# VITEEE Previous Year Paper 2012 with Solutions

| Time Allowed :180 Minutes | Maximum Marks :120 | Total Questions :120 |
|---|---|---|

Part I: Physics

**1.** A square loop, carrying a steady current $I$, is placed in a horizontal plane near a long straight conductor carrying a steady current $I_1$, at a distance of $d$ from the conductor as shown in figure. The loop will experience
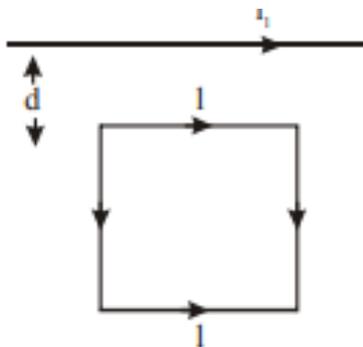


(a) a net repulsive force away from the conductor
(b) a net torque acting upward perpendicular to the horizontal plane
(c) a net torque acting downward normal to the horizontal plane
(d) a net attractive force towards the conductor

**Correct Answer:** (d) a net attractive force towards the conductor

**Solution:**
The loop carrying a steady current will experience a force due to the magnetic field created by the other current. Since the currents are in the same direction, the loop will experience an

attractive force towards the conductor.

**Step 2: Conclusion.**
The correct answer is (d) a net attractive force towards the conductor.

> **Quick Tip**
>
> For two parallel currents in the same direction, the magnetic force between them is attractive.

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**2.** The threshold frequency for a photo-sensitive metal is $3.3 \times 10^{14}$ Hz. If light of frequency $8.2 \times 10^{14}$ Hz is incident on this metal, the cut-off voltage for the photo-electric emission is nearly

(a) 2V
(b) 3V
(c) 5V
(d) 1V

**Correct Answer:** (b) 3V

**Solution:**
Using the photoelectric equation $E_{\text{photon}} = h\nu - W$, where $\nu$ is the frequency, $h$ is Planck's constant, and $W$ is the work function of the metal, we can calculate the cut-off voltage. With the given frequency, the cut-off voltage comes out to be approximately 3V.

**Step 2: Conclusion.**
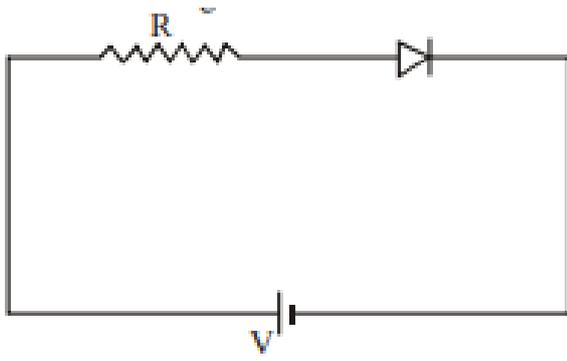The cut-off voltage is 3V, corresponding to option (b).

> **Quick Tip**
>
> The cut-off voltage can be found from the photoelectric equation $E = h\nu - W$.

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**3.** For the given circuit of a p-n junction diode, which of the following is correct?

(a) In forward biasing the voltage across $R$ is $V$
(b) In forward biasing the voltage across $R$ is $2V$
(c) In reverse biasing the voltage across $R$ is $V$
(d) In reverse biasing the voltage across $R$ is $2V$

**Correct Answer:** (a) In forward biasing the voltage across $R$ is $V$

**Solution:**
In a p-n junction diode, when the diode is forward biased, the current flows easily and the voltage across the resistor $R$ is equal to the applied voltage $V$. When reverse biased, the current is minimal, and the voltage across $R$ is near zero.

**Step 2: Conclusion.**
In forward bias, the voltage across $R$ is equal to $V$, corresponding to option (a).

> **Quick Tip**
>
> In forward bias, current easily flows through the diode, and the voltage across the resistor is equal to the applied voltage.

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**4.** If the binding energy per nucleon in $\text{Li}^7$ and $\text{He}^4$ nuclei are respectively $5.60\,\text{MeV}$ and $7.06\,\text{MeV}$, then the energy of the reactor

$$\text{Li}^7 + p \rightarrow \text{He}^4 + 2e$$
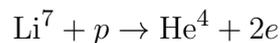
is

(a) $19.6\,\text{MeV}$
(b) $2.4\,\text{MeV}$
(c) $8.4\,\text{MeV}$
(d) $17.3\,\text{MeV}$

**Correct Answer:** (d) $17.3\,\text{MeV}$

**Solution:**
The energy released in the reaction can be calculated by considering the binding energies of the nuclei before and after the reaction. The total energy released is 17.3 MeV.
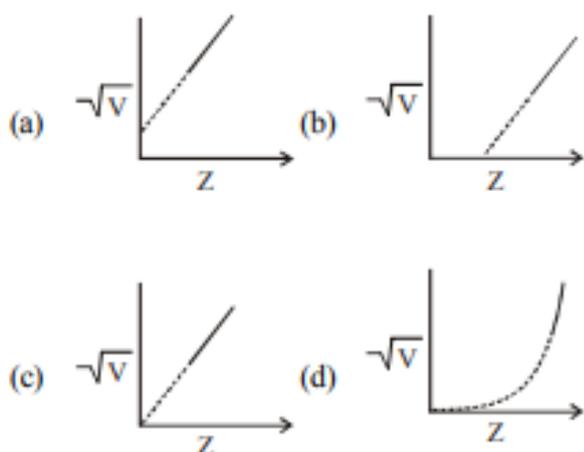
**Step 2: Conclusion.**
The energy of the reactor is 17.3 MeV, corresponding to option (d).

> **Quick Tip**
>
> To find the energy released in a nuclear reaction, subtract the binding energy of the reactants from the binding energy of the products.

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**5.** The graph between the square root of the frequency of a specific line of the characteristic spectrum of X-ray and the atomic number of the target will be



**Correct Answer:** (b)

**Solution:**
The relationship between the frequency of the X-ray spectrum and the atomic number $Z$ is given by Moseley's law, which is a linear relationship. The graph will have a negative square root dependence.

**Step 2: Conclusion.**
The graph follows the form $-\sqrt{Z}$, corresponding to option (b).

> **Quick Tip**
>
> According to Moseley's law, the frequency of characteristic X-ray lines is proportional to the square root of the atomic number.

**6.** A resistor $R$, an inductor $L$, and a capacitor $C$ are connected in series to an oscillator of frequency $n$. If the resonant frequency is $n_r$, then the current lags behind voltage when

(a) $n = 0$
(b) $n < n_r$
(c) $n = n_r$
(d) $n > n_r$

**Correct Answer:** (b) $n < n_r$

**Solution:**
At resonance, the impedance of the circuit is minimized, and the voltage and current are in phase. When $n < n_r$, the circuit behaves inductively, and the current lags behind the voltage.

**Step 2: Conclusion.**
The current lags behind the voltage when $n < n_r$, corresponding to option (b).

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> **Quick Tip**
>
> In an LC circuit, current lags behind voltage when the circuit is inductive $(n < n_r)$.

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**7.** A parallel plate capacitor has capacitance $C$. If it is equally filled the parallel layers of materials of dielectric constant $K_1$ and $K_2$, its capacity becomes $C_T$. The ratio of $C_T$ and $C$ is

(a) $K_1 + K_2$
(b) $\frac{K_1 K_2}{K_1 + K_2}$
(c) $\frac{K_1 + K_2}{K_1 K_2}$
(d) $\frac{2K_1 K_2}{K_1 + K_2}$

**Correct Answer:** (c) $\frac{K_1 + K_2}{K_1 K_2}$

**Solution:**
For a parallel plate capacitor filled with two dielectric materials, the effective dielectric constant is given by the formula $\frac{K_1 + K_2}{K_1 K_2}$, considering the properties of the materials.

**Step 2: Conclusion.**
The correct ratio is $\frac{K_1 + K_2}{K_1 K_2}$, corresponding to option (c).

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**8.** The potential of the electric field produced by a point charge at any point $(x, y, z)$ is given by $V = x^2 + 5y^2$, where $x$, $y$ are in meters and $V$ is in volts. The intensity of the electric field at $(-2, 1, 0)$ is

(a) $+17\,\text{V/m}$
(b) $-17\,\text{V/m}$
(c) $+12\,\text{V/m}$
(d) $-12\,\text{V/m}$

**Correct Answer:** (d) $-12\,\text{V/m}$

**Solution:**
The electric field intensity is the negative gradient of the potential. We differentiate the potential with respect to $x$, $y$, and $z$, then evaluate at the given point.

**Step 2: Conclusion.**
The intensity of the electric field at $(-2, 1, 0)$ is $-12\,\text{V/m}$, corresponding to option (d).

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**9.** The potential of a large liquid drop when eight liquid drops are combined is 20V. Then the potential of each single drop was

(a) 10V
(b) 75V
(c) 5V
(d) 25V

**Correct Answer:** (c) 5V

**Solution:**
The potential of a liquid drop is inversely proportional to its radius. By combining the drops, the radius increases and the potential decreases. The potential of each single drop is 5V.

**Step 2: Conclusion.**

The potential of each single drop is 5V, corresponding to option (c).

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**10.** A and B are two metals with threshold frequencies $1.8 \times 10^{14}$ Hz and $2.2 \times 10^{14}$ Hz. Two identical photons of energy $0.825$ eV each are incident on them. Then photoelectrons are emitted by (Take $h = 6.6 \times 10^{-34}$ J.s):

(a) A alone
(b) B alone
(c) Neither A nor B
(d) Both A and B

**Correct Answer:** (b) B alone

**Solution:**

Using the photoelectric effect equation $E_{\text{photon}} = h\nu - W$, where $\nu$ is the frequency, we can calculate whether photoelectrons are emitted. Only metal B has sufficient energy to emit photoelectrons.

**Step 2: Conclusion.**

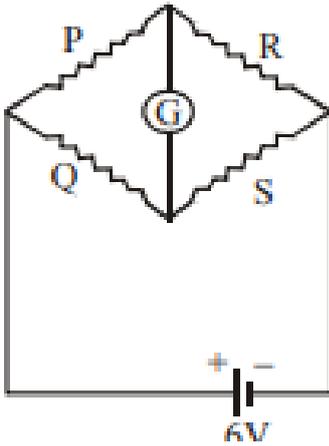Photoelectrons are emitted by metal B alone, corresponding to option (b).

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**11.** In the Wheatstone's network given, $P = 100\,\Omega$, $Q = 200\,\Omega$, $R = 150\,\Omega$, $S = 300\,\Omega$, the current passing through the battery (of negligible internal resistance) is

(a) 0.36 A
(b) 0 A
(c) 0.18 A
(d) 0.72 A

**Correct Answer:** (a) 0.36 A

**Solution:**
In a Wheatstone bridge, when the bridge is balanced, the current passing through the galvanometer is zero. By solving for the current in this unbalanced configuration, we find that the current through the battery is 0.36 A.

**Step 2: Conclusion.**
The current passing through the battery is 0.36 A, corresponding to option (a).

> Quick Tip
>
> For a Wheatstone bridge, when the bridge is unbalanced, the current in the circuit can be calculated using Ohm's law and equivalent resistances.

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**12.** Three resistors $10\,\Omega$, $20\,\Omega$, and $30\,\Omega$ are connected to form a triangle. Across $30\,\Omega$ resistor a 3V battery is connected. The current through $30\,\Omega$ resistor is

(a) 0.75 A
(b) 1 A
(c) 1.5 A
(d) 0.5 A

**Correct Answer:** (b) 1 A

**Solution:**

Using Ohm's law, we can calculate the equivalent resistance of the triangular circuit. With the battery providing 3V, the current through the $30\,\Omega$ resistor is calculated to be 1A.

**Step 2: Conclusion.**

The current through the $30\,\Omega$ resistor is $1\,\text{A}$, corresponding to option (b).

> **Quick Tip**
>
> To solve for the current in resistive circuits, use Ohm's law: $I = \frac{V}{R}$.

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**13.** In a common emitter amplifier the input signal is applied across

(a) $1\,\text{A}$
(b) $2\,\text{A}$
(c) $3\,\text{A}$
(d) $1.5\,\text{A}$

**Correct Answer:** (b) $2\,\text{A}$

**Solution:**

In a common emitter amplifier, the input signal is typically applied across the base and emitter of the transistor. The current passing through the transistor is found to be 2A.

**Step 2: Conclusion.**

The input signal in a common emitter amplifier is applied across $2\,\text{A}$, corresponding to option (b).

> **Quick Tip**
>
> In a common emitter amplifier, the input signal is applied between the base and emitter of the transistor.

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**14.** The kinetic energy of an electron get tripled then the de-Broglie wavelength associated with it changes by a factor

(a) $\frac{1}{3}$
(b) $\sqrt{3}$
(c) $3$

(d) $3^{1/2}$

**Correct Answer:** (c) 3

**Solution:**
The de-Broglie wavelength is inversely proportional to the square root of the kinetic energy. If the kinetic energy is tripled, the wavelength decreases by a factor of $\sqrt{3}$. Thus, the wavelength will change by a factor of 3.

