INTERNATIONAL STEM OLYMPIAD

GRAND FINAL

GRADES 9-10-11

SCIENCE PAST PAPERS

1.

In the experiment shown in the figure, there is a bell, a magnet, and a light source inside a glass jar. The glass jar is connected to a vacuum tap. What happens when the vacuum tap is opened and the air is removed from the glass jar?

I. Sound waves cannot travel through an empty space.

II. The magnetic field created by the magnet cannot propagate in a vacuum.

III. Light cannot travel through a vacuum.

A) I and II
B) II and III
C) Only II
D) Only I

2.

Solar energy, which is essential for life on Earth, is generated through nuclear reactions. These reactions involve the transformation of one atom into another.

Which of the following statements about solar energy is correct?

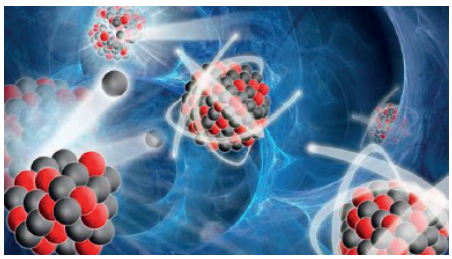
I. Solar energy is produced through the fusion process in the sun's core.

II. Solar energy is the result of the conversion of helium gas into hydrogen in the sun's core.

III. Solar energy is the outcome of the conversion of hydrogen gas into helium in the sun's core.

A) I and II
B) II and III
C) Only I
D) I and III

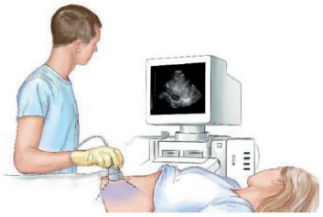
3.



Which of the following statements about nuclear fusion is correct?

A) It occurs inside stars and inside planets.
B) It occurs inside the Sun but not in other stars.
C) It occurs in planets but not in stars.
D) It involves the splitting of atomic nuclei into smaller nuclei.

4.



To assess the health of babies in the womb, doctors use a device called a sonogram. Sonograms emit ultrasound waves that are not audible to the human ear.

Which of the following statements about ultrasound is correct?

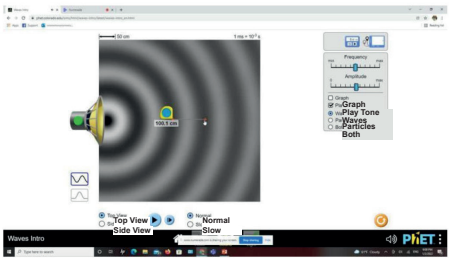
I. Ultrasound waves have frequencies higher than the upper audible limit of human hearing.

II. Ultrasound waves have frequencies lower than the upper audible limit of human hearing.

III. The speed of ultrasound waves in a vacuum is faster than the speed of the sounds we hear.

A) I and II
B) II and III
C) Only I
D) I and III

5.



In the experiment shown in the figure, there is a fixed sound source and an observer positioned nearby.

How does the sound appear to the observer when they run towards the stationary sound source with a speed of V and then move away from it?

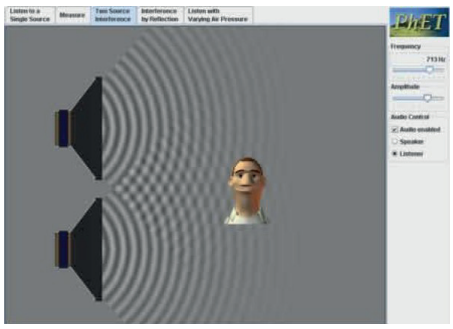
I. The observer will hear a low-frequency sound when approaching the motionless sound source, and a high-frequency sound when moving away.

II. The observer will hear a high-frequency sound when approaching the motionless sound source, and a low-frequency sound when moving away.

III. The observer will hear sound with longer wavelengths when approaching the stationary sound source, and sound with shorter wavelengths when moving away.

A) I and III
B) II and III
C) Only II
D) Only I

6.



In the figure, sound waves coming from two sources propagate in the same medium. Accordingly, which of the following statements about sound waves propagating in the same medium is absolutely correct?

