Answers

1. **Answer: c**

Explanation:

CONCEPT:

- Acceleration Due to Gravity : The force of attraction exerted by the earth on a body is called gravitational pull or gravity.
  - We know that when a force acts on a body, it produces acceleration. Therefore, a body under the effect of gravitational pull must accelerate.
- The acceleration produced in the motion of a body under the effect of gravity is called acceleration due to gravity , it is denoted by g.

If g is the acceleration due to gravity, then

$g = \frac{GM}{R^2}$

Where G = universal gravitational constant, M = mass of the earth and R = radius of the earth

- The difference in the true value and measured value of a quantity is called error of measurement .
- Error in the division of quantities: Suppose
- Let Δa = absolute error in measurement of a,

Δb = absolute error in measurement of b, Δx = absolute error in the calculation of x i.e. division of a and b, and the maximum permissible error in x is $\frac{\Delta x}{x} \times 100 = \pm \left(\frac{\Delta a}{a} \times 100 + \frac{\Delta b}{b} \times 100\right)$

CALCULATION:

Given that:

ΔR/R = 1%

- The acceleration due to gravity is

$\Rightarrow g = \frac{GM}{R^2}$

$g = \frac{GM}{R^2}$, for constant G and M

- The maximum permissible error in the acceleration due to gravity is

$\Rightarrow \frac{\Delta g}{g} \times 100 = -2 \times \frac{\Delta R}{R} \times 100$

$\Rightarrow \frac{\Delta g}{g} = -2 \times (-1)\,\% = +2\%$

- The **value of g increases by 2%** . So option 3 is correct.

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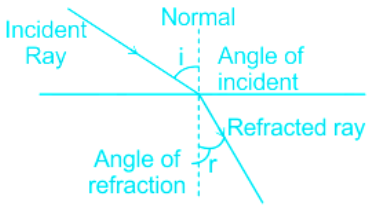
2. **Answer: b**

Explanation:

CONCEPT:

- Refraction of Light: The bending of the ray of light passing from one medium to the other medium is called refraction.

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- The refraction of light takes place on going from one medium to another because the speed of light is different in the two media .
- The greater the differencein the speeds of light in the two media, the greater will be the amount of refraction .
- A medium in which the speed of light is more is known as optically rarer medium and a medium in which the speed of light is less is known as an optically denser medium .

EXPLANATION:

- Since the **frequency** of any light, wave depends on the source frequency. Frequency doesn't depend on the medium. So whenever the light goes from one medium to another , the frequency of light and phase of light does not change . Therefore option 2 is correct.
- However, the **velocity** of light, the **wavelength** of light, and **amplitude** depend on the medium, and hence they change. Therefore option 1, 3, and 4 are incorrect

---

3. **Answer: b**

Explanation:

CONCEPT:

- Reflection: The phenomena in which a light ray is sent back into the same medium from which it is coming, on interaction with boundary , is called reflection.
- Lambert's cosine law: This law states that 'illumination, E at any point on a surface is directly proportional to the cosine of the angle between the normal at that point and the line of flux.
  - Law of inverse squares: According to the Law of inverse squares, illumination of a surface is inversely proportional to the square of the distance between the surface and the light source.

$E = \frac{I}{d^2}$

Where E is the illuminance, I is the luminous intensity, and D is the distance between the surface and the source

- Refraction: When a ray of light passes from one medium to another it suffers a change in direction at the boundary of two media is called refraction.
- Interference: The combination of two or more electromagnetic waveforms to form a resultant wave that may have greater, lower, or the same amplitude is called interference.

EXPLANATION:

- **Lambert's law is related to illumination** . So option 2 is correct.

Important Point :

- Inverse-square law is only applicable for the surfaces if the surface is normal to the line of flux
- Lambert's cosine law is applicable for the surfaces if the surface is inclined at an angle θ to the line of flux

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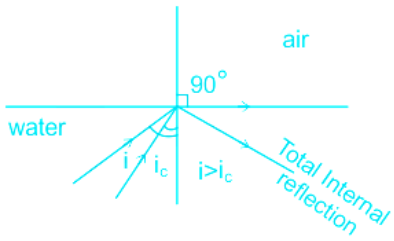
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4. **Answer: d**

Explanation:

CONCEPT:

- Total internal reflection (TIR): Total internal reflection (TIR) occurs at the interface of two transparent medium when the ray of light travels from a denser medium to a rarer medium.
  - The critical angle is the angle of incidence in the denser medium for which the angle of refraction in the rarer medium is 90°.



- Total internal reflection (TIR) of light is the reflection of light within the same medium when a ray of light is incident at the interface of two medium at an angle of incidence which is greater than the critical angle for the pair of media i.e. i > i c.

Conditions for TIR:

1. The ray must travel from denser medium to rarer medium .
2. The angle of incidence (i) must be greater than the critical angle (i c) .

EXPLANATION:

Refractive index of water = 1.33

Refractive index of glass = 1.5

Refractive index of air = 1

- It is the necessary condition that, ray must be travelling from denser medium to rare medium.
- When light is going from **water (rare medium, μ = 1.33) to glass (Denser medium, μ = 1.5) then there won't be any possibility of TIR** . So option 4 is correct.

---

5. **Answer: c**

Explanation:

CONCEPT:

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Three modes of Transmission of heat/heat flow			
Sl. No	Conduction	Convection	Radiation
1	Heat dissipates from one place to another by molecular vibration	Heat is transfer from one place to another by transfer of molecules	It transfers heat in the form of electromagnetic wave
2	Conduction is relevant to solid only .	Convection happens in liquid or gases	It can heat any form of material.
3	Need medium to transfer heat	Need medium to transfer heat	No need of medium
4	Good Conductor - The objects which transfer heat easily. Ex- metals, human body etc Bad Conductor - The objects which do not transfer heat easily. Ex- Wood, Air, etc. Thermal Insulator - No heat is transferred by any means. Ex- Abonite, asbestos etc.	When molecules are heated they headed upward and upper molecules go downward and this cyclic process continues. Boiling of fluid	Heat travels in terms of energy packets or waves The heat absorbed by the body gain energy Radiations of Sun

EXPLANATION:

- Here in the case of a furnace, there is atmospheric air from which convection heat transfer can take place but due to less convection rate, it won't be too much in effective.
- There will be a **radiation heat transfer which doesn't need any medium to travel. That's why it will be dominant.** Hence option 3 is correct.

---

6. **Answer: d**

Explanation:

CONCEPT:

- Resistance (R): The resistance offered to the flow of current is known as the resistance .
- SI unit of resistance is the ohm (Ω).

Mathematically resistance can be written as:

$R = \frac{\rho l}{A}$

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Where R = resistance, l = length, A = area of cross-section and ρ = resistivity

CALCULATION:

Given that: R 1 = 5 ohm and d 2 = 3 mm, d 1 = 6 mm

A 1/A 2 = ((πd 2 1)/4)/((πd 2 2)/4) = 6 ^{2}/3 ^{2} = 4

A $_2$ = A $_1$/4

As we know that the **resistance** of the wire is,

$R = \frac{\rho l}{A}$

When the wire is stretched then, then its length will increase automatically. But the volume of wire will be the same.

∴ The volume of original wire = volume of new wire

A 1l 1 = A 2l 2

(πd ^{2}1 l1)/4 = (πd ^{2}2 l2)/4

⇒ l $_1$/l $_2$ = d $_2^2$ /d $_1^2$ = 3 ^{2}/6 ^{2} = 1/4

So **l$_2$ = 4 l $_1$**

The resistance of the wire in 1 st case:

$R_1 = R = \frac{\rho l_1}{A_1}$ ----(1)

The resistance of the wire in 1 st case

$R_2 = \frac{\rho l_2}{A_2} = \frac{\rho 4 l_1}{\frac{A_1}{4}} = \frac{16 \rho l_1}{A_1}$ -----(2)

Divide equation 1 and 2, we get

$\frac{R}{R_2} = \frac{\frac{\rho l_1}{A_1}}{\frac{16 \rho l_1}{A_1}} = \frac{1}{16}$

R 2 = 16 R $_1$ = 80 ohm

Hence option 4 is correct.

---

7. **Answer: c**

Explanation:

CONCEPT:

- Capacitor: A capacitor is a device that stores electrical energy in an electric field.
  - The SI unit of capacitance is the farad (F) , named in the honor of Michael Faraday.
- The capacitance of a capacitor (C): The capacitance of a conductor is the ratio of charge (Q) to it by a rise in its potential (V), i.e.

C = Q/V

SI unit of C = unit of Q/unit of V = Coulomb/volt = farad (F)

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- Electric potential: The amount of work done in moving a unit charge from a reference point to a specific point in the electric field without producing any acceleration is called electric potential.
  - Volt (V) is the SI unit of the Electric Potential .
- **Electric field** : The space or region around the electric charge in which electrostatic force can be experienced by other charged particle is called an electric field by that electric charge.
  - The SI unit of the electric field is **Newton/coulomb or volt/meter** .

EXPLANATION:

- Since **Coulomb force is also a type of force and the SI unit of this force will be Newton (N)** like all other forces. So the option is not correctly matched. Hence option 3 is correct.
- Rest all other options are correctly matched with their respective units.

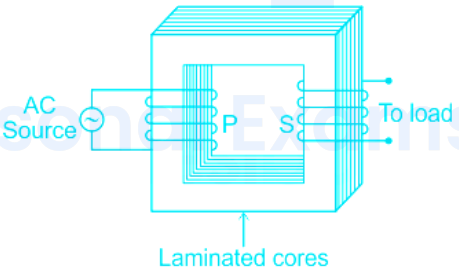
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8. **Answer: d**

Explanation:

CONCEPT:

- **Dynamo/electric generator** : An electric generator is a device that is used to convert mechanical energy into electric energy.
  - An electric generator works on the Electromagnetic Induction Principle.
- Conductor : The materials in which the electric current can flow easily are called conductors.
- Transformer: An electrical device that is used to transfer electrical energy from one electrical circuit to another is called a transformer.
  - In a transformer, there are two coils- The primary coil (P) and secondary coil (S).
  - A Transformer is used to convert low voltage (or high current) to high voltage (or low current) and high voltage to low voltage.



- **Inductor** : The coil which stores magnetic energy in a magnetic field is called an inductor.

EXPLANATION:

- The **device that steps up or steps down the voltage is called a transformer.** So option 4 is correct.

EXTRA POINTS:

There are two types of transformer :

- Step-up transformer : The transformer which increases the potential is called a step-up transformer.
  - The number of turns in the secondary coil is more than that in the primary coil.
- Step-down transformer : The transformer which decreases the potential is called a step-down transformer.
  - The number of turns in the secondary coil is less than that in the primary coil

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9. **Answer: a**

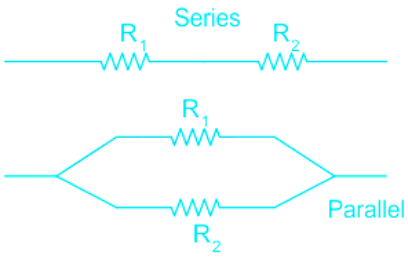
Explanation:

CONCEPT:

There are mainly two ways of the combination of resistances:

1. Resistances in series combination

2. Resistances in parallel combination



- When two or more resistances are connected one after another such that the same current flows through them are called as resistances in series .

The net resistance/equivalent resistance (R) of resistances in series is given by:

Equivalent resistance, R = R 1 + R 2

- When the terminals of two or more resistances are connected at the same two points and the potential difference across them is equal is called resistances in parallel.

The net resistance/equivalent resistance(R) of resistances in parallel is given by:

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

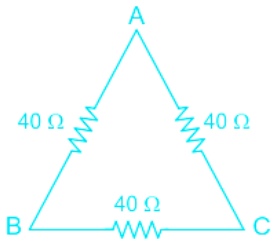
CALCULATION:

Given that:

Resistance per unit length = 4 ohm/cm

Length of each side = 10 cm

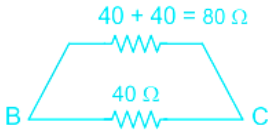
So the **resistance of each side = 4 × 10 = 40 Ω**



Here we will find equivalent resistance across BC, the resistances across AB and AC are in series combination.

So $R_{AB \text{ and } AC}$ = 40 + 40 = 80 Ω

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Now 80 ohm and 40 ohm are in parallel combination:

1/R = 1/80 + 1/40 = 3/80

So R = 80/3 Ω

Hence option 1 is correct.

---

10. Answer: b

Explanation:

CONCEPT:

- Permeability (**μ 0**): The measurement of the ability of any material which allows the formation of magnetic lines of force is called permeability .
- **Saturation** : The state reached when an increase in applied external magnetic field (H) cannot increase the magnetization of the material further is called saturation.
  - Also, the arrangement of molecules of a magnet in the direction of the magnetic field is called saturation.
- **Retentivity** : The ability to retain a magnetic field after the removal of the externally applied magnetic field is called retentivity.
- **Reluctance** : The property of a magnetic circuit of opposing the passage of magnetic flux lines is called reluctance.

EXPLANATION:

- According to the definition of saturation, **all the molecules in a magnet arrange themselves in the direction of the magnetic field is due to the saturation.** So option 2 is correct.

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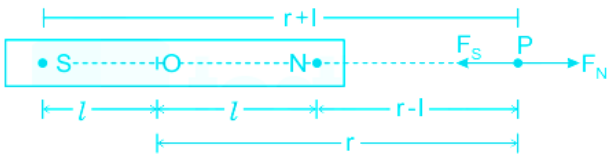
11. Answer: c

Explanation:

CONCEPT:

- Bar Magnet: A bar magnet consists of two equal and opposite magnetic pole separated by a small distance. Poles are not exactly at the ends.
  - The shortest distance between two poles is called effective length (L e) and is less than its geometric length (L g) for bar magnet.

CALCULATION:



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- If we consider a bar magnet of length l , then the magnetic moment is M = 2m × l

Where m is the magnitude of poles.

- Considering thedistance r from the center of the bar magnet, we can write magnetic field intensity as a product of magnetic field strength and positional feature.
- Therefore, the field intensity at a distance r is given by (r 2 - l 2) 2.

The magnetic field of a bar magnet at an axial point is given by

$B = \frac{\mu_o}{4\pi}\frac{2Mr}{(r^2-l^2)^2}$

At the centre of the magnet, r = 0

So $B = \frac{\mu_o}{4\pi}\frac{2Mr}{(r^2-l^2)^2} = \frac{\mu_o}{4\pi}\frac{2M\times 0}{(r^2-l^2)^2} = 0$

Hence option 3 is correct.

---

12. Answer: a

Explanation:

CONCEPT:

- Ohm's law: At constant temperature and other physical quantities, the potential difference across a current-carrying wire is directly proportional to the current flowing through it.

V= RI

Where V is the potential difference , R is resistance and I is current .

- Power : The rate of work done by an electric current is called power. It is denoted by P. The SI unit of power is the watt (W).

