Answers

1. **Answer: b**

Explanation:

Concept:

- The isothermal bulk modulus is defined as the **volume times negative partial derivatives of pressure with respect to volume at a constant temperature.**
- Mathematically, $K = -V(\frac{\delta P}{\delta V})_T$
- The ideal gas equation is determined by **macroscopic and microscopic** parameters like **pressure, volume, and temperature.**
- The **ideal gas equation** , P V = n R T
- The **SI unit** of the bulk modulus is the pascal, which is also a **SI unit of pressure** .

Explanation:

The isothermal bulk modulus is defined as the volume times negative partial derivatives of pressure with respect to volume at a constant temperature.

$\Rightarrow K = -V(\frac{\delta P}{\delta V})_T$ ..... (1)

The ideal gas equation, P V = n R T

So, the pressure of the ideal gas, $P = \frac{nRT}{V}$ .....(2)

The partial derivatives of the above equation with respect to volume at a constant temperature.

$(\frac{\delta P}{\delta V})_T = nRT\frac{\delta(1/V)}{\delta V}$

$(\frac{\delta P}{\delta V})_T = -\frac{nRT}{V^2}$

$(\frac{\delta P}{\delta V})_T = -\frac{P}{V}$ (From equation 2)

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Hence, the bulk modulus, $K = -V \times (\frac{-P}{V}) = P$ **Additional Information**

- The value of absolute temperature is -273.15°C.
- Absolute zero temperature at which a **thermodynamic system** has the **lowest energy** .

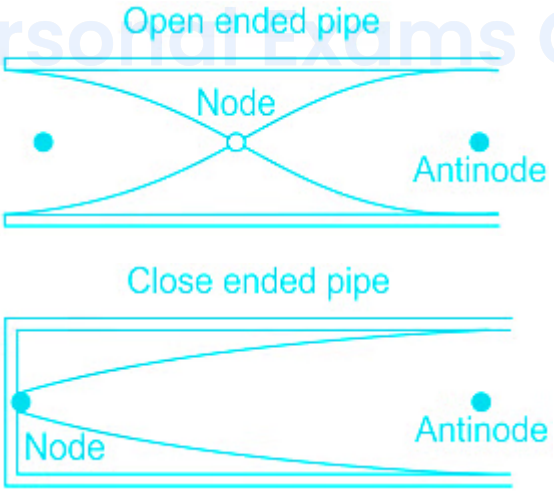
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2. Answer: b

Explanation:

Concept:

- **Beat:** The combination of two waves of slightly different frequencies, perceived as a periodic variation whose rate is a difference of two frequencies.
- **Beat frequency** , n = $|f_1 - f_2|$, where f_1 and f_2 are two frequencies
- The frequency of the n^{th} harmonic in an open pipe is given as, $f = \frac{nv}{2L}$ where, n is the n^{th} harmonic, v is a velocity and L is the length of the pipe.
- The frequency of the n th harmonic in a closed pipe is given as, $f = \frac{(2n-1)v}{4L}$, where n is a n th harmonic, v is a velocity and L is the length of the pipe.
- For frequency at fundamental nodes, we put n = 1 in both of the above formula,



Explanation:

The fundamental frequency of the open pipe is given by, $f_o = \frac{v}{2L}$

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The beat frequency, $f_o - f_c = 4$

If the length of the open pipe will increase, the frequency will decrease, then the number of beats will also decrease.

---

3. Answer: d

Explanation:

Concept:

- The frequency is defined as the **number of oscillations** in one second.
- The **SI unit** of frequency is Hz.
- The frequency of a sound wave depends on the **source of the sound, not the medium of propagation.**

Explanation:

- The frequency made underwater will be the same when heard by an observer who is standing in the air because frequency does not depend on the propagation medium, but it depends on the vibration of the source.
- **Hence, the frequency of the sound heard by an observer who is standing in the air is 600 Hz.**

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4. Answer: a

Explanation:

Concept:

- The average power is given by, P = $\frac{1}{2}$ ρ ω 2 A 2 Sv
- The **propagation constant** , $K = \frac{2\pi}{\lambda}$, here, λ = wavelength
- The relation between the **angular frequency and linear frequency** is given as, ω = 2 π f

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- The relation between the **linear frequency and wavelength** is **inversely proportional** to each other, so, f ∝ $\frac{1}{\lambda}$
- The pressure amplitude, P = B 0 A K,
- The pressure is defined as **the force per unit area** .

Explanation:

Given, the average power transmitted, P $_1$:P $_2$ =1:1, Wavelengths, λ $_1$:λ $_2$ = 1:2

The average power is given by, P = $\frac{1}{2}$ ρω ^{2}A ^{2}Sv

As the average power transmitted across a cross-section by the two waves are equal.

$\frac{1}{2}$ ρ ω $_1$2 A $_1$2 Sv = $\frac{1}{2}$ ρ ω $_2$2 A $_2$2 Sv

⇒ ω 12 A 12 = ω 22 A 22

⇒ ω 1 A 1 = ω 2 A 2

Or, $\frac{A_1}{A_2} = \frac{\omega_2}{\omega_1}$ .....(1)

The relation between the angular frequency and wavelength is inversely proportional to each other, so, ω ∝ $\frac{1}{\lambda}$

$\frac{\omega_1}{\omega_2} = \frac{\lambda_2}{\lambda_1} = \frac{2}{1}$

From equation (1), $\frac{A_1}{A_2} = \frac{1}{2}$

Now, the pressure amplitude, P = B $_0$ A K

∴ $\frac{P_1}{P_2} = \frac{A_1 \times K_1}{A_2 \times K_2} = \frac{A_1 \times \lambda_2}{A_2 \times \lambda_1}$, Here, $K = \frac{2\pi}{\lambda}$

⇒ $\frac{P_1}{P_2} = \frac{1}{2} \times \frac{2}{1} = 1$

---

5. Answer: c

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Explanation:

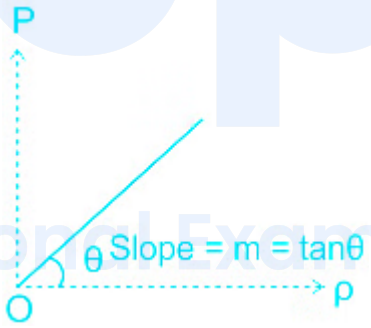
Concept:

- **Ideal gas equation** , PV = nRT, where P = Pressure, V = volume, n = number of moles, R = Universal gas constant, T = Temperature.
- A mole is defined as the **mass of a substance** that consists of an equal quantity of basic units.
- Mathematically, no. of moles, $n = \frac{Given\ mass}{Molecular\ mass}$
- In the process PV=constant, **Temperature** T must be **constant**
- **In terms of density,** PM = ρRT, ρ = density, M = molecular mass.
- The **equation of the straight line** , y = m x + C, m= slope, and C = y-intercept

Explanation:

From the ideal gas equation PV = nRT. . . . . .(1)

In the process PV = constant, Temperature T must be constant.



We are also known as, P M = ρ R T

$\Rightarrow P = \frac{\rho RT}{M}$ .....(2)

Compare equation (2) with the equation of the straight line, y = mx + C, where m= slope, and c= intercept.

So, $m = \frac{RT}{M}$ = slope which is positive and y-intercept, c = 0, y = P, x = ρ

Hence, the straight line passes through the origin with a positive slope.

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6. **Answer: c**

Explanation:

Concept:

- The ideal gas law states that the **product of the pressure and the volume** of one gram molecule of an ideal gas is equal to the **product of the absolute temperature of the gas and the universal gas constant.**
- The **empirical form** of an ideal gas equation: P V = n R T
- In the process, P V=constant, **temperature** T must be **constant**
- The relation between the universal gas constant R, and Boltzmann's constant k is given as, R=Nk

Explanation:

From the ideal gas equation, PV=nRT

$\Rightarrow n = \frac{PV}{RT}$ .....(1)

The relation between the universal gas constant R, and Boltzmann's constant k is given as,

R = N k.....(2)

Substitute equation (2) with equation (1), and we get

$n = \frac{PV}{NkT}$

$n \times N = \frac{PV}{kT}$

This quantity represents **the number of molecules in the gas** .

---

7. **Answer: b**

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Explanation:

Concept:

- Molar-specific heat capacity at constant volume is defined as **the amount of heat energy required to raise the temperature of one mole of a substance through 1K or 1^0C at constant volume.**
- It is denoted by C_V.
- For hydrogen H, $C_v(H) = \frac{5}{2}R$, here R=universal gas constant
- For helium He, $C_v(He) = \frac{3}{2}R$
- For the **mixture** , $C_V = \frac{n_1C_{v_1}+n_2C_{v_2}}{n_1+n_2}$
- The heat energy, Q = nC V (ΔT), where n= number of moles
- The number of moles is defined as the **given substance to the molecular mass.**
- Formula, the number of moles, $n = \frac{Given\ mass}{Molecular\ mass}$

Calculation:

For H, $C_v(H) = \frac{5}{2}R$, For He, $C_v(He) = \frac{3}{2}R$

The molar specific heat capacity at constant volume of the mixture of hydrogen H and Helium He is given as,

$C_V = \frac{n_1C_{v_1}+n_2C_{v_2}}{n_1+n_2}$

$C_V = \frac{\frac{10}{2}\times\frac{5R}{2}+\frac{40}{4}\times\frac{3R}{2}}{\frac{10}{2}+\frac{40}{4}} = \frac{27.5R}{15}$

The heat energy, Q = nC $_V$ (Δ T)

Q = (5 + 10) × $\frac{27.5\times8.314}{15}$ × 50

Q = 2750 cal

⭐ Additional Information

- Molar-specific heat capacity at constant pressure is defined as **the amount of heat energy required to raise the temperature of one mole of a substance through 1K or 1°C at constant pressure.**
- It is denoted by C_P.

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- The relation between C_P, C_V, R is, $C_P - C_V = R$

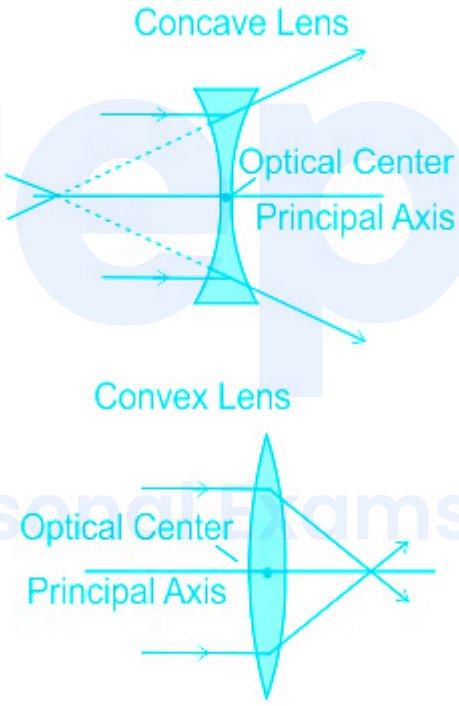
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8. **Answer: c**

Explanation:

Concept:

- A lens is a **transmissive optical device** that focuses or disperses light beams using **refraction** .
- Two types of lenses:



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Convex lens :

- Convex lenses are **thick in the middle and thinner at the edges** .
- A convex lens is also known as a **converging lens** as the light rays bend inwards and converge at a point which is known as focal length.

Concave lens :

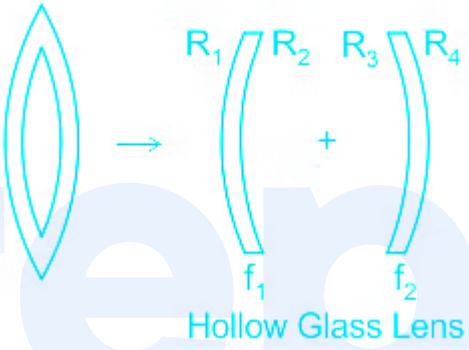
- A concave lens is flat in the **middle and thicker at the edges.**

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- The concave lens is also known as a **diverging lens** because it bends the parallel light rays outward and diverges them at the focal point.
- In lenses, the relation between the power and lens is **inversely proportional** to each other.
- Formula, $P_1 = \frac{1}{f_1} = (\mu_g - 1)(\frac{1}{R_1} - \frac{1}{R_2})$
- Here, μ is the refractive index of glass or lenses.

Explanation:

The hollow convex lens is shown in the below figure



The power of a convex lens is given as,

$P_1 = \frac{1}{f_1} = (\mu_g - 1)(\frac{1}{R_1} - \frac{1}{R_2})$ .....(1)

If R 1=R 2, then P=0

So, f 1=∞ , similarly, f 2=∞

We know that the focal length of the plane mirror is infinite. Therefore, a hollow convex lens of any material will behave like a glass plate.

⭐ Additional Information

- A plane mirror is a **flat reflecting surface** .
- In the case of a plane mirror, when the parallel rays of light strike the mirror they get reflected back parallel to each other.
- They never meet or we can say they meet at **infinity.**
- Therefore, the **focal length** of the plane mirror is **Infinity.**

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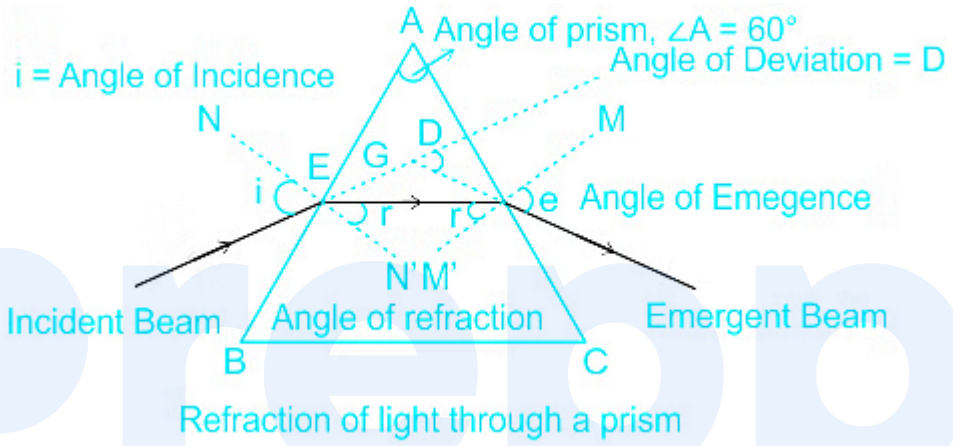
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9. **Answer: a**

Explanation:

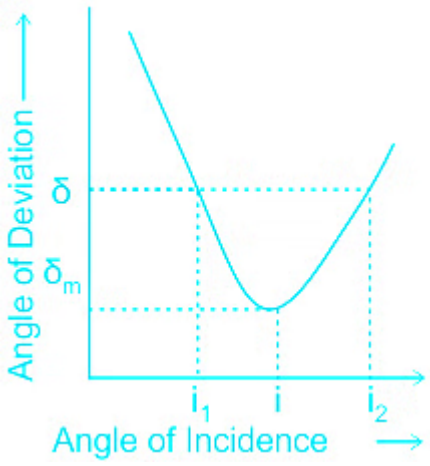
Concept:

- **Prism:** It is a **wedge-shaped** portion of a transparent refracting medium bounded by two plane **faces inclined** to each other at a certain angle.