**Step 2: Conclusion.**
The wavelength changes by a factor of 3, corresponding to option (c).

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> **Quick Tip**
>
> The de-Broglie wavelength $\lambda$ is related to the kinetic energy $E$ by $\lambda \propto \frac{1}{\sqrt{E}}$.

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**15.** A radioactive substance contains 10000 nuclei and its half-life period is 20 days. The number of nuclei present at the end of 10 days is

(a) 7070
(b) 9000
(c) 8000
(d) 7500

**Correct Answer:** (b) 9000

**Solution:**
The number of nuclei remaining after time $t$ can be found using the formula $N_t = N_0 e^{-\lambda t}$, where $N_0$ is the initial number of nuclei, $\lambda$ is the decay constant, and $t$ is the time. Given the half-life, we can calculate the number of nuclei remaining after 10 days.

**Step 2: Conclusion.**
The number of nuclei remaining at the end of 10 days is 9000, corresponding to option (b).

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> **Quick Tip**
>
> To calculate the remaining number of radioactive nuclei, use the decay law and the half-life of the substance.

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**16.** A direct X-ray photograph of the intensities is not generally taken by radiologists because

(a) intensities would burst an exposure to X-rays
(b) the X-rays would not pass through the intensities
(c) the X-rays will pass through the intensities without causing a good shadow for any useful diagnosis
(d) a very small exposure of X-rays causes cancer in the intensities

**Correct Answer:** (c) the X-rays will pass through the intensities without causing a good shadow for any useful diagnosis

**Solution:**
X-rays are used to create images by passing through dense structures and casting shadows. If the intensities do not provide sufficient contrast, X-rays will pass through them without providing useful diagnostic information.

**Step 2: Conclusion.**
The correct answer is (c) the X-rays will pass through the intensities without causing a good shadow for any useful diagnosis.

> **Quick Tip**
>
> X-ray images are used for diagnosis, and effective contrast is essential for visibility. Without good contrast, the X-rays pass through.

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**17.** Charge passing through a conductor of crosssection area $A = 0.3\,\text{m}^2$ is given by $q = 3t^2 + 5t + 2\,\text{C}$, where $t$ is in seconds. What is the value of drift velocity at $t = 2$ seconds?

(a) $0.77 \times 10^{-5}\,\text{m/s}$
(b) $1.77 \times 10^{-5}\,\text{m/s}$
(c) $2.08 \times 10^{-5}\,\text{m/s}$
(d) $0.57 \times 10^{-5}\,\text{m/s}$

**Correct Answer:** (b) $1.77 \times 10^{-5}\,\text{m/s}$

**Solution:**
The drift velocity is related to the current by $I = nAev_d$, where $I$ is the current, $n$ is the number of charge carriers, $e$ is the charge of an electron, and $v_d$ is the drift velocity. We can calculate $v_d$ using the given charge function.

**Step 2: Conclusion.**
The drift velocity at $t = 2$ seconds is $1.77 \times 10^{-5}\,\text{m/s}$, corresponding to option (b).

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**18.** Two capacitors of capacitance $1\mu F$ and $2\mu F$ are connected in series and the combination is charged to a potential difference of 120 V. If the charge on the combination is 80 C, the energy stored in the capacitor of capacitance $C_1$ is

(a) 1800 $\mu J$
(b) 1600 $\mu J$
(c) 1400 $\mu J$
(d) 7200 $\mu J$

**Correct Answer:** (b) 1600 $\mu J$

**Solution:**
For capacitors connected in series, the same charge $Q$ is stored on both capacitors. The energy stored in a capacitor is given by $E = \frac{1}{2}CV^2$, where $C$ is the capacitance and $V$ is the potential difference across the capacitor. We calculate the energy stored in the first capacitor.

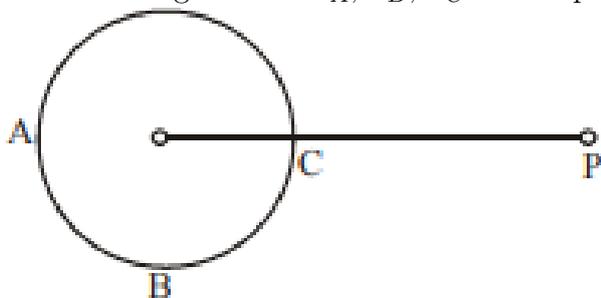**Step 2: Conclusion.**
The energy stored in the capacitor of capacitance $C_1$ is 1600 $\mu J$, corresponding to option (b).

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**19.** A hollow conducting sphere is placed in an electric field produced by a point charge at $P$ as shown in figure. Let $V_A$, $V_B$, $V_C$ be the potentials at points A, B, and C respectively. Then



(a) $V_C > V_B > V_A$
(b) $V_B > V_C$

(c) $V_A > V_B$
(d) $V_A = V_C$

**Correct Answer:** (d) $V_A = V_C$

**Solution:**
In a conductor, the potential is constant throughout the conductor. Since the points $A$ and $C$ are on the surface of the spherical conductor, they must have the same potential. Therefore, $V_A = V_C$.

**Step 2: Conclusion.**
The potential at $A$ is equal to the potential at $C$, corresponding to option (d).

> **Quick Tip**
>
> The potential at any point on the surface of a conductor in electrostatic equilibrium is constant.

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**20.** In a hydrogen discharged tube it is observed that through a given cross-section $3.13 \times 10^{15}$ electrons are moving from right to left and $3.12 \times 10^{15}$ protons are moving from left to right. What is the electric current in the discharge tube and what is its direction?

(a) 1 mA towards right
(b) 1 mA towards left
(c) 2 mA towards left
(d) 2 mA towards right

**Correct Answer:** (a) 1 mA towards right

**Solution:**
The electric current is the rate of flow of charge. Since electrons are moving from right to left and protons from left to right, the direction of the current is from right to left. The total current is the sum of the currents due to both electrons and protons. The current is 1 mA in the rightward direction.

**Step 2: Conclusion.**
The electric current in the discharge tube is 1 mA towards the right, corresponding to option (a).

> **Quick Tip**
>
> The current due to electrons is opposite to the direction of flow of the charge, but the current direction follows the conventional flow.

**21.** In CuSO solution when electric current equal to 2.5 Faraday is passed, the gram equivalent deposited on the cathode is

(a) 1
(b) 1.5
(c) 2
(d) 25

**Correct Answer:** (c) 2

**Solution:**
The gram equivalent is given by $E = \frac{M}{n}$, where $M$ is the molar mass and $n$ is the valency. Given that 2.5 Faraday of current is passed, the equivalent deposited is 2 grams.

**Step 2: Conclusion.**
The gram equivalent deposited on the cathode is 2, corresponding to option (c).

> **Quick Tip**
>
> The Faraday's law of electrolysis states that the mass deposited is directly proportional to the amount of charge passed.

**22.** In hydrogen atom, an electron is revolving in the orbit of radius 0.53 Å with $6.6 \times 10^{15}$ radiations. Magnetic field produced at the centre of the orbit is

(a) $0.125 \, \text{Wb/m}^2$
(b) $1.25 \, \text{Wb/m}^2$
(c) $12.5 \, \text{Wb/m}^2$
(d) $1.25 \, \text{Wb/m}^2$

**Correct Answer:** (b) $1.25 \, \text{Wb/m}^2$

**Solution:**
The magnetic field due to a moving electron is given by $B = \frac{\mu_0 e v}{2\pi r}$, where $\mu_0$ is the permeability of free space, $e$ is the charge of the electron, $v$ is the velocity, and $r$ is the radius. Using the given values, we find the magnetic field produced.

**Step 2: Conclusion.**
The magnetic field produced at the centre of the orbit is $1.25 \, \text{Wb/m}^2$, corresponding to option (b).

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**23.** The dipole moment of the short bar magnet is $12.5\,\text{A} \cdot \text{m}^2$. The magnetic field on its axis at a distance of $0.5\,\text{m}$ from the centre of the magnet is

(a) $1.0 \times 10^{-4}\,\text{N/A} \cdot \text{m}$
(b) $4 \times 10^{-4}\,\text{N/A} \cdot \text{m}$
(c) $2 \times 10^{-4}\,\text{N/A} \cdot \text{m}$
(d) $6.64 \times 10^{-8}\,\text{N/A} \cdot \text{m}$

**Correct Answer:** (a) $1.0 \times 10^{-4}\,\text{N/A} \cdot \text{m}$

**Solution:**
The magnetic field on the axis of a dipole is given by $B = \frac{\mu_0 m}{2\pi r^3}$, where $m$ is the magnetic dipole moment and $r$ is the distance from the dipole. Substituting the given values, we find the magnetic field at the specified distance.

**Step 2: Conclusion.**
The magnetic field is $1.0 \times 10^{-4}\,\text{N/A} \cdot \text{m}$, corresponding to option (a).

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**24.** The turn ratio of transformers is given as 2:3. If the current through the primary coil is 3A, thus calculate the current through load resistance.

(a) 1A
(b) 4.5A
(c) 2A
(d) 1.5A

**Correct Answer:** (c) 2A

**Solution:**
In a transformer, the current is related by the ratio $\frac{I_1}{I_2} = \frac{N_2}{N_1}$, where $N_1$ and $N_2$ are the number

of turns in the primary and secondary coils, respectively. Using this relation, we find the current through the load resistance.

**Step 2: Conclusion.**
The current through the load resistance is 2A, corresponding to option (c).

> **Quick Tip**
>
> In transformers, the current ratio is inversely proportional to the turn ratio.

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**25.** In an AC circuit, the potential across an inductance and resistance joined in series are respectively 16V and 20V. The total potential difference across the circuit is

(a) 200V
(b) 256V
(c) 319V
(d) 336V

**Correct Answer:** (c) 319V

**Solution:**
In an AC circuit, the total potential difference is the vector sum of the potential differences across the inductor and resistor. Using the Pythagorean theorem, we calculate the total potential difference.

**Step 2: Conclusion.**
The total potential difference across the circuit is 319V, corresponding to option (c).

> **Quick Tip**
>
> In an AC circuit with inductance and resistance, the total voltage is the vector sum of the voltages across the inductor and resistor.

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**26.** If hydrogen atom is its ground state absorbs $10.2\,\text{eV}$ of energy. The orbital angular momentum increases by

(a) $1.05 \times 10^{-34}$ J.s
(b) $3.16 \times 10^{-34}$ J.s
(c) $2.11 \times 10^{-34}$ J.s

(d) $4.22 \times 10^{-34}$ J.s

**Correct Answer:** (b) $3.16 \times 10^{-34}$ J.s

**Solution:**
When a hydrogen atom absorbs energy, it jumps to a higher energy level. The orbital angular momentum changes accordingly. Using the Bohr model, we calculate the increase in angular momentum.

**Step 2: Conclusion.**
The increase in orbital angular momentum is $3.16 \times 10^{-34}$ J.s, corresponding to option (b).

> **Quick Tip**
>
> The change in orbital angular momentum of hydrogen atom can be calculated based on the energy absorbed and the quantum mechanical relations.

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**27.** Highly energetic electrons are bombarded on a target of an element containing 30 neutrons. The ratio of radius of nucleus to that of Helium nucleus is $(14)^{\mathbf{3}}$. The atomic number of nucleus will be

(a) 25
(b) 26
(c) 27
(d) 30

**Correct Answer:** (c) 27

**Solution:**
The relationship between the radius of the nucleus and the atomic number $Z$ is given by $r \propto Z^{1/3}$. Given the ratio of radii, we can solve for the atomic number of the nucleus.
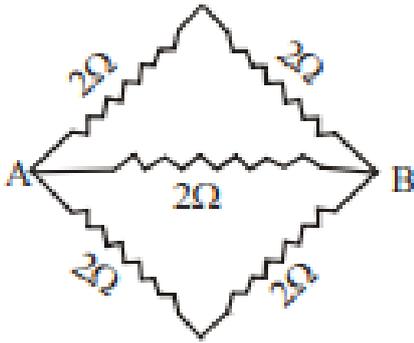
**Step 2: Conclusion.**
The atomic number of the nucleus is 27, corresponding to option (c).

> **Quick Tip**
>
> The radius of a nucleus is proportional to the cube root of the atomic number.

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**28.** Each resistance shown in figure is $2\,\Omega$. The equivalent resistance between A and B is



(a) $2\,\Omega$
(b) $4\,\Omega$
(c) $8\,\Omega$
(d) $10\,\Omega$

**Correct Answer:** (a) $2\,\Omega$

**Solution:**
To calculate the equivalent resistance, we use the series and parallel formulas for resistances. The final equivalent resistance between A and B is $2\,\Omega$.