Power dissipation is given by:

Power (P) = V I = V 2/R = I 2 R

Where V is the potential difference across resistance, I is current flowing and R is resistance.

CALCULATION:

Given that:

Resistance (R) = 50 ohm

Power (P) = 0.5 W

Power (P) = V 2/R = 0.5

So V ^{2} = 0.5 × 50 = 25

Voltage (V) = √25 = 5 V

Hence option 1 is correct.

---

13. Answer: d

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Explanation:

CONCEPT:

- Heating effect of electric current: When a current is flowing in a circuit having resistance there is heat dissipation due to the resistance. This is called the heating effect of electric current .

The heat dissipated is given by :

Heat (H) = I 2 R t

Work done (W) = Heat (H) = Power (P) × Time taken (t)

Where I = the current flowing in the circuit, R = the resistance of the circuit, and t = the time taken

1 Hp = 1 horsepower = 746 Watt (W)

CALCULATION:

Given that:
Power (P) = 100 watt
Energy = Heat = Power (P) × Time taken (t) = 5000
100 × t = 5000
So **t = 50 sec**
Hence option 4 is correct.

---

14. **Answer: a**

Explanation:

CONCEPT:

- Electric current : The rate of flow of electric charge is called electric current.
  - The SI unit of electric current is Ampere (A)

Hence, Electric current (I) = Q/t = Charge/time

EXPLANATION:

- The passage of current is due to the **flow** of positive charges . This is what we call the conventional flow of current , i.e. in the direction of flow of positive charges .
- The direction of the conventional current corresponds to the **direction of positive charge** which is from higher potential(positive) to lower potential(negative).
- After the discovery of electrons, it was observed that electrons are the particles that flow in a conductor.
- Electrons being negatively charged flow from the negative terminal to the positive terminal of the voltage source . So, the actual direction of the current should be from the negative to the positive terminal .
- Electric current is associated with the movement of electrons which is from lower potential(negative) to higher potential(positive), therefore, the direction of electric current is opposite to that of conventional current.
- Thus the **direction of electric current is always opposite to the direction of conventional current in metallic conductors** . So option 1 is correct.

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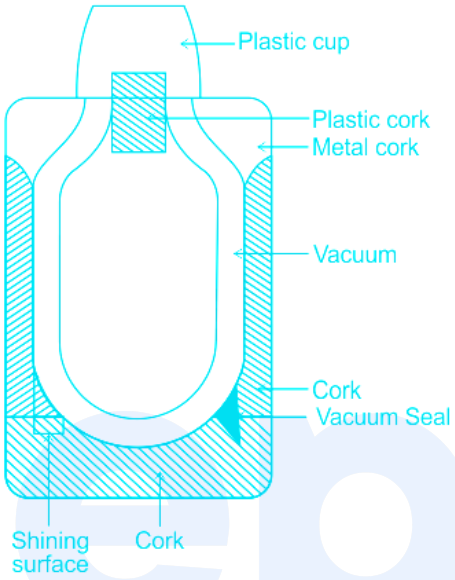
15. **Answer: d**

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Explanation:

CONCEPT:

- **Thermos flask** : A thermos flask is an instrument that keeps hot liquids hot and cold liquids cold for long hours.
  - So it's an ideal example of a closed system so ideally no heat is radiated/absorbed through the thermos.
  - It consists of a glass vessel with double walls. The glass vessel is enclosed by a metal or plastic cover for protection against damage.



- The outer surface of the inner wall and the inner surface of the outer wall are silvered (shining). The shining surfaces reduce heat loss due to radiation.
- An insulating stopper (cork) is used to close the mouth of the vessel. The vessel is kept over an insulating (cork) pad.
- It is therefore thermally insulated. Hence, heat does not leave or enter easily and hot liquids remain hot while cold liquids remain cold inside the flask.

EXPLANATION:

- The **space between the walls is a vacuum which reduces the heat loss due to conduction and convection** . If there is any atmospheric air or any material in between then there definitely will be some amount of heat transfer through the conduction and convection processes. Hence option 4 is correct.

EXTRA POINTS:

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Three modes of Transmission of heat/heat flow			
Sl. No	Conduction	Convection	Radiation
1	Heat dissipates from one place to another by molecular vibration	Heat is transfer from one place to another by transfer of molecules	It transfers heat in the form of electromagnetic wave
2	Conduction is relevant to solid only .	Convection happens in liquid or gases	It can heat any form of material.
3	Need medium to transfer heat	Need medium to transfer heat	No need of medium
4	Good Conductor - The objects which transfer heat easily. Ex- metals, human body etc Bad Conductor - The objects which do not transfer heat easily. Ex- Wood, Air, etc. Thermal Insulator - No heat is transferred by any means. Ex- Abonite, asbestos etc.	When molecules are heated they headed upward and upper molecules go downward and this cyclic process continues. Boiling of fluid	Heat travels in terms of energy packets or waves The heat absorbed by body gain energy Radiations of Sun

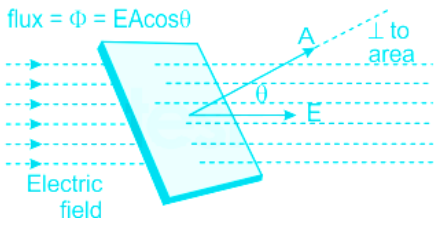
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16. **Answer: a**

Explanation:

CONCEPT:

- Electric flux : The number of electric field lines passing through a surface area normally is called electric flux. It is denoted by Φ.



- The electric flux through a chosen surface is given by:

$\Delta\phi = \vec{E}.\Delta\vec{S} = E\Delta Scos\theta$

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Where θ is the angle between the electrical field and the positive normal to the surface.

EXPLANATION:

- The **number of electric lines of force passing through unit area is called electric flux** . So option 1 is correct.
- The electric charge per unit area is called electric **surface charge density** of that surface.
- The space or region around the electric charge in which electrostatic force can be experienced by other charged particles is called an electric field by that electric charge.

EXTRA POINTS:

- Gauss's Law : It states that the net electric field through a closed surface equals the net charge enclosed by the surface divided by ϵ 0.

$\oint \vec{E}.\overrightarrow{ds} = \frac{q_{inside}}{\epsilon_0}$

Where E = electric field, ds = small area, q inside = the total charge inside the surface, and ϵ 0 = the permittivity of free space.

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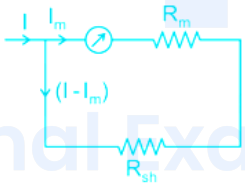
17. **Answer: a**

Explanation:

CONCEPT:

- Ammeter: An ammeter is an instrument that is used to measure the current flowing through the circuit.
  - It has low resistance , ideally zero.
  - By connecting the ammeter in series, it allows all of the circuit current to pass through it and hence measure it.

EXPLANATION:



- The **ammeter** is connected in series with the circuit. To increase its range means we have to enable it to read a higher value of current.
- For this, we connect a **low-value resistance in parallel to it which leads to bypassing a major portion of current through it.** So option 1 is correct.

⭐ Additional Information

- To increase the ranges of a voltmeter, we need to connect a high series of multiplier resistance in series with voltmeters.

---

18. **Answer: a**

Explanation:

CONCEPT:

- Frequency (f): The number of waves that pass a given point per second is called frequency.

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- The unit of frequency is vibration per second or Hertz.
- Time period (T) : The time taken to complete one full oscillation or cycle by the Wave is called time period.
  - The SI unit of the time period is second (s).

The relationship between time period and frequency is given as:

Time period (T) = 1/f

CALCULATION:

Number of vibrations = 2

Time for 2 vibrations = 0.4 sec

So the time for 1 vibration = 0.4/2 = 0.2 sec

Time period (T) = 0.2 sec

Frequency (f) = 1/T = 1/0.2 = 5 Hz

So option 1 is correct.

---

19. **Answer: b**

Explanation:

CONCEPT:

- Wave: It is a disturbance that transfers energy from one place to another .
- SHM (Simple harmonic motion): The type of oscillatory motion in which the restoring force on the system is directly proportional to the displacement of the system is called SHM .

The general expression for the simple harmonic equation is given by:

X = A Sin (ω t)

Where A is the amplitude of SHM, ω is the angular frequency and t is time

The velocity (V) of a particle at any position is given by:

$V = \omega\sqrt{A^2 - x^2}$

The relation between Time period (T) and angular frequency (ω) is given by:

T = 2π/ω

CALCULATION:

Given that:

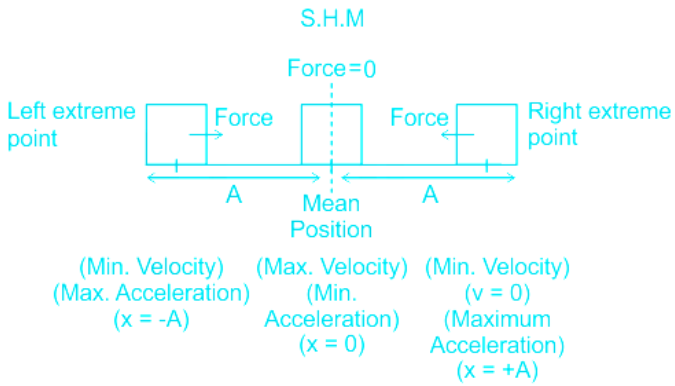
Time period (T) = 2 sec

Amplitude (A) = 2 m

Angular frequency (ω) = 2π/T = 2π/2 = π rad/s

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Since $V = \omega\sqrt{A^2 - x^2}$

- The speed or velocity(V) of the particle will be maximum at the mean position (x = 0).

$Maximum\ velocity\ (V) = \omega\ \sqrt{A^2 - x^2} = \omega\ \sqrt{A^2 - 0^2} = \omega\ A = \pi \times 2\ m/s$

So maximum speed (V) = 2π m/s

Hence option 2 is correct.

---

20. **Answer: d**

Explanation:

CONCEPT:

- Wave: It is a disturbance that transfers energy from one place to another .
- SHM (Simple harmonic motion): The type of oscillatory motion in which the restoring force on the system is directly proportional to the displacement of the system is called SHM .

The general expression for the simple harmonic equation is given by:

X = A Sin (ω t)

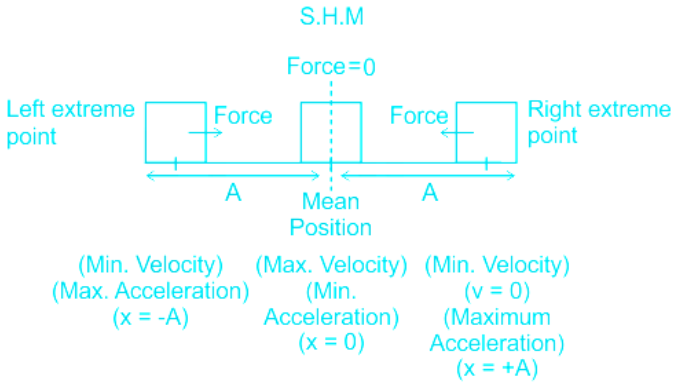
Where A is the amplitude of SHM, ω is the angular frequency and t is time

Acceleration of the particle at any position is given by:

Acceleration (a) = ω 2 x

CALCULATION:

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- The acceleration of the particle will be maximum at extreme points (**x = A**) .

Maximum Acceleration (a) = ω 2 x = ω 2 A

So option 4 is correct.

---

21. **Answer: a**

Explanation:

CONCEPT:

- **Energy (E)** : The capacity to do work is called energy.
  - There are various forms of energy.
  - For example, **Light** , wave, electricity, Heat, etc
- **Pressure (P)** : The force per unit area is called pressure.
- **Momentum (p)** : The multiplication of mass and velocity of a body is called the momentum of that body.
- **Power (P)** : The rate of work done is called power.

EXPLANATION:

- **Light** : The electromagnetic wave which is needed to see the colorful world with the help of our eye is called light.
- It is a **form of energy** that carries heat. So option 1 is correct.

---

22. **Answer: a**

Explanation:

CONCEPT:

- Fermi meter : The unit of spatial measurement or length which is equal to 10 -15 m is called one fermi meter .
  - A fermi meter is denoted by fm .

1 fm = 10 -15 m

EXPLANATION:

1 fm = 10 -15 m

Hence option 1 is correct.

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NOTE :

The prefix used for the SI units		
For small measurements		
Factor	Prefix	Symbol
10 -1	Deci	D
10 -2	centi	C
10 -3	Milli	m
10 -6	Micro	μ
10 -9	Nano	n
10 -12	Pico	p
10 -15	**femto/fermi**	**f**
10 -18	atto	a
10 -21	zepto	z
10 -24	yoeto	y

---

23. Answer: a

Explanation:

CONCEPT:

- Kinetic energy (K.E): The energy possessed by a body by the virtue of its motion is called kinetic energy.

The expression for kinetic energy is given by:

$KE = \frac{1}{2}mv^2$

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Where m = mass of the body and v = velocity of the body

- Momentum (p) : The product of mass and velocity is called momentum.

Momentum (p) = mass (m) × velocity (v)

The relationship between the kinetic energy and Linear momentum is given by:

As we know,

$KE = \frac{1}{2}mv^2$

Divide numerator and denominator by m, we get

$KE = \frac{1}{2}\frac{m^2v^2}{m} = \frac{1}{2}\frac{(mv)^2}{m} = \frac{1}{2}\frac{p^2}{m}$ [p = mv]

$\therefore KE = \frac{1}{2}\frac{p^2}{m}$

$p = \sqrt{2mKE}$

CALCULATION:

Given that:

K.E 1 = K.E 2= K.E (let say)

m_1 = 1 kg and m_2 = 4 kg

The relation between the momentum and the kinetic energy is given by:

$P = \sqrt{2m\ K.E}$

But as K.E is the same

$\therefore\ P \propto \sqrt{m}$

Or, $\frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{1}{4}} = 1:2$

So option 1 is correct.

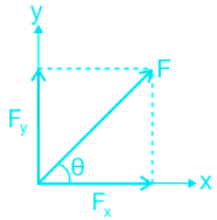
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24. Answer: b

Explanation:

CONCEPT:

- Resolution of vectors into components : We have a vector (F) where the magnitude of the vector is F and the angle with horizontal is θ.



The vector has two components : 1. Vertical component and 2. Horizontal component

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Vertical component (F y) = F Sinθ

Horizontal component (F x) = F Cosθ

Here $F = \sqrt{F_x^2 + F_y^2}$

tanθ = F_y/F_x

CALCULATION:

The x-component of the applied force F x = 5 N

The y-component of the applied force F y = 5 N

We know that the vector sum of the force

$F = \sqrt{F_x^2 + F_y^2}$

$F = \sqrt{5^2 + 5^2} = 5\sqrt{2}$

Tan θ = F y/F x = 5/5 = 1

So **Direction (θ) = 45° = π/4**

Hence option 2 is correct.

---

25. Answer: d

Explanation:

CONCEPT :

- Torque (τ): It is the twisting force that tends to cause rotation. The point where the object rotates is known as the axis of rotation.