- Angle of incidence +angle of emergence=angle of prism+angle of deviation, I + e=A + δ
- **The refractive index** of the prism, $\mu = \frac{sin(\frac{A+\delta_m}{2})}{sin(\frac{A}{2})}$
- **The factors on which the angle of deviation depends** :
  - The angle of incidence
  - The material of the prism
  - The wavelength of the light used
  - The angle of the prism
- **The variation of the angle of deviation with the angle of incidence,**

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- At minimum deviation, **the angle of incidence** is given as, $i = \frac{\delta_m + A}{2}$
- **The angle of refraction** can be calculated as, $r = \frac{A}{2}$

Calculation:

Given, the angle of minimum deviation is equal to the angle of prism A of an equilateral glass prism, $\delta_m = 60°$

In an equilateral glass prism, the angle of the prism, A = 60°

At minimum deviation, the angle of incidence, $i = \frac{\delta m + A}{2}$

$\Rightarrow i = \frac{60+60}{2} = 60°$

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10. Answer: d

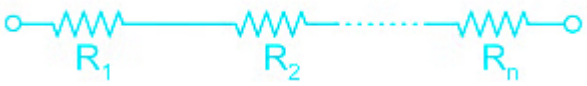
Explanation:

Concept:

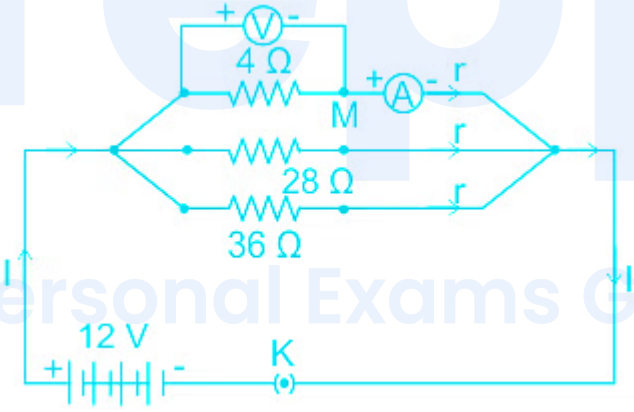
- R esistance refers to **the property of a substance that impedes the flow of electric current.**
- **From ohm's law:** $R = \frac{V}{I}$
- The **SI unit** of resistance is ohm and it is denoted by the symbol Ω.
- **Combination of resistance:**
  - **Series combination** :

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- Whenever two or more resistances are linked edge to edge or down the middle sequentially, they have been shown to be connected throughout the series.
- The current through each element seems to be similar, as well as the voltage spanning the circuit equals the **summation** of such voltages across each element.
- Formula, $R_{eq} = R_1 + R_2 + \ldots\ldots + R_n$.

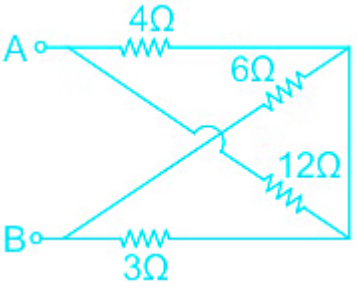


- **Parallel combination:**
  - Two or more resistance are said to be connected in parallel connected when they are connected between two points and each has a different current direction.
  - Formula, $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots + \frac{1}{R_n}$



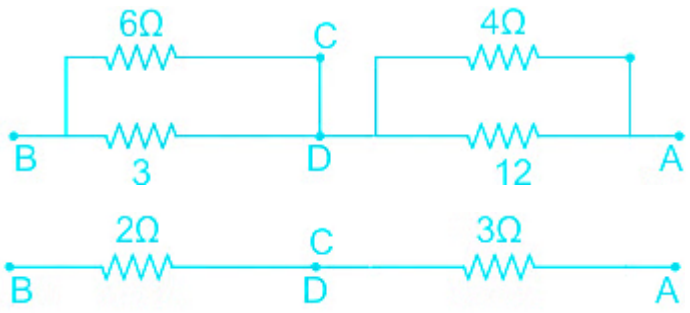
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<u>Calculation:</u>



Redraw this circuit,

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In the above circuit, the resistance 6Ω and 3Ω are connected in parallel, So, the equivalent resistance is calculated as,

$\frac{1}{R'_P} = \frac{1}{3} + \frac{1}{6}$

$\Rightarrow R'_P = 2\ \Omega$

the resistance 4Ω and 12Ω are connected in parallel, So, the equivalent resistance is calculated as,

$\frac{1}{R''_P} = \frac{1}{4} + \frac{1}{12}$

$\Rightarrow R''_P = 3\ \Omega$

Now, R'_P and R''_P are in series, so the equivalent resistance between the points A and B is,

$R_{eq} = R'_P + R''_P$

$R_{eq} = 2 + 3 = 5\ \Omega$

---

11. Answer: d

Explanation:

Concept:

- A **semiconductor** is a material product usually comprised of **silicon or germanium**, which conducts electricity more than an insulator, but less than a pure conductor.

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- In semiconductors, the conduction band and the valence band are separated by a relatively small energy gap.
- For germanium , this gap is 0.67eV
- For silicon, this gap is 1.1 eV.
- **Temperature Dependence of conductivity of a semiconductor**
    - If the temperature is increased, the average energy exchanged in a collision increases.
    - More valence electrons cross the gap and the number of electron-hole pairs increases.
    - Thus, more electrons from the valence band reach the conduction band.
    - The increase in the number of electron-hole pairs results in an increase in the conductivity
    - And decrease in the resistivity of the material.
- **The resistivity (ρ)** of a material is a fundamental property, and it shows how strongly the material opposes the electric current.
- **Temperature dependence of resistivity**
    - As the temperature of a conductor is increased, the thermal agitation and the collisions become more frequent.
    - The average time t between the successive collisions decreases and hence the drift speed decreases.
    - Thus, the conductivity decreases, and the resistivity increases as the temperature increases.
    - $\rho = \rho_0[1 + \alpha t (T - T_0)]$
- Resistance $R = \rho\frac{L}{A}$
- where ρ and ρ_0 denote the resistivity at temperature T and T_0 respectively and α is called the temperature coefficient of resistivity, L = the length of the conductor, and A = the area of the cross-section of the material.

Explanation:

- When a piece of copper is cooled from room temperature (298 K) to 80 K,
- The temperature of the copper metal is decreased. With the decrease in temperature of a metal, the resistivity and hence resistance also decreases.
- **So, the resistance of copper pieces will decrease when cooled to 80 K.**
- When a piece of germanium is cooled from room temperature (298 K) to 80 K,

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- The temperature of the germanium semiconductor is decreased.
- With the decrease in temperature of semiconducting material, the resistivity and hence resistance increases.
- **So, the resistance of germanium pieces will increase when cooled to 80 K.**

---

12. Answer: a

Explanation:

<u>Concept:</u>

- The **electrostatic or electric force** is defined as the force between two electric charges.
- It is one of the fundamental forces in the universe.
- The electrostatic force may be attractive or repulsive.
- **Coulomb's law** states that the force of attraction or repulsion between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them.
- Consider q_1 and q_2 as two charges placed with a distance 'r' between them. Then, according to Coulomb's law
  - $F_E = K\frac{q_1 q_2}{r^2}$
  - Where, $K = \frac{1}{4\pi\epsilon_0}$ = $9 \times 10^9 Nm^2/c^2$
- Charge on the particle is given by q = ne
- Where, n = natural number and e = the charge on an electron = 1.6×10^{-19} C

<u>Calculation:</u>

Given, distance, r = 1 m

Minimum charge on particle $q_1 = q_2 = ne = 1 \times e = 1.6 \times 10^{-19}$ C

Now, $F_E = K\frac{q_1 q_2}{r^2}$

$\Rightarrow F_E = 9 \times 10^9 \times \frac{(1.6\times10^{-19})^2}{1^2}$

$\Rightarrow F_E = 2.3 \times 10^{-28}$ N

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13. **Answer: c**

Explanation:

Concept:

- A combination of two conductors placed close to each other is called a **capacitor.**
- The charge on the positive plate is called the charge on the capacitor.
  - **Q = CV**
- **Capacitance(C)** is the ability of a component or circuit to collect and store energy in the form of an electrical charge
- Where, Q = charge, V = potential difference between plates.
- **The capacitance of the parallel-plate capacitor is**
  - $C = \frac{\varepsilon_0 A}{d}$
- The force between the plates of a capacitor
  - $F_c = \frac{Q^2}{2\varepsilon_0 A}$

Calculation:

Let initial separation between the plate is d and charged is Q

Then the force of attraction between the plates

$F_c = \frac{Q^2}{2\varepsilon_0 A}$ ---- (1)

When the separation between them is halved, d' = 0.5d

Then the capacitance, $C' = \frac{\varepsilon_0 A}{\frac{d}{2}} = 2C$

Also, Q' = C'V = 2CV = 2Q

Then the force of attraction between the plates,

$F_c' = \frac{(2Q)^2}{2\varepsilon_0 A}$ --- (2)

From equation 1 and 2

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$F_C = 4 \times F_C'$

The force of attraction between the plates when the separation between them is halved becomes four times

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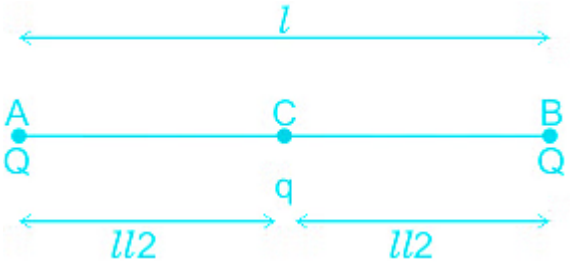
14. Answer: b

Explanation:

Concept:

- The **electrostatic or electric force** is defined as the force between two electric charges.
- It is one of the fundamental forces in the universe.
- The electrostatic force may be attractive or repulsive.
- **Coulomb's law** states that the force of attraction or repulsion between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them.
- Consider q_1 and q_2 as two charges placed with a distance 'r' between them. Then, according to Coulomb's law
  - $F_E = K\frac{q_1 q_2}{r^2}$
  - Where, $K = \frac{1}{4\pi\epsilon_0}$ = 9×10^9 Nm^2/c^2

Calculation:



From fig,

- For the equilibrium of charge Q at A, the force applied by both the charges i.e., another charge Q at B and q at C should be equal in magnitude and opposite in direction.

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- This is only possible when q has a negative charge.

Let the distance between the charges is l

So, the force on charge Q at A due Q at C is F_{AB} and due to q is F_{AC}

$F_{AC} = -F_{AB}$

$\Rightarrow K\frac{Qq}{(\frac{l}{2})^2} = -K\frac{Q^2}{l^2}$

$\Rightarrow q = -\frac{Q}{4}$

---

15. Answer: c

Explanation:

<u>Concept:</u>

- A current-carrying wire produces a magnetic field because inside the conductor charges are moving.
- The magnetic field produced by current-carrying wire,
- $B = \frac{\mu_0 . i}{2\pi l}$
- Where, μ_0 is called the permeability of a free space = $4\pi \times 10^{-7}$, i = current in wire, B = magnetic field, l = distance from wire
- The magnetic field decreases as the radial distance increases.
- So, the maximum occurs on the surface of the wire

<u>Calculation:</u>

Given, the maximum magnetic field due to the wire is 5×10^{-3} T,

The magnetic field decreases as the radial distance increases. So, the maximum occurs on the surface of the wire

$l = \frac{d}{2} = \frac{1.6}{2}$ = 0.8 mm = 0.8×10^{-3} m

Now, $B = \frac{\mu_0 . i}{2\pi l}$

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$\Rightarrow 5 \times 10^{-3} = \frac{4\pi \times 10^{-7} i}{2\pi \times 0.8 \times 10^{-3}}$

$\Rightarrow$ i = 20 A

---

16. Answer: d

Explanation:

Concept:

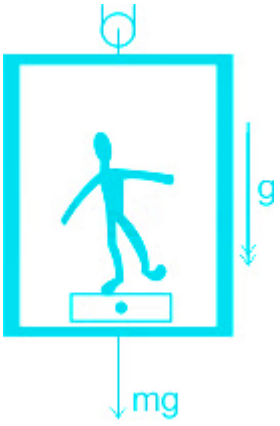
- Force applied by the earth's gravity on a body is called the **weight** of that body.
  - W = mg
  - m = mass of body, g = acceleration due to gravity.
- A **Pseudo force** (also called a fictitious force, or inertial force) is an apparent force that acts on all masses whose motion is described using a non-inertial frame of reference.
  - $F = ma_0$
  - where m is the mass of the body and a_0 is the acceleration of the frame
- Pseudo force comes into effect when a frame is non-inertial.
- The pseudo force is applied in the opposite to the direction of motion of the reference

Explanation:

When the cable of the lift breaks, then the lift will fall down with acceleration due to gravity

acceleration of lift, $a_0 = g$

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Now the man experiences a pseudo force in an upward direction, as lift falls freely downward

$F_P = ma_0 = mg$ --- (1)

Also, the original weight of the man in a downward direction,

$W = mg$ ---- (2)

Now the total force acting on the man



$\Rightarrow N + F_P = mg$

From equation 1 and 2

$\Rightarrow N + mg = mg$

$\Rightarrow N = 0$

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N is the normal force and is equal to zero so the weight of the man in the lift will become zero.

---

17. **Answer: b**

Explanation:

Explanation:

- The SI unit is an international system of units used in technical and scientific research to minimize confusion with measuring units.
- There are two types of quantities
  - **Fundamental quantities** or base quantities

Quantity	Name of unit	Symbol
Mass	kilogram	kg
Length	metre	m
Time	second	s
Electric current	ampere	A
Thermodynamic Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

- **Derived quantities** are those quantities derived from the base quantities
- **Acceleration** is the rate at which velocity changes with respect to time
- Acceleration is derived quantities from length and time
- **S.I. Unit of acceleration is ms $^{-2}$**

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The dimensional formula is a compound expression showing how and which of the fundamental quantities are involved in making that physical quantity.

Some denotation of fundamental quantities

- Mass - M
- Distance - L
- Time - T
- Temperature - K
- Electric Current - A

---

18. Answer: a

Explanation:

Concept:

For a body moving in a straight line with constant acceleration, then

- v = u + at
- s = ut + $\frac{1}{2}$ at 2
- v 2 = u 2 + 2as

Where u = initial velocity, v = final velocity, a = acceleration, s = displacement, t = time

Acceleration due to gravity, g = 9.8 m/s 2

Calculation:

Let after time t, the distance between the particles is 10 m,

Then the distance traveled by the first particle is,

initial speed, u = 0, a = g = 10 m/s ^{2} (given)

$s_1 = 0 \times t + \frac{1}{2}gt^2 = \frac{1}{2}gt^2$ --- (1)

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Now, after 1 s, second particle is released then the t' = t-1, u = 0,

Then the distance traveled by the second particle is,

$s_2 = 0 \times (t-1) + \frac{1}{2}g(t-1)^2 = \frac{1}{2}g(t-1)^2$ --- (2)

Now, $s_1 - s_2 = 10$ m,

Then, from equation 1 and 2

$\Rightarrow \frac{1}{2} \times 10 \times t^2 - \frac{1}{2} \times 10 \times (t-1)^2 = 10$

$\Rightarrow t^2 - (t^2 + 1 - 2t) = 2$

$\Rightarrow$ **t = 1.5 s**

---

19. Answer: c

Explanation:

Concept:

The **law of conservation of energy** states that the total energy of an isolated system remains constant.

- It can only be transferred from one form to another form.

The **spring's potential energy** is the energy stored because of the deformation of the spring.

- $P.E. = \frac{1}{2}Kx^2$
- Where, P.E = Spring Potential Energy, k = Spring Constant, x = Spring Displacement

Kinetic energy is defined as the energy that is produced by an object due to its motion.

- The kinetic energy of a moving body, $K.E. = \frac{1}{2}mv^2$
- Where, m = mass of the body, v = velocity of the body

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Projectile motion is a form of motion in which an object or particle is thrown near the earth's surface, and it moves along a curved path under the action of gravity only.

- Time of flight, $T = \frac{2usin\theta}{g}$
- **Range** , it is the distance traveled by the particle in time T.
- $R = \frac{u^2 sin2\theta}{g}$
- The range is maximum at an angle of θ = 45°
- The maximum height reached, $H = \frac{u^2 sin^2\theta}{2g}$
- Where, u = initial speed, θ = angle from horizontal,

Calculation:

Given, the spring is compressed by a distance, x = 5 cm, K = 600 N/m

So, the potential energy stored in spring,

$P.E. = \frac{1}{2}Kx^2 = \frac{1}{2} \times 600 \times (0.05)^2$ = 0.75 J

From the law of conservation of energy, the elastic potential energy of the spring is converted into kinetic energy.

So, $K.E. = \frac{1}{2}mv^2$ = P.E.

⇒ 0.015 × v^2 = 2 × 0.75 (m = 15g = 0.015 kg)

⇒ **v = 10 m/s**

For **maximum range θ = 45 ° u = v = 10 m/s**

Then the range , $R = \frac{u^2 sin2\theta}{g}$

$\Rightarrow R = \frac{10^2 sin(2\times45)}{10} = 10\ m$

---

20. Answer: a

Explanation:

Concept:

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Kinetic energy is defined as the energy that is produced by an object due to its motion.