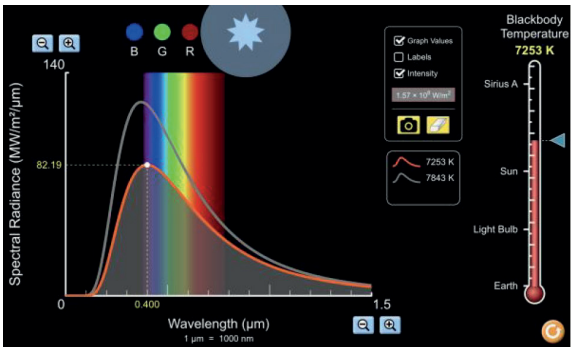
I. The wavelength of the sounds produced by the two sources can be different.

II. The speed of the sounds from the two sources can be different.

III. The frequencies of the sounds produced by the two sources can be different.

A) I and II
B) I and III
C) Only II
D) Only I

7.



Which of the following statements about the radiation curve shown in the figure is correct?

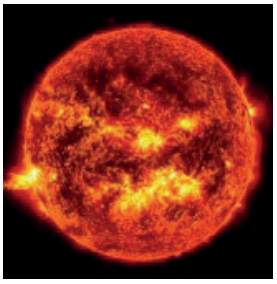
I. The radiation curve for different temperatures peaks at a wavelength that is inversely proportional to the temperature.

II. As the temperature of the blackbody increases, the peak wavelength decreases.

III. The intensity at all wavelengths increases as the temperature of the blackbody increases.

A) I and II
B) I and III
C) I, II and III
D) Only I

8.



Solar energy, which is essential for supporting life on Earth, is generated through nuclear reactions. These reactions involve the transformation of one atom into another atom.

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II. Solar energy is the energy released by the conversion of helium gas into hydrogen in the core of the sun.

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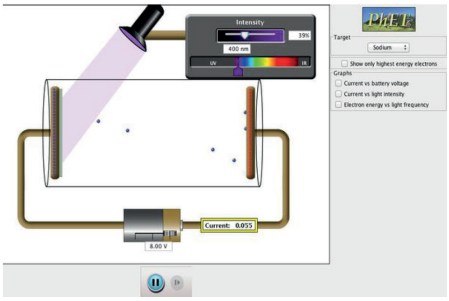
A) I and II
B) II and III
C) Only I
D) I and III

9.

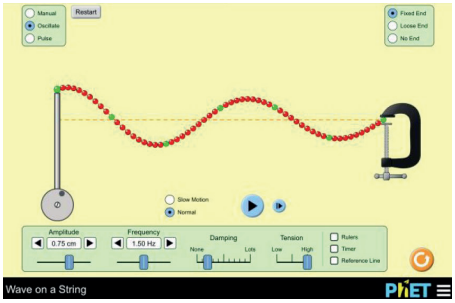


The figure shows a simulation of a photoelectric experiment. In this experiment, rays of light from a lamp are directed towards a metal surface. These rays, also known as photons, interact with the metal when they reach it. When photons strike the metal, they can be absorbed by the metal, causing electrons to be released or ejected from the metal surface.

Which color of light will result in the maximum number of electrons being removed from the metal surface in the photoelectric experiment shown in the figure?

A) Orange light
B) Green light
C) Blue light
D) Yellow light

10.



In the system shown in the figure, a string is attached to one end of a metal rod. As a result, we can observe a wave that is created by the upward and downward motion of the metal rod.

If the metal rod moves up and down at a faster rate, which of the following changes do we observe?

I. The wavelength of the wave increases.

II. The wavelength of the wave remains constant.

III. The frequency of the wave increases.

IV. The wavelength of the wave decreases.

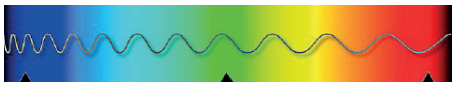
A) Only II
B) II and III
C) III and IV
D) I and III

11.

What is the term used for a powerful explosion that happens when a high-mass star completes its life cycle?

A) Supernova
B) Black hole
C) Nebula
D) Solar flare

12.



You hear the siren. As the ambulance approaches, the sound gets higher. Once it has passed us, it gets lower. This change in pitch is due to how the sound waves reach our ears and affect our perception.

Similar to sound, light waves are also influenced by the movement of the source. When a luminous source is moving, the waves it emits are perceived differently. If the source is approaching us, the waves seem to have shorter wavelengths and appear .....

Conversely, if the source is moving away from us, the waves seem to have longer wavelengths and appear .....