Mathematically it is written as,

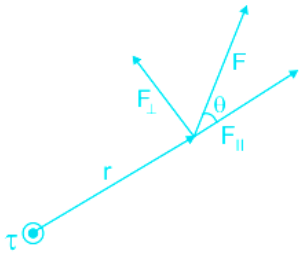
τ = r F sin θ

Where r is the distance from the axis of rotation, F is force and θ is the angle between r and F.

Also Torque (τ) = Moment of inertia (I) × Angular acceleration (α)

EXPLANATION:

- Torque (τ): The physical quantity, similar to force that causes the rotational motion . It is the cross product of the force (F) with the perpendicular distance (r) between the axis of rotation and the point of application of the force with the force.



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Torque (τ) = r × F = r F sin θ

So option 4 is correct.

Quantity	Definition	Formula
Kinetic energy (KE)	The energy possessed by a body by virtue of its motion is called kinetic energy.	$KE = \frac{1}{2}mv^2$ Where m = mass of the body and v = velocity of the body
Work (W)	Work is said to be done by a force when the body is displaced actually through some distance in the direction of the applied force.	W = Fs Cosθ Where F is force, s is displacement, and θ is the angle between F and s
Potential energy (PE)	The energy possessed by a body by virtue of its position or configuration is called potential energy.	PE = m g h where m is mass, g is the acceleration due to gravity, and h is the height

---

26. Answer: c

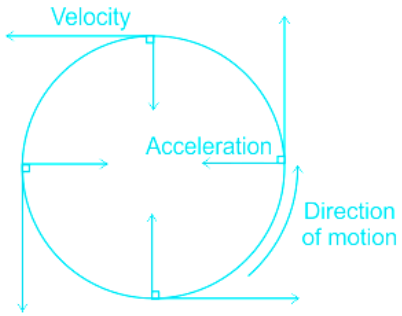
Explanation:

CONCEPT:

- Circular Motion : Circular motion is a movement of an object along the circumference of a circle or rotation along a circular path.
  - The force acts continuously at right angles to the velocity of the particle.
- Uniform circular motion : The circular motion in which the speed of the particle remains constant is called uniform circular motion.
  - In a uniform circular motion, force supplies the centripetal acceleration.

a c = v 2/r, where a c is centripetal acceleration , v is velocity, r is the radius.

- The speed and kineticenergy of the particle remainsconstant .



- Non-uniform circular motion: The circular motion in which the speed of the particles changes by time is called non uniform circular motion.

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EXPLANATION:

- Given motion is uniform circular motion.
- As shown in the above diagram of uniform circular motion, the **velocity and acceleration (which is centripetal acceleration) are normal to each other.** So option 3 is correct.

---

27. **Answer: c**

Explanation:

CONCEPT :

- Newton's Third Law: To every action, there is always an equal (in magnitude) and opposite (in direction) reaction.
- When a bo dy exerts a force on any other body , the second body also exerts an equal and opposite force on the first .
- Forces in nature always occur in pairs. A single isolated force is not possible.

EXPLANATION :

- When a bird is flying, the bird pushes the air with its feather in the backward direction (action) and the air, in turn, pushes them forward due to the force of reaction.
- Thus the **flying of bird is a consequence of Newton's third law of motion** . So option 3 is correct.

EXTRA POINTS:

- Newton's Second law of motion : The rate of change of momentum of any object is directly proportional to the applied force on the body.

$\text{Force } (\text{F}) = \frac{\Delta P}{\Delta t}$

Where Δ P = Change in momentum and Δ t = change in time taken

- According to Newton's first law of motion, an object will remain at rest or in uniform motion in a straight line unless acted upon by an external force.

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28. **Answer: d**

Explanation:

CONCEPT :

- Simple pendulum : When a point mass is suspended with the help of a string or rod of negligible mass and does the to and fro motion about its mean position is called as a simple pendulum .
- For a simple pendulum, the time period of swing of a pendulum depends on the length of the string and acceleration due to gravity.

$T = 2\Pi\sqrt{\frac{\text{l}}{\text{g}}}$

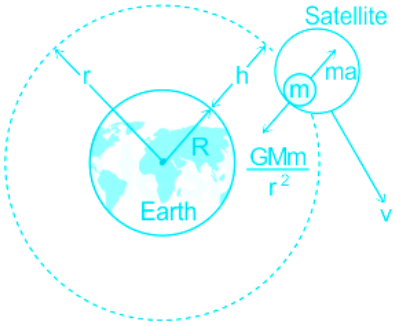
The above formula is only valid for small angular displacements.

Where, T = Time period of oscillation, l = length of the pendulum, and g = gravitational acceleration

- A satellite, which does not produce its own gravity moves around the earth in a circular orbit under the action of gravity.
- The acceleration of the satellite is $\frac{GM}{R^2}$ towards the center of the earth.

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- If a body of mass m placed on a surface inside a satellite moving around the earth . Then force on the body is



The gravitational pull of the earth is
$F = G\frac{M_1M_2}{R^2}$ ----- (1)

The reaction by the surface = R

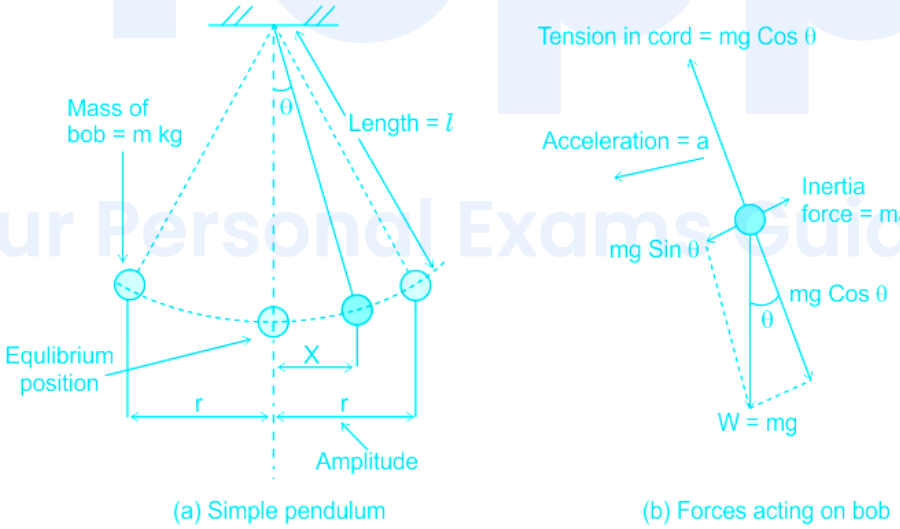
$G\frac{M_1M_2}{R^2} - R = ma$

$\Rightarrow G\frac{M_1M_2}{R^2} - R = m\left(\frac{GM}{R^2}\right)$

⇒ R = 0

- Thus the surface does not exert any force on the body and hence its apparent weight is zero and the acceleration due to gravity inside a satellite is zero.

CALCULATION:



- Since there is no g in the satellite. So **there is no driving force (mg) on the bob of a pendulum for oscillation. Hence the bob will stop oscillating**. So option 4 is correct.

---

29. **Answer: d**

Explanation:

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CONCEPT:

- Thermal expansion: When the temperature of any object is changed then the tendency of changing the shape, area, and volume of the body is called the thermal expansion of that object.

There are three types of thermal expansion:

Sl.No	1. Linear expansion	2. Areal Expansion	3. Volume expansion
1	When the temperature of anybody is changed then the tendency of changing the length of the body is called a linear thermal expansion of that body.	When the temperature of anybody is changed then the tendency of changing the area of the body is called the areal thermal expansion of that body.	When the temperature of anybody is changed then the tendency of changing the volume of the body is called a volume thermal expansion of that body.
2	Change in length is defined as: $\Delta L = L \alpha \Delta T$ Where ΔL = changes in length, L = original length, ΔT = changes in temperature of the body, and α = coefficient of linear expansion.	The change in area is defined as: $\Delta A = A \beta \Delta T$ Where ΔA = changed in the area, A = the original area, β = the coefficient of areal expansion, and ΔT = temperature change.	Change in volume (ΔV) is given by: $\Delta V = V \gamma \Delta T$ Where V = original volume, γ = the coefficient of volume expansion and ΔT = temperature change.

The relation between α, β, and γ is given by:

$\beta = 2\alpha$, and $\gamma = 3\alpha$

- **Density (d)** : The mass per unit volume is called density.

Density (d) = Mass (m)/Volume (V)

EXPLANATION:

- Since the **radius increment** is a linear expansion, which is directly proportional to the temperature change.
- Similarly, the **area change and volume change** are directly proportional to the temperature change.

Density change (Δ d) = Mass (m)/Change in volume (ΔV)

- Since the **density change is inversely proportional to volume change, so the density will have a minimum percentage increase.** Hence option 4 is correct.

---

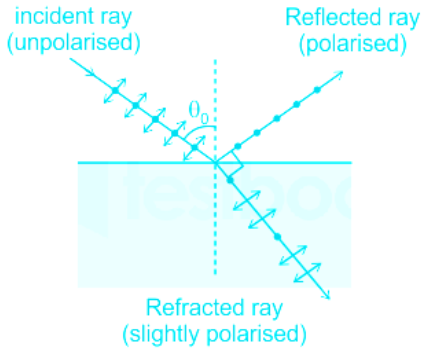
30. **Answer: c**

Explanation:

Concept:

- The angle of incidence at which a beam of unpolarized light falling on a transparent surface is reflected as a beam of completely plane polarised light is called polarising or Brewster angle . It is denoted by ip.
- Brewster's law : It states that when a ray is passed through some transparent medium having refractive index μ at any particular angle of incidence, the reflected ray is completely polarized ; and the angle between reflected and refracted ray is 90 0.

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μ = tan θ B

Where,

μ = refractive index and

θ_B is Brewster's angle or polarizing angle (i_p).

Calculation :

Given that:

The angle of incidence (i_p) = 60°

Refractive index (μ) = tan θ B= tan i p = tan 60° = √3 = 1.7

Hence option 3 is correct.

---

31. Answer: c

Explanation:

CONCEPT:

- Kinetic energy (KE): The energy possessed by a body by virtue of its motion is called kinetic energy .

$KE = \frac{1}{2}mv^2$

Where m = mass of the body and v = velocity of the body

- Potential energy (PE): The energy possessed by a body by virtue of its position or configuration is called potential energy.

$PE = mgh$

Where, m = mass of the body, g = acceleration due to gravity and h = height of the body

CALCULATION:

Given that:

Mass of the body (m) = 0.5 kg

Kinetic energy (KE) = 980 J

Since there is no friction, so all the potential energy converted into kinetic energy.

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So PE = KE = 980 J

m g h = 980

0.5 × 9.8 h = 980

Height (h) = 980/(0.5 × 9.8) = 200 m

So option 3 is correct.

---

32. Answer: c

Explanation:

CONCEPT :

- Sound: A sound is a form of energy that produces a sensation of hearing in our ears.
- Loudness is a measure of the response of the ear to the sound .
  - Even when two sounds are of equal intensity , we may hear one as louder than the other simply because our ear detects it better.

EXPLANATION :

- A sound's loudness or sound level is measured in decibels (dB) . So option 3 is correct.
- The loudness that we sense is related to the intensity of sound though it is not directly proportional.
- A **musical instrument** is a device that produces music.
- The **wavelength** is the distance between two crests or troughs.
- The **pitch** of sound simply tells how low or high a musical note sounds.

---

33. Answer: c

Explanation:

The correct answer is **Scattering**.

⭐ Important Points

- Rayleigh's law of scattering : According to Rayleigh's law of scattering, the intensity of light of wavelength λ present in the scattered light is inversely proportional to the fourth power of λ, provided the size of the scattering particles is much smaller than λ.

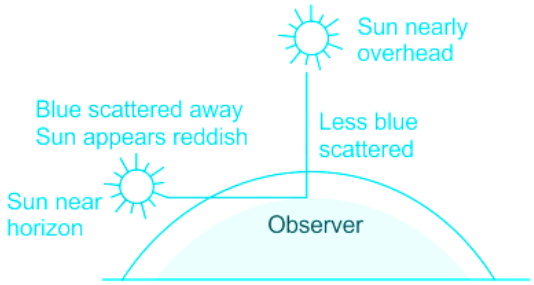
Mathematically,

$I \propto \frac{1}{\lambda^4}$

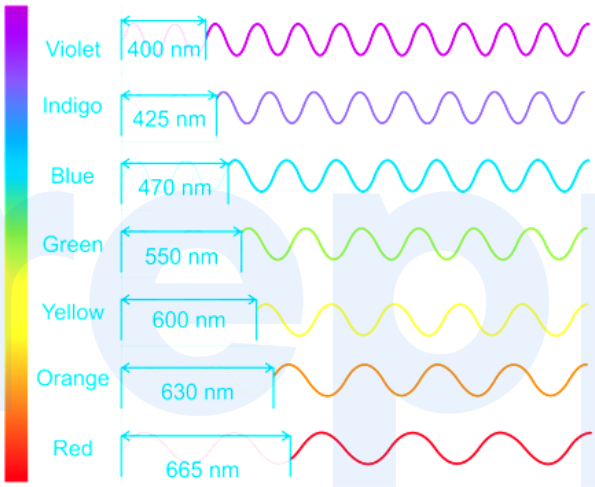
- Thus the scattered intensity is maximum for shorter wavelength .

EXPLANATION:

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- The sun looks reddish at the time of sunrise and sunset :
- At the time of sunrise and sunset , the sun is near the horizon . The rays from the sun have to travel a larger part of the atmosphere .
- As the wavelength of red color is more than that of blue color($\lambda_b \ll \lambda_r$) and the intensity of scattered light is $\propto \frac{1}{\lambda^4}$, therefore, most of the blue light is scattered away .



- Only the least scattered red light enters our eyes and appears to come from the sun . Hence the sun looks red , both at the time of sunrise and sunset .
- The red colour of the sun at sunset and sunrise is due to the scattering of sunlight . So option 3 is correct.

---

34. Answer: c

Explanation:

CONCEPT :

- Temperature: It is the measure of the degree of hotness and coldness of a body.
  - The SI unit of temperature is Kelvin (K).
- The various temperature scales commonly used are Celsius (C), Kelvin (K), Fahrenheit (F), and Rankine (Ra).
- Celsius : It has 100 degrees between the freezing and boiling points of water.
  - Here 0° represents the freezing point and 100° represents the boiling point. In many countries, celsius is used to communicate day to day temperatures.
  - It can be negative and positive both.
- Fahrenheit: The Fahrenheit scale was proposed by physicist Daniel Gabriel Fahrenheit in 1724.
  - The Fahrenheit scale has the melting point of ice at 32° F and the boiling point of water at 212°.
  - It can be negative and positive both.

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- The **Kelvin scale** has the ice point at 273K and the steam point at 373K.

EXPLANATION:

- Since the absolute zero temperature is 0 Kelvin. Below this temperature, we can't measure in kelvin scale.
- So the **Kelvin scale of temperature is only positive.** So option 3 is correct.

