The formula for momentum is $p = mv$, where m is the mass of an object and v is the velocity of an object.

Select the appropriate words or phrases to complete the sentence.

The mass of the system will

<input type="radio"/> increase,
<input type="radio"/> decrease,
<input type="radio"/> stay the same,

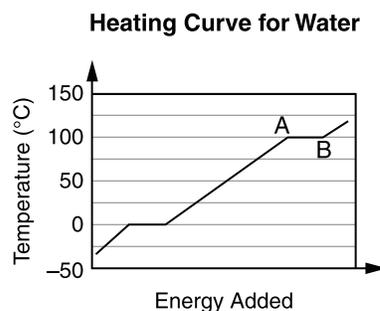
 and the velocity of the system will

<input type="radio"/> increase,
<input type="radio"/> decrease,
<input type="radio"/> stay the same,

 while the momentum of the system will

<input type="radio"/> increase.
<input type="radio"/> decrease.
<input type="radio"/> stay the same.

28. The graph shows a heating curve for water.

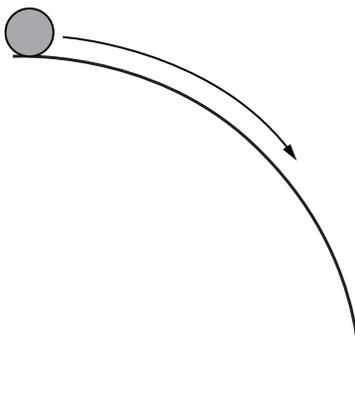


A sample of water is heated to 120°C. Select the appropriate phrase to complete the sentence.

As heat is added between points A and B, the temperature of the water remains a constant 100°C. During this boiling phase, the temperature remains constant because all of the energy added to the system is being used

- | |
|---|
| <input type="radio"/> to form surface tension between molecules. |
| <input type="radio"/> to form hydrogen bonds between molecules. |
| <input type="radio"/> to overcome energy forces creating the molecules. |
| <input type="radio"/> to overcome attractive forces creating the molecules. |

29. The potential energy of a 5 kg ball at the top of a hill is 250 J.



Kinetic energy can be modeled by the formula $KE = \frac{1}{2}mv^2$, where m is the mass of an object and v is the velocity of an object.

If all of the potential energy of the ball is transformed into kinetic energy, what is the velocity of the ball at the point of maximum kinetic energy?

- A. 5 m/s
- B. 10 m/s
- C. 100 m/s
- D. 1,250 m/s

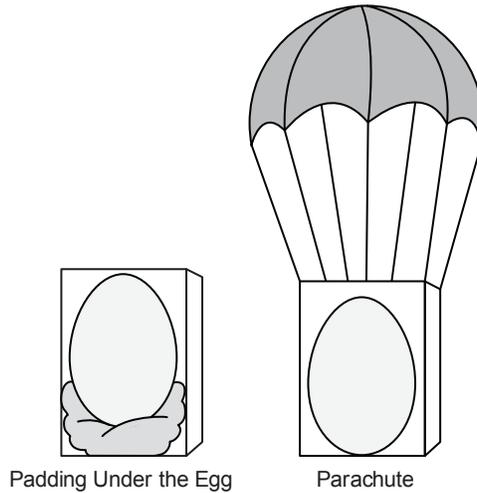
30. Use the formula $F = G \frac{m_1 m_2}{d^2}$, where

- F is the force of gravity
- G is the universal gravitational constant, $6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2 / \text{kg}^2$
- m_1 and m_2 are the masses of the two objects
- d is the distance between the centers of the two objects

The left column describes changes to variables in the formula. Match the changes to variables to order their resulting gravitational force from least to greatest.

A.	decreasing the distance between the objects to $\frac{1}{4}$	<input type="radio"/> A <input type="radio"/> B <input type="radio"/> C	1 (least)
B.	doubling the mass of both objects	<input type="radio"/> A <input type="radio"/> B <input type="radio"/> C	2
C.	doubling the distance between the two objects	<input type="radio"/> A <input type="radio"/> B <input type="radio"/> C	3 (greatest)

31. Students are conducting the egg drop lab. In this lab, they design cartons to prevent raw eggs from cracking when they hit the ground.



Use the equation $F\Delta t = m\Delta v$ as a model for the lab, where

- F is the force of collision
- Δt is the time interval of collision
- m is the mass of an object, and
- Δv is the change in velocity during collision

Match each solution with the variables it affects.