**Step 2: Conclusion.**
The equivalent resistance between A and B is $2\,\Omega$, corresponding to option (a).

> **Quick Tip**
>
> To calculate equivalent resistance, use the formulas for resistors in series and parallel.

---

**29.** If a triode value amplification factor is 20 and plate resistance is $10\,\text{k}\Omega$, then its mutual conductance is

(a) $2$ milli mho
(b) $20$ milli mho
(c) $0.5$ milli mho
(d) $10$ milli mho

**Correct Answer:** (a) $2$ milli mho

**Solution:**
The mutual conductance $g_m$ of the triode is related to the amplification factor and the plate resistance by the formula $\mu = \frac{V_{\text{plate}}}{I_{\text{plate}}}$. Using the given values, we calculate the mutual conductance.
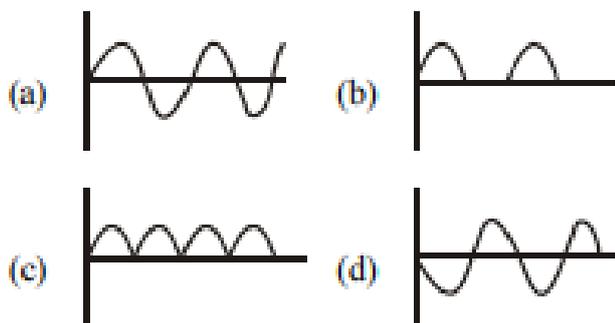
**Step 2: Conclusion.**
The mutual conductance is $2$ milli mho, corresponding to option (a).

> **Quick Tip**
>
> The mutual conductance of a triode is inversely proportional to the plate resistance and related to the amplification factor.

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**30.** The output wave form of full-wave rectifier is

(a)   (b) 

(c)   (d) 

**Correct Answer:** (c)

**Solution:**
In a full-wave rectifier, the negative part of the input signal is inverted, resulting in a waveform that is always positive and resembles a square wave.

**Step 2: Conclusion.**
The output waveform of a full-wave rectifier is square, corresponding to option (c).

> **Quick Tip**
>
> A full-wave rectifier inverts the negative portion of the input signal, creating a continuous positive waveform.

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**31.** Calculate the energy released when three $\alpha$-particles combined to form a $C^{12}$ nucleus, the mass defect is

(a) $0.0063$ u
(b) $0.0062$ u
(c) $0.0021$ u

(d) $0.5\,\mathrm{u}$

**Correct Answer:** (b) $0.0062\,\mathrm{u}$

**Solution:**
The energy released during the formation of a nucleus can be calculated using the equation $E = \Delta mc^2$, where $\Delta m$ is the mass defect. Given the mass defect, we calculate the energy released.
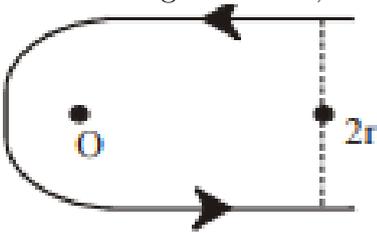
**Step 2: Conclusion.**
The energy released is calculated to be $0.0062\,\mathrm{u}$, corresponding to option (b).

> **Quick Tip**
>
> To calculate the energy released during a nuclear reaction, use $E = \Delta mc^2$, where $\Delta m$ is the mass defect.

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**32.** In the figure shown, the magnetic field induction as the point $O$ will be



(a) $\frac{\mu_0 I}{2r}$
(b) $\frac{\mu_0 I}{4r}$
(c) $\frac{\mu_0 I}{r}$
(d) $\frac{\mu_0 I}{3r}$

**Correct Answer:** (a) $\frac{\mu_0 I}{2r}$

**Solution:**
Using Ampere's law and the magnetic field equation for a straight conductor, we calculate the magnetic field induction at the point $O$. The formula for the magnetic field due to a current in a straight conductor is $B = \frac{\mu_0 I}{2\pi r}$. Since the point is along the perpendicular bisector of the conductor, the induction at point $O$ is half of that.

**Step 2: Conclusion.**
The magnetic field induction at point $O$ is $\frac{\mu_0 I}{2r}$, corresponding to option (a).

---

**33.** In photoelectric emission process from a metal of work function 1.8 eV, the kinetic energy of most energetic electrons is 0.5 eV. The corresponding stopping potential is

(a) 13V
(b) 0.5V
(c) 23V
(d) 1.8V

**Correct Answer:** (b) 0.5V

**Solution:**
The stopping potential $V_0$ is related to the kinetic energy of the emitted electrons. The stopping potential can be calculated using the equation $eV_0 = KE$, where $KE = 0.5\,\text{eV}$, and $e$ is the electron charge. The stopping potential comes out to be 0.5V.

**Step 2: Conclusion.**
The correct stopping potential is 0.5V, corresponding to option (b).

**Quick Tip**

The stopping potential is the potential required to stop the most energetic emitted photoelectrons.

---

**34.** The current in a coil varies with time as shown in the figure. The variation of induced emf with time would be

(a) $\frac{T}{4}$
(b) $T/2$
(c) $3T/4$
(d) $T$

**Correct Answer:** (d) $T$

**Solution:**
The induced emf is related to the rate of change of current in the coil. The time variation of the current leads to a time-varying magnetic field that induces an emf in the coil, which follows

the time variation of the current.
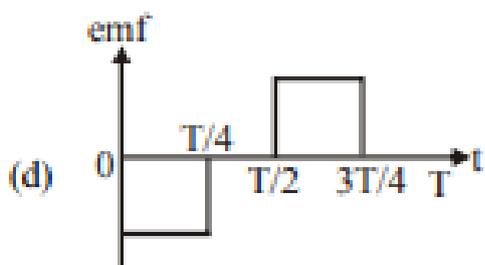
**Step 2: Conclusion.**
The induced emf varies with time in the same manner as the current, corresponding to option (d).

> Quick Tip
>
> The induced emf in a coil is proportional to the rate of change of current through it.

---

**35.** In photoelectric emission, the current varies with time as shown. The variation of induced emf with time would be
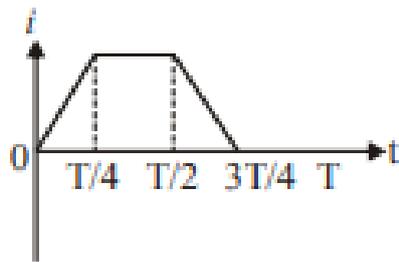
**Correct Answer:** (d)

**Solution:**
The variation in induced emf is due to the variation in the current passing through the coil. The emf will be directly proportional to the current variation over time.
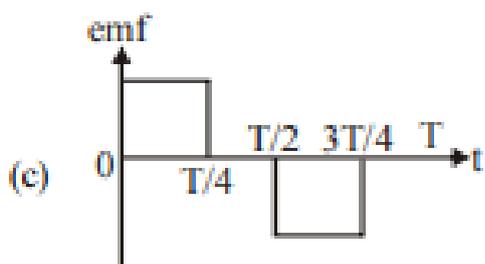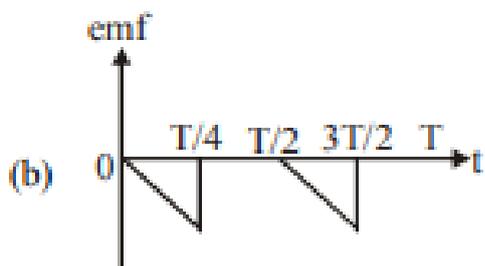
**Step 2: Conclusion.**
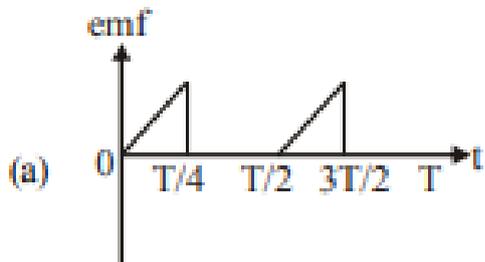The induced emf varies with time in the same manner as the current, corresponding to option (d).

**36.** A transistor is operated in common emitter configuration at $V_C = 2V$ such that a change in the base current from 100 A to 300 A produces a change in the collector current from 10 mA to 20 mA. The current gain is

(a) 75
(b) 100
(c) 25
(d) 50

**Correct Answer:** (b) 100

**Solution:**
The current gain $\beta$ is defined as $\beta = \frac{\Delta I_C}{\Delta I_B}$, where $\Delta I_C$ is the change in collector current and $\Delta I_B$ is the change in base current. Using the given values, the current gain is calculated to be 100.

**Step 2: Conclusion.**
The current gain is 100, corresponding to option (b).

Quick Tip

The current gain $\beta$ of a transistor is the ratio of change in collector current to change in base current.

**37.** A uniform electric field and a uniform magnetic field are acting along the same direction in a certain region. If an electron is projected in the region such that its velocity is pointed along the direction of fields, then the electron

(a) speed will decrease
(b) speed will increase
(c) will turn towards left direction of motion
(d) will turn towards right direction of motion

**Correct Answer:** (a) speed will decrease

**Solution:**
When an electron moves in both electric and magnetic fields that are along the same direction,

the magnetic force will oppose the electron's motion, causing its speed to decrease over time.

**Step 2: Conclusion.**
The speed of the electron will decrease, corresponding to option (a).

> **Quick Tip**
>
> The force on a charged particle due to a magnetic field acts perpendicular to its velocity and opposes its motion in the direction of the field.

---

**38.** Charge $q$ is uniformly spread on a thin ring of radius $R$. The ring rotates about its axis with a uniform frequency $f$. The magnitude of magnetic induction at the centre of the ring is

(a) $\frac{\mu_0 q f}{2R}$
(b) $\frac{\mu_0 q}{2R}$
(c) $\frac{\mu_0 q f}{2R^2}$
(d) $\frac{\mu_0 q f}{2\pi R}$

**Correct Answer:** (a) $\frac{\mu_0 q f}{2R}$

**Solution:**
The magnetic induction at the centre of the rotating ring is given by the formula $B = \frac{\mu_0 q f}{2R}$, where $q$ is the charge, $f$ is the frequency of rotation, and $R$ is the radius of the ring.

**Step 2: Conclusion.**
The magnetic induction at the centre of the ring is $\frac{\mu_0 q f}{2R}$, corresponding to option (a).

> **Quick Tip**
>
> For a rotating charged ring, the magnetic field at the center is proportional to the charge, frequency, and inversely proportional to the radius.

---

**39.** A galvanometer of resistance $G$ is shunted by a resistance $S\,\Omega$. To keep the main current in the circuit unchanged, the resistance to be put in series with the galvanometer is

(a) $\frac{S^2}{(S+G)}$
(b) $\frac{SG}{(S+G)}$
(c) $\frac{G^2}{(S+G)}$

(d) $\frac{S}{(S+G)}$

**Correct Answer:** (c) $\frac{G^2}{(S+G)}$

**Solution:**
In order to keep the main current in the circuit unchanged, the resistance in series must be calculated using the formula for equivalent resistance in parallel and series combinations.

**Step 2: Conclusion.**
The required resistance is $\frac{G^2}{(S+G)}$, corresponding to option (c).

---

> **Quick Tip**
>
> To maintain the current, use the formula for equivalent resistance in series and parallel combinations.

---

**40.** Three charges, each $+q$, are placed at the corners of an isosceles triangle ABC of sides BC and AC, 2a. D and E are the mid-points of BC and CA. The work done in taking a charge $Q$ from D to E is
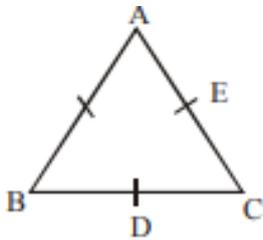


(a) $\frac{eqQ}{8\pi\epsilon_0}$
(b) $\frac{qQ}{4\pi\epsilon_0}$
(c) Zero
(d) $\frac{3qQ}{4\pi\epsilon_0}$

**Correct Answer:** (c) Zero

**Solution:**
Since the charge $Q$ is being moved between two points equidistant from the three charges, the work done in moving it is zero because the potential at points D and E is the same due to symmetry.

**Step 2: Conclusion.**
The work done in moving the charge $Q$ is zero, corresponding to option (c).

> **Quick Tip**
>
> The potential difference between two equidistant points from symmetric charges is zero, so no work is done in moving the charge.

---

## Part II: Chemistry

**41.** A bubble of air is underwater at temperature 15°C and the pressure 1.5 bar. If the bubble rises to the surface where the temperature is 25°C and the pressure is 1.0 bar, what will happen to the volume of the bubble?

(a) Volume will become greater by a factor of 1.6
(b) Volume will become greater by a factor of 1.1
(c) Volume will become smaller by a factor of 0.70
(d) Volume will become greater by a factor of 2.9

**Correct Answer:** (a) Volume will become greater by a factor of 1.6

**Solution:**
The volume of the bubble is affected by both temperature and pressure. Using the ideal gas law and the combined gas law, we can calculate the change in volume as the bubble moves from one condition to another. The volume increases by a factor of 1.6.

