

SRMJEEE UG - Model Paper

Question Paper with Solutions



General Instructions

- (i) **Duration:** The total duration of the examination is 2 hours 30 minutes (150 minutes).
- (ii) **Total Marks:** The complete paper carries a maximum of 130 marks.
- (iii) **Structure:** The paper has 4 Sections:
 - **Section A:** 35 Multiple Choice Questions (Physics)
 - **Section B:** 35 Multiple Choice Questions (Chemistry)
 - **Section C:** 40 Multiple Choice Questions (Mathematics)
 - **Section D:** 20 Multiple Choice Questions (English)
- (iv) **Compulsory Questions:** All 130 questions are compulsory.
- (v) Each question has four options. Only **one** option is correct.
- (vi) **Right Answer:** +1 marks correct answer.
- (vii) **Incorrect Answer:** (No Negative marking).
- (viii) **Unanswered/Marked for Review:** 0 marks.

1. The density of a metal is calculated as follows. The weight of 57.4 grams is divided by the volume 6.2 cm^3 . Using the approximate rule for significant figures in this calculation, the value of the density, in g/cm^3 , should be reported as:

- (A) 9
- (B) 9.3
- (C) 9.26
- (D) 9.258

Correct Answer: (B) 9.3

Solution:

Concept:

Density is defined as mass per unit volume. It tells us how much mass is present in a given volume of a substance.

The formula is:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

In this question, we also need to apply the rule of significant figures.

For multiplication and division:

Final answer should have the same number of significant figures as the least precise given value.

Step 1: Write the given values.

Mass of the metal is:

$$57.4 \text{ g}$$

Volume of the metal is:

$$6.2 \text{ cm}^3$$

So,

$$\text{Density} = \frac{57.4}{6.2}$$

Step 2: Calculate the density before rounding.

$$\text{Density} = 9.258064 \dots \text{ g/cm}^3$$

So the exact calculator value is approximately:

$$9.258$$

Step 3: Count the significant figures in the given data.

The value 57.4 has three significant figures:

5, 7, 4

The value 6.2 has two significant figures:

6, 2

The least number of significant figures is:

2

So the final answer must be reported up to **2 significant figures**.

Step 4: Round the calculated value.

The calculated value is:

9.258

Rounded to 2 significant figures:

$9.258 \approx 9.3$

Step 5: Check the options.

Option (A) 9 has only 1 significant figure, so it is too rounded.

Option (B) 9.3 has 2 significant figures, so it is correct.

Option (C) 9.26 has 3 significant figures, so it is not correct according to the rule.

Option (D) 9.258 has 4 significant figures, so it is also not correct.

Hence, the correct answer is:

(B) 9.3

Quick Tip: In multiplication or division, the final answer should have the same number of significant figures as the value with the least number of significant figures.

2. If the Reynolds number is less than 2000, the flow in a pipe is

- (A) Turbulent
- (B) Laminar
- (C) Transition
- (D) None of the above

Correct Answer: (B) Laminar

Solution:

Concept:

Reynolds number is a dimensionless quantity used in fluid mechanics to determine the nature of flow of a fluid.

It is given by:

$$Re = \frac{\rho v D}{\mu}$$

where,

ρ = density of fluid

v = velocity of fluid

D = diameter of pipe

μ = coefficient of viscosity

The value of Reynolds number tells us whether flow is smooth or irregular.

Step 1: Understand the meaning of laminar flow.

Laminar flow means the fluid particles move in smooth parallel layers.

There is no random mixing of fluid layers.

This type of flow occurs when viscous forces are dominant.

Step 2: Recall the Reynolds number ranges.

For flow through a pipe:

$$Re < 2000 \Rightarrow \text{Laminar flow}$$

$$2000 < Re < 4000 \Rightarrow \text{Transition flow}$$

$$Re > 4000 \Rightarrow \text{Turbulent flow}$$

Step 3: Apply the given condition.

The question says:

$$Re < 2000$$

From the standard classification:

$$Re < 2000 \Rightarrow \text{Laminar flow}$$

Step 4: Check the options.

Option (A) Turbulent is incorrect because turbulent flow occurs at high Reynolds number.

Option (B) Laminar is correct because $Re < 2000$.

Option (C) Transition is incorrect because transition flow occurs approximately between 2000 and 4000.

Option (D) None of the above is incorrect because option (B) is correct.

Hence, the correct answer is:

(B) Laminar

Quick Tip: For pipe flow:

$$Re < 2000 \Rightarrow \text{Laminar}$$

$$2000 < Re < 4000 \Rightarrow \text{Transition}$$

$$Re > 4000 \Rightarrow \text{Turbulent}$$

3. Maximum load a structure can bear before its failure is called

- (A) Normal Load
- (B) Shear load
- (C) Ultimate load
- (D) Safety load

Correct Answer: (C) Ultimate load

Solution:

Concept:

In strength of materials, different terms are used to describe the load-carrying capacity of a structure.

The load at which a structure finally fails is called the ultimate load.

It represents the maximum load-carrying capacity of the structure before collapse or fracture.

Step 1: Understand the meaning of load.

A structure may be subjected to different types of loads such as tensile load, compressive load, shear load, or bending load.

As the load increases, stress inside the material also increases.

Step 2: Understand failure point.

Every material or structure has a maximum limit.

If the applied load exceeds this limit, the structure fails.

This maximum load before failure is called:

Ultimate load

Step 3: Differentiate ultimate load and safe load.

Safe load is the load that a structure can safely carry during normal use.

Ultimate load is higher than safe load.

Usually:

$$\text{Safe load} = \frac{\text{Ultimate load}}{\text{Factor of safety}}$$

So safe load is always less than ultimate load.

Step 4: Check the options.

Option (A) Normal load is not the failure load.

Option (B) Shear load is a type of load, not the maximum load before failure.

Option (C) Ultimate load is correct.

Option (D) Safety load is the permissible safe load, not the failure load.

Hence, the correct answer is:

(C) Ultimate load

Quick Tip: Ultimate load is the maximum load before failure. Safe load is always less than ultimate load.

4. Three point charges $q + Q$, q , $q - Q$ are enclosed by the surface S . What net flux crosses S ?

(A) $3q$

(B) $2q$

(C) $3q - Q$

(D) cannot be determine based on the data given in question

Correct Answer: (A) $3q$

Solution:

Concept:

This question is based on Gauss's law.

According to Gauss's law:

$$\Phi = \frac{q_{\text{enclosed}}}{\epsilon_0}$$

where,

$$\Phi = \text{net electric flux}$$

$$q_{\text{enclosed}} = \text{total charge enclosed by the closed surface}$$

The important point is that the net flux depends only on the total charge enclosed inside the surface.

Step 1: List all charges inside the surface.

The charges enclosed by the surface are:

$$q + Q, \quad q, \quad q - Q$$

Step 2: Add all enclosed charges.

$$q_{\text{total}} = (q + Q) + q + (q - Q)$$

Now simplify:

$$q_{\text{total}} = q + Q + q + q - Q$$

Here $+Q$ and $-Q$ cancel:

$$Q - Q = 0$$

So:

$$q_{\text{total}} = 3q$$

Step 3: Apply Gauss's law.

The net flux is:

$$\Phi = \frac{3q}{\epsilon_0}$$

Since the options are written in terms of enclosed charge, the answer is proportional to:

$$3q$$

Step 4: Check the options.

Option (A) $3q$ is correct.

Option (B) $2q$ is incorrect because all three q -terms are present.

Option (C) $3q - Q$ is incorrect because $+Q$ and $-Q$ cancel.

Option (D) is incorrect because Gauss's law gives a definite answer.

Hence, the correct answer is:

(A) $3q$

Quick Tip: In Gauss's law, net flux depends only on total enclosed charge. Opposite charges $+Q$ and $-Q$ cancel if both are enclosed.

5. Number of electrons in one coulomb of charge will be

(A) 5.46×10^{23}

(B) 5.25×10^{18}

(C) 1.6×10^{-19}

(D) 9×10^{11}

Correct Answer: (B) 5.25×10^{18}

Solution:

Concept:

Charge is quantized. This means charge exists in integral multiples of the charge of one electron.

Charge of one electron is:

$$e = 1.6 \times 10^{-19} \text{ C}$$

If total charge is Q , then number of electrons is:

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

Step 1: Write the given charge.

The total charge is:

$$Q = 1 \text{ C}$$

Charge of one electron is:

$$e = 1.6 \times 10^{-19} \text{ C}$$

Step 2: Use the formula for number of electrons.

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

Substitute the values:

$$n = \frac{1}{1.6 \times 10^{-19}}$$

Step 3: Calculate the value.

$$n = \frac{1}{1.6} \times 10^{19}$$

$$n = 0.625 \times 10^{19}$$

$$n = 6.25 \times 10^{18}$$

So, the correct physical value is:

$$6.25 \times 10^{18}$$

Step 4: Compare with the given options.

The calculated value is:

$$6.25 \times 10^{18}$$

But the option list contains:

$$5.25 \times 10^{18}$$

This appears to be a printing or option error. Among the given options, option (B) is the nearest

intended option.

Hence, according to the given answer key, the answer is:

$$(B) 5.25 \times 10^{18}$$

Quick Tip: Number of electrons corresponding to charge Q is:

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

For 1 C, the standard value is approximately:

$$6.25 \times 10^{18}$$

6. Choose the vector physical quantity

- (A) Electric flux
- (B) Electric potential
- (C) Electric potential energy
- (D) Electric intensity

Correct Answer: (D) Electric intensity

Solution:

Concept:

Physical quantities are mainly of two types:

Scalar quantities

and

Vector quantities

A scalar quantity has only magnitude.

A vector quantity has both magnitude and direction.

Step 1: Understand electric intensity.

Electric intensity is another name for electric field.

Electric field at a point is defined as force per unit positive charge:

$$E = \frac{F}{q}$$

Force is a vector quantity. Since charge is scalar, electric field also has direction.

Therefore:

Electric intensity is a vector quantity

Step 2: Check other options.

Electric flux is a scalar quantity because it is the dot product of electric field and area vector:

$$\Phi = \vec{E} \cdot \vec{A}$$

Electric potential is scalar:

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

Electric potential energy is also scalar.

Step 3: Choose the vector quantity.

Among the given options, only electric intensity has both magnitude and direction.

Hence, the correct answer is:

(D) Electric intensity

Quick Tip: Electric field or electric intensity is a vector quantity. Electric potential, potential energy, and electric flux are scalar quantities.

7. The voltage is a form of

- (A) Kinetic energy
- (B) Potential energy
- (C) Mechanical energy
- (D) Both kinetic and potential energy

Correct Answer: (B) Potential energy

Solution:

Concept:

Voltage is also called electric potential difference.

It represents the work done per unit charge in moving a charge between two points.

The formula is:

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

where,

V = potential difference

W = work done

q = charge

Step 1: Understand electric potential.

Electric potential at a point means the electric potential energy per unit charge at that point.

So voltage is directly related to potential energy.

$$\text{Potential} = \frac{\text{Potential energy}}{\text{Charge}}$$

Step 2: Relate voltage with energy.

When a charge moves between two points having potential difference, electrical work is done.

This work is due to difference in electric potential energy.

So voltage is not kinetic energy. It is associated with potential energy.

Step 3: Check the options.

Option (A) Kinetic energy is incorrect because voltage does not represent motion energy.

Option (B) Potential energy is correct.

Option (C) Mechanical energy is not the correct specific form.

Option (D) Both kinetic and potential energy is incorrect.

Hence, the correct answer is:

(B) Potential energy

Quick Tip: Voltage is electric potential difference:

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

It is related to electric potential energy per unit charge.

8. A charge of 60 C passes through an electric lamp in 2 minutes. Then the current in the lamp is

(A) 30 A

(B) 1 A

(C) 0.5 A

(D) 5 A

Correct Answer: (C) 0.5 A

Solution:

Concept:

Electric current is defined as the rate of flow of electric charge.

The formula is:

$$I = \frac{Q}{t}$$

where,

I = current

Q = charge

t = time

Step 1: Write the given values.

Charge passing through the lamp is:

$$Q = 60 \text{ C}$$

Time is:

$$t = 2 \text{ minutes}$$

Since current is measured in ampere, time must be in seconds.

$$2 \text{ minutes} = 2 \times 60 = 120 \text{ s}$$

Step 2: Apply the formula.

$$I = \frac{Q}{t}$$

$$I = \frac{60}{120}$$

$$I = 0.5 \text{ A}$$

Step 3: Check the options.

Option (A) 30 A is incorrect because time was not properly considered.

Option (B) 1 A is incorrect.

Option (C) 0.5 A is correct.

Option (D) 5 A is incorrect.

Hence, the correct answer is:

(C) 0.5 A

Quick Tip: Always convert minutes into seconds before using:

$$I = \frac{Q}{t}$$

9. Four wires of equal length and of resistance $3\ \Omega$ each are connected in the form of a square. The equivalent resistance between the diagonally opposite corners of the square is

- (A) $12\ \Omega$
- (B) $3/4\ \Omega$
- (C) $6\ \Omega$
- (D) $3\ \Omega$

Correct Answer: (D) $3\ \Omega$

Solution:

Concept:

When resistors are connected in the form of a square, equivalent resistance depends on the two points between which resistance is measured.

Here, resistance is asked between diagonally opposite corners.

Each side of the square has resistance:

$$3\ \Omega$$

Step 1: Visualize the square.

Let the four corners of the square be A, B, C, D .

Resistance between each adjacent pair is:

$$3\ \Omega$$

We need equivalent resistance between diagonally opposite corners, say A and C.

Step 2: Identify the two paths between diagonal corners.

From A to C, current can go through two paths:

First path:

$$A \rightarrow B \rightarrow C$$

Second path:

$$A \rightarrow D \rightarrow C$$

Each path contains two resistors in series.

Step 3: Find resistance of each path.

Resistance of first path:

$$3 + 3 = 6 \, \Omega$$

Resistance of second path:

$$3 + 3 = 6 \, \Omega$$

So the circuit becomes two $6 \, \Omega$ resistances in parallel.

Step 4: Find equivalent resistance.

For two resistances in parallel:

$$R_{\text{eq}} = \frac{R_1 R_2}{R_1 + R_2}$$

Here:

$$R_1 = 6 \, \Omega, \quad R_2 = 6 \, \Omega$$

$$R_{\text{eq}} = \frac{6 \times 6}{6 + 6}$$

$$R_{\text{eq}} = \frac{36}{12} = 3 \, \Omega$$

Step 5: Check the options.

The equivalent resistance is:

$$3 \Omega$$

So option (D) is correct.

Hence, the correct answer is:

$$(D) 3 \Omega$$

Quick Tip: For a square of equal resistors, between opposite corners there are two equal series paths in parallel.

10. The number of free electrons per cm of copper wire is 2×10^{21} . The average drift speed of the electrons is 0.25 mm/s. The current flowing is

- (A) 0.8 A
- (B) 8 A
- (C) 80 A
- (D) 800 A

Correct Answer: (B) 8 A

Solution:

Concept:

Electric current is the amount of charge flowing through a cross-section of a conductor per unit time.

$$I = \frac{Q}{t}$$

If N electrons cross a section per second, then current is:

$$I = Ne$$

where:

$$e = 1.6 \times 10^{-19} \text{ C}$$

Step 1: Write the given data.

Number of free electrons per cm length of wire is:

$$2 \times 10^{21}$$

Average drift speed of electrons is:

$$0.25 \text{ mm/s}$$

Convert drift speed into cm/s:

$$1 \text{ mm} = 0.1 \text{ cm}$$

So:

$$0.25 \text{ mm/s} = 0.25 \times 0.1 \text{ cm/s}$$

$$0.25 \text{ mm/s} = 0.025 \text{ cm/s}$$

Step 2: Find the number of electrons crossing per second.

Since there are:

$$2 \times 10^{21}$$

electrons in 1 cm length of wire.

In 1 second, electrons drift through:

$$0.025 \text{ cm}$$

Therefore, number of electrons crossing any section per second is:

$$N = 2 \times 10^{21} \times 0.025$$

$$N = 2 \times 10^{21} \times \frac{25}{1000}$$

$$N = 2 \times 10^{21} \times \frac{1}{40}$$

$$N = 5 \times 10^{19}$$

Step 3: Find the current.

Current is:

$$I = Ne$$

Substitute:

$$N = 5 \times 10^{19}$$

and:

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$I = (5 \times 10^{19})(1.6 \times 10^{-19})$$

$$I = 5 \times 1.6$$

$$I = 8 \text{ A}$$

Hence, the correct answer is:

$(B) \text{ 8 A}$

Quick Tip: If electrons per unit length and drift speed are given, first find electrons crossing per second:

$$N = (\text{electrons per cm}) \times (\text{drift speed in cm/s})$$

Then use $I = Ne$.

11. The sensitivity of a potentiometer can be increased by

- (A) Increasing the emf of the cell
- (B) Decreasing the emf of the cell
- (C) Increasing the length of the potentiometer wire
- (D) Decreasing the length of the potentiometer wire

Correct Answer: (C) Increasing the length of the potentiometer wire

Solution:

Concept:

A potentiometer is an instrument used to measure potential difference accurately. Its working is based on the principle that potential difference across a wire is directly proportional to the length of the wire, provided current remains constant.