The **freezing point and boiling point** of water at different temperature scales are:

Scale	Freezing Point	Boiling Point
Centigrade (°C)	0°C	100°C
Fahrenheit (°F)	32°F	212°F
Kelvin (K)	273 K	373 K
Reaumur (°R)	0°R	80°R

---

35. **Answer: a**

Explanation:

CONCEPT:

- Surface tension (S): It is the property by virtue of which the free surface of a liquid at rest behaves like elastic stretched membrane tending to contract so as to occupy the minimum surface area .
- Surface tension is measured as the force acting per unit length of an imaginary line drawn on the liquid surface.

S = Force/length

- Surface energy (U) is given by:

$U = S \times (\Delta A)$

Where ΔA = change in area

EXPLANATION:

- When a big drop of water is broken into smaller drops then the **total surface area of all the smaller drops will be more than that of big drop** .
- As the **surface energy (U) is directly proportional to the surface area** as written in the concept part.
- So the **surface energy increases** . Hence option 1 is correct.

---

36. **Answer: a**

Explanation:

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CONCEPT:

- Scattering of light : The phenomenon in which the light ray is redirected in all other directions on passing through particles of dimensions comparable to the wavelength of the light used is called scattering of light .

EXPLANATION:

- If earth were deprived of atmosphere, the absence of atmosphere and molecules of air would lead to **no scattering of sunlight** .
- **The sky would look pitch dark/black** with bright stars and sun. Sun would appear white and brighter in the dark background. So option 1 is correct.

---

37. **Answer: c**

Explanation:

CONCEPT:

- **Band spectra** : The part of the optical spectra of polyatomic systems including condensed materials and large molecules is called band spectra.
  - The band spectra are produced when the emitting substance is in the **molecular state** .

EXPLANATION:

- The **band spectrum is produced due to molecules** in a vacuum tube. So option 3 is correct.
- The energy levels of molecules are very close to each other and they combine to form a band.
- The valence band and the conduction band are two types of bands. The electron transition between these two bands forms the band spectrum.

---

38. **Answer: b**

Explanation:

CONCEPT:

- Rectification : A rectifier is a device that converts alternating current (AC) into a direct current (DC). This process is called rectification .
  - A p-n junctiondiode can be used as a rectifier because it permits current in one direction only.
- A **triode** is a vacuum tube with three electrodes which are a cathode, Anode, and a control grid.
- The **thermocouple** is an electrical device containing junctions of two dissimilar metal joints. It is used as temperature sensors.
- Transistor: A semiconductor device used to amplify or switch electronic signals and electrical power is called a transistor .

EXPLANATION:

- Since a **p-n junction diode** is used as a rectifier to rectify alternating current.
- That's why in order to **rectify an alternating current one uses a diode** . So option 2 is correct.

---

39. **Answer: a**

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Explanation:

CONCEPT:

There are two types of mechanical waves:

- Transverse waves: The wave in which the movement of the particles is at right angles to the motion of the energy is called as transverse wave.
  - Light is an example of transverse wave.
- Longitudinal wave: The wave in which the movement of the particles are parallel to the motion of the energy is called as longitudinal wave.
  - Sound wave is an example of longitudinal wave.

EXPLANATION:

- The **sound wave** is a mechanical wave. It needs a medium to travel.
- **Sound** travels through atmospheric air in which many small particles are there. Sound travel through it and suffers obstruction from particles of medium (air) due to which the sound dies out because of **absorption by the atmospheric air** and their particle. So option 1 is correct.

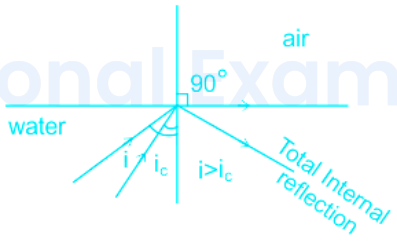
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40. **Answer: c**

Explanation:

CONCEPT:

- Total internal reflection (TIR): Total internal reflection (TIR) occurs at the interface of two transparent medium when the ray of light travels from a denser medium to a rarer medium .
- The critical angle is the angle of incidence in the denser medium for which the angle of refraction in the rarer medium is 90° .



- Total internal reflection (TIR) of light is the reflection of light within the same medium when a ray of light is incident at the interface of two medium at an angle of incidence which is greater than the critical angle for the pair of media i.e. i > i c

EXPLANATION:

- Diamond is the hardest substance in nature and diamond has a high refractive index.
- The **sparkling of a diamond is because of total internal reflection** followed by trapping of light rays. So option 3 is correct.

---

41. **Answer: b**

Explanation:

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Concept:

Sample space is nothing but a set of all possible outcomes of the experiment.

If we toss a coin n times then possible outcomes or number of elements in sample space = 2^n elements

Calculation:

Number of outcomes when a coin is tossed = 2 (Head or Tail)

∴Total possible outcomes when a coin is tossed 6 times = 2 × 2 × 2 × 2 × 2 × 2 = 64

---

42. Answer: c

Explanation:

Concept:

If $\frac{A}{B} = \frac{C}{D}$, property of **componendo and dividendo** is given by, $\frac{A+B}{A-B} = \frac{C+D}{C-D}$

In triangle ABC, if a, b and c are sides and A, B, and C are angles then **sine rule** is given by, $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

and **law of cosine** is given by, $c^2 = a^2 + b^2 - 2ab\cos(C)$, $a^2 = b^2 + c^2 - 2bc\cos A$, $b^2 = a^2 + c^2 - 2ac\cos B$

Calculation:

Here, $\frac{\tan A - \tan B}{\tan A + \tan B} = \frac{c-b}{c}$

Using componendo and dividendo, we get

$\frac{(\tan A - \tan B)+(\tan A + \tan B)}{(\tan A + \tan B)-(\tan A - \tan B)} = \frac{c-b+c}{c-(c-b)}$

$\frac{2\tan A}{2\tan B} = \frac{2c-b}{b}$

$\frac{\tan A}{\tan B} = \frac{2c-b}{b}$

$\frac{\tan A}{\tan B} = \frac{2c}{b} - 1$

$\frac{\sin A}{\cos A} \times \frac{\cos B}{\sin B} = \frac{2c}{b} - 1$

by sine rule, $\frac{a}{\sin A} = \frac{b}{\sin B} \Rightarrow \frac{\sin A}{\sin B} = \frac{a}{b}$

by law of cosine, $\cos B = \frac{a^2 + c^2 - b^2}{2ac}$ and $\cos A = \frac{b^2 + c^2 - a^2}{2bc}$

$\Rightarrow \frac{a}{b} \times \left(\frac{a^2 + c^2 - b^2}{2ac}\right)\left(\frac{2bc}{b^2 + c^2 \cdot a^2}\right) = \frac{2c}{b} - 1$

$\Rightarrow \frac{a^2+c^2-b^2}{b^2+c^2-a^2} = \frac{2c}{b} - 1$

$\Rightarrow \frac{a^2+c^2-b^2}{b^2+c^2-a^2} + 1 = \frac{2c}{b}$

$\Rightarrow \frac{a^2+c^2-b^2+b^2+c^2-a^2}{b^2+c^2-a^2} = \frac{2c}{b}$

$\Rightarrow \frac{2c^2}{b^2+c^2-a^2} = \frac{2c}{b}$

$bc = b^2 + c^2 - a^2$

$\frac{b^2+c^2-a^2}{bc} = 1$

$\frac{b^2+c^2-a^2}{2bc} = \frac{1}{2}$ (divide by 2)

$\cos A = \frac{1}{2}$

∴A = 60°

Hence, option (3) is correct.

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43. **Answer: b**

Explanation:

Concept:

Function	Domain	Range
$\sin^{-1} x$	[-1, 1]	$\left[\frac{-\pi}{2}, \frac{\pi}{2}\right]$
$\cos^{-1} x$	[-1, 1]	[0, π]
$\tan^{-1} x$	(-∞ , ∞)	$\left(\frac{-\pi}{2}, \frac{\pi}{2}\right)$
$\cot^{-1} x$	(-∞ , ∞)	(0, π)
$\sec^{-1} x$	(-∞ , -1] ∪ [1, ∞)	$\left[0, \frac{\pi}{2}\right) \cup \left(\frac{\pi}{2}, \pi\right]$
$\operatorname{cosec}^{-1} x$	(-∞ , -1] ∪ [1, ∞)	$\left[\frac{-\pi}{2}, 0\right) \cup \left(0, \frac{\pi}{2}\right]$

Calculation:

We have to find the principal value of $\sin^{-1}(-\sqrt{3}/2)$

Let $\sin^{-1}(-\sqrt{3}/2)$ = x

⇒ sin x = $\frac{-\sqrt{3}}{2}$

⇒ sin x = $-\sin\left(\frac{\pi}{3}\right) = \sin\left(\frac{-\pi}{3}\right)$

∴ x = $\frac{-\pi}{3}$ $\left(\because x \in \left[\frac{-\pi}{2}, \frac{\pi}{2}\right]\right)$

---

44. **Answer: a**

Explanation:

Concept:

$\tan^{-1} x + \tan^{-1} y = \tan^{-1}\left(\frac{\tan x + \tan y}{1 - \tan x \tan y}\right)$

$\tan^{-1} x = \cot^{-1} \frac{1}{x}$

$\cot(\cot^{-1} x) = x$

Calculation:

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We have to find the value of $\cot\left[\tan^{-1}\frac{1}{2}+\tan^{-1}\frac{1}{8}\right]$

$\tan^{-1}\left(\frac{1}{2}\right)+\tan^{-1}\left(\frac{1}{8}\right)$

$=\tan^{-1}\left(\frac{\frac{1}{2}+\frac{1}{8}}{1-\frac{1}{2}\times\frac{1}{8}}\right)$ $\left(\because \tan^{-1}x+\tan^{-1}y=\tan^{-1}\left(\frac{\tan x+\tan y}{1-\tan x\tan y}\right)\right)$

$=\tan^{-1}\frac{\left(\frac{8+2}{16}\right)}{\left(\frac{16-1}{16}\right)}$

$=\tan^{-1}\frac{\left(\frac{10}{16}\right)}{\left(\frac{15}{16}\right)}$

$=\tan^{-1}\frac{10}{15}=\tan^{-1}\frac{2}{3}$

As we know, $\tan^{-1}x=\cot^{-1}\frac{1}{x}$

So, $\tan^{-1}\frac{2}{3}=\cot^{-1}\frac{3}{2}$

Now,

$\cot\left[\tan^{-1}\frac{1}{2}+\tan^{-1}\frac{1}{8}\right]=\cot\cot^{-1}\frac{3}{2}=\frac{3}{2}$

---

45. Answer: c

Explanation:

Concept:

Mean = $\frac{\text{sum of observation}}{\text{no. of observations}}$

Calculations:

Given, The mean of 18 observation is -7

Mean = $\frac{\text{sum of observation}}{\text{no. of observations}}$

$\Rightarrow -7=\frac{\text{sum of observation}}{18}$

⇒ sum of observations = (18)(- 7) = - 126

Now, each observation is increased by 3.

⇒ sum of observations of new set = -126 + (3)(18) = - 72

Mean of new set = $\frac{\text{sum of observation of new set}}{\text{no. of observations of new set}}$

⇒Mean of new set = $\frac{-72}{18}$

⇒Mean of new set = - 4

Hence, the mean of 18 observation is -7 and if each observation is increased by 3, the mean of the new set is - 4

---

46. Answer: d

Explanation:

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Concept:

Combined Mean:

Let x_1 and x_2 are the mean of the first and second group of data containing n_1 and n_2 items respectively.

Then the combined mean is:

$$\frac{n_1\bar{x}_1 + n_2\bar{x}_2}{n_1 + n_2}$$

Calculation:

Given: Arithmetic mean of 9 observations is 100 and that of 6 is 80

$n_1 = 9$ and $\bar{x}_1 = 100$

$n_2 = 6$ and $\bar{x}_2 = 80$

As we know combined mean = $\frac{n_1\bar{x}_1 + n_2\bar{x}_2}{n_1 + n_2}$

$= \frac{9 \times 100 + 6 \times 80}{9 + 6} = \frac{1380}{15} = 92$

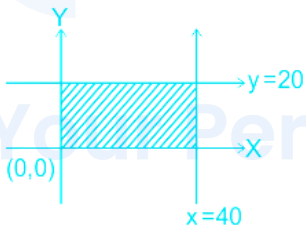
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47. **Answer: c**

Explanation:

Calculation:

Here, constraints: $x \le 40$, $y \le 20$ and $x, y \ge 0$



We get minimum value of P, only when x = 0 and y = 0

So, P = 6(0) + 16(0) = 0

Hence, option (3) is correct.

---

48. **Answer: a**

Explanation:

Concept:

Trace of a matrix:

Trace of a matrix is the **sum** of elements on the **main diagonal.**

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The **trace** is only defined for a square **matrix** (n × n).

Let A be n × n matrix.

$\rm tr\left(A \right) = \mathop \sum \limits_{n = 1}^n {A_{nn}}$

Calculation:

Given: $A = \begin{bmatrix} 1 & -5 & 7 \\ 0 & 7 & 9 \\ 11 & 8 & 9 \end{bmatrix}$

Trace of matrix = sum of elements on the main diagonal

= 1 + 7 + 9

= 17

---

49. Answer: a

Explanation:

Concept:

Logarithm properties:

Product rule: The log of a product equals the sum of two logs.

$\log_a (mn) = \log_a m + \log_a n$

Quotient rule: The log of a quotient equals the difference of two logs.

$\log_a \frac{m}{n} = \log_a m - \log_a n$

Power rule: In the log of power the exponent becomes a coefficient.