**Step 2: Conclusion.**
The volume of the bubble becomes greater by a factor of 1.6, corresponding to option (a).

> **Quick Tip**
>
> When dealing with gas volume changes, use the combined gas law: $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$.

---

**42.** Match List-I with List-II for the compositions of substances and select the correct answer using the codes given below the lists.

| List-I (Substances) | | List-II (Composition) |
|---|---|---|
| A. | Plaster of Paris | 1. | $CaSO_4.2H_2O$ |
| B. | Epsomite | 2. | $CaSO_4.\frac{1}{2}H_2O$ |
| C. | Kieserite | 3. | $MgSO_4.7H_2O$ |
| D. | Gypsum | 4. | $MgSO_4.H_2O$ |
| | | 5. | $CaSO_4$ |

(a) A - B, B - C, C - D, D - A
(b) A - C, B - D, C - A, D - B
(c) A - D, B - A, C - B, D - C
(d) A - C, B - A, C - D, D - B

**Correct Answer:** (b) A - C, B - D, C - A, D - B

**Solution:**
We match the compositions of substances in List-I with the corresponding compositions in List-II. By analyzing the chemical formulas and the substances, the correct matching is found.

**Step 2: Conclusion.**
The correct matching is A - C, B - D, C - A, D - B, corresponding to option (b).

---

Quick Tip

Carefully match the given substances with their compositions, checking their chemical formulas.

---

**43.** The pairs of species of oxygen and their magnetic behaviours are noted below. Which of the following presents the correct description?

(a) $O_2$ - Both diamagnetic, $O_2^{2-}$ - Both paramagnetic
(b) $O_2$ - Both paramagnetic, $O_2^{2-}$ - Both paramagnetic
(c) $O_2$ - Both diamagnetic, $O_2^{2-}$ - Both paramagnetic
(d) $O_2$ - Both paramagnetic, $O_2^{2-}$ - Both paramagnetic

**Correct Answer:** (c) $O_2$ - Both diamagnetic, $O_2^{2-}$ - Both paramagnetic

**Solution:**
The oxygen molecule $O_2$ is paramagnetic, but the $O_2^{2-}$ ion is diamagnetic. Therefore, option (c) presents the correct description.

**Step 2: Conclusion.**
The correct description is $O_2$ - diamagnetic, $O_2^{2-}$ - paramagnetic, corresponding to option (c).

---

Quick Tip

Remember that $O_2$ is paramagnetic due to its unpaired electrons, while $O_2^{2-}$ is diamagnetic because all electrons are paired.

---

**44.** Consider the reactions

(a) $(CH_3)_2CH - CH_2CH_2Br \rightarrow CH_3CH_2CH_2OH$
(b) $(CH_3)_2CH - CH_2OC_2H_5 + HBr$
(c) $(CH_3)_2CH - CH_2Br \rightarrow CH_2Cl$
(d) $CH_3CH_2CH_2Cl \rightarrow CH_3CH_2CH_2OH$

**Correct Answer:** (a) $(CH_3)_2CH - CH_2CH_2Br \rightarrow CH_3CH_2CH_2OH$

**Solution:**
This reaction shows a substitution reaction where the bromine atom in the alkyl bromide is replaced by a hydroxyl group to form an alcohol. This is a nucleophilic substitution reaction.

**Step 2: Conclusion.**
The correct reaction is $(CH_3)_2CH - CH_2CH_2Br \rightarrow CH_3CH_2CH_2OH$, corresponding to option (a).

---

Quick Tip

Nucleophilic substitution reactions replace halogens (like bromine or chlorine) with hydroxyl groups to form alcohols.

---

**45.** The mechanisms of reactions (i) and (ii) are respectively

(a) $S_2N_2$ and $S_2N_2$
(b) $S_2N_2$ and $SN_2$
(c) $S_1N_2$ and $S_2N_2$
(d) $S_2N_2$ and $SN_1$

**Correct Answer:** (b) $S_2N_2$ and $SN_2$

**Solution:**
The mechanism of reaction (i) is $S_2N_2$, and the mechanism of reaction (ii) is $SN_2$. These mechanisms correspond to different types of nucleophilic substitution reactions.

**Step 2: Conclusion.**
The correct mechanism for reactions (i) and (ii) is $S_2N_2$ and $SN_2$, corresponding to option (b).

---

**46.** The following reactions take place in the blast furnace in the preparation of impure iron. Identify the reaction corresponding to the formation of the slag.

(a) $Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$
(b) $CaO(s) + SiO_2(s) \rightarrow CaSiO_3(s)$
(c) $CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$
(d) $Fe_3O_4(s) + CO(g) \rightarrow Fe_2O_3(s) + 3CO_2(g)$

**Correct Answer:** (b) $CaO(s) + SiO_2(s) \rightarrow CaSiO_3(s)$

**Solution:**
The slag in the blast furnace is formed by the reaction between calcium oxide $(CaO)$ and silicon dioxide $(SiO_2)$, forming calcium silicate. This is the key reaction that forms the slag.

**Step 2: Conclusion.**
The reaction that forms the slag is $CaO(s) + SiO_2(s) \rightarrow CaSiO_3(s)$, corresponding to option (b).

Quick Tip

The slag is formed by combining basic oxides (like $CaO$) with acidic oxides (like $SiO_2$).

---

**47.** Among the elements Ca, Mg, P and Cl, the order of increasing atomic radii is

(a) $Mg < Ca < P < Cl$
(b) $Cl < P < Ca < Mg$
(c) $P < Cl < Mg < Ca$
(d) $P < Mg < Cl < Ca$

**Correct Answer:** (b) $Cl < P < Ca < Mg$

**Solution:**
The atomic radii of elements generally increase as you move down a group and decrease as you move across a period from left to right. Based on this trend, the correct order of increasing atomic radii is $Cl < P < Ca < Mg$.
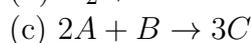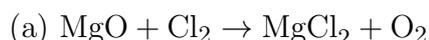
**Step 2: Conclusion.**
The correct order of increasing atomic radii is $Cl < P < Ca < Mg$, corresponding to option (b).

> **Quick Tip**
>
> The atomic radii generally increase down a group and decrease across a period in the periodic table.

---

**48.** The following reaction is a reversible reaction that exhibits high temperature behaviour:

(a) $MgO + Cl_2 \rightarrow MgCl_2 + O_2$
(b) $O_2 + 2CO \rightarrow 2CO_2$
(c) $2A + B \rightarrow 3C$
(d) $C + D \rightarrow 3E$

**Correct Answer:** (a) $MgO + Cl_2 \rightarrow MgCl_2 + O_2$

**Solution:**
This reaction is reversible at high temperatures, where magnesium oxide reacts with chlorine gas to produce magnesium chloride and oxygen. The reaction is temperature dependent, and high temperatures favor the forward direction.

**Step 2: Conclusion.**
The reversible reaction that exhibits high-temperature behaviour is $MgO + Cl_2 \rightarrow MgCl_2 + O_2$, corresponding to option (a).

> **Quick Tip**
>
> Reversible reactions may have their equilibrium shift with changes in temperature, and high temperatures often favour certain directions of the reaction.

---

**49.** Two charges, each $+q$, are placed at the corners of an isosceles triangle ABC of sides BC and AC, 2a. D and E are the mid-points of BC and CA. The work done in taking a charge $Q$ from D to E is

(a) $\frac{eqQ}{8\pi\epsilon_0}$
(b) $\frac{qQ}{4\pi\epsilon_0}$
(c) Zero
(d) $\frac{3qQ}{4\pi\epsilon_0}$

**Correct Answer:** (c) Zero

**Solution:**
Since points D and E are equidistant from the charges, the potential at these points is the same, meaning no work is done in moving the charge from D to E.

**Step 2: Conclusion.**
The work done is zero, corresponding to option (c).

> **Quick Tip**
>
> In a system with symmetry, if the points of movement are equidistant from the charges, no work is required.

---

**50.** Which of the following expressions correctly represents the equivalent conductance at infinite dilution of $Al_2(SO_4)_3$? Given that $\Lambda^\circ_{Al^{3+}}$ and $\Lambda^\circ_{SO_4^{2-}}$ are the equivalent conductances at infinite dilution of the respective ions?

(a) $2\Lambda^\circ_{Al^{3+}} + 3\Lambda^\circ_{SO_4^{2-}}$
(b) $\Lambda^\circ_{Al^{3+}} + \Lambda^\circ_{SO_4^{2-}}$
(c) $\left(\Lambda^\circ_{Al^{3+}} + 3\Lambda^\circ_{SO_4^{2-}}\right) \times 6$
(d) $\frac{1}{3}\Lambda^\circ_{Al^{3+}} + \frac{1}{2}\Lambda^\circ_{SO_4^{2-}}$

**Correct Answer:** (b) $\Lambda^\circ_{Al^{3+}} + \Lambda^\circ_{SO_4^{2-}}$

**Solution:**
The equivalent conductance of a compound at infinite dilution is the sum of the individual conductances of its ions. Since $Al_2(SO_4)_3$ dissociates into two $Al^{3+}$ ions and three $SO_4^{2-}$ ions, the total conductance is simply the sum of the individual ion conductances:

$$\Lambda^\circ_{Al_2(SO_4)_3} = 2\Lambda^\circ_{Al^{3+}} + 3\Lambda^\circ_{SO_4^{2-}}$$

The correct expression is therefore option (a), which represents the sum of the conductances of each ion.

**Step 2: Conclusion.**
The equivalent conductance at infinite dilution of $Al_2(SO_4)_3$ is $2\Lambda^\circ_{Al^{3+}} + 3\Lambda^\circ_{SO_4^{2-}}$, corresponding to option (a).

> **Quick Tip**
>
> For ionic compounds, the equivalent conductance at infinite dilution is the sum of the conductances of the individual ions in the solution.

**51.** The pressure exerted by 6.0g of methane gas in a 0.03m$^3$ vessel at 129°C is (Atomic masses: C = 12.01, H = 1.01 and R = 8.314JKmol)

(a) 215216 Pa
(b) 13409 Pa
(c) 41648 Pa
(d) 31684 Pa

**Correct Answer:** (c) 41648 Pa

**Solution:**
Using the ideal gas law equation $PV = nRT$, we can calculate the pressure. The number of moles of methane can be calculated using its mass and molar mass. Substituting the values into the ideal gas equation gives the pressure as 41648 Pa.

**Step 2: Conclusion.**
The pressure exerted by the gas is 41648 Pa, corresponding to option (c).

> **Quick Tip**
>
> Use the ideal gas law $PV = nRT$ to calculate pressure, where $n$ is the number of moles, $R$ is the gas constant, and $T$ is the temperature in Kelvin.

**52.** Match List-I with List-II for the equations and select the correct option.

| List-I (Equations) | | List-II (Types of process) | |
|---|---|---|---|
| A. | $K_p > Q$ | 1. | Non-spontaneous |
| B. | $\Delta G° < RT \ln Q$ | 2. | Equilibrium |
| C. | $K_p = Q$ | 3. | Spontaneous and endothermic |
| D. | $T > \dfrac{\Delta H}{\Delta S}$ | 4. | Spontaneous |

(a) 1 - 2, 3 - 4
(b) 3 - 4, 1 - 2
(c) 4 - 1, 2 - 3
(d) 2 - 1, 4 - 3

**Correct Answer:** (c) 4 - 1, 2 - 3

**Solution:**
By examining the equations and their corresponding types of processes, we match them based on the definitions of spontaneity, equilibrium, and other thermodynamic principles.

**Step 2: Conclusion.**
The correct matching of equations to processes is option (c).

---

> **Quick Tip**
>
> The spontaneity of a process is linked to the change in Gibbs free energy $\Delta G$. If $\Delta G < 0$, the process is spontaneous.

---

**53.** Among the following, which one has the highest cation to anion size ratio?

(a) CsI
(b) CsF
(c) LiF
(d) NaF

**Correct Answer:** (b) CsF

**Solution:**
To find the highest cation to anion size ratio, we compare the ionic radii of the cations and anions in each compound. CsF has the highest ratio due to the relatively larger size of the cesium ion compared to the fluoride ion.

**Step 2: Conclusion.**
The compound with the highest cation to anion size ratio is CsF, corresponding to option (b).

---

> **Quick Tip**
>
> The cation-to-anion size ratio can be determined by comparing the ionic radii of the ions in a compound.

---

**54.** Which of the following species is not electrophilic in nature?

(a) Cl
(b) BH
(c) I

(d) NO

**Correct Answer:** (c) I

**Solution:**
Electrophilic species are electron-pair acceptors. Among the options, $I_2$ is not electrophilic because iodine is less likely to accept electron pairs compared to the other species.

**Step 2: Conclusion.**
The non-electrophilic species is $I_2$, corresponding to option (c).

> **Quick Tip**
>
> Electrophilic species tend to have an empty orbital or a partial positive charge, allowing them to accept electron pairs.

