AIIMS B.Sc. Nursing 2026

Question Paper with Solutions

Conducted by All India Institute of Medical Sciences (AIIMS), New Delhi

General Instructions

(i) The test is of 2 hours (120 minutes) duration.

(ii) This test paper consists of 100 multiple-choice questions. The maximum marks are 100.

(iii) The paper contains four sections: Physics (30 questions), Chemistry (30 questions), Biology (30 questions), and General Knowledge (10 questions).

(iv) Each question carries +1 mark for a correct answer and −1/3 mark for an incorrect answer. No marks will be deducted for unanswered questions.

Physics

1. What is the dimensional formula of electric potential?

(A) $[L^2T^{-3}A^{-1}]$
(B) $[L^2T^{-2}A^{-1}]$
(C) $[ML^2T^{-3}A^{-2}]$
(D) $[L^2T^{-2}A^{-2}]$

Correct Answer: (A) $[L^2T^{-3}A^{-1}]$

Solution:

Step 1: Understanding the Concept:
Electric potential (V) at any point is defined as the work done (W) per unit charge (q) in

bringing a positive charge from infinity to that point.

Step 2: Key Formula or Approach:

The formula for electric potential is:

$$V = \frac{W}{q}$$

Step 3: Detailed Explanation:

First, let us determine the dimensional formula of work done (W):

$$\text{Work} = \text{Force} \times \text{displacement}$$

$$[W] = [MLT^{-2}] \times [L] = [ML^2T^{-2}]$$

Next, we find the dimensional formula of electric charge (q):

$$\text{Charge} = \text{Current} \times \text{time}$$

$$[q] = [A] \times [T] = [AT]$$

Substituting these dimensions into the electric potential formula:

$$[V] = \frac{[ML^2T^{-2}]}{[AT]} = [ML^2T^{-3}A^{-1}]$$

The standard dimensional formula is $[ML^2T^{-3}A^{-1}]$.

Due to a minor typographical omission of the mass term M in the options, option (A) correctly corresponds to the dimensional ratios for length, time, and current.

Step 4: Final Answer:

Therefore, the correct dimensional formula representation corresponds to Option (A).

Quick Tip: Always relate potential to Work Done ($[ML^2T^{-2}]$) and Charge ($[AT]$). This simple base relation prevents errors when dealing with complex electrical dimensions.

2. The electron mobility in a conductor is $32\ \text{cm}^2/\text{Vs}$. What is the relaxation time of free electrons? (Given: $e = 1.6 \times 10^{-19}$ C, $m = 9.1 \times 10^{-31}$ kg)

(A) 1.82×10^{-12} s

(B) 2.73×10^{-12} s

(C) 1.82×10^{-14} s

(D) 2.73×10^{-14} s

Correct Answer: (C) 1.82×10^{-14} s

Solution:

Step 1: Understanding the Concept:

Mobility (μ) of charge carriers represents the ease with which electrons drift under an applied electric field, which directly relates to the relaxation time (τ).

Step 2: Key Formula or Approach:

The relation between electron mobility and relaxation time is:

$$\mu = \frac{e\tau}{m} \implies \tau = \frac{\mu m}{e}$$

Step 3: Detailed Explanation:

Convert mobility from cm^2/Vs to standard SI units (m^2/Vs):

$$\mu = 32\ \text{cm}^2/\text{Vs} = 32 \times 10^{-4}\ \text{m}^2/\text{Vs}$$

Substitute the given physical constants into our rearranged expression:

$$\tau = \frac{(32 \times 10^{-4}\ \text{m}^2/\text{Vs}) \times (9.1 \times 10^{-31}\ \text{kg})}{1.6 \times 10^{-19}\ \text{C}}$$

$$\tau = \left(\frac{32}{1.6}\right) \times 9.1 \times 10^{-4-31+19}$$

$$\tau = 20 \times 9.1 \times 10^{-16}$$

$$\tau = 182 \times 10^{-16}\ \text{s} = 1.82 \times 10^{-14}\ \text{s}$$

Step 4: Final Answer:

The relaxation time is 1.82×10^{-14} s, matching Option (C).

Quick Tip: Always convert cm^2 to m^2 by multiplying by 10^{-4}. Neglecting this step is a common pitfall that leads to choosing incorrect powers of ten.

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3. The area of an airplane wing is $A = 4$ m^2. Air flows with velocity $v_1 = 80$ m/s above the wing and $v_2 = 60$ m/s below it. The density of air is 1.2 kg/m^3. Find the pressure difference (ΔP) between the upper and lower surfaces of the wing.

(A) 1200 Pa

(B) 1680 Pa

(C) 2400 Pa

(D) 3600 Pa

Correct Answer: (B) 1680 Pa

Solution:

Step 1: Understanding the Concept:

Dynamic lift on an aircraft wing is modeled using Bernoulli's principle. Higher wind speed above the wing creates a region of lower static pressure, resulting in an upward pressure difference.

Step 2: Key Formula or Approach:

For a horizontal stream:

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

The pressure difference is:

$$\Delta P = P_2 - P_1 = \frac{1}{2}\rho(v_1^2 - v_2^2)$$

Step 3: Detailed Explanation:

Given values:

$$\rho = 1.2 \text{ kg/m}^3$$

$$v_1 = 80 \text{ m/s} \quad \text{(above the wing)}$$

$$v_2 = 60 \text{ m/s} \quad \text{(below the wing)}$$

Substitute these values into the pressure difference formula:

$$\Delta P = \frac{1}{2} \times 1.2 \times (80^2 - 60^2)$$

$$\Delta P = 0.6 \times (6400 - 3600)$$

$$\Delta P = 0.6 \times 2800 = 1680 \text{ Pa}$$

Step 4: Final Answer:

The pressure difference is 1680 Pa, corresponding to Option (B).

Quick Tip: Use the difference of squares identity $a^2 - b^2 = (a - b)(a + b)$ to simplify: $80^2 - 60^2 = (20)(140) = 2800$. This allows for rapid mental calculation!

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4. What is the minimum wavelength in the Lyman series of the hydrogen spectrum?

(A) 91.2 nm

(B) 121.6 nm

(C) 656.3 nm

(D) 364.6 nm

Correct Answer: (A) 91.2 nm

Solution:

Step 1: Understanding the Concept:

The Lyman series involves transitions ending at the ground state ($n_1 = 1$). The minimum wavelength (series limit) corresponds to the maximum energy transition, starting from $n_2 = \infty$.

Step 2: Key Formula or Approach:

The Rydberg equation is:

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Step 3: Detailed Explanation:

Set $n_1 = 1$ and $n_2 = \infty$ for the series limit (minimum wavelength):

$$\frac{1}{\lambda_{\text{min}}} = R\left(\frac{1}{1^2} - \frac{1}{\infty}\right) = R$$

$$\lambda_{\text{min}} = \frac{1}{R}$$

Taking the Rydberg constant $R \approx 1.097 \times 10^7\ \text{m}^{-1}$:

$$\lambda_{\text{min}} = \frac{1}{1.097 \times 10^7}\ \text{m} \approx 9.115 \times 10^{-8}\ \text{m} = 91.2\ \text{nm}$$

Step 4: Final Answer:

The minimum wavelength in the Lyman series is 91.2 nm, matching Option (A).

Quick Tip: Memorize the value of the reciprocal of the Rydberg constant: $\frac{1}{R} \approx 912$ Å $= 91.2$ nm. This shortcut directly yields the Lyman limit.

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5. Two parallel wires carry equal currents of 2A in opposite directions. If the length of each wire is 0.5 m and the distance between them is 10 cm, then find the force between them.

(A) 2×10^{-6} N

(B) 4×10^{-6} N

(C) 8×10^{-6} N

(D) 1.6×10^{-5} N

Correct Answer: (B) 4×10^{-6} N

Solution:

Step 1: Understanding the Concept:

Parallel conductors carrying currents exert magnetic forces on each other. When currents run in opposite directions, the force between them is repulsive.

Step 2: Key Formula or Approach:

The magnetic force F between parallel current-carrying wires is:

$$F = \frac{\mu_0 I_1 I_2 L}{2\pi d}$$

Step 3: Detailed Explanation:

Given values:

$$I_1 = I_2 = 2 \text{ A}$$

$$L = 0.5 \text{ m}$$

$$d = 10 \text{ cm} = 0.1 \text{ m}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ T} \cdot \text{m/A}$$

Substitute the values:

$$F = \frac{(4\pi \times 10^{-7}) \times 2 \times 2 \times 0.5}{2\pi \times 0.1}$$

$$F = 2 \times 10^{-7} \times \frac{2}{0.1}$$

$$F = 20 \times 2 \times 10^{-7} = 4 \times 10^{-6} \text{ N}$$

Step 4: Final Answer:

The force is repulsive and has a magnitude of 4×10^{-6} N, matching Option (B).

Quick Tip: Remember: Like currents attract, opposite currents repel. The factor $\frac{\mu_0}{2\pi}$ simplifies directly to 2×10^{-7} in calculations.

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6. A thin prism has an angle of 8° and a minimum deviation of 6°. Find the speed of light in the prism.

(A) 1.71×10^8 m/s
(B) 2.0×10^8 m/s
(C) 2.5×10^8 m/s
(D) 3.0×10^8 m/s

Correct Answer: (A) 1.71×10^8 m/s

Solution:

Step 1: Understanding the Concept:
For a thin prism (where the prism angle $A \leq 10^\circ$), the angle of minimum deviation (δ) can be solved using a simplified linear equation.

Step 2: Key Formula or Approach:
The deviation formula for a thin prism is:

$$\delta = (\mu - 1)A$$

The relationship between speed and refractive index is:

$$v = \frac{c}{\mu}$$

Step 3: Detailed Explanation:
Given values:

$$A = 8^\circ, \quad \delta = 6^\circ$$

Solve for refractive index (μ):

$$6 = (\mu - 1) \times 8$$

$$\mu - 1 = \frac{6}{8} = 0.75$$

$$\mu = 1.75$$

Now, calculate speed of light in the prism with $c = 3 \times 10^8$ m/s:

$$v = \frac{3 \times 10^8}{1.75} \approx 1.714 \times 10^8 \text{ m/s}$$

Step 4: Final Answer:

The speed of light in the prism is 1.71×10^8 m/s, corresponding to Option (A).

Quick Tip: When μ is 1.75, the velocity must be significantly less than 2.0×10^8 m/s (since $\mu = 1.5$ gives 2.0×10^8 m/s). This logic helps eliminate incorrect options instantly.

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7. A car moves at a speed of 600 km/h on a frictionless banked road with $\theta = 30°$. Take $g = 10$ m/s^2. Find the radius of the road.

(A) 2.4 km

(B) 3.2 km

(C) 4.8 km

(D) 6.4 km

Correct Answer: (C) 4.8 km

Solution:

Step 1: Understanding the Concept:

On a banked frictionless curve, the normal reaction force's horizontal component provides the entire centripetal force required to keep the vehicle in circular motion.

Step 2: Key Formula or Approach:

The ideal speed on a banked road is given by:

$$\tan\theta = \frac{v^2}{rg} \implies r = \frac{v^2}{g\tan\theta}$$

Step 3: Detailed Explanation:

Convert velocity from km/h to m/s:

$$v = 600 \text{ km/h} = 600 \times \frac{5}{18} \text{ m/s} = \frac{500}{3} \text{ m/s} \approx 166.67 \text{ m/s}$$

Given parameters:

$$\theta = 30^\circ \implies \tan 30^\circ = \frac{1}{\sqrt{3}} \approx 0.577$$

$$g = 10 \text{ m/s}^2$$

Compute the radius:

$$r = \frac{\left(\frac{500}{3}\right)^2}{10 \times \frac{1}{\sqrt{3}}} = \frac{250000}{9 \times 10 \times 0.577}$$

$$r = \frac{25000}{5.196} \approx 4811 \text{ m} \approx 4.8 \text{ km}$$

Step 4: Final Answer:

The radius of the road is 4.8 km, matching Option (C).

Quick Tip: Keep equations in fractional form: $\frac{25000\sqrt{3}}{9}$. Since $\sqrt{3} \approx 1.732$, we get $2777.7 \times 1.732 \approx 4800$ m. This reduces rounding errors.

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8. $L = 50$ **mH,** $C = 100$ μ**F,** $R = 50\ \Omega$**. What does this circuit represent? (Assume** $\omega = 200$ **rad/s)**

(A) Inductive circuit

(B) Capacitive circuit

(C) Resonant circuit

(D) Purely resistive circuit

Correct Answer: (B) Capacitive circuit

Solution:

Step 1: Understanding the Concept:

In an alternating current (AC) circuit containing an inductor, capacitor, and resistor (LCR), the dominant reactance determines whether the circuit behaves in an inductive, capacitive, or resistive manner.

Step 2: Key Formula or Approach:

Compare inductive reactance X_L and capacitive reactance X_C:

$$X_L = \omega L$$

$$X_C = \frac{1}{\omega C}$$

Step 3: Detailed Explanation:

Given values:

$$L = 50 \times 10^{-3} \text{ H}, \quad C = 100 \times 10^{-6} \text{ F}, \quad \omega = 200 \text{ rad/s}$$

Calculate the reactances:

$$X_L = 200 \times (50 \times 10^{-3}) = 10 \ \Omega$$

$$X_C = \frac{1}{200 \times (100 \times 10^{-6})} = \frac{1}{0.02} = 50 \ \Omega$$

Since $X_C > X_L$, the capacitive reactance is greater, making the circuit net capacitive.

Step 4: Final Answer:

The circuit represents a Capacitive circuit, corresponding to Option (B).

Quick Tip: At resonance, $X_L = X_C$. If $X_C > X_L$, the current leads the voltage, meaning the circuit is capacitive.

9. A sphere encloses charges $+5$ C and -2 C, while a charge -3 C is outside the sphere. What is the electric flux through the sphere?

(A) $\frac{3C}{\varepsilon_0}$

(B) $-\frac{3C}{\varepsilon_0}$

(C) Zero

(D) $\frac{10C}{\varepsilon_0}$

Correct Answer: (A) $\frac{3C}{\varepsilon_0}$

Solution:

Step 1: Understanding the Concept:

By Gauss's law, the net electric flux through any closed Gaussian surface depends solely on the algebraic sum of the charges enclosed inside the volume. Charges outside have no contribution.

Step 2: Key Formula or Approach:

The electric flux Φ is:

$$\Phi = \frac{q_{\text{enclosed}}}{\varepsilon_0}$$

Step 3: Detailed Explanation:

Identify the charges inside the spherical surface:

$$q_{\text{enclosed}} = +5 \text{ C} + (-2 \text{ C}) = +3 \text{ C}$$

The external charge (-3 C) does not affect the net flux.

Thus, the electric flux is:

$$\Phi = \frac{3 \text{ C}}{\varepsilon_0}$$

Step 4: Final Answer:

The electric flux is $\frac{3C}{\varepsilon_0}$, corresponding to Option (A).

Quick Tip: Always filter out any charge specified as "outside" the surface, as its incoming and outgoing field lines cancel out completely.

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10. A current of 50 mA flows through a loop of area 10 cm^2 placed in a magnetic field of 0.1 T. The angle between the magnetic field and the loop is 60°. Find the torque acting on the loop.

(A) 2.5×10^{-5} N m

(B) 4.33×10^{-5} N m

(C) 4.33×10^{-6} N m

(D) 2.5×10^{-6} N m

Correct Answer: (D) 2.5×10^{-6} N m

Solution:

Step 1: Understanding the Concept:
A current loop in a magnetic field experiences torque. The relevant angle (θ) is measured between the normal vector of the loop area and the magnetic field.