- The kinetic energy of a moving body, $K.E. = \frac{1}{2}mv^2$
- Where, m = mass of the body, v = velocity of the body
- $\frac{dv}{dt} = a$
- F = ma
- Where, m = mass, a = acceleration,

Explanation:

Given, $K = 4t^2$

Then $\frac{1}{2}mv^2 = 4t^2$

$= v^2 \propto t^2$

$= v \propto t$

Differentiating both sides,

$\Rightarrow \frac{d(\frac{1}{2}mv^2)}{dt} = \frac{d(4t^2)}{dt}$

$\Rightarrow \frac{1}{2}m(2v)\frac{dv}{dt} = 8t$

$\Rightarrow m.v.a = 8t$

$\Rightarrow F.v = 8t$

$\Rightarrow v \propto t$

$\Rightarrow F \propto$ constant

So, force acting on particles constant with time.

---

21. Answer: c

Explanation:

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Concept:

- **Newton's second law of motion** states that " the rate of change of momentum of a body is directly proportional to the applied force on it.
- $F = K\frac{\Delta P}{\Delta T}$
- where k is proportionality constant and equal to 1, ΔP = change in momentum, Δt = change in time
- P = MV.
- where, M = mass and V = velocity.

Calculation:

Given, m = 1 kg, g = 10 m/s ^{2}, Δt = 1 s

- Since there will not be any momentum change in the horizontal direction in projectile motion as no external force is acting in this direction.
- The linear momentum will change in the vertical direction as the external force mg is acting on the parietal in this direction.
- **So, the total charge in the linear momentum = Change in linear momentum in y direction only = Impulse in the y direction**

⇒ The total charge in the linear momentum = Impulse in y direction = mg Δt

Here, F = mg = 1 × 10 = 10 N

⇒ The total charge in the linear momentum (ΔP) = F × Δt

⇒ **ΔP = 10 × 1 = 10 kg-m/s**

---

22. Answer: a

Explanation:

Concept:

- **Angular velocity** is defined as the rate at which an object rotates around an axis in a given time period.

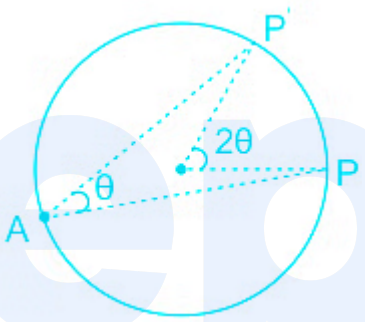
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- It is also known as rotational velocity
- $\omega = \frac{\theta}{t}$
- Where, θ = angular displacement, t = time
- In a circle, angle subtended by an arc at the Centre is double of the angle subtended anywhere on the circumference.

Calculation:

Given, angular velocity about a point P on its circumference = ω

Let the angular displacement from point P to point P' on its circumference in time t is θ



From fig the angular displacement about its centre is θ' = 2θ

So, the angular velocity of the particle about its centre is ω'

$\omega' = \frac{\theta'}{t}$

$\Rightarrow \omega' = \frac{2\theta}{t} = 2\frac{\theta}{t} = 2\omega$

---

23. Answer: c

Explanation:

Concept:

- **Mechanical energy** is the energy of an object due to its motion (**kinetic energy**) and position (**potential energy**)
  - $K.E. = \frac{1}{2}mv^2$

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- The potential energy of a particle of mass m on surface of the earth, $U = -\frac{GM}{R}.m$

- The **escape velocity** is the lowest velocity which a body must have in order to escape the gravitational attraction of a particular planet.
- $V_e = \sqrt{2gR} = \sqrt{\frac{2GM}{R}}$
- $g = \frac{GM}{R^2}$
- Where, G = gravitational constant, R = radius of earth, M = mass of earth
- For earth escape velocity is 11.2 km/s

Calculation:

The total mechanical energy on earth's surface is E

Then E = KE + U

$\Rightarrow E = \frac{1}{2}mv^2 + (-\frac{GM}{R}.m)$ ---- (1)

Given velocity, v = escape velocity, $V_e = \sqrt{\frac{2GM}{R}}$

Putting the value of v in equation 1

$\Rightarrow E = \frac{1}{2}m(\sqrt{\frac{2GM}{R}})^2 + (-\frac{GM}{R}.m)$

$\Rightarrow E = \frac{1}{2}\frac{2GM}{R}.m + (-\frac{GM}{R}.m) = 0$

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---

24. Answer: c

Explanation:

Concept:

- Acceleration due to gravity is the acceleration due to the gravitational force of the earth.
- $g = G\frac{M}{R^2}$ --- (1)
- M = mass of earth, R = radius of earth, G = the universal gravitational constant,
- Mass per unit volume is called density.
- $\rho = \frac{M}{V}$ --- (2)

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-

Calculation:

Given, mass of planet m' = 8 M,

Let the density of the earth is ρ, then the density of the planet is called, ρ' = 8 ρ

Also, the radius of the earth is R and the radius of the planet is r

From equation 2, the Radius of earth R

$V = \frac{M}{\rho}$

$\Rightarrow \frac{4}{3}\pi R^3 = \frac{M}{\rho}$

$\Rightarrow R = (\frac{3}{4\pi}\frac{M}{\rho})^{\frac{1}{3}}$ --- (3)

And the radius of the planet is r

$V = \frac{8M}{8\rho}$

$\Rightarrow \frac{4}{3}\pi r^3 = \frac{M}{\rho}$

$\Rightarrow r = (\frac{3}{4\pi}\frac{M}{\rho})^{\frac{1}{3}}$ --- (4)

From equations (3) and (4), R = r

Now, the acceleration due to gravity on the earth's surface is given by,

$g = G\frac{M}{R^2}$ --- (5)

Also, acceleration due to gravity on planet's surface is given by

$g' = G\frac{m}{r^2} = G\frac{8M}{R^2}$ --- (6)

Dividing equation 6 by 5, we get

g' = 8g

---

25. Answer: c

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Explanation:

Concept:

Gravitational potential energy is the energy stored in any two objects due to their gravity and the distance between them.

- $U = -\frac{GMm}{R}$
- Where, m is the mass of the first body, M = mass of the second body, R is the distance between them, G = the universal gravitational constant,

Calculation:

Let the mass m is at distance r from one of the spheres and the mass of spheres is M



Then the total potential energy of the system is,

$U = -\frac{GM^2}{R} - \frac{GMm}{r} - \frac{GMm}{(R-r)}$

Now at $r = \frac{R}{4}$, the potential energy of the system is,

$U_1 = -\frac{GM^2}{R} - \frac{GMm}{\frac{R}{4}} - \frac{GMm}{(R-\frac{R}{4})}$

$\Rightarrow U_1 = -(\frac{GM^2}{R} + (\frac{16}{3})\frac{GMm}{R})$ ---- (1)

Now at $r = \frac{R}{2}$, the potential energy of the system is,

$U_2 = -\frac{GM^2}{R} - \frac{GMm}{\frac{R}{2}} - \frac{GMm}{(R-\frac{R}{2})}$

$\Rightarrow U_2 = -(\frac{GM^2}{R} + 4\frac{GMm}{R})$ ---- (2)

Now at $r = \frac{3R}{4}$, the potential energy of the system is,

$U_3 = -\frac{GM^2}{R} - \frac{GMm}{\frac{3R}{4}} - \frac{GMm}{(R-\frac{3R}{4})}$

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$\Rightarrow U_3 = -(\frac{GM^2}{R} + (\frac{15}{3})\frac{GMm}{R})$ --- (3)

Now from equations 1, 2, and 3,

U $_1$is less than U $_2$and U $_2$is greater than U $_3$, so the potential energy first increases and then decreases.

---

26. Answer: d

Explanation:

Calculation:

$$\begin{vmatrix} 0 & x-a & x-b \\ x+a & 0 & x-c \\ x+b & x+c & 0 \end{vmatrix} = 0$$

Solving determinants we get

⇒ 0[0 -(x + c)(x - c)] - (x - a)[(0 - (x + b)(x - c)] + (x - b)[(x + a)(x +c) - 0] = 0

⇒ (x - a) (x + b) (x - c) + (x - b) x + a) (x + c) = 0

The only value that satisfies the above equation is x = 0

∴ The value of x is 0.

---

27. Answer: d

Explanation:

Concept-

Non-singular matrix:

The determinant of a matrix is not equal to zero.

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Calculation-

Let's consider the 3 × 3 non-singular matrix that is

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Here three entries are 1 rest are 0

Hence, remaining 1 we can insert in rest 6 places of 0.

The total no of cases formed will be = 6

Since the mattrix is invertible, one more matrix is possible

$$\begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$

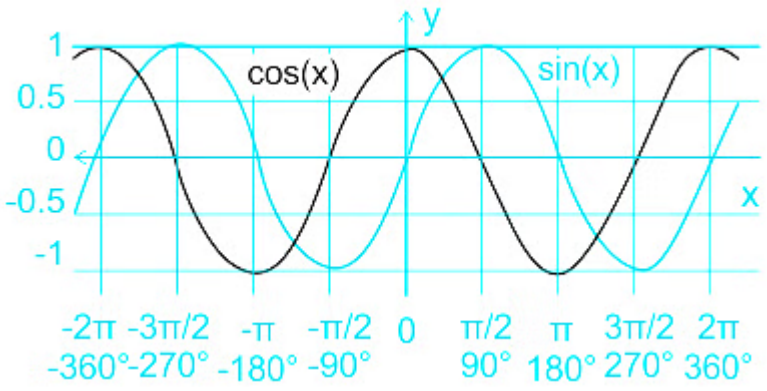
∴ The total no of cases formed will be at least 7.

---

28. Answer: a

Explanation:

Concept:



Calculation:

From the sin cos graph,

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When $0° < \theta < 45°$

$\Rightarrow \cos\theta > \sin\theta$

$\Rightarrow \cos 10° > \sin 10°$

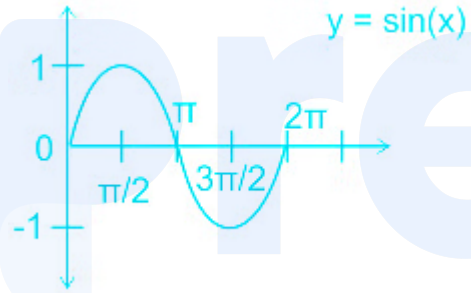
$\therefore$ cos10° - sin10° is always positive.

---

29. Answer: b

Explanation:

Concept-



$\sin\theta$ increases in the interval $0° \le \theta \le 90°$

1 radian = 57.3°

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Calculation-

We know that, $1^\circ = \frac{\pi}{180} radian$

Since 1 radian > 1°

By using the above concept,

sin 57.3° > sin 1°

$\therefore$ sin 1° < sin 1

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30. **Answer: c**

Explanation:

Concept:

sin A sin (60 - A) sin (60 + A) = $\frac{sin3A}{4}$

Calculation:

We have

sin 20° sin 40 ° sin 60 ° sin 80 °

⇒ sin 60°[sin 20° sin 40° sin 80 °]

⇒ sin 60°[sin 20° sin (60° - 20°) sin (60°+20°)

By using the above formula

⇒ $\frac{\sqrt{3}}{2}\left[\frac{sin3(20^\circ)}{4}\right]$

⇒ $\frac{\sqrt{3}}{2}\left[\frac{sin60^\circ}{4}\right]$

⇒ $\frac{\sqrt{3}}{2}\left[\frac{1}{4}\times\frac{\sqrt{3}}{2}\right]$ ($\because$ sin 60° = $\frac{\sqrt{3}}{2}$)

∴ sin 20° sin 40 ° sin 60 ° sin 80 ° = $\frac{3}{16}$

---

31. **Answer: a**

Explanation:

Concept:

$tan\theta = \frac{perpendicular}{hypotenuse}$

Calculation:

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We know that,

$tan\theta = \frac{AB}{AC}$

$\Rightarrow tan\theta = \frac{15}{15} = 1$

$\Rightarrow \theta = 45°$.

∴ The angle of elevation of the top is 45°.

---

32. Answer: c

Explanation:

Concept-

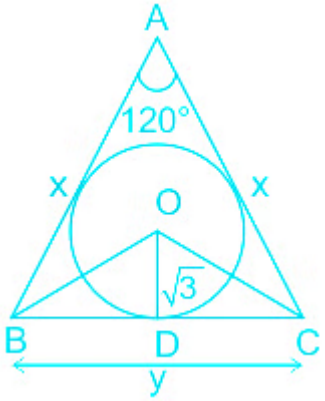
According to the sin rule-

$\frac{a}{sinA} = \frac{b}{sinB} = \frac{c}{sinC}$

Inradius = $\frac{area\ of\ triangle}{semiperimeter}$

Area (Δ) = $\frac{1}{2}$ ab sin C = $\frac{1}{2}$ bc sin A = $\frac{1}{2}$ ca sin B

Calculation-



∠B = ∠C (angle opposite to equal side are equal)

One angle is 120°, therefore

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∠B & ∠C must be equal to 30°

By using the sin rule

$\frac{x}{sin30^\circ} = \frac{y}{sin120^\circ}$

⇒ y = x√3

Now, the area of a triangle

Δ = $\frac{1}{2}$. x. x sin 120°

⇒ Δ = $\frac{\sqrt{3}}{4}$ x^2 ------(1)

Semi-perimeter, $S = \frac{2x+y}{2} = \frac{2x+x\sqrt{3}}{2}$

By using the above formula,

Inradius $r = \frac{\triangle}{s}$

⇒ $\sqrt{3} = \frac{\frac{\sqrt{3}}{4}x^2}{\frac{2x+x\sqrt{3}}{2}}$

⇒ x = 4 + 2√3

Now, from equation (1)

⇒ $\triangle = \frac{\sqrt{3}}{4}(4+2\sqrt{3})^2$

⇒ $\triangle = \frac{\sqrt{3}}{4}(16+12+16\sqrt{3})$

⇒ $\triangle = \frac{4\sqrt{3}}{4}(7+4\sqrt{3})$

⇒ $\triangle = 12+7\sqrt{3}$

∴ the area of the triangle is 12 + 7√ 3.