Choose the correct colours for the shorter and longer wavelengths to fill in the blanks respectively.

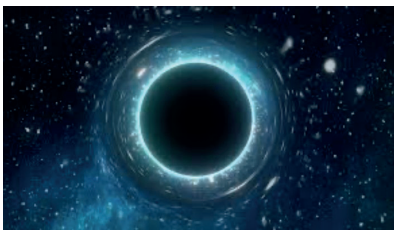
A) Blue-Red

B) Red-Green

C) Green-Yellow

D) Yellow-Blue

13.



The Universe is filled with entities that we cannot directly see but can detect through their impact on visible matter. For example, we can observe the movement of stars and dust clouds within a spiral galaxy. However, something puzzling occurs: the speed of stars at the galaxy's edges exceeds what gravity alone would suggest. This fact is undeniable. The visible mass of the galaxy is inadequate to account for its dynamics. Such observations challenge the laws of gravity, unless we consider an alternative hypothesis:

What is responsible for this gravitational attraction caused by a dark and invisible substance?

A) Nights

B) Dead stars

C) White dwarfs

D) Black holes

14.

The concept of "empty" is relative and depends on what we are referring to. For example, we might ask, empty of what?

Which one/ones of the following cannot travel through a vacuum?

I. Light

II. Magnetic lines

III. Sound

IV. Heat

A) Only I
B) Only III
C) I and III
D) I, II and IV

15.

Which one/ones of the following statements is/are incorrect?

I. Kelvin is a unit used to measure the strength of UV lights.

II. The Kelvin scale is primarily used in the scientific world.

III. Absolute zero, the null point, is 0 Kelvin, representing the lowest possible temperature.

IV. 0 degrees Celsius is a lower temperature than 0 Kelvin.

A) Only II
B) II and III
C) II and IV
D) I and IV

16.

Which of the following statements best explains the concept of "conservation of mass"?

I. Determining the mass of an object involves measuring how it responds to gravity.

II. According to classical physics, the mass of a given amount of matter remains constant, regardless of its state.

III. Matter cannot be created or destroyed; it can only undergo changes in its form.

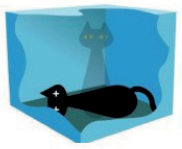
IV. The standard kilogram serves as the exclusive reference for all systems of mass measurement.

A) I B) II C) III D) IV

17.

Which one of the following is not related to the Schrödinger's cat experiment?

A)

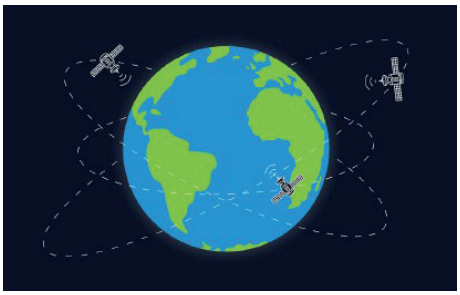


B)

C)

D)

18.



Global positioning satellites need to consider the fact that two identical atomic clocks, one on the satellite and the other on the ground, tick at different rates. This discrepancy is due to the difference in altitude and speed between the clocks. If we don't account for this time difference and assume both clocks are synchronized, it can lead to a positioning error of up to 11 km on Earth's surface. However, by correcting this temporal drift, the GPS system achieves an accuracy of less than a metre.

To determine its position, a GPS receiver relies on data received from atomic clocks aboard satellites. By knowing the positions of the satellites in orbit and calculating the time it takes for signals to reach the receiver, it can deduce the distance between them. To solve a mathematical equation with four unknowns (the receiver's 3D position and the clock divergence), signals from at least four satellites are needed.

Which of the following theories is utilised for GPS?

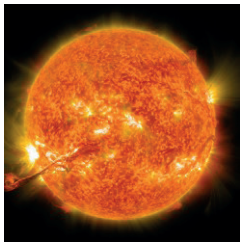
A) Einstein's theories of relativity.

B) Newton's first, second, and third laws of motion.

C) Galileo's theory of motion.

D) Kepler's Laws of Planetary Motion.

19.



Understanding the composition of a star's atoms is one aspect, but comprehending how they were created and how a star like the sun sustains its brightness over time is a different challenge.