$\log_a m^n = n\log_a m$

Change of base rule

$\log_m n = \frac{\log_a n}{\log_a m}$

If m = n; then $\log_m m = \frac{\log_a m}{\log_a m} = 1$

Calculation:

Given: $f(x) = \log_{x^2} x$

Apply change of base rule

$= \frac{\log x}{\log x^2}$

Apply power rule

$= \frac{\log x}{2\log x} = \frac{1}{2}$

Differentiating with respect to x, we get

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⇒ f'(x) = 0 (∵ Differentiate of constant term is zero)

---

50. Answer: c

Explanation:

Concept:

If the curve is y = f(x) then (slope of tangent)(slope of normal) = -1

Slope of tangent to the curve = $\frac{dy}{dx}$

Calculations:

Consider the curve is y = f(x) with the slope $\frac{dy}{dx}$

⇒ slope of tangent to the curve = $\frac{dy}{dx}$

(slope of tangent)(slope of normal) = -1

⇒Slope of normal = $\frac{-1}{\text{slope of tangent}}$

⇒Slope of normal = $\frac{-dx}{dy}$

Given , the normal to a given curve is parallel to x-axis

⇒(slope of normal) = (slope of x- axis)

⇒ $\frac{-dx}{dy}$ = 0

⇒ $\frac{dx}{dy}$ = 0

Hence, the normal to a given curve is parallel to x-axis if $\frac{dx}{dy}$ = 0

---

51. Answer: a

Explanation:

Concept:

cosec (-x) = -cosec x

cosec (2nπ + θ) = cosec θ

Calculation:

We have to find the value of cosec (-750°)

cosec (-750°)

= -cosec (750°) (∵ cosec (-x) = -cosec x)

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= -cosec (720° + 30°)

= -cosec(4π + 30°)

= -cosec 30° (∵ cosec (2nπ + θ) = cosec θ)

= -2

---

52. **Answer: c**

Explanation:

Concept:

sin (π + x) = - sin x

sin 18° = $\frac{\sqrt{5}-1}{4}$

sin 54° = $\frac{\sqrt{5}+1}{4}$

Calculations:

Consider, $\sin\frac{\pi}{10}\sin\frac{13\pi}{10} = \sin\frac{\pi}{10}\sin(\pi+\frac{3\pi}{10})$

$= -\sin\frac{\pi}{10}\sin\frac{3\pi}{10}$ (∵ sin (π + x) = - sin x)

= - sin 18° sin 54°

$= -\left(\frac{\sqrt{5}-1}{4}\right)\left(\frac{\sqrt{5}+1}{4}\right)$

$= -\left(\frac{5-1}{16}\right)$

$= -\frac{1}{4}$

---

53. **Answer: c**

Explanation:

Formula used:

1. $(x+y)^n = {}^nC_0 (x^n)(y^0) + {}^nC_1 (x^{n-1})y + \ldots\ldots {}^nC_n (x^0)(y^n)$

2. ${}^nC_r = {}^nC_{n-r}$

3. n C 0 = 1

4. ${}^nC_1 = n$

Calculations:

Let y = 4 n - 3n - 1

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⇒ y = (1 + 3) n - 3n - 1

By using the above formula

⇒ y = n C 0 (1 n) (3 0) + n C 1 (1) n-1 (3 1) + ... n C n (1 0)(3 n) - 3n - 1

Again, using the formula (1), (2) & (3)

⇒ y = nC 0 + nC 1 (3) + n C 2 (3 2) + ... nC n (3 n) - 3n - 1

⇒ y = 1 + 3n + $^{n}C_{2}$ 3^{2} + ...+ n C n 3 n - 3n - 1

⇒ y = 3 2(n C 2 3 2 + $^{n}C_{3}3^{3}$ .....+ n C n 3 n)

⇒ y = 9 × Integer

∴ **4 n - 3n - 1 is always divisible by 3 & 9 both.**

⭐ Alternate Method

Since, n is positive, put n = 1, 2, 3....

Put n = 1

⇒ 4 1 - 3(1) - 1 = 4 - 3 - 1 = 0

Which is divisible by **3, 9**, 8, 27

Put n = 2,

⇒ 4 2 - 3(2) - 1 = 16 - 6 - 1 = 9

Which is divisible by **3, 9**

Put n = 3

⇒ 43 - 3(3) - 1 = 64 - 9 - 1 = 54

Which is divisible by **3, 9**, 27

Put n = 4,

⇒ 44 - 3(4) - 1 = 256 - 12 - 1 = 243

Which is divisible by **3, 9**, 27

Put n = 5,

⇒ 45 - 3(5) - 1 = 1024 - 15 - 1 = 1008 ,

Which is divisible by **3, 9**, 27

Continued so on....

∴ 4 n - 3n - 1 is always divisible by 3 & 9 both

Note: This is BSF RO Official Paper (Conducted on 22-Sep-2019) official paper and there were options 3, 9, 8 & 27 in the option. Since the relation is satisfied for both 3 & 9 therefore, we have changed the option.

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54. **Answer: c**

Explanation:

Concept:

The distance of a point from the **y-axis** is called its x-coordinate

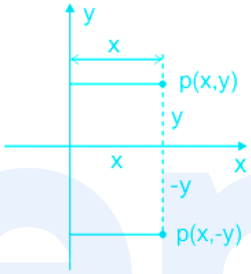
The distance of a point from the x-axis is called it's y-coordinate

Calculations:

The **distance** of a **point** from the **y-axis** is called its **x**-coordinate.

Case (i)

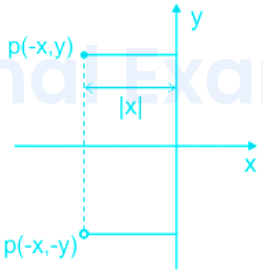
If the point (x, y), where x and y both + ve or x is + ve and y is - ve, the distance of the point (x, y) from y-axis is x.



Case (ii)

If the point (x, y), where x and y both - ve or x is - ve and y is + ve , we can not be a negative distance away from an axis, so we take the absolute value of x.

Hence, the distance of the point (x, y) from y-axis is |x|.



---

55. **Answer: b**

Explanation:

Concept:

If two lines are perpendicular then product of their slopes equal to -1

Equation of line in slope intercept form: y = mx + c, Where m =slope

$\tan(A+B)=\frac{\tan A+\tan B}{1-\tan A\tan B}$

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$\cos(\alpha - \beta) = \cos\alpha\cos\beta + \sin\alpha\sin\beta$

Calculation:

x cos α + y sin α = p 1

$\Rightarrow$ $y\sin\alpha = -x\cos\alpha + p_1$

$\Rightarrow y = -x\frac{cos\alpha}{sin\alpha} + \frac{p_1}{sin\alpha}$ and

x cos β + y sin β = p 2

$\Rightarrow y\ \sin\beta = -\cos\beta + p_2$

$\Rightarrow y = -x\frac{cos\beta}{sin\beta} + \frac{p_2}{sin\beta}$

These lines are perpendicular so, product of slopes = -1

$\left(-\frac{\cos\alpha}{\sin\alpha}\right) \times \left(-\frac{\cos\beta}{\sin\beta}\right) = -1$
$\cos\alpha\cos\beta + \sin\alpha\sin\beta = 0$
$\cos(\alpha - \beta) = 0$
$\cos(\alpha - \beta) = \cos\left(\frac{\pi}{2}\right)$
$\therefore \quad |\alpha - \beta| = \left(\frac{\pi}{2}\right)$

Hence, option (2) is correct.

---

56. Answer: d

Explanation:

Concept:

On X- axis y-intercept will be zero, similarly, on Y-axis x-intercept will be zero.

Calculation:

On Y-axis x-intercept = 0

So,

$x^2 + y^2 + 4x - 7y + 12 = 0 \Rightarrow y^2 - 7y + 12 = 0 \Rightarrow y^2 - 4y - 3y + 12 = 0 \Rightarrow y(y-4) - 3(y-4) = 0 \Rightarrow (y-3)(y-4) = 0$

y = 3 and 4

Points (0, 3) and (0, 4)

Now length =

$= \sqrt{0^2 + (3-4)^2}$
$= 1$

Hence, option (4) is correct.

---

57. Answer: c

Explanation:

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Concept:

Equation of circle having centre (0, 0): $x^2 + y^2 = r^2$, r= radius

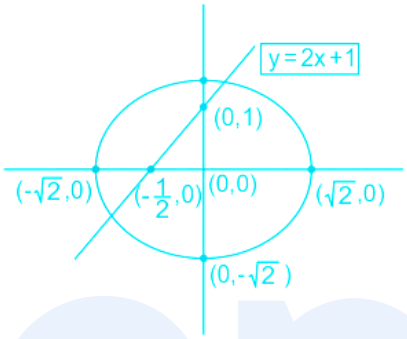
Calculation:

Here, equation of circle: $x^2 + y^2 = 2$

So, radiius = √2

Chord, y = 2x + 1, when x = 0, y = 1 and when y = 0,x = -1/2

So the chord passing through points (0, 1) and (-1/2, 0)



$x^2 + y^2 = 2$

$\Rightarrow x^2 + (2x+1)^2 = 2 \Rightarrow x^2 + 4x^2 + 4x + 1 = 2 \Rightarrow 5x^2 + 4x - 1 = 0 \Rightarrow 5x^2 + 5x - x - 1 = 0 \Rightarrow 5x(x+1) - 1(x+1) \Rightarrow (x+1)(5x-1) = 0 x = -1, 1/5$

When, x = -1, y = 2(-1) +1 = -1

and when x = 1/5, y =2(1/5) + 1 = 7/5

So chord cut the circle at points (-1, -1) and (1/5, 7/5)

Now, length of chord =

$\sqrt{(\frac{1}{5}+1)^2 + (\frac{7}{5}+1)^2}$

$= \sqrt{\frac{36}{25} + \frac{144}{25}}$

$= \frac{6\sqrt{5}}{5}$

$= \frac{6}{\sqrt{5}}$

Hence, option (3) is correct.

---

58. **Answer: b**

Explanation:

Concept:

Standard Form of the equation of a circle, $(x - h)^2 + (y - k)^2 = r^2$, where the centre (h, k) and the radius r

Calculation:

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Here, the centre of the circle is on Y-axis. Let the centre be (0, m)

It is passing through (0, 0) and (2, 3)

∴Distance from the centre to this point will be equal

$\sqrt{0+(m-0)^2}=\sqrt{(0-2)^2+(m-3)^2} \Rightarrow m^2=4+m^2-6m+9 \Rightarrow 6m=13$

m = 13/6

∴ Centre of the circle (0, 13/6)

Now radius =

$=\sqrt{0+(0-\frac{13}{6})^2}=\frac{13}{6}$

∴ Equation of circle:

$(x-0)^2+(y-\frac{13}{6})^2=(\frac{13}{6})^2 \Rightarrow x^2+y^2-\frac{26}{6}y+\frac{169}{36}=\frac{169}{36} \Rightarrow x^2+y^2-\frac{13}{3}y=0 \Rightarrow 3x^2+3y^2-13y=0$

Hence, option (2) is correct.

---

59. Answer: c

Explanation:

Concept:

Let us consider the standard form of a quadratic equation, ax 2 + bx + c =0

Let α and β be the two roots of the above quadratic equation.

The sum of the roots of a quadratic equation is given by: $\alpha+\beta=-\frac{b}{a}=-\frac{\text{coefficient of x}}{\text{coefficient of x}^2}$

The product of the roots is given by: $\alpha\beta=\frac{c}{a}=\frac{\text{constant term}}{\text{coefficient of x}^2}$

Calculations:

Given , equation is ax 2 + bx + c = 0 with the roots α,β

The roots of the equation ax 2 + bx + c = 0 are reciprocal to each other.

So, $\beta=\frac{1}{\alpha}$

If α,β are the roots of quadratic the equation ax 2 + bx + c = 0 then $\alpha\beta=\frac{c}{a}$

Product of roots = $\frac{c}{a}$

$\Rightarrow \alpha.\frac{1}{\alpha}=\frac{c}{a}$

$\Rightarrow 1=\frac{c}{a}$

⇒ a = c

∴ a - c = 0

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60. **Answer: c**

Explanation:

Concept:

The sequence a, b, c, d, ...is considered as an arithmetic progression; the harmonic progression can be written as 1/a, 1/b, 1/c, 1/d, ...

Calculation:

a, b, c,d are in HP, so 1/a, 1/b,1/c,1/d are in AP

Let, 1/a = x, 1/b = x + y, 1/c = x + 2y, 1/d = x + 3y

⇒ a = 1/x, b = 1/(x + y), c = 1/(x + 2y), d = 1/(x + 3y)

Now,

a + d

$= \frac{1}{x} + \frac{1}{x+3y} = \frac{2x+3y}{x^2+3xy}$

b+c

$= \frac{1}{x+y} + \frac{1}{x+2y} = \frac{2x+3y}{x^2+2xy+xy+2y^2} = \frac{2x+3y}{x^2+3xy+2y^2}$

Numerator of a+d and b+c are equal but, denominator of b+c is greater than a + d

So, a+d > b+ c

Hence, option (3) is correct.

---

61. **Answer: b**

Explanation:

The correct answer is **Stable.**

CONCEPT:

- Radioactivity: Radioactive decay is the process by which an unstable atomic nucleus loses energy by radiation. A material containing unstable nuclei is considered radioactive.
  - A radioactive nucleus consists of an unstable assembly of protons and neutrons which becomes more stable by emitting an alpha, a beta particle, or a gamma photon.
  - Atoms are radioactive if their nuclei are unstable and spontaneously (and random) emit various particles α, β, and/or γ radiations.
- Isotopes : The atoms of an element having the same atomic number but a different mass number are called isotopes. All isotopes have the same chemical properties.
- Isobars : The nuclei which have the same mass number (A) but a different atomic number (Z) are called isobars.

EXPLANATION:

U_{92}^{238} ------→ A 46 119 + B 46 119

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- Since the U -238 is an unstable atomic nucleus. The nucleus having an even number of protons and neutrons then that nucleus will be stable.
- After splitting into **two identical parts it produced two stable nuclei because both have an even number of protons and neutrons.** Hence option 2 is correct.

---

62. **Answer: c**

Explanation:

CONCEPT:

- **Reduction** : Reduction is the process that includes-

1. Gain/addition of electrons or
2. Removal of oxygen atom in a molecule or
3. Addition of hydrogen atom in a molecule.

- **Oxidation** : The Loss of electrons and an increase in the oxidation state is the characteristics of an oxidation reaction and this is called oxidation.

For example: $H_2S + Cl_2 \rightarrow 2HCl + S$

- In this reaction, the **chlorine** is getting reduced to hydrochloric acid (HCl) on the addition of hydrogen provided by Hydrogen sulfide (H_2S).

$$\text{Oxidant} + e^- \xrightarrow{\text{Reduction}} \text{Product}$$
(Electrons grained; oxidation number decreases)

$$\text{Reductant} \xrightarrow{\text{Oxidation}} \text{Product} + e^-$$
(Electrons lost; oxidation number increases)

EXPLANATION:

- Since Al is more reactive than H that's why the **aluminium oxide (Al_2O_3) cannot be reduced by hydrogen** even under very hot conditions. So option 3 is correct.
- **Cu, Fe and Sn** are below hydrogen in the metal reactivity series. That's why their oxides can be reduced by Hydrogen.

---

63. **Answer: b**

Explanation:

CONCEPT:

- **Anodizing** : An electrochemical process that converts the metal surface into a decorative, durable, corrosion-resistant, anodic oxide finish is called anodizing.
- It is the process of forming a thick oxide layer of Aluminium.
- The process is called **anodizing** because the part to be treated forms the anode of an electrolytic cell.

EXPLANATION:

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- The **deposition of a layer of aluminium oxide** is called anodizing and the aluminium surface is often anodized. So option 2 is correct.
- The anodizing process on aluminium increases corrosion and wear resistance.