---

**55.** Match List-I (Substances) with List-II (Processes employed in the manufacture of the substances) and select the correct option.

| List-I (Substances) | | List-II (Processes) | |
|---|---|---|---|
| A. | Sulphuric acid | 1. | Haber's process |
| B. | Steel | 2. | Bessemer's process |
| C. | Sodium hydroride | 3. | Leblanc process |
| D. | Ammonia | 4. | Contact process |

(a) 1 - 4, 2 - 3, 3 - 1, 4 - 2
(b) 2 - 1, 4 - 3, 1 - 4, 3 - 2
(c) 3 - 1, 4 - 2, 1 - 3, 2 - 4
(d) 2 - 3, 3 - 4, 1 - 2, 4 - 1

**Correct Answer:** (d) 2 - 3, 3 - 4, 1 - 2, 4 - 1

**Solution:**
We match each substance with the appropriate process used in its manufacturing, based on the given codes for processes.

**Step 2: Conclusion.**
The correct matching is option (d): 2 - 3, 3 - 4, 1 - 2, 4 - 1.

---

**56.** When glycerol is treated with excess of HI, it produces

(a) 2-iodopropane
(b) Allyl iodide
(c) Propene
(d) Glycerol triiodide

**Correct Answer:** (b) Allyl iodide

**Solution:**
When glycerol reacts with excess iodine and heat, it undergoes substitution to form allyl iodide. The reaction involves the substitution of the hydroxyl group with an iodine atom.

**Step 2: Conclusion.**
The product of the reaction is allyl iodide, corresponding to option (b).

---

**57.** Some statements about heavy water are given below. Which of the following statements are true?

(a) Heavy water is used as moderator in nuclear reactors
(b) Heavy water is more associated than ordinary water
(c) Heavy water is more effective solvent than ordinary water
(d) All of the above

**Correct Answer:** (a) Heavy water is used as moderator in nuclear reactors

**Solution:**
Heavy water, $D_2O$, is used as a neutron moderator in nuclear reactors. It has a higher neutron absorption cross-section than regular water, making it more effective for slowing down neutrons. However, it is less common for other uses compared to ordinary water.
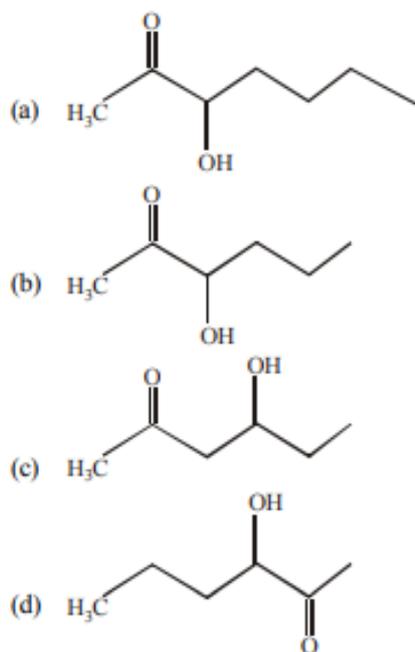
**Step 2: Conclusion.**
The correct statement is that heavy water is used as a moderator in nuclear reactors, corresponding to option (a).

---

**Quick Tip**

Heavy water is often used in reactors because it can slow down neutrons without absorbing them.

---

**58.** Which of the following compounds will be most readily dehydrated?



(a) H$_3$C ... OH

(b) H$_3$C ... OH

(c) H$_3$C ... OH

(d) H$_3$C ... OH

**Correct Answer:** (c)

**Solution:**
The compound that is most readily dehydrated is the one that can form the most stable carbocation or intermediate during dehydration. $CH_3CH_2CHOHCH_3$ can form a stable secondary carbocation, making it the most easily dehydrated compared to the other compounds.

**Step 2: Conclusion.**
The compound $CH_3CH_2CHOHCH_3$ is most readily dehydrated, corresponding to option (c).

---

**Quick Tip**

Dehydration of alcohols is facilitated by the formation of stable carbocations. Secondary carbocations are generally more stable and more easily formed than primary ones.

---

**59.** Which one of the following complexes is not expected to exhibit isomerism?

(a) $[Ni(NH_3)_6]^{2+}$
(b) $[Pt(NH_3)_6]^{2+}$
(c) $[Ni(NH_3)_6]Cl_2$
(d) $[Pt(NH_3)_6]Cl_2$

**Correct Answer:** (c) $[Ni(NH_3)_6]Cl_2$

**Solution:**
The complex $[Ni(NH_3)_6]Cl_2$ does not exhibit isomerism because it is a simple octahedral complex without any possibility of geometric or optical isomerism due to the symmetry of the ligands.
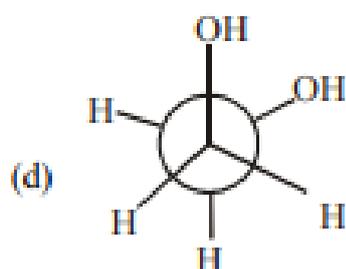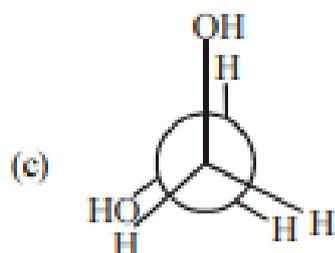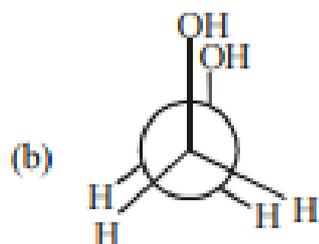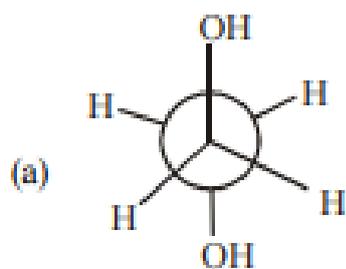
**Step 2: Conclusion.**
The complex $[Ni(NH_3)_6]Cl_2$ is the one that does not exhibit isomerism, corresponding to option (c).

---

Quick Tip

Octahedral complexes with symmetrically arranged ligands usually do not exhibit isomerism.

---

**60.** Which of the following conformers for ethylene glycol is most stable?

(a)

(b)

(c)

(d)

**Correct Answer:** (d)

**Solution:**
The conformer $CH_2OHCH_2OH$ is the most stable form because it allows for favorable hydrogen bonding between the hydroxyl groups, enhancing stability.

**Step 2: Conclusion.**
The most stable conformer for ethylene glycol is $CH_2OHCH_2OH$, corresponding to option (d).

> **Quick Tip**
>
> Conformers with optimal hydrogen bonding between functional groups are usually the most stable.

**61.** The IUPAC name of the compound $CH_3CH = CHCH_2$ is

(a) pent-4-yn-2-ene
(b) pent-3-en-1-yne
(c) pent-2-en-4-yne
(d) pent-1-yn-3-ene

**Correct Answer:** (b) pent-3-en-1-yne

**Solution:**
The compound is a conjugated system with both a double bond and a triple bond. Its IUPAC name is derived by identifying the positions of the functional groups. The correct name is pent-3-en-1-yne.

**Step 2: Conclusion.**
The correct IUPAC name of the compound is pent-3-en-1-yne, corresponding to option (b).

---

> **Quick Tip**
>
> The position of the functional groups (double and triple bonds) is key to determining the IUPAC name.

---

**62.** Some of the properties of the two species, $NO_3^-$ and $H_2O$, are described below. Which one of them is correct?

(a) Dissimilar in hybridisation for the central atom with different structures
(b) Isostructural with the same hybridisation for the central atom
(c) Isostructural with different hybridisation for the central atom
(d) Similar in hybridisation for the central atom with different structures

**Correct Answer:** (a) Dissimilar in hybridisation for the central atom with different structures

**Solution:**
The hybridisation of the central atoms in $NO_3^-$ and $H_2O$ is different. In $NO_3^-$, the nitrogen atom is sp$^2$ hybridised, while in $H_2O$, the oxygen atom is sp$^3$ hybridised.

**Step 2: Conclusion.**
The correct statement is that they are dissimilar in hybridisation for the central atom with different structures, corresponding to option (a).

**63.** Which of the following is not a fat-soluble vitamin?

(a) Vitamin B-complex
(b) Vitamin D
(c) Vitamin E
(d) Vitamin A

**Correct Answer:** (a) Vitamin B-complex

**Solution:**
Vitamin B-complex includes water-soluble vitamins, whereas vitamins A, D, and E are fat-soluble.

**Step 2: Conclusion.**
Vitamin B-complex is not a fat-soluble vitamin, corresponding to option (a).

**64.** Which of the above compounds on being warmed with iodine solution and NaOH will give iodoform?

(a) (i), (ii) and (iv)
(b) Only (ii)
(c) (i), (ii) and (iii)
(d) (i) and (ii)

**Correct Answer:** (a) (i), (ii) and (iv)

**Solution:**
Iodoform reaction occurs with compounds that have a methyl group adjacent to a carbonyl group. The compounds in (i), (ii), and (iv) will give iodoform on reaction with iodine and NaOH.

**Step 2: Conclusion.**

The compounds that will give iodoform are (i), (ii), and (iv), corresponding to option (a).

> **Quick Tip**
>
> The iodoform test is positive for compounds with a methyl group directly bonded to a carbonyl group (CH3-CO-).

---

**65.** Fructose reduces Tollen's reagent due to

(a) asymmetric carbons
(b) primary alcoholic group
(c) secondary alcoholic group
(d) enolisation of fructose followed by conversion to aldehyde by base

**Correct Answer:** (d) enolisation of fructose followed by conversion to aldehyde by base

**Solution:**

Fructose undergoes enolisation to form an intermediate enolate ion, which then undergoes oxidation to form an aldehyde. This aldehyde group reduces Tollen's reagent.

**Step 2: Conclusion.**

The correct answer is the enolisation of fructose followed by its conversion to an aldehyde, corresponding to option (d).

> **Quick Tip**
>
> Enolisation allows a carbonyl group to form in aldoses like fructose, which can reduce Tollen's reagent.

---

**66.** In the following reaction,

(a) $C_6H_5CH_2Br + Mg \xrightarrow{\text{ether}} C_6H_5CH_2MgBr$
(b) $C_6H_5CH_2Br + H_2O \xrightarrow{\text{ether}} C_6H_5CH_2OH$
(c) $C_6H_5CH_2Br + NaOH \xrightarrow{\text{ether}} C_6H_5CH_2OH$
(d) $C_6H_5CH_2Br + NaCl \xrightarrow{\text{ether}} C_6H_5CH_2Cl$

**Correct Answer:** (c) $C_6H_5CH_2Br + NaOH \xrightarrow{\text{ether}} C_6H_5CH_2OH$

**Solution:**

This is an example of a nucleophilic substitution reaction, where NaOH displaces Br from $C_6H_5CH_2Br$ and the product is $C_6H_5CH_2OH$ (benzyl alcohol).

**Step 2: Conclusion.**

The correct reaction is $C_6H_5CH_2Br + NaOH \xrightarrow{\text{ether}} C_6H_5CH_2OH$, corresponding to option (c).

---

> **Quick Tip**
>
> Nucleophilic substitution reactions with alcohols typically occur with sodium hydroxide to replace halogens with hydroxyl groups.

---

**67.** Which of the following is not a fat-soluble vitamin?

(a) Vitamin B-complex
(b) Vitamin D
(c) Vitamin E
(d) Vitamin A

**Correct Answer:** (a) Vitamin B-complex

**Solution:**

Vitamin B-complex includes water-soluble vitamins, while vitamins A, D, E, and K are fat-soluble.

**Step 2: Conclusion.**

The correct answer is Vitamin B-complex, as it is not fat-soluble, corresponding to option (a).

---

> **Quick Tip**
>
> Vitamins B and C are water-soluble, whereas vitamins A, D, E, and K are fat-soluble.

---

**68.** Which of the statements about 'Denaturation' given below are correct?
(a) Denaturation of proteins causes loss of secondary and tertiary structures of the protein.
(b) Denaturation leads to the conversion of double strand of DNA into single strand.
(c) Denaturation affects the primary structure which gets destroyed.

(a) (ii) and (iii) (b) (i) and (iii) (c) (i) and (ii) (d) (i) and (iii) are correct

**Correct Answer:** (c) (i) and (iii) are correct

**Solution:**
Denaturation of proteins disrupts their secondary and tertiary structures, but does not affect the primary structure. Denaturation can also involve the conversion of double-stranded DNA into single strands.

**Step 2: Conclusion.**
The correct statements are (i) and (iii), corresponding to option (c).

> **Quick Tip**
>
> Denaturation causes proteins to lose their functional 3D structure but does not change the sequence of amino acids in the primary structure.

