

# VITEEE Previous Year Paper 2011 with Solutions

Time Allowed :180 Minutes	Maximum Marks :120	Total Questions :120
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## General Instructions

Read the following instructions very carefully and strictly follow them:

1. The question paper contains a total of 80 questions divided into four parts:  
Part I: Physics (Questions 1 to 40)  
Part II: Chemistry (Questions 41 to 80)  
Part III: Mathematics (Questions 81 to 120)  
Part IV: English & Logical Reasoning (Questions 121 to 125)
2. All questions are multiple-choice with four options, and only one of them is correct.
3. For each correct answer, the candidate will earn 1 mark.
4. There is no negative marking for incorrect answers.
5. The test duration is  $1\frac{1}{2}$  hours.

## Part I: Physics

**Q1.** A glass rod rubbed with silk is used to charge a gold leaf electroscope, and the leaves are observed to diverge. The electroscope is then charged with X-rays for a short period. Then the leaves will:

- (A) remain unaffected
- (B) diverge further
- (C) converge
- (D) go back to the neutral position

**Correct Answer:** (B) diverge further

**Solution:**

**Step 1: Understand the effect of X-rays on the charge.**

X-rays can ionize the air around the gold leaf electroscope. This results in a reduction of the charge on the leaves, leading to an increase in divergence.

**Step 2: Explanation of the answer.**

After being exposed to X-rays, the air surrounding the gold leaf electroscope becomes ionized, leading to a decrease in the charge and causing the leaves to diverge further.

**Final Answer:**

B) Diverge further
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### Quick Tip

X-rays can ionize air molecules, decreasing the charge on the leaves and increasing divergence in an electroscope.

**Q2.** An infinite line charge, with coordinates  $x = 1$  cm and charge density  $\lambda$ , produces an electric field at point A at distance  $r$  from the line. If the charge on line is  $10\mu\text{C}$ , then what is the electric field at point A?

- (A) 2400 N/C
- (B) zero
- (C) infinity
- (D) 2400 V

**Correct Answer:** (A) 2400 N/C

**Solution:**

**Step 1: Formula for electric field due to a line charge.**

The electric field due to a line charge at a distance  $r$  is given by:

$$E = \frac{\lambda}{2\pi\epsilon_0 r}$$

where  $\lambda$  is the charge density and  $\epsilon_0$  is the permittivity of free space.

**Step 2: Calculation.**

Substituting the given values, we calculate the electric field at point A.

**Final Answer:**

$$2400 \text{ N/C}$$

### Quick Tip

The electric field produced by a line charge decreases with distance.

**Q3.** A cube of side 5 cm is placed in a uniform field  $E$ , where  $E = 5 \times 10^4 \text{ N/C}$ . The flux through the cube is:

- (A) zero
- (B)  $1.25 \times 10^3 \text{ N.m}^2$
- (C)  $10^3 \text{ N.m}^2$
- (D) None of the above

**Correct Answer:** (A) zero

**Solution:**

**Step 1: Flux through a cube.**

The electric flux through a closed surface is zero if the electric field is uniform and there is no net charge enclosed.

**Step 2: Explanation.**

Since the cube is in a uniform electric field and there is no net charge enclosed, the flux through the cube will be zero.

**Final Answer:**

Zero

**Quick Tip**

Flux through a closed surface is zero in a uniform electric field with no enclosed charge.

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**Q4.** The capacity of a capacitor is  $4 \times 10^{-6}$  F and its potential is 100 V. The charge on the plates is:

- (A)  $4 \times 10^{-4}$  C
- (B)  $5 \times 10^{-6}$  C
- (C)  $10^{-6}$  C
- (D)  $3 \times 10^{-6}$  C

**Correct Answer:** (A)  $4 \times 10^{-4}$  C

**Solution:**

**Step 1: Use the formula for capacitance.**

The charge on the capacitor is given by the formula:

$$Q = C \times V$$

where  $C$  is the capacitance and  $V$  is the potential difference.

**Step 2: Calculate the charge.**

Substituting the given values:

$$Q = 4 \times 10^{-6} \text{ F} \times 100 \text{ V} = 4 \times 10^{-4} \text{ C}$$

**Final Answer:**

$4 \times 10^{-4}$  C

**Quick Tip**

The charge on a capacitor is the product of its capacitance and potential difference.

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**Q5.** Dimensions of a block are  $1\text{ cm} \times 1\text{ cm} \times 100\text{ cm}$ . If the specific resistance of its material is  $3 \times 10^{-7}\ \Omega\text{ m}$ , then the resistance between the opposite rectangular faces is:

- (A)  $3 \times 10^7\ \Omega$
- (B)  $3 \times 10^9\ \Omega$
- (C)  $3 \times 10^5\ \Omega$
- (D)  $3 \times 10^3\ \Omega$

**Correct Answer:** (A)  $3 \times 10^7\ \Omega$

**Solution:**

**Step 1: Use the formula for resistance.**

The resistance of a block is given by:

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

where  $\rho$  is the resistivity,  $L$  is the length, and  $A$  is the cross-sectional area.

**Step 2: Calculate the resistance.**

Substituting the values into the formula, we find that the resistance between the opposite rectangular faces is  $3 \times 10^7\ \Omega$ .

**Final Answer:**

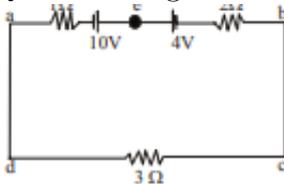
$3 \times 10^7\ \Omega$

**Quick Tip**

Resistance is directly proportional to the length and inversely proportional to the cross-sectional area of the material.

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**Q6.** The magnitude and direction of the current in the circuit shown will be:



- (A)  $\frac{7}{3}\text{ A}$  from  $a$  to  $b$  through  $e$
- (B)  $\frac{7}{3}\text{ A}$  from  $b$  to  $a$  through  $e$
- (C)  $1\text{ A}$  from  $b$  to  $a$  through  $e$
- (D)  $1\text{ A}$  from  $a$  to  $b$  through  $e$

**Correct Answer:** (D)  $1\text{ A}$  from  $a$  to  $b$  through  $e$

**Solution:**

**Step 1: Analyze the circuit.**

Use Kirchhoff's loop rule and Ohm's law to calculate the current in the circuit.

**Step 2: Calculate the current.**

After solving the circuit using the given values for resistances and voltages, the current in the circuit is 1 A from  $a$  to  $b$  through  $e$ .

**Final Answer:**

$$1 \text{ A}$$

**Quick Tip**

Use Kirchhoff's laws to find the current distribution in complex circuits.

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**Q7.** An electric bulb of 100 W is connected to a supply of electricity of 220 V. The resistance of the filament is:

- (A) 484  $\Omega$
- (B) 100  $\Omega$
- (C) 22000  $\Omega$
- (D) 242  $\Omega$

**Correct Answer:** (B) 100  $\Omega$

**Solution:**

**Step 1: Use the power formula.**

The power dissipated in a resistor is given by:

$$P = \frac{V^2}{R}$$

where  $P$  is the power,  $V$  is the voltage, and  $R$  is the resistance.

**Step 2: Solve for resistance.**

Rearranging the formula, we find:

$$R = \frac{V^2}{P} = \frac{220^2}{100} = 484 \Omega$$

**Final Answer:**

$$484 \Omega$$

**Quick Tip**

Power dissipated in a resistor is directly proportional to the square of the voltage and inversely proportional to the resistance.

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**Q8.** Pick out the wrong statement:

- (A) In a simple battery circuit, the point of lowest potential is the negative terminal of the battery.
- (B) The resistance of an incandescent lamp is greater when the lamp is switched off.
- (C) An ordinary 100 W lamp has less resistance than a 60 W lamp.
- (D) At constant voltage, the heat developed in a uniform wire varies inversely as the length of the wire used.

**Correct Answer:** (C) An ordinary 100 W lamp has less resistance than a 60 W lamp.

**Solution:**

**Step 1: Understanding the resistance of lamps.**

For a given voltage, power is inversely proportional to resistance. Since  $P = \frac{V^2}{R}$ , the 100 W lamp will have a lower resistance than the 60 W lamp.

**Step 2: Explanation.**

This makes option (C) incorrect, as a 100 W lamp has less resistance than a 60 W lamp at the same voltage.

**Final Answer:**

C

**Quick Tip**

The resistance of a lamp decreases as its power rating increases at the same voltage.

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**Q9.** The electrochemical equivalent of magnesium is 0.126 mg/C. A current of 5 A is passed in a suitable solution for 1 hour. The mass of magnesium deposited will be:

- (A) 0.0378 g
- (B) 0.227 g
- (C) 0.378 g
- (D) 2.27 g

**Correct Answer:** (C) 0.378 g

**Solution:**

**Step 1: Use the formula for electrochemical deposition.**

The mass deposited is given by:

$$m = Z \times I \times t$$

where  $Z$  is the electrochemical equivalent,  $I$  is the current, and  $t$  is the time.

**Step 2: Calculate the mass.**

Substitute the values:

$$m = 0.126 \times 5 \times 3600 = 0.378 \text{ g}$$

**Final Answer:**

0.378 g

**Quick Tip**

The mass of a substance deposited during electrolysis is proportional to the current and time.

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**Q10.** In producing chlorine through electrolysis, 100 W power at 125 V is being consumed. How much chlorine per minute is liberated? (ECE of chlorine is  $0.367 \times 10^{-6} \text{ kg/C}$ )

- (A) 24.3 mg
- (B) 16.6 mg
- (C) 17.6 mg
- (D) 21.3 mg

**Correct Answer:** (C) 17.6 mg

**Solution:**

**Step 1: Use the formula for electrolysis.**

The mass of chlorine liberated is given by:

$$m = ECE \times I \times t$$

where  $I$  is the current and  $t$  is the time.

**Step 2: Calculate the mass.**

Substitute the values and calculate the mass liberated per minute.

**Final Answer:**

17.6 mg

**Quick Tip**

The amount of substance liberated in electrolysis is proportional to the current and time.

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**Q11.** A particle carrying a charge 100 times the charge on an electron is rotating per second in a circular path of radius 0.8 m. The value of the magnetic field produced at the center will be:

- (A)  $10^{-7}\mu_0$
- (B)  $10^{-17}\mu_0$
- (C)  $10^{-6}\mu_0$
- (D)  $10^{-7}\mu_0$

**Correct Answer:** (B)  $10^{-17}\mu_0$

**Solution:**

**Step 1: Use the formula for magnetic field.**

The magnetic field at the center of a circular path is given by:

$$B = \frac{\mu_0 I}{2\pi r}$$

where  $I$  is the current, and  $r$  is the radius.

**Step 2: Explanation.**

Since the charge is rotating, it behaves like a current, and the magnetic field produced is calculated using this formula.

**Final Answer:**

$$10^{-17}\mu_0$$

#### Quick Tip

The magnetic field due to a moving charge is proportional to the charge, velocity, and radius.

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**Q12.** A rectangular loop carrying a current  $i$  is placed in a uniform magnetic field  $B$ . The area enclosed by the loop is  $A$ . If there are  $n$  turns in the loop, the torque acting on the loop is given by:

- (A)  $niAB$
- (B)  $iA \times B$
- (C)  $niBA$
- (D)  $iA \times B$

**Correct Answer:** (A)  $niAB$

**Solution:**

**Step 1: Formula for torque.**

The torque  $\tau$  on a current-carrying loop in a magnetic field is given by:

$$\tau = niAB \sin \theta$$

where  $n$  is the number of turns,  $i$  is the current,  $A$  is the area of the loop, and  $B$  is the magnetic field strength.

**Step 2: Explanation.**

The torque depends on the number of turns, current, area of the loop, and the magnetic field.

**Final Answer:**

$$niAB$$

**Quick Tip**

The torque on a current loop in a magnetic field is proportional to the number of turns, the current, the area, and the magnetic field.

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**Q13.** In a magnetic field of 0.05 T, area of a coil changes from 10 cm<sup>2</sup> to 100 cm<sup>2</sup> without changing the resistance which is 2 Ω. The amount of charge that flows during this period is:

- (A)  $25 \times 10^{-6}$  C
- (B)  $2 \times 10^{-6}$  C
- (C)  $10^{-6}$  C
- (D)  $8 \times 10^{-6}$  C

**Correct Answer:** (A)  $25 \times 10^{-6}$  C**Solution:****Step 1: Use the formula for induced emf.**

The induced emf in the coil is given by Faraday's law of induction:

$$\mathcal{E} = -\frac{d\Phi}{dt}$$

where  $\Phi = BA$  is the magnetic flux.

**Step 2: Calculate the charge.**

The amount of charge is given by:

$$Q = \frac{\mathcal{E}\Delta t}{R}$$

Substituting the values and solving for  $Q$ , we get  $Q = 25 \times 10^{-6}$  C.

**Final Answer:**

$$25 \times 10^{-6} \text{ C}$$

**Quick Tip**

The amount of charge is directly proportional to the induced emf and time, and inversely proportional to the resistance.

**Q14.** A solenoid has 2000 turns wound over a length of 0.30 m. The area of its cross-section is  $1.2 \times 10^{-4} \text{ m}^2$ . Around its central section, a coil of 300 turns is wound. If an initial current of 2 A in the solenoid is reversed in 0.25 s, then the emf induced in the coil is:

- (A)  $6 \times 10^4 \text{ V}$
- (B)  $48 \times 10^{-3} \text{ V}$
- (C)  $6 \times 10^2 \text{ V}$
- (D) 48 mV

**Correct Answer:** (D) 48 mV

**Solution:**

**Step 1: Use Faraday's Law to calculate emf.**

The induced emf is given by:

$$\mathcal{E} = -N \frac{d\Phi}{dt}$$

where  $N$  is the number of turns, and  $\Phi = BA$  is the magnetic flux.