Select all that apply.

	Decreases F	Increases Δt	Decreases Δv
padding under the egg			
parachute			

32. An unbalanced chemical equation for a reaction is shown.



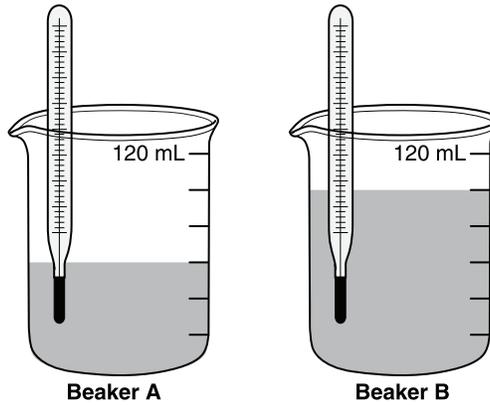
Select the correct coefficients to balance the equation.

<input type="radio"/> 1		<input type="radio"/> 1
<input type="radio"/> 2		<input type="radio"/> 2
<input type="radio"/> 3		<input type="radio"/> 3
<input type="radio"/> 4	$\text{NH}_3 \leftrightarrow \text{N}_2 +$	<input type="radio"/> 4 H_2
<input type="radio"/> 5		<input type="radio"/> 5
<input type="radio"/> 6		<input type="radio"/> 6

Go On ►

Physical Science

33. In an investigation, Beaker A and Beaker B each contain 50 mL of water at the initial temperature of 40°C .



Select the words to correctly complete the sentence.

Beaker A receives 10 mL of water at 10°C and Beaker B receives 50 mL of water

at 10°C . The temperature change in Beaker A will be

less than

the same as the

greater than

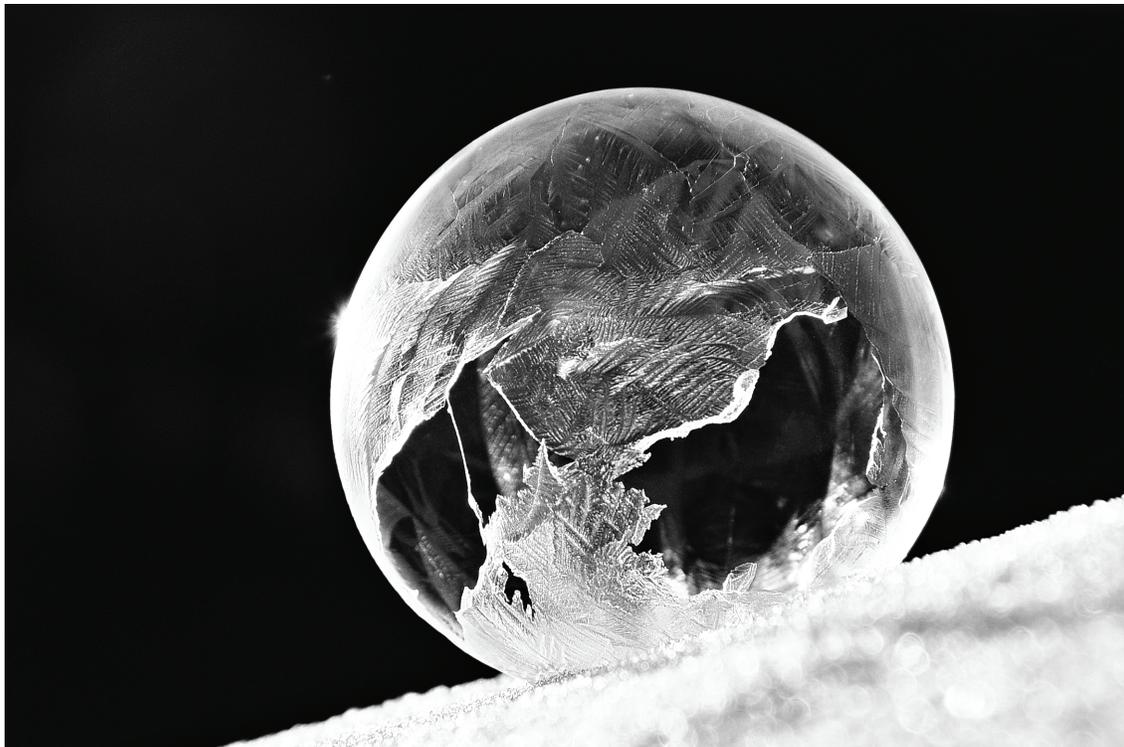
temperature change in Beaker B.