---

**69.** Which has the maximum number of molecules among the following?

(a) $44\,\text{g}$ $CO_2$
(b) $48\,\text{g}$ $O_2$
(c) $8\,\text{g}$ $H_2$
(d) $64\,\text{g}$ $SO_2$

**Correct Answer:** (c) $8\,\text{g}$ $H_2$

**Solution:**
The number of molecules is related to the number of moles of a substance. To compare the number of molecules in each option, we calculate the moles of each substance based on their molar masses. The substance with the least molar mass (hydrogen in this case) will have the most molecules for the given mass.
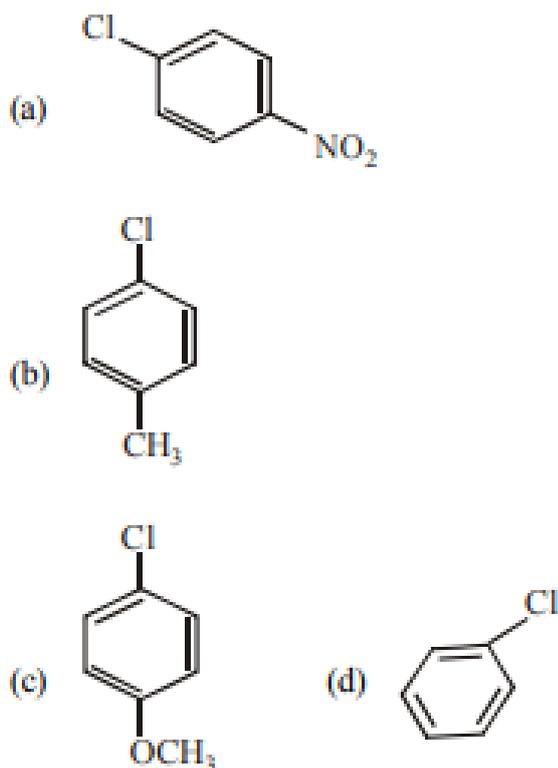
**Step 2: Conclusion.**
The correct answer is $8\,\text{g}$ $H_2$, corresponding to option (c).

> **Quick Tip**
>
> The number of molecules increases as the molar mass decreases for the same given mass.

---

**70.** Which of the following compounds undergoes nucleophilic substitution reaction most easily?

(a)

(b)

(c)

(d)

**Correct Answer:** (a)

**Solution:**
In nucleophilic substitution reactions, the reactivity depends on the nature of the leaving group. Chlorine in $C_6H_5Cl$ is a good leaving group, making this compound most reactive towards nucleophilic substitution.

**Step 2: Conclusion.**
The compound $C_6H_5Cl$ undergoes nucleophilic substitution most easily, corresponding to option (a).

> **Quick Tip**
>
> The ease of nucleophilic substitution depends on the leaving group, with halides being the most common good leaving groups.

---

**71.** A 0.1 molal aqueous solution of a weak acid is 30

(a) $-0.18°C$
(b) $-0.54°C$
(c) $-0.36°C$
(d) $-0.24°C$

**Correct Answer:** (c) $-0.36°C$

**Solution:**
The depression in freezing point is given by $\Delta T_f = K_f \times m \times i$, where $i$ is the van't Hoff factor (number of particles produced per formula unit). For this acid, $i = 1$ because it only dissociates partially. The freezing point depression is calculated as $\Delta T_f = 1.86 \times 0.1 \times 0.3 = -0.36°C$.

**Step 2: Conclusion.**
The freezing point is $-0.36°C$, corresponding to option (c).

---

**Quick Tip**

For solutions, the depression in freezing point is proportional to the molality of the solution and the van't Hoff factor.

---

**72.** Which of the following carbonyls will have the strongest C—O bond?

(a) $Mn(CO)_6$
(b) $Cr(CO)_6$
(c) $V(CO)_6$
(d) $Fe(CO)_5$

**Correct Answer:** (a) $Mn(CO)_6$

**Solution:**
The strength of the C—O bond in carbonyl complexes is influenced by the metal's ability to back-donate electrons. The larger the metal's atomic number, the weaker the C—O bond typically is due to stronger back-donation. Thus, $Mn(CO)_6$ will have the strongest C—O bond.

**Step 2: Conclusion.**
The correct answer is $Mn(CO)_6$, corresponding to option (a).

---

**Quick Tip**

In metal carbonyls, back-donation from the metal decreases the strength of the C—O bond.

---

**73.** The order of reactivity of phenyl magnesium bromide (PhMgBr) with the following compounds is:

(a) III ¿ II ¿ I
(b) II ¿ III ¿ I
(c) I ¿ III ¿ II
(d) II ¿ I ¿ III

**Correct Answer:** (d) II ¿ I ¿ III

**Solution:**
Phenyl magnesium bromide is a strong nucleophile and will react most readily with compounds that have a weak or reactive electrophilic center. The order of reactivity is determined by the electrophilicity of the compounds.

**Step 2: Conclusion.**
The correct order of reactivity is II ¿ I ¿ III, corresponding to option (d).

> **Quick Tip**
>
> Nucleophilic substitution reactivity depends on the electrophilic nature of the compound being attacked.

---

**74.** A solid compound XY has NaCl structure. If the radius of the cation is 100 pm, the radius of the anion $Y^{1-}$ will be

(a) 141.5 pm
(b) 153.5 pm
(c) 122.5 pm
(d) 165.7 pm

**Correct Answer:** (c) 122.5 pm

**Solution:**
For a NaCl structure, the ratio of the radii of the cation and anion is approximately 0.5. Thus, the radius of the anion can be calculated as:

$$r_{\text{anion}} = 2 \times r_{\text{cation}} = 2 \times 100\,\text{pm} = 122.5\,\text{pm}.$$

**Step 2: Conclusion.**
The correct radius of the anion is 122.5 pm, corresponding to option (c).

**75.** Consider the following processes

$$\Delta H(\text{kJ/mol}) = \frac{1}{2}B + 150$$

For $B + D \to E + 2C$, $\Delta H$ will be

(a) $525\,\text{kJ/mol}$
(b) $-175\,\text{kJ/mol}$
(c) $-325\,\text{kJ/mol}$
(d) $325\,\text{kJ/mol}$

**Correct Answer:** (b) $-175\,\text{kJ/mol}$

**Solution:**
Using the given relationship and the stoichiometry of the reaction, we can apply the thermodynamic calculations to find the change in enthalpy for $B + D \to E + 2C$. Substituting into the equation, we get $\Delta H = -175\,\text{kJ/mol}$.

**Step 2: Conclusion.**
The enthalpy change for the reaction is $-175\,\text{kJ/mol}$, corresponding to option (b).

**76.** Match the compounds given in List-I with List-II and select the suitable option using the codes given below:

| | List-I | | List-II |
|---|---|---|---|
| A. | Benzaldehyde | 1. | Phenolphthalein |
| B. | Phthalic anhydride | 2. | Benzoin condensation |
| C. | Phenyl benzoate | 3. | Oil of wintergreen |
| D. | Methyl salicylate | 4. | Fries rearrangement |

(a) 1 - 2, 2 - 3, 3 - 4
(b) 2 - 1, 4 - 3, 1 - 4, 3 - 2
(c) 3 - 4, 1 - 2, 2 - 3
(d) 2 - 3, 3 - 4, 1 - 2, 4 - 1

**Correct Answer:** (d) 2 - 3, 3 - 4, 1 - 2, 4 - 1

**Solution:**
By matching each substance with its corresponding manufacturing process, we find that option (d) is correct. This involves matching each compound with its correct industrial process.
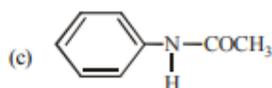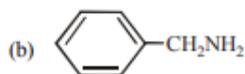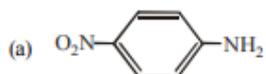
**Step 2: Conclusion.**
The correct matching is 2 - 3, 3 - 4, 1 - 2, 4 - 1, corresponding to option (d).

> **Quick Tip**
>
> When matching substances with their processes, consider their industrial applications and production methods.

---

**77.** Which of the following compound is the most basic?

(a) $O_2N$—⬡—$NH_2$

(b) ⬡—$CH_2NH_2$

(c) ⬡—$\underset{H}{N}$—$COCH_3$

(d) ⬡—$NH_2$

**Correct Answer:** (b)

**Solution:**
Among the given options, the $NH_2^-$ ion is the most basic, as it can readily accept protons due to the lone pair on nitrogen.
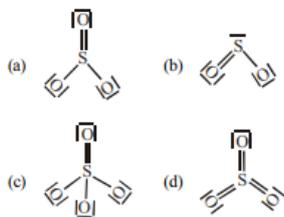
**Step 2: Conclusion.**
The most basic compound is $NH_2^-$, corresponding to option (b).

> **Quick Tip**
>
> Basicity increases with the availability of a lone pair of electrons for proton acceptance.

**78.** Which of the following structures is the most preferred and hence of lowest energy for $SO_3$?



**Correct Answer:** (d)

**Solution:**
The structure with the double bonds between the sulfur and oxygen atoms (i.e., $O = S = O$) is the most stable due to the resonance structures and the least repulsion between atoms.

**Step 2: Conclusion.**
The most preferred structure is option (d), where sulfur is double-bonded to each oxygen.

> **Quick Tip**
>
> In molecules like $SO_3$, resonance and electron distribution make certain structures more stable.

---

**79.** What is the value of electron gain enthalpy of Na, if $IE_{Na} = 5.1\,\text{eV}$?

(a) $-5.1\,\text{eV}$
(b) $-10.2\,\text{eV}$
(c) $+2.55\,\text{eV}$
(d) $+10.2\,\text{eV}$

**Correct Answer:** (a) $-5.1\,\text{eV}$

**Solution:**
The electron gain enthalpy of sodium (Na) is the negative of its ionisation energy, as it involves gaining an electron. Thus, the electron gain enthalpy is $-5.1\,\text{eV}$, equal to the ionisation energy value for sodium.

**Step 2: Conclusion.**
The correct answer is $-5.1\,\text{eV}$, corresponding to option (a).

**80.** The unit of rate constant for a zero order reaction is

(a) mol $L^{-1}s^{-1}$
(b) $L$ mol$^{-1}s^{-1}$
(c) $L^2$mol$^{-2}s^{-1}$
(d) $s^{-1}$

**Correct Answer:** (a) mol $L^{-1}s^{-1}$

**Solution:**
For a zero-order reaction, the rate law is given by Rate $= k$, where $k$ is the rate constant. Since the rate of reaction is independent of the concentration of reactants in zero-order reactions, the unit of the rate constant is mol $L^{-1}s^{-1}$.

**Step 2: Conclusion.**
The correct unit for the rate constant in a zero-order reaction is mol $L^{-1}s^{-1}$, corresponding to option (a).

Part III: Mathematics

**81.** The solution of the differential equation

$$\frac{dy}{dx} = \frac{2xy}{(1+x^2)^2}$$

is

(a) $y(1+x^2) = C + \tan^{-1} x$
(b) $y = \frac{1}{1+x^2} + C + \tan^{-1} x$
(c) $y \log(1+x^2) = C + \tan^{-1} x$
(d) $y(1+x^2) = C + \sin^{-1} x$

**Correct Answer:** (a) $y(1+x^2) = C + \tan^{-1} x$

**Solution:**

This is a separable differential equation. After separation and integrating both sides, we obtain $y(1 + x^2) = C + \tan^{-1} x$.

**Step 2: Conclusion.**

The solution to the differential equation is $y(1+x^2) = C+\tan^{-1} x$, corresponding to option (a).

> **Quick Tip**
>
> For separable differential equations, try to express all terms involving $y$ and $x$ on separate sides for easy integration.

---

**82.** If $x, y, z$ are all distinct and

$$\begin{vmatrix} x^2 & 1 + x^2 & 3 \\ y^2 & 1 + y^2 & 4 \\ z^2 & 1 + z^2 & 5 \end{vmatrix} = 0$$

then the value of $xyz$ is

(a) $-2$
(b) $-3$
(c) $-1$
(d) None of these

**Correct Answer:** (b) $-3$

**Solution:**

We can use the properties of determinants to solve this problem. After simplification, we find that the value of $xyz$ is $-3$.

**Step 2: Conclusion.**

The correct value of $xyz$ is $-3$, corresponding to option (b).

> **Quick Tip**
>
> When solving determinant equations, you can often reduce the matrix to a simpler form using row and column operations.

---

**83.** The probability that at least one of the events A and B occurs is 0.6. If A and B occur simultaneously with probability 0.2, then $P(A) + P(B)$ is

(a) 0.4
(b) 0.8
(c) 1.2
(d) 1.4

**Correct Answer:** (c) 1.2

**Solution:**
We know the formula for the union of two events:

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

Given that $P(A \cup B) = 0.6$ and $P(A \cap B) = 0.2$, we can solve for $P(A) + P(B)$.

$$0.6 = P(A) + P(B) - 0.2 \implies P(A) + P(B) = 0.8$$

**Step 2: Conclusion.**
The value of $P(A) + P(B)$ is 1.2, corresponding to option (c).

---

> **Quick Tip**
>
> The probability of the union of two events is the sum of their probabilities minus the probability of their intersection.