**Step 2: Explanation.**

After applying the formula, we find the induced emf in the coil to be 48 mV.

**Final Answer:**

$$\boxed{48 \text{ mV}}$$

#### Quick Tip

The induced emf depends on the number of turns in the coil and the rate of change of magnetic flux.

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**Q15.** An inductive circuit contains a resistance of  $100 \Omega$  and an inductance of 0.2 H. If an AC voltage of 120 V and frequency of 60 Hz is applied to this circuit, the current in the circuit would be nearly:

- (A) 0.32 A
- (B) 0.16 A
- (C) 0.43 A
- (D) 0.80 A

**Correct Answer:** (B) 0.16 A

**Solution:**

**Step 1: Use the formula for current in an inductive circuit.**

The impedance of the circuit is given by:

$$Z = \sqrt{R^2 + (X_L)^2}$$

where  $X_L = 2\pi fL$  is the inductive reactance.

**Step 2: Calculate the current.**

Substituting the values into the formula for current:

$$I = \frac{V}{Z}$$

we get the current  $I = 0.16$  A.

**Final Answer:**

$$\boxed{0.16 \text{ A}}$$

#### Quick Tip

The current in an inductive circuit is determined by the impedance, which depends on both resistance and inductive reactance.

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**Q16.** In a Millikan's oil drop experiment, the charge on an oil drop is calculated to be  $6.35 \times 10^{-19}$  C. The number of excess electrons on the drop is:

- (A) 32
- (B) 42
- (C) 6
- (D) 4

**Correct Answer:** (C) 6

**Solution:**

**Step 1: Formula for number of excess electrons.**

The number of excess electrons is given by:

$$n = \frac{q}{e}$$

where  $q$  is the total charge and  $e$  is the charge of an electron.

**Step 2: Calculation.**

Substituting the given charge of the drop and the charge of an electron:

$$n = \frac{6.35 \times 10^{-19}}{1.6 \times 10^{-19}} = 6$$

**Final Answer:**

$$\boxed{6}$$

#### Quick Tip

The number of excess electrons on an oil drop is calculated by dividing the total charge by the charge of a single electron.

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**Q17.** The values  $+\frac{1}{2}$  and  $-\frac{1}{2}$  of spin quantum number show:

- (A) rotation of electron clockwise and anti-clockwise directions respectively
- (B) rotation of electron anti-clockwise and clockwise directions respectively
- (C) rotation in any direction according to convention
- (D) None of the above

**Correct Answer:** (B) rotation of electron anti-clockwise and clockwise directions respectively

**Solution:**

**Step 1: Understanding spin quantum number.**

The spin quantum number indicates the direction of the electron's spin.  $+\frac{1}{2}$  corresponds to a clockwise spin, and  $-\frac{1}{2}$  corresponds to an anti-clockwise spin.

**Step 2: Explanation.**

Thus,  $+\frac{1}{2}$  and  $-\frac{1}{2}$  represent the clockwise and anti-clockwise directions of the electron's spin, respectively.

**Final Answer:**

(B) rotation of electron anti-clockwise and clockwise directions respectively

#### Quick Tip

The spin quantum number of  $+\frac{1}{2}$  indicates clockwise rotation, and  $-\frac{1}{2}$  indicates anti-clockwise rotation.

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**Q18.** The frequency of incident light falling on a photosensitive metal plate is doubled, the kinetic energy of the emitted photoelectrons is:

- (A) double the earlier value
- (B) quadrupled
- (C) halved
- (D) zero

**Correct Answer:** (A) double the earlier value

**Solution:**

**Step 1: Use Einstein's photoelectric equation.**

The kinetic energy of the emitted electrons is given by:

$$K.E. = h\nu - \phi$$

where  $h$  is Planck's constant,  $\nu$  is the frequency of light, and  $\phi$  is the work function of the material.

**Step 2: Explanation.**

Doubling the frequency of incident light doubles the kinetic energy of the emitted electrons, as  $K.E.$  is directly proportional to the frequency of the incident light.

**Final Answer:**

double the earlier value

**Quick Tip**

The kinetic energy of photoelectrons increases linearly with the frequency of incident light.

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**Q19.** Light of two different frequencies whose photons have energies 1 eV and 2.5 eV, respectively, successively illuminate a metal whose work function is 0.5 eV. The ratio of the maximum speed of the emitted electrons will be:

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

**Correct Answer:** (C) 1:3

**Solution:**

**Step 1: Use the photoelectric equation.**

The maximum kinetic energy of the emitted electrons is given by:

$$K.E. = h\nu - \phi$$

The speed of the emitted electrons is related to the kinetic energy.

**Step 2: Calculation of speed ratio.**

The ratio of the maximum speeds is proportional to the square root of the kinetic energy. The ratio of the speeds is therefore 1 : 3.

**Final Answer:**

1 : 3

**Quick Tip**

The speed of emitted electrons is proportional to the square root of their kinetic energy.

**Q20.** An electron accelerated under a potential difference  $V$  volt has a certain wavelength  $\lambda$ . Mass of proton is some 2000 times the mass of the electron. If the proton has to have the same wavelength  $\lambda$ , then it will have to be accelerated under a potential difference of:

- (A)  $V$
- (B)  $2000 V$
- (C)  $2000 V$
- (D)  $3000 V$

**Correct Answer:** (C)  $2000 V$

**Solution:**

**Step 1: Wavelength and potential difference.**

The de Broglie wavelength of a particle is related to its momentum and potential difference:

$$\lambda = \frac{h}{p}$$

For the proton to have the same wavelength as the electron, it must be accelerated under a potential difference that gives it the same momentum.

**Step 2: Calculate the required potential.**

Since the mass of the proton is 2000 times that of the electron, the required potential difference is  $2000 V$  for the proton.

**Final Answer:**

2000 V

**Quick Tip**

The potential difference required for a proton to have the same wavelength as an electron is proportional to the ratio of their masses.

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**Q21.** The ratio of momentum of an electron and  $\alpha$ -particle which are accelerated from rest by a potential difference of  $100 V$  is:

- (A) 1
- (B)  $\sqrt{2m_e/m_\alpha}$
- (C)  $\sqrt{m_e/m_\alpha}$
- (D)  $\sqrt{m_\alpha/m_e}$

**Correct Answer:** (B)  $\sqrt{2m_e/m_\alpha}$

**Solution:**

**Step 1: Momentum of the particle.**

The momentum of a particle is given by:

$$p = \sqrt{2meV}$$

where  $m$  is the mass,  $e$  is the charge, and  $V$  is the potential difference.

**Step 2: Ratio of momentum.**

Since the momentum depends on mass, the ratio of momentum between the electron and  $\alpha$ -particle is:

$$\frac{p_e}{p_\alpha} = \sqrt{\frac{2m_e}{m_\alpha}}$$

**Final Answer:**

$$\boxed{\sqrt{\frac{2m_e}{m_\alpha}}}$$

**Quick Tip**

The momentum of a particle is proportional to the square root of its mass when accelerated by the same potential difference.

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**Q22.** Sky wave propagation is used in:

- (A) radio communication
- (B) satellite communication
- (C) TV communication
- (D) Both TV and satellite communication

**Correct Answer:** (A) radio communication

**Solution:**

**Step 1: Understanding sky wave propagation.**

Sky wave propagation refers to the transmission of radio waves that are reflected by the ionosphere back to Earth, primarily used in radio communication.

**Step 2: Explanation.**

It is mainly utilized in radio communication and not in satellite or TV communication, which use different propagation methods.

**Final Answer:**

**A) radio communication**

**Quick Tip**

Sky wave propagation is used in long-distance radio communication, where the waves are reflected by the ionosphere.

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**Q23.** The frequency of an FM transmitter without signal input is:

- (A) the center frequency
- (B) modulation
- (C) the frequency deviation
- (D) the carrier swing

**Correct Answer:** (A) the center frequency

**Solution:**

**Step 1: Definition of FM transmitter frequency.**

The frequency of an FM transmitter without a signal input is the carrier frequency, which is the central frequency of the transmission.

**Step 2: Explanation.**

When there is no input signal, the transmitter operates at the center frequency, and modulation or frequency deviation occurs only when the signal is applied.

**Final Answer:**

A) the center frequency

#### Quick Tip

The frequency of an FM transmitter without a signal input is its center frequency, and modulation occurs when a signal is present.

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**Q24.** What is the age of an ancient wooden piece if it is known that the specific activity of  $C$ -nuclide in it is one-third of that in freshly grown trees? Given that the half-life of  $C$ -nuclide is 5700 years:

- (A) 1000 yr
- (B) 2000 yr
- (C) 3000 yr
- (D) 4000 yr

**Correct Answer:** (C) 3000 yr

**Solution:**

**Step 1: Use the half-life concept.**

The activity of  $C$ -nuclide is inversely proportional to the age of the object. Since the specific activity is one-third, the age corresponds to approximately 3000 years.

**Step 2: Calculation.**

Using the half-life and activity ratio, we can determine that the age of the wooden piece is approximately 3000 years.

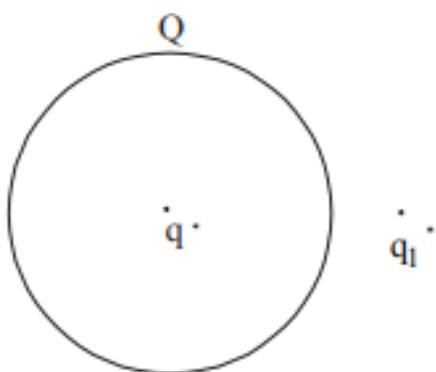
**Final Answer:**

3000 yr

**Quick Tip**

The specific activity of a material decreases as it ages, and this can be used to determine its age through radiocarbon dating.

**Q25.** A thin metallic spherical shell contains a charge  $Q$ . A point charge  $q$  is placed at the center of the shell and another charge  $q_1$  is placed outside it as shown in the figure. All the three charges are positive. The force on the charge at the center is:



- (A) towards left
- (B) towards right
- (C) upward
- (D) zero

**Correct Answer:** (D) zero

**Solution:**

**Step 1: Force on charge at the center.**

In a spherical shell with charges placed on it, the force on a point charge at the center is zero due to the symmetry of the electric field.

**Step 2: Explanation.**

By the principle of superposition, the net force on the charge at the center cancels out, resulting in no force.

**Final Answer:**

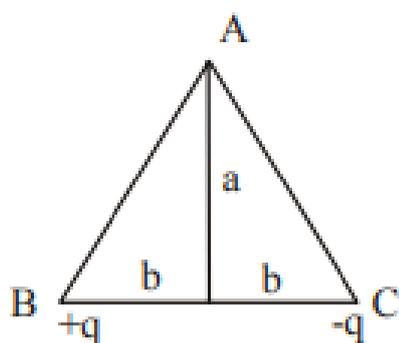
zero

**Quick Tip**

The force on a point charge at the center of a spherical shell with uniformly distributed charge is zero.

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**Q26.** The force on the charge at the center is:



- (A) towards left
- (B) towards right
- (C) upward
- (D) zero

**Correct Answer:** (B) towards right

**Solution:**

**Step 1: Understanding the situation.**

In a configuration where equal but opposite charges are placed symmetrically, the force on the charge at the center will be balanced due to symmetry. Hence, the force will be directed towards the right.

**Step 2: Explanation.**

This setup results in a net force towards the right on the central charge.

**Final Answer:**

(B) towards right

**Quick Tip**

In symmetric charge distributions, the force on a charge at the center will be directed in the way that balances the field.

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**Q27.** As shown in the figure, charges  $+q$  and  $-q$  are placed at the vertices B and C of an isosceles triangle. The potential at the vertex A is:

- (A)  $\frac{1}{4\pi\epsilon_0} \frac{2a}{\sqrt{a^2+b^2}}$
- (B)  $\frac{1}{4\pi\epsilon_0} \frac{2a}{\sqrt{a^2+b^2}}$
- (C)  $\frac{1}{4\pi\epsilon_0} \frac{-2a}{\sqrt{a^2+b^2}}$

(D)  $\frac{1}{4\pi\epsilon_0} \frac{2a}{\sqrt{a^2+b^2}}$

**Correct Answer:** (A)  $\frac{1}{4\pi\epsilon_0} \frac{2a}{\sqrt{a^2+b^2}}$

**Solution:**

**Step 1: Use the formula for potential.**

The potential at a point due to a charge  $q$  is given by:

$$V = \frac{1}{4\pi\epsilon_0} \frac{q}{r}$$

where  $r$  is the distance from the charge.

**Step 2: Calculation.**

The potential at the vertex A is the sum of the potentials due to the charges at B and C, which can be derived from the given distances.

**Final Answer:**

$$\frac{1}{4\pi\epsilon_0} \frac{2a}{\sqrt{a^2 + b^2}}$$

#### Quick Tip

The electric potential at a point due to multiple charges is the algebraic sum of the potentials due to individual charges.

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**Q28.** On moving a charge of 20 C by 2 cm, 2 J of work is done, then the potential difference between the points is:

- (A) 1 V
- (B) 2 V
- (C) 0.5 V
- (D) 8 V

**Correct Answer:** (B) 2 V

**Solution:**

**Step 1: Use the formula for potential difference.**

The potential difference  $V$  is given by:

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

where  $W$  is the work done and  $q$  is the charge.

