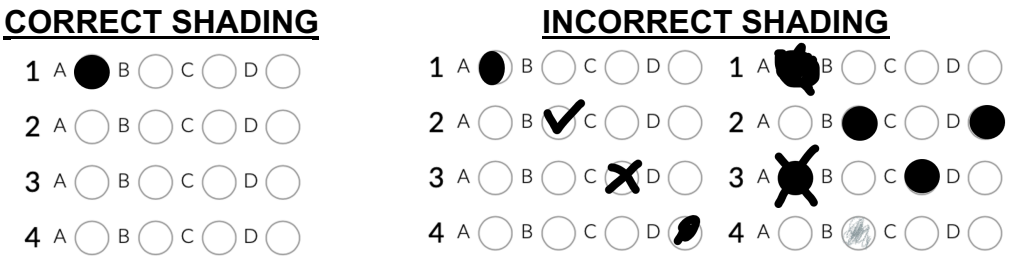
Wenzhou City, China 2024
International Mathematics and Science Olympiad

21st International Mathematics and Science Olympiad (IMSO)
Science Theory 1 Test

Wenzhou, China
03 October 2024

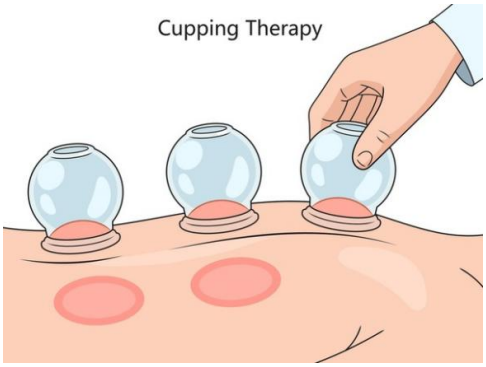
Instructions:

1. Do not turnover this page until you are told to do so.
2. Write your ID Code and shade your Seat Number on the spaces provided in your scannable answer sheet.
3. Answer all the questions by shading the letter on the scannable answer sheet. Here are some shading reminders:



4. A correct answer for each question will be awarded 1 point.
5. There are 30 questions printed on a total of 16 pages, excluding this cover page.
6. You have 60 minutes to complete this test.

1. Bekam, also known as wet cupping or cupping therapy, is a traditional healing method that uses cups to create suction and pull skin into the cup, which can help relieve pain and other issues. The cups are usually placed on areas of the body that are often in pain, such as the back, neck, shoulders, or legs. The cups can be heated with alcohol, herbs, or paper to create a vacuum that pulls the skin and muscles in. The skin can become red as a result of doing this treatment.



Why does it leave reddish marks on the skin after undergoing cupping treatment?

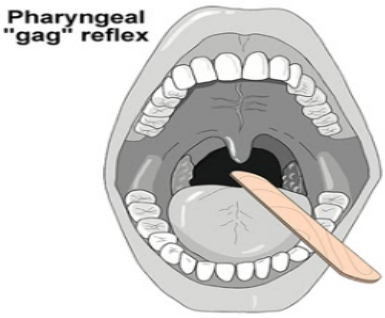
A. The arteries narrow so that oxygen is not distributed properly due to suction pressure.
B. The suction force from the cups breaks open capillaries under the skin.
C. More carbon dioxide accumulates in erythrocytes due to the suction pressure of the cup.
D. Leukocytes cannot carry out the blood clotting process due to the pressure from suction.

2. During the Paris 2024 Olympics, a marathon runner is pushing her limits in the final lap of the race. As she sprints to the finish line, her muscles are working at maximum capacity and her body begins to experience oxygen deficiency. Due to the shortage of oxygen in her active muscle cells, certain substance of energy metabolism accumulate, causing a change in pH.

Which of the following options correctly identifies the nature of the pH change and the major substance responsible for it?

	pH Change	**Substance**
A	Decrease	Carbon dioxide
B	Decrease	Lactic acid
C	Increase	Carbon dioxide
D	Increase	Lactic acid

3. The gag reflex is a reflex contraction of the muscles of the throat, which stops material from entering the throat (except in swallowing) and helps to prevent choking. The sensory nerve in this reflex is the glossopharyngeal nerve, and the motor nerve to the throat muscles is the vagus nerve.



Which of the following statements correctly describes the role of the glossopharyngeal nerve and the vagus nerve in the gag reflex?

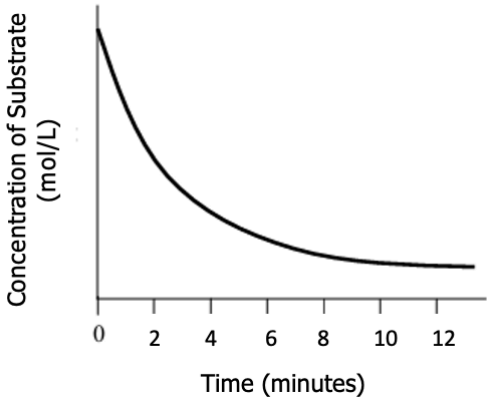
A. The glossopharyngeal nerve provides motor control to the throat muscles, while the vagus nerve detects potentially harmful material entering the throat.