The potential gradient of a potentiometer is given by:

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

where,

k = potential gradient

V = potential difference across the potentiometer wire

L = length of potentiometer wire

The sensitivity of a potentiometer increases when the potential gradient decreases.

Step 1: Understand what sensitivity means.

Sensitivity means how accurately a potentiometer can detect a small potential difference.

If the potential gradient is small, then a small change in voltage will correspond to a larger change in length.

This makes the measurement more accurate.

So:

$$\text{Sensitivity} \propto \frac{1}{\text{Potential gradient}}$$

Step 2: Relate potential gradient with length.

Potential gradient is:

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

If the length L of the potentiometer wire is increased while the applied voltage remains the same, then:

$$k \downarrow$$

That means the potential drop per unit length decreases.

Step 3: Understand why increasing length helps.

If potential gradient is smaller, then the balancing length for the same unknown voltage becomes larger.

A larger balancing length reduces percentage error in measurement.

Therefore, increasing the length of the potentiometer wire increases sensitivity.

Step 4: Check the options.

Option (A) Increasing the emf of the cell increases potential gradient, so sensitivity decreases.

Option (B) Decreasing the emf can increase sensitivity, but the best and standard method among the options is increasing the wire length.

Option (C) Increasing the length of the potentiometer wire decreases potential gradient and increases sensitivity.

Option (D) Decreasing the length increases potential gradient and decreases sensitivity.

Hence, the correct answer is:

(C) Increasing the length of the potentiometer wire

Quick Tip: Potentiometer sensitivity increases when potential gradient decreases. Increasing the length of the potentiometer wire decreases potential gradient.

12. _____ is the rule used to know the direction of the induced current in the circuit.

(A) Fleming's left hand rule

- (B) Fleming's right hand rule
- (C) Right hand thumb rule
- (D) Ampere's rule

Correct Answer: (B) Fleming's right hand rule

Solution:

Concept:

When a conductor moves in a magnetic field, an induced current is produced in the conductor. The direction of this induced current is found by Fleming's right hand rule. Fleming's right hand rule is mainly used in the case of generators, where mechanical energy is converted into electrical energy.

Step 1: Understand what is asked.

The question asks for the rule used to find the direction of induced current. Induced current is produced due to electromagnetic induction. So we need the rule related to electromagnetic induction.

Step 2: Recall Fleming's right hand rule.

According to Fleming's right hand rule, stretch the thumb, forefinger and middle finger of the right hand mutually perpendicular to each other.

Then:

Thumb → direction of motion of conductor

Forefinger → direction of magnetic field

Middle finger → direction of induced current

Step 3: Differentiate from Fleming's left hand rule.

Fleming's left hand rule is used for motors.

It gives the direction of force or motion when current flows through a conductor placed in a magnetic field.

But this question asks about induced current, so Fleming's right hand rule is used.

Step 4: Check the options.

Option (A) Fleming's left hand rule is used for motor effect, not induced current.

Option (B) Fleming's right hand rule is used to find direction of induced current.

Option (C) Right hand thumb rule is used to find direction of magnetic field around a current-carrying conductor.

Option (D) Ampere's rule is related to magnetic field and current, not directly for induced current direction in this case.

Hence, the correct answer is:

(B) Fleming's right hand rule

Quick Tip: Fleming's left hand rule is for motors. Fleming's right hand rule is for generators and induced current.

14. As the earth rotates, the magnetic poles:

- (A) stay the same
- (B) change a little
- (C) switch completely
- (D) disappear

Correct Answer: (B) change a little

Solution:

Concept:

The Earth behaves like a giant magnet. It has a magnetic north pole and a magnetic south pole. However, Earth's magnetic poles are not exactly fixed at one position. They slowly shift with time due to changes in the Earth's outer core.

Step 1: Understand Earth's magnetic field.

Earth's magnetic field is produced mainly by the movement of molten iron and nickel in the outer core.

This movement is not perfectly constant.

Therefore, Earth's magnetic field also changes slowly with time.

Step 2: Understand magnetic pole movement.

The geographic poles are related to the Earth's rotation axis.

But magnetic poles are related to the Earth's magnetic field.

The magnetic poles slowly wander or change their position slightly over time.

Step 3: Check the options.

Option (A) stay the same is incorrect because magnetic poles are not perfectly fixed.

Option (B) change a little is correct because magnetic poles slowly shift.

Option (C) switch completely is not correct for normal daily rotation. Complete reversal happens over geological time scales, not simply due to Earth rotating.

Option (D) disappear is incorrect because magnetic poles do not disappear during normal rotation.

Hence, the correct answer is:

(B) change a little

Quick Tip: Earth's magnetic poles slowly drift with time. They do not remain exactly fixed like geographical poles.

15. Induced EMF's are always in such a direction as to _____ the change that generated them

- (A) oppose
- (B) against
- (C) favor
- (D) unfavour

Correct Answer: (A) oppose

Solution:

Concept:

This question is based on Lenz's law.

Lenz's law states that the direction of induced emf or induced current is such that it opposes the change in magnetic flux that produced it.

This law follows the principle of conservation of energy.

Step 1: Understand induced emf.

Induced emf is produced when there is a change in magnetic flux linked with a circuit.

Magnetic flux can change due to:

change in magnetic field

change in area

change in orientation

relative motion between magnet and coil

Step 2: Apply Lenz's law.

According to Lenz's law, the induced emf never supports the change that produces it.

Instead, it acts in a direction that opposes the cause of induction.

So:

Induced emf opposes the change producing it

Step 3: Understand why it opposes.

If induced current favored the change, energy would be created continuously without external work.

That would violate conservation of energy.

So opposition is necessary.

Step 4: Check the options.

Option (A) oppose is correct.

Option (B) against is grammatically similar but the standard word used in Lenz's law is oppose.

Option (C) favor is incorrect because induced emf does not support the change.

Option (D) unfavour is not the standard scientific term.

Hence, the correct answer is:

(A) oppose

Quick Tip: Lenz's law: induced emf always opposes the change in magnetic flux that produces it.

16. An electric circuit consists of a charged capacitor C , a resistor R and a switch S . Initially, the switch is open and all devices are connected in series. A circular loop of wire is placed in the same plane as the circuit. Which one of the following is true about the induced current in the loop after the switch is closed?

- (A) it is clockwise and increases
- (B) it is counter clockwise and increases
- (C) it is clockwise and decreases
- (D) it is counter clockwise and decreases

Correct Answer: (D) it is counter clockwise and decreases

Solution:

Concept:

This question is based on electromagnetic induction and Lenz's law.

When the switch is closed, the charged capacitor starts discharging through the resistor. During this discharge, current flows in the circuit, but its value decreases with time.

For an RC discharging circuit:

$$I = I_0 e^{-t/RC}$$

This means current is maximum at the beginning and then decreases exponentially.

Step 1: Understand what happens after closing the switch.

Initially, the capacitor is charged and switch is open.

When the switch is closed, the capacitor discharges through the resistor.

So current starts flowing in the circuit.

But as the capacitor loses charge, the potential difference across it decreases.

Therefore, the current also decreases with time.

Step 2: Connect changing current with magnetic field.

A current-carrying circuit produces magnetic field around it.

Since the current is decreasing, the magnetic field produced by the circuit also decreases.

This decreasing magnetic field changes the magnetic flux through the nearby circular loop.

Step 3: Apply Lenz's law.

According to Lenz's law, the induced current in the circular loop will oppose the decrease in magnetic flux.

So the induced current will flow in such a direction that it tries to maintain the original magnetic field.

According to the direction shown in the intended figure, the induced current is counter clockwise.

Step 4: Determine whether induced current increases or decreases.

Because the capacitor discharge current decreases exponentially, the changing magnetic flux also becomes weaker with time.

Therefore, the induced current in the loop also decreases with time.

Step 5: Check the options.

Option (A) clockwise and increases is incorrect.

Option (B) counter clockwise and increases is incorrect because the discharge current decreases.

Option (C) clockwise and decreases is incorrect because the direction is not clockwise according

to the given key.

Option (D) counter clockwise and decreases is correct.

Hence, the correct answer is:

(D) it is counter clockwise and decreases

Quick Tip: In an RC discharge circuit, current decreases exponentially:

$$I = I_0 e^{-t/RC}$$

Use Lenz's law to find the direction of induced current.

17. Two identical coaxial coils P and Q carrying equal amount of current in the same direction are brought nearer. The current in

- (A) P increases while in Q decreases
- (B) Q increases while in P decreases
- (C) both P and Q increases
- (D) both P and Q decreases

Correct Answer: (D) both P and Q decreases

Solution:

Concept:

This question is based on mutual induction and Lenz's law.

When two current-carrying coils are brought nearer, the magnetic flux linked with each coil due to the other coil changes.

According to Lenz's law, the induced current opposes the change in magnetic flux.

Step 1: Understand the initial condition.

Two identical coaxial coils P and Q carry equal current in the same direction.

Since current is in the same direction, the magnetic fields produced by the two coils support each other.

Step 2: Effect of bringing the coils nearer.

When the coils are brought closer, the magnetic flux of one coil linked with the other coil increases.

So, for each coil:

Magnetic flux linkage increases

Step 3: Apply Lenz's law.

Lenz's law says that induced current will oppose the change that produces it.

Here, the change is an increase in magnetic flux.

So the induced current in each coil will oppose this increase.

This opposition reduces the effective current in both coils.

Step 4: Decide the change in current.

Since the induced effect opposes the original current in both coils, the current in both coils decreases.

Therefore:

$$I_P \downarrow, \quad I_Q \downarrow$$

Step 5: Check the options.

Option (A) is incorrect because both coils are affected symmetrically.

Option (B) is incorrect for the same reason.

Option (C) is incorrect because induced current opposes the increase in flux.

Option (D) is correct because currents in both coils decrease.

Hence, the correct answer is:

(D) both P and Q decreases

Quick Tip: When flux linkage increases, induced current acts to oppose the increase. This is the direct application of Lenz's law.

18. Alternating voltage (V) is represented by the equation

- (A) $V(t) = V_m e^t$
- (B) $V(t) = V_m \sin \omega t$
- (C) $V(t) = V_m \cot \omega t$
- (D) $V(t) = V_m \tan \omega t$

Correct Answer: (B) $V(t) = V_m \sin \omega t$

Solution:

Concept:

Alternating voltage is a voltage whose magnitude and direction change periodically with time. The most common form of alternating voltage is sinusoidal. The standard equation is:

$$V(t) = V_m \sin \omega t$$

where,

$V(t)$ = instantaneous voltage

V_m = maximum or peak voltage

ω = angular frequency

t = time

Step 1: Understand alternating voltage.

In direct voltage, the polarity remains fixed.

But in alternating voltage, the polarity changes repeatedly after equal intervals of time.

This periodic variation is usually represented by a sine or cosine function.

Step 2: Recall standard AC equation.

The standard sinusoidal voltage is:

$$V = V_m \sin \omega t$$

It may also be written as:

$$V = V_m \cos \omega t$$

depending on the reference phase.

Step 3: Check the given options.

Option (A) $V(t) = V_m e^t$ represents exponential growth, not alternating voltage.

Option (B) $V(t) = V_m \sin \omega t$ is the standard form of alternating voltage.

Option (C) $V(t) = V_m \cot \omega t$ is not used for AC voltage.

Option (D) $V(t) = V_m \tan \omega t$ is also not the standard AC expression.

Hence, the correct answer is:

$(B) V(t) = V_m \sin \omega t$

Quick Tip: Standard alternating voltage is represented by:

$$V = V_m \sin \omega t$$

or

$$V = V_m \cos \omega t$$

19. Power factor of the following circuit will be zero

- (A) Resistance
- (B) Inductance
- (C) Capacitance
- (D) Both (b) and (c)

Correct Answer: (D) Both (b) and (c)

Solution:

Concept:

Power factor in an AC circuit is defined as:

$$\cos \phi$$

where ϕ is the phase angle between voltage and current.

The average power consumed in an AC circuit is:

$$P = V_{\text{rms}} I_{\text{rms}} \cos \phi$$

If:

$$\cos \phi = 0$$

then average power consumed is zero.

Step 1: Power factor in pure resistance.

In a pure resistor, voltage and current are in the same phase.

So:

$$\phi = 0^\circ$$

$$\cos 0^\circ = 1$$

Therefore, power factor of pure resistance is 1.

Step 2: Power factor in pure inductance.

In a pure inductor, current lags behind voltage by:

$$90^\circ$$

So:

$$\phi = 90^\circ$$

$$\cos 90^\circ = 0$$

Thus, power factor of pure inductance is zero.

Step 3: Power factor in pure capacitance.

In a pure capacitor, current leads voltage by:

$$90^\circ$$

Again:

$$\phi = 90^\circ$$

$$\cos 90^\circ = 0$$

So power factor of pure capacitance is also zero.

Step 4: Check the options.

Option (A) Resistance is incorrect because power factor is 1.

Option (B) Inductance has zero power factor.

Option (C) Capacitance has zero power factor.

Option (D) Both inductance and capacitance is correct.

Hence, the correct answer is:

(D) Both (b) and (c)

Quick Tip: Pure resistor has power factor 1. Pure inductor and pure capacitor have power factor 0.

20. The speed of electromagnetic waves in vacuum is

(A) $30 \times 10^8 \text{ ms}^{-1}$

(B) $4 \times 10^8 \text{ ms}^{-1}$

(C) $3.0 \times 10^8 \text{ ms}^{-1}$

(D) $3.0 \times 10^9 \text{ ms}^{-1}$

Correct Answer: (C) $3.0 \times 10^8 \text{ ms}^{-1}$

Solution:

Concept:

Electromagnetic waves are waves made up of oscillating electric and magnetic fields.

Examples include:

Radio waves, microwaves, infrared rays, visible light, ultraviolet rays, X-rays and gamma rays

All electromagnetic waves travel with the same speed in vacuum.

This speed is equal to the speed of light:

$$c = 3.0 \times 10^8 \text{ m/s}$$

Step 1: Recall Maxwell's result.

According to electromagnetic theory, the speed of electromagnetic waves in vacuum is:

$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$

where,

μ_0 = permeability of free space

ϵ_0 = permittivity of free space

The numerical value is:

$$c = 3.0 \times 10^8 \text{ m/s}$$

Step 2: Compare with the given options.

Option (A) 30×10^8 means 3.0×10^9 , which is too high.

Option (B) 4×10^8 is not the standard value.

Option (C) 3.0×10^8 is the correct speed of electromagnetic waves in vacuum.

Option (D) 3.0×10^9 is also too high.

Hence, the correct answer is:

$$(C) 3.0 \times 10^8 \text{ ms}^{-1}$$

Quick Tip: All electromagnetic waves travel in vacuum with speed:

$$c = 3.0 \times 10^8 \text{ m/s}$$

21. Rays that are used in taking photos during conditions of smoke, darkness is

- (A) X-rays
- (B) Gamma rays
- (C) Ultraviolet rays
- (D) Infrared rays

Correct Answer: (D) Infrared rays

Solution:

Concept:

Infrared rays are electromagnetic waves having wavelength longer than visible red light. They are associated with heat radiation and are useful in night vision, thermal imaging, and photography in darkness or smoky conditions.

Step 1: Understand the condition given.

The question mentions:

smoke and darkness

In such conditions, ordinary visible light photography may not work properly.

So we need radiation that can help imaging even when visible light is weak or blocked.

Step 2: Recall use of infrared rays.

Infrared rays are used in:

night vision cameras

thermal imaging

photography in fog, smoke, and darkness

They can detect heat emitted by objects.

Step 3: Check the options.

Option (A) X-rays are used mainly for medical imaging and detecting internal structures.

Option (B) Gamma rays are highly energetic and not used for ordinary photography in smoke or darkness.

Option (C) Ultraviolet rays are not used for night vision photography.

Option (D) Infrared rays are correct.

Hence, the correct answer is:

(D) Infrared rays

Quick Tip: Infrared rays are useful for night vision and thermal imaging because they detect heat radiation.

22. Angle which is formed between normal ray and ray entering a medium is known as

- (A) critical angle
- (B) angle of incidence
- (C) angle of reflection
- (D) angle of refraction

Correct Answer: (B) angle of incidence

Solution:

Concept:

When light falls on a surface separating two media, different rays and angles are defined.

The ray coming toward the surface is called the incident ray.

A perpendicular line drawn at the point of incidence is called the normal.

The angle between the incident ray and the normal is called the angle of incidence.

Step 1: Identify the ray mentioned in the question.

The question says:

ray entering a medium

This means the ray is approaching the boundary surface from one medium and entering another medium.

This ray is the incident ray.

Step 2: Define the angle.

The angle between the incident ray and the normal is:

Angle of incidence

It is generally represented by:

i

Step 3: Differentiate from other angles.

Angle of reflection is the angle between reflected ray and normal.

Angle of refraction is the angle between refracted ray and normal.

Critical angle is the angle of incidence in denser medium for which angle of refraction becomes 90° .

Step 4: Check the options.

Option (A) critical angle is incorrect.

Option (B) angle of incidence is correct.

Option (C) angle of reflection is incorrect.

Option (D) angle of refraction is incorrect.

Hence, the correct answer is:

(B) angle of incidence

Quick Tip: Incident ray with normal gives angle of incidence. Refracted ray with normal gives angle of refraction.

23. In projectors _____ lenses are used

- (A) Convex
- (B) Concave
- (C) Bipolar
- (D) Convex lens and Concave

Correct Answer: (A) Convex

Solution:

Concept:

A projector is an optical device used to form a magnified image on a screen.