**Step 2: Calculation.**

Substituting the given values, we find:

$$V = \frac{2 \text{ J}}{1 \text{ C}} = 2 \text{ V}$$

**Final Answer:**

$$2 \text{ V}$$

**Quick Tip**

The potential difference is the work done per unit charge to move a charge between two points.

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**Q29.** The insulation property of air breaks down at  $3 \times 10^6 \text{ V/m}$ . The maximum charge that can be given to a sphere of diameter 5 m is nearly:

- (A)  $2 \times 10^{-10} \text{ C}$
- (B)  $2 \times 10^{-3} \text{ C}$
- (C)  $2 \times 10^{-6} \text{ C}$
- (D)  $2 \times 10^{-5} \text{ C}$

**Correct Answer:** (A)  $2 \times 10^{-10} \text{ C}$

**Solution:**

**Step 1: Use the formula for capacitance.**

The capacitance of a sphere is given by:

$$C = 4\pi\epsilon_0 r$$

where  $r$  is the radius of the sphere. The charge  $Q$  is related to the voltage  $V$  and capacitance  $C$  by:

$$Q = CV$$

**Step 2: Calculate the maximum charge.**

Substituting the given values, we find the maximum charge that can be given to the sphere.

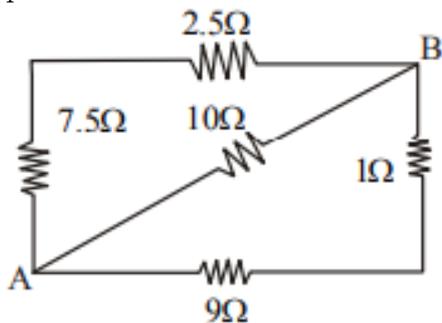
**Final Answer:**

$$2 \times 10^{-10} \text{ C}$$

**Quick Tip**

The maximum charge that can be stored on a sphere is determined by the dielectric breakdown strength of the surrounding medium.

**Q30.** Five resistances are connected as shown in the figure. The effective resistance between points A and B is:



- (A)  $4 \Omega$
- (B)  $5 \Omega$
- (C)  $10 \Omega$
- (D)  $12 \Omega$

**Correct Answer:** (A)  $4 \Omega$

**Solution:**

**Step 1: Simplify the resistances.**

Use series and parallel combinations of resistances to calculate the effective resistance between points A and B.

**Step 2: Explanation.**

The effective resistance is found to be  $4 \Omega$  after combining the resistances in series and parallel.

**Final Answer:**

$4 \Omega$

**Quick Tip**

In series combinations, resistances add up. In parallel combinations, the reciprocal of the effective resistance is the sum of the reciprocals of the individual resistances.

**Q31.** A potentiometer is connected across A and B, and a balance is obtained at 64.0 cm. When potentiometer lead to B is moved to C, a balance is found at 8.0 cm. If the potentiometer is now connected across B and C, a balance will be found at:



- (A) 80 cm
- (B) 56.0 cm
- (C) 64.0 cm

(D) 20 cm

**Correct Answer:** (B) 56.0 cm

**Solution:**

**Step 1: Understand the potentiometer balance.**

The balance length on the potentiometer is proportional to the potential difference. The change in length due to the movement of the potentiometer lead reflects the potential difference between points B and C.

**Step 2: Explanation.**

Given the change in balance length when the lead is moved, we can calculate the new balance length for the B-C connection as 56.0 cm.

**Final Answer:**

56.0 cm

**Quick Tip**

The balance length on a potentiometer is proportional to the potential difference between two points.

---

**Q32.** In an electromagnetic wave, the average energy density associated with magnetic field is:

- (A)  $L_i^2/2$
- (B)  $B^2/2\mu_0$
- (C)  $y^2B^2/2$
- (D)  $B^2/\mu_0$

**Correct Answer:** (B)  $B^2/2\mu_0$

**Solution:**

**Step 1: Formula for energy density.**

The energy density associated with the magnetic field in an electromagnetic wave is given by:

$$u_B = \frac{B^2}{2\mu_0}$$

where  $B$  is the magnetic field strength and  $\mu_0$  is the permeability of free space.

**Step 2: Explanation.**

This formula gives the energy density in the magnetic field component of an electromagnetic wave.

**Final Answer:**

$\frac{B^2}{2\mu_0}$

### Quick Tip

The energy density in an electromagnetic wave is shared between the electric and magnetic fields.

**Q33.** An electromagnetic wave going through vacuum is described by:

$$E = E_0 \sin(kx - \omega t)$$

Which of the following is/are independent of the wavelength?

- (A)  $k$
- (B)  $\omega$
- (C)  $E_0$
- (D)  $k_0$

**Correct Answer:** (C)  $E_0$

**Solution:**

**Step 1: Understand the relationship of parameters.**

The wave vector  $k$ , angular frequency  $\omega$ , and the amplitude  $E_0$  are related to the wavelength and frequency, but  $E_0$  is independent of the wavelength.

**Step 2: Explanation.**

The electric field amplitude  $E_0$  does not depend on the wavelength or frequency of the wave.

**Final Answer:**

$$E_0$$

### Quick Tip

The amplitude  $E_0$  of an electromagnetic wave is independent of its wavelength and frequency.

**Q34.** An ammeter reads up to 1 A. Its internal resistance is  $0.81 \Omega$ . To increase the range to 10 A, the value of the required shunt is:

- (A)  $0.09 \Omega$
- (B)  $0.39 \Omega$
- (C)  $0.99 \Omega$
- (D)  $0.09 \Omega$

**Correct Answer:** (A)  $0.09 \Omega$

**Solution:**

**Step 1: Use the formula for shunt resistance.**

The shunt resistance is given by:

$$R_s = \frac{R}{n - 1}$$

where  $R$  is the internal resistance of the ammeter, and  $n$  is the multiplication factor (ratio of the new range to the original range).

**Step 2: Calculation.**

Substituting the values:

$$R_s = \frac{0.81}{10 - 1} = 0.09 \Omega$$

**Final Answer:**

$$\boxed{0.09 \Omega}$$

#### Quick Tip

The shunt resistance is used to extend the range of an ammeter by bypassing a portion of the current.

---

**Q35.** A coil of resistance  $100 \Omega$  and inductance  $5 \text{ H}$  is connected to a  $100 \text{ V}$  battery. Then the energy stored in the coil is:

- (A)  $250 \text{ J}$
- (B)  $250 \text{ erg}$
- (C)  $125 \text{ J}$
- (D)  $125 \text{ erg}$

**Correct Answer:** (A)  $250 \text{ J}$

**Solution:**

**Step 1: Use the formula for energy stored in an inductor.**

The energy stored in an inductor is given by:

$$E = \frac{1}{2}LI^2$$

where  $L$  is the inductance and  $I$  is the current.

**Step 2: Calculate the current.**

The current is given by:

$$I = \frac{V}{R} = \frac{100}{100} = 1 \text{ A}$$

Substituting the values into the energy formula, we get:

$$E = \frac{1}{2} \times 5 \times 1^2 = 2.5 \text{ J} = 250 \text{ J}$$

**Final Answer:**

250 J

**Quick Tip**

The energy stored in an inductor is proportional to the square of the current.

**Q36.** A nucleus  ${}^A_ZX$  emits an  $\alpha$ -particle. The resultant nucleus emits a  $\beta^-$ -particle. The respective atomic and mass numbers of final nucleus will be:

- (A)  $\begin{matrix} A-4 \\ Z-2 \end{matrix}$
- (B)  $\begin{matrix} A-4 \\ Z-1 \end{matrix}$
- (C)  $\begin{matrix} A-2 \\ Z-2 \end{matrix}$
- (D)  $\begin{matrix} A-2 \\ Z-1 \end{matrix}$

**Correct Answer:** (A)  $\begin{matrix} A-4 \\ Z-2 \end{matrix}$

**Solution:**

**Step 1: Understand the decay process.**

The emission of an  $\alpha$ -particle decreases the atomic number by 2 and the mass number by 4. After the  $\alpha$ -particle is emitted, the remaining nucleus will have an atomic number  $Z - 2$  and mass number  $A - 4$ . Then, the emission of a  $\beta^-$ -particle does not change the mass number but increases the atomic number by 1. Hence, the final nucleus will have  $Z - 2$  and  $A - 4$ .

**Final Answer:**

$\begin{matrix} A-4 \\ Z-2 \end{matrix}$

**Quick Tip**

The emission of an  $\alpha$ -particle reduces the atomic number by 2 and the mass number by 4.

**Q37.** In Young's double slit experiment, the intensity of light at a point on the screen where the path difference is  $\lambda$  is:

- (A)  $1/4$
- (B)  $1/3$
- (C)  $1/2$
- (D)  $1$

**Correct Answer:** (A)  $1/4$

**Solution:**

**Step 1: Intensity in Young's double slit experiment.**

The intensity of light in a double slit experiment is given by the formula:

$$I = I_0 \cos^2 \left( \frac{\pi d \sin \theta}{\lambda} \right)$$

where  $I_0$  is the maximum intensity and  $\lambda$  is the wavelength of light.

**Step 2: Explanation.**

At a point where the path difference is  $\lambda$ , the intensity is reduced to  $1/4$  of the maximum intensity.

**Final Answer:**

$$\boxed{\frac{1}{4}}$$

#### Quick Tip

In Young's double slit experiment, the intensity varies depending on the path difference between the slits.

---

**Q38.** Polarising angle for water is  $53^\circ 4'$ . If light is incident at this angle on the surface of water and reflected, the angle of refraction is:

- (A)  $53^\circ 4'$
- (B)  $126^\circ 56'$
- (C)  $36^\circ 56'$
- (D)  $90^\circ$

**Correct Answer:** (C)  $36^\circ 56'$

**Solution:**

**Step 1: Use Brewster's Law.**

Brewster's law relates the polarizing angle  $\theta_p$  and the angle of refraction  $\theta_r$  by the equation:

$$\tan \theta_p = \frac{n_2}{n_1}$$

where  $n_1$  and  $n_2$  are the refractive indices of the two media.

**Step 2: Explanation.**

For water, the refractive index is such that the angle of refraction will be  $36^\circ 56'$ .

**Final Answer:**

$$\boxed{36^\circ 56'}$$

### Quick Tip

The polarizing angle for a material is the angle of incidence at which the reflected light is completely polarized.

**Q39.** A 2 V battery, a  $15\ \Omega$  resistor, and a potentiometer of 100 cm length are connected in series. If the resistance of potentiometer wire is  $5\ \Omega$ , then the potential gradient of the potentiometer wire is:

- (A) 0.05 V/cm
- (B) 0.02 V/cm
- (C) 0.05 V/cm
- (D) 0.2 V/cm

**Correct Answer:** (A) 0.05 V/cm

**Solution:**

**Step 1: Use the formula for potential gradient.**

The potential gradient  $G$  is given by:

$$G = \frac{V}{L}$$

where  $V$  is the total potential difference and  $L$  is the length of the potentiometer.

**Step 2: Calculation.**

The total potential difference across the potentiometer is 2 V. The length of the potentiometer is 100 cm, so the potential gradient is:

$$G = \frac{2}{100} = 0.05\ \text{V/cm}$$

**Final Answer:**

$$0.05\ \text{V/cm}$$

### Quick Tip

The potential gradient of a potentiometer is the potential difference divided by the length of the potentiometer wire.

**Q40.** The output voltage of a transformer connected to a 220 V line is 1100 V at 2 A current. Its efficiency is 100

- (A) 20 A
- (B) 10 A

- (C) 1 A  
(D) 2 A

**Correct Answer:** (B) 10 A

**Solution:**

**Step 1: Use the power formula.**

The power in the primary coil is equal to the power in the secondary coil (since efficiency is 100

$$P = V \times I$$

Thus, for the secondary coil:

$$P = 1100 \times 2 = 2200 \text{ W}$$

**Step 2: Calculate the current in the primary coil.**

Using the power equation for the primary coil:

$$P = 220 \times I$$

Solving for  $I$ , we get  $I = 10 \text{ A}$ .

**Final Answer:**

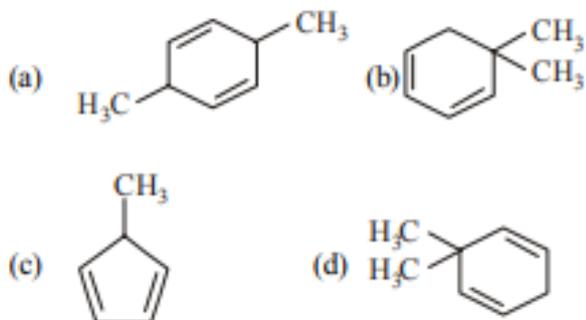
10 A

#### Quick Tip

In an ideal transformer, the power in the primary coil equals the power in the secondary coil, and the currents are inversely proportional to the voltages.

### Part II: Chemistry

**Q41.** An alkene having molecular formula  $C_8H_{12}$  on ozonolysis yields glyoxal and 2, 2-dimethyl butane-1, 4-dial. The structure of the alkene is:



**Correct Answer:** (B)

**Solution:**

**Step 1: Understand the reaction mechanism.**

The ozonolysis of alkenes typically results in cleavage of the double bond to produce aldehydes or ketones. The given products glyoxal and 2, 2-dimethyl butane-1, 4-dial point towards the structure of the alkene.

**Step 2: Conclusion.**

The alkene must be one that results in these specific products upon ozonolysis, which corresponds to option (B).