B. The vagus nerve is responsible for sensory detection of potentially harmful material, while the glossopharyngeal nerve controls the motor contraction of the throat muscles.

C. The glossopharyngeal nerve detects potentially harmful material and initiates the gag reflex, while the vagus nerve controls the motor contraction of the throat muscles to prevent choking.

D. Both the glossopharyngeal nerve and the vagus nerve are involved in sensory detection, with the glossopharyngeal nerve specifically handling detection and the vagus nerve managing motor responses.

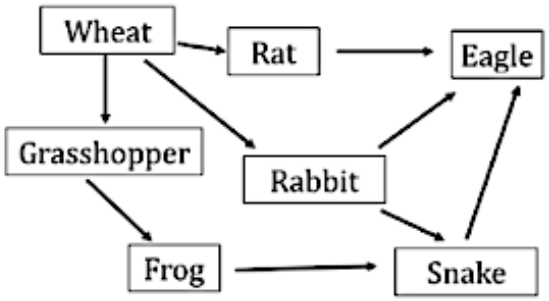
4. The graph below illustrates the reduction in substrate concentration during an enzymatic reaction over time. The half-life of a reaction refers to the duration required for the concentration of a limiting reactant to decrease by half.



What is the best estimate of the half-life for this reaction?

A. 1 minute
B. 2.5 minutes
C. 4 minutes
D. 6 minutes

5. A group of students is studying the feeding relationships among various organisms in a farm ecosystem. They have sketched a food web, as shown in the figure below.

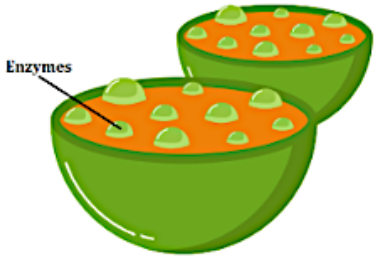


Which of the following statements about the food web is/are correct?

I. There are only 2 herbivores in the food web.
II. The energy source of frogs comes only from grasshoppers.
III. The population of snakes will increase if the population of eagle decreases
IV. If the intensity of light is reduced, the population of wheat will be affected first.

A. I only
B. II and III only
C. I, II, and III only
D. II, III, and IV only

6. Cells rely on various organelles to maintain their structures and functions. Some organelles, like in the diagram below are specialized for the breakdown and recycling of cellular components, playing crucial roles in processes like *autolysis* or the self-destruction of damaged cells and *autophagy* or the recycling of cellular materials.

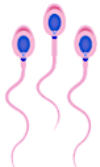


Given its role in autolysis and autophagy, this organelle is most abundant in which of the following structures?


A


B


C

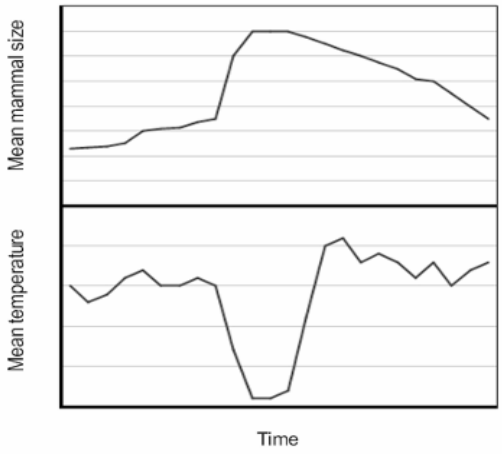

D

7. You are conducting a laboratory experiment on a particular group of cells that have been supplied with oxygen. After a certain period, you decide to cut off the oxygen supply to these cells. Following this, you observe that the amount of amino acid absorbed by the cells drops drastically.

   Based on these observations, which of the following statements **BEST** explains why the amount of amino acid absorbed by the cells decreased so significantly when the oxygen was cut off?

   A. Amino acids cannot be absorbed by the cells when oxygen is absent.
   B. Amino acids are absorbed by the cells mainly through active transport.
   C. Amino acids require oxygen for digestion of protein molecules by enzymes.
   D. Amino acids are absorbed by the cells mainly by muscular contractions of the cells.