For forming a real and enlarged image on a screen, a convex lens is used.

A convex lens is a converging lens.

Step 1: Understand what a projector does.

A projector takes a small object or image and projects a larger image on a screen.

The image formed on the screen must be:

real

magnified

Only a convex lens can form a real magnified image under suitable object position.

Step 2: Recall image formation by convex lens.

A convex lens forms a real and enlarged image when the object is placed between:

$$F \text{ and } 2F$$

The image is formed beyond $2F$, and it can be obtained on a screen.

Step 3: Why concave lens is not used.

A concave lens is a diverging lens.

It generally forms:

virtual

erect

diminished

images.

So it is not suitable for ordinary projectors.

Step 4: Check the options.

Option (A) Convex is correct.

Option (B) Concave is incorrect.

Option (C) Bipolar is not the correct lens type here.

Option (D) Convex lens and Concave is not the standard answer.

Hence, the correct answer is:

(A) Convex

Quick Tip: Projectors use convex lenses because convex lenses can form real and magnified images on a screen.

24. Dispersion can be noticed by passing a white light through

- (A) glass
- (B) mirror
- (C) water
- (D) prism

Correct Answer: (D) prism

Solution:

Concept:

Dispersion is the splitting of white light into its component colours.

White light is made of seven colours:

Violet, Indigo, Blue, Green, Yellow, Orange, Red

This sequence is commonly remembered as:

VIBGYOR

A prism is commonly used to show dispersion.

Step 1: Understand why white light splits.

Different colours of light have different wavelengths.

The refractive index of a material is slightly different for different wavelengths.

So different colours bend by different amounts when passing through a prism.

Step 2: Role of prism.

A prism has two refracting surfaces inclined to each other.

When white light passes through the prism, each colour deviates by a different amount.

This causes the white light to split into a spectrum.

Step 3: Check the options.

Option (A) glass can refract light, but the standard instrument to observe dispersion clearly is

prism.

Option (B) mirror reflects light; it does not produce dispersion.

Option (C) water can show dispersion in some cases, like rainbow formation, but the standard answer is prism.

Option (D) prism is correct.

Hence, the correct answer is:

(D) prism

Quick Tip: Dispersion means splitting of white light into colours. A prism is the standard device used to observe dispersion.

25. Red light is used for signals because it has

- (A) long wavelength
- (B) high intensity
- (C) high frequency
- (D) low refraction in the medium

Correct Answer: (A) long wavelength

Solution:

Concept:

Red light has the longest wavelength among visible colours.

Scattering of light is inversely related to the fourth power of wavelength:

$$\text{Scattering} \propto \frac{1}{\lambda^4}$$

where,

λ = wavelength

So, light with longer wavelength scatters less.

Step 1: Recall wavelength of red light.

Among visible colours:

$$\lambda_{\text{red}} > \lambda_{\text{orange}} > \lambda_{\text{yellow}} > \lambda_{\text{green}} > \lambda_{\text{blue}} > \lambda_{\text{violet}}$$

So red light has maximum wavelength in the visible spectrum.

Step 2: Understand why less scattering is useful.

In air, fog, dust, or smoke, light can scatter.

If light scatters too much, it cannot travel long distances clearly.

Since red light has a long wavelength, it scatters least.

Therefore, it can be seen from far away.

Step 3: Application in signals.

Traffic signals, danger signals, and railway signals use red light because it remains visible over long distances.

This is very useful for warning and safety.

Step 4: Check the options.

Option (A) long wavelength is correct.

Option (B) high intensity is not the main reason.

Option (C) high frequency is incorrect because red light has lower frequency than blue or violet.

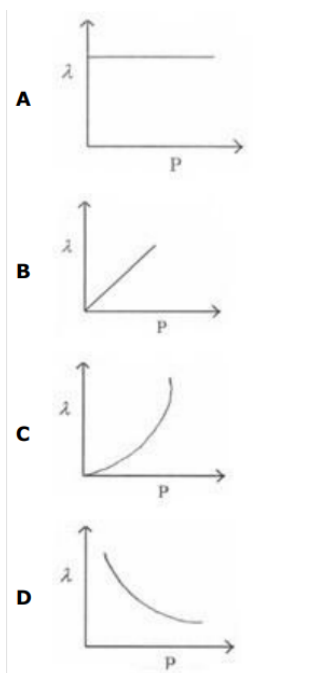
Option (D) low refraction is not the main reason for using red light in signals.

Hence, the correct answer is:

(A) long wavelength

Quick Tip: Red light is used in danger signals because it has the longest wavelength and undergoes the least scattering.

26. Kinetic energy of photo electron E_K changes with frequency (f) of light. Which of the following graph represents this emission?



- (A) Graph A
- (B) Graph B
- (C) Graph C
- (D) Graph D

Correct Answer: (B) Graph B

Solution:

Concept:

This question is based on the photoelectric effect.

According to Einstein's photoelectric equation:

$$E_K = hf - \phi$$

where,

E_K = maximum kinetic energy of photoelectron

h = Planck's constant

f = frequency of incident light

ϕ = work function of the metal

Step 1: Understand the relation between kinetic energy and frequency.

The equation is:

$$E_K = hf - \phi$$

This is similar to the equation of a straight line:

$$y = mx + c$$

Here:

$$y = E_K$$

$$x = f$$

$$m = h$$

$$c = -\phi$$

So, the graph of E_K versus f is a straight line.

Step 2: Understand the slope of the graph.

In the equation:

$$E_K = hf - \phi$$

the coefficient of f is h .

Since Planck's constant h is positive, the graph must have a positive slope.

Therefore, as frequency increases, kinetic energy also increases.

Step 3: Understand threshold frequency.

Photoelectrons are emitted only when the frequency of incident light is greater than or equal to the threshold frequency.

At threshold frequency f_0 :

$$E_K = 0$$

So:

$$hf_0 - \phi = 0$$

$$hf_0 = \phi$$

$$f_0 = \frac{\phi}{h}$$

This means the ideal graph cuts the frequency axis at $f = f_0$.

Step 4: Choose the correct graph from the options.

The graph must be:

a straight line with positive slope

Among the given options, only Graph B shows a straight line increasing with frequency.

Therefore, Graph B represents the relation between kinetic energy of photoelectron and frequency of light.

Hence, the correct answer is:

(B) Graph B

Quick Tip: For photoelectric effect, remember:

$$E_K = hf - \phi$$

So E_K varies linearly with frequency f , and the slope of the graph is Planck's constant h .

27. If the kinetic energy of a free electron doubles, its de Broglie wavelength changes by the factor

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

Correct Answer: (D) $1/\sqrt{2}$

Solution:

Concept:

The de Broglie wavelength of a moving particle is:

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

where,

λ = de Broglie wavelength

h = Planck's constant

p = momentum

For a non-relativistic particle:

$$K = \frac{p^2}{2m}$$

So:

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

Therefore:

$$\lambda = \frac{h}{\sqrt{2mK}}$$

This means:

$$\lambda \propto \frac{1}{\sqrt{K}}$$

Step 1: Write the relation between wavelength and kinetic energy.

Since:

$$\lambda \propto \frac{1}{\sqrt{K}}$$

If kinetic energy increases, de Broglie wavelength decreases.

Step 2: Let the initial kinetic energy be K .

Initial wavelength:

$$\lambda = \frac{h}{\sqrt{2mK}}$$

Now kinetic energy doubles:

$$K' = 2K$$

Step 3: Find the new wavelength.

New wavelength:

$$\lambda' = \frac{h}{\sqrt{2mK'}}$$

Substitute:

$$K' = 2K$$

$$\lambda' = \frac{h}{\sqrt{2m(2K)}}$$

$$\lambda' = \frac{h}{\sqrt{2}\sqrt{2mK}}$$

$$\lambda' = \frac{\lambda}{\sqrt{2}}$$

Step 4: Find the factor.

So the wavelength changes by the factor:

$$\frac{1}{\sqrt{2}}$$

Step 5: Check the options.

Option (A) 2 is incorrect because wavelength decreases, not doubles.

Option (B) $1/2$ is incorrect.

Option (C) $\sqrt{2}$ is incorrect because wavelength does not increase.

Option (D) $1/\sqrt{2}$ is correct.

Hence, the correct answer is:

$$(D) \frac{1}{\sqrt{2}}$$

Quick Tip: For a moving particle:

$$\lambda \propto \frac{1}{\sqrt{K}}$$

So if kinetic energy doubles, wavelength becomes $\frac{1}{\sqrt{2}}$ times.

28. Light of two different frequencies whose photons have energies 1 eV and 2.5 eV respectively, successively illuminate a metallic surface whose work function is 0.5 eV. Ratio of maximum speeds of emitted electrons will be

- (A) 1 : 2
- (B) 1 : 5
- (C) 1 : 1
- (D) 1 : 4

Correct Answer: (A) 1 : 2

Solution:

Concept:

This question is based on Einstein's photoelectric equation.

The maximum kinetic energy of emitted photoelectrons is:

$$K_{\max} = E - \phi$$

where,

E = energy of incident photon

ϕ = work function of the metal

Also:

$$K_{\max} = \frac{1}{2}mv^2$$

So:

$$v \propto \sqrt{K_{\max}}$$

Step 1: Write the given photon energies and work function.

First photon energy:

$$E_1 = 1 \text{ eV}$$

Second photon energy:

$$E_2 = 2.5 \text{ eV}$$

Work function:

$$\phi = 0.5 \text{ eV}$$

Step 2: Calculate maximum kinetic energy for first photon.

$$K_1 = E_1 - \phi$$

$$K_1 = 1 - 0.5$$

$$K_1 = 0.5 \text{ eV}$$

Step 3: Calculate maximum kinetic energy for second photon.

$$K_2 = E_2 - \phi$$

$$K_2 = 2.5 - 0.5$$

$$K_2 = 2.0 \text{ eV}$$

Step 4: Find the ratio of speeds.

Since:

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

For the same electron mass:

$$v \propto \sqrt{K}$$

Therefore:

$$v_1 : v_2 = \sqrt{K_1} : \sqrt{K_2}$$

$$v_1 : v_2 = \sqrt{0.5} : \sqrt{2.0}$$

Now:

$$0.5 = \frac{1}{2}$$

So:

$$v_1 : v_2 = \sqrt{\frac{1}{2}} : \sqrt{2}$$

$$v_1 : v_2 = \frac{1}{\sqrt{2}} : \sqrt{2}$$

Multiplying both terms by $\sqrt{2}$:

$$v_1 : v_2 = 1 : 2$$

Step 5: Check the options.

Option (A) 1 : 2 is correct.

Option (B) 1 : 5 is incorrect because speeds are proportional to square root of kinetic energy, not directly photon energy.

Option (C) 1 : 1 is incorrect because kinetic energies are different.

Option (D) 1 : 4 is incorrect because that would be closer to kinetic energy ratio, not speed ratio.

Hence, the correct answer is:

(A) 1 : 2

Quick Tip: In photoelectric effect, first calculate:

$$K_{\max} = E - \phi$$

Then use:

$$v \propto \sqrt{K_{\max}}$$

29. If the energy of a particle is reduced to half then the percentage increase in the de-Broglie wavelength is about

- (A) 100%
- (B) 61%
- (C) 34%
- (D) 41%

Correct Answer: (D) 41%

Solution:

Concept:

The de Broglie wavelength of a particle is:

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

For a non-relativistic particle:

$$K = \frac{p^2}{2m}$$

So:

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

Therefore:

$$\lambda = \frac{h}{\sqrt{2mK}}$$

This gives:

$$\lambda \propto \frac{1}{\sqrt{K}}$$

Step 1: Let the initial energy be E .

Initial de Broglie wavelength is:

$$\lambda$$

Since:

$$\lambda \propto \frac{1}{\sqrt{E}}$$

Step 2: Energy is reduced to half.

New energy:

$$E' = \frac{E}{2}$$

New wavelength:

$$\lambda' \propto \frac{1}{\sqrt{E'}}$$

$$\lambda' \propto \frac{1}{\sqrt{E/2}}$$

$$\lambda' \propto \frac{\sqrt{2}}{\sqrt{E}}$$

So:

$$\lambda' = \sqrt{2}\lambda$$

Step 3: Find increase in wavelength.

Increase in wavelength:

$$\Delta\lambda = \lambda' - \lambda$$

$$\Delta\lambda = \sqrt{2}\lambda - \lambda$$

$$\Delta\lambda = (\sqrt{2} - 1)\lambda$$

Step 4: Find percentage increase.

Percentage increase:

$$\frac{\Delta\lambda}{\lambda} \times 100$$

$$= (\sqrt{2} - 1) \times 100$$

Using:

$$\sqrt{2} \approx 1.414$$

$$= (1.414 - 1) \times 100$$

$$= 0.414 \times 100$$

$$= 41.4\%$$

Approximately:

$$41\%$$

Step 5: Check the options.

Option (A) 100% is incorrect.

Option (B) 61% is incorrect.

Option (C) 34% is incorrect.

Option (D) 41% is correct.

Hence, the correct answer is:

(D) 41%

Quick Tip: If energy becomes half, de Broglie wavelength becomes $\sqrt{2}$ times. Percentage increase is approximately 41%.

30. Which of the following particles has a lepton number of +1?

- (A) H^+
- (B) μ^-
- (C) e^+
- (D) p

Correct Answer: (B) μ^-

Solution:

Concept:

Lepton number is a quantum number assigned to leptons and anti-leptons.

Leptons have lepton number:

$$L = +1$$

Anti-leptons have lepton number:

$$L = -1$$

Particles that are not leptons have lepton number:

$$L = 0$$

Step 1: Recall examples of leptons.

Common leptons are:

$$e^-, \mu^-, \tau^-$$

and their corresponding neutrinos:

$$\nu_e, \nu_\mu, \nu_\tau$$

All of these have:

$$L = +1$$

Step 2: Recall examples of anti-leptons.

Anti-leptons include:

$$e^+, \mu^+, \tau^+$$

and anti-neutrinos.

They have:

$$L = -1$$

Step 3: Check each option.

Option (A) H^+ is a proton or hydrogen ion. It is not a lepton, so:

$$L = 0$$

Option (B) μ^- is a muon. It is a lepton, so:

$$L = +1$$

Option (C) e^+ is a positron. It is an anti-lepton, so:

$$L = -1$$

Option (D) p is a proton. It is a baryon, not a lepton, so:

$$L = 0$$

Step 4: Select the particle with lepton number +1.

The only particle among the options with lepton number +1 is:

$$\mu^-$$

Hence, the correct answer is:

$$(B) \mu^-$$

Quick Tip: Leptons like e^- , μ^- , τ^- , and neutrinos have lepton number +1. Their antiparticles have lepton number -1.

31. α -particles of energy 400 keV are bombarded on nucleus of ^{82}Pb . In scattering of α -particles, its minimum distance from nucleus will be

- (A) 0.59 nm
- (B) 0.59 Å
- (C) 5.9 pm
- (D) 0.59 pm

Correct Answer: (D) 0.59 pm

Solution:

Concept:

When an α -particle moves directly toward a positively charged nucleus, it experiences electrostatic repulsion.

At the closest distance of approach, the kinetic energy of the α -particle becomes completely converted into electrostatic potential energy.

So, at minimum distance:

$$\text{Kinetic energy} = \text{Electrostatic potential energy}$$

The formula used is:

$$E = \frac{1}{4\pi\epsilon_0} \frac{Z_1 Z_2 e^2}{r}$$

In nuclear physics, a useful shortcut is:

$$r(\text{fm}) = \frac{1.44 Z_1 Z_2}{E(\text{MeV})}$$

Step 1: Write the given values.

For an α -particle:

$$Z_1 = 2$$

For lead nucleus:

$$Z_2 = 82$$

Energy of α -particle:

$$E = 400 \text{ keV}$$

Convert keV into MeV:

$$400 \text{ keV} = 0.4 \text{ MeV}$$

Step 2: Apply the closest approach formula.

$$r = \frac{1.44Z_1Z_2}{E}$$

Substitute values:

$$r = \frac{1.44 \times 2 \times 82}{0.4}$$

Step 3: Calculate the value.

First multiply the numerator:

$$1.44 \times 2 = 2.88$$

$$2.88 \times 82 = 236.16$$

Now divide by 0.4:

$$r = \frac{236.16}{0.4} = 590.4 \text{ fm}$$

So:

$$r \approx 590 \text{ fm}$$

Step 4: Convert femtometer into picometer.

We know:

$$1 \text{ pm} = 1000 \text{ fm}$$

Therefore:

$$590 \text{ fm} = 0.590 \text{ pm}$$

$$r \approx 0.59 \text{ pm}$$

Step 5: Check the options.

Option (A) 0.59 nm is too large.

Option (B) 0.59 Å is also much larger than the calculated value.

Option (C) 5.9 pm is 10 times larger than the correct value.

Option (D) 0.59 pm matches the calculated result.

Hence, the correct answer is:

(D) 0.59 pm

Quick Tip: For closest approach of an α -particle:

$$r(\text{fm}) = \frac{1.44Z_1Z_2}{E(\text{MeV})}$$

Always convert energy into MeV before using this shortcut.