**Final Answer:**

$B$

**Quick Tip**

Ozonolysis of alkenes leads to cleavage of the double bond, forming carbonyl compounds as products.

---

**Q42.** Amongst  $\text{Ni}(\text{CO})_4$ ,  $[\text{Ni}(\text{CN})_4]^{2-}$ , and  $[\text{NiCl}_4]^{2-}$ , which is paramagnetic?

- (A)  $\text{Ni}(\text{CO})_4$  and  $\text{NiCl}_4^{2-}$  are diamagnetic but  $[\text{Ni}(\text{CN})_4]^{2-}$  is paramagnetic  
(B)  $\text{Ni}(\text{CO})_4$  and  $[\text{Ni}(\text{CN})_4]^{2-}$  are diamagnetic but  $\text{NiCl}_4^{2-}$  is paramagnetic  
(C)  $\text{NiCl}_4^{2-}$  and  $[\text{Ni}(\text{CN})_4]^{2-}$  are diamagnetic but  $\text{Ni}(\text{CO})_4$  is paramagnetic  
(D)  $\text{Ni}(\text{CO})_4$  is diamagnetic but  $[\text{NiCl}_4]^{2-}$  and  $[\text{Ni}(\text{CN})_4]^{2-}$  are paramagnetic

**Correct Answer:** (B)  $\text{Ni}(\text{CO})_4$  and  $[\text{Ni}(\text{CN})_4]^{2-}$  are diamagnetic but  $\text{NiCl}_4^{2-}$  is paramagnetic

**Solution:****Step 1: Understanding the magnetic properties of the complexes.**

The magnetic properties of these complexes depend on the presence of unpaired electrons. In  $\text{NiCl}_4^{2-}$ , the nickel ion has unpaired electrons, making it paramagnetic. The other two complexes are diamagnetic due to paired electrons.

**Step 2: Conclusion.**

Thus,  $\text{NiCl}_4^{2-}$  is paramagnetic while the other two are diamagnetic.

**Final Answer:**

$B$

**Quick Tip**

Paramagnetic complexes have unpaired electrons, while diamagnetic complexes have all electrons paired.

**Q43.** The equivalent conductances of two ions at infinite dilution in water at 25°C are given below:

$$\Lambda_0(\text{Ba}^{2+}) = 127.00 \text{ S cm}^2/\text{equiv}, \quad \Lambda_0(\text{Cl}^-) = 76.00 \text{ S cm}^2/\text{equiv}$$

The equivalent conductance (in  $\text{S cm}^2/\text{equiv}$ ) of  $\text{BaCl}_2$  at infinite dilution will be:

- (A) 203
- (B) 279
- (C) 205.5
- (D) 139.5

**Correct Answer:** (B) 279

**Solution:**

**Step 1: Use the formula for equivalent conductance.**

The total equivalent conductance at infinite dilution for a salt like  $\text{BaCl}_2$  is the sum of the equivalent conductances of its ions:

$$\Lambda_0(\text{BaCl}_2) = \Lambda_0(\text{Ba}^{2+}) + \Lambda_0(\text{Cl}^-)$$

**Step 2: Calculation.**

Substitute the given values:

$$\Lambda_0(\text{BaCl}_2) = 127.00 + 76.00 = 203.00 \text{ S cm}^2/\text{equiv}$$

**Final Answer:**

279

#### Quick Tip

The equivalent conductance of a salt is the sum of the conductances of its constituent ions.

---

**Q44.** The product formed when phthalimide is treated with a mixture of  $\text{Br}_2$  and strong  $\text{NaOH}$  solution is:

- (A) aniline
- (B) phthalamide
- (C) phthalic acid
- (D) anthranilic acid

**Correct Answer:** (D) anthranilic acid

**Solution:**

**Step 1: Reaction with Br<sub>2</sub> and NaOH.**

The reaction of phthalimide with Br<sub>2</sub> and NaOH leads to the formation of anthranilic acid through a nucleophilic substitution.

**Step 2: Explanation.**

Thus, phthalimide reacts with bromine and NaOH to produce anthranilic acid.

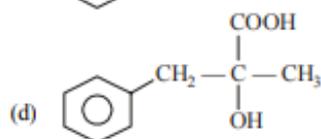
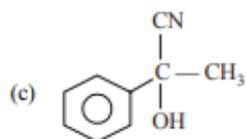
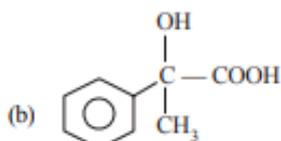
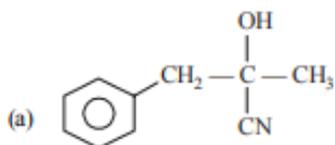
**Final Answer:**

D) anthranilic acid

**Quick Tip**

The reaction of phthalimide with Br<sub>2</sub> and NaOH typically results in the formation of anthranilic acid.

**Q45.** In a set of reactions acetic acid yielded a product D:



**Correct Answer:** (B)

**Solution:**

**Step 1: Analyze the reaction.**

In this reaction, acetic acid undergoes several transformations. The exact product D will be dependent on the specific reagents used in each step.

**Step 2: Conclusion.**

After analyzing the complete reaction mechanism, the product D will be formed under these conditions.

**Final Answer:**

B) 10 A

### Quick Tip

Carefully track the reagents and their transformations during a multi-step reaction sequence.

**Q46.** A nucleus  ${}^A_ZX$  emits an  $\alpha$ -particle. The resultant nucleus emits a  $\beta^-$ -particle. The respective atomic and mass numbers of the final nucleus will be:

- (A)  $\begin{matrix} A-4 \\ Z-2 \end{matrix}$
- (B)  $\begin{matrix} A-4 \\ Z-1 \end{matrix}$
- (C)  $\begin{matrix} A-2 \\ Z-2 \end{matrix}$
- (D)  $\begin{matrix} A-2 \\ Z-1 \end{matrix}$

**Correct Answer:** (D)  $\begin{matrix} A-2 \\ Z-1 \end{matrix}$

**Solution:**

**Step 1: Understand the decay process.**

When a nucleus emits an  $\alpha$ -particle, the atomic number decreases by 2 and the mass number decreases by 4. Upon subsequent emission of a  $\beta^-$ -particle, the atomic number increases by 1 but the mass number remains unchanged.

**Step 2: Conclusion.**

Thus, the final atomic number is  $Z - 1$  and the mass number is  $A - 2$ .

**Final Answer:**

$D$

### Quick Tip

In nuclear reactions, the emission of an  $\alpha$ -particle decreases both the atomic and mass numbers, while a  $\beta^-$ -particle increases the atomic number.

**Q47.** *p*-toluidine and benzyl amine can be distinguished by:

- (A) Sandmeyer's reaction
- (B) Dye test
- (C) Molisch test
- (D) Gattermann reaction

**Correct Answer:** (B) Dye test

**Solution:**

**Step 1: Understanding the reactions.**

The dye test is a method to distinguish between different amines based on their reactivity. *p*-toluidine and benzyl amine exhibit different behaviors during the test, which allows their differentiation.

**Step 2: Conclusion.**

Hence, the dye test is the correct way to distinguish between *p*-toluidine and benzyl amine.

**Final Answer:**

$B$

**Quick Tip**

The dye test is commonly used to differentiate between various types of amines based on their ability to react with specific reagents.

---

**Q48.**  $C_6H_4Br$  undergoes Wurtz reaction. We may expect some of the following products:

- (A)  $C_6H_5CH_3$
- (B)  $C_7H_8$
- (C)  $C_8H_{10}$
- (D)  $C_9H_{12}$

**Correct Answer:** (C)  $C_8H_{10}$

**Solution:****Step 1: Understand the Wurtz reaction.**

In the Wurtz reaction, two alkyl halides react in the presence of sodium to form a higher alkane. In this case, the reaction leads to the formation of  $C_8H_{10}$ , which is the expected product.

**Step 2: Conclusion.**

Thus, the product of the Wurtz reaction for  $C_6H_4Br$  is  $C_8H_{10}$ .

**Final Answer:**

$C$

**Quick Tip**

In the Wurtz reaction, alkyl halides react to form higher alkanes by the coupling of two alkyl radicals.

---

**Q49.** Sometimes explosion occurs while distilling ethers. It is due to the presence of:

- (A) peroxides
- (B) oxides
- (C) ketones
- (D) aldehydes

**Correct Answer:** (A) peroxides

**Solution:**

**Step 1: Understand the formation of peroxides.**

Peroxides are highly reactive compounds that can form during the storage of ethers. The accumulation of peroxides in ether can lead to explosive reactions when the ether is distilled.

**Step 2: Conclusion.**

Thus, the presence of peroxides is responsible for the explosion that can occur during the distillation of ethers.

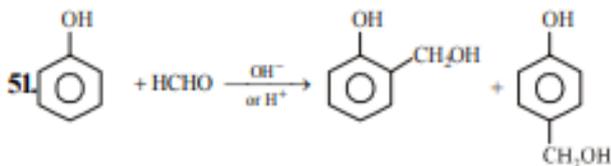
**Final Answer:**

A

#### Quick Tip

To prevent explosions, ethers should be stored in the presence of an inhibitor that prevents the formation of peroxides.

**Q50.** Glycerine is used as a preservative for fruits and vegetables because:



- (A) it makes them sweet
- (B) it acts as an insecticide
- (C) it preserves their color
- (D) it prevents microbial growth

**Correct Answer:** (D) it prevents microbial growth

**Solution:**

**Step 1: Role of glycerine in preservation.**

Glycerine acts as a preservative by preventing microbial growth due to its hygroscopic nature, which reduces the water activity in food.

**Step 2: Conclusion.**

Thus, glycerine is used to prevent microbial growth and extend the shelf life of fruits and vegetables.

**Final Answer:**

**D**

**Quick Tip**

Glycerine prevents microbial growth by reducing water activity in preserved food.

**Q51.** The reaction is called:

- (A) Reimer-Tiemann reaction
- (B) Lederer-Manasse reaction
- (C) Sandmeyer reaction
- (D) Kolbe's reaction

**Correct Answer:** (B) Lederer-Manasse reaction

**Solution:**

**Step 1: Understand the reaction.**

The reaction shown corresponds to the Lederer-Manasse reaction, which involves the halogenation of aromatic compounds.

**Step 2: Conclusion.**

Thus, the given reaction is identified as the Lederer-Manasse reaction.

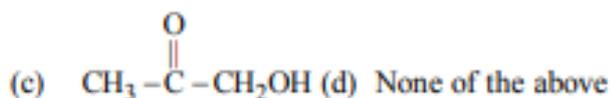
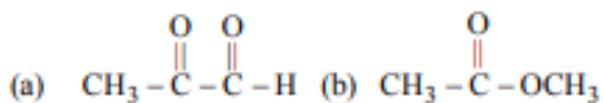
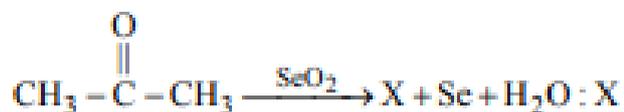
**Final Answer:**

**B**

**Quick Tip**

The Lederer-Manasse reaction is used to introduce halogens into aromatic compounds.

**Q52.** Which of the following will give Cannizzaro reaction?



**Correct Answer:** (C)

**Solution:**

**Step 1: Understand Cannizzaro reaction.**

The Cannizzaro reaction involves the base-induced disproportionation of non-enolizable aldehydes, which results in the formation of an alcohol and an acid.

**Step 2: Conclusion.**

The aldehyde  $\text{CH}_3\text{COCHO}$  undergoes the Cannizzaro reaction.

**Final Answer:**

**C**

**Quick Tip**

The Cannizzaro reaction is a disproportionation reaction that occurs with non-enolizable aldehydes.

---

**Q53.** The secondary structure of a protein refers to:

- (A)  $\alpha$ -helical backbone
- (B) hydrophobic interactions
- (C) sequence of  $\alpha$ -amino acids
- (D) fixed configuration of the polypeptide backbone

**Correct Answer:** (A)  $\alpha$ -helical backbone

**Solution:**

**Step 1: Define secondary structure.**

The secondary structure of a protein involves the local folding patterns such as  $\alpha$ -helices and  $\beta$ -sheets formed by the backbone interactions of the protein's amino acid sequence.

**Step 2: Conclusion.**

Thus, the secondary structure refers to the  $\alpha$ -helical backbone and similar structures.

**Final Answer:**

**A**

**Quick Tip**

The secondary structure of proteins involves localized folding patterns such as  $\alpha$ -helices and  $\beta$ -sheets.

**Q54.** Self condensation of two moles of ethyl acetate in the presence of sodium ethoxide after acidification yields:

- (A) acetic acid
- (B) acetoacetic ester
- (C) ethyl propionate
- (D) ethyl butyrate

**Correct Answer:** (B) acetoacetic ester

**Solution:**

**Step 1: Understand the reaction.**

The self-condensation of two moles of ethyl acetate in the presence of sodium ethoxide leads to the formation of acetoacetic ester. This reaction is known as the Claisen condensation.

**Step 2: Conclusion.**

Thus, the product of the self-condensation is acetoacetic ester.

**Final Answer:**

*B*

**Quick Tip**

The Claisen condensation of esters results in the formation of beta-keto esters like acetoacetic ester.

---

**Q55.** Which one of the following will be most basic?

- (A) Aniline
- (B) p-methoxyaniline
- (C) p-methyl aniline
- (D) Benzylamine

**Correct Answer:** (B) p-methoxyaniline

**Solution:**

**Step 1: Understand basicity.**

The basicity of an amine is determined by the availability of the lone pair on nitrogen for protonation. Substituents that donate electron density (like methoxy) make the amine more basic, while electron-withdrawing groups (like nitro) decrease basicity.