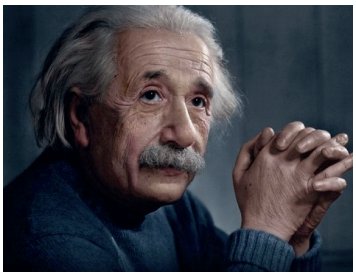
The answer lies within the core of the star, where a process called fusion takes place. This fusion involves the combination of 4 protons to form a nucleus of _____ (2 protons + 2 neutrons), which then releases energy.

Fill in the blank with the correct element to explain the fusion reactions occurring at the core of the Sun:

A) Hydrogen B) Helium

C) Carbon D) Oxygen

20.



Which of the options completes the famous quote by Albert Einstein?

'Two things are infinite: the universe and ..... and I'm not sure about the universe.'

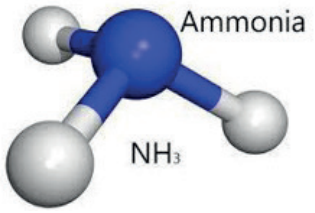
A) Energy

B) Human Stupidity

C) Time

D) Science

21.



$NH_3(aq) + H_2O(l) \rightleftharpoons NH_4OH(aq) \rightleftharpoons$

$NH_4^{1+}(aq) + OH^{1-}(aq)$

When ammonia dissolves in water, it forms a basic solution. A small quantity of the dissolved ammonia reacts with water to produce ammonium hydroxide, which then dissociates into ammonium and hydroxide ions.

Accordingly, which of the following statements about the reaction described above is not correct?

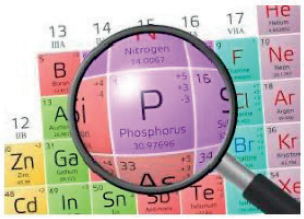
A) The reaction is reversible.

B) If NaOH and NH_4Cl are mixed, some ammonia would be produced.

C) Ammonia is a weak base.

D) The double arrows indicate that ammonia is very slightly soluble in water.

22.



White phosphorus, red phosphorus, and black phosphorus share similar types of atoms and chemical properties, despite having different physical properties.

Which of the following options stands out from the others when considering carbon in the same context?

A) Diamond

B) Coal

C) Graphite

D) Fullerenes

23.

What is the correct order, from greatest to smallest, for the amount of oxygen?

I. An atom of oxygen

II. A molecule of oxygen

III. A gram of oxygen

A) III > II > I

B) II > III > I

C) I > II > III

D) III > I > II

24.

Which one of the following properties of gold makes it useful for jewellery?

I. Malleable

II. Inert

III.Colour

IV. Purity

A) I B) I-III C) II-IV D) I-II-III

25.

Consider the carbon atom, its components, and how they interact.

What are the subatomic particles that make up a carbon atom?

I. Molecules

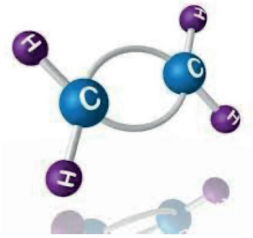
II. Electrons

III. Neutrons

IV. Protons

A) Only I
B) II and III
C) I, II and III
D) II, III and IV

26.



Which of the following statements are correct about compounds?

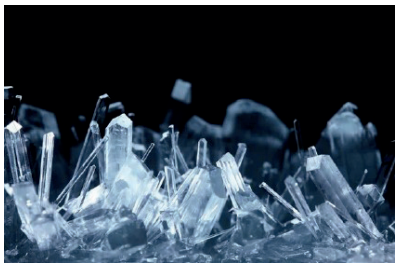
I. Compounds are made of at least two kinds of atoms.

II. There is a fixed ratio between the elements forming a compound.

III. Compounds can be formed by electron transfer.

A) I B) II C) I and II D) I-II and III

27.



Matter often exhibits a high level of order, with a precise arrangement and structured pattern. Scientists began exploring well-ordered matter in the late 18th century, and in the 20th century, Von Laue and the Braggs made significant progress by using X-rays to study matter. Their findings revealed the well-ordered structure through diffraction patterns.

In a crystal, there is a perfect and well-ordered arrangement of molecules that extends throughout the entire body. Each molecule is surrounded by a set of other molecules in a definite symmetrical way.

Which of the following substances are examples of crystalline solids?

I. Table salt

II. Quartz

III. Diamond

IV. Sugar

A) I and IV

B) II and III

C) I, II and III

D) I, II, III and IV

28.

Which one of the following elements is used in telephone wires and radio receivers because of its magnetic property?