Step 2: Key Formula or Approach:
The torque equation is:

$$\tau = IAB \sin\theta$$

If the angle of the field with the loop's plane is α, then:

$$\theta = 90^\circ - \alpha$$

Step 3: Detailed Explanation:
Given values:

$$I = 50 \text{ mA} = 50 \times 10^{-3} \text{ A}$$

$$A = 10 \text{ cm}^2 = 10 \times 10^{-4} \text{ m}^2 = 10^{-3} \text{ m}^2$$

$$B = 0.1 \text{ T}$$

$$\alpha = 60^\circ \implies \theta = 90^\circ - 60^\circ = 30^\circ$$

Calculate torque:

$$\tau = (50 \times 10^{-3}) \times 10^{-3} \times 0.1 \times \sin 30^\circ$$

$$\tau = 5 \times 10^{-6} \times 0.5 = 2.5 \times 10^{-6} \text{ N m}$$

Step 4: Final Answer:

The torque is 2.5×10^{-6} N m, matching Option (D).

Quick Tip: Always distinguish between the angle with the "loop plane" (α) and the angle with the "area vector" (θ). Use $\cos\alpha$ directly if the angle is with the plane.

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11. A 1 μF capacitor is charged to 12 V and then connected to an identical uncharged capacitor. What will be the common potential?

(A) 12 V

(B) 6 V

(C) 3 V

(D) 4 V

Correct Answer: (B) 6 V

Solution:

Step 1: Understanding the Concept:

When two capacitors are joined in parallel, charge redistributes until they reach a uniform electric potential. Total charge is conserved.

Step 2: Key Formula or Approach:

The common potential (V_c) is:

$$V_c = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$

Step 3: Detailed Explanation:

Given values:

$$C_1 = 1\ \mu\text{F}, \quad V_1 = 12\ \text{V}$$

$$C_2 = 1\ \mu\text{F}, \quad V_2 = 0\ \text{V}$$

Substitute these values:

$$V_c = \frac{(1 \times 12) + (1 \times 0)}{1 + 1} = \frac{12}{2} = 6\ \text{V}$$

Step 4: Final Answer:

The common potential is 6 V, which matches Option (B).

Quick Tip: When connecting any charged capacitor to an identical uncharged capacitor in parallel, the charge is shared equally, meaning the final potential is exactly half the initial potential.

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12. If the work function of a metal is 1.2 eV and the stopping potential is 1.8 V, find the frequency of incident light on the metal surface.

(A) 4.84×10^{14} Hz

(B) 7.25×10^{14} Hz

(C) 1.45×10^{14} Hz

(D) 9.67×10^{14} Hz

Correct Answer: (B) 7.25×10^{14} Hz

Solution:

Step 1: Understanding the Concept:

Einstein's photoelectric equation states that the energy of the incident photon is equal to the

sum of the work function and the maximum kinetic energy of the emitted electrons.

Step 2: Key Formula or Approach:

The photoelectric equation is:

$$E = \phi + K_{\max} \implies hf = \phi + eV_0$$

Step 3: Detailed Explanation:

Given values:

$$\phi = 1.2 \text{ eV}$$

$$V_0 = 1.8 \text{ V} \implies K_{\max} = 1.8 \text{ eV}$$

Calculate total photon energy:

$$E = 1.2 \text{ eV} + 1.8 \text{ eV} = 3.0 \text{ eV}$$

Convert energy to Joules:

$$E = 3.0 \times 1.6 \times 10^{-19} \text{ J} = 4.8 \times 10^{-19} \text{ J}$$

Calculate frequency (f):

$$f = \frac{E}{h} = \frac{4.8 \times 10^{-19} \text{ J}}{6.626 \times 10^{-34} \text{ J s}} \approx 7.244 \times 10^{14} \text{ Hz}$$

Step 4: Final Answer:

The frequency of incident light is 7.25×10^{14} Hz, matching Option (B).

Quick Tip: Always sum up energy values in eV first (which is simple addition), and perform the conversion to Joules at the final step to keep calculations easy.

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13. Which of the following statements is correct during the formation of a PN junction?

(A) Electrons diffuse from the P-region to the N-region.

(B) Holes diffuse from the N-region to the P-region.

(C) Electrons diffuse from the N-region to the P-region.

(D) Holes drift from the N-region to the P-region.

Correct Answer: (C) Electrons diffuse from the N-region to the P-region.

Solution:

Step 1: Understanding the Concept:

During p-n junction formation, concentration differences of charge carriers across the boundary initiate the movement of major carriers, a process called diffusion.

Step 2: Detailed Explanation:

- The N-region has a high concentration of free electrons (majority carriers).
- The P-region has a low concentration of free electrons.
- Consequently, electrons diffuse from the N-region to the P-region.
- Simultaneously, holes (majority carriers in P-region) diffuse from the P-region to the N-region.

Step 3: Final Answer:

The correct statement is Option (C).

Quick Tip: Diffusion involves majority carriers moving from high to low concentration regions, whereas drift involves minority carriers moving under an internal electric field.

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14. A spring of force constant $K = 1000$ N/m is compressed by 5 cm. If a mass of 2.5 kg is attached and released, find its speed as it passes the equilibrium position.

(A) 0.5 m/s

(B) 1.0 m/s

(C) 1.5 m/s

(D) 2.0 m/s

Correct Answer: (B) 1.0 m/s

Solution:

Step 1: Understanding the Concept:

By the law of conservation of mechanical energy, the entire potential energy stored in a compressed spring is converted into the kinetic energy of the mass as it passes through the equilibrium position.

Step 2: Key Formula or Approach:

$$\frac{1}{2}Kx^2 = \frac{1}{2}mv^2 \implies v = x\sqrt{\frac{K}{m}}$$

Step 3: Detailed Explanation:

Given values:

$$K = 1000 \text{ N/m}$$

$$x = 5 \text{ cm} = 0.05 \text{ m}$$

$$m = 2.5 \text{ kg}$$

Substitute the values:

$$v = 0.05 \times \sqrt{\frac{1000}{2.5}}$$

$$v = 0.05 \times \sqrt{400} = 0.05 \times 20 = 1.0 \text{ m/s}$$

Step 4: Final Answer:

The speed at the equilibrium position is 1.0 m/s, corresponding to Option (B).

Quick Tip: Remember to convert compression x from centimeters to meters to maintain unit consistency with standard SI units.

15. The temperature of 2 moles of a monoatomic gas changes from 25°C to 35°C in an adiabatic process. Find the work done.

(A) −249.4 J

(B) +249.4 J

(C) −498.8 J

(D) +498.8 J

Correct Answer: (A) −249.4 J

Solution:

Step 1: Understanding the Concept:

In an adiabatic process, there is no heat transfer ($Q = 0$). According to the first law of thermodynamics, work done is equal to the negative change in internal energy.

Step 2: Key Formula or Approach:

$$W = -\Delta U$$

For n moles of a monoatomic gas:

$$\Delta U = nC_v\Delta T = n\left(\frac{3}{2}R\right)\Delta T$$

Step 3: Detailed Explanation:

Given values:

$$n = 2$$

$$\Delta T = T_f - T_i = 35^\circ\text{C} - 25^\circ\text{C} = 10\ \text{K}$$

$$R = 8.314\ \text{J/(mol K)}$$

Calculate internal energy change:

$$\Delta U = 2 \times \frac{3}{2} \times 8.314 \times 10 = 249.42\ \text{J}$$

Work done:

$$W = -\Delta U = -249.4 \text{ J}$$

Step 4: Final Answer:

The work done in the adiabatic process is -249.4 J, corresponding to Option (A).

Quick Tip: An increase in temperature ($\Delta T > 0$) means internal energy increases. In an adiabatic system, this requires work to be done on the gas, which is negative by thermodynamic convention. This eliminates positive options immediately!

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16. Two large, thin, parallel sheets have surface charge densities of opposite signs and equal magnitude σ. What is the magnitude of the electric field (E) in the region between the sheets?

(A) $\frac{\sigma}{2\varepsilon_0}$

(B) $\frac{\sigma}{\varepsilon_0}$

(C) Zero

(D) $\frac{2\sigma}{\varepsilon_0}$

Correct Answer: (B) $\frac{\sigma}{\varepsilon_0}$

Solution:

Step 1: Understanding the Concept:

The electric field generated by a large thin plane sheet with uniform charge distribution is constant in magnitude and directed normally.

Step 2: Key Formula or Approach:

The electric field due to a single infinite sheet is:

$$E = \frac{\sigma}{2\varepsilon_0}$$

Step 3: Detailed Explanation:

Between a positively charged plate and a negatively charged plate: - The positive sheet creates a field $E_1 = \frac{\sigma}{2\varepsilon_0}$ pointing away from it. - The negative sheet creates a field $E_2 = \frac{\sigma}{2\varepsilon_0}$ pointing towards it.

Since both fields point in the same direction (from positive to negative plate), they reinforce each other:

$$E_{\text{net}} = E_1 + E_2 = \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0} = \frac{\sigma}{\varepsilon_0}$$

Step 4: Final Answer:

The electric field strength between the sheets is $\frac{\sigma}{\varepsilon_0}$, corresponding to Option (B).

Quick Tip: For oppositely charged parallel plates, the field adds up to $\frac{\sigma}{\varepsilon_0}$ in the interior, while cancelling out to zero in exterior regions.

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17. A small ball is tied to a light inextensible thread of length 64 cm and is whirled in a vertical circle. If the thread is just taut at the highest point of the circle, then the minimum speed of the ball at the lowest point is: (Take $g = 10$ m/s^2)

(A) 2.53 m/s

(B) 5.66 m/s

(C) 8.0 m/s

(D) 10.0 m/s

Correct Answer: (B) 5.66 m/s

Solution:

Step 1: Understanding the Concept:

To complete a vertical circle supported by a string, the critical minimum speed occurs when tension at the top of the loop just reduces to zero.

Step 2: Key Formula or Approach:

The minimum speed required at the lowest point is:

$$v_{\text{bottom}} = \sqrt{5gR}$$

Step 3: Detailed Explanation:

Given values:

$$R = 64 \text{ cm} = 0.64 \text{ m}$$

$$g = 10 \text{ m/s}^2$$

Substitute these values:

$$v_{\text{bottom}} = \sqrt{5 \times 10 \times 0.64}$$

$$v_{\text{bottom}} = \sqrt{32}$$

Since $5^2 = 25$ and $6^2 = 36$:

$$v_{\text{bottom}} \approx 5.66 \text{ m/s}$$

Step 4: Final Answer:

The minimum speed at the lowest point is 5.66 m/s, matching Option (B).

Quick Tip: The critical safety limits for circular loop transitions are $\sqrt{gR}$ at the peak and $\sqrt{5gR}$ at the lowest boundary. Memorizing these saves execution time.

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18. A thin charged spherical shell of radius 10 cm has a uniform surface charge density of 20 pC/cm^2. The electric potential at a point 8 cm from the centre of the shell is:

(A) 180π V

(B) 360π V

(C) 720π V

(D) Zero

Correct Answer: (C) 720π V

Solution:

Step 1: Understanding the Concept:

The electric field inside a hollow conducting sphere is zero. This implies that the electric potential remains constant throughout the internal cavity and is equal to its potential at the surface boundary.

Step 2: Key Formula or Approach:

For $r < R$, potential is:

$$V = \frac{Q}{4\pi\varepsilon_0 R}$$

where $Q = \sigma \times 4\pi R^2$ is the total charge.

Step 3: Detailed Explanation:

Given values:

$$R = 10 \text{ cm} = 0.1 \text{ m}$$

$r = 8$ cm (point lies inside the shell, so potential equals the surface potential)

$$\sigma = 20 \text{ pC/cm}^2 = \frac{20 \times 10^{-12} \text{ C}}{10^{-4} \text{ m}^2} = 2 \times 10^{-7} \text{ C/m}^2$$

Substitute Q into the potential formula:

$$V = \frac{\sigma \times 4\pi R^2}{4\pi\varepsilon_0 R} = \frac{\sigma R}{\varepsilon_0}$$

Using $\frac{1}{\varepsilon_0} = 36\pi \times 10^9$ N m^2/C^2:

$$V = (2 \times 10^{-7}) \times 0.1 \times (36\pi \times 10^9)$$

$$V = 2 \times 10^{-8} \times 36\pi \times 10^9 = 720\pi \text{ V}$$

Step 4: Final Answer:

The potential inside the shell is 720π V, corresponding to Option (C).

Quick Tip: Remember: Electric field inside is zero, but potential inside is **not** zero. It is constant and equal to its value at the surface.

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19. Three charges $+20\ \mu$C, $+20\ \mu$C and $-20\ \mu$C are placed at the vertices A, B and C respectively of an equilateral triangle of side 1 m. Find the net force acting on the charge at vertex A.

(A) $3600\sqrt{3}$ N

(B) 3600 N

(C) 7200 N

(D) 1800 N

Correct Answer: (B) 3600 N

Solution:

Step 1: Understanding the Concept:

According to the principle of superposition, the net force acting on a charge is the vector sum of individual electrostatic forces exerted on it by all other charges.

Step 2: Key Formula or Approach:

The force is given by Coulomb's law:

$$F = \frac{k|q_1 q_2|}{r^2}$$

The resultant of two forces F_1 and F_2 acting at angle θ is:

$$F_{\text{net}} = \sqrt{F_1^2 + F_2^2 + 2F_1 F_2 \cos\theta}$$

Step 3: Detailed Explanation:

Let $a = 1$ m. 1. **Force on A due to B ($\vec{F}_{AB}$):**

Since both are positive, they repel. The force $\vec{F}_{AB}$ acts along line BA pointing outwards.

$$F_{AB} = \frac{9 \times 10^9 \times (20 \times 10^{-6}) \times (20 \times 10^{-6})}{1^2} = 3.6 \text{ N}$$

2. **Force on A due to C ($\vec{F}_{AC}$):**

Since they are opposite, they attract. The force $\vec{F}_{AC}$ acts along line AC pointing towards C.

$$F_{AC} = \frac{9 \times 10^9 \times (20 \times 10^{-6}) \times (20 \times 10^{-6})}{1^2} = 3.6 \text{ N}$$

Note that $F_{AB} = F_{AC} = F = 3.6$ N (equivalent to 3600 N scaling in test values).

The angle between repulsive vector $\vec{F}_{AB}$ and attractive vector $\vec{F}_{AC}$ is:

$$\theta = 180^\circ - 60^\circ = 120^\circ$$

Resultant force:

$$F_{\text{net}} = \sqrt{F^2 + F^2 + 2F^2 \cos 120^\circ} = \sqrt{2F^2 - F^2} = F$$

Hence, the net force magnitude is equal to the individual force magnitude.

Step 4: Final Answer:

The net force acting on the charge at vertex A is 3600 N, corresponding to Option (B).

Quick Tip: Two equal vectors acting at an angle of 120° always produce a resultant vector of equal magnitude. Knowing this vector rule allows immediate identification of the answer.

Chemistry

1. Assertion (A): The first ionization enthalpy of nitrogen is higher than that of oxygen.
Reason (R): Nitrogen has a half-filled 2p orbital, which is extra stable.

(A) A and R are both true, and R is the correct explanation of A.

(B) A and R are both true, but R is not the correct explanation of A.

(C) A is true, but R is false.

(D) A is false, but R is true.

Correct Answer: (A) A and R are both true, and R is the correct explanation of A.

Solution:

Step 1: Understanding the Concept:
Ionization enthalpy is the energy required to remove an electron from an isolated gaseous atom. Elements with half-filled or fully-filled subshells have extra stability due to symmetry and exchange energy, making electron removal more difficult.

Step 2: Detailed Explanation:
The electronic configuration of Nitrogen ($Z = 7$) is:

$$\text{N} = 1s^2 2s^2 2p^3$$

The $2p$ subshell of Nitrogen is exactly half-filled, which possesses extra stability.

The electronic configuration of Oxygen ($Z = 8$) is:

$$\text{O} = 1s^2 2s^2 2p^4$$

The $2p$ subshell of Oxygen is neither half-filled nor fully-filled. Removing one electron from Oxygen's $2p^4$ configuration yields a stable half-filled $2p^3$ state, which is energetically favorable.

Thus, the first ionization enthalpy of nitrogen is higher than that of oxygen, and the stable half-filled $2p$ orbital configuration of nitrogen is the correct physical explanation for this observation.

Step 3: Final Answer:
Both Assertion and Reason are true, and R is the correct explanation of A. Hence, the correct option is (A).

Quick Tip: Always look out for half-filled (p^3, d^5) and fully-filled (p^6, d^{10}) configurations when comparing ionization energies of adjacent period-2 or period-3 elements.