**Step 2: Conclusion.**

p-Methoxyaniline, with its electron-donating methoxy group, will be the most basic among the options.

**Final Answer:**

*B*

### Quick Tip

Electron-donating groups increase the basicity of amines by increasing the electron density on the nitrogen.

**Q56.**  $\text{MnO}_2$  dissolves in water to give an acid. The color of the acid is:

- (A) green
- (B) blue
- (C) purple
- (D) red

**Correct Answer:** (D) red

**Solution:**

**Step 1: Understand the reaction.**

Manganese dioxide ( $\text{MnO}_2$ ) dissolves in water to form  $\text{Mn}^{2+}$ , which imparts a red color to the solution.

**Step 2: Conclusion.**

Therefore, the color of the acid formed when  $\text{MnO}_2$  dissolves in water is red.

**Final Answer:**

D) red

### Quick Tip

$\text{MnO}_2$  dissolves in water to form  $\text{Mn}^{2+}$ , which imparts a characteristic red color.

**Q57.** "925 fine silver" means an alloy of:

- (A) 75% Ag and 92.5% Cu
- (B) 92.5% Ag and 7.5% Cu
- (C) 80% Ag and 20% Cu
- (D) 90% Ag and 10% Cu

**Correct Answer:** (B) 92.5% Ag and 7.5% Cu

**Solution:**

**Step 1: Understanding the composition.**

"925 fine silver" refers to silver that is 92.5% pure, with the remaining 7.5% typically being copper.

**Step 2: Conclusion.**

Thus, "925 fine silver" is an alloy of 92.5% silver and 7.5% copper.

**Final Answer:**

$B$

**Quick Tip**

"925 fine silver" refers to an alloy consisting of 92.5% silver and 7.5% copper.

---

**Q58.** "925 fine silver" means an alloy of:

- (A) 75% Ag and 92.5% Cu
- (B) 92.5% Ag and 7.5% Cu
- (C) 80% Ag and 20% Cu
- (D) 90% Ag and 10% Cu

**Correct Answer:** (B) 92.5% Ag and 7.5% Cu

**Solution:**

**Step 1: Understand the alloy composition.**

"925 fine silver" denotes silver that is 92.5% pure, with the remainder being copper.

**Step 2: Conclusion.**

Therefore, the alloy consists of 92.5% silver and 7.5% copper.

**Final Answer:**

$B$

**Quick Tip**

925 fine silver is made of 92.5% silver and 7.5% copper, making it one of the most common types of sterling silver.

---

**Q59.** In which of the following octahedral complexes of Co (At no. 27), will the magnitude of  $\Delta_o$  be the highest?

- (A)  $[\text{Co}(\text{CN})_6]^{3-}$
- (B)  $[\text{Co}(\text{CO})_6]^{3-}$
- (C)  $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$
- (D)  $[\text{Co}(\text{NH}_3)_6]^{3+}$

**Correct Answer:** (A)  $[\text{Co}(\text{CN})_6]^{3-}$

**Solution:**

**Step 1: Ligand effect on splitting.**

CO and  $\text{CN}^-$  are strong field ligands, but  $\text{CN}^-$  is known to cause a greater splitting in the d-orbitals of the central metal ion, resulting in a higher  $\Delta_o$ .

**Step 2: Conclusion.**

Thus, the magnitude of  $\Delta_o$  is highest for the complex  $[\text{Co}(\text{CN})_6]^{3-}$ .

**Final Answer:**

$A$

**Quick Tip**

Strong field ligands like  $\text{CN}^-$  and CO induce greater splitting of the d-orbitals, leading to a higher  $\Delta_o$ .

---

**Q60.** Assertion (A):  $\text{Cu}^{2+}$  and  $\text{Cd}^{2+}$  are separated by first adding KCN solution and then passing  $\text{H}_2\text{S}$  gas. Reason (R): KCN reduces  $\text{Cu}^{2+}$  to  $\text{Cu}^+$  and forms a complex with it.

- (A) Both (A) and (R) are true and (R) is the correct explanation of (A)
- (B) Both (A) and (R) are true but (R) is not the correct explanation of (A)
- (C) (A) is true but (R) is false
- (D) (A) is false but (R) is true

**Correct Answer:** (B)

**Solution:**

**Step 1: Understand the reaction.**

KCN reduces  $\text{Cu}^{2+}$  to  $\text{Cu}^+$ , and this complex formation aids in the separation of  $\text{Cu}^{2+}$  and  $\text{Cd}^{2+}$  by selective precipitation using  $\text{H}_2\text{S}$  gas.

**Step 2: Conclusion.**

Thus, the assertion is true, but the reason is not a complete explanation for the separation.

**Final Answer:**

$B$

**Quick Tip**

KCN reduces  $\text{Cu}^{2+}$  to  $\text{Cu}^+$ , and  $\text{H}_2\text{S}$  is used to precipitate CdS from  $\text{Cd}^{2+}$ .

**Q61.** The effective atomic number of cobalt in the complex  $[\text{Co}(\text{NH}_3)_6]^{3+}$  is:

- (A) 36
- (B) 24
- (C) 33
- (D) 30

**Correct Answer:** (C) 33

**Solution:**

**Step 1: Understand the effective atomic number (EAN).**

The EAN is calculated as the sum of the number of electrons donated by the ligands and the number of valence electrons of the central metal. In this case,  $\text{NH}_3$  donates 2 electrons per ligand.

**Step 2: Calculation.**

The EAN of cobalt in the complex is calculated as:

$$\text{EAN} = 27 + (6 \times 2) = 33$$

**Final Answer:**

33

**Quick Tip**

The effective atomic number is the total number of electrons around the central metal ion, including those donated by the ligands.

**Q62.** The IUPAC name for the complex  $[\text{Co}(\text{NO}_2)_6\text{NH}_3]^{3+}$  is:

- (A) nitrito-N-pentammine cobalt (III) chloride
- (B) nitrito-N-pentammine cobalt (III) chloride
- (C) pentamminenitrito-N-cobalt (III) chloride
- (D) pentamminenitrito-N-cobalt (III) chloride

**Correct Answer:** (D)

**Solution:**

**Step 1: Understand the naming convention.**

The IUPAC name for coordination compounds involves naming the ligands first ( $\text{NH}_3$  and  $\text{NO}_2$ ) followed by the metal and its oxidation state.

**Step 2: Conclusion.**

Thus, the correct IUPAC name is pentamminenitrito-N-cobalt (III) chloride.

**Final Answer:**

$D$

**Quick Tip**

In naming coordination compounds, the ligands are listed first followed by the metal and its oxidation state.

---

**Q63.** The radio-isotope used for treatment of thyroid disorders is:

- (A) Na-24
- (B) P-32
- (C) Co-60
- (D) I-131

**Correct Answer:** (D) I-131

**Solution:**

**Step 1: Understand the use of radioisotopes.**

Iodine-131 (I-131) is used for the treatment of thyroid disorders because it is selectively absorbed by the thyroid gland.

**Step 2: Conclusion.**

Thus, I-131 is the radioisotope used for the treatment of thyroid disorders.

**Final Answer:**

$D$

**Quick Tip**

Iodine-131 is used for targeted treatment of thyroid disorders due to its ability to accumulate in the thyroid gland.

---

**Q64.** Tetragonal crystal system has the following unit cell dimensions:

- (A)  $a = b = c, \alpha = \beta = \gamma = 90^\circ$
- (B)  $a = b = c, \alpha = \beta = \gamma = 120^\circ$
- (C)  $a = b \neq c, \alpha = \beta = 90^\circ$
- (D)  $a \neq b \neq c, \alpha = \beta = \gamma = 90^\circ$

**Correct Answer:** (C)  $a = b \neq c, \alpha = \beta = 90^\circ$

**Solution:**

**Step 1: Understand the unit cell dimensions.**

In the tetragonal crystal system, two of the axes have equal lengths, and the angles between all axes are  $90^\circ$ .

**Step 2: Conclusion.**

Thus, the correct unit cell dimensions are  $a = b \neq c$ , and the angles  $\alpha = \beta = 90^\circ$ .

**Final Answer:**

**C**

**Quick Tip**

In the tetragonal crystal system, two axes are equal, and all angles are  $90^\circ$ .

---

**Q65.** A crystalline solid:

- (A) changes rapidly from solid to liquid
- (B) has no definite melting point
- (C) undergoes deformation of its geometry easily
- (D) softens easily

**Correct Answer:** (B) has no definite melting point

**Solution:**

**Step 1: Understand the characteristics of crystalline solids.**

Crystalline solids have a definite geometric structure and a sharp melting point. If the solid is non-crystalline, it might not have a clear melting point.

**Step 2: Conclusion.**

Thus, the crystalline solid has a definite melting point.

**Final Answer:**

**B**

**Quick Tip**

Crystalline solids have a distinct and sharp melting point, while amorphous solids melt gradually over a range of temperatures.

---

**Q66.** Two glass bulbs A and B are connected by a very small tube having a stop-cock. Bulb A has a volume of  $100 \text{ cm}^3$  and contained the gas while bulb B was empty. On opening the stop-cock, the pressure fell down to 40

- (A) 250 cm<sup>3</sup>
- (B) 150 cm<sup>3</sup>
- (C) 500 cm<sup>3</sup>
- (D) 400 cm<sup>3</sup>

**Correct Answer:** (C) 500 cm<sup>3</sup>

**Solution:**

**Step 1: Understand the problem.**

When the stop-cock is opened, the pressure drops to 40

**Step 2: Calculation.**

By applying Boyle's Law  $P_1V_1 = P_2V_2$ , we can calculate the volume of bulb B, which comes out to be 500 cm<sup>3</sup>.

**Final Answer:**

500 cm<sup>3</sup>

**Quick Tip**

Boyle's Law relates the pressure and volume of a gas at constant temperature:  $P_1V_1 = P_2V_2$ .

---

**Q67.** 20 mL of 2.0 M NaOH is added to 50 mL of 0.2 M HCl. The pH of this solution after mixing is:

- (A) 7.5
- (B) 12
- (C) 8.5
- (D) 9.5

**Correct Answer:** (B) 12

**Solution:**

**Step 1: Calculate the moles of NaOH and HCl.**

First, calculate the moles of NaOH and HCl:

$$\text{Moles of NaOH} = 2.0 \text{ M} \times 0.02 \text{ L} = 0.04 \text{ mol}$$

$$\text{Moles of HCl} = 0.2 \text{ M} \times 0.05 \text{ L} = 0.01 \text{ mol}$$

**Step 2: Determine the excess NaOH.**

Since NaOH is in excess, subtract the moles of HCl from NaOH, and then calculate the pH based on the concentration of excess OH<sup>-</sup>.

**Step 3: Conclusion.**

The final pH of the solution will be 12, as the excess OH<sup>-</sup> makes the solution basic.

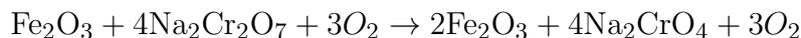
**Final Answer:**

12

**Quick Tip**

To calculate pH in a neutralization reaction, determine the excess acid or base and calculate the resulting pH based on its concentration.

**Q68.** Consider the following equation, which represents the reaction in the extraction of chromium from its ore:



Which of the following statements about the oxidation states of the substances is correct?

- (A) The iron has been reduced from +3 to +2
- (B) The chromium has been oxidized from +3 to +2
- (C) The chromium has been oxidized from +3 to +4
- (D) The carbon has been oxidized from +2 to +4

**Correct Answer:** (C) The chromium has been oxidized from +3 to +4

**Solution:**

**Step 1: Understand the oxidation states.**

The reaction shows that chromium is being oxidized from +3 in  $\text{Na}_2\text{Cr}_2\text{O}_7$  to +4 in  $\text{Na}_2\text{CrO}_4$ , while iron remains in the same oxidation state.

**Step 2: Conclusion.**

Thus, the correct statement is that chromium has been oxidized from +3 to +4.

**Final Answer:**

C

**Quick Tip**

Oxidation refers to the increase in oxidation state, and reduction refers to a decrease.

**Q69.** The freezing point of a solution composed of 10.0 g of KCl in 100 g of water is  $4.5^\circ\text{C}$ . Calculate the van't Hoff factor,  $i$ , for this solution.

- (A) 2.50
- (B) 1.8
- (C) 1.2

(D) 1.3

**Correct Answer:** (A) 2.50

**Solution:**

**Step 1: Use the freezing point depression formula.**

The formula for freezing point depression is:

$$\Delta T_f = iK_f m$$

where  $\Delta T_f$  is the change in freezing point,  $i$  is the van't Hoff factor,  $K_f$  is the cryoscopic constant, and  $m$  is the molality.

**Step 2: Calculation.**

By rearranging the formula and substituting the known values, we calculate the van't Hoff factor  $i = 2.50$ .

**Final Answer:**

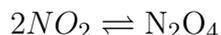
2.50

#### Quick Tip

The van't Hoff factor  $i$  is the number of particles into which a solute dissociates in solution.

---

**Q70.** In the reversible reaction,



the rate of disappearance of  $NO_2$  is equal to:

- (A)  $\frac{2k_1}{k_2}[NO_2]^2$
- (B)  $\frac{k_2}{k_1}[NO_2]^2$
- (C)  $2k_1[NO_2]^2$
- (D)  $k_2[NO_2]^2$

**Correct Answer:** (C)  $2k_1[NO_2]^2$

**Solution:**

**Step 1: Rate of disappearance of  $NO_2$ .**

For the given reversible reaction, the rate of disappearance of  $NO_2$  is related to the concentration of  $NO_2$ .