---

33. Answer: b

Explanation:

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Formula used:

- sin $^2\theta$ + cos $^2\theta$ + 2 sin θcos θ
- 1 + cos 2 θ = 2 cos $^2\theta$
- sin θ / cos θ = tan θ
- 1 + tan $^2\theta$ = sec ^{2}
- (a + b) 2 = a 2 + b 2+ 2ab
- ∫ e x [f(x) + f'(x)] = e xf(x)

Calculation:

$\int \frac{e^x(1+\sin x)}{(1+\cos x)}\text{dx}$

$\Rightarrow \int e^x \left(\frac{sin^2\frac{x}{2}+cos^2\frac{x}{2}+2sin\frac{x}{2}cos\frac{x}{2}}{2cos^2\frac{x}{2}}\right)dx$

$\Rightarrow \int \frac{e^x}{2}\left(\frac{sin\frac{x}{2}+cos\frac{x}{2}}{cos\frac{x}{2}}\right)^2 dx$

$\Rightarrow \int \frac{e^x}{2}\left(\frac{sin\frac{x}{2}}{cos\frac{x}{2}}+\frac{cos\frac{x}{2}}{cos\frac{x}{2}}\right)^2 dx$

$\Rightarrow \int \frac{e^x}{2}\left(1+tan\frac{x}{2}\right)^2 dx$

$\Rightarrow \int \frac{e^x}{2}\left(1+tan^2\frac{x}{2}+2tan\frac{x}{2}\right)dx$

$\Rightarrow \int \frac{e^x}{2}\left(sec^2\frac{x}{2}+2tan\frac{x}{2}\right)dx$

$\Rightarrow \int e^x\left(tan\frac{x}{2}+\frac{sec^2\frac{x}{2}}{2}\right)dx$

If, $f(x) = tan\frac{x}{2}$

then, $f'(x) = \left(\frac{1}{2}\right)sec^2\frac{x}{2}$

We know that,

∫ e ^{x} [(f(x) + f'(x)]dx = e ^{x} f(x)

On integration we get,

$\int \frac{e^x(1+\sin x)}{(1+\cos x)}\text{dx} = e^x tan\frac{x}{2}$

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34. Answer: c

Explanation:

Concept-

- cos (90°- θ) = sin θ
- sin (90 ° - θ) = cos θ
- $\int_0^a f(x)dx = \int_0^a f(a-x)dx$

Calculation-

Let $I = \int_0^{\pi/2} \frac{\sqrt{\cos x}}{\sqrt{(\sin x)}+\sqrt{(\cos x)}}dx$ ----(1)

$I = \int_0^{\pi/2} \frac{\sqrt{\cos(\frac{\pi}{2}-x)}}{\sqrt{(\sin(\frac{\pi}{2}-x))}+\sqrt{(\cos(\frac{\pi}{2}-x))}}dx$

$I = \int_0^{\pi/2} \frac{\sqrt{\sin x}}{\sqrt{(\cos x)}+\sqrt{(\sin x)}}dx$. ---- (2)

Add equations (1) and (2) we get,

$2I = \int_0^{\pi/2} \frac{\sqrt{cosx}+\sqrt{\sin x}}{\sqrt{(\cos x)}+\sqrt{(\sin x)}}dx$

$\Rightarrow 2I = \int_0^{\frac{\pi}{2}} dx$

$\Rightarrow 2I = [x]_0^{\frac{\pi}{2}}$

$\Rightarrow I = \frac{\pi}{4}$

$\therefore \int_0^{\pi/2} \frac{\sqrt{\cos x}}{\sqrt{(\sin x)}+\sqrt{(\cos x)}}dx = \frac{\pi}{4}$

---

35. Answer: a

Explanation:

Concept:

Equation of the form $\frac{dy}{dx} + Py = Q$ solve by following the steps

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1. find I.F = $e^{\int P dx}$
2. The solution will be y I.F = ∫ Q I.F dx + C

Formula used:

1. sin θ/coa θ = tan θ

2. 1/cos θ = sec θ

3. $e^{\ln x} = x$

4. ∫ $\sec^2 x = \tan x$

Calculation:

cos x dy = y (sin x - y) dx

⇒ cos x dy = y $\frac{\sin x}{\cos x}$ - y^2 dx

⇒ $\frac{dy}{dx}$ = y tan x - y^2 sec x

⇒ $\frac{1}{y^2}\frac{dy}{dx} - \frac{1}{y}tanx = -secx$

Now, let y = $\frac{1}{t}$

therefore $\frac{1}{y^2}\frac{dy}{dx} = -\frac{dt}{dx}$

Putting these values we get

$-\frac{dt}{dx} - t\ tanx = -secx$

$\frac{dt}{dx} + t\ tanx = secx$

Now,

I.F = $e^{\int tan\ x\ dx} = e^{log\ sec\ x} = sec\ x$

The solution of the equation will be

⇒ t (I.F) = ∫ (I.F) sec x dx + c

⇒ t (sec x) = ∫ (I.F) sec x dx + c

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⇒ t sec x = $\int$ sec ^{2} x + c

⇒ sec x = (tan x + c)y

∴ The solution of an equation is sec x = (tan x + c)y.

---

36. Answer: a

Explanation:

Concept-

- Combined mean $\bar{x}_{12} = \frac{n_1x_1+n_2x_2}{n_1+n_2}$
- Combined S.D $\sigma_{12} = \sqrt{\frac{n_1(\sigma_1+d_1^2)+n_2(\sigma_2+d_2^2)}{n_1+n_2}}$

Where, $d_1 = \bar{x}_1 - \bar{x}_{12}\ and\ d_2 = \bar{x}_2 - \bar{x}_{12}$

Calculation-

Given that, $\bar{x}_1$ = 80, n $_1$ = 35, σ $_1$ = 4

$\bar{x}_2$ = 70, n $_2$ = 65, σ $_2$ = 3

Now, $\bar{x}_{12} = \frac{35\times80+65\times70}{35+65} = 73.5$

Combined S.D will be

⇒ $\sigma_{12} = \sqrt{\frac{35(16+(80-73.5)^2)+65(9+(70-73.5)^2)}{35+65}}$

⇒ σ $_{12}$ = 5.85.

∴ S.D of the combined sample is 5.85.

---

37. Answer: c

Explanation:

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Concept:

The sum of n natural no is = $\frac{n(n+1)}{2}$

Avergae = (sum of observations) / (total number of observations)

Calculation:

By using the above formula,

The Sum of 99 natural no is

1 + 2 + ...+ 99 = (99×100) / 2 = 4950

The average of 1,2,3,....98,99,x is 100 x.

⇒ $100x = \frac{1+2+3.....+98+99+x}{100}$

⇒ 10000x = 4950 + x

⇒ 9999x = 4950

$\therefore x = \frac{50}{101}$

---

38. Answer: c

Explanation:

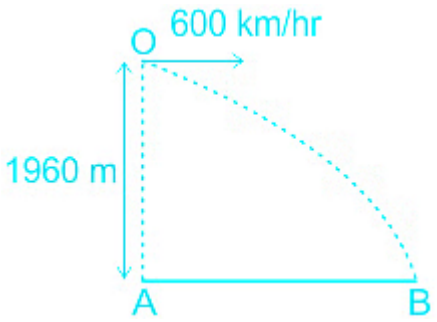
Concept-

By the laws of motion

S = ut + $\frac{1}{2}$ at ^{2}

Calculation-

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velocity of body u_x = 600 km/hr and u_y = 0.

Also g = -9.8m/s, h = 1960m

$h = u_y t + \frac{1}{2} gt^2$

$\Rightarrow t = \sqrt{\frac{2\times1960}{9.8}} = 20s$

Horizontal distance AB will be

$\Rightarrow S_{AB} = u_x t + \frac{1}{2} a_x t^2$

Since, in x horizontal direction $a_x = 0$. Therefore

$\Rightarrow S_{AB} = (600 \times \frac{5}{18})m/s \times 20s$

$\Rightarrow$ AB = 3333.33m

$\Rightarrow$ AB = 3.33 km

∴ The distance AB is 3.33 km

---

39. Answer: c

Explanation:

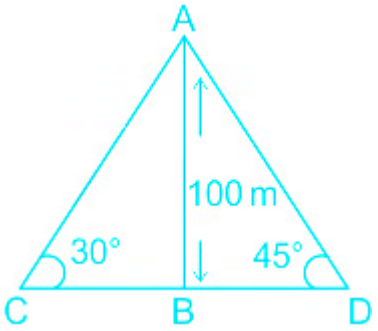
Concept:

- $tan\theta = \frac{perpendicular}{base}$
- $tan30^\circ = \frac{1}{\sqrt{3}}$

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- tan45° = 1

Calculation:



In triangle ABC

$tan\ 30° = \frac{1}{\sqrt{3}} = \frac{100}{CB}$

⇒ CB = 100 $\sqrt{3}$m

Now, in triangle ABD

$tan\ 45° = 1 = \frac{100}{CD}$

⇒ CD = 100 m.

⇒ CD = CB + CD

⇒ CD = 100 ($\sqrt{3}$ + 1) m

⇒ CD = 100 (2.73) m

∴ The distance between the two ships is 273 m.

---

40. Answer: a

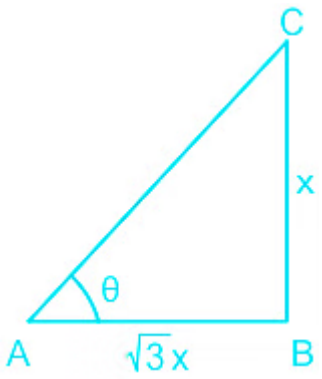
Explanation:

Concept:

tan θ = Perpendicular / Base

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Calculation:



Let the height of the tree & length of the shadow be x & 3x

respectively

tanθ = Perpendicular/base

$\Rightarrow \tan\theta = \frac{BC}{AB}$

$\Rightarrow \tan\theta = \frac{1}{\sqrt{3}}$

$\Rightarrow \theta = 30^\circ$

∴ The angle of elevation of the sun is 30°

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41. Answer: b

Explanation:

Concept:

- Distance = Speed × Time
- Perimeter of rectangle = 2(Length + Breadth)
- Area of rectangle = length × breadth
- 1 km = 1000 m
- 1 hour = 60 minutes

Explanation:

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According to the question,

A man cycling along the boundary of the park at the speed of 12 km/hr (12 km/hr = $\frac{12000}{60}$ m/minutes) completes one round in 8 minutes

i.e. Perimeter = Distance Travelled in 8 minutes

⇒ Perimeter = $\frac{12000}{60} \times 8$ (As Distance = Speed × Time)

⇒ Perimeter = 1600 m

Now According to the question,

We know,

The ratio between the length and the breadth of a rectangular park is 3 : 2

Let Length = 3x and Breadth = 2x.

Now,

Perimeter of rectangle = 2(Length + Breadth)

So, Perimeter = 2(3x + 2x)

⇒ Perimeter = 2 × 5x

⇒ 1600 = 10x

⇒ x = 160

So, Length = 3x = 3 × 160 = 480 m

Breadth = 2x = 2 × 160 = 320 m

Therefore,

Area of rectangle = length × breadth

⇒ Area = 480 × 320 m^2

⇒ Area = 153600 m 2

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42. **Answer: b**

Explanation:

Calculation:

We are given (935421 × 625) i.e.

(935421 × 625) = (935421 × 5^4) (As 625 = 5^4)

⇒ (935421 × 625) = $(935421 \times (\frac{10}{2})^4)$ (As $5 = \frac{10}{2}$)

⇒ (935421 × 625) = $\frac{(935421 \times 10^4)}{2^4}$

⇒ (935421 × 625) = $\frac{9354210000}{16}$

⇒ (935421 × 625) = **584638125**

By Simple Mathematical Calculation,

⭐ Alternate Method

935421 × 625 = **584638125**

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43. **Answer: b**

Explanation:

Concept:

Distance formula between the points (x 1 , y 1 , z 1) and (x 2, y 2, z 2) is =

$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}$

Explanation:

We have to find the distance between the point P (2m, 3m, 4m) and the x-axis.

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Now,

The General point in the x-axis can be represented as (x, 0, 0) (As the point is in x-axis, its y and z

coordinates will be 0)

⇒ We have to find the distance between the point P (2m, 3m, 4m) and (2m, 0, 0).

Thus,

Distance between the point P (2m, 3m, 4m) and the x-axis =

Distance between the point P (2m, 3m, 4m) and the (2m, 0, 0) =

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

$\Rightarrow \sqrt{9m^2+16m^2}$

$\Rightarrow \sqrt{25m^2}$

⇒ 5m

---

44. Answer: a

Explanation:

Concept:

Sum of the n terms in an A.P. = $\frac{n}{2}(2a+(n-1)d)$

Where n = Number of terms,

a = First Term,

d = Common Difference.

Explanation:

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We have to find the sum of 40 terms of an A.P. whose first term is 2 and common difference 4

i.e.

n = 40, a = 2 and d = 4

Thus,

Sum = $\frac{40}{2}(2(2) + (40 - 1)(4))$

⇒ Sum = 20 × (4 + (39 × 4))

⇒ Sum = 20 × (160)

⇒ Sum = 3200

---

45. Answer: c

Explanation:

Concept:

Arithmetic Progression: Sequence where the differences between every two consecutive terms are the same.

For example:- a, a + d, a + 2d, ... are in AP.

Four terms that are in AP can be taken as

a - 3d, a - d, a + d, a + 3d

Harmonic mean (HM): If a, b & c are in HP then,

1/a, 1/b, 1/c are in harmonic progression (AP).

Calculation:

Given that, a, b, c, d are in H.P. then

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$\frac{1}{a}, \frac{1}{b}, \frac{1}{c}, \frac{1}{d}$ are in A.P

Let these terms be (x - 3y), (x - y), (x + y), (x + 3y)

Hence,

$\left(\frac{1}{a^2} - \frac{1}{d^2}\right)\left(\frac{1}{b^2} - \frac{1}{c^2}\right)^{-1}$

Since, $p^2 - q^2 = (p + q)(p - q)$

$\Rightarrow \left(\left(\frac{1}{a} - \frac{1}{d}\right)\left(\frac{1}{a} + \frac{1}{d}\right)\right)\left(\left(\frac{1}{b} - \frac{1}{c}\right)\left(\frac{1}{b} - \frac{1}{c}\right)^{-1}\right.$

$\Rightarrow \frac{[(x-3y)-(x+3y)][(x-3y)+(x+3y)]}{[(x-y)-(x+y)][(x-y)+(x+y)]}$

$\Rightarrow \frac{-6y \times 2x}{-2y \times 2x} = 3$

$\Rightarrow \left(\frac{1}{a^2} - \frac{1}{d^2}\right)\left(\frac{1}{b^2} - \frac{1}{c^2}\right)^{-1} = 3$

---

46. Answer: b

Explanation:

CONCEPT:

Arithmetic progression:

The Standard form of an arithmetic progression (AP) is given by: a, a+ d, a + 2d, a + 3d ..... so on.

⇒ The nth term of an AP series is T n = a+ (n - 1) d,

⇒ Sum of n terms of an A.P is S n = n/2 [2a + (n - 1) d]

'a'= first term and

'd'= common difference.

CALCULATION:

Given that: a 1 = a 2 = a 3 = ... = a 10 = 150 and a 10 , a 11 , a 12 , ... are in AP.

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So, the person counts 1500 notes in 10 minutes. The remaining notes which he need to count are

⇒ 4500 – 1500 = 3000

It is given that a 11 , a 12 , a 13 are in AP with a common difference of -2.

Hence, a 10 = 150, a 11 = 148, a 12 = 146, a 13 = 144 ... and so on.

So, the sum of all the notes must be 3000.

Hence, s n = 3000, a = 148 (as he already counted 1500 notes in 10 minutes, so we need to start from

a 11 = 148, d = -2

$\Rightarrow s_n = \frac{n}{2}[(2a + (n-1)d]$

$\Rightarrow 3000 = \frac{n}{2}[(2 \times 148) + (n-1)(-2)]$

$\Rightarrow 3000 = \frac{n}{2}[296 + 2 - 2n]$

⇒ 3000 = n (149 – n)

⇒ 3000 = 149n – n 2

⇒ n 2 – 149n + 3000 = 0

⇒ n 2 – 125n – 24n + 3000 = 0

⇒ n (n – 125) – 24(n – 125) = 0

⇒ (n – 24) (n – 125) = 0

⇒ n = 24, 125

So, the time taken by the person to count 3000 notes is 24 minutes.

Now, the count will take place until a 35 term because the count of 3000 notes started from a 11 but not a 1.

Hence, the total time required to count 4500 notes = 10 + 24 = 34 minutes

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47. **Answer: b**

Explanation:

Concept:

- if α ,β ,γ are the roots of a cubic equation, then Cubic equation is written as: $x^3 - (\alpha + \beta + \gamma)x^2 + (\alpha\beta + \beta\gamma + \alpha\gamma)x - \alpha\beta\gamma = 0$.
- If the cubic equation is of the form $ax^3 + bx^2 + cx + d = 0$ and α , β and γ are its roots, then:

i) $\alpha + \beta + \gamma = -\frac{b}{a}$ .....(1)

ii) $\alpha\beta + \beta\gamma + \gamma\alpha = \frac{c}{a}$ .....(2)

iii) $\alpha\beta\gamma = -\frac{d}{a}$ .....(3)

Explanation:

We are given that 2 and 3 are the roots of the equation $2x^3 + mx^2 - 13x + n = 0$

Let δ be the third root.

Using (1),

$2 + 3 + \delta = -\frac{m}{2}$

$\Rightarrow 5 + \delta = -\frac{m}{2}$ .....(4)

Using (2),

$(2)(3) + 3\delta + 2\delta = \frac{-13}{2}$

$\Rightarrow 6 + 5\delta = \frac{-13}{2}$

$\Rightarrow \delta = -\frac{5}{2}$

Using (3),

$2 \times 3 \times \delta = -\frac{n}{2}$

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$\Rightarrow 2 \times 3 \times -\frac{5}{2} = -\frac{n}{2}$

$\Rightarrow$ n = 30

And Using (4),

$5 + (-\frac{5}{2}) = -\frac{m}{2}$

$\Rightarrow$ m = -5

Thus, **m = -5 and n = 30** .