Frigid air can transform an ordinary soap bubble into a glittery “snow globe.” No shaking required.

When a bubble is placed in a freezer set to -20° Celsius, delicate ice crystals swirl gracefully across the soapy film, gradually growing larger until the bubble freezes solid. The phenomenon can also be observed when blowing soap bubbles outside in wintry weather. Researchers from Virginia Tech in Blacksburg explained the physics behind the miniature snowstorm on November 20, during the American Physical Society Division of Fluid Dynamics meeting in Denver.

As ice crystals form at a bubble’s base, the change from liquid to solid releases heat. This “latent heat,” the heat that is absorbed or released in a phase transition, is trapped in the bottom of the bubble because the orb’s skin is too thin—about a hundredth of a millimeter—for heat to easily conduct.

As a result, the remaining liquid at the bottom of the bubble is warmer, and so has lower surface tension, than liquid at the top. That mismatch sets up currents in the fluid, causing the soapy water to stream from warmer to colder regions, a process known as Marangoni flow. The flow is so strong, says coauthor and engineer Jonathan Boreyko, “it’s ripping off the ice crystals that are growing from the bottom and taking them along for the ride.” Eventually, the ice crystals grow large enough that they lock into place, and the whole bubble freezes.



Physical Science

34. Select the phrases to complete the sentence.

The transformation of the bubble from a liquid to a solid is an example of

conduction because

light energy

nuclear energy

thermal energy

chemical energy

is transferred through

chemical reactions.

molecular collisions.

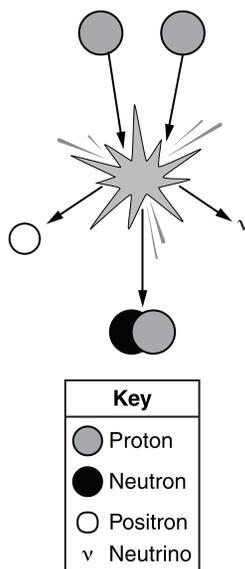
electromagnetic waves.

35. Use the Periodic Table.

Match each statement with the proper classification.

	Metals	Nonmetals
sodium		
fluorine		
contains many gases		
conducts electricity in the solid state		
tends to lose electrons and form positive ions		

36. The model represents a nuclear reaction.



What process is shown?

- A. nuclear decay
- B. nuclear fission
- C. nuclear fusion
- D. nuclear power

ITEM TYPES

CR – Constructed Response
IC – Inline Choice
HT – Hot Text
MC – Multiple Choice
TE – Text Entry

DND – Drag and Drop
LM – Line Match
Match – Match Table
MS – Multi-Select Response

Session	Item	Type	MLS Code	Answer	Points	Point Breakdown
1	1	MC	9-12.PS2.A.2	B	1	
1	2	MC	9-12.PS3.C.1	B	1	
1	3	Match	9-12.PS3.B.1	Letters = Columns Numbers = Rows A1, B1, D1, F1	1	<ul style="list-style-type: none"> 1 point for four correct answers
1	4	TE	9-12.PS2.A.2	32	1	
1	5	LM	9-12.PS4.A.2	Numbers = Left Column Letters = Right Column A1, B2, C1, D1	2	<ul style="list-style-type: none"> 2 points for four correct 1 point for three correct and zero incorrect OR four correct and one incorrect 0 points for all other combinations
1	6	MC	9-12.PS2.B.1	C	1	
1	7	MC	9-12.PS2.B.1	A	1	
1	8	IC	9-12.PS1.B.2	Double The Amount Of Product	1	
1	9	MS	9-12.ESS1.A.1	A, C, D	2	<ul style="list-style-type: none"> 2 points for three correct answers 1 point for two correct answers OR three correct answers and one incorrect answer 0 points for less than two correct answers
1	10	Part A: MC Part B: TE	9-12.PS1.A.2	Part A: A Part B: 1, 7, +1, -1	3	<p align="center">Part A (1 point):</p> <ul style="list-style-type: none"> 1 point for the correct answer <p align="center">Part B (2 points):</p> <ul style="list-style-type: none"> 2 points for all four correct answers 1 point for the first two boxes correct OR the last two boxes correct
1	11	MC	9-12.PS3.A.1	A	1	
1	12	CR	9-12.PS1.B.3		1	<ul style="list-style-type: none"> 1 point for correctly referring to atoms of oxygen and hydrogen on reactant side are the same as on the product side.
1	13	MC	9-12.ESS1.A.2	B	1	
1	14	MS	9-12.PS1.B.1	B, C, D	2	<ul style="list-style-type: none"> 2 points for three correct and no incorrect answers 1 point for two or three correct answers and one incorrect answer 0 points for all other combination