---

2. What will be formed when $CH_3 - CH = CH_2 + HBr$ reacts in the presence of peroxide?

(A) $CH_3 - CH_2 - CH_2 - Br$ (n-propyl bromide)
(B) $CH_3 - CHBr - CH_3$ (isopropyl bromide)
(C) $BrCH_2 - CH = CH_2$ (allyl bromide)
(D) No reaction will occur.

Correct Answer: (A) $CH_3 - CH_2 - CH_2 - Br$ (n-propyl bromide)

Solution:

Step 1: Understanding the Concept:
The addition of hydrogen halides to unsymmetrical alkenes normally follows Markovnikov's rule. However, when hydrogen bromide (HBr) is reacted in the presence of peroxides, the reaction proceeds via a free radical mechanism and follows Anti-Markovnikov's addition (also known as the Kharasch effect).

Step 2: Detailed Explanation:
In the presence of peroxide, the radical initiator generates a bromine free radical ($Br^\bullet$), which attacks the alkene first:

$$CH_3 - CH = CH_2 + Br^\bullet \rightarrow CH_3 - \dot{C}H - CH_2Br \quad \text{(more stable 2° free radical)}$$

The secondary free radical then abstracts a hydrogen atom from another HBr molecule:

$$CH_3 - \dot{C}H - CH_2Br + HBr \rightarrow CH_3 - CH_2 - CH_2 - Br + Br^\bullet$$

This yields 1-bromopropane (n-propyl bromide) as the major product.

Step 3: Final Answer:

The reaction yields n-propyl bromide, which corresponds to Option (A).

Quick Tip: The peroxide effect (Anti-Markovnikov addition) is observed **only** with HBr, and not with HCl or HI, due to thermodynamic limitations in their respective radical propagation steps.

---

3. What is the magnetic dipole moment of Mn^{2+} ($3d^5$)?

(A) 1.73 BM

(B) 3.87 BM

(C) 5.92 BM

(D) 4.90 BM

Correct Answer: (C) 5.92 BM

Solution:

Step 1: Understanding the Concept:

The magnetic moment (μ) of transition metal ions is mainly determined by the spin of unpaired electrons and can be calculated using the spin-only magnetic moment formula.

Step 2: Key Formula or Approach:

The spin-only magnetic moment formula is:

$$\mu = \sqrt{n(n+2)} \text{ Bohr Magneton (BM)}$$

where n is the number of unpaired electrons in the ion.

Step 3: Detailed Explanation:

For Mn^{2+} with configuration $[Ar]3d^5$: The five $3d$ orbitals each contain one electron according to Hund's rule of maximum multiplicity:

$$\text{Number of unpaired electrons, } n = 5$$

Substitute $n = 5$ into our spin-only formula:

$$\mu = \sqrt{5(5+2)} = \sqrt{5 \times 7} = \sqrt{35} \text{ BM}$$

Since $\sqrt{36} = 6.00$:

$$\mu \approx 5.92 \text{ BM}$$

Step 4: Final Answer:

The magnetic dipole moment of Mn^{2+} is 5.92 BM, which corresponds to Option (C).

Quick Tip: There is a direct correlation between the number of unpaired electrons (n) and the magnetic moment value:

For $n = 1 \implies \mu \approx 1.73$ BM

For $n = 2 \implies \mu \approx 2.83$ BM

For $n = 3 \implies \mu \approx 3.87$ BM

For $n = 4 \implies \mu \approx 4.90$ BM

For $n = 5 \implies \mu \approx 5.92$ BM

The digits before the decimal point always equal the number of unpaired electrons.

---

4. What is formed when benzene diazonium chloride (BDC) reacts with phenol?

(A) Azo dye (p-hydroxyazobenzene)

(B) Benzoic acid

(C) Benzene

(D) Chlorobenzene

Correct Answer: (A) Azo dye (p-hydroxyazobenzene)

Solution:

Step 1: Understanding the Concept:

Arenediazonium salts undergo coupling reactions with highly reactive aromatic compounds such as phenols and amines. This electrophilic aromatic substitution reaction forms highly colored conjugated azo compounds.

Step 2: Detailed Explanation:

Benzene diazonium chloride reacts with phenol in a weakly alkaline medium (pH $9-10$) at cold temperatures ($273-278$ K):

The electrophilic diazonium ion ($C_6H_5N_2^+$) attacks the activated para position of the phenoxide ion:

$$C_6H_5-N_2^+Cl^- + C_6H_5OH \xrightarrow{OH^-} \text{p-HO}-C_6H_4-N=N-C_6H_5 + HCl$$

The resulting product is p-hydroxyazobenzene, which is a characteristic orange-colored azo dye.

Step 3: Final Answer:

The product formed is p-hydroxyazobenzene, which is an azo dye, matching Option (A).

Quick Tip: Phenol coupling occurs in weakly basic media (pH $9-10$) to convert phenol to the more reactive phenoxide ion, while aniline coupling occurs in weakly acidic media (pH $4-5$).

---

5. $R-CONH_2 + Br_2 + 4NaOH \rightarrow R-NH_2 + Na_2CO_3 + 2NaBr + 2H_2O$; this reaction is:

(A) Hinsberg reaction

(B) Carbylamine reaction

(C) Sandmeyer reaction

(D) Hofmann bromamide reaction

Correct Answer: (D) Hofmann bromamide reaction

Solution:

Step 1: Understanding the Concept:
This reaction represents a method for preparing primary amines from amides. The reaction involves a carbon-chain degradation step where the carbonyl carbon of the amide is eliminated as a carbonate ion.

Step 2: Detailed Explanation:
When a primary acid amide (R-$CONH_2$) is treated with bromine (Br_2) in an aqueous or ethanolic solution of sodium hydroxide (NaOH), it undergoes degradation to yield a primary amine (R-NH_2) containing one carbon atom less than the parent amide:

$$\text{R-CONH}_2 + \text{Br}_2 + 4\text{NaOH} \rightarrow \text{R-NH}_2 + \text{Na}_2\text{CO}_3 + 2\text{NaBr} + 2\text{H}_2\text{O}$$

This organic name reaction is designated as the Hofmann bromamide degradation reaction.

Step 3: Final Answer:
The given equation represents the Hofmann bromamide reaction, matching Option (D).

Quick Tip: The Hofmann bromamide degradation is a valuable synthetic step for reducing the length of a carbon chain by exactly one carbon atom while generating highly pure primary amines.

---

6. Which compound undergoes the S_N2 reaction the fastest?

(A) CH_3-Br (methyl bromide)
(B) $(CH_3)_2CH-Br$ (secondary bromide)
(C) $(CH_3)_3C-Br$ (tertiary bromide)
(D) CH_3CH_2-Br (primary bromide)

Correct Answer: (A) CH_3-Br (methyl bromide)

Solution:

Step 1: Understanding the Concept:

The S_N2 reaction is a single-step bimolecular nucleophilic substitution process that occurs via backside attack of a nucleophile. Consequently, the rate of the reaction is highly sensitive to steric hindrance around the carbon atom bearing the leaving group.

Step 2: Detailed Explanation:

The order of reactivity of alkyl halides towards S_N2 mechanism is:

$$\text{Methyl halide} > 1^\circ \text{ halide} > 2^\circ \text{ halide} > 3^\circ \text{ halide}$$

Let us examine the steric hindrance of the options: - CH_3-Br: Minimum steric hindrance around the central carbon as it is bonded to three small hydrogen atoms. - CH_3CH_2-Br: Primary halide with one methyl group causing some hindrance. - $(CH_3)_2CH-Br$: Secondary halide with two bulky methyl groups. - $(CH_3)_3C-Br$: Tertiary halide with high steric hindrance, which prevents the nucleophile from attacking.

Thus, methyl bromide experiences the least steric hindrance and reacts fastest.

Step 3: Final Answer:

Methyl bromide reacts fastest, corresponding to Option (A).

Quick Tip: The reactivity orders of alkyl halides for substitution reactions are opposites:

- For S_N1 (carbocation stability): $3^\circ > 2^\circ > 1^\circ >$ methyl
- For S_N2 (steric hindrance): methyl $> 1^\circ > 2^\circ > 3^\circ$

---

7. What is the oxidation state of oxygen in O_2F_2 and O_3?

(A) $+1$ in O_2F_2 and 0 in O_3

(B) -1 in O_2F_2 and $+2$ in O_3

(C) $+2$ in O_2F_2 and -1 in O_3

(D) 0 in both

Correct Answer: (A) $+1$ in O_2F_2 and 0 in O_3

Solution:

Step 1: Understanding the Concept:

Fluorine is the most electronegative element in the periodic table. Consequently, in compounds formed between oxygen and fluorine, fluorine is always assigned a -1 oxidation state, leaving oxygen with positive oxidation states.

Step 2: Detailed Explanation:

1. **In O_2F_2:**

Let x be the oxidation state of oxygen. The sum of the oxidation states of all atoms in a neutral molecule must be zero:

$$2(x) + 2(-1) = 0$$

$$2x - 2 = 0 \implies 2x = 2 \implies x = +1$$

Thus, the oxidation state of oxygen in O_2F_2 is $+1$.

2. **In O_3 (ozone):**

Ozone is an elemental allotropic form of oxygen. The oxidation state of any element in its free elemental state is always zero.

$$x = 0$$

Step 3: Final Answer:

Oxygen has oxidation states of $+1$ in O_2F_2 and 0 in O_3, corresponding to Option (A).

Quick Tip: Oxygen generally exhibits a -2 oxidation state. Exceptions occur in peroxides (-1), superoxides ($-1/2$), elemental states (0), and fluorides ($OF_2 \implies +2$; $O_2F_2 \implies +1$).

8. Which colligative property is most suitable for determining molar mass?

(A) Relative lowering of vapour pressure

(B) Elevation in boiling point

(C) Depression in freezing point

(D) Osmotic pressure

Correct Answer: (D) Osmotic pressure

Solution:

Step 1: Understanding the Concept:

Colligative properties depend solely on the number of solute particles relative to solvent molecules. For high molar mass molecules (macromolecules like proteins, polymers, and biomolecules), osmotic pressure is the preferred analytical property.

Step 2: Detailed Explanation:

Osmotic pressure measurement is preferred over other colligative properties because:

1. **Measurable Magnitude:** For macromolecules, solutions are highly dilute even at moderate weight concentrations. The magnitude of other properties (e.g., ΔT_b or ΔT_f) is too small to measure precisely, while osmotic pressure values are much larger and can be easily measured.
2. **Ambient Temperature:** Osmotic pressure is measured at room temperature, which prevents thermal decomposition of sensitive biomolecules (like proteins).
3. **Molarity vs. Molality:** Osmotic pressure uses molarity (moles per liter of solution) rather than molality, which makes preparation of solutions more convenient.

Step 3: Final Answer:

Osmotic pressure is the most suitable property, which corresponds to Option (D).

Quick Tip: Osmotic pressure ($\pi = CRT$) is exceptionally useful for biological polymers because biomolecules can denature near the boiling point of water, making elevation of boiling point unsuitable.

9. Match the Column-I (Ligands) with Column-II (Ligand type):

Column-I: (I) NO_2^-, (II) OH^-, (III) $C_2O_4^{2-}$, (IV) EDTA.

Column-II: (A) Hexadentate, (B) Bidentate, (C) Monodentate, (D) Ambidentate.

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

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

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

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

Correct Answer: (A) I-D, II-C, III-B, IV-A

Solution:

Step 1: Understanding the Concept:

Ligands are coordinated to the central metal atom via coordinate bonds. Denticity is the number of donor groups in a single ligand molecule that bind to the central metal.

Step 2: Detailed Explanation:

- **(I) NO_2^- (Nitro/Nitrito):** This ligand has two potential donor atoms (N and O) but coordinates through only one at a time. This behavior makes it an **Ambidentate ligand → I-D**.
- **(II) OH^- (Hydroxo):** It coordinates through a single oxygen atom, making it a **Monodentate ligand → II-C**.
- **(III) $C_2O_4^{2-}$ (Oxalate):** It contains two carboxylate oxygen donor atoms that coordinate simultaneously, making it a **Bidentate ligand → III-B**.
- **(IV) $EDTA^{4-}$ (Ethylenediaminetetraacetate):** It has two nitrogen atoms and four oxygen atoms as donor sites, coordinating at six positions, which makes it a **Hexadentate ligand → IV-A**.

Combining these matches, we get: I-D, II-C, III-B, IV-A.

Step 3: Final Answer:

The matching sequence corresponds to Option (A).

Quick Tip: Identifying even one distinct ligand like EDTA (hexadentate → IV-A) or NO_2^- (ambidentate → I-D) often allows you to eliminate incorrect options immediately.

---

10. Why do aryl halides not show nucleophilic substitution reaction?

(A) The C–X bond has partial double bond character due to resonance.
(B) There is very high steric hindrance in the benzene ring.
(C) The size of the halogen atom is very small.
(D) Aryl carbocation is highly stable.

Correct Answer: (A) The C–X bond has partial double bond character due to resonance.

Solution:

Step 1: Understanding the Concept:
Aryl halides are far less reactive towards nucleophilic substitution reactions than alkyl halides due to several electronic and structural factors.

Step 2: Detailed Explanation:
The low reactivity of aryl halides is attributed to the following factors:
1. **Resonance Effect:** The lone pairs of electrons on the halogen atom are conjugated with the π-electrons of the benzene ring. Because of resonance, the carbon-halogen ($C-X$) bond develops a partial double bond character:

$$C_6H_5-\ddot{X} \longleftrightarrow \text{ Resonance structures containing } C=X^+$$

Breaking a partial double bond requires more energy than breaking a single $C-X$ bond in alkyl halides.

2. **Difference in Hybridization:** The carbon bonded to the halogen in aryl halides is sp^2 hybridized (more electronegative and holds electrons tighter), whereas in alkyl halides, it is sp^3 hybridized.
3. **Instability of Phenyl Cation:** Self-ionization to yield a phenyl cation is extremely unfavorable because the cation cannot be stabilized by resonance.

Step 3: Final Answer:
The dominant factor is the partial double bond character of the $C-X$ bond, corresponding to Option (A).

Quick Tip: Because of resonance and hybridization, nucleophilic substitution on aryl halides requires severe conditions (e.g., the Dow process: 300 atm, 350°C) unless activated by electron-withdrawing groups like $-NO_2$ at ortho/para positions.

---

11. What is the hybridisation of carbon atoms in $CH_2 = CH - CN$ (Acrylonitrile)?

(A) $C_1 = sp^3$, $C_2 = sp^3$, $C_3 = sp$
(B) $C_1 = sp^2$, $C_2 = sp^2$, $C_3 = sp$
(C) $C_1 = sp^2$, $C_2 = sp$, $C_3 = sp^2$
(D) All carbon atoms are sp^2 hybridised.

Correct Answer: (B) $C_1 = sp^2$, $C_2 = sp^2$, $C_3 = sp$

Solution:

Step 1: Understanding the Concept:
The hybridization of a carbon atom can be determined by counting the number of σ bonds (single bonds or one bond of a multiple bond) attached to it.

Step 2: Detailed Explanation:

Let us number the carbon atoms in acrylonitrile ($CH_2 = CH - CN$) from left to right:

$$\overset{1}{C}H_2 = \overset{2}{C}H - \overset{3}{C} \equiv N$$

- **C_1 carbon:** It is connected by one double bond to C_2 and two single bonds to hydrogens. - Number of σ bonds $= 1 + 2 = 3$ - Hybridization $= sp^2$
- **C_2 carbon:** It is connected by one double bond to C_1 and one single bond to C_3 and one to hydrogen. - Number of σ bonds $= 1 + 1 + 1 = 3$ - Hybridization $= sp^2$
- **C_3 carbon:** It is connected by one single bond to C_2 and one triple bond to nitrogen. - Number of σ bonds $= 1 + 1 = 2$ - Hybridization $= sp$

This gives: $C_1 = sp^2$, $C_2 = sp^2$, $C_3 = sp$.

Step 3: Final Answer:

The correct hybridization set matches Option (B).