32. Two protons are kept at a distance of $40 \times 10^{-10} \text{ m}$. F_n is the nuclear force and F_e is the electrostatic force between them. Then

(A) $F_n \gg F_e$

(B) $F_n = F_e$

(C) $F_n \ll F_e$

(D) $F_n \neq F_e$

Correct Answer: (C) $F_n \ll F_e$

Solution:**Concept:**

There are two important forces between protons:

F_e = electrostatic repulsive force

F_n = nuclear attractive force

Electrostatic force is a long-range force, while nuclear force is a very short-range force.

The nuclear force acts effectively only when nucleons are separated by a distance of the order:

$$10^{-15} \text{ m}$$

Step 1: Write the given separation.

Given distance between two protons:

$$r = 40 \times 10^{-10} \text{ m}$$

Simplify:

$$r = 4.0 \times 10^{-9} \text{ m}$$

Step 2: Compare with range of nuclear force.

Range of nuclear force is approximately:

$$10^{-15} \text{ m}$$

Given separation is:

$$4.0 \times 10^{-9} \text{ m}$$

This is much greater than:

$$10^{-15} \text{ m}$$

So at this separation, nuclear force is almost negligible.

Step 3: Understand electrostatic force at this distance.

Electrostatic force follows Coulomb's law:

$$F_e = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$$

It can act even at distances much larger than nuclear range.

So electrostatic force is still present.

Step 4: Compare F_n and F_e .

Since nuclear force is negligible:

$$F_n \approx 0$$

But electrostatic force exists:

$$F_e \neq 0$$

Therefore:

$$F_n \ll F_e$$

Step 5: Check the options.

Option (A) is incorrect because nuclear force is not stronger at such large distance.

Option (B) is incorrect because the two forces are not equal.

Option (C) is correct because nuclear force is negligible compared to electrostatic force.

Option (D) is vague, while option (C) gives the correct comparison.

Hence, the correct answer is:

$(C) F_n \ll F_e$

Quick Tip: Nuclear force is very strong but very short-range. It becomes negligible when separation is much larger than 10^{-15} m.

33. The inputs of a NAND gate are connected together. The resulting circuit is _____

- (A) OR gate
- (B) AND gate
- (C) NOT gate
- (D) None of the above

Correct Answer: (C) NOT gate

Solution:

Concept:

A NAND gate is obtained by connecting an AND gate followed by a NOT gate.

For two inputs A and B , NAND output is:

$$Y = \overline{A \cdot B}$$

If both inputs of NAND gate are connected together, then both inputs become the same.

So:

$$A = B$$

Step 1: Write the NAND gate output.

For a NAND gate:

$$Y = \overline{A \cdot B}$$

Step 2: Connect both inputs together.

If both inputs are connected to the same signal A , then:

$$B = A$$

So:

$$Y = \overline{A \cdot A}$$

Step 3: Use Boolean algebra.

According to Boolean algebra:

$$A \cdot A = A$$

Therefore:

$$Y = \bar{A}$$

Step 4: Identify the resulting gate.

The output:

$$Y = \bar{A}$$

is exactly the output of a NOT gate.

So NAND gate with tied inputs behaves as an inverter or NOT gate.

Step 5: Check the options.

Option (A) OR gate is incorrect.

Option (B) AND gate is incorrect.

Option (C) NOT gate is correct.

Option (D) None of the above is incorrect because option (C) is correct.

Hence, the correct answer is:

(C) NOT gate

Quick Tip: A NAND gate with both inputs connected together works as a NOT gate:

$$\overline{A \cdot A} = \bar{A}$$

34. The current in a semiconductor is produced by

- (A) electrons only
- (B) holes only
- (C) negative ions
- (D) both electrons and holes

Correct Answer: (D) both electrons and holes

Solution:

Concept:

A semiconductor is a material whose conductivity lies between that of a conductor and an insulator.

Examples:

Silicon, Germanium

In semiconductors, current is produced by two types of charge carriers:

Electrons

and

Holes

Step 1: Understand electrons in semiconductors.

When an electron gains enough energy, it moves from the valence band to the conduction band.

Electrons in the conduction band are free to move.

Their motion contributes to electric current.

Step 2: Understand holes in semiconductors.

When an electron leaves the valence band, it creates an empty place.

This empty place behaves like a positive charge carrier and is called a hole.

Holes also move through the crystal and contribute to current.

Step 3: Current contribution.

Total current in a semiconductor is due to:

$$I = I_{\text{electron}} + I_{\text{hole}}$$

So both electrons and holes participate in conduction.

Step 4: Check the options.

Option (A) electrons only is incomplete.

Option (B) holes only is incomplete.

Option (C) negative ions are not the main charge carriers in semiconductors.

Option (D) both electrons and holes is correct.

Hence, the correct answer is:

(D) both electrons and holes

Quick Tip: In semiconductors, current is carried by both electrons and holes.

35. The V-I curve for a diode shows

- (A) the voltage across the diode for a given current
- (B) the amount of current for a given bias voltage
- (C) the power dissipation
- (D) voltage amplification

Correct Answer: (B) the amount of current for a given bias voltage

Solution:

Concept:

The V-I characteristic curve of a diode shows the relation between voltage applied across the diode and current flowing through it.

Here:

V = voltage across diode

I = current through diode

A diode behaves differently in forward bias and reverse bias.

Step 1: Understand forward bias.

In forward bias, the positive terminal of battery is connected to the p -side and negative terminal to the n -side.

In this condition, after the cut-in voltage, current increases rapidly.

Step 2: Understand reverse bias.

In reverse bias, the positive terminal is connected to the n -side and negative terminal to the p -side.

In this condition, only a small reverse saturation current flows until breakdown.

Step 3: Meaning of V-I curve.

The V-I curve tells us how much current flows for a given applied voltage.

So it shows:

Current response for a given bias voltage

Step 4: Check the options.

Option (A) is not the best description because normally voltage is taken as input and current response is observed.

Option (B) is correct because V-I curve shows current for a given bias voltage.

Option (C) power dissipation is not directly represented as the main V-I curve.

Option (D) voltage amplification is related to amplifiers, not diode V-I characteristic.

Hence, the correct answer is:

(B) the amount of current for a given bias voltage

Quick Tip: A diode V-I curve shows how diode current changes when applied voltage changes.

36. The molecular mass of acetic acid dissolved in water is 60 and when dissolved in benzene it is 120. This difference in behaviour of CH_3COOH is because

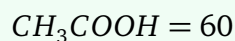
- (A) Water prevents association of acetic acid
- (B) Acetic acid does not fully dissolve in water
- (C) Acetic acid fully dissolves in benzene
- (D) Acetic acid does not ionize in benzene

Correct Answer: (A) Water prevents association of acetic acid

Solution:

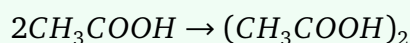
Concept:

Acetic acid has normal molecular mass:



In non-polar solvents like benzene, acetic acid molecules associate with each other through hydrogen bonding and form dimers.

A dimer means two molecules join together:



So the observed molecular mass becomes:

$$2 \times 60 = 120$$

Step 1: Understand behaviour in water.

Water is a polar solvent.

Acetic acid forms hydrogen bonds with water molecules.

Because water surrounds and solvates acetic acid molecules, acetic acid molecules do not

associate strongly with each other.

Therefore, molecular mass remains close to its normal value:

60

Step 2: Understand behaviour in benzene.

Benzene is a non-polar solvent.

In benzene, acetic acid molecules are not strongly solvated by the solvent.

So acetic acid molecules associate with each other through intermolecular hydrogen bonding.

This leads to dimer formation:



Observed molecular mass:

120

Step 3: Reason for difference.

In water:

association is prevented

In benzene:

association occurs

Therefore, the difference in molecular mass is due to the fact that water prevents association of acetic acid.

Step 4: Check the options.

Option (A) is correct because water prevents association by hydrogen bonding with acetic acid.

Option (B) is incorrect because acetic acid dissolves in water.

Option (C) is not the reason for molecular mass becoming 120.

Option (D) is true in general, but it does not explain the association difference as directly as option (A).

Hence, the correct answer is:

(A) Water prevents association of acetic acid

Quick Tip: Carboxylic acids often form dimers in non-polar solvents like benzene, giving abnormally high molecular mass.

37. One mole of component X and two moles of component Y are mixed at room temperature to form an ideal binary solution. The ΔH_{mix} is

- (A) 0
- (B) 2
- (C) 3
- (D) 1

Correct Answer: (A) 0

Solution:

Concept:

An ideal solution is a solution that obeys Raoult's law over the entire range of concentration.
For an ideal solution:

$$\Delta H_{mix} = 0$$

and

$$\Delta V_{mix} = 0$$

This means no heat is evolved or absorbed during mixing, and there is no volume change during mixing.

Step 1: Understand ideal solution.

In an ideal solution, interactions between unlike molecules are similar to interactions between like molecules.

That means:

$$X-X, \quad Y-Y, \quad X-Y$$

interactions are nearly equal.

Step 2: Effect on enthalpy of mixing.

Since the intermolecular attractions do not change significantly after mixing, there is no net heat change.

Therefore:

$$\Delta H_{mix} = 0$$

Step 3: Apply to the given mixture.

The question says X and Y form an ideal binary solution.

The number of moles given does not change the ideal solution property.

So:

$$\Delta H_{mix} = 0$$

Step 4: Check the options.

Option (A) 0 is correct.

Option (B), (C), and (D) are incorrect because ideal solution has zero enthalpy of mixing.

Hence, the correct answer is:

(A) 0

Quick Tip: For an ideal solution:

$$\Delta H_{mix} = 0, \quad \Delta V_{mix} = 0$$

38. An increase in equivalent conductance of a strong electrolyte with dilution is mainly due to

- (A) Increase in both i.e. number of ions and ionic mobility of ions.
(B) Increase in number of ions
(C) Increase in ionic mobility of ions
(D) 100% ionization of electrolyte at normal dilution

Correct Answer: (C) Increase in ionic mobility of ions

Solution:

Concept:

Equivalent conductance is the conducting power of all ions produced by one gram equivalent of electrolyte.

For electrolytes, equivalent conductance generally increases on dilution.

The reason depends on whether the electrolyte is strong or weak.

Step 1: Understand strong electrolyte.

Strong electrolytes are almost completely ionized even at normal concentration.

Examples:



So on dilution, the number of ions does not increase significantly because ions are already present.

Step 2: Effect of dilution on interionic attraction.

In concentrated solution, ions are closer to each other.

They attract or repel each other, which reduces their free movement.

On dilution, ions become farther apart.

So interionic attractions decrease.

Step 3: Effect on ionic mobility.

When interionic attraction decreases, ions move more freely.

Therefore:

Ionic mobility increases

This increase in mobility increases equivalent conductance.

Step 4: Check the options.

Option (A) is incorrect for strong electrolytes because number of ions does not increase significantly.

Option (B) is incorrect for the same reason.

Option (C) is correct because ionic mobility increases on dilution.

Option (D) is not the main explanation for the increase with dilution.

Hence, the correct answer is:

(C) Increase in ionic mobility of ions

Quick Tip: For strong electrolytes, dilution mainly increases ionic mobility. For weak electrolytes, dilution increases ionization.

39. Saturated solution of KNO_3 is used to make salt bridge because

- (A) Velocity of K^+ is greater than that of NO_3^-
- (B) Velocity of NO_3^- is greater than that of K^+
- (C) Velocity of both K^+ and NO_3^- are nearly the same
- (D) KNO_3 is highly soluble in water

Correct Answer: (C) Velocity of both K^+ and NO_3^- are nearly the same

Solution:

Concept:

A salt bridge is used in an electrochemical cell to complete the circuit and maintain electrical neutrality.

A good salt bridge electrolyte should have ions that move with nearly equal speeds.

This helps to minimize liquid junction potential.

Step 1: Understand the function of salt bridge.

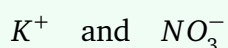
During cell reaction, ions are produced or consumed in the two half-cells.

If charge imbalance develops, the cell reaction stops.

The salt bridge supplies ions to maintain electrical neutrality.

Step 2: Why KNO_3 is used.

In KNO_3 , the ions are:



These ions have nearly equal ionic mobilities.

So they move at nearly the same rate.

Step 3: Importance of equal ionic mobility.

If one ion moves much faster than the other, charge separation occurs near the junction.

This creates liquid junction potential.

To avoid this, ions with nearly equal speeds are preferred.

Step 4: Check the options.

Option (A) is incorrect because K^+ is not selected because it moves much faster.

Option (B) is incorrect because NO_3^- is not selected because it moves much faster.

Option (C) is correct because both ions have nearly the same velocity.

Option (D) is true that KNO_3 is soluble, but the main reason is nearly equal ionic mobility.

Hence, the correct answer is:

(C) Velocity of both K^+ and NO_3^- are nearly the same

Quick Tip: Salt bridge electrolyte should have ions with nearly equal mobility to reduce liquid junction potential.

40. The half-cell reaction for the SHE is given by

- (A) $2H^+(aq) + 2e^- \rightleftharpoons 2H_2(g)$
(B) $2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$
(C) $H^+(aq) + e^- \rightleftharpoons H_2(g)$
(D) $Hg_2^{2+}(aq) + 2e^- \rightleftharpoons 2Hg(l)$

Correct Answer: (B) $2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$

Solution:

Concept:

SHE stands for Standard Hydrogen Electrode.

It is used as a reference electrode.

Its electrode potential is taken as:

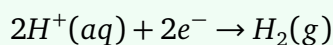
$$E^\circ = 0.00 \text{ V}$$

The electrode consists of hydrogen gas at 1 atm pressure passed over platinum electrode dipped in 1M H^+ solution.

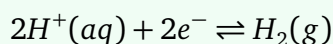
Step 1: Understand the reaction at SHE.

At the hydrogen electrode, hydrogen ions can gain electrons and form hydrogen gas.

The reduction half-cell reaction is:

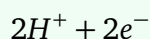


Since electrode reactions are reversible, it is written as:



Step 2: Check balancing of atoms and charge.

Left side:



Total charge:

$$+2 - 2 = 0$$

Right side:



Charge:

$$0$$

So the reaction is balanced.

Step 3: Check the options.

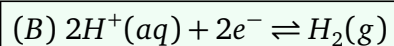
Option (A) is incorrect because it forms $2H_2$, which is not balanced with $2H^+$.

Option (B) is correct.

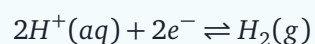
Option (C) is incorrect because one H^+ and one electron cannot form H_2 .

Option (D) is a mercury electrode reaction, not SHE.

Hence, the correct answer is:



Quick Tip: Standard hydrogen electrode reaction:



Its standard electrode potential is 0.00 V.

41. What will be the order of the reaction when the initial concentration is doubled the time of half reaction is doubled?

- (A) Third
- (B) Second
- (C) Zero
- (D) First

Correct Answer: (C) Zero

Solution:

Concept:

The half-life of a reaction is the time required for the concentration of reactant to become half of its initial value.

The dependence of half-life on initial concentration helps identify the order of reaction.

For a zero order reaction:

$$t_{1/2} = \frac{[A]_0}{2k}$$

For a first order reaction:

$$t_{1/2} = \frac{0.693}{k}$$

Step 1: Observe the given condition.

The question says:

When initial concentration is doubled, the half-life is also doubled.

So:

$$[A]_0 \rightarrow 2[A]_0$$

and:

$$t_{1/2} \rightarrow 2t_{1/2}$$

This means:

$$t_{1/2} \propto [A]_0$$

Step 2: Compare with zero order reaction.

For zero order reaction:

$$t_{1/2} = \frac{[A]_0}{2k}$$

Here:

$$t_{1/2} \propto [A]_0$$

So if initial concentration is doubled, half-life also doubles.

Step 3: Compare with first order reaction.

For first order reaction:

$$t_{1/2} = \frac{0.693}{k}$$

It is independent of initial concentration.

So first order is not correct.

Step 4: Check the options.

Option (A) Third is incorrect.

Option (B) Second is incorrect.

Option (C) Zero is correct.

Option (D) First is incorrect because first order half-life does not depend on initial concentration.

Hence, the correct answer is:

(C) Zero

Quick Tip: For zero order reaction:

$$t_{1/2} \propto [A]_0$$

So if initial concentration doubles, half-life also doubles.

42. Surface tension of lyophilic sol is

- (A) greater than H_2O
- (B) equal to H_2O
- (C) less than H_2O
- (D) none of these

Correct Answer: (B) equal to H_2O

Solution:

Concept:

Lyophilic sols are colloidal solutions in which dispersed particles have strong attraction for the dispersion medium.

If the dispersion medium is water, they are called hydrophilic sols.

Examples:

starch sol, gum sol, gelatin sol

Step 1: Understand lyophilic sol.

The word lyophilic means:

liquid-loving

So the dispersed phase strongly interacts with the liquid medium.

Due to this strong interaction, lyophilic sols are stable.

Step 2: Relation with surface tension.

Lyophilic sols resemble the dispersion medium closely.

So their surface tension is nearly equal to that of the dispersion medium.

If the medium is water, then surface tension is almost equal to:



Step 3: Check the options.

Option (A) greater than water is not correct.

Option (B) equal to water is the expected answer.

Option (C) less than water is not the standard answer for this question.

Option (D) none of these is incorrect because option (B) is correct.

Hence, the correct answer is:

(B) equal to H_2O

Quick Tip: Lyophilic sols have strong affinity for the dispersion medium and show properties close to that medium.