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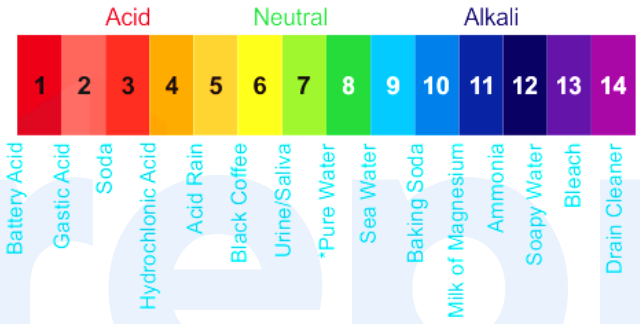
64. **Answer: c**

Explanation:

The correct answer is 7.

Concept:

The pH scale stands for potential of hydrogen and it ranges from 0-14 with 7 being at the centre and it is for a completely neutral solution.



For range 0-7 the solution is acidic and for 7-14 it is basic.

Explanation:

From the above explanation, we know that pH of basic solution is between 7 and 14 and in our case pH of ethyl alcohol is **7.33** whereas pH of sodium salt will be neutral (since its neither basic nor acidic)

Hence the **pH of aqueous solution of sodium salt and ethyl alcohol will be around 7,** since the value of ethyl alcohol is **very close to 7.**

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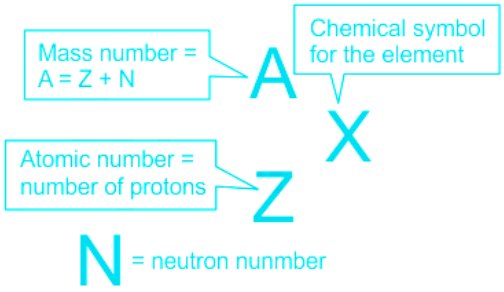
65. **Answer: c**

Explanation:

CONCEPT :

- Atomic number: It is defined as the number of protons present in the nucleus. It is denoted by the letter Z.
- Mass number/atomic mass number: The total number of protons and neutrons present in a nucleus is called the mass number of the element. It is denoted by letter A.

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- **Electronic configuration** filled according to the Aufbau principle.
- Aufbau Principle: It states that **electrons** are filled into atomic orbitals in the increasing order of orbital energy levels.
  - The order of energy level is 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, 7p, and so on.

EXPLANATION:

Given that: The atomic mass = 19 and atomic number = 9

The **electronic configuration** is given by:

M (9): $1s^2\ 2s^2 2p^5$

- The given element (M) requires only 1 electron to attain a stable noble gas configuration.
- So M will easily accept 1 electron and will form an anion having -1 charge and become stable.
- Thus the element has 9 protons, 9 electrons, and 10 neutrons. So its **single negative ion will be represented by M^-**. Hence option 3 is correct.

---

66. **Answer: a**

Explanation:

Concept:

Oxidation number (also called oxidation state) is the total number of electrons that an atom either gains or loses in order to form a chemical bond with another atom.
Generally, In most of its compounds, oxygen has an oxidation state of -2 but for OF_2 the oxidation number of oxygen is +2 whereas for O_2F_2 it is +1

Calculation:

Since the overall charge of the compound will be zero and we have to the oxidation state of oxygen in our case

The oxidation number can be predicted by a given equation

$X+2(-1) = 0 \Rightarrow X = +2$

Here, X is the oxidation number of oxygen, and -1 is the oxidation number of fluorine F in our compound.

Hence oxidation number of OF_2 is +2 in this case.

---

67. **Answer: b**

Explanation:

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The correct answer is KNO_3.

⭐ Key Points

- **Acid** : The compound that produces hydrogen ion when it dissolved in the solution is called acid.
  - The **acidic property** depends on the concentration of the Hydrogen ion in the solution.
  - H + ion cannot exist alone. It always conjugates with the water and forms hydronium ion(H 3O +)

The **identification of the acidic or basic nature of any salt solution** by the reactions:

- Strong acid + strong base ---------→ water + neutral salt
- Weak acid + strong base ---------→ water + basic salt
- Strong acid + weak base ---------→ water + acidic salt
- Weak acid + weak base ---------→ water + salt (It may be a neutral, acidic, or basic depending on the reactants used in the reaction)

EXPLANATION:

- KNO_3 is completely ionized in the water that gives the **Nitric acid which is a strong acid** . So **KNO 3 can be used for identifying an acid solution** . Hence option 2 is correct.
- The K^+ is an unreactive ion because it is produced from the dissolution of the **strong base** (KOH). So K 2SO 4 can't be used to identify the acidic solution.
- NaCl is a **neutral solution** that's why we can't use it also.
- Since Na 2CO 3 is formed by a **weak acid** Carbonic acid (H 2CO 3). That's why it can't be used also.

'

⭐ Additional Information

Strong acid	Weak acid
If the concentration of H + ion or hydronium ion is more then it is called the Strong acid.	If the concentration of H + ion or hydronium ion is less then it is called the weak acid
Example: Hydrochloric acid(HCl), Sulphuric acid(H 2SO 4), Nitic acid(HNO 3), etc.	Example: Acetic acid(CH 3COOH), Carbonic acid(H 2CO 3), etc.

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68. **Answer: b**

Explanation:

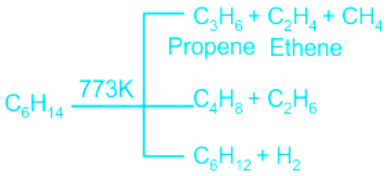
Concept:

- Cracking reaction to the reaction in which large structure of the organic compound is broken apart to form the small structure of hydrocarbon.
- It is used in the petrochemical industry.

Explanation:

In our case, Hexane can be cracked to get the following result

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Hence from the above reaction, we can see that ethane can be obtained from Hexan by **Cracking**

---

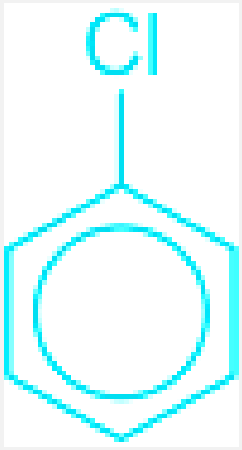
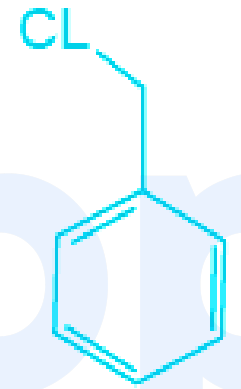
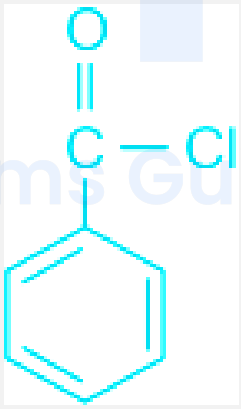
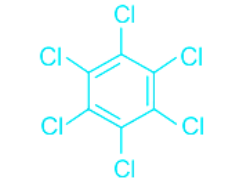
69. **Answer: c**

Explanation:

Concept:

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Chemical	Formula	Symbol
chlorobenzene	C_6H_5Cl	
benzyl chloride or (chloromethyl)benzene	C_7H_7Cl	
benzoyl chloride	C_7H_5ClO	
benzene hexachloride	$C_6H_6Cl_6$	 Benzene hexachloride

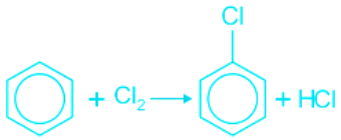
Explanation:

The reaction between **Benzene** and **chlorine** in presence of **iron** or aluminium chloride is used to produce **chlorobenzene**

i.e.,

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or $C_6H_6 + Cl_2 \rightarrow C_6H_5\text{-}Cl + HCl$

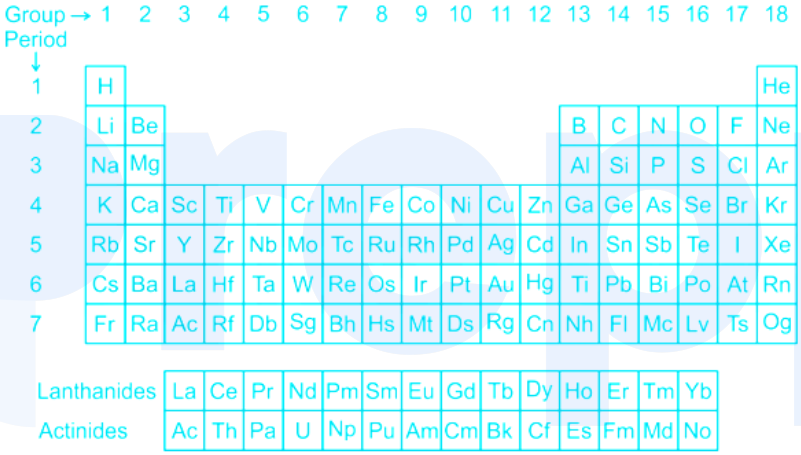
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70. **Answer: b**

Explanation:

Concept:

- The modern periodic table is the tabular arrangement of chemical elements.
- The Modern Periodic table consists of 18 groups and 7 periods.



Explanation:

From the above figure, we can see that Ni, Cu and Zn belong to the same 4th period of Modern periodic table.

Whereas He, Ne, Ar and Cl, Br, I belongs in the same group i.e., group 18 and 17 respectively

---

71. **Answer: d**

Explanation:

Concept:

- Alloys are substances which possess metallic character and are obtained by mixing of metal with another metal or another element.
- Either the mixture/alloy of mercury (Hg) with any other metal is called an amalgam whereas **Tungsten, Platinum, Iron, and Tantalum are exceptions that do not form an amalgam.**
- The alloys of mercury with any other metal are termed as amalgams and depending upon the proportion of mercury, they can be liquid, paste or solid in nature.
- One of the best examples of Amalgam is a mixture of mercury and silver which is used by the dentist for a dental filling.

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Explanation:

From the above explanation, we can see that amalgams are an alloy of mercury and other metal like zinc copper magnesium except iron

i.e., **Iron or Fe is the metal which can not be used to form amalgum alloy.**

---

72. **Answer: d**

Explanation:

The correct answer is 14 C6

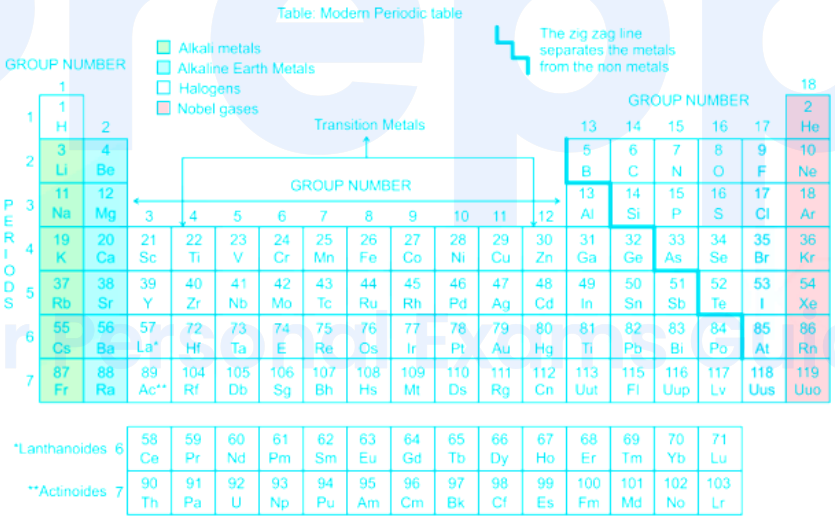
Concept:

Isotopes are defined as the atoms of the same element, having the same atomic number but different mass numbers.

For example, Hydrogen (1H) has three naturally occurring isotopes 1H, 2H, and 3H.

Explanation:

From the above explanation, we can see that isotope of any material have different atomic mass i.e., number of nucleons are different but the number of protons is the same



- From the above periodic table, we can see that carbon has 12 nucleons i.e., 6 protons and 6 neutrons.
- Whereas **Carbon-14 is one of the isotopes of carbon** in which is used for carbon dating

---

73. **Answer: a**

Explanation:

Concept:

- As the name suggests, Carbon Monoxide has a chemical formula of CO, that is **one atom of carbon and one atom of oxygen** .
- It is a pollutant formed because of incomplete combustion of fossil fuels in an oxygen-starved environment.

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- It is tasteless, colourless and odourless and is poisonous if inhaled in large quantities

Calculation:

Given that,

The ration of carbon and oxygen in CO = 1: 1

Molar mass of carbon, m_C = 12 g/mole

Molar mass of oxygen, m_O = 16 g/mole

Thus the ratio of its mass can be expressed as

$\frac{m_C}{m_O} = \frac{12}{16} = 3 : 4$

---

74. **Answer: a**

Explanation:

Concept:

Boyle's law :

- At constant temperature, the pressure of a fixed amount (i.e. a number of moles n) of gas varies inversely with its volume.
- If a fixed amount of gas at constant temperature T occupying volume V 1 at pressure p 1 undergoes expansion, so that volume becomes V 2 and pressure becomes p 2, then according to Boyle's law p1 V1 =p 2V 2

Charles' law

- It states that with pressure remaining constant, the volume of a fixed mass of a gas is directly proportional to its absolute temperature.

Gay Lussac's law

- It states that at constant volume, the pressure of a fixed amount of a gas varies directly with the temperature.

Avogadro Law

- It states that equal volumes of all gases under the same conditions of temperature and pressure contain an equal number of molecules.

Explanation:

From the above explanation, we can see that

- Avogadro's Law states that at the constant temperature and pressure, the volumes of gas are directly proportional to the number of molecules.
- Either according to **Avogadro's Law Equal volumes of all gases under the same temperature and pressure contain an equal number of molecules,**

---

75. **Answer: a**

Explanation:

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Concept:

Methane :

- Methane (CH 4), is a gas produced by a group of colonic anaerobes, absorbed from the colon and excreted in expired air.
- Methane is a colorless odorless gas.
- It is also known as marsh gas or methyl hydride.

Gobat gas:

- Gobar gas is also known as biogas.
- Biogas is produced through anaerobic decomposition of organic wastes from animals and plants.
- Biogas is primarily a mixture of mainly methane and carbon dioxide and methane is a major component of biogas.

Explanation:

From the above explanation we can see that,

Bio gas is a clean unpolluted and cheap source of energy in rural areas. It consists of **55-70% methane** which is inflammable. Bio gas is produced from cattle dung in a bio gas plant commonly known as gobar gas plant through a process called digestion.

---

76. **Answer: a**

Explanation:

Concept:

- An atom consists of many orbitals which are distinguished from each other based on their shape, size and orientation in space.
- Thus Quantum number are those numbers that designate and distinguish various atomic orbitals and electrons present in an atom.
- There are four types of quantum number:
- Angular quantum number determines the three-dimensional shape of the orbital quantum number.
  - Denoted by the symbol 'l' is also known as orbital angular momentum or subsidiary quantum number.
  - It defines the three-dimensional shape of the orbital.
- Principal quantum number
  - Denoted by the symbol 'n'.
  - Determines the size and to a large extent the energy of the orbital. Hence, statement (ii) is NOT correct.
- Magnetic orbital quantum number
  - Denoted by the symbol 'ml'.
  - Gives information about the spatial orientation of the orbital concerning standard set of co-ordinate axis. Hence, statement (iii) is NOT correct.
- Electron Spin quantum number
  - Denoted by the symbol (ms) refers to the orientation of the spin of the electron .