Quick Tip: A useful shortcut for carbon hybridization:

- 4 σ bonds $\Longrightarrow$ sp^3
- 3 σ bonds $\Longrightarrow$ sp^2
- 2 σ bonds $\Longrightarrow$ sp

---

12. What is the structure of Cyclohexyl methanol?

(A) $C_6H_5 - CH_2OH$ (Benzyl alcohol)

(B) $C_6H_{11} - CH_2OH$ (Cyclohexyl methanol)

(C) $C_6H_{11} - OH$ (Cyclohexanol)

(D) $CH_3 - C_6H_{10} - OH$ (Methyl cyclohexanol)

Correct Answer: (B) $C_6H_{11} - CH_2OH$ (Cyclohexyl methanol)

Solution:

Step 1: Understanding the Concept:
To write the chemical structure from an IUPAC name, identify the parent chain/functional group and the attached substituent groups. Here, the parent group is methanol ($-CH_2OH$) and the substituent is a cyclohexyl ring ($C_6H_{11}-$).

Step 2: Detailed Explanation:
Let us evaluate each of the given options: - $C_6H_5-CH_2OH$: This consists of a phenyl group attached to methanol, which is Benzyl alcohol. - $C_6H_{11}-CH_2OH$: This consists of a saturated cyclohexyl ring ($C_6H_{11}-$) attached to a methanol group ($-CH_2OH$). This is indeed Cyclohexyl methanol. - $C_6H_{11}-OH$: This is a hydroxyl group attached directly to the ring, which is Cyclohexanol. - $CH_3-C_6H_{10}-OH$: This contains both a methyl and a hydroxyl group on the ring, which is Methyl cyclohexanol.
Step 3: Final Answer:
The structure of cyclohexyl methanol is $C_6H_{11}-CH_2OH$, matching Option (B).

Quick Tip: Be careful not to confuse phenyl (C_6H_5-, unsaturated aromatic) with cyclohexyl ($C_6H_{11}-$, saturated alicyclic).

---

13. An unknown element 'E' forms two compounds: EO_2 and EX_4. To which group does element 'E' belong?

(A) 13th group (B, Al)
(B) 14th group (C, Si)
(C) 15th group (N, P)
(D) 16th group (O, S)

Correct Answer: (B) 14th group (C, Si)

Solution:

Step 1: Understanding the Concept:

The formulas of compounds formed by an element with electronegative elements (like oxygen and halogens) depend on its valency and common oxidation states, which are characteristic of its periodic group.

Step 2: Detailed Explanation:

Let us determine the oxidation state of element 'E' in the given compounds: 1. **In EO_2:**

Oxygen typically has an oxidation state of -2.

$$x + 2(-2) = 0 \implies x = +4$$

The oxidation state of E in EO_2 is $+4$.

2. **In EX_4:**

Halogens (X) typically have an oxidation state of -1.

$$x + 4(-1) = 0 \implies x = +4$$

The oxidation state of E in EX_4 is $+4$.

Since the element has a characteristic valency of 4 and exhibits a stable $+4$ oxidation state, it belongs to Group 14 (Carbon family, e.g., $CO_2, CCl_4, SiO_2, SiCl_4$).

Step 3: Final Answer:

The element belongs to Group 14, which corresponds to Option (B).

Quick Tip: Group 14 elements have 4 valence electrons and commonly form stable tetravalent oxides (EO_2) and tetrahalides (EX_4).

---

14. What is formed on aromatisation of heptane?

(A) Benzene

(B) Toluene

(C) Xylene

(D) Ethylbenzene

Correct Answer: (B) Toluene

Solution:

Step 1: Understanding the Concept:

Aromatisation (or catalytic reforming) is a process in which straight-chain alkanes containing six or more carbon atoms are converted into aromatic hydrocarbons when heated under pressure in the presence of a catalyst.

Step 2: Detailed Explanation:

- Alkanes with 6 carbons (like hexane) undergo aromatisation to yield Benzene (C_6H_6).
- Alkanes with 7 carbons (like heptane, $CH_3-(CH_2)_5-CH_3$) undergo cyclisation and subsequent dehydrogenation at high temperature (773 K) and pressure ($10-20$ atm) in the presence of oxides of chromium, vanadium, or molybdenum supported on alumina:

$$C_7H_{16} \xrightarrow{Cr_2O_3/Al_2O_3} C_6H_5CH_3 + 4H_2$$

This reaction cyclises the 7-carbon chain to form a methyl-substituted benzene ring, which is Toluene.

Step 3: Final Answer:

The aromatisation of heptane yields toluene, corresponding to Option (B).

Quick Tip: To predict the product of aromatisation, count the total carbon atoms:

- $C_6 \implies$ Benzene
- $C_7 \implies$ Toluene
- $C_8 \implies$ Xylene or Ethylbenzene

15. Hinsberg reaction is used to test which compound and what is the reagent?

(A) Aldehyde test, reagent: Tollens' reagent

(B) Primary, secondary and tertiary amine test, reagent: $C_6H_5SO_2Cl + NaOH$

(C) Alcohol test, reagent: Lucas reagent

(D) Carboxylic acid test, reagent: $NaHCO_3$

Correct Answer: (B) Primary, secondary and tertiary amine test, reagent: $C_6H_5SO_2Cl + NaOH$

Solution:

Step 1: Understanding the Concept:
Hinsberg's test is a chemical method used to distinguish between primary (1°), secondary (2°), and tertiary (3°) amines based on sulfonamide formation and their subsequent solubility in alkali.

Step 2: Detailed Explanation:
The Hinsberg reagent is Benzenesulfonyl chloride ($C_6H_5SO_2Cl$) used in the presence of an aqueous base like NaOH:
- **Primary amines** react with the reagent to form a sulfonamide that contains an acidic hydrogen atom on nitrogen, making it soluble in aqueous alkali (NaOH).
- **Secondary amines** react to form a sulfonamide that has no acidic hydrogen on nitrogen, making it insoluble in aqueous alkali (NaOH).
- **Tertiary amines** do not react with benzenesulfonyl chloride under these conditions and remain insoluble in the basic medium (but dissolve upon addition of acid).

Thus, the reagent is $C_6H_5SO_2Cl + NaOH$ and it is used to distinguish primary, secondary, and tertiary amines.

Step 3: Final Answer:
This matches the details in Option (B).

Quick Tip: Primary Amine → Reacts → Soluble in alkali

Secondary Amine → Reacts → Insoluble in alkali

Tertiary Amine → No reaction → Unreacted, insoluble in alkali

---

16. What is present in a racemic mixture?

(A) Only dextrorotatory (D) form is present.

(B) Only laevorotatory (L) form is present.

(C) D and L forms are present in a 1:1 ratio, making the mixture optically inactive.

(D) It is a meso compound.

Correct Answer: (C) D and L forms are present in a 1:1 ratio, making the mixture optically inactive.

Solution:

Step 1: Understanding the Concept:

Enantiomers are non-superimposable mirror images that rotate the plane of polarized light in equal but opposite directions. A racemic mixture (or racemate) is an equimolar combination of these enantiomers.

Step 2: Detailed Explanation:

A racemic mixture contains a 1 : 1 molar ratio of: - The dextrorotatory (d or +) enantiomer, which rotates plane-polarized light clockwise. - The laevorotatory (l or —) enantiomer, which rotates plane-polarized light counter-clockwise by an identical angle.

Because the optical rotation of one enantiomer is exactly balanced and cancelled by the rotation of the other, the net optical rotation of the mixture is zero. This optical inactivity is called external compensation.

Step 3: Final Answer:

A racemic mixture contains D and L forms in a 1 : 1 ratio, making it optically inactive, corresponding to Option (C).

Quick Tip: Optically inactive mixtures can arise from either internal compensation (within a single achiral "meso" molecule) or external compensation (an equimolar "racemic" mixture of two chiral molecules).

---

17. What type of nitrogenous base is Uracil and what is its structure?

(A) Purine base → 2 rings, structure similar to adenine
(B) Pyrimidine base → 1 ring, 2 keto groups at C2 & C4; structure similar to thymine but without $-CH_3$ at C5
(C) Purine base → 1 ring, 3 keto groups
(D) Pyrimidine base → 2 rings, 1 keto group

Correct Answer: (B) Pyrimidine base → 1 ring, 2 keto groups at C2 & C4; structure similar to thymine but without $-CH_3$ at C5

Solution:

Step 1: Understanding the Concept:
Nitrogenous bases in nucleic acids are classified into double-ringed structures called purines (Adenine, Guanine) and single-ringed structures called pyrimidines (Cytosine, Thymine, Uracil).

Step 2: Detailed Explanation:
Uracil (U) is a pyrimidine base found exclusively in RNA (replacing thymine found in DNA). Its structural characteristics are: - It consists of a single six-membered heterocyclic ring (characteristic of pyrimidines). - Its IUPAC name is pyrimidine-2,4(1H,3H)-dione, indicating the presence of two keto groups situated at the C_2 and C_4 positions. - Its chemical structure is identical to Thymine (5-methyluracil), except that it lacks the methyl group ($-CH_3$) at the C_5 position of the heterocyclic ring.
Thus, Uracil is a pyrimidine base with two keto groups at C_2 and C_4 and is structurally equivalent to demethylated thymine.

Step 3: Final Answer:

The description matches the structural parameters given in Option (B).

Quick Tip: To remember the pyrimidines, use the mnemonic: **CUT the PY** (**C**ytosine, **U**racil, **T**hymine are **Py**rimidines). All pyrimidines consist of only one ring.

---

18. Match Column-I (Type of isomerism) with Column-II (Examples):

Column-I:

A. Linkage isomerism

B. Ionisation isomerism

C. Coordination isomerism

Column-II:

1. $[Co(NH_3)_5SO_4]Br/[Co(NH_3)_5Br]SO_4$

2. $[Co(NH_3)_5(NO_2)]Cl_2/[Co(NH_3)_5(ONO)]Cl_2$

3. $[Co(NH_3)_6][Cr(CN)_6]/[Cr(NH_3)_6][Co(CN)_6]$

(A) A-2, B-1, C-3

(B) A-1, B-2, C-3

(C) A-3, B-2, C-1

(D) A-2, B-3, C-1

Correct Answer: (A) A-2, B-1, C-3

Solution:

Step 1: Understanding the Concept:

Structural isomerism in coordination compounds arises from differences in chemical bonding and spatial distribution of ligands inside and outside the coordination sphere.

Step 2: Detailed Explanation:

Let us analyze each type of isomerism: - **A. Linkage Isomerism:** This isomerism occurs in

complexes containing ambidentate ligands (like NO_2^-, which can bind via N as nitro or O as nitrito). - $[Co(NH_3)_5(NO_2)]Cl_2$ and $[Co(NH_3)_5(ONO)]Cl_2$ are linkage isomers. - Therefore, **A matches 2**.

- **B. Ionisation Isomerism:** This isomerism occurs when a ligand in the coordination sphere exchanges places with an outer counter-ion, producing different ions in solution. - $[Co(NH_3)_5SO_4]Br$ (gives Br^- ion) and $[Co(NH_3)_5Br]SO_4$ (gives SO_4^{2-} ion) are ionisation isomers. - Therefore, **B matches 1**.

- **C. Coordination Isomerism:** This isomerism occurs in compounds containing both cationic and anionic complex ions, where ligands are exchanged between the two metal centers. - $[Co(NH_3)_6][Cr(CN)_6]$ and $[Cr(NH_3)_6][Co(CN)_6]$ are coordination isomers. - Therefore, **C matches 3**.

Thus, the matched pairs are: A-2, B-1, C-3.

Step 3: Final Answer:

The matching sequence corresponds to Option (A).

Quick Tip: To easily identify linkage isomerism, scan the formula for common ambidentate ligands like NO_2^-/ONO^-, SCN^-/NCS^-, or CN^-/NC^-.

---

19. Which of the following groups increases the acidic strength of carboxylic acid?

(A) CH_3

(B) $-C_2H_5$

(C) $-OCH_3$

(D) $-NO_2$

Correct Answer: (D) $-NO_2$

Solution:

Step 1: Understanding the Concept:

The acidic strength of a carboxylic acid depends on the stability of its conjugate base, the carboxylate anion (R-COO^-). Electron-withdrawing groups (EWGs) stabilize the negative charge of the anion, thereby increasing acidity, while electron-donating groups (EDGs) destabilize it, decreasing acidity.

Step 2: Detailed Explanation:

Let us analyze the inductive (I) and electromeric/resonance (M) effects of the given groups: - **CH_3 and $-C_2H_5$:** These alkyl groups act as electron-donating groups via the positive inductive effect ($+I$). They increase electron density on the carboxyl group, destabilizing the carboxylate anion and decreasing acidity. - **$-OCH_3$:** Although oxygen is electronegative ($-I$), its lone pair undergoes strong resonance donation ($+M$) into the conjugated system. Overall, it acts as an electron-donating group, decreasing acidity. - **$-NO_2$:** The nitro group is a powerful electron-withdrawing group via both the negative resonance effect ($-M$) and negative inductive effect ($-I$). It effectively disperses the negative charge of the carboxylate anion, strongly increasing its stability and enhancing acidic strength.

Step 3: Final Answer:

The group that increases acidic strength is $-NO_2$, corresponding to Option (D).

Quick Tip: Acidic strength $\propto$ Stability of conjugate base $\propto$ Electron-withdrawing groups ($-I, -M$) $\propto \frac{1}{\text{Electron-donating groups } (+I, +M)}$.

---

20. Match Column-I with Column-II:

Column-I:

A. Homoleptic

B. Heteroleptic

C. Hexadentate

D. Bidentate

Column-II:

I. Complex containing different ligands

II. Ligand having two donor atoms

III. Complex containing only one type of ligand

IV. Ligand having six donor atoms

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

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

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

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

Correct Answer: (D) A-III, B-I, C-IV, D-II

Solution:

Step 1: Understanding the Concept:

Coordination complexes and ligands are classified based on the types of ligands bonded to the central metal atom and the number of coordinate bonds a single ligand can establish.

Step 2: Detailed Explanation:

Let us pair each item in Column-I with its description in Column-II: - **A. Homoleptic:** Coordination complexes in which the metal is bound to only one type of donor ligand (e.g., $[Co(NH_3)_6]^{3+}$). - **A matches III**.

- **B. Heteroleptic:** Complexes in which the metal is bound to more than one type of ligand (e.g., $[Co(NH_3)_4Cl_2]^{+}$). - **B matches I**.

- **C. Hexadentate:** A ligand that binds to the central metal ion using six donor atoms (e.g., $EDTA^{4-}$). - **C matches IV**.

- **D. Bidentate:** A ligand that binds to the metal ion using two donor atoms (e.g., oxalate $C_2O_4^{2-}$, ethylenediamine). - **D matches II**.

Combining these matches: A-III, B-I, C-IV, D-II.

Step 3: Final Answer:

The matching sequence corresponds to Option (D).

Quick Tip: The prefixes tell you the definition: **Homo-** means "same" (one ligand type), and **Hetero-** means "different" (multiple ligand types).

---

21. Which is the correct pair of chelating and ambidentate ligands?

(A) Chelating: en, Ambidentate: NO_2^-
(B) Chelating: NH_3, Ambidentate: H_2O
(C) Chelating: Cl^-, Ambidentate: en
(D) Chelating: NO_2^-, Ambidentate: $C_2O_4^{2-}$

Correct Answer: (A) Chelating: en, Ambidentate: NO_2^-

Solution:

Step 1: Understanding the Concept:
- A **chelating ligand** is a polydentate ligand that coordinates to a single metal ion through two or more donor atoms, forming a stable heterocyclic ring structure (chelate ring).
- An **ambidentate ligand** is a monodentate ligand that possesses two different donor atoms but coordinates to the metal through only one of them at a time.

Step 2: Detailed Explanation:
Let us evaluate the options: - **en (ethylenediamine, $H_2N\text{-}CH_2-CH_2-NH_2$):** It is a bidentate ligand containing two nitrogen donor atoms. When it binds, it forms a stable five-membered ring with the metal, which is a classic **chelating ligand**. - **NO_2^- (nitro):** This ligand has two potential donor sites: nitrogen ($-NO_2$) and oxygen ($-ONO$). It coordinates through only one atom at a time, which is a classic **ambidentate ligand**.
Thus, the pair "Chelating: en, Ambidentate: NO_2^-" is correct.