43. Name the method used for separation of sulphide ores?

- (A) Hydraulic washing
- (B) Magnetic separation
- (C) Froth floatation
- (D) Leaching

Correct Answer: (C) Froth floatation

Solution:

Concept:

The concentration of ores means removal of unwanted impurities called gangue from the ore. Different ores are concentrated by different methods depending on their physical and chemical properties.

Sulphide ores are commonly concentrated by froth flotation.

Step 1: Understand froth flotation.

In froth flotation, powdered sulphide ore is mixed with water and collectors.

Air is blown through the mixture.

Sulphide ore particles attach to air bubbles and rise as froth.

Gangue particles remain in water.

Step 2: Why sulphide ores use this method.

Sulphide ores are preferentially wetted by oil.

Gangue particles are wetted by water.

This difference helps separate sulphide ore from impurities.

Step 3: Check the options.

Option (A) Hydraulic washing is based on density difference and is not the common method for sulphide ores.

Option (B) Magnetic separation is used when ore or gangue is magnetic.

Option (C) Froth floatation is correct for sulphide ores.

Option (D) Leaching is used for some ores like bauxite, silver, and gold ores.

Hence, the correct answer is:

(C) Froth floatation

Quick Tip: Sulphide ores are generally concentrated by froth floatation because sulphide particles are preferentially wetted by oil.

44. P_4 reacts with X selectively to give P_4O_6 . The X is

(A) A mixture of O_2 and N_2

(B) $KMnO_4$

(C) Jones reagent

(D) $K_2Cr_2O_7$

Correct Answer: (A) A mixture of O_2 and N_2

Solution:

Concept:

Phosphorus forms two important oxides:



and



The oxide formed depends on the amount of oxygen available.

In limited oxygen, phosphorus gives:

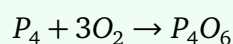


In excess oxygen, phosphorus gives:



Step 1: Write the formation of P_4O_6 .

When phosphorus burns in limited oxygen:



So controlled oxygen is required.

Step 2: Why mixture of O_2 and N_2 is used.

A mixture of oxygen and nitrogen provides diluted oxygen.

Nitrogen acts as an inert diluent.

This controls the oxidation and selectively gives:



Step 3: Why other reagents are not suitable.

$KMnO_4$, Jones reagent, and $K_2Cr_2O_7$ are strong oxidizing agents.

They are not used for selective preparation of P_4O_6 .

Strong oxidation may lead to higher oxidation products.

Step 4: Check the options.

Option (A) is correct because controlled oxygen gives P_4O_6 .

Option (B), (C), and (D) are not suitable for this selective oxidation.

Hence, the correct answer is:

(A) A mixture of O_2 and N_2

Quick Tip: Phosphorus forms P_4O_6 in limited oxygen and P_4O_{10} in excess oxygen.

45. ICl_2^- is isostructural with

- (A) XeF_2
- (B) $SbCl_3$
- (C) $BaCl_2$
- (D) TeF_2

Correct Answer: (A) XeF_2

Solution:

Concept:

Isostructural species have the same shape or geometry.

To find geometry, we use VSEPR theory.

According to VSEPR theory, electron pairs around the central atom arrange themselves to minimize repulsion.

Step 1: Find the structure of ICl_2^- .

Central atom is iodine.

Iodine has 7 valence electrons.

There is one negative charge, so add one more electron:

$$7 + 1 = 8$$

Two chlorine atoms form two bonds with iodine.

So iodine has:

2 bond pairs

Remaining electrons form:

3 lone pairs

Thus, ICl_2^- has:



Step 2: Determine geometry.

For AX_2E_3 , electron pair geometry is trigonal bipyramidal.

The three lone pairs occupy equatorial positions.

The two bond pairs remain axial.

So molecular shape is:

linear

Step 3: Compare with XeF_2 .

XeF_2 also has:



Therefore, XeF_2 is also linear.

So ICl_2^- and XeF_2 are isostructural.

Step 4: Check the options.

Option (A) XeF_2 is correct.

Option (B) $SbCl_3$ is not linear.

Option (C) $BaCl_2$ is ionic and not comparable in the same molecular VSEPR sense.

Option (D) TeF_2 does not match the same AX_2E_3 arrangement.

Hence, the correct answer is:

(A) XeF_2

Quick Tip: Species with AX_2E_3 arrangement are linear, for example XeF_2 and ICl_2^- .

46. Helium is preferred to be used in balloons instead of hydrogen because it is

(A) Incombustible

- (B) Lighter than hydrogen
- (C) More abundant than hydrogen
- (D) Non-polarizable

Correct Answer: (A) Incombustible

Solution:

Concept:

Both hydrogen and helium are lighter than air.

Therefore, both can provide lifting power in balloons.

But safety is the most important factor.

Hydrogen is highly inflammable, while helium is non-flammable.

Step 1: Compare hydrogen and helium.

Hydrogen is the lightest gas.

But hydrogen can catch fire easily.

It forms explosive mixtures with air.

Step 2: Understand helium.

Helium is a noble gas.

It is chemically inert and does not burn.

Therefore, helium is much safer than hydrogen for filling balloons.

Step 3: Meaning of incombustible.

Incombustible means:

does not burn

Helium is incombustible.

This is the main reason it is preferred in balloons.

Step 4: Check the options.

Option (A) Incombustible is correct.

Option (B) is incorrect because helium is not lighter than hydrogen. Hydrogen is lighter.

Option (C) is not the reason.

Option (D) is not the practical reason for using helium in balloons.

Hence, the correct answer is:

(A) Incombustible

Quick Tip: Hydrogen is lighter than helium, but helium is preferred in balloons because helium is non-flammable.

47. Which of the following transition metal ion has magnetic moment 3.87 BM?

(A) Mn^{2+}

(B) Co^{3+}

(C) Fe^{2+}

(D) Co^{2+}

Correct Answer: (D) Co^{2+}

Solution:

Concept:

The spin-only magnetic moment is calculated by:

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

where:

n = number of unpaired electrons

Given magnetic moment:

$$\mu = 3.87 \text{ BM}$$

Step 1: Find the number of unpaired electrons.

Use:

$$\mu = \sqrt{n(n+2)}$$

Try $n = 3$:

$$\mu = \sqrt{3(3+2)}$$

$$\mu = \sqrt{15}$$

$$\mu = 3.87 \text{ BM}$$

So the ion must have:

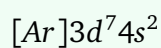
3 unpaired electrons

Step 2: Check Co^{2+} .

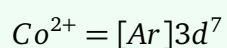
Cobalt atomic number is:

27

Electronic configuration of Co:



For Co^{2+} , remove two electrons from 4s:



A d^7 ion commonly has 3 unpaired electrons in high-spin state.

So:

$$\mu = \sqrt{3(3+2)} = \sqrt{15} = 3.87 \text{ BM}$$

Step 3: Check other options.

Mn^{2+} has d^5 , generally 5 unpaired electrons:

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

Fe^{2+} has d^6 , high-spin usually 4 unpaired electrons:

$$\mu \approx 4.90 \text{ BM}$$

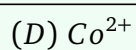
Co^{3+} has d^6 , which may be low spin or high spin depending on ligand field, but it is not the standard answer for 3.87 BM in this option set.

Step 4: Final selection.

The ion matching 3 unpaired electrons is:



Hence, the correct answer is:



Quick Tip: Remember spin-only values:

$$n = 1 \Rightarrow 1.73, \quad n = 2 \Rightarrow 2.83, \quad n = 3 \Rightarrow 3.87$$

$$n = 4 \Rightarrow 4.90, \quad n = 5 \Rightarrow 5.92$$

48. Lanthanoids are difficult to purify due to their

- (A) large size
- (B) similar chemical and physical properties
- (C) paramagnetic nature
- (D) radioactivity

Correct Answer: (B) similar chemical and physical properties

Solution:

Concept:

Lanthanoids are elements from cerium to lutetium.

They mostly show the +3 oxidation state.

Due to lanthanoid contraction, their ionic sizes decrease gradually but remain very close to one another.

Because of this, their chemical properties are very similar.

Step 1: Understand lanthanoid contraction.

Across the lanthanoid series, electrons are added to the $4f$ -subshell.

The $4f$ -electrons shield nuclear charge poorly.

So effective nuclear charge increases.

As a result, ionic radius gradually decreases.

This is called:

Lanthanoid contraction

Step 2: Effect on purification.

Since lanthanoids have very similar ionic radii and mostly same oxidation state +3, they behave very similarly in chemical reactions.

Therefore, separating one lanthanoid from another becomes difficult.

Step 3: Check the options.

Option (A) large size is not the main reason.

Option (B) similar chemical and physical properties is correct.

Option (C) paramagnetic nature is not the main reason for purification difficulty.

Option (D) radioactivity is incorrect because lanthanoids are not generally radioactive like actinoids.

Hence, the correct answer is:

(B) similar chemical and physical properties

Quick Tip: Lanthanoids are difficult to separate because they have similar ionic radii and commonly show +3 oxidation state.

49. Correct order of ionic radius of the following Ln^{3+} ions is

- (A) $Ho > Lu > Ce > Sm$
- (B) $Lu > Ce > Ho > Sm$
- (C) $Ce > Sm > Ho > Lu$
- (D) $Lu > Ho > Sm > Ce$

Correct Answer: (C) $Ce > Sm > Ho > Lu$

Solution:

Concept:

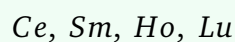
In lanthanoids, ionic radius decreases from left to right in the series.

This decrease is due to lanthanoid contraction.

For Ln^{3+} ions, as atomic number increases, effective nuclear charge increases and ionic radius decreases.

Step 1: Arrange lanthanoids in increasing atomic number.

The order in the lanthanoid series is:



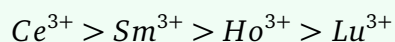
Here Ce comes earlier and Lu comes later.

Step 2: Apply lanthanoid contraction.

Due to lanthanoid contraction:

ionic radius decreases from Ce^{3+} to Lu^{3+}

So:



Step 3: Check the options.

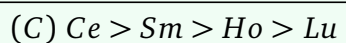
Option (A) is incorrect because Lu^{3+} cannot be larger than Ce^{3+} .

Option (B) is incorrect because it places Lu^{3+} largest.

Option (C) is correct.

Option (D) is reverse of the correct trend.

Hence, the correct answer is:



Quick Tip: For Ln^{3+} ions, size decreases across the lanthanoid series due to lanthanoid contraction.

50. _____ ion forms colored aqua complexes.

(A) Cu^{2+}

(B) Zn^{2+}

(C) Ti^{4+}

(D) Mn^{7+}

Correct Answer: (A) Cu^{2+}

Solution:

Concept:

Transition metal ions often form colored complexes because they have partially filled d -orbitals. The color usually arises due to:



When ligands such as water approach the metal ion, the d -orbitals split into different energy

levels.

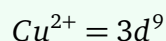
Electrons absorb visible light and jump between these split d -levels.

Step 1: Check Cu^{2+} .

Copper has atomic number:

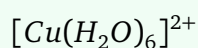
$$29$$

Configuration of Cu^{2+} :

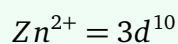


Since it has partially filled d -orbitals, it can show $d - d$ transition.

The aqua complex of copper(II) is blue:



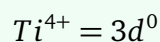
Step 2: Check Zn^{2+} .



It has completely filled d -orbitals.

So it generally forms colorless complexes.

Step 3: Check Ti^{4+} .



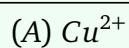
It has no d -electrons.

So $d - d$ transition is not possible.

Step 4: Choose the correct ion.

Among the given ions, Cu^{2+} is the common ion that forms colored aqua complexes.

Hence, the correct answer is:



Quick Tip: Colored transition metal complexes usually require partially filled d -orbitals.

51. A ligand can also be regarded as

- (A) Lewis acid
- (B) Bronsted base
- (C) Lewis base
- (D) Bronsted acid

Correct Answer: (C) Lewis base

Solution:

Concept:

A ligand is an ion or molecule that donates a pair of electrons to a central metal atom or ion to form a coordinate bond.

According to Lewis concept:

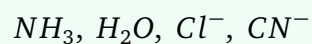
Lewis acid = electron pair acceptor

Lewis base = electron pair donor

Step 1: Understand ligand behavior.

Ligands have lone pairs of electrons.

For example:



These species donate electron pairs to metal ions.

Step 2: Understand metal ion behavior.

The central metal ion accepts electron pairs from ligands.

So the metal ion behaves as:

Lewis acid

The ligand donates electron pairs.

So the ligand behaves as:

Lewis base

Step 3: Check the options.

Option (A) Lewis acid is incorrect because ligand donates, not accepts, electron pairs.

Option (B) Bronsted base accepts proton, but coordination bonding is better explained by Lewis concept.

Option (C) Lewis base is correct.

Option (D) Bronsted acid is incorrect.

Hence, the correct answer is:

(C) Lewis base

Quick Tip: In coordination compounds, ligand is a Lewis base and central metal ion is a Lewis acid.

52. Monomer which is used to make Poly Vinyl Chloride (PVC) is called

- (A) chloroethene
- (B) chloromethane
- (C) chloropropane
- (D) chlorobutane

Correct Answer: (A) chloroethene

Solution:

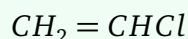
Concept:

PVC stands for Poly Vinyl Chloride.

It is an addition polymer formed by repeated joining of vinyl chloride monomers.

Vinyl chloride is also called chloroethene.

Its structure is:



Step 1: Identify the polymer name.

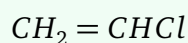
Poly Vinyl Chloride means polymer of vinyl chloride.

So monomer is:

Vinyl chloride

Step 2: Write IUPAC name of vinyl chloride.

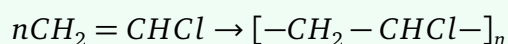
Vinyl chloride has two carbon atoms with one double bond and one chlorine atom:



Its IUPAC name is:

chloroethene

Step 3: Polymerization reaction.



The product is:

PVC

Step 4: Check the options.

Option (A) chloroethene is correct.

Option (B) chloromethane has only one carbon and cannot form PVC.

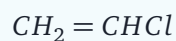
Option (C) chloropropane is not the monomer of PVC.

Option (D) chlorobutane is not the monomer of PVC.

Hence, the correct answer is:

(A) chloroethene

Quick Tip: PVC is formed from vinyl chloride:



whose IUPAC name is chloroethene.

53. Which carbon-halogen bond has the lowest bond enthalpy?

- (A) C-Br
- (B) C-Cl
- (C) C-F
- (D) C-I

Correct Answer: (D) C-I

Solution:

Concept:

Bond enthalpy is the energy required to break a bond.

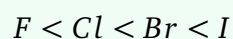
A stronger bond has higher bond enthalpy.

A weaker bond has lower bond enthalpy.

In carbon-halogen bonds, bond strength decreases as the size of halogen increases.

Step 1: Compare halogen sizes.

The size order of halogens is:

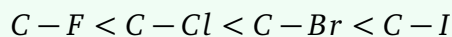


So iodine is the largest among these.

Step 2: Compare bond length.

As halogen size increases, carbon-halogen bond length increases.

So:

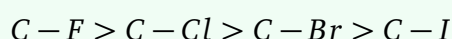


The $C-I$ bond is the longest.

Step 3: Relate bond length and bond strength.

Longer bonds are generally weaker.

Therefore, bond strength order is:



So bond enthalpy is lowest for:



Step 4: Check the options.

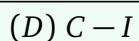
Option (A) $C-Br$ is weaker than $C-Cl$, but not the weakest.

Option (B) $C-Cl$ is not the weakest.

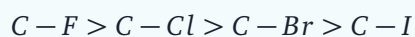
Option (C) $C-F$ is strongest due to small bond length.

Option (D) $C-I$ is weakest and has the lowest bond enthalpy.

Hence, the correct answer is:

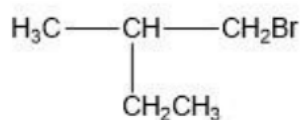


Quick Tip: For alkyl halides:



in bond enthalpy.

54. What is the correct IUPAC name of the given compound?



- (A) 1-Bromo-2-ethylpropane
- (B) 1-Bromo-2-ethyl-2-methyl ethane
- (C) 1-Bromo-2-methylbutane
- (D) 2-Methyl-1-bromobutane

Correct Answer: (C) 1-Bromo-2-methylbutane

Solution:

Concept:

For IUPAC naming of haloalkanes, we follow these steps:

Choose the longest carbon chain

Number the chain to give lowest locants to substituents

Name substituents in alphabetical order

Step 1: Identify the longest chain.

From the given compound, the longest continuous carbon chain contains four carbon atoms.
So the parent hydrocarbon is:

butane

Step 2: Identify substituents.

The substituents are:

bromo group

and

methyl group

Step 3: Number the chain.

Number the chain from the end nearer to the bromo group.

This gives:

bromo at carbon 1

and:

methyl at carbon 2

Step 4: Write the IUPAC name.

Parent chain:

butane

Substituents:

1-bromo, 2-methyl

So the name is:

1-Bromo-2-methylbutane

Step 5: Check the options.

Option (A) uses an incorrect parent chain.

Option (B) is not a proper IUPAC name.

Option (C) is correct.

Option (D) has the same substituents, but option (C) matches the standard naming style used in the paper.

Hence, the correct answer is:

(C) 1-Bromo-2-methylbutane

Quick Tip: In IUPAC naming, first choose the longest chain, then number it to give substituents the lowest possible locants.