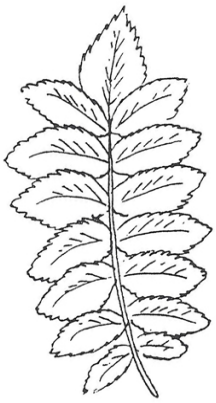
8. A study examining the factors influencing evolutionary changes in animal size was conducted. Researchers calculated the mean size of all mammals in a region of North America over a period of 10 million years, using data from the fossil record. Additionally, they determined the temperature in the region during this time. The graphs representing these findings are shown below:



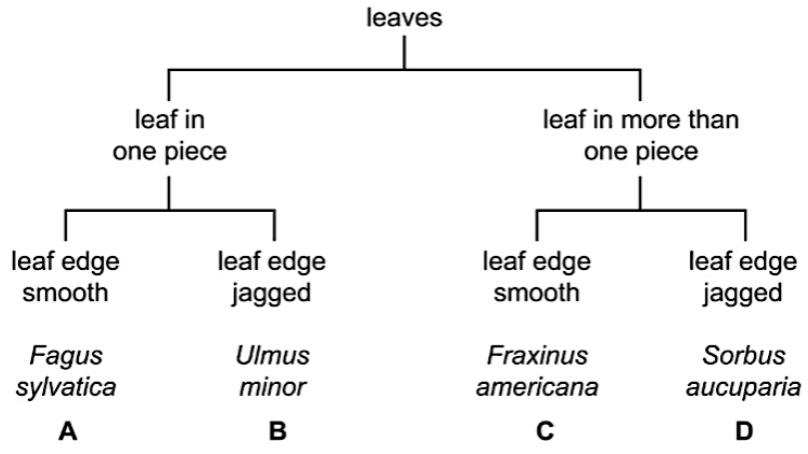
   Which of the following is the **MOST** likely explanation for the trend observed in the graphs?

   A. Larger animals can more easily avoid predation, giving them a selective advantage during cold periods when food is scarce.
   B. Larger animals produce less CO_2 through respiration, contributing to lower atmospheric CO_2 levels and decreased global temperatures.
   C. The cold climate stimulates animals to grow larger, and they pass this characteristic on to their offspring.
   D. The decreased surface area to volume ratio of larger mammals gives them a selective advantage during cold periods.

9. Leaves can vary greatly in shape, size, and structure. These differences help in identifying the plant species to which they belong. By using a key, you can systematically determine the correct classification based on specific characteristics of the leaf. Use the key to identify **Plant W.**



Plant W



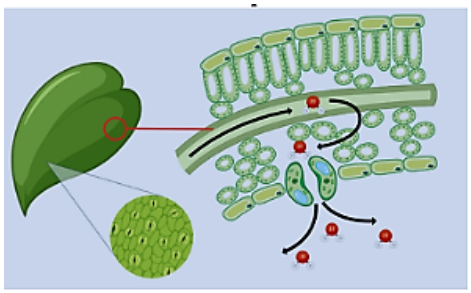
10. In modern medicine, biotechnology plays a significant role in producing treatments for various conditions, including diabetes. One of the most well-known applications of biotechnology is the production of insulin, which is vital for managing diabetes. What is the **MOST** likely method used to produce this insulin through biotechnology?

A. Insulin is extracted from plants and purified in a lab.
B. Scientists insert the human insulin gene into bacteria, which then produce insulin.
C. The insulin is synthesized entirely by chemical processes without using any living organisms.
D. Insulin is collected from healthy humans and injected into patients who need it.

11. Mangrove ecosystems are unique environments where various living organisms (biotic factors) interact with non-living components (abiotic factors) to create a balanced ecosystem. Which of the following combinations is **MOST** accurate in a mangrove ecosystem?

	Biotic Factor	**Abiotic factor**
A.	Types of crabs	Burrows in the sand
B.	Amount of sunlight received	Warm temperature
C.	Different species of mangrove	Presence of fungi
D.	Nutrients from the dead plant matter	Warm temperature

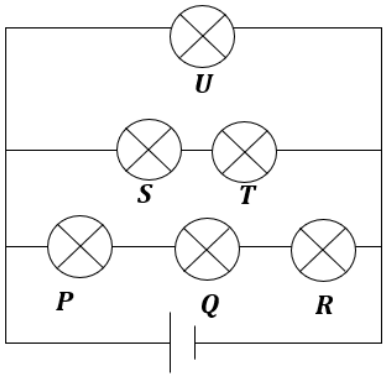
12. Plant transpiration is the process by which water is lost from the leaves to the atmosphere, primarily through stomata. The rate of transpiration is influenced by external factors like temperature, humidity, and wind speed and internal factors such stomatal density and cuticle thickness.



Which of the following adaptations will help plants retain moisture by reducing rate of transpiration especially in hot and dry environment?