---

48. Answer: c

Explanation:

<u>Concept:</u>

- Number of terms in the expansion of $(x_1 + x_2 + x_3 + ... + x_r)^n$ is = $^{n+r-1}C_n$, Where n = exponent of the term to be expanded, r = number of terms to be expanded
- $^nC_r = \frac{n!}{(n-r)!\,r!}$

<u>Explanation:</u>

Number of terms in (x + y + z) 10 = $^{10+3-1}C_{10}$ (Since, n = 10 and r = 3)

$\Rightarrow$ $^{12}C_{10}$

Since, $^{12}C_{10} = \frac{12!}{(12-10)!\,10!}$

$\Rightarrow ^{12}C_{10} = 66$

---

49. Answer: b

Explanation:

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Concept:

Coefficients of x ^{m} in $(a+b)^n$ is = ${}^nC_m(a)^{n-m}(b)^m$

Calculation:

We are given that the coefficients of x 7 and x 8 in $(2+\frac{x}{3})^n$ are equal

i.e.

Coefficients of x ^{7} in $(2+\frac{x}{3})^n$ is = ${}^nC_7(2)^{n-7}(\frac{1}{3})^7$

Coefficients of x ^{8} in $(2+\frac{x}{3})^n$ is = ${}^nC_8(2)^{n-8}(\frac{1}{3})^8$

$\Rightarrow {}^nC_7(2)^{n-7}(\frac{1}{3})^7 = {}^nC_8(2)^{n-8}(\frac{1}{3})^8$ (Since, the coefficients of x 7 and x 8 are equal)

$\Rightarrow \frac{{}^nC_8}{{}^nC_7} = \frac{2^{n-7}(\frac{1}{3})^7}{2^{n-8}(\frac{1}{3})^8}$

$\Rightarrow \frac{{}^nC_8}{{}^nC_7} = 2^{n-7-(n-8)}(\frac{1}{3})^{7-8}$

$\Rightarrow \frac{{}^nC_8}{{}^nC_7} = 2^1 \times (\frac{1}{3})^{-1}$

$\Rightarrow \frac{{}^nC_8}{{}^nC_7} = 2 \times 3$ (Since, $(\frac{1}{a})^{-1} = a$)

$\Rightarrow \frac{{}^nC_8}{{}^nC_7} = 6$

$\Rightarrow \frac{\frac{n!}{(n-8)!\,8!}}{\frac{n!}{(n-7)!\,7!}} = 6$

$\Rightarrow \frac{n!}{(n-8)!\,8!} \times \frac{(n-7)!\,7!}{n!} = 6$

$\Rightarrow \frac{(n-7)!\,7!}{(n-8)!\,8!} = 6$

$\Rightarrow \frac{(n-7)\,(n-8)!\,7!}{(n-8)! \times 8 \times 7!} = 6$

$\Rightarrow \frac{n-7}{8} = 6$

⇒ n - 7 = 48

⇒ n = 55

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50. **Answer: c**

Explanation:

Concept:

- If X = $\begin{vmatrix} w & x \\ y & z \end{vmatrix}$ then, |X| = $n \begin{vmatrix} \frac{w}{n} & \frac{x}{n} \\ \frac{y}{n} & \frac{z}{n} \end{vmatrix}$

Explanation:

Consider a third-order matrix, A = $\begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix}$

Now, the determinant of A,

|A| = $\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix}$

Now, if each element is multiplied by 3, then we get another matrix B as

|B| = $\begin{vmatrix} 3a & 3b & 3c \\ 3d & 3e & 3f \\ 3g & 3h & 3i \end{vmatrix}$

|B| = 3 × $\begin{vmatrix} a & 3b & 3c \\ d & 3e & 3f \\ g & 3h & 3i \end{vmatrix}$ (Taking 3 common from First column)

|B| = 3 × 3 × $\begin{vmatrix} a & b & 3c \\ d & e & 3f \\ g & h & 3i \end{vmatrix}$ (Taking 3 common from Second column)

|B| = 3 × 3 × 3 × $\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix}$ (Taking 3 common from Third column)

|B| = 27 × |A|

Thus,

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If each element of a determinant of third order with value A is multiplied by 3, then the value of the newly formed determinant is = 27|A|.

⭐ Alternate Method

If a number n is multiplied to the determinant of the matrix, then it gets multiplied by each entity of the matrix.

Thus,

If each element of a determinant of third order with value A is multiplied by 3, then the value of the newly formed determinant is = 3 × 3 × 3 × A .

⇒ 27|A|

---

51. Answer: a

Explanation:

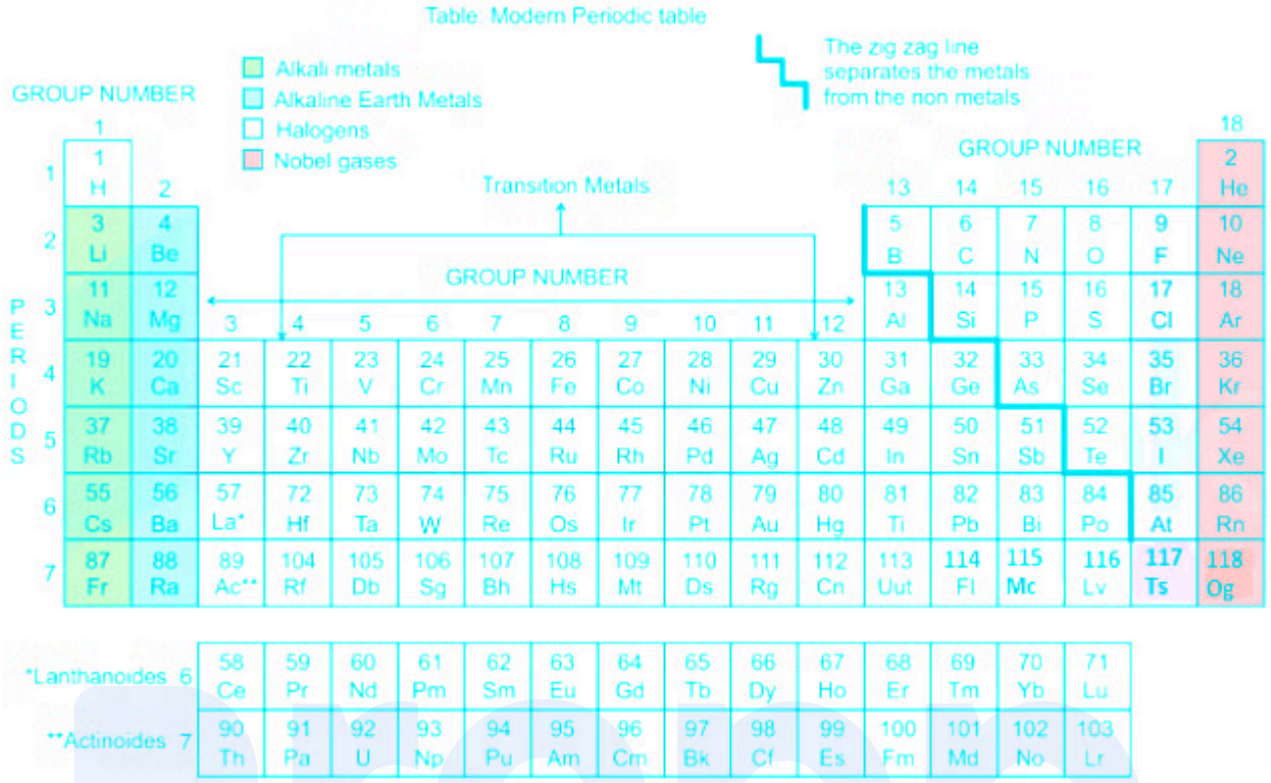
The number of elements in the 5th period of the periodic table is 18 .

⭐ Key Points

- The horizontal rows of the periodic table are called periods.
  - The elements in the periodic table are arranged in rows.
  - Elements of the same period have the same number of electron orbitals .
- Group -
  - There are 18 vertical columns in the periodic table.
  - All elements in a group have similar chemical and physical properties.
  - Because they have the same number of outer electrons.

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52. **Answer: b**

Explanation:

Concept:

The trends followed in the modern periodic table is:

Across Period:

- Atomic radius decreases in moving from left to right along a period.
- This is due to an increase in nuclear charge which tends to pull the electrons closer to the nucleus and reduces the size of the atom.

Down the Group:

- Atomic size increases down the group. This is because new shells are being added as we go down the group.
- This results in an increase in atomic radius down the group.

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Explanation:

Moving from left to right, the atomic radius decreases. So,

The radius of O < Radius of C

Moving from top to bottom, the atomic radius increases. Hence, The

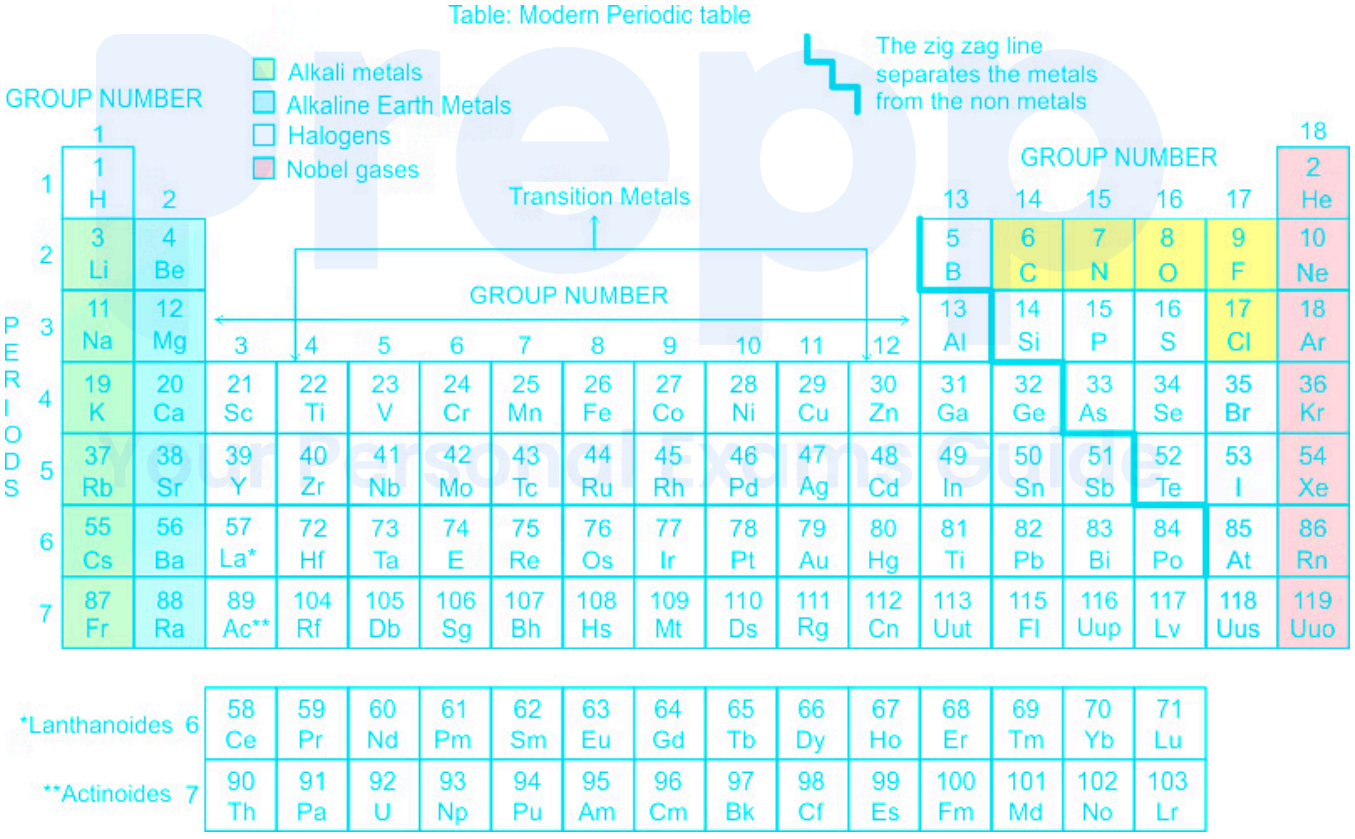
the correct order of increasing atomic radius is

O < C < S < Se

Additional Information

The modern periodic table is shown:

Table: Modern Periodic table



53. **Answer: a**

Explanation:

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Concept:

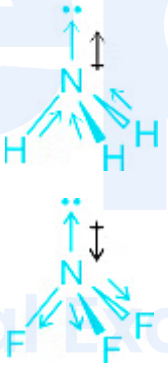
Dipole moment:

- The polarity or ionic character of a covalent bond is considered in terms of its dipole moment.
- The dipole moment of a bond (μ) of a bond is defined as the product of the magnitude of charge (q) at one pole and the distance (r) between the centers of positive and negative charges .

$\mu = q \times r$

- SI unit of dipole moment is Coulomb metre (Cm) .
- The dipole moment is often expressed in Debyeunits (D) .
- 1 D= 3.33564×10 -19 Cm

Explanation:



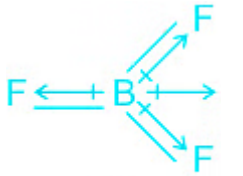
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- in the case of NH_3, the orbital dipole due to the lone pair is in the same direction as the resultant dipole moment of the N - H bonds.
- In NF_3 the orbital dipole is in the direction opposite to the resultant dipole moment of the three N - F bonds.
- The orbital dipole because of the lone pair decreases the effect of the resultant N - F bond moments, which results in the low dipole moment of NF_3

★ Additional Information

BF_3:

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(a)



(b)

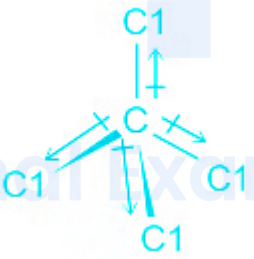
- The dipole moment is not zero in BF 3.
- The dipole moment, in this case, is zero although the B—F bonds are oriented at an angle of 120° to one another.

CO_2:



- CO 2 is a linear molecule, so the resultant dipole moment is zero.

CCl 4:



- The direction of bond polarity of the C-Cl bond is from carbon to chlorine .
- The net dipole moment between three C-Cl bond acts downwards .
- The fourth dipole moment acts upwards.
- The molecular geometry is such that all the individual bond moments cancel out and makes the nonpolar.

---

54. Answer: b

Explanation:

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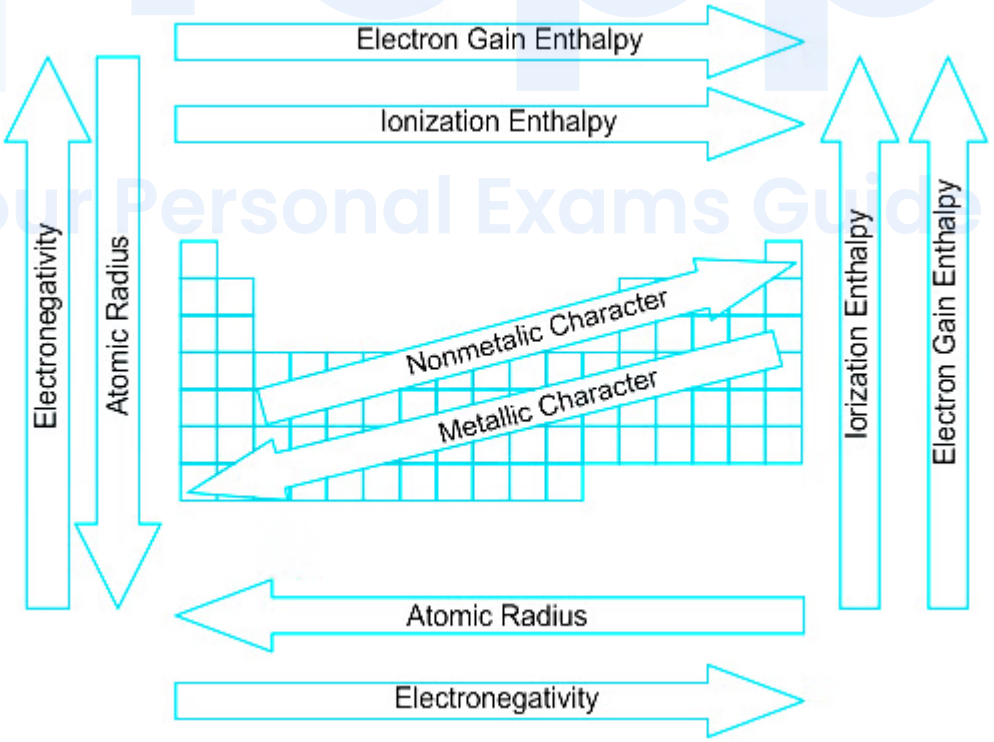
Concept:

Ionic radius:

- It corresponds to the radius of an ion in an ionic crystal.
- It is defined as the effective distance from the center of the nucleus of an ion up to which it has an influence on its electron charge cloud.
- Cation with a more positive charge has less ionic radii because of more nuclear charge.
- Anion with more charge negative charge has more ionic radii because of lesser nuclear charge.