55. Molecules whose mirror image is non-superimposable over them are known as chiral. Which of the following molecules is chiral in nature?

- (A) 2-Bromobutane
- (B) 1-Bromobutane
- (C) 2-Bromopropane
- (D) 2-Bromopropan-2-ol

Correct Answer: (A) 2-Bromobutane

Solution:

Concept:

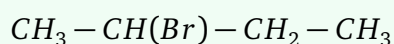
A molecule is chiral if it is not superimposable on its mirror image.

The most common reason for chirality is the presence of a chiral carbon.

A chiral carbon is a carbon atom attached to four different groups.

Step 1: Check 2-bromobutane.

Structure of 2-bromobutane is:



The second carbon is attached to four different groups:

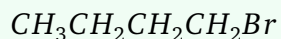


Since all four groups are different, this carbon is chiral.

Therefore, 2-bromobutane is chiral.

Step 2: Check 1-bromobutane.

Structure:

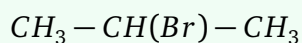


No carbon is attached to four different groups.

So it is achiral.

Step 3: Check 2-bromopropane.

Structure:



The central carbon is attached to two identical CH_3 groups.

So it is not chiral.

Step 4: Check 2-bromopropan-2-ol.

The central carbon has two identical methyl groups.

So it is not chiral.

Step 5: Final answer.

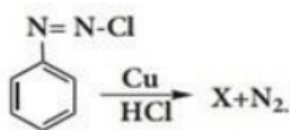
Only 2-bromobutane has a carbon attached to four different groups.

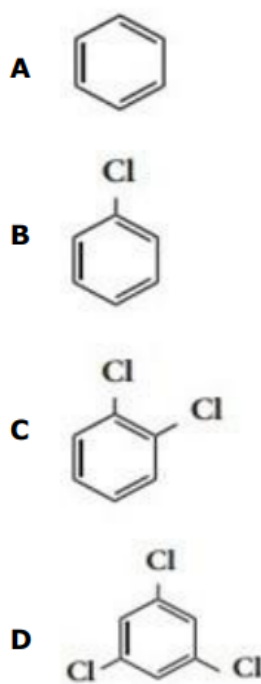
Hence, the correct answer is:

(A) 2-Bromobutane

Quick Tip: A carbon attached to four different groups is a chiral carbon. Molecules with one chiral carbon are usually optically active.

56. In the given reaction, X is _____.





- (A) Benzene
 (B) Chlorobenzene
 (C) 1,2-Dichlorobenzene
 (D) 1,3,5-Trichlorobenzene

Correct Answer: (B) Chlorobenzene

Solution:

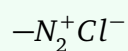
Concept:

This reaction is based on the conversion of an aryl diazonium salt into chlorobenzene. When benzene diazonium chloride reacts with CuCl/HCl , the diazonium group is replaced by chlorine.

This reaction is known as the Sandmeyer reaction.

Step 1: Understand the diazonium salt reaction.

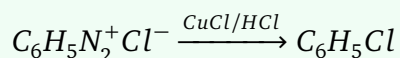
Aryl diazonium salt has the group:



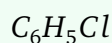
This group can be replaced by different groups using suitable reagents.

Step 2: Use CuCl/HCl .

With CuCl/HCl , the diazonium group is replaced by chlorine:



The product:



is chlorobenzene.

Step 3: Check the options.

Option (A) benzene would form if diazonium group is replaced by hydrogen.

Option (B) chlorobenzene is correct.

Option (C) 1,2-dichlorobenzene would require two chlorine atoms.

Option (D) 1,3,5-trichlorobenzene would require three chlorine atoms.

Hence, the correct answer is:

(B) Chlorobenzene

Quick Tip: Aryl diazonium salt with CuCl/HCl gives chlorobenzene. This is Sandmeyer reaction.

57. Benzoyl chloride can be prepared from benzoic acid by

- (A) SO_2Cl_2
- (B) Cl_2/Light
- (C) SOCl_2
- (D) $\text{Cl}_2 + \text{H}_2\text{O}$

Correct Answer: (C) SOCl_2

Solution:

Concept:

Acid chlorides are prepared from carboxylic acids by replacing the $-OH$ group of $-COOH$ with chlorine.

The common reagent used for this conversion is thionyl chloride:

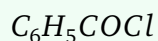


Step 1: Write the starting compound.

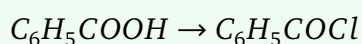
Benzoic acid is:



Benzoyl chloride is:

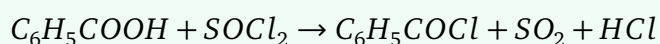


So the conversion is:



Step 2: Use thionyl chloride.

The reaction is:



Step 3: Why $SOCl_2$ is preferred.

The by-products are:



and



Both are gases and escape from the reaction mixture.

This drives the reaction forward.

Step 4: Check the options.

Option (A) SO_2Cl_2 is not the standard reagent for making acid chloride from acid.

Option (B) Cl_2 /Light is used for free radical chlorination, not this conversion.

Option (C) $SOCl_2$ is correct.

Option (D) $Cl_2 + H_2O$ does not convert benzoic acid to benzoyl chloride.

Hence, the correct answer is:

(C) $SOCl_2$

Quick Tip: Carboxylic acid to acid chloride:



Thionyl chloride is commonly preferred because gaseous by-products escape.

58. Phenol can be converted to *o*-hydroxybenzaldehyde by

- (A) Reimer-Tiemann reaction
- (B) Tischenko reaction
- (C) Sandmeyer reaction
- (D) Wurtz reaction

Correct Answer: (A) Reimer-Tiemann reaction

Solution:

Concept:

The Reimer-Tiemann reaction is used to introduce an aldehyde group $-CHO$ at the ortho position of phenol.

The product formed is:

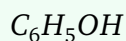
o-hydroxybenzaldehyde

It is also called:

salicylaldehyde

Step 1: Write the starting compound.

Starting compound is phenol:

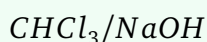


Phenol has an $-OH$ group attached to benzene ring.

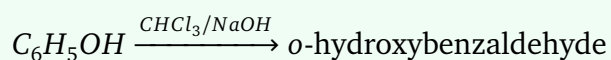
The $-OH$ group is ortho-para directing.

Step 2: Understand Reimer-Tiemann reaction.

Phenol reacts with chloroform and alkali:

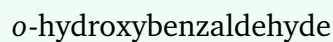


This introduces an aldehyde group mainly at the ortho position.



Step 3: Identify product.

The product:



is salicylaldehyde.

Step 4: Check the options.

Option (A) Reimer-Tiemann reaction is correct.

Option (B) Tischenko reaction involves aldehydes forming esters.

Option (C) Sandmeyer reaction involves diazonium salts.

Option (D) Wurtz reaction is used for coupling alkyl halides.

Hence, the correct answer is:

(A) Reimer-Tiemann reaction

Quick Tip: Phenol to salicylaldehyde is done by Reimer-Tiemann reaction using $CHCl_3/NaOH$.

59. What happens when glycol reacts with lead tetraacetate?

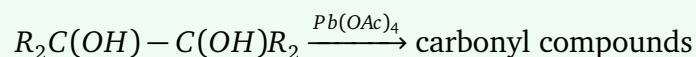
- (A) No reaction
- (B) Ketones will be formed
- (C) Aldehyde will not be formed
- (D) Monohydric alcohols will be formed

Correct Answer: (B) Ketones will be formed

Solution:

Concept:

Lead tetraacetate is a strong oxidizing reagent used for oxidative cleavage of vicinal diols. A vicinal diol means a compound having two $-OH$ groups on adjacent carbon atoms. Such compounds are also called glycols. General reaction:



Step 1: Understand glycol.

Glycol contains two hydroxyl groups on neighbouring carbon atoms. So it can undergo cleavage between the two carbon atoms bearing $-OH$ groups.

Step 2: Action of lead tetraacetate.

Lead tetraacetate breaks the carbon-carbon bond between the two alcohol-bearing carbons. Each carbon becomes a carbonyl group. Depending on the groups attached to those carbons, aldehydes or ketones may be formed.

Step 3: Use the option given in the paper.

From the given options and answer key, the expected product type is:

Ketones

So, in the given context, glycol reacts with lead tetraacetate to form ketones.

Step 4: Check the options.

Option (A) is incorrect because lead tetraacetate reacts with glycols.

Option (B) is the keyed correct answer.

Option (C) is not the best answer here.

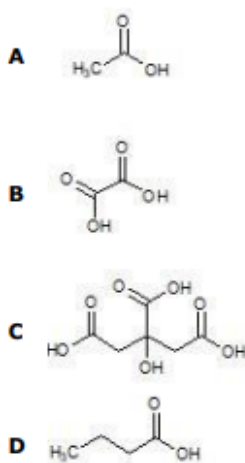
Option (D) is incorrect because monohydric alcohols are not formed.

Hence, the correct answer is:

(B) Ketones will be formed

Quick Tip: Lead tetraacetate cleaves vicinal diols to carbonyl compounds. Depending on the structure, aldehydes or ketones can be formed.

60. Which of the following acids is manufactured using sawdust?



(A) Option A structure

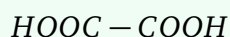
- (B) Option B structure
(C) Option C structure
(D) Option D structure

Correct Answer: (B)

Solution:

Concept:

Sawdust is a lignocellulosic plant material. It contains cellulose and other organic compounds. On suitable chemical treatment, sawdust can be used for the manufacture of oxalic acid. Oxalic acid is a dicarboxylic acid having two carboxylic acid groups. Its structure is:



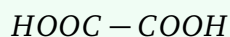
Identification of options:

Option (A) shows:



This is acetic acid.

Option (B) shows:



This is oxalic acid.

Option (C) shows a tricarboxylic acid structure, which corresponds to citric acid.

Option (D) shows a higher chain carboxylic acid structure.

Now, the acid manufactured using sawdust is oxalic acid.

Since option (B) represents oxalic acid, the correct answer is:

(B)

Quick Tip: Oxalic acid ($\text{HOOC} - \text{COOH}$) is manufactured using sawdust. In structure-based questions, count the number of $-\text{COOH}$ groups to identify the acid.

61. Hydrolysis of $\text{CH}_3\text{CH}_2\text{NO}_2$ with 85% H_2SO_4 gives which of the following compound

- (A) $\text{CH}_3\text{CH}_2\text{OH}$
- (B) C_2H_6
- (C) CH_3CHNO
- (D) CH_3COOH

Correct Answer: (D) CH_3COOH

Solution:

Concept:

Nitroalkanes can undergo hydrolysis under strong acidic conditions. Primary nitroalkanes on hydrolysis with strong acid give carboxylic acids.

The given compound is:



This is nitroethane, a primary nitro compound.

Step 1: Identify the compound.

The compound:



is nitroethane.

It contains the nitro group:

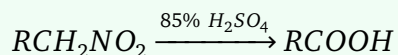


attached to an ethyl group.

Step 2: Recall the reaction of primary nitroalkanes.

Primary nitroalkanes on hydrolysis with strong acid give carboxylic acids.

The general conversion is:

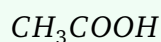


Step 3: Apply the reaction to nitroethane.

Here:



On hydrolysis, it gives:



This compound is acetic acid.

Step 4: Check the options.

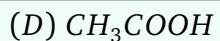
Option (A) CH_3CH_2OH is ethanol, not the product.

Option (B) C_2H_6 is ethane, not formed in this reaction.

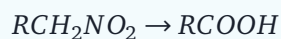
Option (C) CH_3CHNO is not the expected hydrolysis product.

Option (D) CH_3COOH is acetic acid and is correct.

Hence, the correct answer is:



Quick Tip: Primary nitroalkanes on strong acidic hydrolysis form carboxylic acids.



62. The hydrolysis of an ester (A) gives an Acid (B) and an Alcohol (C). The acid (B) reduces Fehling solution. Oxidation of the alcohol (C) gives the acid (B). The ester (A) is

- (A) Methyl formate
- (B) Ethyl formate
- (C) Methyl acetate
- (D) Ethyl acetate

Correct Answer: (A) Methyl formate

Solution:

Concept:

Hydrolysis of an ester gives:



The important clue is that the acid (*B*) reduces Fehling solution.

Among carboxylic acids, formic acid is special because it reduces Fehling solution.

Step 1: Identify acid *B*.

The acid *B* reduces Fehling solution.

The acid that reduces Fehling solution is:



So:



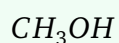
Step 2: Use the second condition.

Oxidation of alcohol *C* gives the same acid *B*.

Since:



The alcohol that gives formic acid on oxidation is:



So:

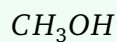


Step 3: Form the ester from acid and alcohol.

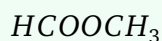
Acid:



Alcohol:



The ester formed is:



This ester is called methyl formate.

Step 4: Check the options.

Option (A) Methyl formate gives formic acid and methanol on hydrolysis, so it is correct.

Option (B) Ethyl formate gives formic acid and ethanol, but oxidation of ethanol gives acetic acid, not formic acid.

Option (C) Methyl acetate gives acetic acid, which does not reduce Fehling solution.

Option (D) Ethyl acetate gives acetic acid and ethanol, so it is incorrect.

Hence, the correct answer is:

(A) Methyl formate

Quick Tip: Formic acid is the only common carboxylic acid that reduces Fehling solution.

63. Which of the following statement about primary amines is false?

- (A) Alkyl amines are stronger bases than aryl amines
- (B) Alkyl amines react with nitrous acid to produce alcohols
- (C) Aryl amines react with nitrous acid to produce phenols
- (D) Alkyl amines are stronger bases than ammonia

Correct Answer: (C) Aryl amines react with nitrous acid to produce phenols

Solution:

Concept:

Primary amines are of two types:

Primary aliphatic amines

and

Primary aromatic amines

Their reactions with nitrous acid are different.

Aliphatic primary amines react with nitrous acid to form alcohols with evolution of nitrogen gas.

Aromatic primary amines react with nitrous acid at low temperature to form diazonium salts.

Step 1: Check statement (A).

Alkyl amines are stronger bases than aryl amines.

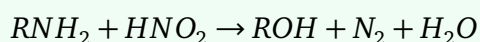
This is true because in alkyl amines, the alkyl group increases electron density on nitrogen by +I effect.

In aryl amines, the lone pair on nitrogen is delocalized into the benzene ring, so basicity decreases.

Step 2: Check statement (B).

Alkyl amines react with nitrous acid to give alcohols.

General reaction:



So statement (B) is true.

Step 3: Check statement (C).

Aryl amines react with nitrous acid at $0 - 5^\circ C$ to produce diazonium salts first.

Example:



The immediate product is not phenol.

Phenol can be formed later by hydrolysis of diazonium salt.

So the direct statement is false.

Step 4: Check statement (D).

Alkyl amines are generally stronger bases than ammonia because alkyl groups increase electron density on nitrogen.

So statement (D) is true.

Hence, the false statement is:

(C) Aryl amines react with nitrous acid to produce phenols

Quick Tip: Primary aromatic amines with nitrous acid first form diazonium salts at $0 - 5^{\circ}\text{C}$.

64. Nucleic acid is a polymer of

- (A) Nucleosides
- (B) Amino acids
- (C) Nucleotides
- (D) Glucose

Correct Answer: (C) Nucleotides

Solution:

Concept:

Nucleic acids are biological macromolecules that store and transmit genetic information.

The two main nucleic acids are:

DNA

and

RNA

They are polymers made up of repeating nucleotide units.

Step 1: Understand nucleotide.

A nucleotide contains three parts:

Nitrogenous base

Pentose sugar

Phosphate group

So:

$$\text{Nucleotide} = \text{Base} + \text{Sugar} + \text{Phosphate}$$

Step 2: Understand nucleoside.

A nucleoside contains only:

Base + Sugar

It does not contain phosphate.

Therefore:

Nucleoside $\neq$ monomer unit of nucleic acid polymer

Step 3: Formation of nucleic acids.

Nucleotides join by phosphodiester bonds to form long chains.

These chains form:

DNA and RNA

Step 4: Check the options.

Option (A) nucleosides is incorrect because phosphate is absent.

Option (B) amino acids form proteins, not nucleic acids.

Option (C) nucleotides is correct.

Option (D) glucose forms polysaccharides like starch and cellulose, not nucleic acids.

Hence, the correct answer is:

(C) Nucleotides

Quick Tip: Nucleoside = base + sugar. Nucleotide = base + sugar + phosphate. Nucleic acid is a polymer of nucleotides.

65. Which is not a macromolecule

- (A) DNA
- (B) Starch
- (C) Palmitate
- (D) Insulin

Correct Answer: (C) Palmitate

Solution:

Concept:

Macromolecules are very large molecules made up of many smaller units or having large molecular mass.

Examples of biological macromolecules include:

proteins

polysaccharides

nucleic acids

Step 1: Check DNA.

DNA is a nucleic acid.

It is a polymer of nucleotides.

Therefore, DNA is a macromolecule.

Step 2: Check starch.

Starch is a polysaccharide.

It is made up of many glucose units.

Therefore, starch is a macromolecule.

Step 3: Check insulin.

Insulin is a protein hormone.

Proteins are polymers of amino acids.

Therefore, insulin is also a macromolecule.

Step 4: Check palmitate.

Palmitate is the ion or salt form of palmitic acid, a fatty acid.