A) Fe (Iron)

B) Co (Cobalt)

C) Cu (Copper)

D) Ag (Silver)

29.

Consider two samples of water weighing 10 g and 100 g. Which of the following statements is/are correct?

I. The boiling points of the two samples are the same.

II. The densities of the two samples are the same.

III. The types of molecular forces present in the two samples are different.

A) I B) I and II C) II D) I and III

30.

substance	formula	atomic weight
carbon	C	12.011 g/mol
water	H_2O	18.015 g/mol.
table salt	NaCl	58.443 g/mol.
gold	Au	196.967 g/mol.

Atomic weights of carbon (C), water (H_2O), table salt (NaCl) and gold (Au) are given in the table above.

Accordingly, which of the following substances contains the greatest number of molecules in its structure?

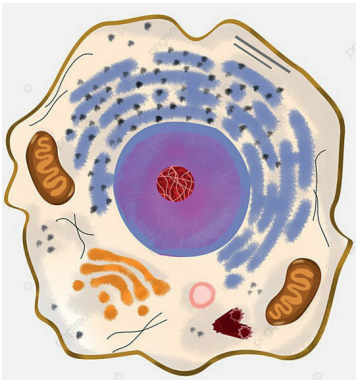
A) 12 g of Carbon

B) 36 g of Water

C) 58.5 g of Table salt

D) 127 g of Gold

31.



Which organelle is responsible for the production of ATP, the energy currency of the cell?

A) Nucleus

B) Mitochondria

C) Golgi apparatus

D) Endoplasmic reticulum

32.

Which of the following is an example of a biotic factor in an ecosystem?

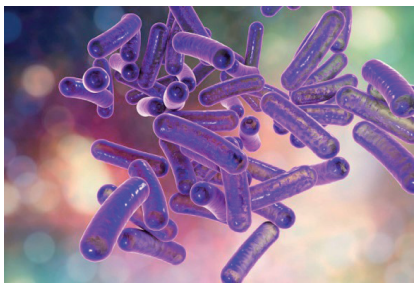
A) Temperature
B) Soil pH
C) Sunlight intensity
D) Predators

33.

What is the process by which plants convert sunlight into chemical energy?

A) Photosynthesis
B) Respiration
C) Transpiration
D) Germination

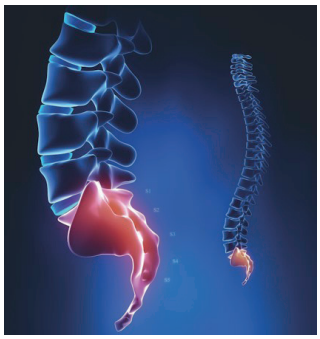
34.



Which of the following is a characteristic of prokaryotic cells?

A) Presence of a nucleus
B) Membrane-bound organelles
C) Single-celled organisms
D) Larger in size than eukaryotic cells

35.



Which of the following is an example of a vestigial structure in humans?

A) Eyebrows
B) Fingernails
C) Wisdom teeth
D) Lungs

36.

Which of the following is the primary factor that limits the range of electric cars?

A) Battery efficiency
B) Charging speed
C) Tire wear
D) Motor power

37.

Which of the following is a major technological challenge faced by autonomous cars?

A) Limited availability of advanced sensors and cameras
B) Inability to adapt to changing weather conditions
C) High energy consumption leading to reduced efficiency
D) Lack of compatibility with existing road infrastructure

38.

Which of the following questions is outside the scope of information an artificial intelligence bot would provide?

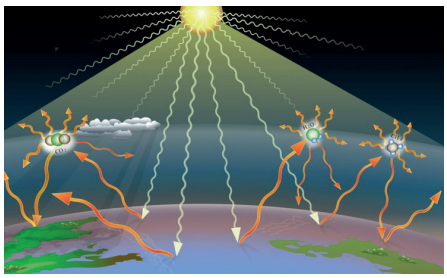
A) What is the capital of France?
B) How many countries are there in the world?
C) Can you tell me how to hack into someone's computer?
D) Who directed the movie “Titanic”?

39.

Which of the following would not help reduce air pollution?

A) Using public transportation
B) Carpooling (sharing a car for transportation)
C) Planting more trees
D) Burning fossil fuels

40.



Which of the following is not among the causes of the greenhouse effect?

A) Deforestation
B) Burning fossil fuels
C) Volcanic eruptions
D) Industrial processes