Trends in ionic radii:

- Generally, the ionic radius decrease when we move from left to right across a periodic table . this is due to the increase in nuclear charge as we move across a period.
- The ionic radii increase as we move down the period because electrons get added to an extra outermost shell.



- The more the charge on a cation , the lesser is its ionic radii.

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- The more the charge on an anion , the higher the ionic radii.

Explanation:

- We know that ionic radii increase as we move down the period. Therefore order of radius will be like $F^- < Cl^- < Br^-$
- Since, the ionic radius decrease when we move from left to right across, therefore, the radius of F^- is less than H^-.
- **Hence, F^- will have the smallest radius.**

---

55. Answer: b

Explanation:

Concept:

Boiling Point:

- The temperature at which a liquid boils and turns into a vapor state is known as the boiling point of the liquid.
- The boiling points, in general, increase from top to bottom in the group, i.e. with an increase in their molecular weight.

Hydrogen bond:

- The attractive force binds the hydrogen atom of one molecule with the electronegative atom (F, O or N) of another molecule.
- A hydrogen bond is weaker than a covalent bond.
- The melting and boiling temperatures of compounds with hydrogen bonds are unusually high.
- This is because more energy is required to break hydrogen bonds.

Explanation:

By using the above concept, we can conclude that,

- The order of boiling point will be like HF < HCl < HBr < HI.

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- Since there is hydrogen boing in the HF molecule. Therefore, the boiling point of HF will be high.
- Hence, **HCl** compound will have the lowest boiling point.

---

56. Answer: c

Explanation:

Solid NaCl is a bad conductor of electricity because solid **NaCl there are no ions to move** .

⭐ Key Points

Electrical conductivity:

- Conductivity is the measure of the ease at which an electric charge or heat can pass through a material.
- Electrical conductivity tells us how well a material will allow electricity to travel through it.
- Since the substance can only conduct electricity if it contains charged particles.
- In **solid sodium chloride** , there are ions but these **ions are locked** into the ionic lattice and are unable to move.

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57. Answer: c

Explanation:

Concept:

The ideal gas equation can be written as,

PV = nRT

Here, P = pressure of the ideal gas,

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V = Volume of the ideal gas,

R = universal gas constant.

n = amount of gas in moles.

T = Temperature.

A number of moles = Given mass / Molar mass

Calculation:

We know that

PV = nRT

Since gases are taken at the identical condition

$V_{O_2} : V_{H_2} : V_{CH_4} = n_{O_2} : n_{H_2} : n_{CH_4}$

Since,

Number of moles = Given mass / Molar mass

$\Rightarrow n_{O_2} : n_{H_2} : n_{CH_4} = \frac{w}{16+16} : \frac{w}{1+1} : \frac{w}{12+1+1+1+1}$

$\Rightarrow n_{O_2} : n_{H_2} : n_{CH_4} = \frac{w}{32} : \frac{w}{2} : \frac{w}{16}$

$\Rightarrow V_{O_2} : V_{H_2} : V_{CH_4} = \frac{1}{32} : \frac{1}{2} : \frac{1}{16}$

$\therefore V_{O_2} : V_{H_2} : V_{CH_4} = 1 : 16 : 2$

---

58. Answer: c

Explanation:

C 6 H 5 -CO-CH 3 is known as **Acetophenone.**

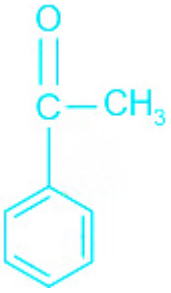
⭐ **Key Points**

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Acetophenone:

- Acetophenone is the organic compound with the formula C 6 H 5 -CO-CH 3.
- It is an organic compound used as an ingredient in perfumes.
- It also has been used as a drug to induce sleep.
- The structure of the a cetophenone is given below



⭐ **Additional Information**

- The chemical formula of acetic acid is CH_3COOH.
- The chemical formula of acetone is CH 3COCH $_3$.
- The chemical formula of Phenyl acetate is $C_8H_8O_2$.

---

59. Answer: b

Explanation:

Concept:

Molar mass: It is the mass in grams of one mole of the compound.

Molar mass = Mass of substance / number of moles of substance

Calculation:

Let oxide be with one nitrogen atom given is NO_x

Molar mass = 14 + 16 × (x)

According to the question,

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N in the NO_x is 30.4 %

$\Rightarrow \frac{14}{14+16x} = \frac{30.4}{100}$

$\Rightarrow 14 \times 100 = 30.4\ (14 + 16x)$

$\Rightarrow 1400 = 425.6 + 486.4x$

$\Rightarrow 486.4x = 974.4$

$\Rightarrow$ **x = 2**

Therfore the compound is **NO_2**

Molar mass = $14 + 16 \times 2 = 46$

Molar mass of oxygon (O_2) = 16 + 16 = 32

Relative density = 46/32 = 1.4345

∴ The density of the oxide relative to oxygen is 1.44.

---

60. Answer: b

Explanation:

<u>Concept:</u>

1. Grams = moles × atomic weight
2. Atomic weight = number of neutrons + number of protons
3. Atomic weight of sodium atom is 23.

<u>Calculation:</u>

Given that,

There is a 1 mole of sodium atoms. Therefore,

By using the above concept

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Grams = 1 mole × atomic weight

Since, atomic weight = 23

Therefore,

Grams = 1 mole × 23 = 23 grams

∴ 23 grams are contained in 1 mole of sodium atom.

---

61. Answer: a

Explanation:

Concept:

The ideal gas equation can be written as,

PV = nRT

Here, P = pressure of the ideal gas,

V = Volume of the ideal gas,

R = universal gas constant.

n = amount of gas in moles.

T = Temperature.

Calculation:

From the above concept, we know that,

PV = nRT

For close vessel, volume is constant & there will be no change in the number of moles of the gas. Hence, V & n are constant.

⇒ P ∝ T

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When the temperature is doubled, the pressure is also doubled

The number of moles remains constant.

∴ **The number of moles of the gas will be 5.**

---

62. Answer: a

Explanation:

The correct answer is **2.16 g**.

⭐ **Key Points**

- The **formula of silver carbonate** is **Ag_2CO_3**.
- **Molecular weight of** Ag_2CO_3 = 2 × 108 + 12 + 3 × 16 = **276g.**
- **Reaction involved** :
  - $Ag_2CO_3(s) \xrightarrow{heat} 2Ag(s) + CO_2(g) + \frac{1}{2}O_2(g)$.
- **Molecular weight of Ag** =2×108 = 216 g.
- This means **276 g of** Ag_2CO_3 yields **216 g of Ag** .
- So, the amount of silver produced by 1 gram of Ag_2CO_3= $\frac{216}{276}$.

Similarly,
The amount of **silver produced by 2.76 grams** of Ag_2CO_3= $\frac{216}{276} \times 2.76 = 2.16g$

- **Hence the correct answer is option 1.**

---

63. Answer: b

Explanation:

The correct answer is **option 2**.

⭐ **Key Points**

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- **Given Reaction:**
  - A + 2B → C.
  - This means 1 mole of A reacts with 2 moles of B to produce 1 mole of C.
  - No. of moles of B that react with 1 mole of A = 2.
- According to question,
  - No. of moles of B present = 8.
  - Therefore, 8 moles of B will react with **4 moles of A** to form **4 moles of C.**
  - **1 mole of A will remain unreacted** after the consumption of 8 moles of B as **B is the limiting reagent** in the reaction.

Hence 5 moles of A and 8 moles of B will produce 4 moles of C.

⭐ Important Points

- There must be at least two reactants for a reaction to take place.
- Sometimes reactions are carried out with amounts of reactants that are different than the amounts as required by a balanced chemical reaction.
- In such situations, one reactant is in a greater amount than the amount required by a balanced chemical reaction.
- The reactant which is present in the least amount gets consumed after some time and after that further reaction does not take place whatever be the amount of the other reactant.
- Hence, the reactant, which gets consumed first, limits the amount of product formed called the limiting reagent.

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64. Answer: a

Explanation:

The correct answer is **18 hours**.

⭐ Key Points

Given Reaction:

- $2H_2O \rightarrow 2H_2 + 2O$.

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- **Molecular mass** of H 2 O = 2 × 1 + 16 = 18g.
- $No.of Moles = \frac{Molecular\ Mass}{Given\ Mass} = \frac{18\ gram}{18\ gram/mole} = 1.$
- Therefore, one mole of water is used in the electrolytic reaction.

Calculation:

- **Q = nF,** where n = Number of electrons involved and F = Faraday Constant
  - **F** = 96500 C mol $^{-1}$
  - **n** = 2, as one mole of water needs two electrons to decompose into two hydrogens and one oxygen molecule.

$\Rightarrow Q = 2 \times 96500 = 193000C.$

$\Rightarrow Q = It = 193000\ C.$

$\Rightarrow Time\ Required,\ t = \frac{193000\ C}{3\ Csec^{-1} \times 3600\ Sec} = 17.87\ Hrs.$

Hence time required to decompose electrolytically 18 g of H $_2$O is approximately 18 hours.

---

65. Answer: c

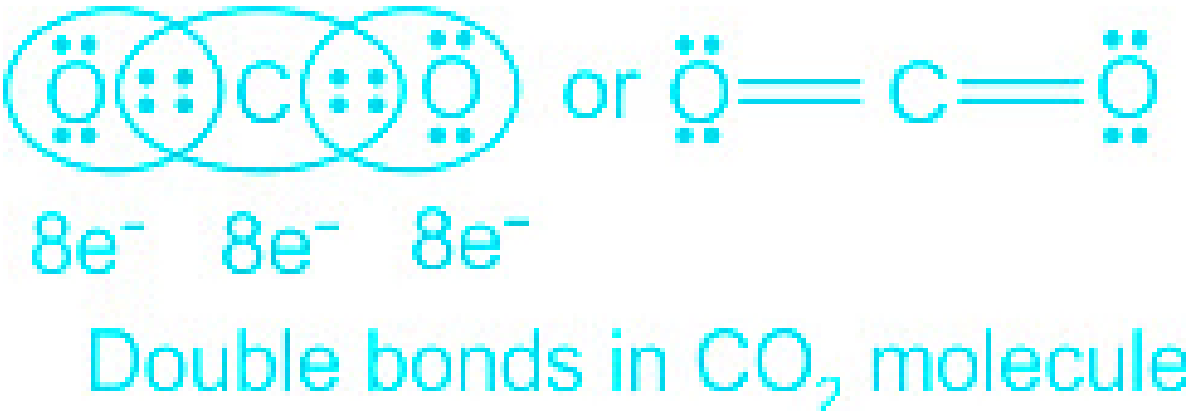
Explanation:

The correct answer is **3**.

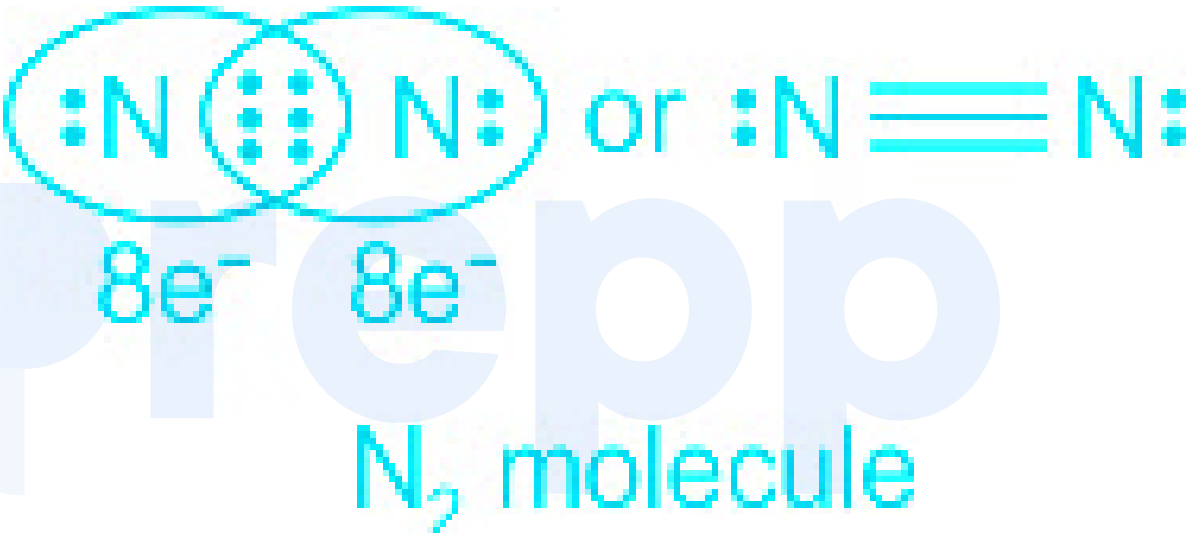
⭐ **Key Points**

- When two atoms share one electron pair they are said to be joined by a **single covalent bond.**
- If two atoms share two pairs of electrons, the covalent bond between them is called a **double bond** .
  - **For example,** in the carbon dioxide molecule, we have two double bonds between the carbon and oxygen atoms.

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- When combining atoms share three electron pairs as in the case of two **nitrogen atoms in the N $_2$molecule** , a **triple bond is formed.**



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⭐ Important Points

- In many compounds, we have multiple bonds between atoms. The formation of **multiple bonds** envisages sharing of **more than one electron pair between two atoms** .

---

66. **Answer: d**

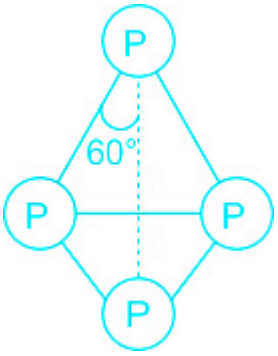
Explanation:

The correct answer is**P4**.

⭐ Key Points

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- Phosphorus is found in many allotropic forms, the important ones being white, red, and black.
- **The molecular formula of phosphorous is P 4.**



⭐ Important Points

White phosphorus

- It is a translucent white waxy solid.
- It is poisonous, insoluble in water but soluble in carbon disulphide, and glows in dark (chemiluminescence).
- It dissolves in boiling NaOH solution in an inert atmosphere giving PH_3.
- It is less stable and therefore, more reactive than the other solid phases under normal conditions.
- It readily catches fire in the air to give dense white fumes of P_4O_{10}.

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Red phosphorus

- It is obtained by heating white phosphorus at 573K in an inert atmosphere for several days.
- When red phosphorus is heated under high pressure, a series of phases of black phosphorus is formed.
- Red phosphorus possesses iron grey lustre.
- It is odourless, nonpoisonous and insoluble in water as well as in carbon disulphide.

Black phosphorus

- It has two forms α-black phosphorus and β-black phosphorus.

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- α-Black phosphorus is formed when red phosphorus is heated in a sealed tube at 803K.
- It can be sublimed in air and has opaque monoclinic or rhombohedral crystals. It does not oxidise in air.
- β-Black phosphorus is prepared by heating white phosphorus at 473 K under high pressure.

---

67. **Answer: c**

Explanation:

The correct answer is **14**.