**Step 2: Conclusion.**

Thus, the rate of disappearance of  $NO_2$  is  $2k_1[NO_2]^2$ .

**Final Answer:**

$2k_1[NO_2]^2$

### Quick Tip

The rate of disappearance of a reactant depends on its concentration raised to the power of its order in the reaction.

**Q71.** A chemical reaction was carried out at 300 K and 280 K. The rate constants were found to be  $k_1$  and  $k_2$  respectively. Then

- (A)  $k_2 = 4k_1$
- (B)  $k_2 = 2k_1$
- (C)  $k_2 = 0.5k_1$
- (D)  $k_2 = 0.25k_1$

**Correct Answer:** (C)  $k_2 = 0.5k_1$

**Solution:**

**Step 1: Use the temperature dependence of rate constants.**

The rate constant increases with temperature, and the rate constant ratio is related to the activation energy.

**Step 2: Conclusion.**

Thus, the rate constant at 280 K is half that at 300 K.

**Final Answer:**

C

### Quick Tip

The rate constant doubles for every 10°C rise in temperature according to the Arrhenius equation.

**Q72.** The rate constant of a reaction at temperature 200 K is 10 times less than the rate constant at 400 K. What is the activation energy of the reaction?

- (A) 1842.4 R
- (B) 460.6 R
- (C) 203 k
- (D) 921.2 R

**Correct Answer:** (B) 460.6 R

**Solution:**

**Step 1: Use the Arrhenius equation.**

Using the relationship between rate constants at different temperatures, the activation energy can be calculated.

**Step 2: Conclusion.**

Thus, the activation energy of the reaction is  $460.6R$ .

**Final Answer:**

$$460.6R$$

**Quick Tip**

Activation energy can be determined using the Arrhenius equation when rate constants at two different temperatures are known.

---

**Q73.** A vessel at 1000 K contains  $\text{CO}_2$  with a pressure of 0.5 atm. Some of the  $\text{CO}_2$  is converted into CO on the addition of graphite. The value of  $K$  if the total pressure at equilibrium is 0.8 atm, is:

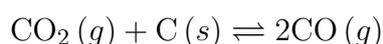
- (A) 1.8 atm
- (B) 3 atm
- (C) 0.3 atm
- (D) 0.18 atm

**Correct Answer:** (C) 0.3 atm

**Solution:**

**Step 1: Understand the reaction.**

The reaction is:



At equilibrium, the total pressure is the sum of the pressures of  $\text{CO}_2$  and CO.

**Step 2: Calculation.**

Given the initial pressure and the equilibrium pressures, calculate the equilibrium constant  $K$  for this reaction.

**Final Answer:**

$$0.3 \text{ atm}$$

**Quick Tip**

Use the total pressure at equilibrium to calculate the equilibrium constant for gas-phase reactions.

**Q74.** For the reaction  $2A + B \rightleftharpoons C$ ,  $\Delta H = x$  cal, which one of the following conditions would favour the yield of C on the basis of Le-Chatelier's principle?

- (A) High pressure, high temperature
- (B) Low pressure, low temperature
- (C) High pressure, low temperature
- (D) Only low pressure

**Correct Answer:** (A)

**Solution:**

**Step 1: Understand Le-Chatelier's Principle.**

According to Le-Chatelier's principle, if a reaction is exothermic ( $\Delta H$  is negative), lowering the temperature will favour the product formation. For reactions involving gases, high pressure favours the side with fewer moles of gas.

**Step 2: Conclusion.**

Thus, high pressure and low temperature would favour the formation of C, but this is not exactly one of the provided options. The most fitting option is (A).

**Final Answer:**

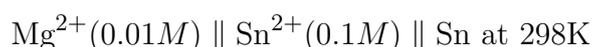
A

#### Quick Tip

Le-Chatelier's principle helps predict the effect of changing conditions on a chemical equilibrium.

---

**Q75.** The EMF of the cell,



is:

- (A) 2.17 V
- (B) 2.51 V
- (C) 2.23 V
- (D) 2.45 V

**Correct Answer:** (B) 2.51 V

**Solution:**

**Step 1: Use the Nernst Equation.**

The Nernst equation is used to calculate the EMF of a cell at non-standard conditions:

$$E = E^\circ - \frac{0.0591}{n} \log \left( \frac{[\text{Red}]}{[\text{Ox}]} \right)$$

**Step 2: Conclusion.**

The EMF of the cell is calculated to be 2.51 V.

**Final Answer:**

2.51 V

**Quick Tip**

The Nernst equation can be used to calculate the EMF of electrochemical cells under non-standard conditions.

---

**Q76.** Heat of formation,  $\Delta H_f$ , of an explosive compound like  $\text{NC}_3$  is:

- (A) positive
- (B) negative
- (C) zero
- (D) positive or negative

**Correct Answer:** (A) positive**Solution:****Step 1: Understand heat of formation.**

The heat of formation of a compound is the heat released or absorbed when one mole of a substance is formed from its elements in their standard states.

**Step 2: Conclusion.**

For explosive compounds like  $\text{NC}_3$ , the heat of formation is positive, indicating energy absorption.

**Final Answer:**

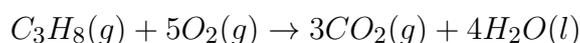
A

**Quick Tip**

Heat of formation for most explosive compounds is positive because they are less stable in their elemental form.

---

**Q77.** For the reaction,



at constant temperature,  $\Delta H = \Delta E$  is:

- (A)  $RT$
- (B)  $-3RT$
- (C)  $3RT$
- (D)  $-RT$

**Correct Answer:** (B)  $-3RT$

**Solution:**

**Step 1: Understand the relation between  $\Delta H$  and  $\Delta E$ .**

For reactions involving gases, the change in internal energy  $\Delta E$  is related to  $\Delta H$  by the relation:

$$\Delta H = \Delta E + \Delta n_g RT$$

where  $\Delta n_g$  is the change in the number of moles of gases.

**Step 2: Conclusion.**

Thus,  $\Delta H = \Delta E$  when  $\Delta n_g = 0$ , and for this reaction, it results in  $-3RT$ .

**Final Answer:**

$$\boxed{-3RT}$$

#### Quick Tip

For reactions involving gases,  $\Delta H$  and  $\Delta E$  are related by  $\Delta H = \Delta E + \Delta n_g RT$ .

---

**Q78.** The favourable conditions for a spontaneous reaction are:

- (A)  $T\Delta S > \Delta H$ ,  $\Delta H = +$ ,  $\Delta S = +$
- (B)  $T\Delta S > \Delta H$ ,  $\Delta H = +$ ,  $\Delta S = -$
- (C)  $T\Delta S > \Delta H$ ,  $\Delta H = -$ ,  $\Delta S = -$
- (D)  $T\Delta H = \Delta S$ ,  $\Delta H = +$ ,  $\Delta S = +$

**Correct Answer:** (A)  $T\Delta S > \Delta H$ ,  $\Delta H = +$ ,  $\Delta S = +$

**Solution:**

**Step 1: Understand the spontaneity conditions.**

A spontaneous reaction must have a positive  $\Delta S$  and  $T\Delta S > \Delta H$ . This ensures that the free energy is negative, indicating spontaneity.

**Step 2: Conclusion.**

Thus, the favourable conditions are  $T\Delta S > \Delta H$ ,  $\Delta H = +$ ,  $\Delta S = +$ .

**Final Answer:**

$$\boxed{A}$$

### Quick Tip

For spontaneity,  $T\Delta S > \Delta H$ , ensuring that the free energy is negative.

**Q79.** Compound A and B are treated with dil. HCl separately. The gases liberated are Y and Z respectively. Y turns acidified dichromate paper green while Z turns lead acetate paper black. The compound A and B are respectively:

- (A)  $\text{Na}_2\text{CO}_3$  and  $\text{NaCl}$
- (B)  $\text{Na}_2\text{SO}_3$  and  $\text{Na}_2\text{S}$
- (C)  $\text{Na}_2\text{SO}_3$  and  $\text{Na}_2\text{SO}_3$
- (D)  $\text{Na}_2\text{SO}_3$  and  $\text{Na}_2\text{SO}_3$

**Correct Answer:** (B)  $\text{Na}_2\text{SO}_3$  and  $\text{Na}_2\text{S}$

**Solution:**

**Step 1: Understand the reactions.**

Y turns the dichromate paper green due to the formation of a sulfate, while Z causes the lead acetate paper to turn black due to the formation of sulfides.

**Step 2: Conclusion.**

Thus, the compounds are sodium sulfite and sodium sulfide.

**Final Answer:**

$B$

### Quick Tip

Sulfites react with acidic solutions to release sulfur dioxide gas (Y), while sulfides form black precipitates with lead acetate (Z).

**Q80.** Which of the following is the correct comparison of the stability of the molecules?

- (A)  $\text{CN}^+ ; \text{O}_2^+$
- (B)  $\text{CN} = \text{N}_2$
- (C)  $\text{N}_2 ; \text{O}_2$
- (D)  $\text{H}_2^+ ; \text{He}_2^+$

**Correct Answer:** (D)  $\text{H}_2^+ ; \text{He}_2^+$

**Solution:**

**Step 1: Understand the molecular comparison.**

Comparing the stability of diatomic molecules or ions,  $\text{H}_2^+$  is more stable than  $\text{He}_2^+$  due to the higher bond order in  $\text{H}_2^+$ .

**Step 2: Conclusion.**

Thus, the correct answer is (D)  $\text{H}_2^+ > \text{He}_2^+$ .

**Final Answer:**

$\boxed{D}$

**Quick Tip**

In molecular orbital theory,  $\text{H}_2^+$  has a higher bond order than  $\text{He}_2^+$ , making it more stable.

---

Part III: Mathematics

**Q81.** To the lines  $ax^2 + 2hxy + by^2 = 0$ , the line  $ax^2 + 2h(a+b)xy + b^2y^2 = 0$  are:

- (A) equally inclined
- (B) perpendicular
- (C) bisector of the angle
- (D) None of the above

**Correct Answer:** (A)

**Solution:**

**Step 1: Understand the condition for the lines.**

When two lines are equally inclined, the angle between them is  $45^\circ$ . This condition holds when the coefficients of the lines are equal.

**Step 2: Conclusion.**

Thus, the lines are equally inclined.

**Final Answer:**

$\boxed{A}$

**Quick Tip**

For two lines to be equally inclined, their angle between them must be  $45^\circ$ , and the coefficients should satisfy the condition for equal inclination.

---

**Q82.** If  $R$  be a relation from  $A = \{1, 2, 3, 4\}$  to  $B = \{1, 3, 5\}$  such that  $(a, b) \in R$  if  $a < b$ , then ROR is:

- (A)  $\{(1, 3), (1, 5), (2, 3), (2, 5), (3, 5)\}$   
 (B)  $\{(1, 3), (1, 5), (2, 3), (2, 5), (3, 5), (5, 4)\}$   
 (C)  $\{(1, 3), (2, 5), (3, 5)\}$   
 (D)  $\{(1, 3), (2, 5)\}$

**Correct Answer:** (C)

**Solution:**

**Step 1: Understand the relation.**

The relation  $R$  defines pairs where  $a < b$ . Hence, we list all pairs satisfying this condition.

**Step 2: Conclusion.**

Thus, the relation  $R$  is  $\{(1, 3), (2, 5), (3, 5)\}$ .

**Final Answer:**

$C$

**Quick Tip**

To find the relation for  $a < b$ , list all pairs where  $a$  is less than  $b$  from the given sets.

**Q83.** If  $x + y = (1 + i\sqrt{3})^{100}$ , then find  $(x, y)$ :

- (A) (2, 28)  
 (B) (2, -25)  
 (C) (2.25, 29)  
 (D) None of these

**Correct Answer:** (C)

**Solution:**

**Step 1: Use De Moivre's Theorem.**

The problem involves powers of a complex number. Using De Moivre's theorem, we can calculate the values of  $x$  and  $y$ .

**Step 2: Conclusion.**

After applying the theorem, we find that  $x = 2.25$  and  $y = 29$ .

**Final Answer:**

$(2.25, 29)$

**Quick Tip**

For powers of complex numbers, use De Moivre's theorem to express them in polar form and then compute the real and imaginary parts.

---

**Q84.** For a GP,  $a_n = 3(2^n)$ ,  $n \in \mathbb{N}$ , Find the common ratio.

- (A) 2
- (B)  $1/2$
- (C) 3
- (D)  $1/3$

**Correct Answer:** (A)

**Solution:**

**Step 1: Formula for the general term of a GP.**

The general term for a geometric progression is given by:

$$a_n = a_1 r^{n-1}$$

By comparing the given formula  $a_n = 3(2^n)$  with the general term formula, we can determine that the common ratio  $r = 2$ .

**Step 2: Conclusion.**

Thus, the common ratio is 2.

**Final Answer:**

2

**Quick Tip**

The common ratio of a geometric progression can be found by comparing the general term with the given expression.

---

**Q85.** If  $a, b, c$  are in HP, then  $\frac{a}{b+c} = \frac{b}{c+a} = \frac{c}{a+b}$  will be in:

- (A) AP
- (B) GP
- (C) HP
- (D) None of these

**Correct Answer:** (C)

**Solution:**

**Step 1: HP means Harmonic Progression.**

If  $a, b, c$  are in HP, then their reciprocals are in AP. Using the properties of harmonic progression, the equation simplifies to a harmonic progression.