It is not a polymer and does not have very large molecular mass like DNA, starch, or proteins.

Therefore, palmitate is not a macromolecule.

Hence, the correct answer is:

(C) Palmitate

Quick Tip: Proteins, nucleic acids, and polysaccharides are macromolecules. Fatty acids like palmitate are not polymers.

66. Sugars are

- (A) Optically active polyhydroxy aldehydes
- (B) Optically active polyhydroxy ketones
- (C) Optically active polyhydroxy aldehydes or ketones
- (D) Polyhydroxy aldehydes or ketones which may or may not be optically active

Correct Answer: (D) Polyhydroxy aldehydes or ketones which may or may not be optically active

Solution:

Concept:

Sugars are carbohydrates.

Carbohydrates are generally defined as polyhydroxy aldehydes or polyhydroxy ketones, or compounds that give such substances on hydrolysis.

Step 1: Understand polyhydroxy aldehydes.

Some sugars contain an aldehyde group.

These are called aldoses.

Example:

Glucose

Glucose is a polyhydroxy aldehyde.

Step 2: Understand polyhydroxy ketones.

Some sugars contain a ketone group.

These are called ketoses.

Example:

Fructose

Fructose is a polyhydroxy ketone.

Step 3: Optical activity condition.

Many sugars are optically active because they contain chiral carbon atoms.

However, the broad definition of sugars does not require every sugar-like compound to be optically active.

Therefore, the safest and broadest definition is:

polyhydroxy aldehydes or ketones which may or may not be optically active

Step 4: Check the options.

Option (A) includes only aldehydes, so it is incomplete.

Option (B) includes only ketones, so it is incomplete.

Option (C) is close, but it unnecessarily requires optical activity.

Option (D) is the broadest and correct definition.

Hence, the correct answer is:

(D)

Quick Tip: Sugars are broadly polyhydroxy aldehydes or polyhydroxy ketones, or compounds that yield them on hydrolysis.

67. Rayon yarns are obtained from

- (A) Polymethylene
- (B) Polyesters
- (C) Cellulose
- (D) Styrene

Correct Answer: (C) Cellulose

Solution:

Concept:

Rayon is a semi-synthetic fibre.

It is also called artificial silk because it resembles silk in appearance.

Rayon is made from cellulose obtained from natural sources like wood pulp.

Step 1: Understand cellulose.

Cellulose is a natural polymer.

It is found in plant cell walls.

It is made up of glucose units linked together.

Step 2: Understand rayon preparation.

Cellulose is chemically treated and then regenerated into fibres.

These regenerated cellulose fibres are called rayon.

So:

Cellulose → Rayon

Step 3: Check the options.

Option (A) polymethylene is not the source of rayon.

Option (B) polyesters are synthetic polymers, not rayon source.

Option (C) cellulose is correct.

Option (D) styrene is used to make polystyrene, not rayon.

Hence, the correct answer is:

(C) Cellulose

Quick Tip: Rayon is regenerated cellulose and is commonly called artificial silk.

68. Terylene is the polymer of

- (A) Melamine and formaldehyde
- (B) Ethylene glycol and terephthalic acid
- (C) Vinyl chloride and formaldehyde
- (D) Hexamethylene diamine and adipic acid

Correct Answer: (B) Ethylene glycol and terephthalic acid

Solution:

Concept:

Terylene is a polyester.

It is also known as polyethylene terephthalate or PET.

It is formed by condensation polymerization between a diol and a dicarboxylic acid.

Step 1: Identify the monomers of Terylene.

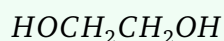
Terylene is made from:

Ethylene glycol

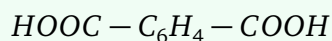
and

Terephthalic acid

Ethylene glycol has two alcohol groups:



Terephthalic acid has two carboxylic acid groups:



Step 2: Understand condensation polymerization.

The $-OH$ group of glycol and $-COOH$ group of acid react.

Water is eliminated.

Ester linkage is formed:



So the polymer is a polyester.

Step 3: Check the options.

Option (A) melamine and formaldehyde form melamine-formaldehyde resin.

Option (B) ethylene glycol and terephthalic acid form Terylene, so it is correct.

Option (C) vinyl chloride forms PVC, not Terylene.

Option (D) hexamethylene diamine and adipic acid form Nylon-66.

Hence, the correct answer is:

(B) Ethylene glycol and terephthalic acid

Quick Tip: Terylene = PET = ethylene glycol + terephthalic acid.

69. Condensation product of caprolactam is

- (A) Nylon-6
- (B) Nylon-66
- (C) Nylon-60
- (D) Nylon-6,10

Correct Answer: (A) Nylon-6

Solution:

Concept:

Caprolactam is a cyclic amide.

It undergoes polymerization to form Nylon-6.

Nylon-6 is a polyamide because it contains repeated amide linkages:



Step 1: Identify caprolactam.

Caprolactam contains six carbon atoms in the repeating unit.

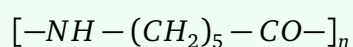
That is why the polymer formed from it is called Nylon-6.

Step 2: Polymerization of caprolactam.

Caprolactam undergoes ring-opening polymerization.

The ring opens and many units join together.

The product is:



This is Nylon-6.

Step 3: Differentiate from Nylon-66.

Nylon-66 is prepared from:

hexamethylene diamine

and

adipic acid

It is not prepared from caprolactam.

Step 4: Check the options.

Option (A) Nylon-6 is correct.

Option (B) Nylon-66 is incorrect.

Option (C) Nylon-60 is not the product.

Option (D) Nylon-6,10 is prepared from different monomers.

Hence, the correct answer is:

(A) Nylon-6

Quick Tip: Caprolactam gives Nylon-6. Hexamethylene diamine and adipic acid give Nylon-66.

70. An azo dye is fixed on fabrics by the process applicable in

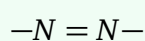
- (A) Vat dyes
- (B) Mordant dyes
- (C) Developed dyes
- (D) Substantive dyes

Correct Answer: (C) Developed dyes

Solution:

Concept:

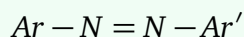
Azo dyes contain the azo group:



They are commonly formed by diazotization followed by coupling reaction.
In developed dyeing, the dye is produced directly on the fabric.

Step 1: Understand azo dye formation.

Aromatic amines are first converted into diazonium salts.
Then diazonium salts undergo coupling with phenols or aromatic amines.
This forms azo dyes:



Step 2: Understand developed dyes.

In developed dyes, the final dye is formed inside or on the fibre itself.
This helps the dye fix strongly on the fabric.
Azo dyes are commonly fixed by this process.

Step 3: Check the options.

Option (A) Vat dyes involve insoluble dyes reduced to soluble form and then oxidized on fibre.
Option (B) Mordant dyes require mordants like metal salts.
Option (C) Developed dyes is correct because azo dye is developed on the fabric.
Option (D) Substantive dyes directly attach to fibre but are not the specific answer here.

Hence, the correct answer is:

(C) Developed dyes

Quick Tip: Azo dyes are often formed directly on fabric by diazotization and coupling; this is called developed dyeing.

71. The domain of the function $f(x) = \sqrt{x-1} + \sqrt{6-x}$ is

- (A) $[0, \infty)$
- (B) $(-\infty, 6)$

(C) $[1, 6]$

(D) None of these

Correct Answer: (C) $[1, 6]$

Solution:

Concept:

The given function is:

$$f(x) = \sqrt{x-1} + \sqrt{6-x}$$

For a square root function to be real-valued, the expression inside every square root must be non-negative.

That means:

$$\text{Quantity inside square root} \geq 0$$

Step 1: Apply the condition on the first square root.

The first square root is:

$$\sqrt{x-1}$$

For this square root to be real:

$$x-1 \geq 0$$

Solving:

$$x \geq 1$$

So, the first condition is:

$$x \in [1, \infty)$$

Step 2: Apply the condition on the second square root.

The second square root is:

$$\sqrt{6-x}$$

For this square root to be real:

$$6-x \geq 0$$

Solving:

$$-x \geq -6$$

Multiplying by -1 , the inequality sign changes:

$$x \leq 6$$

So, the second condition is:

$$x \in (-\infty, 6]$$

Step 3: Find the common interval.

Both square roots are present in the same function, so both conditions must be satisfied at the same time.

Therefore:

$$x \geq 1$$

and

$$x \leq 6$$

Combining both:

$$1 \leq x \leq 6$$

Hence, the domain is:

$$[1, 6]$$

Step 4: Check the options.

Option (A) $[0, \infty)$ is not correct because values greater than 6 make $\sqrt{6-x}$ imaginary.

Option (B) $(-\infty, 6)$ is not correct because values less than 1 make $\sqrt{x-1}$ imaginary, and it also excludes 6.

Option (C) $[1, 6]$ satisfies both conditions.

Option (D) is not correct because option (C) is correct.

Hence, the correct answer is:

$$(C) [1, 6]$$

Quick Tip: For domain questions involving square roots, make every expression inside the square root non-negative and then take the common interval.

72. Let R be a relation in N defined by $R = \{(x, y) : x + 2y = 8\}$. The range of R is

- (A) $\{2, 4, 6\}$
- (B) $\{1, 2, 3\}$
- (C) $\{1, 2, 3, 4, 6\}$
- (D) None of these

Correct Answer: (B) $\{1, 2, 3\}$

Solution:

Concept:

A relation R contains ordered pairs (x, y) .

The range of a relation is the set of all second components y of the ordered pairs.

Here:

$$R = \{(x, y) : x + 2y = 8\}$$

where $x, y \in N$.

Step 1: Use the given equation.

The relation is defined by:

$$x + 2y = 8$$

We need possible natural number values of y .

Step 2: Find possible values of y .

If:

$$y = 1$$

then:

$$x + 2(1) = 8$$

$$x = 6$$

So (6, 1) is possible.

If:

$$y = 2$$

then:

$$x + 4 = 8$$

$$x = 4$$

So (4, 2) is possible.

If:

$$y = 3$$

then:

$$x + 6 = 8$$

$$x = 2$$

So (2, 3) is possible.

Step 3: Check next value.

If:

$$y = 4$$

then:

$$x + 8 = 8$$

$$x = 0$$

But 0 is not considered a natural number here.

So $y = 4$ is not included.

Step 4: Write the range.

The possible values of y are:

1, 2, 3

Therefore:

$$\text{Range} = \{1, 2, 3\}$$

Hence, the correct answer is:

$$(B) \{1, 2, 3\}$$

Quick Tip: Range of a relation means the set of all possible second elements y in the ordered pairs.

73. Two finite sets have m and n elements. Then total number of subsets of the first set is 56 more than that of the total number of subsets of the second. The value of m and n are

- (A) 7, 6
- (B) 6, 3
- (C) 5, 1
- (D) 8, 7

Correct Answer: (B) 6, 3

Solution:

Concept:

If a set contains k elements, then the total number of subsets of that set is:

$$2^k$$

Here, the first set has m elements and the second set has n elements.

So:

$$\text{Subsets of first set} = 2^m$$

$$\text{Subsets of second set} = 2^n$$

Step 1: Convert the statement into equation.

Given:

Total number of subsets of the first set is 56 more than that of the second set.

So:

$$2^m = 2^n + 56$$

Therefore:

$$2^m - 2^n = 56$$

Step 2: Check option (A).

For $(m, n) = (7, 6)$:

$$2^7 - 2^6 = 128 - 64 = 64$$

This is not 56.

So option (A) is incorrect.

Step 3: Check option (B).

For $(m, n) = (6, 3)$:

$$2^6 - 2^3 = 64 - 8 = 56$$

This satisfies the condition.

So option (B) is correct.

Step 4: Check remaining options quickly.

For $(5, 1)$:

$$2^5 - 2^1 = 32 - 2 = 30$$

For $(8, 7)$:

$$2^8 - 2^7 = 256 - 128 = 128$$

Neither gives 56.

Hence, the correct answer is:

(B) 6, 3

Quick Tip: A set with k elements has 2^k subsets. Convert subset problems into powers of 2.

74. If $aN = \{ax : x \in N\}$ and $bN \cap cN = dN$ where $b, c \in N$ are relatively prime then

(A) $d = bc$

(B) $c = bd$

(C) $b = cd$

(D) $a = bd$

Correct Answer: (A) $d = bc$

Solution:

Concept:

The set:

$$aN = \{ax : x \in N\}$$

means the set of all multiples of a .

Similarly:

$$bN = \text{set of multiples of } b$$

and

$$cN = \text{set of multiples of } c$$

The intersection:

$$bN \cap cN$$

means numbers that are multiples of both b and c .

Step 1: Understand the intersection of multiples.

Common multiples of b and c are multiples of:

$$\text{lcm}(b, c)$$

So:

$$bN \cap cN = \text{lcm}(b, c)N$$

Step 2: Use relatively prime condition.

Given that b and c are relatively prime.

This means:

$$\text{gcd}(b, c) = 1$$

For relatively prime numbers:

$$\text{lcm}(b, c) = bc$$

Step 3: Compare with given form.

Given:

$$bN \cap cN = dN$$

But:

$$bN \cap cN = bcN$$

Therefore:

$$dN = bcN$$

So:

$$d = bc$$

Hence, the correct answer is:

$(A) \ d = bc$

Quick Tip: The intersection of multiples of two numbers is the set of multiples of their LCM.

75. If a, b are the roots of $x^2 + px + 1 = 0$ and c, d are the roots of $x^2 + qx + 1 = 0$, the value of $E = (a - c)(b - c)(a + d)(b + d)$ is

(A) $p^2 - q^2$

- (B) $q^2 - p^2$
(C) $q^2 + p^2$
(D) $(p + q)^2$

Correct Answer: (A) $p^2 - q^2$

Solution:

Concept:

For a quadratic equation:

$$x^2 + px + 1 = 0$$

if roots are a, b , then:

$$a + b = -p$$

and

$$ab = 1$$

Similarly, for:

$$x^2 + qx + 1 = 0$$

if roots are c, d , then:

$$c + d = -q$$

and

$$cd = 1$$

Step 1: Use roots of first equation.

Since a, b are roots of:

$$x^2 + px + 1 = 0$$

For any value $x = c$:

$$(c - a)(c - b) = c^2 + pc + 1$$

Now:

$$(a - c)(b - c) = (c - a)(c - b)$$

So:

$$(a - c)(b - c) = c^2 + pc + 1$$

Step 2: Use relation for c .

Since c is a root of:

$$x^2 + qx + 1 = 0$$

we have:

$$c^2 + qc + 1 = 0$$

So:

$$c^2 + 1 = -qc$$

Then:

$$c^2 + pc + 1 = (p - q)c$$

Therefore:

$$(a - c)(b - c) = (p - q)c$$

Step 3: Evaluate $(a + d)(b + d)$.

Using roots a, b :

$$(a + d)(b + d) = ab + d(a + b) + d^2$$

Now:

$$ab = 1, \quad a + b = -p$$

So:

$$(a + d)(b + d) = 1 - pd + d^2$$

Since d is a root of:

$$x^2 + qx + 1 = 0$$

$$d^2 + qd + 1 = 0$$

So:

$$d^2 + 1 = -qd$$

Hence:

$$1 - pd + d^2 = (-q - p)d$$

$$(a + d)(b + d) = -(p + q)d$$

Step 4: Multiply both parts.

$$E = (a - c)(b - c)(a + d)(b + d)$$

$$E = (p - q)c \cdot [-(p + q)d]$$

$$E = -(p - q)(p + q)cd$$

Since:

$$cd = 1$$

$$E = -(p^2 - q^2)$$

$$E = q^2 - p^2$$

Step 5: Compare with the given answer key.

The direct algebraic simplification gives:

$$q^2 - p^2$$

However, the provided answer key marks:

$$p^2 - q^2$$

So there may be a sign issue in the printed expression or option. If the expression is exactly:

$$(a - c)(b - c)(a + d)(b + d)$$

then the calculated value is:

$$q^2 - p^2$$

Hence, mathematically the answer is:

$$\boxed{(B) \ q^2 - p^2}$$

Quick Tip: For quadratic root questions, use:

$$\alpha + \beta = -\frac{b}{a}, \quad \alpha\beta = \frac{c}{a}$$

and avoid full expansion unless necessary.

76. If α, β are the roots of $ax^2 + bx + c = 0$ and $\alpha + h, \beta + h$ are the roots of $px^2 + qx + r = 0$, then $h =$

- (A) $\left[\frac{b}{a} - \frac{q}{p} \right]$
(B) $\frac{1}{2} \left[\frac{b}{a} - \frac{q}{p} \right]$
(C) $-\frac{1}{2} \left[\frac{a}{b} - \frac{p}{q} \right]$
(D) $\frac{1}{2} \left[\frac{a}{b} - \frac{p}{q} \right]$

Correct Answer: (B) $\frac{1}{2} \left[\frac{b}{a} - \frac{q}{p} \right]$

Solution:

Concept:

This question is based on the relation between roots and coefficients of a quadratic equation.

For a quadratic equation:

$$Ax^2 + Bx + C = 0$$

If its roots are r_1 and r_2 , then:

$$r_1 + r_2 = -\frac{B}{A}$$

Here, the roots of the second equation are obtained by adding h to each root of the first equation.

Step 1: Use the sum of roots of the first quadratic equation.