⭐ **Key Points**

- **A group or a series of organic compounds each containing a characteristic functional group** forms a homologous series and the members of the series are called homologues.
- The members of a homologous series can be represented by general molecular formula and the **successive members differ from each other in molecular formula by a $-CH_2$ unit i.e. 14.**

⭐ **Important Points**

- **Homologous series of Alkanes with molecular mass:**
  - Ethane (C_2H_6) - $2 \times 12 + 6 \times 1 = 30g$.
  - Propane (C_3H_8) - $3 \times 12 + 8 \times 1 = 44g$.
  - Butane (C_4H_{10}) - $4 \times 12 + 10 \times 1 = 58g$.
- **Homologous series of Alkenes with molecular mass:**
  - Ethene ($C\ 2H_4$) - $2 \times 12 + 4 \times 1 = 28g$.
  - Propene ($C\ 3H_6$) - $3 \times 12 + 6 \times 1 = 42g$.
  - Butene ($C\ 4H_8$) - $4 \times 12 + 8 \times 1 = 56g$.

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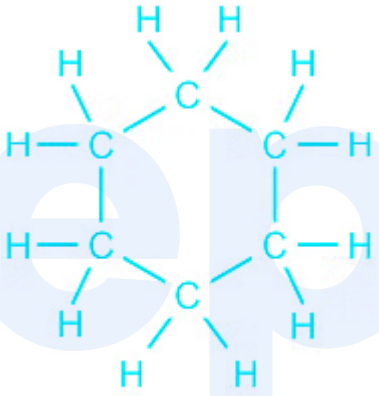
68. **Answer: c**

Explanation:

The correct answer is 18.

⭐ Key Points

- **Cyclohexane** is made up of **6 C-C sigma bonds** and **12 C-H sigma bonds** configured in a strain-free six-membered ring. **Hence a total of 18 sigma bonds are present in it.**



Cyclohexane

- Cyclohexane **appears as a clear colorless liquid** with a petroleum-like odor.

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⭐ Important Points

- **It is used to make nylon, as a solvent, paint remover** , and to make other chemicals.
- It has a role as a non-polar solvent. It is a cycloalkane and a volatile organic compound.

---

69. **Answer: b**

Explanation:

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Concept:

Basicity of a compound-

- It is the ability of a compound to donate its pair of electrons.

The basicity of a compound depends on the-

- The less electronegative element has greater basicity due to the low attraction of electrons.
- The compound having a negative charge will have a greater ability to donate electrons and higher will be the basicity.
- Compounds with positive charges will not be willing to give up electrons and will be the least basic.
- Molecules, where the electron pair is delocalized by resonance, will be less basic.
- Compounds, where more than one donor centres are present, will be highly basic.

Explanation:

- In decreasing order of basicity is $LiCH_3 > LiNH_2 > LiOH > LiF$.
- The ions, F^-, OH^-, NH_2^- and CH_3^- are stable ions compared to their conjugate acid.

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70. **Answer: d**

Explanation:

Concept:

- Strong acids completely dissociate into ions in solution.
- The relative strength of an acid can be predicted based on its chemical structure.
- In general, an acid is stronger when the H–A bond is more polar. Acidity is also greater when the H–A bond is weaker and when the conjugate base, A⊠, is

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more stable

Explanation:

- CH_3Cl is the strongest acid.
- The strength of acidity of a compound is determined by its ease of donating its hydrogen ion. The easier it is to donate its hydrogen ion the stronger the acid is.
- **Hence the correct answer is CH_3Cl**

---

71. Answer: b

Explanation:

Concept:

- Strong acids completely dissociate into ions in solution.
- For example, hydrochloric acid is a strong acid.
- The relative strength of an acid can be predicted based on its chemical structure.
- In general, an acid is stronger when the H–A bond is more polar. Acidity is also greater when the H–A bond is weaker and when the conjugate base, A , is more stable

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Explanation:

- Acidity ∝ Electronegativity
- We know that going from left to right in the period of electronegativity increases
- So the increasing order of acidic strength is
- **$CH_3- CH_3 < CH_3- NH_2 < CH_3OH$**
- **Hence option 2 is the correct answer**

---

72. Answer: c

Explanation:

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Concept:

Electropositive element-

- The electropositive elements are the elements which lose its electron and attain positively charged cations.
- The electropositivity is generally shown by the Alkali and Alkaline earth metals.

The periodic trend of Electropositive elements-

- Electropositivity is known to increase down groups and decrease across periods in the modern periodic table
- Electropositivity decreases from left to right and it increases from up to down

Explanation:

- The most electropositive element is Caesium.
- The atomic number of Caesium is 55.
- The electronic configuration of the Caesium is [Xe] $6S^1$

Hence the correct answer is option 3

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73. **Answer: c**

Explanation:

The correct answer is 6.

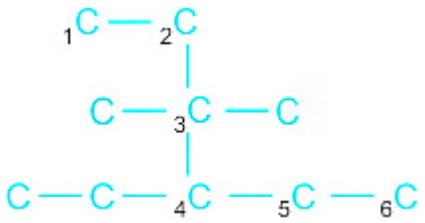
Concept:

According to the rules of nomenclature,

The longest chain should be considered the main chain. irrespective of the position of the carbon.

Explanation

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- The longest chain containing the functional groups has 6 carbon atoms; hence the parent hydrocarbon is hexane.
- **Hence the total number of the carbon present in the given compound is six**

---

74. Answer: b

Explanation:

Concept:

- The central metal atom is linked to ligands by the donation of pairs of electrons by ligands to the central metal atom.
- In coordination complexes, the cations with higher oxidation states result in the formation of more stable complexes with common ligands like ammonia or water.
- Moreover, with a decrease in the size of the metal cation, the stability of these metal complexes increases.
- The stability of a coordination complex increases with an increase in charge density. More is the charge density on the metal ion, the more strongly will the ligand be attached to the central metal ion and thus resulting in increased stability.

Explanation:

- The oxidation state of the CN ion is +3 in $[Fe(CN)_6]^{3-}$
- There the CN ion is the most stable ion
- **The correct answer is option 2**

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75. **Answer: b**

Explanation:

Concept:

- **Pi-bond:** π bonds are simply the second bond made in a double bond.
- Any pure double bond is one σ and one π bond.

Explanation:

- To count pi electrons, you must consider the number of double bonds and the number of lone pairs in the molecule's ring.
- Each double bond has 2 pi electrons.
- Count how many double bonds there are and then multiply that number by 2.
- The product is the number of pi electrons in the molecule's double bonds
- In this provided figure we have three double bonds and each Pi bond is consist of two-electron.
- **Hence the total π electron is 6**

---

76. **Answer: d**

Explanation:

The correct answer is "terminated"

⭐ Key Points

- Let's look at the meaning of the word, given in the question:
  - Commissioned - order or authorize the production of (something).
- Look at the example:
  - The machine was commissioned by his inventor n 1666.
- Look at the meaning of the selected word:
  - **Terminated(past form of terminate)** - bring to an end.
- Look at the example:

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- His contract was terminated last month.
- You can see that **"terminated"** and **"commissioned"** have opposite meanings.

Hence, the correct answer:*terminated*

⭐ **Additional Information**

- Let's look at the meanings of other options:
  - finished- ended(something)
  - **Closed-** not open.

⭐ **Confusion Points**

- Look at the difference between terminated and finish
  - **"terminate"** is a formal way of finishing something.
- As a noun finish is an end: the end of anything.
- As a adjective terminate is terminated; limited; bounded; ended.

⭐ **Hinglish**

- commissioned- किसी चीज़ का चालू होना
- started- चालू होना
- finished- ख़तम होना
- terminated- बर्खास्त, आधिकारिक रूप से किसी काम को बंद करना

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---

77. **Answer: c**

Explanation:

The correct answer is **"a journey into outer space "**

⭐ **Key Points**

- Let's look at the meaning of the command module:
  - **Command Module-** the detachable control compartment of a manned spacecraft.
- Look at an example:

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- Apollo 16's **command module** is on display.
- Command Module is related to a journey outside space.
- So, it will be the most appropriate option as compared to the other options>

Hence, the correct answer is *a journey into outer space*

---

78. Answer: c

Explanation:

The correct answer is **"A catastrophe was imminent."**

⭐ Key Points

- When you read the given passage, you will find that it talks about tunnel shivering and the squealing of the master alarm.
- These things tell about a disaster.
  - I felt the wall of the **tunnel shiver.** The **master alarm squeals** through my earphones. Almost simultaneously, Jack yelled down to me that there was a warning light on. Fleeting but spectacular sights snapped into ans out of view, the snow, the shower of debris, the moon, looming close and big, and the dazzling sunshine for once unfiltered by layers of air. The last twelve hours before re-entry were particularly **bone-chilling.** During this period, I had to go up into the command module. Even after the fiery re-entry splashing down in 81° water in the south pacific, we could still see our frosty breath inside the command module.
- Disaster is similar to a catastrophe.
- The passage is focussing towards an upcoming catastrophe.

Hence, the correct answer: *A catastrophe was imminent.*

---

79. Answer: d

Explanation:

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The correct answer is **"none of the above"**

⭐ Key Points

- When we read the whole passage, we can't find any conclusive evidence regarding the given phrase in the question.

Hence, the correct answer: none of the above

---

80. Answer: d

Explanation:

The correct answer is "short"

⭐ Key Points

- Let's look at the meaning of the word, given in the question:
  - Brief - of short duration
- Look at the example:
  - Write the answer in **brief.**
- Look at the meaning of the selected word:
  - Short: lasting or taking a small amount of time.
- Look at the example:
  - Explain the problem in short.

Hence, the correct answer:*short*

⭐ Additional Information

- Let's look at the meanings of other options:
  - Limited- having a limit
  - small- of a size that is less than normal or usual.
  - little- small in size, amount, or degree

⭐ Hinglish

- Brief- जो काम समय तक चले

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- short- जो काम समय तक चले
- small- आकर में छोटा
- little- आकर में छोटा
- limited- जो सिमित हो

---

81. Answer: c

Explanation:

The correct answer is **"Dignified"**

⭐ Key Points

- Let's look at the meaning of the word, given in the question:
  - **August** - respected and impressive.
- Look at the example:
  - Addidas is an august company.
- Look at the meaning of the selected word:
  - **Dignified** - having or showing a composed or serious manner that is worthy of respect.
- Look at the example:
  - Sabrina has a **dignified** manner.

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Hence, the correct answer:*Dignified*

⭐ Additional Information

- Let's look at the meanings of other options:
  - **Common-** which can be found everywhere
  - **Ridiculous-** absurd
  - **Petty-** of little importance; trivial.

⭐ Hinglish

- **Dignified-** बहुत ही प्रतिष्ठित
- **August-** बहुत ही प्रतिष्ठित
- **Common-** जो हर जगह मिल जाए

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- **Ridiculous-** अजीबोगरीब
- **Petty-** जिसका कोई महत्व न हो

---

82. Answer: c

Explanation:

The correct answer is **"45123 "**

⭐ Key Points

- Let's look at the given words:
  - **1. left**
    2. the
    3. House
    4. he
    5. suddenly
- A noun or pronoun can be the core of a sentence.
- There is one noun **(House)** and one pronoun **(He)** .
- Left is a verb which can't be used with a house because a house is not a living being(House can't left)
- So our subject will be the pronoun **"He"**
- The pronoun is followed by a verb so **"left"** will follow **"He".**
- The adverb **(suddenly)** will come before the **verb(left)** .
  - **He suddenly left.**
- The article and object will come after the **Pronoun+adverb+verb**
  - **He suddenly left the house**

Hence, the correct answer:*45123*

---

83. Answer: c

Explanation:

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The correct answer is **"24153"**

⭐ Key Points

- Some disorganised words are given, and we have to arrange them to make a sentence.
- " **Have some of something** " is used when you offer something to someone.
- Look at the following example:
  - Have some water.
  - Have some coffee.
  - Have some rice.
- Hence, **"Have some tea"** will be the correct order.
- Now, the remaining words are "before" and "that"
- **"Before"** is a preposition.
- **"That"** is a relative pronoun.
- Prepositions are the words used before a noun or pronoun.
  - So we will use **"Before"** before **"that"**
- Now, we have two choices:
  - Before that have some tea.
  - Have some tea before that.
- "Before that have some tea" is not grammatically incorrect.(we have to use comma after **"that"**)

Hence, the correct sentence: *24153*

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---

84. Answer: d

Explanation:

The correct answer is "Imposter"

⭐ Key Points

- Look at the meaning of the selected word:
  - Imposter - A person pretending to be somebody he is not.
- Look at the example:

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- We thought, he was an officer but he was an **imposter** .

Hence, the correct answer is *Imposter.*

⭐ **Additional Information**

- Let's look at the meanings of other options:
  - Rogue- a dishonest or unprincipled man.
  - Liar- a person who lies
  - Magician- a person who does magic

⭐ **Hinglish**

- Imposter- जो अपना पहचान बदलकर बताता हो
- Rogue- बईमान आदमी
- Liar- जो झूठ बोलता हो
- Magician- जादू दिखने वाला

---

85. Answer: c

Explanation:

The correct answer is **"does"**

⭐ **Key Points**

- Let's look at the grammatical correctness of the given sentence.
- The sentence is in the present tense so the usage of **"was done"** is wrong
- The main subject of the sentence is **"The small Child".**
- The given sentence is made up of two different clauses.
  - The small child does. **(independent clause)**
  - Whatever his father was done. **(dependent clause)**
- In this type of sentence, the word form will according to the independent clause.
- Look at the given example:
  - I do whatever she does.
  - I eat whatever my mom eats

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- The correct sentence will be **"The small child does whatever his father does."**

Hence, the correct option: *does*

---

86. Answer: b

Explanation:

The correct answer is **"speak for itself"**

⭐ Key Points

- Let's look at the meaning of the phrase "speak for itself"
  - **Speak for itself-** something clear and no need for explanation.
- Look at the examples:
  - The girl's performance speaks for itself
  - The school's excellent record speaks for itself.
  - I don't have to tell anything, my work speaks for itself.

Hence, the correct answer:*speaks for itself*

---

87. Answer: a

Explanation:

The correct answer is Only the first stanza.

⭐ Key Points

- "Jana Gana Mana" is the national anthem of India.
  - Written in highly Sanskritised (Tatsama) Bengali , it is the first of five stanzas of a Brahmo hymn composed and scored by Nobel laureate Rabindranath Tagore.
    - But only 1 stanza of Rabindranath Tagore's "Jana Gana Mana" song was adopted as the National Anthem of India.

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- It was first sung in the Calcutta Session of the Indian National Congress on 27 December 1911.
- "Jana Gana Mana" was officially adopted by the Constituent Assembly as the Indian national anthem on 24 January 1950 .
- 27 December 2011 marked the completion of 100 years of Jana Gana Mana since it was sung for the first time.
- The original poem written by Rabindranath Tagore was translated into Hindi by Abid Ali .
- A formal rendition of the national anthem takes fifty-two seconds.

⭐ Important Points

- Vande Mataram song:
  - The song was Sung by Rabindranath Tagore.
  - The song was written by Bankim Chandra Chatterjee in 1874.
  - The song was published in the Bengali novel Anandamath in 1882.
- 'Vande Mataram' song was sung for the first time at the Indian National Congress session at Kolkata in 1896.
- The president of the Kolkata session was Rahmatullah M. Sayani.

---

88. **Answer: b**

Explanation:

The correct answer is Only II follows.

⭐ Key Points

- In a situation of a **severe drought** , the **basic duty of the government** is to **provide food, water, and fodder** immediately to **save the people and cattle.**
- In situations of a drought, there is a **scarcity of water** and hence, **food and fodder also become scarce.**
  - Hence, the government must **mobilize the resources** and **send these to the affected areas as soon as possible** .
  - An immediate attempt must be made to provide relief to people in **terms of providing basic amenities** , and not financial resources.***Hence, only II***

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follows.

⭐ Additional Information

- **Drought** is a **prolonged dry period** in the natural climate cycle.
  - It is a **slow-onset disaster** characterized by the **lack of precipitation, resulting in a water shortage.**
  - Drought can have a **serious impact** on **health, agriculture, economies, energy, and the environment.**
    - It leadsto a **serious shortage of food and fodder too** .

---

89. Answer: b

Explanation:

The correct answer is **Services sector**.