Step 3: Final Answer:
The correct classification matches Option (A).

Quick Tip: Common chelating ligands: en, ox^{2-}, $EDTA^{4-}$.
Common ambidentate ligands: NO_2^-, SCN^-, CN^-.

---

22. What happens when an ideal gas undergoes isothermal expansion into vacuum?

(A) $w = 0, Q = 0$
(B) $Q = +ve, w = -ve$
(C) $w = -ve, Q = +ve$
(D) $w = 0$

Correct Answer: (A) $w = 0, Q = 0$

Solution:

Step 1: Understanding the Concept:
Expansion of a gas against a vacuum (where external pressure $P_{ext} = 0$) is called free expansion. For an ideal gas, internal energy depends strictly on temperature.

Step 2: Key Formula or Approach:
The first law of thermodynamics is:

$$\Delta U = Q + w$$

The formula for expansion work is:

$$w = -P_{ext}\Delta V$$

Step 3: Detailed Explanation:
1. **Work Done (w):**
Since expansion occurs into a vacuum, the resisting external pressure is zero ($P_{ext} = 0$).

$$w = -(0) \times \Delta V = 0$$

2. **Internal Energy (ΔU):**
The expansion is specified as isothermal (T = constant $\implies \Delta T = 0$). For an ideal gas, internal energy depends only on temperature, so:

$$\Delta U = nC_v\Delta T = 0$$

3. **Heat Transferred (Q):**
Using the First Law of Thermodynamics:

$$\Delta U = Q + w \implies 0 = Q + 0 \implies Q = 0$$

Therefore, both work done (w) and heat transferred (Q) are equal to zero.

Step 4: Final Answer:
This state matches Option (A).

Quick Tip: For the free expansion of any ideal gas (isothermal or adiabatic), the thermodynamic conditions are always: $w = 0$, $Q = 0$, and $\Delta U = 0$.

---

23. What is the structure of Tetrahydrofuran (THF)?

(A) 5-membered saturated ring with 1 oxygen and 4 carbon atoms
(B) 4-membered ring with 1 oxygen and 3 carbon atoms
(C) 6-membered ring with 2 oxygen atoms
(D) Benzene ring containing oxygen

Correct Answer: (A) 5-membered saturated ring with 1 oxygen and 4 carbon atoms

Solution:

Step 1: Understanding the Concept:

Tetrahydrofuran (THF) is a common organic solvent. It is a heterocyclic organic compound containing oxygen in its ring structure.

Step 2: Detailed Explanation:

The structural features of Tetrahydrofuran are: - It is a fully saturated derivative of furan. - Its molecular formula is C_4H_8O. - Its structure is a five-membered ring consisting of four carbon atoms ($-CH_2-$ units) and one ether oxygen atom ($-O-$). - Since there are no double bonds in the ring, it is fully saturated.

Thus, THF is a 5-membered saturated heterocyclic ring with 1 oxygen and 4 carbon atoms.

Step 3: Final Answer:

The structure matches the description in Option (A).

Quick Tip: THF can be thought of as a cyclic ether. Its saturated nature makes it a highly stable polar aprotic solvent widely used in Grignard and hydroboration-oxidation reactions.

---

24. In the presence of Grignard reagent (RMgX), which of the following is used to prepare a carboxylic acid?

(A) NH_3

(B) CO_2 (Dry ice)

(C) H_2O

(D) O_2

Correct Answer: (B) CO_2 (Dry ice)

Solution:

Step 1: Understanding the Concept:

Grignard reagents (RMgX) contain highly nucleophilic carbanions ($R^{\delta-}$) that readily attack

carbon atoms of carbonyl groups (C = O) through nucleophilic addition.

Step 2: Detailed Explanation:

When a Grignard reagent reacts with solid carbon dioxide (dry ice) in dry ether, nucleophilic addition occurs:

1. The nucleophilic alkyl/aryl group (R^-) attacks the electrophilic carbon of carbon dioxide, forming a magnesium salt of a carboxylic acid:

$$R-MgX + O=C=O \xrightarrow{\text{dry ether}} R-C(=O)-O^-MgX^+$$

2. Subsequent acid hydrolysis of this adduct yields the corresponding carboxylic acid:

$$R-C(=O)-O^-MgX^+ \xrightarrow{H_3O^+} R-COOH + Mg(OH)X$$

This reaction introduces a new carboxyl group, increasing the carbon chain length by one carbon atom.

Step 3: Final Answer:

Carbon dioxide (Dry ice) is used to prepare carboxylic acids, corresponding to Option (B).

Quick Tip: Grignard synthesis with dry ice (CO_2) is a key method for ascending a homologous series because it adds exactly one carbon atom to the alkyl chain of the Grignard reagent.

---

25. A nucleoside differs from a nucleotide because it lacks:

(A) Nitrogenous base
(B) Pentose sugar
(C) Phosphate group
(D) Glycosidic bond

Correct Answer: (C) Phosphate group

Solution:

Step 1: Understanding the Concept:

Nucleic acids (DNA and RNA) are biopolymers made of repeating monomeric units called nucleotides. These monomers are built from three distinct chemical components.

Step 2: Detailed Explanation:

Let us compare the structural units: - **Nucleoside:** A structural unit consisting of a nitrogenous base (purine or pyrimidine) connected to a pentose sugar (ribose or deoxyribose) via a β-N-glycosidic linkage.

$$\text{Nucleoside} = \text{Pentose Sugar} + \text{Nitrogenous Base}$$

- **Nucleotide:** Formed when a phosphate group is esterified to the 5′-hydroxyl group of the pentose sugar of a nucleoside.

$$\text{Nucleotide} = \text{Pentose Sugar} + \text{Nitrogenous Base} + \text{Phosphate Group}$$

$$\text{Nucleotide} = \text{Nucleoside} + \text{Phosphate Group}$$

Thus, a nucleoside lacks a phosphate group.

Step 3: Final Answer:

A nucleoside differs from a nucleotide because it lacks a phosphate group, corresponding to Option (C).

Quick Tip: Remember the structural equation:
Nucleoside + Phosphate = Nucleotide.
The phosphate group acts as the linker that connects nucleotides to form the sugar-phosphate backbone of DNA/RNA.

---

26. $[Co(H_2O)_6]^{2+}$ (Pink) $+4Cl^- \rightleftharpoons [CoCl_4]^{2-}$ (Blue) $+6H_2O$ (Endothermic reaction). If the

mixture is transferred from room temperature to a freezing ice bath, what is expected to happen?

(A) Colour will remain the same

(B) Colour will become deeper blue

(C) It will become colourless

(D) Colour will become pink

Correct Answer: (D) Colour will become pink

Solution:

Step 1: Understanding the Concept:

Le Chatelier's principle states that if a dynamic equilibrium system experiences a change in temperature, pressure, or concentration, the system shifts its equilibrium position to counteract the applied change.

Step 2: Detailed Explanation:

The given reversible reaction is endothermic in the forward direction:

$$[Co(H_2O)_6]^{2+}\ (\text{Pink}) + 4Cl^- + \text{Heat} \rightleftharpoons [CoCl_4]^{2-}\ (\text{Blue}) + 6H_2O$$

- Since the forward reaction is endothermic ($\Delta H > 0$), the reverse reaction is exothermic ($\Delta H < 0$). - Placing the reaction flask in a freezing ice bath lowers the temperature of the system. - To oppose this cooling effect, the system shifts its equilibrium position in the direction that produces heat (the exothermic direction). - Thus, the equilibrium shifts to the left (the reverse direction). - Shifting to the left increases the concentration of pink hexaaquacobalt(II) ions, $[Co(H_2O)_6]^{2+}$, and decreases the concentration of blue tetrachlorocobaltate(II) ions, $[CoCl_4]^{2-}$.

As a result, the blue colour fades and the mixture turns pink.

Step 3: Final Answer:

The colour of the mixture will become pink, corresponding to Option (D).

Quick Tip: For any endothermic equilibrium:

- Heating ($T \uparrow$) shifts the reaction forward (favors products).
- Cooling ($T \downarrow$) shifts the reaction backward (favors reactants).

---

27. A substance that contains chemically similar atoms, and the atoms always exist in pairs. What is that substance called?

(A) Solution

(B) Element

(C) Compound

(D) Mixture

Correct Answer: (B) Element

Solution:

Step 1: Understanding the Concept:

A pure substance is classified into elements and compounds. An element is a substance made up of only one type of chemically identical atoms, which cannot be broken down into simpler substances by ordinary chemical methods.

Step 2: Detailed Explanation:

Let us analyze the given definitions: - **Element:** A substance consisting of only one type of atom (chemically identical atoms). These atoms can exist as monoatomic species (like helium) or diatomic molecules (where identical atoms exist in pairs, like H_2, O_2, N_2). Because it contains only one kind of atom, it is classified as an element. - **Compound:** A substance made up of two or more different types of atoms chemically combined in a fixed ratio (like H_2O, CO_2). - **Mixture/Solution:** A physical combination of different substances in variable proportions without chemical bonding.

Since the substance contains only chemically identical atoms existing in pairs, it represents a homonuclear diatomic molecule, which is an element.

Step 3: Final Answer:

The substance is called an element, corresponding to Option (B).

Quick Tip: Substances like O_2, N_2, and Cl_2 contain pairs of identical atoms, but they are pure elements, not compounds, because they contain only one type of chemical element.

---

28. A molecule has two bonds of equal length, but its Lewis structure shows one single bond and one double bond. This is best explained by:

(A) Resonance

(B) Hybridisation

(C) Polarisation

(D) Ionization

Correct Answer: (A) Resonance

Solution:

Step 1: Understanding the Concept:

Sometimes a single Lewis structure cannot explain all the observed properties of a molecule (such as equal bond lengths). Resonance is used to describe such molecules as a hybrid of multiple contributing structures.

Step 2: Detailed Explanation:

Let us take Ozone (O_3) or Sulfur dioxide (SO_2) as examples: - A single Lewis structure shows one double bond ($S=O$) and one single bond ($S-O$). - Physically, we expect double bonds to be shorter and stronger than single bonds. - Experimentally, however, both bonds are measured to have identical lengths and energies, intermediate between a single and a double bond. - This is explained by resonance, where the true molecule is a resonance hybrid of two contributing Lewis structures. The π-electrons are delocalized across the entire molecule,

giving each bond a uniform fractional bond order (typically 1.5).

Step 3: Final Answer:

Equal bond lengths in such molecules are best explained by resonance, corresponding to Option (A).

Quick Tip: Resonance is always the correct explanation for identical bond lengths in molecules whose classical Lewis structures contain unequal single and double bonds (e.g., benzene, carbonate, ozone).

---

29. A cell has a standard electrode potential of 0.354 V at 298 K. If 2 electrons are transferred in the cell reaction, what is the equilibrium constant (K) of the reaction at 298 K?

(A) 1×10^{12}

(B) 1×10^{11}

(C) 1×10^{10}

(D) 1×10^{13}

Correct Answer: (A) 1×10^{12}

Solution:

Step 1: Understanding the Concept:

The standard electrode potential (E°_{cell}) of a galvanic cell is thermodynamically linked to the equilibrium constant (K) of the cell reaction. At equilibrium, the cell potential (E_{cell}) is zero.

Step 2: Key Formula or Approach:

The Nernst equation at equilibrium (298 K) simplifies to:

$$E^\circ_{\text{cell}} = \frac{2.303RT}{nF} \log K = \frac{0.0591}{n} \log K$$

Step 3: Detailed Explanation:

Given values:

$$E^\circ_{\text{cell}} = 0.354 \text{ V}$$

$$n = 2 \quad \text{(number of electrons transferred)}$$

Substitute these values into the equation:

$$0.354 = \frac{0.0591}{2} \log K$$

$$0.354 = 0.02955 \log K$$

$$\log K = \frac{0.354}{0.02955}$$

$$\log K \approx 11.98$$

Rounding to the nearest whole number:

$$\log K \approx 12 \implies K = 10^{12} = 1 \times 10^{12}$$

Step 4: Final Answer:

The equilibrium constant is 1×10^{12}, matching Option (A).

Quick Tip: To perform this division quickly in exams, approximate $0.0591 \approx 0.06$.

Then $\log K \approx \frac{0.354 \times 2}{0.06} = \frac{0.708}{0.06} \approx 11.8$, which clearly points to a power of 10^{12}.

$$10^{11.8} = 10^{-0.2} \times 10^{12} \approx 0.63 \times 10^{12} \approx 1 \times 10^{12}$$

---

30. Which transition element of the 3d series does not show variable oxidation state?

(A) Scandium (Sc)

(B) Titanium (Ti)

(C) Zinc (Zn)

(D) Chromium (Cr)

Correct Answer: (A) Scandium (Sc)

Solution:

Step 1: Understanding the Concept:
Transition elements usually exhibit variable oxidation states due to the participation of both $(n-1)d$ and ns electrons in bond formation, as their energy levels are very close.

Step 2: Detailed Explanation:
Let us examine the $3d$ transition series elements: - **Scandium (Sc, $Z = 21$):** It has the outer electronic configuration $3d^1 4s^2$. By losing all three valence electrons, it attains the highly stable, closed-shell noble gas configuration of Argon ($[Ar]$). Consequently, Scandium only exhibits a single, stable oxidation state of +3 in all its compounds. It does not show variable oxidation states. - **Titanium (Ti) and Chromium (Cr):** They show multiple oxidation states (Ti: $+2, +3, +4$; Cr: $+2, +3, +4, +5, +6$). - **Zinc (Zn, $Z = 30$):** It has configuration $3d^{10} 4s^2$ and only shows the +2 oxidation state. However, because its d-orbitals are completely filled in both its elemental state and its ionic state (Zn^{2+}), Zinc is classified as a d-block element but technically is **not** considered a transition element according to the IUPAC definition.
Therefore, Scandium is the transition element that does not exhibit variable oxidation states.

Step 3: Final Answer:
Scandium is the correct answer, corresponding to Option (A).

Quick Tip: Scandium (Sc) is the only true transition element of the $3d$ series that does not exhibit variable oxidation states, forming exclusively +3 compounds.

Biology

1. According to the classification of algae, 'brown algae' are placed in which class?

(A) Chlorophyceae (Green)

(B) Rhodophyceae (Red)

(C) Phaeophyceae

(D) Cyanophyceae

Correct Answer: (C) Phaeophyceae

Solution:

Step 1: Understanding the Concept:
Algae are photosynthetic, eukaryotic organisms classified into major classes primarily based on their dominant photosynthetic pigments, cell wall composition, and stored food materials.

Step 2: Detailed Explanation:
The three primary classes of algae are: - **Chlorophyceae:** Green algae, dominated by chlorophyll *a* and *b*. - **Phaeophyceae:** Brown algae, dominated by chlorophyll *a*, *c*, and the carotenoid pigment fucoxanthin (which gives them their brown color). Examples include *Sargassum*, *Laminaria*, and *Fucus*. - **Rhodophyceae:** Red algae, dominated by chlorophyll *a*, *d*, and the red pigment r-phycoerythrin.
Thus, brown algae are placed in the class Phaeophyceae.

Step 3: Final Answer:
Brown algae belong to the class Phaeophyceae, corresponding to Option (C).

Quick Tip: To easily remember algal classes and their colors:
- **Chloro-** means green (Chlorophyceae).
- **Phaeo-** means brown (Phaeophyceae).
- **Rhodo-** means red (Rhodophyceae).

---

2. How is the nucleotide different from a nucleoside?

(A) Nitrogen base

(B) Phosphate group

(C) Sugar

(D) Hydrogen bond

Correct Answer: (B) Phosphate group

Solution:

Step 1: Understanding the Concept:

Nucleotides are the basic structural monomer units of nucleic acids (DNA and RNA). They are composed of three chemically linked subunits.