A. Increased leaf surface area
B. Sunken stomata
C. Thin cuticle on the surface of leaves
D. Absence of leaf hairs or trichomes

13. Wong has set up an electric circuit using six light bulbs, as shown in the diagram below:

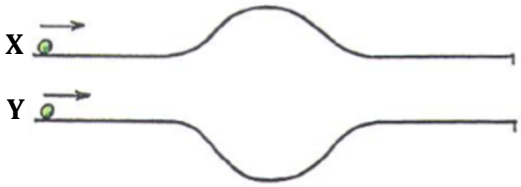


Assuming each bulb has the same resistance, which of the following statements is **CORRECT**?

I. The current passing through bulb U will be greater than the current passing through bulb Q because bulb U is directly connected in parallel with the power source.
II. If bulb S burns out, bulb T will not light up because they are connected in series in the same branch.
III. Bulb P will glow brighter than bulb S because bulb P is directly connected to the power source.
IV. All the bulbs in the circuit will glow with the same brightness because they all have the same resistance and are connected to the same power source.

A. I, II and III only
B. I and II only
C. II and IV only
D. Only IV

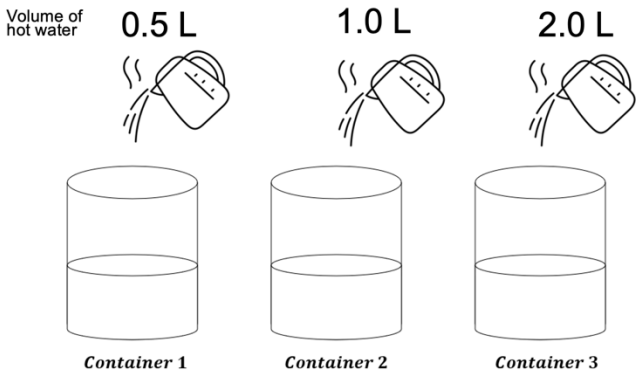
14. Two smooth tracks of equal length have “bumps” of the same curvature where ball **X** travels up and ball **Y** travels down with the same maximum change in height.



If the two balls start simultaneously with the same initial speed, which ball will complete the journey first?

A. Ball **X** will complete the journey first.
B. Ball **Y** will complete the journey first.
C. Both balls will complete the journey at the same time.
D. Impossible to tell since the masses of ball **X** and **Y** are unknown.

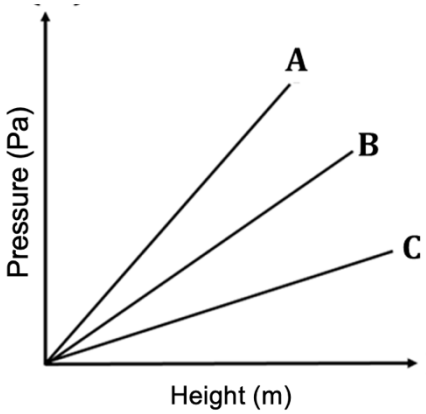
15. There are three containers containing 1 L of water with varying temperatures. Hot water (60 °C) of varying volume is then added to each container, but with different volumes.



After the addition of hot water, each container has the same final temperature of 40 °C. If the containers are assumed to have no heat absorption and release, what is the correct conclusion from this information?

A. The initial temperature of the water in container 2 is the smallest.
B. The initial temperature of the water in container 3 is the greatest.
C. The initial temperature of the water in container 2 is less than that of container 3.
D. The initial temperature of the water in container 3 is greater than that of container 2.

16. Three different liquids, labelled A, B. and C, have their hydrostatic pressure measured at several points. The measurement results are shown in the following graph.



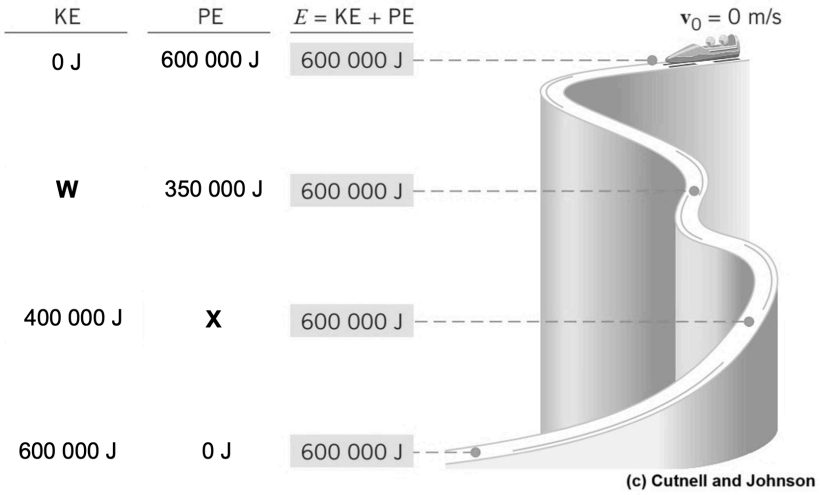
The following table shows the density data of each liquid:

Liquid	Density (kg/m^3)
Cooking oil	910
Water	1000
Glycerol	1261

Determine the identity of liquids A, B and C

	A	B	C
A.	Cooking oil	Water	Glycerol
B.	Cooking oil	Glycerol	Water
C.	Glycerol	Water	Cooking oil
D.	Glycerol	Cooking oil	Water

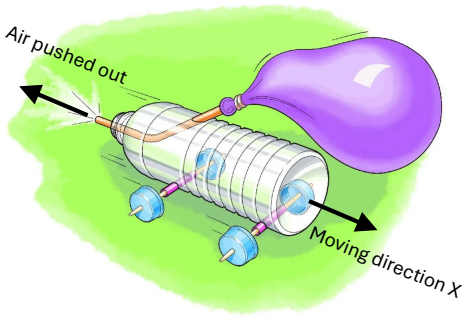
17. Refer to the figure below:



If friction and wind resistance are ignored, a bobsled run illustrates how kinetic energy and potential energy can be interconverted, while the total mechanical energy remains constant. What are the values for W and X?

A. W = 200,000 J; X = 200,000 J
B. W = 200,000 J; X = 400,000 J
C. W = 250,000 J; X = 200,000 J
D. W = 250,000 J; X = 400,000 J

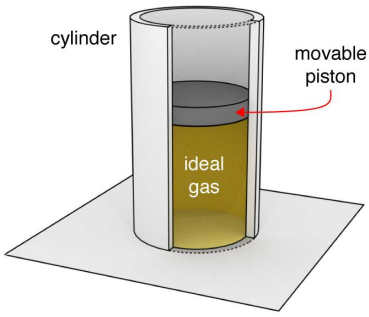
18. A "balloon racer" is a fun simple toy. It is made by taping an inflated balloon firmly to a toy car, as shown below. After removing the plug of the balloon, air rushes out of the balloon, producing a force.



The force caused the balloon and the toy car to move in direction X because this force was greater than the _____.

A. Weight of the toy car and the balloon.
B. Weight of the toy car and the wheels.
C. Friction between the balloon and the toy car.
D. Friction between the wheels and the ground.

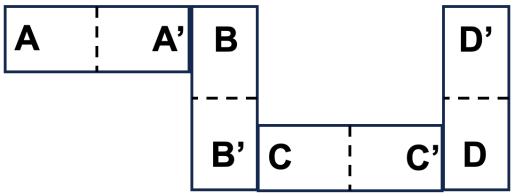
19. The diagram below shows a metal cylinder with a movable piston. The cylinder is filled with gas of a fixed mass.



What will happen to the gas's volume, pressure, and temperature when heat is applied?

	Volume	**Pressure**	**Temperature**
A	increases	unchanged	increases
B	decreases	unchanged	decreases
C	increases	decreases	increases
D	decreases	unchanged	increases

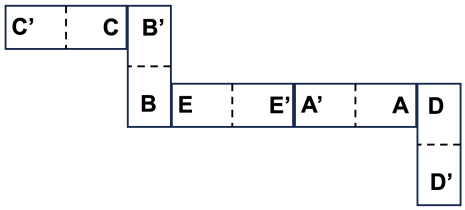
20. Alesha was able to arrange four bar magnets as shown below:



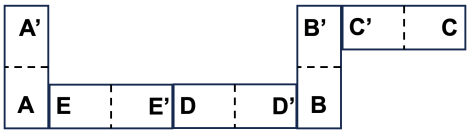
She introduced a new magnet

It was observed that the E' side is attracted to the A side. If she intends to connect the new magnet to the current arrangement, which of the following is a possible re-arrangement?

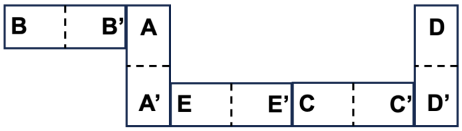
A.



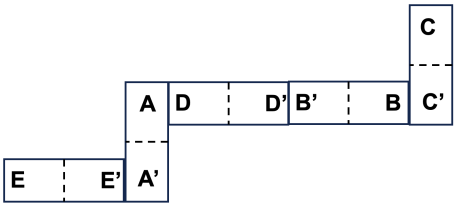
C.



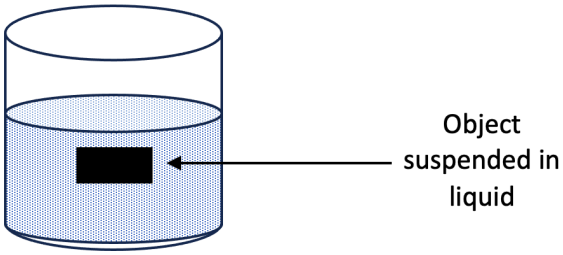
B.