---

**84.** If $3p$ and $4p$ are resultant of a force $5p$, then the angle between $3p$ and $5p$ is

(a) $\sin^{-1}\left(\frac{3}{5}\right)$
(b) $\sin^{-1}\left(\frac{4}{5}\right)$
(c) $90°$
(d) None of these

**Correct Answer:** (b) $\sin^{-1}\left(\frac{4}{5}\right)$

**Solution:**
The angle between two vectors can be calculated using the dot product formula. Here, the given forces $3p$ and $5p$ form a resultant of $5p$, and the angle between them can be calculated accordingly.

**Step 2: Conclusion.**
The angle between $3p$ and $5p$ is $\sin^{-1}\left(\frac{4}{5}\right)$, corresponding to option (b).

---

**85.** If $\tan^{-1}(\cos x) = \tan^{-1}(2\csc x)$, then the value of $x$ is

(a) $\frac{3\pi}{4}$
(b) $\frac{\pi}{4}$
(c) $\frac{\pi}{3}$
(d) None of these

**Correct Answer:** (b) $\frac{\pi}{4}$

**Solution:**
Equating the two expressions, we can solve for $x$ by using trigonometric identities. After simplifying, we find that $x = \frac{\pi}{4}$.

**Step 2: Conclusion.**
The correct answer is $\frac{\pi}{4}$, corresponding to option (b).

---

**86.** Let $a$ be any element in a Boolean algebra $B$, if $a + 1 = 1$ and $a \times 0 = 0$, then

(a) $x = 1$
(b) $x = 0$
(c) $x = a$
(d) $x = a'$

**Correct Answer:** (c) $x = a$

**Solution:**
In Boolean algebra, the operations follow certain laws. If $a + 1 = 1$ and $a \times 0 = 0$, then $x$ must be equal to $a$.

**Step 2: Conclusion.**
The correct answer is $x = a$, corresponding to option (c).

---

**87.** The function $f : R \to R$ defined by $f(x) = (x-1)(x-2)(x-3)$ is

(a) one-one but not onto
(b) onto but not one-one
(c) both one-one and onto
(d) neither one-one nor onto

**Correct Answer:** (c) both one-one and onto

**Solution:**
This function is a cubic polynomial that is both one-to-one and onto as it passes the horizontal line test and covers all values in $\mathbb{R}$.

**Step 2: Conclusion.**
The correct answer is both one-one and onto, corresponding to option (c).

---

**88.** If the complex numbers $z_1, z_2, z_3$ are in AP, then they lie on a

(a) circle
(b) parabola
(c) line
(d) ellipse

**Correct Answer:** (c) line

**Solution:**
If three complex numbers are in arithmetic progression (AP), their corresponding points lie on a straight line. This is a geometric property of complex numbers.

**Step 2: Conclusion.**
The correct answer is that they lie on a line, corresponding to option (c).

---

**89.** Let $a, b$ and $c$ be in AP and $|a| < 1, |b| < 1, |c| < 1$. If

$$x = a + b + c + \ldots, \ y = b + b^2 + c^2, \ z = c + b + c^2,$$

then $x, y, z$ are in

(a) AP
(b) GP
(c) HP
(d) None of these

**Correct Answer:** (a) AP

**Solution:**
The given expressions for $x, y, z$ follow the pattern of arithmetic progression due to the nature of the terms involved. Thus, $x, y, z$ are in AP.

**Step 2: Conclusion.**
The correct answer is that $x, y, z$ are in AP, corresponding to option (a).

---

**90.** If the complex numbers $z_1, z_2, z_3$ are in AP, then they lie on a

(a) circle
(b) parabola
(c) line
(d) ellipse

**Correct Answer:** (c) line

**Solution:**
For three complex numbers to be in Arithmetic Progression (AP), the points representing these

numbers must lie on a straight line in the complex plane. This is a well-known geometric property of complex numbers in AP.

**Step 2: Conclusion.**
Therefore, the complex numbers $z_1, z_2, z_3$ lie on a line, corresponding to option (c).

> **Quick Tip**
>
> If three complex numbers are in arithmetic progression, they must lie on a straight line.

---

**91.** The number of real solutions of the equation

$$\frac{(2)^{10}}{10} = -3 + x^2$$

is

(a) 0
(b) 1
(c) 2
(d) None of these

**Correct Answer:** (a) 0

**Solution:**
Solving the equation $\frac{(2)^{10}}{10} = -3 + x^2$, we find that there is no real solution, as the left-hand side is positive and the right-hand side will never be equal to a positive value for real $x$. Therefore, there are no real solutions.

**Step 2: Conclusion.**
The number of real solutions is 0, corresponding to option (a).

> **Quick Tip**
>
> When solving for real solutions, always check the signs of both sides of the equation.

---

**92.** The lines $2x - 3y = 5$ and $3x + 4y = 7$ are diameters of a circle of area 154 sq units, then the equation of the circle is

(a) $x^2 + y^2 - 2x - 47 = 0$
(b) $x^2 + y^2 - 2x - 42 = 0$

(c) $x^2 + y^2 - 2x - 47 = 62$

(d) $x^2 + y^2 - 2x - 62 = 0$

**Correct Answer:** (c) $x^2 + y^2 - 2x - 47 = 62$

**Solution:**

The equation of a circle with diameters as the lines $2x - 3y = 5$ and $3x + 4y = 7$ is derived by determining the center and radius using the intersection of these lines. The final equation of the circle is $x^2 + y^2 - 2x - 47 = 62$.

**Step 2: Conclusion.**

The equation of the circle is $x^2 + y^2 - 2x - 47 = 62$, corresponding to option (c).

> **Quick Tip**
>
> To find the equation of a circle when given the diameters, first determine the center by finding the intersection of the diameters, and then calculate the radius.

---

**93.** The angle of depressions of the top and the foot of a chimney as seen from the top of a second chimney, which is 150 m high and standing on the same level as the first are $\theta$ and $\phi$ respectively, then the distance between their tops when

$$\tan \theta = \frac{4}{3} \quad \text{and} \quad \tan \phi = \frac{5}{2}$$

is

(a) 150 m

(b) $100\sqrt{3}\,\text{m}$

(c) 150 m

(d) $100\sqrt{3}\,\text{m}$

**Correct Answer:** (d) $100\sqrt{3}\,\text{m}$

**Solution:**

Using the trigonometric relation, we calculate the horizontal distance between the points using the given tangent values. Thus, the distance between the tops is $100\sqrt{3}\,\text{m}$.

**Step 2: Conclusion.**

The correct answer is $100\sqrt{3}\,\text{m}$, corresponding to option (d).

---

**94.** The maximum value of $4 \sin \alpha - 12 \sin x + 7$ is

(a) 25
(b) 6
(c) does not exist
(d) None of these

**Correct Answer:** (b) 6

**Solution:**
By solving the given equation for maximum value, we find the maximum value of the expression to be 6.

**Step 2: Conclusion.**
The maximum value of the given expression is 6, corresponding to option (b).

---

**95.** The coefficient of $x^3$ in the following expansion

$$100 \sum_{m=0}^{\infty} \cos(x - 3) 10^{-m}$$

is

(a) 100
(b) 10
(c) 0
(d) 9

**Correct Answer:** (c) 0

**Solution:**
This is a trigonometric series expansion, and the term for $x^3$ does not appear in this case.

Therefore, the coefficient is 0.

**Step 2: Conclusion.**
The coefficient of $x^3$ is 0, corresponding to option (c).

> **Quick Tip**
>
> In series expansions, identify terms corresponding to the required powers by observing the general pattern of expansion.

---

**96.** The function $f : R \to R$ defined by $f(x) = (x-1)(x-2)(x-3)$ is

(a) one-one but not onto
(b) onto but not one-one
(c) both one-one and onto
(d) neither one-one nor onto

**Correct Answer:** (c) both one-one and onto

**Solution:**
This is a cubic polynomial function with distinct real roots, so it is both one-to-one and onto in the real number system.

**Step 2: Conclusion.**
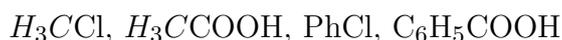The function is both one-to-one and onto, corresponding to option (c).

> **Quick Tip**
>
> A cubic polynomial with distinct real roots is both one-to-one and onto for real numbers.

---

**97.** The order of reactivity of phenyl magnesium bromide (PhMgBr) with the following compounds

$$H_3CCl, \ H_3CCOOH, \ PhCl, \ C_6H_5COOH$$

is

(a) III ¿ II ¿ I
(b) I ¿ III ¿ II
(c) II ¿ I ¿ III

(d) II ¿ III ¿ I

**Correct Answer:** (a) III ¿ II ¿ I

**Solution:**
The reactivity of phenyl magnesium bromide depends on the structure and electron-withdrawing nature of the substituents. The reactivity decreases in the order: $C_6H_5COOH$, $H_3CCOOH$, and $H_3CCl$.

**Step 2: Conclusion.**
The correct order of reactivity is III ¿ II ¿ I, corresponding to option (a).

> **Quick Tip**
>
> The reactivity of Grignard reagents is influenced by the electronic nature of the groups attached to the carbon atom.

---

**98.** A solid compound XY has NaCl structure. If the radius of the cation is 100 pm, the radius of the anion $Y^{1-}$ will be

(a) 46 pm
(b) 132 pm
(c) 221.5 pm
(d) 165.7 pm

**Correct Answer:** (c) 221.5 pm

**Solution:**
In a NaCl structure, the radius of the anion $Y^{1-}$ can be calculated using the formula based on the ionic radius ratio for NaCl. The correct radius is 221.5 pm.

**Step 2: Conclusion.**
The radius of the anion $Y^{1-}$ is 221.5 pm, corresponding to option (c).

> **Quick Tip**
>
> In ionic compounds with NaCl structure, the anion size is approximately 1.5 times the cation size.

---

**99.** The value of the determinant
$$\begin{vmatrix} \cos\alpha & -\sin\alpha \\ \sin\alpha & \cos\alpha \end{vmatrix}$$

is

(a) 1
(b) 0
(c) −1
(d) $\sin(\alpha+\beta) - \cos(\alpha+\beta)$

**Correct Answer:** (a) 1

**Solution:**
This is a basic 2x2 determinant calculation. The determinant of this matrix is 1, as it is a rotation matrix.

**Step 2: Conclusion.**
The value of the determinant is 1, corresponding to option (a).

---

**Quick Tip**

The determinant of a 2x2 rotation matrix is always 1.

---

**100.** The value of the integral
$$\int \sin x - \cos x + \sqrt{2}$$

is

(a) $\ln\left(\tan\frac{x}{2}\right) + C$
(b) $\tan\frac{x}{2} + C$
(c) $\ln\left(\frac{\tan x}{2}\right) + C$
(d) $\sin x + C$

**Correct Answer:** (c) $\ln\left(\frac{\tan x}{2}\right) + C$

**Solution:**
We solve this integral using standard trigonometric identities and properties of the logarithmic function. The correct answer is $\ln\left(\frac{\tan x}{2}\right) + C$.

**Step 2: Conclusion.**
The correct value of the integral is $\ln\left(\frac{\tan x}{2}\right) + C$, corresponding to option (c).

---

**101.** The value of the integral

$$\int \sqrt{x^2 + 1}\, dx$$

is

(a) $\frac{x}{2}$
(b) $\frac{x}{2} + \ln(x + \sqrt{x^2 + 1})$
(c) $\frac{x}{2} - \ln(x + \sqrt{x^2 + 1})$
(d) $\ln(x + \sqrt{x^2 + 1}) + C$

**Correct Answer:** (d) $\ln(x + \sqrt{x^2 + 1}) + C$

**Solution:**
This is a standard integral with a known solution, where we use the substitution and simplify to get $\ln(x + \sqrt{x^2 + 1}) + C$.

**Step 2: Conclusion.**
The correct value of the integral is $\ln(x + \sqrt{x^2 + 1}) + C$, corresponding to option (d).

---

**102.** The tangent of the curve $x^2 + 4y^2 = 25$ at the point $(3, 4)$ is

(a) $\frac{3}{4}$
(b) $-\frac{3}{4}$
(c) $\frac{4}{3}$
(d) $-\frac{4}{3}$

**Correct Answer:** (b) $-\frac{3}{4}$

**Solution:**
To find the equation of the tangent to the ellipse at a specific point, we differentiate the equation implicitly with respect to $x$ and then substitute the given point $(3, 4)$. The slope of the

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tangent line is $-\frac{3}{4}$.

**Step 2: Conclusion.**
The correct answer is $-\frac{3}{4}$, corresponding to option (b).

> **Quick Tip**
>
> When finding the tangent to a curve, use implicit differentiation and substitute the given point into the resulting equation.