Explanation:

From the above explanation, we can see that,

The quantum number that tends to specify the **orientation** in space for an orbital is the **magnetic quantum number.**

---

77. **Answer: c**

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Explanation:

Concept :

- Acid rain refers to the ways in which acid from the atmosphere is deposited on the earth's surface.
- Oxides of nitrogenand sulphur which are acidic in nature can be blown by the wind along with solid particles in the atmosphere and finally settle down either on the ground as dry deposition or in water, fog and snow as wet deposition.
- Acid rain is a byproduct of a variety of human activities that emit the oxides of sulphur and nitrogen in the atmosphere. As mentioned earlier, **the burning of fossil fuels** (which contain sulphur and nitrogenous matter) such as coal and oil in power stations and furnaces or petrol and diesel in motor engines produce sulphur dioxide and nitrogen oxides.
- SO 2 and NO 2 after oxidation and reaction with water are major contributors to acid rain because polluted air usually contains particulate matter that catalyses the oxidation.

$2SO_2(g) + O_2(g) + 2H_2O(l) \rightarrow 2H_2SO_4(aq)$

$4NO_2(g) + O_2(g) + 2H_2O(l) \rightarrow 4HNO_3(aq)$

Explanation:

- From the above explanation, we can see that acid rain is caused because of the presence of **sulphur and oxides which combine to form sulphuric acid**
- When acid rain falls and flows as groundwater to reach rivers, lakes etc, it affects plants and animal life in the aquatic ecosystem
- Acid rain is harmful to agriculture , trees and plants as it dissolves and washes away nutrients needed for their growth
- It causes respiratory ailments in human beings and animals
- It may also cause corrosion in many buildings bridges, monuments, fencing etc

Hence the presence of **oxides of sulphur** in the atmosphere causes acid rain.

---

78. **Answer: a**

Explanation:

Concept:

Kidney stones, also known as Nephrolithiasis are formed mainly by **Calcium Oxalate.**

- Kidney stones are basically solid masses which are formed due to the high presence of oxalate in the urine and very less liquid.
- The crystals of the oxalate along with cysteine or phosphate forms a solid mass known as the kidney stone.

Explanation

From the above explanation, we can see that the stones formed in human **kidney** mainly consist of **calcium oxalate**

---

79. **Answer: c**

Explanation:

The correct answer is Methane with air.

⭐ Important Points

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- **Methane** explosions occur when methane gas from mining is built up and cannot escape because of high pressure.
- For example, a coal mine methane (CMM) is a mixture of **methane and air** present in the active mining sites.
- This mixture of gas is released during the process of coal mining causes the explosion in the mining area.

⭐ Additional Information

From the above explanation, we can see that most of the **explosions in mines occur due to a mixture of air and methane.**

---

80. **Answer: d**

Explanation:

Concept:

Nichrome:

- Nichrome has high resistivity
- Nichrome is a non-magnetic alloy that is made up of mainly chromium and nickel .
- It has a very high melting point , that makes nichrome ideal to make high-temperature wires.
- It is used in heating elements such as hair dryers, toasters, and ovens also used to make the coils used in water heaters.

Explanation:

- Nichrome is the material which is very hard and very ductile.
- Now comparing other material Nichrome is highly ductile.
- The most common usage is as resistance wire, as heating elements, dental restorations (fillings), and in a few other applications.

Extra point:

This are some important terms

Hard - Can withstand external pressure (to some extent)
Ductile - Which can be drawn out into a thin wire.
Brittle - break without significant plastic deformation under tensile stress (sudden failure).
Malleability - ability of a solid to bend or be hammered into other shapes without breaking.

---

81. **Answer: c**

Explanation:

The correct answer is option 3) i.e. of

⭐ Key Points

- **Proud** always carries preposition **'of'** with it.
- The preposition **'at'** is used to indicate **a particular time or place.**
- The preposition **'on'** is used to express the **position two objects.**
- The preposition **'about'** is expressed **age or position.**
- Thus the **correct** answer is **'of'**

The completed sentence is: She is proud of her beauty.

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82. **Answer: b**

Explanation:

The correct answer is**option 2) i.e. to**

⭐ Key Points

- **Invited** always carries preposition **'to'** with it.
- The preposition **'for'** is used to indicate the **purpose.**
- The preposition ' **upto'** is used to indicate the **limit.**
- The preposition **'at** ' is used to indicate a **particular time or place.**
- Thus the **correct** answer is **'to'.**

The completed sentence is: They have invited us to attend the function.

---

83. **Answer: b**

Explanation:

The correct answer is **option 2) i.e. on**

⭐ Key Points

- **Congratulation** always **carries** preposition **'on'.**
- The preposition **'to'** is used to indicate a particular **time or place.**
- The preposition ' **upon' i**s used to indicate the **movement.**
- The preposition **'for'** is used to indicate **purpose.**
  - So the **correct preposition** is **on**

The completed sentence is:*We offer the heartiest congratulation on your success.*

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84. **Answer: a**

Explanation:

The correct answer is **option 1) i.e. through**

⭐ Key Points

- The verb **'entered'** can carry **all** of the above **prepositions.**
- They **differ** according to their **usage.**
- Let's **look at the** their **usage** of all these **prepositions with 'entered':**

entered through	The police entered through the side door.
entered from	She entered from the back door
entered in	She entered this college in 2000
entered into	The teacher entered into the class when the boys were fighting

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⭐ Important Points

- The preposition **'in'** is used to indicate **time.**
- The preposition **'into'** is used when there is **movement from outside to inside.**

The corrected sentence is: *He entered through the gate without any difficulty.*

---

85. **Answer: b**

Explanation:

The correct answer is **option 2) i.e. to**

⭐ Key Points

- **Tends** usually carries preposition **'to'** along with it.

⭐ Important Points

- The preposition **'for'** is used to express **'the purpose'.**
- The preposition **'upto'** is used to express the **limit.**
- The preposition **'at'** is used to express a **particular time or place.**

⭐ Mistake Points

- If the **first form of the verb follows preposition** it is generally **to.**

The completed sentence: This usually tends to crumble in the face of the smallest challenge.

---

86. **Answer: a**

Explanation:

The correct answer is **option 1) i.e. disparage**

⭐ Key Points

- Let's look at the meaning of the given word and the correct option.
  - **Belittle** : To make an action or a person seem unimportant
  - **Disparage** : To criticize someone or something in a way that shows a lack of respect
- Hence from the given meanings, we find that both the words express similar meanings.
  Let's look at the meanings of the other given words.
  - **Mock:** To laugh at someone, often by copying them in a funny but unkind way
  - **Diminish:** To become or to make something smaller or less important; decrease
  - **Shrink:** To become smaller, or to make something smaller

---

87. **Answer: a**

Explanation:

The correct answer is **unnatural**

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⭐ Key Points

- Let's look at the meaning of the given word and the correct option.
  - **WEIRD:** very strange and unusual, unexpected, or not natural
  - **unnatural:**different from what is normal or expected; not existing in nature; artificial.

Hence from the given meanings, we find that both the words express similar meanings.

- Let's look at the meanings of the other given words.
- **Supernatural:** (of a manifestation or event) attributed to some force beyond scientific understanding or the laws of nature.
- **Hastily :** said or done in a hurry, sometimes without the necessary care or thought
- **Ghost :** an apparition of a dead person which is believed to appear or become manifest to the living

---

88. **Answer: a**

Explanation:

The correct answer is **treatment**

⭐ Key Points

- Let's look at the meaning of the given word and the correct option.
  - **REMEDY :** a medicine or treatment for a disease or injury; Treatment; medicine
  - **Treatment :** M edical care given to a patient for an illness or injury.
- Hence from the given meanings, we find that both the words express similar meanings.
  Let's look at the meanings of the other given words.
  - **Aggravate:**make (a problem, injury, or offence) worse or more serious
  - **Redress:** remedy or set right (an undesirable or unfair situation)
  - **Restorative:** H aving the ability to restore health, strength, or well-being.

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89. **Answer: b**

Explanation:

The correct answer is **option 2) i.e. maiden**

⭐ Key Points

- Let's look at the meaning of the given word and the correct option.
  - Damsel: A young woman who is not married; Young lady, miss
  - **Maiden**: A n unmarried girl or young woman.
- Hence from the given meanings, we find that both the words express similar meanings.
  Let's look at the meanings of the other given words.
  - **spinster :** a woman who is not married, especially a woman who is no longer young and seems unlikely ever to marry
  - **witch :** A woman who is believed to have magical powers

---

90. **Answer: a**

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Explanation:

The correct answer is **option 1) i.e. vagabond**

⭐ Key Points

- Let's look at the meaning of the given word and the correct option.
  - **VAGABOND :**A person who wanders from place to place without a home or job.
  - **Wanderer :**Aperson who travels aimlessly; a traveller.
- Hence from the given meanings, we find that both the words express similar meanings.
  Let's look at the meanings of the other given words.
  - **Beggar:** a person, typically a homeless one, who lives by asking for money or food.
  - **Tramper :**A person who walks for long distances in rough country for recreation.
  - **Traveller:** One who travels or has travelled, as to distant places.

---

91. **Answer: c**

Explanation:

The correct answer is**Lahore.**

⭐ Key Points

- Ranjit Singh was known as the **Lion of Punjab.**
- Ranjit Singh was born on **November 13, 1780, at Gujranwala.**
- He was the founder of the **Sikh rule in Punjab** .
- **In July 1799 he captured Lahore and made it the capital of Punjab .**

⭐ Additional Information

- Zamān Shah, the Afghan king, confirmed Ranjit Singh as governor of the city.
- **In 1801 Ranjit Singh declared himself Maharaja of Punjab.**
- He had coins struck in the name of the Sikh Gurus, the revered line of Sikh leaders, and proceeded to administer the state in the name of the Sikh commonwealth.
- **In 1802 he captured Amritsar, the most important commercial center in northern India and the sacred city of the Sikhs.**
- **He captured Kangra(1809), Ludhiana, and Multan(1808).**
- He continued to conquer the small Sikh and Pashtun territories that were dispersed all through Punjab.
- His later invasions toward the east, in any case, were checked by the English. By a settlement with them, signed in 1806, he consented to remove a Maratha power that had looked for asylum in Punjab.
- The English at that point defeated his aspiration to unite the entirety of the Sikh territories stretching out up to the region of Delhi.
- **In 1809 they constrained him to sign the Treaty of Amritsar, which fixed the Sutlej River as the eastern limit of his territories.**
- All Ranjit Singh's conquests were accomplished by Punjabi armies composed of Sikhs, Muslims, and Hindus.
- **In 1820 Ranjit Singh started to modernize his military, utilizing European officials—a significant number of whom had served in the army of Napoleon I—to prepare the infantry and the ordnance.**
- The modernized Punjabi armed force battled well in crusades in the North-West Frontier (presently Khyber Pakhtunkhwa area, Pakistan, on the Afghanistan fringe), including suppressing an uprising by tribesmen there in 1831 and repelling an Afghan counterattack on Peshawar in 1837.

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92. **Answer: c**

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Explanation:

The correct answer is **Mahabalipuram.**

⭐ **Key Points**

- **The Pallavas dynasty was founded by Simhavishnu and the capital of his kingdom was Kanchi.**
- Their kingdom was stretched from Southern Andhra Pradesh and Northern Tamil Naidu-the fertile plan between the river basin of Penna and Ponnaiyar river.

⭐ **Important Points**

- **Narasimhavarman I occupied Chalukya Capital at Vatapi and assume a title of Vatapikonda.**
- **He was also known as Mamallan and Mamallapuram (Mahabalipuram) was named after him.**
- During his reign, the Chinese traveler Hiuen Tsang visited Kanchipuram in 640 AD.

⭐ **Additional Information**

Shore Temple, Mahabalipuram	• It is built by using **blocks of granite.** • There are **three temples, the main temple, a tribute to Lord Shiva, faces the east so that sun rays shine upon the Shiva Linga, located in the garbhagriha.** • **Of the other two shrines leftover, one is dedicated to Lord Vishnu and another to Lord Shiva.** The temple walls are extravagantly adorned with large sculptures of Nandi and a series of rearing lions. **Marco Polo and other European merchants called the site, Seven Pagodas.** It is on the shore of the **Bay of Bengal.**
Kanchi Kailasanathar Temple	• It is a prominent representation of • **Dravidian architecture** , the compound of the Kanchi Kailasanathar Temple is adorned by carvings of half-animal deities which were popular at the time. • **Sculptures of Lord Shiva holding the musical instrument Veena are also decorated on the walls.** A secret tunnel used for escape was built by the emperors. • **The main shrine has a 16 sided Shiva linga with an exquisitely carved sculpture of Nandi in some distance to serve as a guard to the deity.**
Nalanda Gedige Temple	• The Nalanda Gedige Temple, a Vishnu sanctum, is one such evidence of the far-reaching reputation and power of the once-dominant South Indian kingdom. **Lord Kubera's statue finds itself a commemorative place in this temple** . • The architecture is a mixture of Hindu and Buddhist.
Mandagapattu Cave Temple	• **An inscription in the Pallava Grandha script at the entrance of the temple dedicates the holy sanctum to the trinity of Lord Brahma, Shiva and Vishnu.** • It is built without the use of wood, metal, timber or even brick. Mahendravarman was the king who built this temple.

93. **Answer: d**

Explanation:

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The correct answer is**Venus.**

⭐ Key Points

- **Venus is also known as the morning and evening star as it is seen in the east in the morning and west in the evening.**
- **It is the brightest object in the solar system because it contains 70% albedo.**
- It contains **90 to 95% of Carbon dioxide and 3.5% of Nitrogen** .
- It has the **slowest rotational speed in the solar system and rotates in a clockwise direction** .
- It takes about **257 days** to complete the rotation.
- It rotates from east to west in the solar system.
- **It takes 224.7 days to complete the revolution.**
- It is the hottest planet as it contains a large amount of carbon dioxide.
- **It has no satellite of its own.**
- The density of Venus is less than the earth.
- **Venus is also known as the twin sister of earth.**
- **Venus is the third smallest planet in the solar system.**

⭐ Additional Information

- **Saturn:**
  - It is the **second-largest planet of the solar system** and it is **surrounded by a set of 8 rings, which are made up of primordial dust and ice particles.**
  - **Titan is one of the largest satellites.**
  - It is the least dense planet in the solar system.
  - **Its rotation is 10.7 hr and the revolution is 29.5 years.**
  - Saturn is a massive ball made mostly of hydrogen and helium.
- **Neptune:**
  - It is the Penultimate planet of the solar system.
  - **It has a dynamic atmosphere that contains an Earth-sized blemish called the Great Dark Spot that is reminiscent of Jupiter's Great Red Spot.**
  - **It has a five-ring, which are clumps of dust and debris likely formed by the gravity of a nearby moon. It appears as a Greenish Star.**
  - **It consists of molecular hydrogen, atomic helium, and methane.**
  - Voyager is the only spacecraft to have visited Neptune.
  - **Triton and Nereid are some of the satellites.**
  - It takes 15.7 day to complete the rotation and 165 years to complete the revolution.
- **Pluto:**
  - **it was discovered by Clyde Tombaugh in 1930.**
  - Pluto is considered a dwarf planet.