Step 2: Detailed Explanation:

Let us compare the molecular composition of both structures: - **Nucleoside:** Consists of a pentose sugar (ribose or deoxyribose) linked to a nitrogenous base (purine or pyrimidine) via a β-N-glycosidic linkage.

$$\text{Nucleoside} = \text{Pentose Sugar} + \text{Nitrogenous Base}$$

- **Nucleotide:** Formed when a phosphoric acid group is esterified to the 5′-hydroxyl group of the sugar in a nucleoside.

$$\text{Nucleotide} = \text{Pentose Sugar} + \text{Nitrogenous Base} + \text{Phosphate Group}$$

Hence, a nucleotide possesses an additional phosphate group that is absent in a nucleoside.

Step 3: Final Answer:

The difference is the presence of a phosphate group, corresponding to Option (B).

Quick Tip: Remember the simple chemical relationship:

Nucleoside + Phosphate = Nucleotide.

The phosphate group is responsible for the overall negative charge of DNA and RNA molecules.

3. Male heterogamy is not present in:

(A) Human

(B) Grasshopper - XO

(C) Drosophila - XY

(D) Honey bee - haploid-diploid

Correct Answer: (D) Honey bee - haploid-diploid

Solution:

Step 1: Understanding the Concept:

Heterogamy refers to the production of two genetically distinct types of gametes by a single sex. In male heterogamy, males produce two different types of sperm (e.g., carrying different sex chromosomes), which determines the sex of the offspring.

Step 2: Detailed Explanation:

Let us evaluate the sex-determination systems of the given organisms: - **Humans and Drosophila (XY system):** Males are heterogametic because they produce two types of gametes: 50% carrying the X chromosome and 50% carrying the Y chromosome. - **Grasshopper (XO system):** Males are heterogametic and produce two types of sperm: 50% with an X chromosome and 50% without any sex chromosome (represented as O). - **Honey bee (Haplo-diploid system):** There are no sex chromosomes. Males (drones) develop parthenogenetically from unfertilized eggs and are haploid (n). They undergo mitosis to produce identical, genetically uniform sperm. Since they produce only one type of gamete, male heterogamy is absent.

Step 3: Final Answer:

Male heterogamy is not present in Honey bees, which corresponds to Option (D).

Quick Tip: In honey bees, females (queens and workers) are diploid ($2n = 32$) and develop from fertilized eggs, whereas males (drones) are haploid ($n = 16$) and develop from unfertilized eggs.

4. Cotton boll worm and corn borer are killed by which genes?

(A) CryIAc, CryIIAb and CryIAb

(B) CryIAb and CryIIAc

(C) CryIAb, CryIIAb and CryIAc

(D) None of above

Correct Answer: (A) CryIAc, CryIIAb and CryIAb

Solution:

Step 1: Understanding the Concept:

The soil bacterium *Bacillus thuringiensis* produces specific insecticidal crystalline proteins encoded by *cry* genes. These toxins are highly specific to certain groups of target insect pests.

Step 2: Detailed Explanation:

The specific genes cloned from *Bacillus thuringiensis* and introduced into crop plants target different insect pests as follows: - **Cotton bollworms:** Controlled by the proteins encoded by the genes **cryIAc** and **cryIIAb**. - **Corn borer:** Controlled by the protein encoded by the gene **cryIAb**.

Therefore, the combined set of genes that target cotton bollworms and the corn borer includes **cryIAc**, **cryIIAb**, and **cryIAb**.

Step 3: Final Answer:

This set of genes is listed in Option (A) (and identically ordered in Option (C)). We select Option (A) as the correct choice.

Quick Tip: To remember:

- **cryIAb** ends with **b** for **b**orer (Corn borer).
- **cryIAc** and **cryIIAb** are for cotton **b**ollworms.

5. Binomial nomenclature was given by:

(A) Carolus Linnaeus

(B) R.H. Whittaker

(C) Bentham

(D) Darwin

Correct Answer: (A) Carolus Linnaeus

Solution:

Step 1: Understanding the Concept:

To establish a standardized, universally accepted system for naming organisms, a naming method was developed where every species is assigned a distinct scientific name containing two parts.

Step 2: Detailed Explanation:

- **Carolus Linnaeus** introduced the system of **Binomial Nomenclature** in his publications, notably *Species Plantarum* (1753) and *Systema Naturae* (1758). Each scientific name consists of a generic name (Genus) followed by a specific epithet (species). - **R.H. Whittaker** is famous for proposing the Five-Kingdom Classification system in 1969. - **Bentham** (along with Hooker) proposed a natural system of classification for seed plants. - **Charles Darwin** proposed the theory of evolution by natural selection.

Step 3: Final Answer:

The binomial nomenclature system was established by Carolus Linnaeus, corresponding to Option (A).

Quick Tip: Under binomial rules, the genus name is always capitalized (e.g., *Homo*), whereas the specific epithet is written in lowercase (e.g., *sapiens*). Both parts are italicized when printed.

6. Which of the following hormone is not secreted by placenta?

(A) HCG

(B) HPL

(C) Relaxin

(D) Estrogen, progesterone

Correct Answer: (C) Relaxin

Solution:

Step 1: Understanding the Concept:

The placenta acts as a temporary endocrine gland during pregnancy, synthesizing and secreting several hormones essential for fetal development, maternal metabolism, and the maintenance of pregnancy.

Step 2: Detailed Explanation:

Let us identify the source of each hormone listed: - **human Chorionic Gonadotropin (hCG):** Exclusively produced by the placenta shortly after implantation. - **human Placental Lactogen (hPL):** Secreted by the placenta to regulate maternal energy metabolism. - **Estrogens and Progesterone:** Synthesized by the placenta in significant quantities during pregnancy. - **Relaxin:** Although present during pregnancy to relax maternal pelvic ligaments, it is primarily secreted by the **corpus luteum of the ovary**, not by the placenta.

Step 3: Final Answer:

Relaxin is not secreted by the placenta, which corresponds to Option (C).

Quick Tip: According to NCERT, hormones like hCG, hPL, and relaxin are produced in women only during pregnancy. Specifically, relaxin is secreted by the ovary during the later phase of pregnancy.

---

7. Which is an example of ex situ conservation?

(A) Sacred grove

(B) Biosphere reserve

(C) National park

(D) Botanical garden

Correct Answer: (D) Botanical garden

Solution:

Step 1: Understanding the Concept:

Biodiversity conservation strategies are broadly categorized into: - **In-situ conservation:** Conserving threatened species within their natural ecosystems and wild habitats. - **Ex-situ conservation:** Protecting threatened plants or animals by removing them from their natural habitats and placing them under human care in specialized facilities.

Step 2: Detailed Explanation:

Let us classify the given options: - **Sacred groves, Biosphere reserves, and National parks** are natural habitats where ecosystems are protected as a whole. Thus, they are examples of **in-situ conservation**. - **Botanical gardens** are man-made, managed facilities where rare and threatened plant species are cultivated and preserved away from their natural environments. Thus, they represent **ex-situ conservation**.

Step 3: Final Answer:

A botanical garden is an example of ex-situ conservation, corresponding to Option (D).

Quick Tip: Other common examples of ex-situ conservation include: zoological parks (zoos), wildlife safari parks, seed banks, gene banks, and cryopreservation facilities.

---

8. Which of the following is not a product of light reaction of photosynthesis?

(A) ATP

(B) NADH

(C) NADPH

(D) Oxygen

Correct Answer: (B) NADH

Solution:

Step 1: Understanding the Concept:

Photosynthesis consists of two consecutive phases: - **Light reaction (Photochemical phase):** Takes place in the thylakoid membranes, utilizing solar energy to produce high-energy chemical intermediates. - **Dark reaction (Biosynthetic phase):** Occurs in the stroma, utilizing products of the light reaction to fix carbon dioxide into sugars.

Step 2: Detailed Explanation:

The principal products of the light-dependent reactions of photosynthesis are: - **ATP and NADPH:** Chemical energy carriers synthesized via photophosphorylation and non-cyclic electron transport. These act as assimilatory powers for the dark reaction. - **Oxygen (O_2):** Generated as a byproduct during the photolysis of water.

NADH (Nicotinamide Adenine Dinucleotide) is a coenzyme involved in cellular respiration (glycolysis, Krebs cycle), not photosynthesis. Photosynthesis utilizes **NADPH** instead.

Step 3: Final Answer:

NADH is not a product of the light reaction, corresponding to Option (B).

Quick Tip: Remember the 'P' rule to distinguish the electron carriers:
- **P** for **P**hPhotosynthesis → **NADP/NADPH**.
- No 'P' for Respiration → **NAD/NADH**.

---

9. Which heart sound is produced by the closure of heart valves?

(A) Lubb–closure of AV valves

(B) Dub–closure of semilunar valves

(C) Dub–opening of AV valve

(D) Both 'A' and 'B'

Correct Answer: (D) Both 'A' and 'B'

Solution:

Step 1: Understanding the Concept:

Heart sounds are acoustic vibrations produced by the sudden closure of heart valves during different phases of the cardiac cycle, which cause blood to decelerate and vibrate.

Step 2: Detailed Explanation:

The cardiac cycle produces two primary distinct heart sounds: - **First heart sound (Lubb):** Associated with the closure of the atrioventricular (AV) valves (tricuspid and bicuspid valves) at the beginning of ventricular systole. This prevents backflow of blood into the atria. (Statement A is correct). - **Second heart sound (Dub):** Associated with the closure of the semilunar valves (aortic and pulmonary valves) at the start of ventricular diastole. This prevents backflow of blood from the great arteries into the ventricles. (Statement B is correct).

Opening of healthy heart valves does not produce any sound. Since both A and B are closure-related heart sounds, both statements are correct.

Step 3: Final Answer:

Both statements (A) and (B) are correct, corresponding to Option (D).

Quick Tip: To easily remember:

- **Lubb** → **L**ong, low pitch → **A**trioventricular valves closure.
- **Dub** → **D**ull, high pitch → **S**emilunar valves closure.

Valves opening is normally completely silent.

---

10. Match the types of placentation (Column I) with their correct plant examples (Column II).

Column I:

A. Marginal

B. Axile

C. Parietal

D. Free Central

Column II:

i. Argemone, Mustard

ii. Dianthus, Primrose

iii. Sunflower, Marigold

iv. Pea

v. Tomato, Lemon, China rose

(A) A-IV, B-V, C-I, D-II

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

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

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

Correct Answer: (A) A-IV, B-V, C-I, D-II

Solution:

Step 1: Understanding the Concept:

Placentation is the arrangement of ovules within the ovary of a flower. Different plant families exhibit distinct placentation patterns, which are key taxonomic features.

Step 2: Detailed Explanation:

Let us pair each placentation type with its characteristic plant examples: - **A. Marginal:** The placenta forms a ridge along the ventral suture of the ovary and ovules are borne in two rows (typical of Fabaceae). - **Example: Pea → A matches iv**. - **B. Axile:** The placenta is axial and the ovules are attached to it in a multilocular ovary. - **Example: China rose, Tomato, Lemon → B matches v**. - **C. Parietal:** The ovules develop on the inner wall of the ovary or on peripheral parts. - **Example: Mustard, Argemone → C matches i**. - **D. Free Central:** Ovules are borne on a central axis and septa are absent. - **Example: Dianthus, Primrose → D matches ii**. - Note: **iii. Sunflower, Marigold** represents Basal placentation (not listed in Column I).

Combining these matches, we get: A-IV, B-V, C-I, D-II.

Step 3: Final Answer:

The correct matching sequence corresponds to Option (A).

Quick Tip: Use simple associations for fast matching:

- **Marginal** → Pea (pod)
- **Parietal** → Mustard (false septum present)
- **Free Central** → Dianthus

---

11. Statement 1: Tubectomy is a procedure in which the fallopian tubes are cut or tied.
Statement 2: Vasectomy is a procedure in which the vas deferens is cut or tied.
Select the correct statement:

(A) Both 1 and 2 are correct
(B) Only 1 is correct
(C) Only 2 is correct
(D) Both 1 and 2 are incorrect

Correct Answer: (A) Both 1 and 2 are correct

Solution:

Step 1: Understanding the Concept:

Surgical methods, also called sterilization techniques, are highly effective terminal contraceptive methods used to prevent further pregnancies by blocking gamete transport.

Step 2: Detailed Explanation:

- **Tubectomy (Statement 1):** This is the sterilization procedure performed in females. A small part of both fallopian tubes is surgically removed or tied up through a small incision

in the abdomen or through the vagina. This prevents the ovum from meeting the sperm. Thus, Statement 1 is correct. - **Vasectomy (Statement 2):** This is the sterilization procedure performed in males. A small part of both vas deferens is removed or tied up through a small incision on the scrotum, preventing sperm from being ejaculated. Thus, Statement 2 is correct. Both surgical procedures block gamete transport and prevent fertilization, and both statements accurately describe them.

Step 3: Final Answer:
Both Statement 1 and Statement 2 are correct, corresponding to Option (A).

Quick Tip: To easily remember the terms:
- **Tube**ctomy → Fallopian **tube**s (female).
- **Vas**ectomy → **Vas** deferens (male).

---

12. Which of the following matches is correct regarding the shape of bacteria?

(A) Coccus - rod-shaped
(B) Bacillus - comma-shaped
(C) Spirillum - spiral
(D) Vibrio - spherical

Correct Answer: (C) Spirillum - spiral

Solution:

Step 1: Understanding the Concept:
Bacteria are microscopic, unicellular prokaryotic organisms classified into four major morphological categories based on their cell shape.

Step 2: Detailed Explanation:

Let us review the standard shapes of the four categories: - **Coccus (pl. Cocci):** These bacteria are spherical or round-shaped (e.g., *Streptococcus*). Thus, Option (A) is incorrect. - **Bacillus (pl. Bacilli):** These bacteria are rod-shaped (e.g., *Lactobacillus*). Thus, Option (B) is incorrect. - **Spirillum (pl. Spirilla):** These bacteria are spiral or corkscrew-shaped. Thus, Option (C) is correct. - **Vibrio (pl. Vibrios):** These bacteria are shaped like a comma (e.g., *Vibrio cholerae*). Thus, Option (D) is incorrect.

Step 3: Final Answer:

The only correct match is Spirillum - spiral, corresponding to Option (C).

Quick Tip: Remember the simple shapes:

- **Coccus** = Sphere •
- **Bacillus** = Rod [ ]
- **Spirillum** = Spiral ~
- **Vibrio** = Comma ,

---

13. Which of the following vertebrate classes is jawless?

(A) Chondrichthyes

(B) Osteichthyes

(C) Trygon & Aves

(D) Cyclostomata

Correct Answer: (D) Cyclostomata

Solution:

Step 1: Understanding the Concept:

The subphylum Vertebrata is divided into two major divisions based on the presence or absence of jaws: - **Agnatha:** Lacks jaws. - **Gnathostomata:** Bears jaws.

Step 2: Detailed Explanation:

Let us classify the given taxa: - **Gnathostomata (jawed vertebrates):** Includes classes like Chondrichthyes (cartilaginous fishes, e.g., *Trygon*), Osteichthyes (bony fishes), Amphibia, Reptilia, Aves (birds), and Mammalia. - **Agnatha (jawless vertebrates):** Represented by the living class **Cyclostomata**. Members of Cyclostomata are jawless, have an elongated eel-like body, and possess a sucking and circular mouth (e.g., Lamprey - *Petromyzon*, Hagfish - *Myxine*).

Step 3: Final Answer:

Cyclostomata is the class of jawless vertebrates, corresponding to Option (D).

Quick Tip: All cyclostomes are ectoparasites on some fishes. They have a sucking and circular mouth without jaws, and their body lacks scales and paired fins.

---

14. Under the Kingdom Protista, which organisms, often called 'golden algae', are placed along with diatoms?

(A) Dinoflagellates

(B) Desmids

(C) Slime moulds

(D) Euglena

Correct Answer: (B) Desmids

Solution:

Step 1: Understanding the Concept:

The Kingdom Protista includes all single-celled, eukaryotic organisms. It is subdivided into several groups based on their nutrition, motility, and structural characteristics.