D.



21. The figure below shows an object suspended in the middle of an unknown liquid:

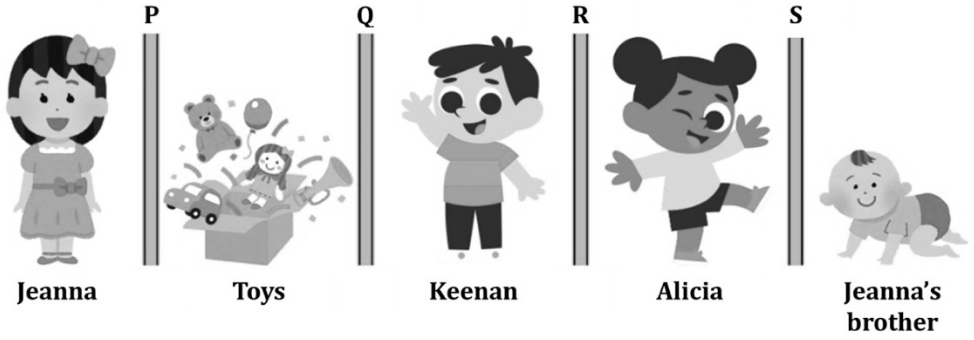


Which of the following objects will suspend in the middle of a container filled with a liquid that has a mass of 180 g and a volume of 200 cm^3?

	Mass (g)	Volume (cm^3)
A.	1185	150
B.	500	200

	Mass (g)	Volume (cm^3)
C.	270	300
D.	100	500

22. Refer on the diagram below:



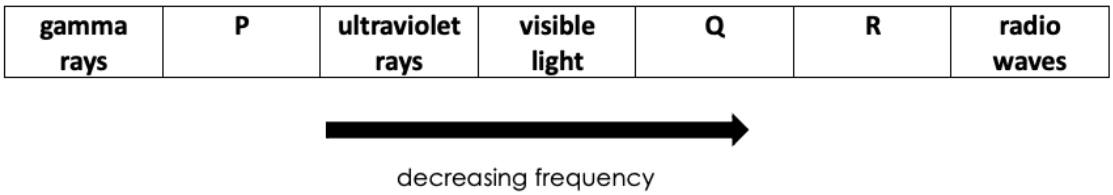
Four children and a box of toys are separated by screen P, Q, R, S. The material of screens is shown in the table below.

Screen	Material
P	Clear plastic
Q	Wood
R	Clear glass
S	Rubber

Based on the information above, which one of the following statements is **CORRECT**?

A. Both Keenan and Alicia are unable to see Jeanna.
B. Alicia can see Keenan and a box of toys.
C. Jeanna is unable to see her brother.
D. Jeanna's brother can see Keenan.

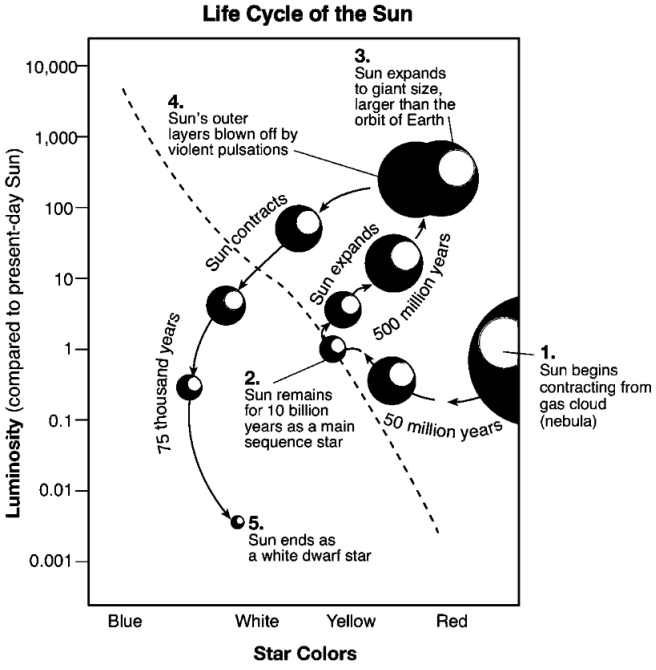
23. The diagram below shows the electromagnetic spectrum in order of decreasing frequency.