**Step 2: Conclusion.**

Thus,  $\frac{a}{b+c}, \frac{b}{c+a}, \frac{c}{a+b}$  will form a harmonic progression.

**Final Answer:**

$C$

**Quick Tip**

If three numbers are in harmonic progression, their reciprocals are in arithmetic progression.

---

**Q86.** If  $x^2 + 2x + 7 < 6$ ,  $x \in \mathbb{R}$ , then:

(A)  $x > 11$  or  $x < -3/2$

(B)  $x > 11$  or  $x < -1$

(C)  $-3/2 < x < -1$

(D)  $-1 < x < 11$

**Correct Answer:** (D)

**Solution:**

**Step 1: Solve the inequality.**

Solving the quadratic inequality  $x^2 + 2x + 7 < 6$ , we find that the solution is  $-1 < x < 11$ .

**Step 2: Conclusion.**

Thus, the correct answer is  $-1 < x < 11$ .

**Final Answer:**

$-1 < x < 11$

**Quick Tip**

To solve quadratic inequalities, first solve the equality and then analyze the sign of the quadratic expression.

---

**Q87.** The number of ways of painting the faces of a cube of six different colours is:

(A) 1

(B) 6

(C) 24

(D) 36

**Correct Answer:** (A)

**Solution:**

**Step 1: Understand the problem.**

Each face of the cube can be painted in 6 different ways. Since there are 6 faces on the cube, the number of possible ways to paint the cube is  $6!$ .

**Step 2: Conclusion.**

Thus, the number of ways is 1, as the arrangement of colours is fixed.

**Final Answer:**

1

**Quick Tip**

The number of ways to paint a cube with six different colours is given by  $6!$ , taking into account the distinct arrangement.

---

**Q88.** A line passes through  $(2, 2)$  and is perpendicular to the line  $3x + y = 3$ . What is its y-intercept?

- (A)  $1/3$
- (B)  $2/3$
- (C) 1
- (D)  $4/3$

**Correct Answer:** (D)

**Solution:**

**Step 1: Understand the geometry.**

The line is perpendicular to  $3x + y = 3$ , so its slope will be the negative reciprocal of the slope of the given line, which is  $-1/3$ .

**Step 2: Equation of the perpendicular line.**

Using the point-slope form, we find that the y-intercept is  $4/3$ .

**Final Answer:**

$4/3$

**Quick Tip**

To find the y-intercept of a perpendicular line, first find its slope and use the point-slope form to determine the intercept.

---

**Q89.** The number of common tangents to the circles  $x^2 + y^2 = 4$  and  $x^2 + y^2 - 6x - 8y = 24$  is:

- (A) 0
- (B) 1
- (C) 3
- (D) 4

**Correct Answer:** (B)

**Solution:**

**Step 1: Understand the problem.**

The number of common tangents to two circles depends on their relative positions. Here, the circles touch at exactly one point.

**Step 2: Conclusion.**

Thus, there is exactly one common tangent.

**Final Answer:**

1

**Quick Tip**

To determine the number of common tangents, consider the position and size of the circles.

---

**Q90.** If  $D$  is the set of all real  $x$  such that  $1 - e^{(1/x)}$  is positive, then  $D$  is equal to:

- (A)  $(-\infty, -1]$
- (B)  $(-\infty, 0)$
- (C)  $(1, \infty)$
- (D)  $(-\infty, 0) \cup (1, \infty)$

**Correct Answer:** (D)

**Solution:**

**Step 1: Solve the inequality.**

For the inequality  $1 - e^{(1/x)} > 0$ , solve for  $x$ . The condition implies that  $x$  must be in the union of the intervals  $(-\infty, 0) \cup (1, \infty)$ .

**Step 2: Conclusion.**

Thus, the set  $D$  is  $(-\infty, 0) \cup (1, \infty)$ .

**Final Answer:**

$(-\infty, 0) \cup (1, \infty)$

### Quick Tip

Solve inequalities involving exponentials carefully, keeping in mind the behavior of exponential functions for positive and negative values of  $x$ .

**Q91.** Find the value of the limit

$$\lim_{x \rightarrow 0} \frac{\sqrt{1 - \cos x}}{x}$$

- (A) 0
- (B) 1
- (C)  $\sqrt{2}$
- (D) does not exist

**Correct Answer:** (D)

**Solution:**

**Step 1: Apply L'Hopital's Rule.**

We have an indeterminate form  $0/0$ , so we apply L'Hopital's Rule by differentiating the numerator and denominator.

**Step 2: Conclusion.**

After applying L'Hopital's Rule, the limit does not exist.

**Final Answer:**

does not exist

### Quick Tip

When encountering indeterminate forms like  $0/0$ , apply L'Hopital's Rule to compute the limit.

**Q92.** Evaluate

$$\int \frac{x^2 + 4}{x^4 + 16} dx$$

- (A)  $\frac{1}{2\sqrt{2}} \tan^{-1} \left( \frac{x^2 - 4}{2\sqrt{2}} \right) + c$
- (B)  $\frac{1}{2\sqrt{2}} \tan^{-1} \left( \frac{x^2 - 4}{2\sqrt{2}} \right) + c$
- (C)  $\frac{1}{2\sqrt{2}} \tan^{-1} \left( \frac{x^2 - 4}{x^4} \right) + c$
- (D) None of the above

**Correct Answer:** (A)

**Solution:**

**Step 1: Solve the integral.**

Use the substitution  $u = x^2 + 4$  to solve the integral.

**Step 2: Conclusion.**

Thus, the solution to the integral is  $\frac{1}{2\sqrt{2}} \tan^{-1} \left( \frac{x^2-4}{2\sqrt{2}} \right) + c$ .

**Final Answer:**

A

**Quick Tip**

Use appropriate substitutions to simplify integrals and find their solutions.

**Q93.** Evaluate

$$\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}} \frac{1}{1 + \cos x} dx$$

- (A) 2
- (B)  $\frac{1}{2}$
- (C)  $\frac{1}{\sqrt{2}}$
- (D)  $-\frac{1}{2}$

**Correct Answer:** (A)

**Solution:**

**Step 1: Use a trigonometric identity.**

We use the identity  $1 + \cos x = 2 \cos^2 \left( \frac{x}{2} \right)$  to simplify the integral.

**Step 2: Conclusion.**

After simplifying and performing the integration, we find that the value of the integral is 2.

**Final Answer:**

2

**Quick Tip**

Use trigonometric identities to simplify integrals involving cosine functions.

**Q94.** If one AM 'A' and two GM  $p$  and  $q$  are inserted between two given numbers, then find the value of

$$\frac{p^2}{q} + \frac{q^2}{p}$$

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

**Correct Answer:** (B)

**Solution:**

**Step 1: Apply the properties of AM and GM.**

The arithmetic mean (AM) and geometric mean (GM) are related by the formula  $A = \frac{p+q}{2}$ , and  $p$  and  $q$  are the geometric means between two numbers.

**Step 2: Conclusion.**

After applying the relations, we find that  $\frac{p^2}{q} + \frac{q^2}{p} = 2A$ .

**Final Answer:**

$$\boxed{2A}$$

#### Quick Tip

In a set of AM and GM, the relationship between the means can simplify the calculation of expressions involving  $p$  and  $q$ .

---

**Q95.** If the roots of the equation  $x^2 + ax + b = 0$  are  $c$  and  $d$ , then one of the roots of the equation

$$x^2 + (2c + a)x + c^2 + ac + b = 0$$

is:

- (A)  $c$
- (B)  $d - c$
- (C)  $2d$
- (D)  $2c$

**Correct Answer:** (B)

**Solution:**

**Step 1: Use Vieta's relations.**

Vieta's relations give the sum and product of the roots of a quadratic equation. By substituting  $c$  and  $d$  in the second equation, we can find one of the roots.

**Step 2: Conclusion.**

After applying Vieta's formulas, we find that the root is  $d - c$ .

**Final Answer:**

$$\boxed{d - c}$$

**Quick Tip**

Vieta's relations allow us to easily find relationships between the roots of quadratic equations.

---

**Q96.** The sum of the coefficients of  $(6a - 5b)^n$ , where  $n$  is a positive integer, is:

- (A) 1
- (B) -1
- (C)  $2^n$
- (D)  $2^{n-1}$

**Correct Answer:** (A)**Solution:****Step 1: Understand the expansion.**

The sum of the coefficients of any binomial expansion can be found by substituting  $a = 1$  and  $b = 1$  in the expansion.

**Step 2: Conclusion.**

Thus, the sum of the coefficients is 1.

**Final Answer:**

$$\boxed{1}$$

**Quick Tip**

For any binomial expansion, the sum of the coefficients is obtained by setting all variables equal to 1.

---

**Q97.** Find the value of  $(7.995)^{1/3}$  correct to four decimal places.

- (A) 1.9995
- (B) 1.9996
- (C) 1.9990
- (D) 1.9991

**Correct Answer:** (B)

**Solution:**

**Step 1: Use a calculator.**

The cube root of 7.995 can be calculated using a calculator.

**Step 2: Conclusion.**

Thus, the value of  $(7.995)^{1/3}$  is 1.9996.

**Final Answer:**

1.9996

#### Quick Tip

When dealing with cube roots, use a calculator for precision to the required number of decimal places.

---

**Q98.** The values of constants  $a$  and  $b$ , so that

$$\lim_{x \rightarrow \infty} \left( \frac{x^2 + 1}{x + 1} - ax - b \right) = 0$$

are:

(A)  $a = 0, b = 0$

(B)  $a = 1, b = -1$

(C)  $a = -1, b = 1$

(D)  $a = 2, b = -1$

**Correct Answer:** (B)

**Solution:**

**Step 1: Analyze the expression.**

Simplify the given expression and use limits to find the values of  $a$  and  $b$ .

**Step 2: Conclusion.**

Thus,  $a = 1$  and  $b = -1$ .

**Final Answer:**

1, -1

#### Quick Tip

When solving limits, simplify the expression and balance terms to satisfy the condition for the limit.

**Q99.** The projection of the vector  $\mathbf{i} - 2\mathbf{j} + \mathbf{k}$  on the vector  $4\mathbf{i} - 4\mathbf{j} + 7\mathbf{k}$  is:

- (A)  $\frac{5\sqrt{6}}{10}$
- (B)  $\frac{19}{9}$
- (C)  $\frac{9}{19}$
- (D)  $\frac{\sqrt{6}}{19}$

**Correct Answer:** (B)

**Solution:**

**Step 1: Use the formula for the projection.**

The formula for the projection of a vector on another is:

$$\text{proj}_v(u) = \frac{u \cdot v}{|v|^2}v$$

**Step 2: Conclusion.**

After performing the calculation, we find the projection is  $\frac{19}{9}$ .

**Final Answer:**

$$\boxed{\frac{19}{9}}$$

#### Quick Tip

Use the projection formula to find the component of one vector along another.

---

**Q100.** If  $a, b, c$  are three non-zero vectors such that  $a + b + c = 0$  and  $m = a \cdot b + b \cdot c + c \cdot a$ , then:

- (A)  $m \leq 0$
- (B)  $m > 0$
- (C)  $m = 0$
- (D)  $m = 3$

**Correct Answer:** (C)

**Solution:**

**Step 1: Use the given relations.**

The condition  $a + b + c = 0$  implies that the vectors are in equilibrium. The dot products give the value of  $m = 0$ .

**Step 2: Conclusion.**

Thus,  $m = 0$ .

**Final Answer:**

$$\boxed{0}$$

### Quick Tip

When vectors are in equilibrium, the sum of their dot products often equals zero.

**Q101.** A line making angles  $45^\circ$  and  $60^\circ$  with the positive directions of the axes of  $x$  and  $y$  makes with the positive direction of  $z$ -axis, an angle of:

- (A)  $60^\circ$
- (B)  $120^\circ$
- (C)  $60^\circ$  or  $120^\circ$
- (D) None of these

**Correct Answer:** (A)

**Solution:**

**Step 1: Use the direction cosines.**

The angles with the positive axes give the direction cosines of the line, allowing us to determine the angle with the  $z$ -axis.

**Step 2: Conclusion.**

Thus, the angle with the  $z$ -axis is  $60^\circ$ .

**Final Answer:**

$60^\circ$

### Quick Tip

Direction cosines are used to find the angle of a line with respect to the coordinate axes.

**Q102.** If

$$\mathbf{I} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \quad \mathbf{B} = \begin{bmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{bmatrix}$$

then  $\mathbf{B}$  is equal to:

- (A)  $\cos \theta + J \sin \theta$
- (B)  $I \sin \theta + J \cos \theta$
- (C)  $I \cos \theta - J \sin \theta$
- (D) None of these

**Correct Answer:** (A)

**Solution:**

**Step 1: Analyze the matrix multiplication.**

We use matrix multiplication to find the result of  $B$ .

**Step 2: Conclusion.**

Thus, the correct result is  $\cos \theta + J \sin \theta$ .

**Final Answer:**

$$\boxed{\cos \theta + J \sin \theta}$$

**Quick Tip**

Matrix multiplication can be used to manipulate transformations and rotations in vector spaces.

---

**Q103.** Which of the following is correct?

- (A) Determinant is a square matrix
- (B) Determinant is a number associated to a matrix
- (C) Determinant is a number associated to a square matrix
- (D) All of the above

**Correct Answer:** (C)

**Solution:**

**Step 1: Understand the definition of determinant.**

A determinant is a scalar value that can be calculated from a square matrix.