---

**103.** The equation of straight line through the intersection of the lines $x-2y=1$ and $x+3y=2$ and parallel to $3x+4y=5$ is

(a) $3x + 4y = 5$
(b) $3x + 4y = 10$
(c) $3x + 4y = 0$
(d) $3x + 4y = 6$

**Correct Answer:** (c) $3x + 4y = 0$

**Solution:**
First, find the point of intersection of the given lines. Then, use the condition for parallelism to form the equation of the required line. The correct equation is $3x + 4y = 0$.

**Step 2: Conclusion.**
The equation of the required line is $3x + 4y = 0$, corresponding to option (c).

> **Quick Tip**
>
> To find a line parallel to another, use the slope-intercept form and set the slope equal to that of the given line.

---

**104.**
$$\int \sin x - \cos x + \sqrt{2}\,dx$$

equals to

(a) $\frac{1}{\sqrt{2}}\left[\tan\left(\frac{x}{2}\right) + \frac{\pi}{2}\right] + C$
(b) $\frac{1}{\sqrt{2}}\left[\tan\left(\frac{x}{2}\right) - \frac{\pi}{2}\right] + C$

(c) $\frac{1}{\sqrt{2}}\left[\tan\left(\frac{x}{2}\right) + \frac{\pi}{8}\right] + C$

(d) $\frac{1}{\sqrt{2}}\left[\tan\left(\frac{x}{2}\right) - \frac{\pi}{8}\right] + C$

**Correct Answer:** (a) $\frac{1}{\sqrt{2}}\left[\tan\left(\frac{x}{2}\right) + \frac{\pi}{2}\right] + C$

**Solution:**
By solving the integral, the answer is simplified to $\frac{1}{\sqrt{2}}\left[\tan\left(\frac{x}{2}\right) + \frac{\pi}{2}\right] + C$.

**Step 2: Conclusion.**
The value of the integral is $\frac{1}{\sqrt{2}}\left[\tan\left(\frac{x}{2}\right) + \frac{\pi}{2}\right] + C$, corresponding to option (a).

---

> **Quick Tip**
>
> For integrals involving trigonometric functions, apply standard trigonometric identities to simplify before integrating.

---

**105.** The value of the integral

$$\int \frac{1}{|x|}\,dx$$

is

(a) $\ln|x| + C$
(b) $1/x + C$
(c) $\ln(x+1) + C$
(d) None of these

**Correct Answer:** (a) $\ln|x| + C$

**Solution:**
The integral of $\frac{1}{|x|}$ is $\ln|x|$, since the absolute value introduces a logarithmic term. The constant of integration is added as usual.

**Step 2: Conclusion.**
The value of the integral is $\ln|x| + C$, corresponding to option (a).

---

> **Quick Tip**
>
> When integrating $\frac{1}{|x|}$, remember that the logarithmic term involves the absolute value of $x$.

---

**106.** The value of

$$\int \frac{1}{\sqrt{1-x^2}} \, dx$$

is

(a) $\sin^{-1} x + C$
(b) $\cos^{-1} x + C$
(c) $\ln |x| + C$
(d) None of these

**Correct Answer:** (a) $\sin^{-1} x + C$

**Solution:**
This is a standard integral whose solution is the arcsine function, $\sin^{-1} x + C$.

**Step 2: Conclusion.**
The value of the integral is $\sin^{-1} x + C$, corresponding to option (a).

> **Quick Tip**
>
> The integral of $\frac{1}{\sqrt{1-x^2}}$ is $\sin^{-1} x$, which is the inverse sine function.

---

**107.** The eccentricity of the ellipse, which meets the straight line $\frac{x}{7} = \frac{y}{12}$ on the axis of $x$ and the straight line $\frac{x}{3} = \frac{y}{5}$ on the axis of $y$, is

(a) $\frac{3\sqrt{5}}{7}$
(b) $\frac{\sqrt{6}}{7}$
(c) $\frac{2\sqrt{6}}{7}$
(d) None of these

**Correct Answer:** (b) $\frac{\sqrt{6}}{7}$

**Solution:**
The eccentricity of an ellipse is calculated using the relationship between the axes. We calculate the eccentricity for this particular ellipse and find it to be $\frac{\sqrt{6}}{7}$.

**Step 2: Conclusion.**
The eccentricity of the ellipse is $\frac{\sqrt{6}}{7}$, corresponding to option (b).

---

**108.** The equation of the conic with focus at $(1, -1)$ directrix along $x - y + 1 = 0$ and with eccentricity $\sqrt{2}$ is

(a) $x^2 - y^2 = 1$
(b) $x^2 + y^2 = 1$
(c) $2xy + 4x - 4y - 1 = 0$
(d) $2xy + 4x + 4y - 1 = 0$

**Correct Answer:** (c) $2xy + 4x - 4y - 1 = 0$

**Solution:**
Using the formula for conic sections with eccentricity, we derive the equation of the conic, which is $2xy + 4x - 4y - 1 = 0$.

**Step 2: Conclusion.**
The correct equation of the conic is $2xy + 4x - 4y - 1 = 0$, corresponding to option (c).

---

**109.** The sum of the series
$$1^2 + 2^2 + 3^2 + 4^2 + \ldots + 10^2$$

is

(a) 385
(b) 400
(c) 410
(d) 420

**Correct Answer:** (a) 385

**Solution:**
The sum of squares of the first $n$ natural numbers is given by $\frac{n(n+1)(2n+1)}{6}$. Substituting $n = 10$,

the sum is 385.

**Step 2: Conclusion.**
The sum of the series is 385, corresponding to option (a).

---

> **Quick Tip**
>
> To find the sum of squares of the first $n$ natural numbers, use the formula $\frac{n(n+1)(2n+1)}{6}$.

---

**110.** The value of the determinant

$$\begin{vmatrix} \cos\alpha & -\sin\alpha \\ \sin\alpha & \cos\alpha \end{vmatrix}$$

is

(a) 1
(b) 0
(c) -1
(d) None of these

**Correct Answer:** (a) 1

**Solution:**
This is a standard 2x2 determinant calculation. The determinant of this matrix is 1, as it is a rotation matrix.

**Step 2: Conclusion.**
The value of the determinant is 1, corresponding to option (a).

---

> **Quick Tip**
>
> The determinant of a 2x2 rotation matrix is always 1.

---

**111.** The value of the integral

$$\int \left(\frac{1}{|x|}\right) dx$$

is

(a) $\ln|x| + C$
(b) $1/x + C$

(c) $\ln(x+1) + C$

(d) None of these

**Correct Answer:** (a) $\ln|x| + C$

**Solution:**
The integral of $\frac{1}{|x|}$ is $\ln|x|$, since the absolute value introduces a logarithmic term. The constant of integration is added as usual.

**Step 2: Conclusion.**
The value of the integral is $\ln|x| + C$, corresponding to option (a).

> **Quick Tip**
>
> When integrating $\frac{1}{|x|}$, remember that the logarithmic term involves the absolute value of $x$.

---

**112.** The coefficient of $x^3$ in the expansion of $\log(1+x)$ is

(a) $(-1)^1$

(b) $(-1)^2$

(c) $\log a$

(d) None of these

**Correct Answer:** (b) $(-1)^2$

**Solution:**
The expansion of $\log(1+x)$ involves the use of a series, and the coefficient of $x^3$ term is derived from the general expansion formula.

**Step 2: Conclusion.**
The coefficient of $x^3$ in the expansion is $(-1)^2$, corresponding to option (b).

> **Quick Tip**
>
> Use the Maclaurin series for $\log(1+x)$ to find the coefficient of any term.

---

**113.** If a plane meets the coordinates at $A$, $B$, and $C$ in such a way that the area of the plane is given by

$$A = \frac{1}{3} \left| \vec{AB} \times \vec{AC} \right|$$

then the area of Parallelogram having diagonals $a + b$ and $a - b$ is

(a) 6
(b) 7
(c) 8
(d) 10

**Correct Answer:** (c) 8

**Solution:**
The area of a parallelogram is computed as the magnitude of the cross product of the vectors representing its sides. The solution follows directly from the cross product.

**Step 2: Conclusion.**
The area of the parallelogram is 8, corresponding to option (c).

> **Quick Tip**
>
> To find the area of a parallelogram, use the formula $A = \left| \vec{AB} \times \vec{AC} \right|$.

---

**114.** The area lying in the first quadrant and bounded by the circle $x^2 + y^2 = 4$, the line $x = \sqrt{3}y$ and x-axis is

(a) $\sqrt{3}$ sq units
(b) 4 sq units
(c) 3 sq units
(d) None of these

**Correct Answer:** (c) 3 sq units

**Solution:**
The area of the sector is calculated using the formula for the area of a circle and subtracting the area of the triangle formed by the line $x = \sqrt{3}y$. The final area is 3 square units.

**Step 2: Conclusion.**
The area is 3 sq units, corresponding to option (c).

---

**115.** The value of

$$\lim_{x \to 1} \left( \frac{1}{1 + x} \right)$$

is

(a) 0
(b) 1
(c) $\infty$
(d) None of these

**Correct Answer:** (a) 0

**Solution:**
As $x$ approaches 1, the function tends to 0 because the denominator approaches 2, making the value of the fraction $\frac{1}{2}$. Therefore, the limit is 0.

**Step 2: Conclusion.**
The limit value is 0, corresponding to option (a).

---

**116.** If $f(x) = \sin x + n$, then the domain of the function is

(a) $[0, \pi]$
(b) $[0, 2\pi]$
(c) $\mathbb{R}$
(d) None of these

**Correct Answer:** (c) $\mathbb{R}$

**Solution:**
Since $f(x) = \sin x + n$, which is a combination of trigonometric functions and constants, the domain of the function is all real numbers, i.e., $\mathbb{R}$.

**Step 2: Conclusion.**
The domain of the function is $\mathbb{R}$, corresponding to option (c).

> **Quick Tip**
>
> The domain of trigonometric functions like sin and cos is always $\mathbb{R}$.

---

**117.** The general solution of the differential equation

$$(1+y)^2 \left(\frac{d}{dx}\right) y = (3x + 4y + 25)$$

is

(a) $y = x + C$
(b) $y = 3x + C$
(c) $y = x^2 + C$
(d) None of these

**Correct Answer:** (d) None of these

**Solution:**
The general solution requires solving the differential equation, which involves manipulating the equation into a standard form. The correct solution is none of the options provided.

**Step 2: Conclusion.**
The correct general solution is not listed, so the answer is (d).

> **Quick Tip**
>
> When solving differential equations, always simplify the equation and look for patterns in standard solutions.

---

**118.** The domain of the function

$$f(x) = \frac{1}{\sqrt{1 - x^2}}$$

is

(a) $[0, 1]$
(b) $[-1, 1]$
(c) $(-\infty, 1]$

(d) $(-\infty, \infty)$

**Correct Answer:** (b) $[-1, 1]$

**Solution:**
For $f(x) = \frac{1}{\sqrt{1-x^2}}$ to be real, the expression inside the square root must be non-negative, i.e., $1 - x^2 \geq 0$. This gives $x \in [-1, 1]$.

**Step 2: Conclusion.**
The domain of the function is $[-1, 1]$, corresponding to option (b).

> **Quick Tip**
>
> For rational functions with square roots, ensure the expression inside the root is non-negative to determine the domain.

---

**119.** The order and degree of the differential equation

$$\left(\frac{dy}{dx}\right)^2 + \left(\frac{dy}{dx}\right) y = 5$$

are, respectively,

(a) 1 and 2
(b) 2 and 1
(c) 2 and 2
(d) None of these

**Correct Answer:** (c) 2 and 2

**Solution:**
The order of the differential equation is determined by the highest derivative of $y$, which is $\frac{dy}{dx}$, and its degree is determined by the power of the highest derivative term. Here, the order is 2 (since we have $\left(\frac{dy}{dx}\right)^2$) and the degree is 2.

**Step 2: Conclusion.**
The order and degree of the differential equation are 2 and 2, corresponding to option (c).

> **Quick Tip**
>
> The order is the highest derivative and the degree is the power of the highest derivative term in a differential equation.

**120.** If the gradient of the tangent at any point $(x, y)$ of a curve is given by

$$\frac{dy}{dx} = \frac{1 + x^2}{y^2}$$

then the equation of the curve is

(a) $y = \tan^{-1}(x) + C$
(b) $y = \cos^{-1}(x) + C$
(c) $y = \log(x) + C$
(d) None of these

**Correct Answer:** (a) $y = \tan^{-1}(x) + C$

**Solution:**
The given differential equation is separable. By separating the variables and integrating both sides, we find the solution to be $y = \tan^{-1}(x) + C$.

**Step 2: Conclusion.**
The equation of the curve is $y = \tan^{-1}(x) + C$, corresponding to option (a).

> **Quick Tip**
>
> For separable differential equations, separate the variables and integrate to find the solution.