⭐ Key Points

- **Foreign direct investment (FDI)** is an **ownership stake in a foreign company or project** made by an investor, company, or government from another country.
  - The term is used to describe a **business decision to acquire a substantial stake in a foreign business** or to buy it outright to expand operations to a new region.
- During the last decade, the **services sector** has attracted the **highest FDI inflows of all sectors** .*Hence option 2 is correct.*
  - Of the **Sector-wise FDI Equity Inflows from April 2000 ,services have the largest share (17.6% of the total inflows)** .
  - **Trading** had a share of 5.81%.
  - **Telecommunication** had a share of 8.13%.
  - **Chemicals** had a share of 3.82%.
  - **Drugs and Pharmaceuticals** had a share of 3.59%.
  - **Construction** had a share of 3.54%.

⭐ Mistake Points

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- In 2021-22, **India received the "highest ever" foreign inflows of USD 83.6 billion** .
  - This FDI has come from **101 countries** and **invested across 31 union territories and states and 57 sectors in the country** .
  - **Top 5 countries for FDI equity inflows into India FY 2021-22** :
    - Singapore (27.01%)
    - USA (17.94%)
    - Mauritius (15.98%)
    - Netherlands (7.86%)
    - Switzerland (7.31%)
  - **Top 5 sectors receiving the highest FDI Equity Inflow during FY 2021-22:**
    - Computer Software & Hardware (24.60%)
    - **Services Sector (Fin., Banking, Insurance, Non-Fin/Business, Outsourcing, R&D, Courier, Tech. Testing and Analysis, Other) (12.13%)**
    - Automobile Industry (11.89%)
    - Trading (7.72%)
    - Construction (Infrastructure) Activities (5.52%)
  - **Top 5 States receiving the highest FDI Equity Inflow during FY 2021-22:**
    - Karnataka (37.55%)
    - Maharashtra (26.26%)
    - Delhi (13.93%)
    - Tamil Nadu (5.10%)
    - Haryana (4.76%)

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90. Answer: d

Explanation:

The correct answer is the16 th Lok Sabha.

⭐ Key Points

- The **Sixteenth Lok Sabha** was from **18/05/2014 to 25/05/2019** .
  - This Lok Sabha held its **sessions between June 2014 to February 2019.**
  - During these five years, **133 Bills were passed** and 45 Ordinances were promulgated.

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- **Members** of the 16 th Lok Sabha were **elected during the 2014 Indian general election.**
- **Sumitra Mahajan** (the **second woman after Meira Kumar** to be elected as Lok Sabha Speaker) was the **speaker** of the 16 th Lok Sabha.

⭐ Additional Information

- The **Lok Sabha** is composed of representatives of people chosen by **direct election** on the **basis of Universal Adult Suffrage** .
  - **Maximum strength** of the House is **552 members** -**530 members** to **represent** the **States, 20 members** to **represent** the **Union Territories,** and **2 members** to be **nominated by the President** from the **Anglo-Indian Community** .
  - At present, the **strength of the House is 543** .
  - The term of the Lok Sabha, unless dissolved, is **five years from the date appointed** for its first meeting.

⭐ Mistake Points

- **At present** , the **country has the 17 th Lok Sabha** .
  - This Lok Sabha was **elected on May 23, 2019** .
  - Shri **Om Birla** was elected as the **17 th Lok Sabha Speaker** .

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91. Answer: a

Explanation:

The correct answer is of six years.

⭐ Key Points

- The members of the Rajya Sabha are elected for a term of 6 years .
  - The Vice President of India is the Chairman of the Rajya Sabha.
  - The Upper House of Parliament, the Rajya Sabha or the Council of States, was constituted on 3 April 1952 and the first session was held on 13 May 1952 .

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⭐ Additional Information

- Rajya Sabha: This is the Upper House (the second house or the House of Elders) and it represents the states and union territories of the Indian Union.
  - The Rajya Sabha is called the permanent house of the Parliament because it is never completely dissolved.
  - Schedule IV of the Constitution of India deals with the allocation of seats in the Rajya Sabha to the States and Union Territories .
- Lok Sabha: It is the lower house (First House or Popular House) and it represents the people of India as a whole.

---

92. Answer: c

Explanation:

The correct answer is **Guide**.

⭐ Key Points

- **Munshi Premchand** was an **Indian writer famous** for his **modern Hindustani literature** .
  - A novel writer, story writer, and dramatist, he has been referred to as the **"Upanyas Samrat"** .
- His works include **more than a dozen novels** , around **250 short stories** , several **essays** , and **translations** of a number of foreign literary works into Hindi.
- The **name of famous books** written by him include:
  - Nirmala
  - Sevasadan
  - Rangbhoomi
  - **Gaban**
  - Premashram
  - Prema
  - Roothi Rani
  - Pratigya
  - **Godaan**

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    - Karmabhoomi
    - Shatranj ke khiladi
    - Kaphan
    - Namak ka Daroga
    - Idgah
    - **Mansarovar, etc.** *Hence Guide was not written by Munshi Premchand.*
- **'The Guide'** is a 1958 novel written, in English, by the **legendary R.K Narayan** .

⭐ Additional Information

- Mushi Premchand's novels describe the **problems of the poor** and the **urban middle class** .
- His works depict a **rationalistic outlook** .
- He used literature for the purpose of **arousing public awareness** about national and social issues and often wrote about topics related to **corruption, child widowhood, prostitution, the feudal system, poverty, colonialism, and on India's freedom movement** .

---

93. **Answer: a**

Explanation:

The correct answer is Indian Oil Corporation Ltd.

⭐ Key Points

- Indian Oil Corporation Limited:
    - It is an Indian government-owned oil and gas company headquartered in New Delhi.
    - The refineries at Mathura, Digboi, and Panipat have been set up by Indian Oil Corporation Limited. Hence, Option 1 is correct.
    - Sanjiv Singh is the current Chairperson of Indian Oil Corporation.
- Hindustan Petroleum Corporation Limited :
    - It is an Indian oil and natural gas company with its headquarters in Mumbai, Maharashtra.

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    - Mukesh Kumar Surana is the current chairperson of Hindustan Petroleum Corporation Limited.
- Bharat Petroleum Corporation Limited :
    - It is a public sector undertaking oil and gas company headquartered in Mumbai, Maharashtra.
    - It has two large refineries located in Kochi and Mumbai.
    - D Rajkumar is the chairman of BPCL.

---

94. Answer: a

Explanation:

The correct answer is India and Pakistan.

⭐ Confusion Points

- **Radcliffe Line**divided British India into two independent countries **India and Pakistan in**1947.
- Border between India and Bangladesh – Purbachal(operating zero lines) – 4096.7 km.

⭐ Key Points

- Radcliffe Line is the boundary line between India and Pakistan.
- Radcliffe Line divided British India into two independent countries India and Pakistan in 1947.
- Radcliffe Line was named after its architect Sir Cyril Radcliffe.
- Three Indian states and two union territory share a boundary with Pakistan.
- Indian states/union territory that share borders with Pakistan are:
    - Jammu and Kashmir
    - Ladakh
    - Rajasthan
    - Gujarat.
    - Punjab.

⭐ Additional Information

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- McMahon Line is the boundary line between China and India.
- The diplomatic relations between India and Bhutan were established in 1968.
- Five Indian states namely, Assam, West Bengal, Mizoram, Meghalaya, and Tripura share borders with Bangladesh.
- The Durand Line is the International border between Pakistan and Afghanistan.
- List of International Boundary Lines Names of All Borders Line Of India
    - Pakistan – Radcliffe Line (3323 km)
    - Bangladesh – Purbachal(operating zero lines) – 4096.7 km.
    - China – McMohan Line – 3380 km.
    - Bhutan – Indo-Bhutan – 699 km.
    - Afghanistan – Durand Line – 106 km.
    - Srilanka – Palk Strait –30kms.



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95. **Answer: c**

Explanation:

Explanation:

Nucleons

- A nucleon can be either a proton or a neutron.
- The total number of protons and neutrons (often referred to as nucleons) in an atomic nucleus is known as the mass number (A).
- For each isotope of a chemical element, the mass number is different.
    - Isotopes of the same element are identified by differences in their mass numbers, which differ only in the number of neutrons they contain.
- This is distinct from the atomic number (Z), which refers to the number of protons in a nucleus and hence uniquely identifies an element
- The mass number of an atom is thus, defined as the sum total of protons and neutrons.
    - As protons and neutrons are also referred to as nucleons, their sum defining the mas number is hence called the nucleon number .
- In an atomic nucleus, nucleons thus have a net positive charge.
    - **Hence, the correct answer to the question is - number of nucleons .**

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⭐ Additional Information

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PROTON	NEUTRON	ELECTRON
Positively charged particles	Neutral particles i.e. no charge is present on them	Negatively charged particles.
Present in the nucleus of the atom	Present in the nucleus of the atom	present in the outer shell, orbiting around the nucleus of the atom.
More massive than electrons	More massive than electrons	Quite lighter particles
Represented as *"p"*	Represented as *"n"*	Represented as *"e"*

---

96. **Answer: d**

Explanation:

The correct answer is **Mg**.

⭐ **Key Points**

- **Seawater** , water that makes up the oceans and seas, **covermore than 70 percent of Earth's surface** .
  - Seawater is a complex mixture of **96.5 percent water** ,**2.5 percent salts** , and **smaller amounts** of other substances, including **dissolved inorganic and organic materials** , particulates, and a few atmospheric gases.
  - The **six most abundant ions** of seawater are **chloride (Cl^-), sodium (Na^+), sulfate (SO_2^{4-}), magnesium (Mg^{2+}), calcium (Ca^{2+}), and potassium (K^+)** .
- Much of the **world's magnesium is recovered from seawater.** The metal for which **sea and briny lakes** are crucially important sources is magnesium.
  - **Dow's process of extraction of Mg** involves extraction of Mg from sea water.

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- The metal is extracted from seawater and brines by means of **electrolysis** , a process that requires the **passing of a current through a molten salt** .
- This extracts the metal from the salt but requires a high temperature to melt the salt.

⭐ Additional Information

- Magnesium is a **low-density** , and therefore lightweight, **metal that produces strong alloys** .
  - Magnesium is used in the **production of alloys** , fertilizers, refractories (for steel production) and flame retardants, and for **water purification** .
  - Magnesium has a variety of potential uses in **clean energy technologies** , including in carbon capture, low-carbon cement, and next-generation batteries.

---

97. **Answer: a**

Explanation:

The correct answer is **sparingly soluble**.

⭐ Key Points

- **Group 8A (or VIII A)** of the **periodic table** are the **noble gases or inert gases** :
  - **Helium** (He)
  - **Neon** (Ne)
  - **Argon** (Ar)
  - **Krypton** (Kr)
  - **Xenon** (Xe)
  - **Radon** (Rn)
- The name comes from the fact that these elements are **virtually unreactive toward other elements or compounds.**
  - They are found in **trace amounts in the atmosphere.**
  - In their **elemental form at room temperature** , these elements are all **colorless, odorless, monatomic gases** .

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- **Noble gases** are **sparingly soluble in water** and **the solubility increases from helium to xenon** .
  - The Solubility of noble gases in the water is due to dipole-induced dipole interaction form.
  - As dipole-induced dipole interaction increases with the increase of molecular mass of noble gases, hence **solubility of noble gases in water increases down the group** .*Hence, the correct answer is sparingly soluble.*

---

98. Answer: c

Explanation:

The correct answer is **periodic table of contents**.

⭐ **Key Points**

- They are associated with the **development of the periodic table of elements.**
  - **Newland** gave **Newland's law of octaves** .
  - **Mendeleev** gave the **period law based on atomic mass** .
  - **Moseley** gave the **modern period law based on atomic number** .

⭐ **Additional Information**

- A British chemist named **John Newlands** attempted to combine the **62 elements** known at the time in **1864** .
  - He arranged them in **ascending order** according to their **atomic weights** and discovered that the **properties of every eighth element were the same.**
  - As a result of this discovery, **Newland's law of octaves was born.**
- **Mendeleev's Periodic Table** is based on the **atomic masses** of the given elements.
  - The chemical elements are arranged in the **increasing order of their atomic masses.**
  - The Mendeleev's Periodic Table came into the picture after the **rejection of Newland's Law of Octaves** .

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- Using **atomic number instead of atomic mass** as the organizing principle was first proposed by the **British chemist Henry Moseley in 1913.**

---

99. Answer: a

Explanation:

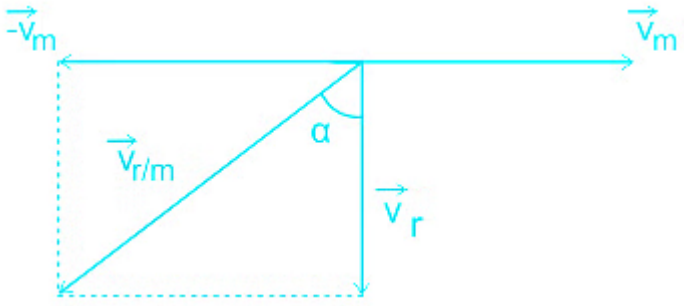
Concept:

- The time rate of change of the displacement of a particle relative to its origin is called **velocity.**
- Velocity has both magnitude and direction.
- The **relative velocity** of body A with respect to another body B, when both are in motion, is the rate at which body A changes its position with respect to body B.
  - $\overrightarrow{V_{AB}} = \overrightarrow{V_A} - \overrightarrow{V_B}$
  - Where, $\overrightarrow{V_{AB}}$ = relative velocity of object A with respect to object B.
- The **resultant velocity** of an object is the sum of its individual vector velocities.
  - $\overrightarrow{V_{A/B}} = \overrightarrow{V_A} + \overrightarrow{V_B}$

Explanation:

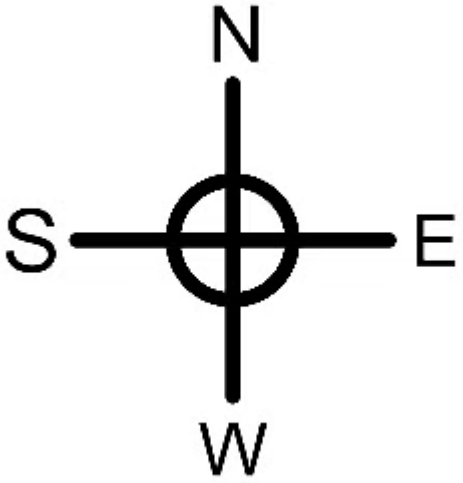
Let the velocity of the running man be $\overrightarrow{V_m}$ in the horizontal direction

And the velocity of the rain be $\overrightarrow{V_r}$ in the vertical direction



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Now relative velocity of rain with respect to running man is $\vec{V}_{rm}$

$\overrightarrow{V_{rm}} = \vec{V_r} - \vec{V_m}$

In the horizontal direction, $\vec{V_r}$ = 0

So, $\overrightarrow{V_{rm}} = 0 - \vec{V_m} = -\vec{V_m}$

- The negative sign indicates the direction
- As the man is moving in the east direction, so the velocity of rain is west with respect to man,
- The rain will appear to be coming from the **east.**

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⭐ Alternate Method

From fig we can see that direction of the **resultant velocity** $\vec{V}_{r/m}$ will be inclined and appear to be coming from the east.

So, the rain will appear to be coming from the east.

---

100. Answer: c

Explanation:

The correct answer is Henri Becquerel.

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⭐ Key Points

- Radioactivity was discovered by Henri Becquerel in 1896 .
- SI unit of radioactivity is becquerel (Bq) .
- Henry Becquerel discovered radioactivity proving that the uranium emitted radiation without an external source of energy such as the Sun.
- Marie Curie , who together with her husband Pierre Curie , actually coined the term radioactivity and began investigating the phenomenon recently discovered by Becquerel.
- In 1903 , Henry Becquerel shared the Nobel Prize for Physics with Pierre and Marie Curie .

⭐ Additional Information

- Radioactivity: The Phenomenon of spontaneous emission of radiation from radioactive substances is called radioactivity .
  - It is actually a property of atoms and Nuclei. Therefore on the nano-level also it is not affected by chemical or physical changes.
  - Radioactivity, basically, is a nuclear phenomenon in which an unstable nucleus undergoes a decay is called radioactive decay.
  - Three types of Radioactive decay:
    - α decay in which Helium nucleus $_2$He 4 is emitted.
    - β decay in which electron or positron are emitted.
    - γ decay in which high-energy photons are emitted.
- Ernest Rutherford did many experiments studying the properties of radioactive decay, named this alpha, beta, and gamma particles, and classified them by their ability to penetrate matter.

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