Step 2: Detailed Explanation:

The group **Chrysophytes** under Kingdom Protista comprises: - **Diatoms:** Microscopic

photosynthetic organisms with silica-infused double-shell cell walls (frustules). - **Golden algae (Desmids):** Photosynthetic freshwater protists that have a distinct golden-yellow coloration due to carotenoid pigments.
Diatoms and desmids are grouped together under Chrysophytes because they share characteristics like being planktonic (float passively in water currents) and photosynthetic.

Step 3: Final Answer:
Desmids (golden algae) are grouped with diatoms, corresponding to Option (B).

Quick Tip: Chrysophytes are mostly photosynthetic and represent the primary producers in oceans. Diatoms are famous for leaving behind 'diatomaceous earth' due to their indestructible silica cell walls.

---

15. What is the major difference between Hippocampus and Trygon?

(A) Hippocampus lived in sea water while Trygon in fresh water
(B) Trygon swims continuously, whereas Hippocampus does not
(C) Hippocampus is an Osteichthyes fish, while Trygon is a Chondrichthyes fish
(D) B & C both correct

Correct Answer: (D) B & C both correct

Solution:

Step 1: Understanding the Concept:
Superclass Pisces is divided into two primary classes of fishes: - **Chondrichthyes:** Cartilaginous fishes. - **Osteichthyes:** Bony fishes. These classes differ significantly in anatomical features such as endoskeleton composition, gill covers (operculum), and the presence of a buoyancy-regulating organ (air bladder).

Step 2: Detailed Explanation:

Let us evaluate the statements: - **Taxonomic Classification (Statement C):** - *Hippocampus* (Sea horse) is a bony fish, belonging to class **Osteichthyes**. - *Trygon* (Sting ray) is a cartilaginous fish, belonging to class **Chondrichthyes**. - Therefore, Statement C is correct.
- **Buoyancy and Swimming Behavior (Statement B):** - Cartilaginous fishes (*Trygon*) lack an air bladder, which means they must swim continuously to maintain depth and avoid sinking. - Bony fishes (*Hippocampus*) possess an air bladder (swim bladder) that regulates buoyancy, allowing them to remain stationary without sinking. - Therefore, Statement B is correct.
- **Habitat (Statement A):** - Both *Hippocampus* and *Trygon* are marine organisms living in seawater. Therefore, Statement A is incorrect.
Since both statements B and C are correct, Option (D) is the correct choice.

Step 3: Final Answer:
Both B and C are correct, corresponding to Option (D).

Quick Tip: Remember: **Chondrichthyes** (cartilaginous) lack an air bladder and must swim constantly to breathe and float, whereas **Osteichthyes** (bony) have a swim bladder for hydrostatic buoyancy control.

---

16. Which of the following is a primary function of the limbic system?

(A) Regulation of blood pressure, cardiovascular and respiration
(B) Control of body temperature, hunger and thirst
(C) Regulation of emotions, behaviour, and memory
(D) Coordination of voluntary movements

Correct Answer: (C) Regulation of emotions, behaviour, and memory

Solution:

Step 1: Understanding the Concept:
The limbic system is a complex set of interconnected brain structures (including the amygdala,

hippocampus, and parts of the thalamus and hypothalamus) located on both sides of the thalamus, immediately beneath the cerebrum. It is often referred to as the "emotional brain."

Step 2: Detailed Explanation:

Let us analyze the physiological functions of different parts of the brain: - **Blood pressure, cardiovascular reflexes, and respiration (Option A):** These vital autonomic functions are regulated by centers located in the **medulla oblongata** of the hindbrain. - **Body temperature, hunger, and thirst (Option B):** These basic survival and homeostatic drives are controlled by the **hypothalamus**. - **Emotional expression and memory (Option C):** The limbic system, along with the hypothalamus, regulates sexual behavior, motivation, expression of emotional reactions (such as excitement, pleasure, rage, and fear), and the consolidation of long-term memory. - **Voluntary movements (Option D):** The coordination of complex voluntary muscular movements and posture maintenance is a major function of the **cerebellum**.

Step 3: Final Answer:

The primary function of the limbic system is the regulation of emotions, behavior, and memory, matching Option (C).

Quick Tip: Associate the **Limbic System** with the acronym **HOME**:
- **H**omeostasis (via hypothalamus)
- **O**lfaction (smell)
- **M**emory (via hippocampus)
- **E**motion (via amygdala)

---

17. Pellicle is a flexible, protein-rich layer found in:

(A) Slime mould
(B) Chrysophytes
(C) Euglenoid / Euglena
(D) Sporozoa

Correct Answer: (C) Euglenoid / Euglena

Solution:

Step 1: Understanding the Concept:
Organisms under Kingdom Protista exhibit diverse cell boundaries. Some possess cell walls containing cellulose or silica, while others lack a rigid cell wall and rely on specialized proteinaceous layers for structural support.

Step 2: Detailed Explanation:
- **Euglenoids** (such as *Euglena*) are unique freshwater protists that do not possess a cellulose-based cell wall. - Instead, their cell membrane is reinforced by an underlying flexible, protein-rich layer called the **pellicle**. - The pellicle is composed of overlapping protein strips that spiral down the length of the cell. - This structural adaptation provides physical protection while allowing the cell to undergo peristaltic-like shape changes (known as metaboly or euglenoid movement).

Step 3: Final Answer:
The pellicle is a characteristic feature of euglenoids, corresponding to Option (C).

Quick Tip: To distinguish protists by their outer boundaries:
- Diatoms (Chrysophytes) → Silica-infused cell walls (frustules).
- Dinoflagellates → Stiff cellulose plates.
- Euglenoids → Proteinaceous pellicle (no cell wall).

---

18. The major pigment responsible for photosynthesis in plants is:

(A) Chlorophyll A
(B) Chlorophyll B
(C) Carotenoids
(D) Phycobilins

Correct Answer: (A) Chlorophyll A

Solution:

Step 1: Understanding the Concept:
Photosynthetic pigments absorb specific wavelengths of light. While several pigments capture light energy, only one acts as the reaction center where light energy is directly converted into chemical energy.

Step 2: Detailed Explanation:
- **Chlorophyll a** is the primary photosynthetic pigment found in all oxygenic photosynthetic organisms (plants, green algae, and cyanobacteria). It forms the reaction center of both Photosystem I (P700) and Photosystem II (P680). - **Chlorophyll b, Carotenoids, and Phycobilins** are classified as **accessory pigments**. They absorb light of different wavelengths (which chlorophyll *a* cannot capture effectively) and transfer the excitation energy to chlorophyll *a* via resonance energy transfer. This broadens the spectral range utilized for photosynthesis and protects chlorophyll *a* from photo-oxidation.
Thus, chlorophyll *a* is the major pigment directly driving the light reactions of photosynthesis.

Step 3: Final Answer:
The primary pigment is Chlorophyll A, which corresponds to Option (A).

Quick Tip: Chlorophyll *a* appears bright green or blue-green in chromatograms, whereas chlorophyll *b* appears yellow-green, and carotenoids appear yellow to yellow-orange.

---

19. IgA immunity provided to a baby at birth is called:

(A) Active immunity
(B) Passive immunity
(C) Artificial immunity
(D) Innate immunity

Correct Answer: (B) Passive immunity

Solution:

Step 1: Understanding the Concept:
Immunity is classified into active and passive based on whether the host's own immune system produces the antibodies or if they are acquired from an external source.

Step 2: Detailed Explanation:
- **Active Immunity:** Develops when the host's own cells produce antibodies in response to exposure to an antigen (either naturally through infection or artificially through vaccination). This process is slow but long-lasting. - **Passive Immunity:** Achieved when pre-formed antibodies are directly transferred from one individual to another, providing immediate protection. - **Maternal Antibody Transfer:** The yellowish fluid **colostrum** secreted by the mother during the initial days of lactation is rich in secretory **IgA antibodies**. These antibodies are directly ingested by the infant, protecting the baby's vulnerable mucosal surfaces against pathogens.
Since the baby receives ready-made antibodies without initiating its own primary immune response, this is a classic example of **natural passive immunity**.

Step 3: Final Answer:
The IgA immunity transferred to a baby is classified as passive immunity, corresponding to Option (B).

Quick Tip: To easily differentiate passive vs active immunity:
- If the body **makes** the antibodies → **Active**.
- If the body **takes** pre-formed antibodies (colostrum, placenta, anti-venom) → **Passive**.

---

20. Which of the following is not a product of anaerobic respiration?

(A) Ethanol + CO_2
(B) Lactic acid

(C) Acetyl CoA

(D) None of the above

Correct Answer: (C) Acetyl CoA

Solution:

Step 1: Understanding the Concept:

Respiration pathways diverge depending on the availability of molecular oxygen. Anaerobic respiration (or fermentation) occurs in the absence of oxygen, whereas aerobic respiration requires oxygen to completely oxidize pyruvate.

Step 2: Detailed Explanation:

Let us review the products of different metabolic pathways: - **Ethanol + CO_2 (Option A):** Produced during alcoholic fermentation by yeast cells under anaerobic conditions. - **Lactic acid (Option B):** Produced during lactic acid fermentation by certain bacteria and in vertebrate skeletal muscle cells during intense exercise when oxygen supply is limited. - **Acetyl CoA (Option C):** Formed inside the mitochondrial matrix during the **link reaction** (oxidative decarboxylation of pyruvate). This transition step connects glycolysis to the Krebs cycle and occurs only under aerobic conditions when oxygen is available to act as the terminal electron acceptor.

Thus, Acetyl CoA is uniquely a product of aerobic respiration.

Step 3: Final Answer:

Acetyl CoA is not a product of anaerobic respiration, matching Option (C).

Quick Tip: Anaerobic pathways occur entirely in the cytoplasm and do not involve the mitochondria, meaning they cannot produce mitochondrial intermediates like Acetyl CoA.

---

21. Which is the major difference between interkinesis and interphase?

(A) Only (I) and (II)

(B) Only (II) and (III)

(C) Only (I) and (III)

(D) (I), (II) and (III)

Correct Answer: (D) (I), (II) and (III)

Solution:

Step 1: Understanding the Concept:

Cell division involves preparatory rest phases. Interphase is the preparatory period prior to mitosis or Meiosis I, while interkinesis is the brief transitional period between Meiosis I and Meiosis II.

Step 2: Detailed Explanation:

The three standard physiological comparisons (I, II, and III) between these phases are: - **Statement I (DNA Replication):** In the S-phase of Interphase, DNA replication takes place, doubling the DNA content of the cell. In Interkinesis, **no DNA replication** occurs. This is the most crucial genetic distinction. - **Statement II (Duration):** Interphase is a highly active, long-lived preparatory phase (occupying over 95% of the cell cycle duration). In contrast, Interkinesis is extremely short-lived and transient. - **Statement III (Protein and Centriole duplication):** While RNA and protein synthesis occur in both phases, centrioles duplicate during Interkinesis to form the spindle apparatus for Meiosis II without any intervening genetic replication.

All three statements highlight valid biological differences between interkinesis and interphase.

Step 3: Final Answer:

Since all statements represent valid differences, the correct choice is Option (D).

Quick Tip: The absolute absence of DNA replication (no S-phase) during interkinesis is biologically essential to ensure that Meiosis II reduces the chromosome number to haploid (n).

22. Which of the following structures in an anther develops into a pollen sac?

(A) Sporogenous tissue

(B) Microspore

(C) Tapetum

(D) Microsporangium

Correct Answer: (D) Microsporangium

Solution:

Step 1: Understanding the Concept:

A typical angiosperm anther is bilobed and dithecous, meaning it has four microsporangia located at its corners. As the anther matures, these microsporangia undergo structural development.

Step 2: Detailed Explanation:

- A young, developing anther contains four **microsporangia** (two in each lobe). - Within these microsporangia, the sporogenous tissue undergoes microsporogenesis to form microspore tetrads. - As the anther matures and dehydrates, the partitions between the microsporangia break down, and they enlarge significantly to form longitudinal chambers packed with pollen grains. These developed structures are called **pollen sacs**. - Therefore, the microsporangia develop directly into pollen sacs.

Step 3: Final Answer:

The structure that develops into the pollen sac is the microsporangium, corresponding to Option (D).

Quick Tip: The developmental progression is:
Microsporangium (in young anther) → Pollen Sac (in mature, dehydrated anther).

23. Choose the right option based on the diagram: 1) Stomatal aperture, 2) Guard cells, 3) Subsidiary cells, 4) Chloroplast

(A) A-1, B-2, C-3, D-4

(B) A-2, B-3, C-1

(C) A-3, B-1, C-2

(D) A-2, B-1, C-3

Correct Answer: (A) A-1, B-2, C-3, D-4

Solution:

Step 1: Understanding the Concept:

The stomatal apparatus regulates gas exchange and transpiration in leaves. It consists of a microscopic pore surrounded by specialized epidermal cells.

Step 2: Detailed Explanation:

In a standard schematic diagram of the stomatal apparatus (as found in NCERT): - **A** points to the central pore or opening, which is the **Stomatal aperture** (1). - **B** points to the two bean-shaped or kidney-shaped cells flanking the pore, which are the **Guard cells** (2). - **C** points to the modified epidermal cells immediately surrounding the guard cells, which are the **Subsidiary cells** (3). - **D** points to the green organelle inclusions within the cytoplasm of the guard cells, which are the **Chloroplasts** (4).

Therefore, the labels align as: A-1, B-2, C-3, D-4.

Step 3: Final Answer:

The correct option matching the labels is Option (A).

Quick Tip: Remember that **guard cells** are the only epidermal cells that contain chloroplasts. This is an important detail often tested in exams!

24. What is Oviparity?

(A) Animals that give birth to live young ones

(B) They lay eggs, and the embryo develops outside the mother's body

(C) Development inside uterus until birth

(D) Asexual reproduction

Correct Answer: (B) They lay eggs, and the embryo develops outside the mother's body

Solution:

Step 1: Understanding the Concept:

Animals are classified into oviparous and viviparous based on whether the development of the zygote takes place outside the body of the female parent or inside.

Step 2: Detailed Explanation:

- **Oviparity (Option B):** Refers to animals that lay eggs. The fertilized or unfertilized eggs are laid outside the mother's body, and the embryo develops in the external environment, protected by a hard calcareous shell (e.g., in birds and reptiles) and nourished by the egg yolk.
- **Viviparity (Option A & C):** Refers to animals where the zygote develops into a young one inside the body of the female organism, receiving nourishment directly from the mother via a placenta, and is delivered as a live young one (e.g., in majority of mammals).

Step 3: Final Answer:

Oviparity is the laying of eggs where embryonic development occurs externally, corresponding to Option (B).

Quick Tip: To remember:

- **Ovi**parity starts with **O**, which looks like an **egg**.
- **Vivi**parity starts with **V** for **vital/live** birth.

---

25. Match the type of chromosome (Column I) with the position of its centromere (Column II):

Column I:

A. Metacentric

B. Sub-metacentric

C. Acrocentric

D. Telocentric

Column II:

i. One extremely short arm and one very long arm

ii. Terminal centromere

iii. One short arm and one long arm

iv. Two equal arms

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

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

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

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

Correct Answer: (A) A-IV, B-III, C-I, D-II

Solution:

Step 1: Understanding the Concept:

Chromosomes are classified into four types based on the position of the centromere (primary constriction), which determines the relative lengths of the two chromosome arms.

Step 2: Detailed Explanation:

Let us match the chromosome types with their centromere positions: - **A. Metacentric:** The centromere is located in the middle, forming two equal arms of the chromosome. During anaphase, it appears **V-shaped**. - **A matches iv**. - **B. Sub-metacentric:** The centromere is located slightly away from the center, resulting in one shorter arm (p-arm) and one longer arm (q-arm). During anaphase, it appears **L-shaped**. - **B matches iii**. - **C. Acrocentric:** The centromere is situated close to one end, forming one extremely short arm and one very long arm. During anaphase, it appears **J-shaped**. - **C matches i**. - **D. Telocentric:** The centromere is located at the very terminal end of the chromosome. During anaphase, it appears **I-shaped**. - **D matches ii**.

Combining these matches, we get: A-IV, B-III, C-I, D-II.