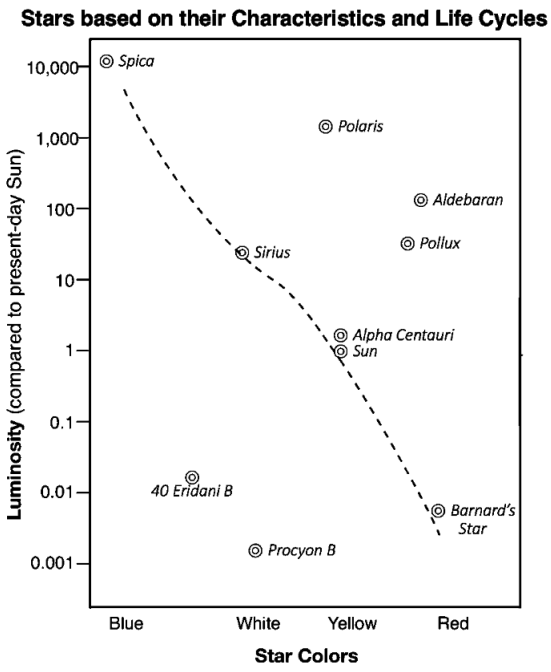


Which of the following is **CORRECT**?

A. Component P has longer wavelength than Q.
B. Component R has shorter wavelength than Q.
C. Component P travels faster in a vacuum than Q and R.
D. Components P, Q, and R travel at the same speed in a vacuum.

24. The diagrams below represents the life cycle of the Sun and example of Stars based on their Characteristics and Life Cycles. The diagonal dashed line represents the main sequence stars. The numbers 1 through 5 represent stages in the life cycle of the Sun.



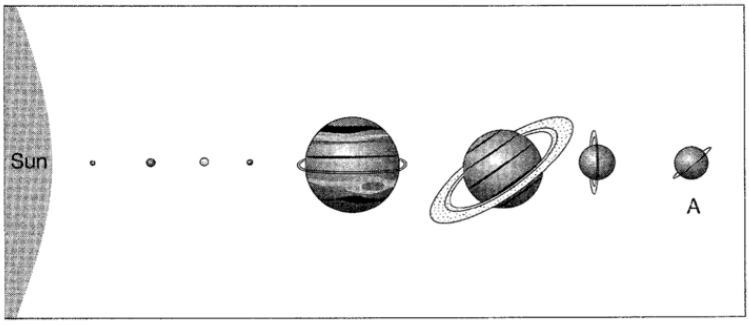


Which of the following statements is correct and incorrect about the stars?

I. *Alpha Centauri* and *Pollux* are two stars that are at the same stage as the Sun
II. *40 Eridani B* is towards the end of its life cycle.
III. *Spica* emits higher energy than *Barnard's Star.*
IV. When Polaris enters stage 5 its relative luminosity increases and its surface temperature decreases
V. Sun is most luminous at stage 3.

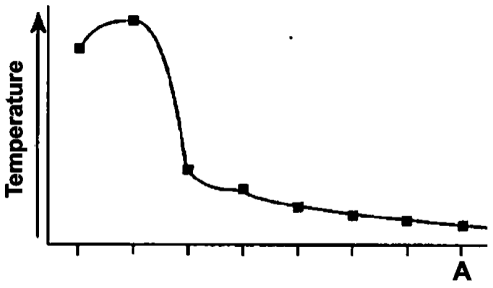
	Correct	*Incorrect*
A.	I, II, IV	III, V
B.	I, IV	II, III, V
C.	II, IV, V	I, III
D.	II, III, V	I, IV

25. The figure below shows the side-view model of the solar system. The planets are shown in their relative order of distance from the Sun. Letter A indicates one of the planets.

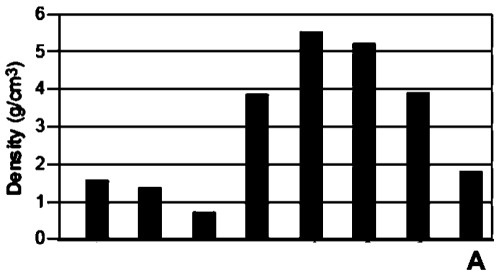


(Not drawn to scale)

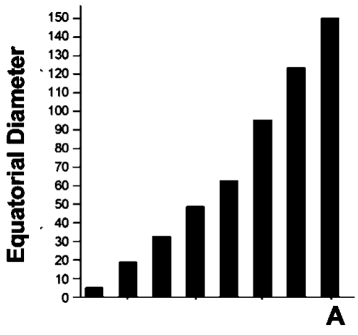
Which of the following graphs best represent the characteristics of planets in the solar system?



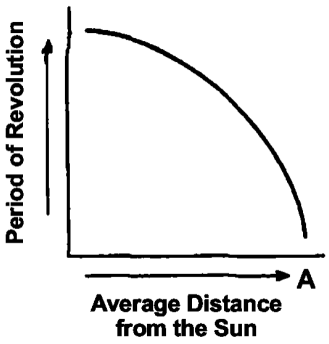
A



B



C



D

26. Choose the most suitable group of statements on the transfer of phosphorus from rock mines to various parts of the world as represented in the figure below.