ITEM TYPES

CR – Constructed Response
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Session	Item	Type	MLS Code	Answer	Points	Point Breakdown
1	15	IC	9-12.ESS1.B.1	Decreases, Closest To The Sun	2	<ul style="list-style-type: none"> 1 point for each correct answer
1	16	IC	9-12.PS3.A.2	Colder Than Room Temperature, The Water Between The Piece Of Wood And The Beaker Was Frozen	2	<ul style="list-style-type: none"> 1 point for each correct answer
1	17	IC	9-12.PS3.B.1	Cold, From, To	1	<ul style="list-style-type: none"> 1 point for three correct answers
1	18	MS	9-12.PS2.A.1	A, E	1	<ul style="list-style-type: none"> 1 point for two correct answers
1	19	MC	9-12.ESS2.A.4	B	1	
1	20	IC	9-12.PS2.B.1	Decreases	1	
1	21	HT	9-12.PS1.A.3	1, 2, 6	2	<ul style="list-style-type: none"> 2 points for three correct answers 1 point for three correct answers and one incorrect answer OR two correct answers and no incorrect answers 0 points for any other combination
1	22	IC	9-12.PS3.C.1	Repel One Another, Decrease	2	<ul style="list-style-type: none"> 1 point for each correct answer
1	23	IC	9-12.PS3.C.1	Gain Energy	1	
1	24	IC	9-12.PS2.A.1	Balanced, Unbalanced, An Unbalanced	2	<ul style="list-style-type: none"> 2 points for three correct answers 1 point for two correct answers 0 points for less than two correct answers
1	25	Part A: MC Part B: CR	9-12.PS1.C.1	Part A: B Part B: (See Point Breakdown)	2	<p>Part A (1 point):</p> <ul style="list-style-type: none"> 1 point for correct answer <p>Part B (1 point):</p> <ul style="list-style-type: none"> 1 point for correctly demonstrating knowledge that fission is the splitting or diving of the nucleus <p>NOTE: No points are awarded for Part B if Part A is incorrect</p>
1	26	MS	9-12.PS3.C.1	B, E	1	<ul style="list-style-type: none"> 1 point for two correct answers
1	27	IC	9-12.PS2.A.2	Increase, Decrease, Stay The Same	2	<ul style="list-style-type: none"> 2 points for three correct answers 1 point for two correct answers 0 points for less than two correct answers

ITEM TYPES

CR – Constructed Response
IC – Inline Choice
HT – Hot Text
MC – Multiple Choice
TE – Text Entry

DND – Drag and Drop
LM – Line Match
Match – Match Table
MS – Multi-Select Response

Session	Item	Type	MLS Code	Answer	Points	Point Breakdown
1	28	IC	9-12.PS1.A.3	To Overcome Attractive Forces Creating The Molecules	1	
1	29	MC	9-12.PS3.A.2	B	1	
1	30	DND	9-12.PS2.B.1	A3, B2, C1	1	<ul style="list-style-type: none"> • 1 point for three correct answers
1	31	Match	9-12.PS2.A.3	Letters = Columns Numbers = Rows A1, B1, A2, C2	2	<ul style="list-style-type: none"> • 2 points for four correct answers and no incorrect answers • 1 point for four correct answers and one incorrect answer OR three correct answers and one or no incorrect answers • 0 points for all other combinations
1	32	IC	9-12.PS1.B.3	First Column: 2 Second Column: 3	1	<ul style="list-style-type: none"> • 1 point for two correct answers
1	33	IC	9-12.PS3.B.1	Less Than	1	
1	34	IC	9-12.PS3.B.1	Thermal Energy, Molecular Collisions	1	<ul style="list-style-type: none"> • 1 point for two correct answers
1	35	Match	9-12.PS1.A.1	Letters = Columns Numbers = Rows A1, B2, B3, A4, A5	2	<ul style="list-style-type: none"> • 2 points for five correct answers • 1 point for three or four correct answers • 0 points for two or less correct answers
1	36	MC	9-12.PS1.C.1	C	1	