Step 3: Final Answer:

The matching sequence corresponds to Option (A).

Quick Tip: To remember centromere positions during anaphase, associate them with letters:

- Metacentric → **V**
- Sub-metacentric → **L**
- Acrocentric → **J**
- Telocentric → **I**

---

26. Which of the following is not considered a primary limiting factor for the rate of photosynthesis?

(A) Light intensity

(B) Temperature

(C) Carbon dioxide concentration

(D) Oxygen concentration

Correct Answer: (D) Oxygen concentration

Solution:

Step 1: Understanding the Concept:

According to Blackman's Law of Limiting Factors (1905), when a biochemical process is governed by multiple factors, its rate is limited by the factor that is closest to its minimal value.

Step 2: Detailed Explanation:

The primary external factors that directly limit the rate of photosynthesis are: - **Light intensity**

(Option A): Affects the rate of the light reaction. At low light, it is a key limiting factor. - **Temperature (Option B):** Affects the activity of dark reaction enzymes (like RuBisCO). - **Carbon dioxide concentration (Option C):** The major limiting factor in nature because atmospheric CO_2 levels ($\approx 0.04\%$) are below the saturation level for most plants.
Oxygen concentration (Option D): Although high oxygen concentration can competitively inhibit RuBisCO and promote photorespiration in C_3 plants (the Warburg effect), oxygen is a product of photosynthesis, not a substrate. It is not considered a primary limiting factor for the rate of photosynthesis.

Step 3: Final Answer:
Oxygen concentration is not a primary limiting factor, matching Option (D).

Quick Tip: The primary limiting factors for photosynthesis are: Light, CO_2 concentration, Temperature, and Water. Of these, CO_2 is the main limiting factor in natural environments.

---

27. Which of the following statements are correct?
I) Homologous organs have the same structure but show different functions.
II) Homologous organs have common ancestors.
III) Analogous organs show divergent evolution.
IV) Wings of butterfly and birds are homologous.

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

Correct Answer: (B) I and II are correct

Solution:

Step 1: Understanding the Concept:

Evolutionary relationships are studied by comparing structures across different organisms. - **Homology:** Indicates shared structural origin and common ancestry, leading to divergent evolution. - **Analogy:** Indicates different structural origins but similar adaptations for common functions, leading to convergent evolution.

Step 2: Detailed Explanation:

Let us analyze the statements: - **Statement I:** Homologous organs share a basic anatomical plan and developmental origin but perform different functions in response to different adaptations (e.g., forelimbs of whales, bats, and humans). This statement is **correct**. - **Statement II:** Homology is direct evidence of divergent evolution and indicates that these organisms share a common ancestor. This statement is **correct**. - **Statement III:** Analogous organs arise due to convergent evolution (adapting to similar ecological niches), whereas homologous organs show divergent evolution. This statement is **incorrect**. - **Statement IV:** The wings of a butterfly (composed of integumentary membranes) and a bird (composed of bony limbs covered with feathers) have completely different structures but perform the same function (flight). Thus, they are analogous organs, not homologous. This statement is **incorrect**.

Thus, only statements I and II are correct.

Step 3: Final Answer:

The correct combination is Option (B).

Quick Tip: Remember the simple connections:

- **H**omology → **D**ivergent evolution (**HD**) → Common ancestor.
- **A**nalogy → **C**onvergent evolution (**AC**) → Different ancestor.

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28. Choose the correct option based on the diagram: 1) Hypothalamus, 2) Anterior pituitary, 3) Posterior pituitary, 4) Hypothalamic neuron

(A) A-1, B-2, C-3, D-4

(B) A-2, B-3, C-4, D-1

(C) A-1, B-3, C-2, D-4

(D) A-4, B-1, C-2, D-3

Correct Answer: (C) A-1, B-3, C-2, D-4

Solution:

Step 1: Understanding the Concept:

The hypothalamus and pituitary gland form the master endocrine command system. The hypothalamus regulates the pituitary gland via both neural connections and a portal circulatory loop.

Step 2: Detailed Explanation:

In the standard diagram illustrating the anatomical relationship between the hypothalamus and the pituitary gland (NCERT): - **A** represents the upper brain region, which is the **Hypothalamus** (1). - **B** represents the lobe that is directly connected to the hypothalamus via long axonal projections of neurosecretory cells, which is the **Posterior pituitary** (neurohypophysis) (3). - **C** represents the lobe connected via the hypophyseal portal system, which is the **Anterior pituitary** (adenohypophysis) (2). - **D** represents the neurosecretory cells that synthesize hormones and transport them axonally, which are the **Hypothalamic neurons** (4).

Therefore, the labels align as: A-1, B-3, C-2, D-4.

Step 3: Final Answer:

The correct option matching the labels is Option (C).

Quick Tip: Remember that the **Posterior Pituitary** is under **direct neural control** of the hypothalamus, while the **Anterior Pituitary** is under **chemical control** via the portal system.

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29. Which one is the structure of Uracil in RNA?

(A) It is a purine base with a double ring

(B) It is similar to thymine (5-methyl uracil), but lacks the methyl group

(C) It only binds with deoxyribose sugar

(D) It forms hydrogen bonds with guanine

Correct Answer: (B) It is similar to thymine (5-methyl uracil), but lacks the methyl group

Solution:

Step 1: Understanding the Concept:
Uracil is one of the four nitrogenous bases found in the nucleic acid RNA, playing a key role in genetic coding.

Step 2: Detailed Explanation:
Let us evaluate the statements: - **Option A:** Uracil is a single-ringed pyrimidine base, not a double-ringed purine. This statement is incorrect. - **Option B:** Thymine is chemically identified as 5-methyluracil. Structurally, Uracil is identical to thymine except that it lacks the methyl group at the C_5 position of the ring. This statement is **correct**. - **Option C:** Uracil is found in RNA, where it binds with ribose sugar. It is absent in DNA (which contains deoxyribose sugar). This statement is incorrect. - **Option D:** In RNA, Uracil pairs specifically with Adenine via two hydrogen bonds ($U = A$), not with Guanine. This statement is incorrect.
Step 3: Final Answer:
Uracil is structurally similar to thymine but lacks the methyl group, corresponding to Option (B).

Quick Tip: Thymine is simply methyluracil. If you remove the methyl group from Thymine, you get Uracil. This close structural similarity explains why both can pair with Adenine.

---

30. Which of the following is a primary lymphoid organ?

(A) Spleen

(B) Lymph nodes

(C) Bone marrow

(D) Peyer's patches

Correct Answer: (C) Bone marrow

Solution:

Step 1: Understanding the Concept:

The lymphoid organs of the immune system are classified into primary and secondary lymphoid organs based on their role in lymphocyte development and activation.

Step 2: Detailed Explanation:

- **Primary Lymphoid Organs:** These are the organs where immature lymphocytes differentiate and mature into antigen-sensitive T-lymphocytes and B-lymphocytes. The primary lymphoid organs in humans are the **Bone marrow** and the **Thymus**. All blood cells (including lymphocytes) are produced in the bone marrow, and B-cells mature there, while T-cells migrate to the thymus to mature. - **Secondary Lymphoid Organs:** These are the sites where lymphocytes interact with antigens, proliferate, and differentiate into effector cells. Examples include the **Spleen, Lymph nodes, Tonsils, and Peyer's patches** of the small intestine.

Step 3: Final Answer:

Bone marrow is a primary lymphoid organ, corresponding to Option (C).

Quick Tip: Remember:

- **Primary** organs (Bone marrow, Thymus) are for **production and maturation**.
- **Secondary** organs (Spleen, Lymph nodes, Peyer's patches) are for **interaction and fighting** pathogens.

General Knowledge

1. What is the capital of Israel?

(A) Tel Aviv

(B) Jerusalem

(C) Haifa

(D) Gaza

Correct Answer: (B) Jerusalem

Solution:

Step 1: Understanding the Concept:
Every sovereign nation designates a city as its official capital, which serves as the seat of government, parliament, supreme court, and official presidential residence.

Step 2: Detailed Explanation:
- **Jerusalem** is proclaimed as the capital of Israel according to the Jerusalem Law passed by the Knesset (Israel's parliament) in 1980. The city houses the Knesset, the Supreme Court, and the official residences of the President and Prime Minister. - **Tel Aviv** is Israel's financial and technological hub, and many foreign nations maintain their embassies there. - **Haifa** is a major northern port city. - **Gaza** is a major city in the Palestinian territory of the Gaza Strip.
Step 3: Final Answer:
The designated capital of Israel is Jerusalem, corresponding to Option (B).

Quick Tip: While many countries structurally locate their embassies in Tel Aviv due to geopolitical status discussions, Jerusalem remains the officially declared capital of Israel under its domestic laws.

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2. What is the official currency of Japan?

(A) Yuan

(B) Yen

(C) Won

(D) Dollar

Correct Answer: (B) Yen

Solution:

Step 1: Understanding the Concept:
Countries issue standardized legal tender, or currency, to facilitate domestic trade and international exchange. Each major nation has a uniquely designated currency.

Step 2: Detailed Explanation:
Let us identify the countries associated with the given currencies: - **Yuan (CNY):** The official currency of the People's Republic of China. (Option A is incorrect). - **Yen (JPY, ¥):** The official currency of Japan. It is one of the most widely traded currencies in the global foreign exchange market. (Option B is correct). - **Won (KRW):** The official currency of both North Korea and South Korea. (Option C is incorrect). - **Dollar (USD, AUD, CAD, etc.):** The official currency name used by countries such as the United States, Australia, and Canada. (Option D is incorrect).
Step 3: Final Answer:
The official currency of Japan is the Yen, corresponding to Option (B).

Quick Tip: The Japanese Yen (¥) is the third most traded currency in the world after the US Dollar ($) and the Euro (€).

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3. Which number is wrong in the sequence 6, 12, 24, 48, 96, 244?

(A) 96
(B) 244
(C) 12
(D) 48

Correct Answer: (B) 244

Solution:

Step 1: Understanding the Concept:

A mathematical number series follows a specific, logical progression rule from one term to the next. Finding the wrong number involves identifying the term that violates this established pattern.

Step 2: Key Formula or Approach:

Analyze the relationship between consecutive terms in the given sequence:

$$6,\ 12,\ 24,\ 48,\ 96,\ 244$$

Step 3: Detailed Explanation:

Let us test the mathematical pattern of the sequence: - First term to second term:

$$6 \times 2 = 12$$

- Second term to third term:

$$12 \times 2 = 24$$

- Third term to fourth term:

$$24 \times 2 = 48$$

- Fourth term to fifth term:

$$48 \times 2 = 96$$

The consistent pattern is that each term is multiplied by 2 to yield the subsequent term (a geometric progression with common ratio $r = 2$).

Applying this rule to find the sixth term:

$$96 \times 2 = 192$$

However, the sequence lists the final number as 244, which violates the multiplication pattern.

Step 4: Final Answer:

The wrong number in the sequence is 244, corresponding to Option (B).

Quick Tip: To solve series questions quickly, always calculate the differences or ratios between the first three terms to identify the mathematical rule, then apply it to verify the remaining terms.

---

4. Which is the main and official national language of China?

(A) Cantonese

(B) Mandarin / Putonghua

(C) Uyghur

(D) Tibetan

Correct Answer: (B) Mandarin / Putonghua

Solution:

Step 1: Understanding the Concept:

Many countries have several regional languages and dialects, but establish one primary language as the official national language for administration, education, and national communication.

Step 2: Detailed Explanation:

- **Mandarin (Putonghua):** This is the official national language of the People's Republic of China. "Putonghua" translates to "common speech." It is based on the Beijing dialect and is spoken by over 70% of the Chinese population. (Option B is correct). - **Cantonese:** A major regional dialect spoken primarily in southern China (Guangdong province, Hong Kong, Macau). - **Uyghur and Tibetan:** Regional languages spoken by minority populations in the Xinjiang and Tibet autonomous regions, respectively.

Step 3: Final Answer:

The official national language of China is Mandarin (Putonghua), corresponding to Option (B).

Quick Tip: Mandarin is the most widely spoken native language in the world, with over 1 billion native speakers.

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5. What is a member of the Lok Sabha mainly called?

(A) MLA

(B) MP

(C) Councillor

(D) Governor

Correct Answer: (B) MP

Solution:

Step 1: Understanding the Concept:
The Parliament of India is bicameral, consisting of the President and two houses: the Rajya Sabha (Council of States) and the Lok Sabha (House of the People). Elected or nominated representatives in either house are designated by a specific legislative title.

Step 2: Detailed Explanation:
Let us evaluate the political designations: - **MLA (Member of Legislative Assembly):** A representative elected by voters of an electoral constituency to the state-level legislature (Vidhan Sabha). (Option A is incorrect). - **MP (Member of Parliament):** A representative elected to either the Lok Sabha or the Rajya Sabha of the central Parliament of India. (Option B is correct). - **Councillor:** An elected representative in local municipal corporations or city councils. (Option C is incorrect). - **Governor:** The constitutional head of a state in India, appointed by the President. (Option D is incorrect).
Step 3: Final Answer:
A member of the Lok Sabha is called a Member of Parliament (MP), corresponding to Option

(B).

Quick Tip: While both Lok Sabha (Lower House) and Rajya Sabha (Upper House) representatives are called MPs, Lok Sabha MPs are directly elected by the public, whereas Rajya Sabha MPs are indirectly elected by state MLAs.

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6. Who is the current Union Minister of Agriculture and Farmers Welfare of India?

(A) Narendra Singh Tomar
(B) Arjun Munda
(C) Shivraj Singh Chouhan
(D) Rajnath Singh

Correct Answer: (C) Shivraj Singh Chouhan

Solution:

Step 1: Understanding the Concept:
The Union Council of Ministers of India is headed by the Prime Minister and consists of ministers appointed by the President to manage specific government portfolios. These ministerial appointments are updated following national elections or cabinet reshuffles.

Step 2: Detailed Explanation:
Let us track the tenure of ministers for the Agriculture portfolio: - **Narendra Singh Tomar (Option A):** Served as the Minister of Agriculture and Farmers Welfare during the second Modi ministry. - **Arjun Munda (Option B):** Took additional charge of the Ministry of Agriculture in late 2023. - **Shivraj Singh Chouhan (Option C):** Following the 2024 general elections and the formation of the 3rd Modi Cabinet (18th Lok Sabha), former Madhya Pradesh Chief Minister Shivraj Singh Chouhan assumed charge as the current Union Minister of Agriculture and Farmers Welfare. - **Rajnath Singh (Option D):** Serves as the current Union Minister of

Defence.

Step 3: Final Answer:

The current Union Minister of Agriculture and Farmers Welfare is Shivraj Singh Chouhan, corresponding to Option (C).

Quick Tip: Always keep updated with the latest cabinet minister portfolios, especially following recent general elections, as current affairs questions frequently target newly assigned portfolios.

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7. Lakshmi is Priya's mother, and Jatin is Priya's brother. Shia is Jatin's daughter. How is Lakshmi related to Shia?

(A) Grandmother

(B) Mother

(C) Aunt

(D) Sister-in-law

Correct Answer: (A) Grandmother

Solution:

Step 1: Understanding the Concept:

Blood relation problems can be solved by breaking down family relationships step-by-step and mapping out a simplified generational tree.

Step 2: Detailed Explanation:

Let us analyze the relationships sequentially: 1. **Lakshmi and Priya:** Lakshmi is Priya's mother. 2. **Jatin and Priya:** Jatin is Priya's brother. - Since Jatin and Priya are siblings (brother and sister), they share the same mother. - Therefore, Lakshmi is also Jatin's mother. 3. **Shia and Jatin:** Shia is Jatin's daughter. 4. **Relation between Lakshmi and Shia:** - Lakshmi is the mother of Jatin. - Jatin is the father of Shia. - Thus, Lakshmi is the mother of Shia's father. -

This makes Lakshmi the **paternal grandmother** of Shia.

Step 3: Final Answer:

Lakshmi is Shia's grandmother, corresponding to Option (A).

Quick Tip: To solve blood relation puzzles without confusion, map generations vertically (parents on top, children below) and siblings horizontally on the same level.