---

94. **Answer: a**

Explanation:

The correct answer is **Nile**.

⭐ Key Points

- The River Nile is around 6,670 km (4,160 miles) long and is the longest waterway in Africa and on the planet.
- It originates in Burundi , south of the equator, and streams toward the north through northeastern Africa.
- The Nile streams into the Mediterranean Sea.

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- The biggest wellspring of the Nile is Lake Victoria, Africa's greatest lake . On the northern edge of the lake, water pours over a cascade, known as Ripon Falls, into a thin opening which a few people accept is the start of the River Nile.
- The biggest feeder of Lake Victoria is the Kagera waterway. The Kagera and its feeder the Ruvubu, with its headwaters in Burundi, is currently viewed as the genuine wellspring of the Nile. It is from here that the Nile is estimated as the world's longest stream.
- The River Nile is shaped from the White Nile, which starts at Lake Victoria and the Blue Nile, which begins at Lake Tana in Ethiopia. These waterways meet in Sudan and afterward go on their long excursion northwards towards the ocean.
- **The Nile bowl is immense and incorporates portions of Tanzania, Burundi, Rwanda, Congo (Kinshasa), Kenya.**

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95. **Answer: a**

Explanation:

The correct answer is **the moon comes between the Sun and the Earth.**

⭐ Key Points

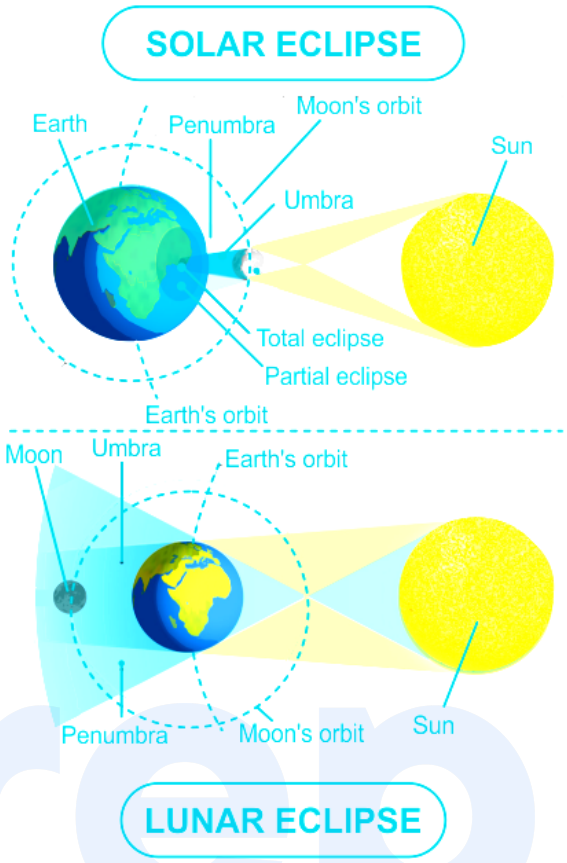
- **A solar eclipse happens when the moon passes between the Sun and the Earth.**
- **It occurs only on a big new moon but it does not happen on every new moon day because of the inclination of the moon's orbital plane.**
- This total eclipse happens about every year and a half somewhere on Earth.
- A partial eclipse, when the moon doesn't completely cover the sun, happens at least twice a year somewhere on Earth.
- On average, the same spot on Earth only gets to see a solar eclipse for a few minutes about every 375 years!

⭐ Additional Information

There are 4 different types of solar eclipses.

- Partial solar eclipses occur when the Moon only partially obscures the Sun's disk.
- Annular solar eclipses take place when the Moon's disk is not big enough to cover the entire disk of the Sun, and the Sun's outer edges remain visible to form a ring of fire in the sky.
- Total solar eclipses happen when the Moon completely covers the Sun, and it can only take place when the Moon's orbit closest to Earth. You can only see a total solar eclipse if you're in the path where the Moon casts its darkest shadow.
- Hybrid solar eclipses also known as annular-total eclipses, are the rarest type. They occur when the same eclipse changes from annular to total solar eclipses, and/or vice versa, along the eclipse's path.

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96. **Answer: b**

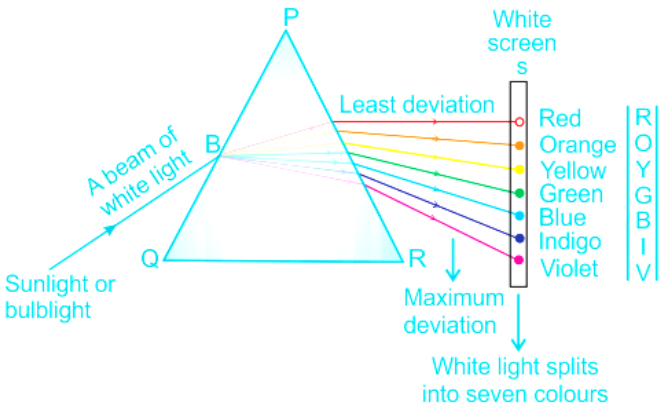
Explanation:

The correct answer is**opposite to the sun**.

⭐ Key Points

- The rainbow is formed opposite to **the sun to receive the sunlight.**
- **The raindrop goes about as a prism or a Spectrum when sunlight falls on it.**
- **At the point when sunlight goes through the raindrop, all the seven hues (VIBGYOR) structures are formed a similar way it structures when a light goes through a prism.**
- Accordingly, the rainbow is inverse to the sun to get the sunlight.
- Sunlight is a blend of color. At the point when it goes through a glass prism, a portion of the light is twisted, or refracted, more than different bits.
- **Light leaving the prism spreads out into a continuous band of colors called a spectrum.**

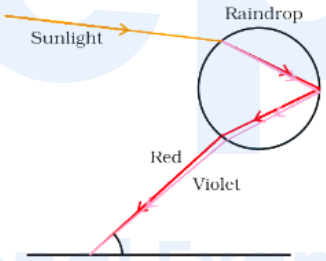
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- **Rainbows are much of the time found in the wake of a rainstorm. They come when the sunlight breaks through rain clouds.**

⭐ Additional Information

- A single, or primary, rainbow has red on the outside or top of the bow and blue on the inside. Usually, the radius of the arc is equal to about one-fourth of the visible sky, or 42 degrees, to the red. When there are showers nearby, simply look in the part of the sky opposite the sun at a 42-degree angle from your shadow; if there is a rainbow, that is where it will be.
- The primary bow is due to light that enters the upper part of the drops and leaves after one internal reflection, so this bow is always brighter than the secondary bow where sunlight is reflected twice within raindrops.
- Sometimes a secondary bow forms outside the primary. It will be fainter, with the colors reversed: red on the inside, violet on the outside. The secondary rainbow forms at a 51-degree angle from your shadow; it's always fainter and usually disappears more quickly than the primary.



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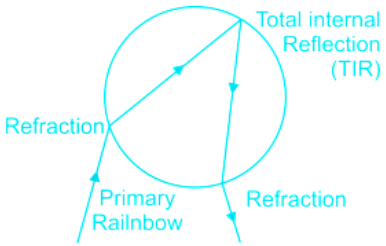
⭐ Important Points

- **Refraction of light** : When a ray of light passes from one medium to another medium to another, it bends from the path towards or away from normal. The phenomenon of bending of light is called the Refraction of light.
- When a ray of light travel from one medium to another medium, the wavelength and velocity change, but frequency does not change.
- **Reflection of light:** The return of light into the same medium after striking a surface is called reflection.
- **Total internal reflection light:** If the angle of incidence is denser medium is greater than the critical angle (the angle of incidence in the denser medium for which the angle of reflection become 90 degrees in rarer medium), then the ray is

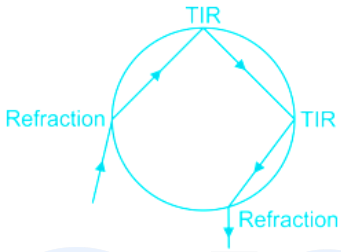
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reflected back into the same medium, this phenomenon is called total internal reflection.

- **Interference of light:** It is a phenomenon of sustained cancellation or reinforcement of two waves when they meet under certain specific condition



Primary rainbow formation



Secondary rainbow formation

97. **Answer: a**

Explanation:

The correct answer is **Shri Suman Bery**.

⭐ **Key Points**

- **NITI Aayog was formed on January 1, 2015.**
- **The National Institution for Transforming India is also called NITI Aayog .**
- **The Government of India constituted the NITI Aayog to replace the Planning Commission instituted in 1950.**
- The NITI AYOG will work as a**"Think Tank"**of government directional and policy dynamo**.**
- **Shri Suman Bery** is currently Vice Chairperson, NITI Aayog, in the rank and status of a Cabinet Minister. An experienced policy economist and research administrator, Mr Bery took over as NITI Aayog Vice Chairperson from 1 May 2022.
- NITI Aayog is creating itself as a State-of-the-craftsmanship Resource Center, with the essential assets, information and skills, that will empower it to act with speed, advance exploration and development, give vital arrangement vision to the legislature, and manage unforeseen issues.
- NITI Aayog's entire gamut of activities can be divided into four main heads:

1. Design Policy & Programme Framework
2. Foster Cooperative Federalism
3. Monitoring & Evaluation
4. Think Tank and Knowledge & Innovation Hub

⭐ **Additional Information**

- Structure of NITI Aayog
  - The Prime minister of India will be a chairperson.

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- The governing council comprises the Chief minister of all the states and the Lieutenant governor of all Union territories.
- The regional meeting will be convened by the Prime minister and comprises the Chief minister of all the states and the Lieutenant governor of all Union territories in the region. These will be chaired by the chairperson of NITI Aayog or his nominee.
- Experts, specialists and practitioners in the relevant domain are special invitees nominated by the Prime minister.

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98. Answer: b

Explanation:

The correct answer is **Chattisgarh.**

⭐ Key Points

- **The Ganga system is the second major drainage system in India.**
- **It is originated from the Gangotri glacier near Gaumukh(3900m) in the Uttarkashi district of Uttarakhand. And this river is known as Bhagirathi.**
- Alaknanda has its sources in the **Satopanth glacier above Bhagirathi** .
- These two rivers meet at Dev Prayag and form a new river Ganga.
- **The length of the Ganga river is 1,560 miles (2,510 km).**
- The Ganga flow through the plain of Rishikesh and Haridwar.
- Ganga enters Uttar Pradesh at **Bijnour** district and flows through major districts Meerut, Hapur, Bulandshahar, Aligarh, Kanpur Allahabad, Varanasi.

⭐ Additional Information

- **Gomati river which flows in Lucknow city merges into Ganga near Jaunpur.**
- Ganga enters Bihar state at Chhapra district where the **Ghaghra** river merges into the Ganga river.
- Gandak River , also called Narayani River , river in central Nepal and northern India merges into the Ganga river at Patna.
- **Gandak River is formed by the union of the Kali and Trisuli rivers, which originate from the Great Himalayan range in Nepal.**
- **Kosi river is known as the "sorrow of Bihar" joins Ganga near Kursela in Bihar.**
- **Its most significant southern tributary is the Son tributary. The river cuts through the Kaimur range and joins the Ganges above Patna.**

⭐ Important Points

- **West Bengal is the last point in India where the Ganges enters, and, after it streams into Bangladesh, the Mahananda River goes along with it from the north.**
- **The westernmost distributaries of the delta are the Bhagirathi and the Hugli (Hooghly) waterways, on the east bank of which stands the enormous city of Kolkata (Calcutta).**
- The Hugli itself is joined by two tributaries streaming in from the west, the Damodar and the Rupnarayan.
- **Damodar river knows as the "sorrow of Bengal" joins Hugli.**
- Damodar river flow in the State of Jharkhand and West Bengal.
- **As the Ganges goes from West Bengal into Bangladesh, various distributaries branch off toward the south into the stream's immense delta.**
- In Bangladesh, the Ganges is joined by the strong Brahmaputra (which is known as the **Jamuna** in Bangladesh) close to Goalundo Ghat.
- The consolidated stream there called**the Padma,**gets together with the**Meghna River**above**Chandpur.**The waters at that point course through the delta locale to the Bay of Bengal by means of incalculable channels,**the biggest of which is known as the Meghna estuary.**

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99. **Answer: c**

Explanation:

The correct answer is P V Sindhu.

⭐ Key Points

- Pusarla Venkata Sindhuis Indian badminton player.
- She is the first Indian womanto win a silver medal at the Olympics and gold at the BWF World Championships in 2019.
- She honoured with Padam Bhushan Award, the third-highest civilian award in India, in January 2020.
- She was honoured with Padam Shri Award, the fourth highest civilian award in India, in March 2015.
- She received Rajiv Gandhi Khel Ratan Award, the highest sporting honour of India, on 29 August 2016.
- She is Bestowed with Arjun Award for badminton on 24 September 2013.
- She won the silver medal at Rio Olympics in 2016. While the Indian shuttler bowed down to the Spaniard's form in all three sets, her silver medal was nonetheless an immense achievement for the nation.

100. **Answer: c**

Explanation:

The correct answer is No Plastic use.

⭐ Key Points

- Mahatma Gandhi was born on October 2, 1869, in Porbandar in Gujarat.
- Prime Minister Narendra Modi visited the Sabarmati Ashram in Ahmedabad on the occasion of the 150th birth anniversary of Mahatma Gandhi and later announced a ban on single-use plastic declared the country.
- Gandhi incorporated a non-violent resistance, taking the forefront of India's freedom struggle movement against the colonial British rule
- The UN General Assembly's decision on 15 June 2007, to embrace a resolution to celebrate 2 October as the International Day of Non-Violence
- On 2 October some people even pay a visit to the Sabarmati Ashram, where Gandhi spent a considerable amount of time.
- Gandhi Jayanti is a way of commemorating and remembering the teachings of Gandhi and spreading his message of peace and harmony forward.
- Some people pay homage to Gandhi's statue in Rajghat, New Delhi. Prayers are also held at his Samadhi in the presence of the President and the Prime minister.
- Gandhi's favorite bhajan (Hindu devotional song), Raghupati Raghav Raja Ram , is usually sung in his memory.
- The teachings and virtues of Gandhi have set the tone of values we share today. Famous quotes by him on forgiveness and non-violence, like – " an eye for an eye makes the whole world blind" – still continue to hold a strong meaning as we celebrate the important day.
- The government has launched several programs to commemorate the occasion. One of the most pivotal steps taken on Gandhi Jayanti is the launch of the Swachh Bharat Mission in 2014. The reach and effect of this cleanliness drive are significant and continue to grow every year.

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