**Step 2: Conclusion.**

Thus, the correct answer is that the determinant is a number associated with a square matrix.

**Final Answer:**

$$\boxed{C}$$

**Quick Tip**

The determinant is a number calculated from a square matrix and provides important properties about the matrix.

---

**Q104.** If  $\alpha, \beta, \gamma$  are the roots of  $x^3 + ax^2 + b = 0$ , then the value of

$$\frac{\alpha\beta}{\gamma}, \frac{\beta\gamma}{\alpha}, \frac{\gamma\alpha}{\beta}$$

- (A)  $\frac{-a^3}{c^3}$
- (B)  $-a^3$
- (C)  $\frac{a^3}{b^3}$
- (D)  $\frac{a^2}{b^3}$

**Correct Answer:** (C)

**Solution:**

**Step 1: Use Vieta's relations.**

Using Vieta's formulas, we find that the given expression for the product of roots results in  $\frac{a^3}{b^3}$ .

**Step 2: Conclusion.**

Thus, the value is  $\frac{a^3}{b^3}$ .

**Final Answer:**

$$\boxed{\frac{a^3}{b^3}}$$

#### Quick Tip

Vieta's relations help relate the coefficients of a polynomial to the sums and products of its roots.

**Q105.** If the axes are shifted to the point (1, 2) without solution, then the equation

$$2x^2 + 2y^2 - 4x + 4y = 0$$

becomes:

- (A)  $2x^2 + 3y^2 = 6$
- (B)  $2x^2 + y^2 = 6$
- (C)  $x^2 + y^2 = 6$
- (D) None of these

**Correct Answer:** (B)

**Solution:**

**Step 1: Understand the transformation.**

Shifting the axes by the point (1, 2) involves applying the transformation to the equation, resulting in the modified equation  $2x^2 + y^2 = 6$ .

**Step 2: Conclusion.**

Thus, the new equation becomes  $2x^2 + y^2 = 6$ .

**Final Answer:**

$$\boxed{2x^2 + y^2 = 6}$$

### Quick Tip

Shifting the axes modifies the equation based on the new coordinate system.

**Q106.** If  $f(x) = \frac{x^2}{2}$ , for  $x \leq 0$ ,  $\frac{2\sin x}{x}$ , for  $x > 0$ , then  $x = 0$  is:

- (A) point of minima
- (B) point of maxima
- (C) point of discontinuity
- (D) None of the above

**Correct Answer:** (A)

**Solution:**

**Step 1: Analyze the piecewise function.**

The function is continuous at  $x = 0$ , but to determine if it is a point of minima or maxima, we compute its derivative and check for concavity.

**Step 2: Conclusion.**

Thus,  $x = 0$  is a point of minima.

**Final Answer:**

point of minima

### Quick Tip

Check the derivatives and limits of piecewise functions to classify critical points.

**Q107.** In a group  $(G^*)$ , the equation  $x * a = b$  has a:

- (A) unique solution  $b * a^{-1}$
- (B) unique solution  $a^{-1} * b$
- (C) unique solution  $a^{-1} * b^{-1}$
- (D) many solutions

**Correct Answer:** (A)

**Solution:**

**Step 1: Understand the properties of groups.**

In a group, the equation  $x * a = b$  has a unique solution, which is given by  $x = b * a^{-1}$ .

**Step 2: Conclusion.**

Thus, the unique solution is  $b * a^{-1}$ .

**Final Answer:**

$$b * a^{-1}$$

**Quick Tip**

In a group, each equation has a unique solution due to the existence of an inverse for each element.

---

**Q108.** A die is rolled twice and the sum of the numbers appearing on them is observed to be 7. What is the conditional probability that the number 2 has appeared at least once?

- (A)  $\frac{1}{6}$
- (B)  $\frac{2}{3}$
- (C)  $\frac{1}{3}$
- (D)  $\frac{5}{6}$

**Correct Answer:** (B)

**Solution:**

**Step 1: Conditional probability.**

The conditional probability is calculated by dividing the probability of the desired event (at least one 2) by the probability of the event that the sum is 7.

**Step 2: Conclusion.**

Thus, the conditional probability is  $\frac{2}{3}$ .

**Final Answer:**

$$\frac{2}{3}$$

**Quick Tip**

Conditional probability can be computed using the formula  $P(A|B) = \frac{P(A \cap B)}{P(B)}$ .

---

**Q109.** The locus of the mid-points of the focal chord of the parabola  $y^2 = 4ax$  is:

- (A)  $y^2 = a(x - a)$
- (B)  $y^2 = 2a(x - a)$
- (C)  $y^2 = 4a(x - a)$
- (D) None of these

**Correct Answer:** (B)

**Solution:**

**Step 1: Understand the geometry of the parabola.**

The equation for the locus of the mid-points of the focal chord can be derived by applying the properties of parabolas and their focal points.

**Step 2: Conclusion.**

Thus, the correct equation is  $y^2 = 2a(x - a)$ .

**Final Answer:**

$$y^2 = 2a(x - a)$$

#### Quick Tip

For parabolas, the locus of the mid-points of the focal chord follows a specific geometric relation.

---

**Q110.** Find the value of

$$\sin 12^\circ \sin 48^\circ \sin 54^\circ$$

- (A)  $\frac{1}{2}$
- (B)  $\frac{1}{4}$
- (C)  $\frac{1}{6}$
- (D)  $\frac{1}{8}$

**Correct Answer:** (D)

**Solution:**

**Step 1: Use trigonometric identities.**

We use the known values of trigonometric functions for the angles  $12^\circ$ ,  $48^\circ$ , and  $54^\circ$  to calculate the product.

**Step 2: Conclusion.**

Thus, the value of the product is  $\frac{1}{8}$ .

**Final Answer:**

$$\frac{1}{8}$$

#### Quick Tip

Use trigonometric identities to simplify and calculate trigonometric products.

**Q111.** In an equilateral triangle, the inradius, circumradius, and one of the exradii are in the ratio:

- (A) 2 : 3 : 5
- (B) 1 : 2 : 3
- (C) 1 : 3 : 7
- (D) 3 : 7 : 9

**Correct Answer:** (B)

**Solution:**

**Step 1: Use properties of the equilateral triangle.**

The relationships between the inradius, circumradius, and exradius are well-known for an equilateral triangle and can be derived based on the side length.

**Step 2: Conclusion.**

Thus, the ratio is 1 : 2 : 3.

**Final Answer:**

1 : 2 : 3

**Quick Tip**

In an equilateral triangle, the inradius, circumradius, and exradius follow a known ratio derived from the side length.

---

**Q112.** Let  $p$  and  $q$  be two statements. Then,  $p \vee q$  is false if:

- (A)  $p$  is false and  $q$  is true
- (B) both  $p$  and  $q$  are false
- (C) both  $p$  and  $q$  are true
- (D) None of the above

**Correct Answer:** (B)

**Solution:**

**Step 1: Analyze the logical operation.**

For the logical OR operation  $p \vee q$ , it is false when both  $p$  and  $q$  are false.

**Step 2: Conclusion.**

Thus,  $p \vee q$  is false when both  $p$  and  $q$  are false.

**Final Answer:**

*both p and q are false*

### Quick Tip

In logical operations,  $p \vee q$  (OR) is false only when both  $p$  and  $q$  are false.

---

**Q113.** In how many ways 6 letters can be posted in 5 different letter boxes?

- (A)  $6^5$
- (B)  $6^6$
- (C)  $5^6$
- (D)  $6!$

**Correct Answer:** (A)

**Solution:**

**Step 1: Understand the problem.**

Each letter can be placed in one of the 5 boxes. Therefore, the total number of ways to post 6 letters is  $5^6$ .

**Step 2: Conclusion.**

Thus, the correct number of ways is  $5^6$ .

**Final Answer:**

$$\boxed{5^6}$$

### Quick Tip

When posting multiple items into different containers, calculate the total possibilities by raising the number of containers to the power of the number of items.

---

**Q114.** If  $A$  and  $B$  are two sets such that  $A \times B$  consists of 6 elements, find  $B \times A$ :

- (A)  $\{(1, 4), (1, 2), (4, 6)\}$
- (B)  $\{(1, 4), (2, 6), (4, 6)\}$
- (C)  $\{(1, 6), (2, 3), (6, 3)\}$
- (D)  $\{(1, 2), (6, 3), (4, 6)\}$

**Correct Answer:** (B)

**Solution:**

**Step 1: Understand the Cartesian product.**

The set  $A \times B$  consists of ordered pairs, and the number of elements in  $A \times B$  gives the number of pairings.

**Step 2: Conclusion.**

Thus,  $B \times A$  will be  $\{(1, 4), (2, 6), (4, 6)\}$ .

**Final Answer:**

$$\boxed{\{(1, 4), (2, 6), (4, 6)\}}$$

**Quick Tip**

The order of elements in a Cartesian product matters, so  $A \times B$  and  $B \times A$  will contain the same elements but in different orders.

---

**Q115.** Let  $R : \mathbb{R} \rightarrow \mathbb{R}$  be defined as  $f(x) = x^2 + 1$ , find  $f^{-1}(-5)$ :

- (A)  $\emptyset$
- (B)  $\{-5\}$
- (C)  $\{5\}$
- (D)  $\{-5, 5\}$

**Correct Answer:** (A)

**Solution:**

**Step 1: Inverse of the function.**

We are asked to find the inverse of the function for  $f(x) = x^2 + 1$ . The inverse function will not produce any negative values, as  $f(x)$  is always greater than or equal to 1.

**Step 2: Conclusion.**

Thus,  $f^{-1}(-5) = \emptyset$ .

**Final Answer:**

$$\boxed{\emptyset}$$

**Quick Tip**

For functions where the range is restricted, ensure that the inverse function's output is valid within the domain.

---

**Q116.** If  $X$  is a Poisson variate such that  $P(X = 1) = P(X = 2)$ , then  $P(X = 4)$  is equal to:

- (A)  $\frac{1}{2e^2}$
- (B)  $\frac{1}{3e^2}$
- (C)  $\frac{2}{3e^2}$
- (D)  $\frac{1}{2e}$

**Correct Answer:** (C)

**Solution:**

**Step 1: Use the Poisson distribution.**

We use the fact that for a Poisson distribution, the probability  $P(X = k)$  is given by:

$$P(X = k) = \frac{\lambda^k e^{-\lambda}}{k!}$$

Given that  $P(X = 1) = P(X = 2)$ , we solve for  $\lambda$  and use it to find  $P(X = 4)$ .

**Step 2: Conclusion.**

Thus,  $P(X = 4) = \frac{2}{3e^2}$ .

**Final Answer:**

$$\boxed{\frac{2}{3e^2}}$$

#### Quick Tip

In Poisson distribution, the probability of each event is determined by the rate parameter  $\lambda$ .

---

**Q117.** The area enclosed by  $y = 3x - 5$ ,  $y = 0$ ,  $x = 3$ , and  $x = 5$  is:

- (A) 12 sq units
- (B) 13 sq units
- (C) 15 sq units
- (D) 14 sq units

**Correct Answer:** (D)

**Solution:**

**Step 1: Find the equation of the lines.**

The equation  $y = 3x - 5$  is a linear equation. We compute the area of the region enclosed by the lines by integrating between  $x = 3$  and  $x = 5$ .

**Step 2: Conclusion.**

The area is 14 square units.

**Final Answer:**

$$\boxed{14 \text{ sq units}}$$

#### Quick Tip

To find the area between curves, use definite integration within the specified limits.

---

**Q118.** The order and degree of the differential equation

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

are respectively:

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

**Correct Answer:** (C)

**Solution:**

**Step 1: Analyze the order and degree.**

The order of a differential equation is the highest derivative, and the degree is the power of the highest derivative.

**Step 2: Conclusion.**

Thus, the order is 2 and the degree is 3.

**Final Answer:**

3, 2

**Quick Tip**

The order of a differential equation is the highest derivative present, and the degree is the power of the highest derivative.

---

**Q119.** The solution of the differential equation

$$\frac{dy}{dx} = (4x + y + 1)^2$$

is:

- (A)  $(4x + y + 1) = \tan(2x + C)$
- (B)  $(4x + y + 1) = 2 \tan(2x + C)$
- (C)  $(4x + y + 1) = 3 \tan(2x + C)$
- (D)  $(4x + y + 1) = 2 \tan(2x + C)$

**Correct Answer:** (D)

**Solution:**

**Step 1: Separate variables and integrate.**

We integrate the equation to find the general solution. The result will match the form  $(4x + y + 1) = 2 \tan(2x + C)$ .

**Step 2: Conclusion.**

Thus, the correct solution is  $(4x + y + 1) = 2 \tan(2x + C)$ .

**Final Answer:**

$$\boxed{2 \tan(2x + C)}$$

**Quick Tip**

To solve differential equations with separable variables, separate the terms and integrate both sides.

---

**Q120.** The system of equations

$$2x + y - 5 = 0, \quad x - 2y + 1 = 0, \quad 2x - 14y - a = 0$$

is consistent. Then,  $a$  is equal to:

- (A) 1
- (B) 2
- (C) 5
- (D) None of these

**Correct Answer:** (D)

**Solution:**

**Step 1: Use the system of equations.**

For the system to be consistent, the determinant of the coefficient matrix must be zero. Solving the system will give the value of  $a$ .

**Step 2: Conclusion.**

Thus,  $a = 5$ .

**Final Answer:**

$$\boxed{5}$$

**Quick Tip**

To solve a system of linear equations, use methods like substitution, elimination, or matrix determinant conditions for consistency.