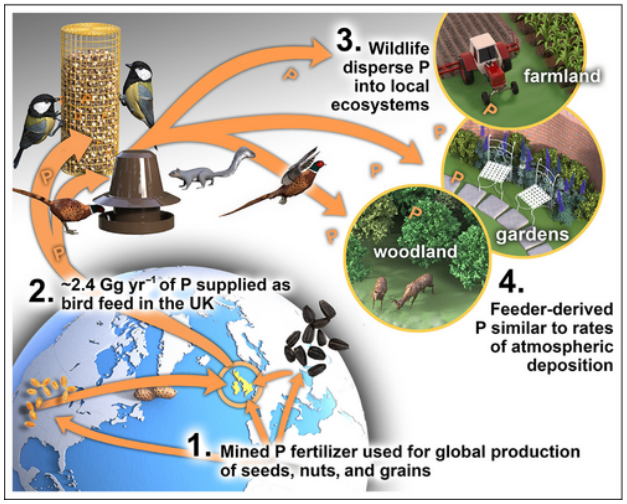


Figure taken from:
https://esajournals.onlinelibrary.wiley.com/doi/10.1002/fee.2793

I. There are only abiotic processes represented in the figure.
II. There can be eutrophication at the local scale.
III. There is a high carbon footprint in the transfer of phosphorus from rock mines to various parts of the world.
IV. Competitive advantage in biodiversity is affected when there is phosphorus dispersal in bird feeds in the UK.

A. I and II
B. I, III and IV
C. II, III and IV
D. II and IV

27. On February 2005, a tragedy occurred in a village in West Java, Indonesia. In the early hours of the morning, an explosion followed by an avalanche of garbage occurred in the Leuwigajah landfill site. The explosion at the landfill is thought to have originated from an accumulation of methane gas in the mountains of garbage. Prior to the explosion, rain had been falling in the area for several days.

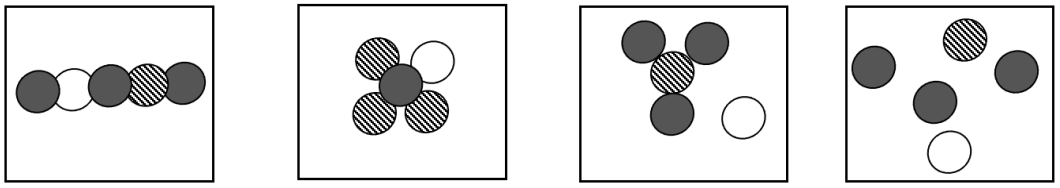
Lifted from: https://geoenvironmental-disasters.springeropen.com/articles/10.1186/s40677-014-0010-5

Which statement is an **INCORRECT** assumption regarding the incident above?

A. Methane gas piles formed due to the decomposition of organic matter by methanogenic bacteria.
B. Methane gas explosion occurs because decomposition by bacteria absorbs heat so that fire can form.
C. One way to prevent methane gas explosions is to ventilate areas suspected of containing methane gas.
D. Continuous rain causes a humid environment, making it easier for bacteria to multiply and decompose organic matter.

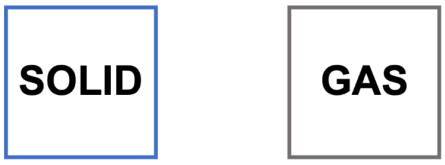
28. During the 2024 Paris Olympics, we saw sports climbing athletes carrying a container at their waist. The container contains a white powdery substance that prevents their hands from becoming slippery when using their hands to grip rocks attached to the cliff. This substance is magnesium carbonate with a chemical formula of $MgCO_3$.

Which of the following diagrams correctly depicts $MgCO_3$?



A B C D

29. In the given diagram, two boxes contain different forms of matter: a solid and a gas. Solids and gases have distinct properties, particularly in how their particles move.



Which of the following statements best describes the behavior of particles in solid and gases?

A. Gases particles are in constant, random motion and occupy the entire volume of their container, unlike solids where particles vibrate in fixed positions.
B. The temperature of gases particles decreases more rapidly than that of solids particles when heat is removed.
C. Solids particles move more rapidly and fill the entire container, whereas gases have stationary particles.
D. Gases particles move more slowly and are closer together than in solids particles.

30. Jane wrote down some physical and chemical changes that she observed at home:

(i) Boiling an egg
(ii) Clothes drying in the wind
(iii) Lighting a gas stove
(iv) Soaking tea leaves in hot water
(v) Dew forming on grass
(vi) Rusting of metal gate

Which of the following items listed above are classified as chemical change?

A. (i), (ii) and (v) only
B. (i), (iii) and (vi) only
C. (ii), (iv) and (v) only
D. (i), (iii), (v) and (vi) only

--- END OF SCIENCE THEORY 1 TEST ---