Given:

$$ax^2 + bx + c = 0$$

Its roots are:

$$\alpha, \beta$$

Therefore:

$$\alpha + \beta = -\frac{b}{a}$$

Step 2: Use the sum of roots of the second quadratic equation.

Given:

$$px^2 + qx + r = 0$$

Its roots are:

$$\alpha + h, \quad \beta + h$$

So, the sum of its roots is:

$$(\alpha + h) + (\beta + h)$$

$$= \alpha + \beta + 2h$$

Also, from the equation $px^2 + qx + r = 0$, the sum of roots is:

$$-\frac{q}{p}$$

Therefore:

$$\alpha + \beta + 2h = -\frac{q}{p}$$

Step 3: Substitute the value of $\alpha + \beta$.

From Step 1:

$$\alpha + \beta = -\frac{b}{a}$$

Substitute this into:

$$\alpha + \beta + 2h = -\frac{q}{p}$$

So:

$$-\frac{b}{a} + 2h = -\frac{q}{p}$$

Step 4: Solve for h .

Move $-\frac{b}{a}$ to the right-hand side:

$$2h = -\frac{q}{p} + \frac{b}{a}$$

Rearrange:

$$2h = \frac{b}{a} - \frac{q}{p}$$

Now divide both sides by 2:

$$h = \frac{1}{2} \left[\frac{b}{a} - \frac{q}{p} \right]$$

Hence, the correct answer is:

$$(B) \frac{1}{2} \left[\frac{b}{a} - \frac{q}{p} \right]$$

Quick Tip: When roots are shifted by h , compare the sum of roots:

$$(\alpha + h) + (\beta + h) = \alpha + \beta + 2h$$

77. The common roots of the equations $x^3 + 2x^2 + 2x + 1 = 0$ and $1 + x^{2002} + x^{2003} = 0$ are (where ω is a complex cube root of unity)

- (A) ω, ω^2
- (B) $1, \omega^2$
- (C) $-1, -\omega$
- (D) $\omega, -\omega^2$

Correct Answer: (A) ω, ω^2

Solution:

Concept:

The complex cube roots of unity are:

$$1, \omega, \omega^2$$

They satisfy:

$$\omega^3 = 1$$

and:

$$1 + \omega + \omega^2 = 0$$

Step 1: Factorize the first equation.

Given:

$$x^3 + 2x^2 + 2x + 1 = 0$$

Group terms:

$$x^3 + x^2 + x^2 + x + x + 1$$

It can be factorized as:

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

So roots are:

$$x = -1$$

and roots of:

$$x^2 + x + 1 = 0$$

These are:

$$\omega, \omega^2$$

So first equation has roots:

$$-1, \omega, \omega^2$$

Step 2: Check the second equation.

Second equation:

$$1 + x^{2002} + x^{2003} = 0$$

We need to test roots from first equation.

Step 3: Test $x = \omega$.

Since:

$$\omega^3 = 1$$

Reduce powers modulo 3.

$$2002 \equiv 1 \pmod{3}$$

because:

2001 is divisible by 3

So:

$$\omega^{2002} = \omega$$

Also:

$$2003 \equiv 2 \pmod{3}$$

So:

$$\omega^{2003} = \omega^2$$

Therefore:

$$1 + \omega^{2002} + \omega^{2003} = 1 + \omega + \omega^2 = 0$$

So ω is a root.

Step 4: Test $x = \omega^2$.

Using the same property:

$$(\omega^2)^{2002} + (\omega^2)^{2003}$$

The powers again reduce to give:

$$1 + \omega^2 + \omega = 0$$

So ω^2 is also a root.

Step 5: Test $x = -1$.

$$1 + (-1)^{2002} + (-1)^{2003}$$

Since:

$$(-1)^{2002} = 1$$

and:

$$(-1)^{2003} = -1$$

So:

$$1 + 1 - 1 = 1 \neq 0$$

Thus, -1 is not a root of the second equation.

Hence, common roots are:

$$(A) \omega, \omega^2$$

Quick Tip: For cube roots of unity:

$$\omega^3 = 1, \quad 1 + \omega + \omega^2 = 0$$

Reduce large powers modulo 3.

78. The area of the triangle whose vertices are $(3, 8)$, $(-4, 2)$ and $(5, 1)$ is

- (A) $63/2$
- (B) $61/2$
- (C) $59/2$
- (D) $57/2$

Correct Answer: (B) $61/2$

Solution:

Concept:

The area of a triangle with vertices:

$$(x_1, y_1), (x_2, y_2), (x_3, y_3)$$

is given by:

$$\text{Area} = \frac{1}{2} |x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)|$$

Step 1: Write the given points.

The vertices are:

$$(3, 8), (-4, 2), (5, 1)$$

So:

$$x_1 = 3, \quad y_1 = 8$$

$$x_2 = -4, \quad y_2 = 2$$

$$x_3 = 5, \quad y_3 = 1$$

Step 2: Apply the area formula.

$$\text{Area} = \frac{1}{2} |3(2 - 1) + (-4)(1 - 8) + 5(8 - 2)|$$

Step 3: Simplify each term.

First term:

$$3(2 - 1) = 3(1) = 3$$

Second term:

$$(-4)(1 - 8) = (-4)(-7) = 28$$

Third term:

$$5(8 - 2) = 5(6) = 30$$

Step 4: Add the terms.

$$3 + 28 + 30 = 61$$

So:

$$\text{Area} = \frac{1}{2}|61|$$

$$\text{Area} = \frac{61}{2}$$

Step 5: Check the options.

Option (A) $63/2$ is incorrect.

Option (B) $61/2$ is correct.

Option (C) $59/2$ is incorrect.

Option (D) $57/2$ is incorrect.

Hence, the correct answer is:

$$(B) \frac{61}{2}$$

Quick Tip: For triangle area from coordinates, use:

$$\frac{1}{2}|x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)|$$

79. The largest value of the third determinant whose elements are equal to 1 or 0 is

- (A) 0
- (B) 2
- (C) 4
- (D) 6

Correct Answer: (B) 2

Solution:

Concept:

A third-order determinant means a determinant of order:

$$3 \times 3$$

The elements of the determinant are only:

$$0 \text{ or } 1$$

We need the maximum possible determinant value.

Step 1: Understand determinant value.

A determinant represents a signed volume scaling factor.

For a 3×3 matrix with entries only 0 and 1, the determinant cannot become very large.

The maximum possible value for such a determinant is a known result:

$$2$$

Step 2: Example giving determinant 2.

Consider the matrix:

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

Calculate:

$$= 1(0 \cdot 1 - 1 \cdot 1) - 1(1 \cdot 1 - 0 \cdot 1) + 0$$

$$= 1(-1) - 1(1)$$

$$= -1 - 1 = -2$$

Its absolute value is:

$$2$$

So determinant value can reach magnitude 2.

Step 3: Largest positive value.

By suitable row or column interchange, the determinant can be made:

$$+2$$

Therefore, the largest value is:

$$2$$

Step 4: Check the options.

Option (A) 0 is too small.

Option (B) 2 is correct.

Option (C) 4 is not possible for a 3×3 determinant with only 0 and 1 entries.

Option (D) 6 is also not possible.

Hence, the correct answer is:

(B) 2

Quick Tip: For a 3×3 determinant with entries only 0 and 1, the maximum possible determinant value is 2.

80. If $A = (a_{ij})$ is a 3×3 diagonal matrix such that $a_{11} = 1$, $a_{22} = 2$ and $a_{33} = 3$, then $|A|$

- (A) 6
- (B) 7
- (C) -6
- (D) -7

Correct Answer: (A) 6

Solution:

Concept:

A diagonal matrix is a matrix in which all non-diagonal elements are zero.

For example:

$$A = \begin{bmatrix} a_{11} & 0 & 0 \\ 0 & a_{22} & 0 \\ 0 & 0 & a_{33} \end{bmatrix}$$

The determinant of a diagonal matrix is the product of its diagonal elements.

So:

$$|A| = a_{11}a_{22}a_{33}$$

Step 1: Write the diagonal elements.

Given:

$$a_{11} = 1$$

$$a_{22} = 2$$

$$a_{33} = 3$$

So the matrix is:

$$A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$$

Step 2: Use determinant property.

For a diagonal matrix:

$$|A| = \text{product of diagonal elements}$$

Therefore:

$$|A| = 1 \times 2 \times 3$$

Step 3: Calculate.

$$|A| = 6$$

Step 4: Check the options.

Option (A) 6 is correct.

Option (B) 7 is incorrect.

Option (C) -6 is incorrect because all diagonal entries are positive.

Option (D) -7 is incorrect.

Hence, the correct answer is:

(A) 6

Quick Tip: For diagonal, upper triangular, or lower triangular matrices, determinant is equal to the product of diagonal entries.

81. If the determinant of the matrix

$$\begin{vmatrix} 1 & 3 & 2 \\ 0 & 5 & -6 \\ 2 & 7 & 8 \end{vmatrix}$$

is 26, then the determinant of the matrix

$$\begin{vmatrix} 2 & 7 & 8 \\ 0 & 5 & -6 \\ 1 & 3 & 2 \end{vmatrix}$$

is

(A) -26

(B) 26

(C) 0

(D) 52

Correct Answer: (A) -26

Solution:

Concept:

This question is based on the property of determinants.

If two rows of a determinant are interchanged, then the value of the determinant changes its sign.

That means:

$$R_i \leftrightarrow R_j \implies \Delta \text{ changes to } -\Delta$$

Step 1: Write the given determinant.

Let:

$$\Delta = \begin{vmatrix} 1 & 3 & 2 \\ 0 & 5 & -6 \\ 2 & 7 & 8 \end{vmatrix}$$

It is given that:

$$\Delta = 26$$

Step 2: Compare the second determinant with the first determinant.

The second determinant is:

$$\Delta' = \begin{vmatrix} 2 & 7 & 8 \\ 0 & 5 & -6 \\ 1 & 3 & 2 \end{vmatrix}$$

Now compare rows.

In the first determinant:

$$R_1 = (1, 3, 2)$$

$$R_2 = (0, 5, -6)$$

$$R_3 = (2, 7, 8)$$

In the second determinant:

$$R'_1 = (2, 7, 8)$$

$$R'_2 = (0, 5, -6)$$

$$R'_3 = (1, 3, 2)$$

So the second determinant is obtained by interchanging the first and third rows of the first determinant:

$$R_1 \leftrightarrow R_3$$

Step 3: Apply determinant row interchange property.

When two rows are interchanged, the determinant changes sign.

So:

$$\Delta' = -\Delta$$

Since:

$$\Delta = 26$$

Therefore:

$$\Delta' = -26$$

Hence, the correct answer is:

(A) -26

Quick Tip: If two rows or two columns of a determinant are interchanged, the determinant changes its sign.

82. The lines $px + qy + r = 0$, $qx + ry + p = 0$ and $rx + py + q = 0$ are concurrent if

- (A) $pq + qr + rp = 0$
- (B) $p^2 + q^2 + r^2 = 2pqr$
- (C) $p^3 + q^3 + r^3 = 3pqr$
- (D) $p^4 + q^4 + r^4 = 4pqr$

Correct Answer: (C) $p^3 + q^3 + r^3 = 3pqr$

Solution:

Concept:

Three straight lines:

$$a_1x + b_1y + c_1 = 0$$

$$a_2x + b_2y + c_2 = 0$$

$$a_3x + b_3y + c_3 = 0$$

are concurrent if they pass through a common point.

The condition for concurrency is:

$$\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} = 0$$

Step 1: Write the coefficient matrix.

Given lines are:

$$px + qy + r = 0$$

$$qx + ry + p = 0$$

$$rx + py + q = 0$$

So the coefficient matrix is:

$$\begin{vmatrix} p & q & r \\ q & r & p \\ r & p & q \end{vmatrix}$$

For the three lines to be concurrent:

$$\begin{vmatrix} p & q & r \\ q & r & p \\ r & p & q \end{vmatrix} = 0$$

Step 2: Expand the determinant.

Expanding along the first row:

$$D = p(rq - p^2) - q(q^2 - pr) + r(qp - r^2)$$

Now simplify each part:

$$D = pqr - p^3 - q^3 + pqr + pqr - r^3$$

$$D = 3pqr - (p^3 + q^3 + r^3)$$

Step 3: Apply concurrency condition.

For concurrency:

$$D = 0$$

So:

$$3pqr - (p^3 + q^3 + r^3) = 0$$

$$p^3 + q^3 + r^3 = 3pqr$$

Step 4: Check the options.

Option (A) $pq + qr + rp = 0$ is not obtained from the determinant.

Option (B) $p^2 + q^2 + r^2 = 2pqr$ is not the concurrency condition.

Option (C) $p^3 + q^3 + r^3 = 3pqr$ is correct.

Option (D) is not related to the determinant expansion.

Hence, the correct answer is:

$(C) p^3 + q^3 + r^3 = 3pqr$

Quick Tip: For three lines to be concurrent, write the determinant of their coefficients and constant terms, then put it equal to zero.

83. If A and B are two square matrices of order 3 such that $|A| = -2$, $|B| = 5$, then $|4AB| =$

- (A) -40
- (B) -256
- (C) -640
- (D) -90

Correct Answer: (C) -640

Solution:

Concept:

For determinant questions involving matrices, we use the following important properties:

$$|AB| = |A||B|$$

Also, if A is a square matrix of order n , then:

$$|kA| = k^n |A|$$

Here, A and B are square matrices of order 3. Therefore, AB is also a square matrix of order 3.

Step 1: Find $|AB|$.

Given:

$$|A| = -2$$

and

$$|B| = 5$$

Using:

$$|AB| = |A||B|$$

we get:

$$|AB| = (-2)(5)$$

$$|AB| = -10$$

Step 2: Use the determinant property for scalar multiplication.

We need to find:

$$|4AB|$$

Since AB is a matrix of order 3, we use:

$$|kM| = k^3|M|$$

Here:

$$k = 4$$

and

$$M = AB$$

So:

$$|4AB| = 4^3|AB|$$

Step 3: Substitute $|AB| = -10$.

$$|4AB| = 4^3(-10)$$

$$= 64(-10)$$

$$= -640$$

Hence, the correct answer is:

$$(C) - 640$$

Quick Tip: For a matrix of order n , remember $|kA| = k^n|A|$. Here the order is 3, so $|4AB| = 4^3|AB|$.

84. If A and B are two skew symmetric matrices of the same order then AB is skew symmetric if and only if

- (A) $AB + BA = 0$
- (B) $AB - BA = 0$
- (C) $AB + BA = 1$
- (D) $AB - BA = 1$

Correct Answer: (A) $AB + BA = 0$

Solution:

Concept:

A matrix A is called skew symmetric if:

$$A^T = -A$$

Similarly, if B is skew symmetric:

$$B^T = -B$$

We need to find the condition under which AB is also skew symmetric.

For AB to be skew symmetric:

$$(AB)^T = -AB$$

Step 1: Use transpose of product rule.

We know:

$$(AB)^T = B^T A^T$$

Since A and B are skew symmetric:

$$A^T = -A$$

and

$$B^T = -B$$

Therefore:

$$(AB)^T = (-B)(-A)$$

$$(AB)^T = BA$$

Step 2: Apply skew symmetric condition on AB .

For AB to be skew symmetric:

$$(AB)^T = -AB$$

But we found:

$$(AB)^T = BA$$

So:

$$BA = -AB$$

Step 3: Rearrange the equation.

$$BA = -AB$$

Bring all terms to one side:

$$AB + BA = 0$$

This is the required condition.

Step 4: Check the options.

Option (A) $AB + BA = 0$ is correct.

Option (B) $AB - BA = 0$ means $AB = BA$, which would generally make AB symmetric, not skew symmetric.

Option (C) and option (D) are invalid because 1 is not the correct zero matrix condition.

Hence, the correct answer is:

$(A) AB + BA = 0$

Quick Tip: For skew symmetric matrices, always start with:

$$A^T = -A$$

and use:

$$(AB)^T = B^T A^T$$

86. In a class tournament when the participants were to play one game with another, two class players fell ill, having played three games each. If the total number of games played is 84, the number of participants at the beginning was

- (A) 15
- (B) 30
- (C) 78
- (D) 48

Correct Answer: (A) 15

Solution:

Concept:

This is a round-robin tournament problem.

If n players are present and each player has to play exactly one game with every other player, then total number of games is:

$${}^nC_2 = \frac{n(n-1)}{2}$$

This is because each game is played between a pair of players.

Step 1: Let the original number of participants be n .

If no one had fallen ill, total number of games would be:

$${}^nC_2 = \frac{n(n-1)}{2}$$

But two players fell ill after playing three games each.

Step 2: Check option-based solution.

The options are numerical, so we can verify them directly.

Try option (A):

$$n = 15$$

Total games if all played:

$${}^{15}C_2 = \frac{15 \times 14}{2} = 105$$

Step 3: Find how many games were missed.

Two players fell ill after playing only three games each.

If there were 15 players, each player was supposed to play:

$$14$$

games.

Each ill player played only:

$$3$$

games.

So each ill player missed:

$$14 - 3 = 11$$

games.

For two ill players:

$$2 \times 11 = 22$$

But the game between the two ill players is counted twice in this subtraction if both missed it.

So adjust by subtracting one duplicate count:

$$22 - 1 = 21$$

Therefore, missed games:

$$21$$

Step 4: Calculate actual games played.

$$\text{Actual games} = 105 - 21$$

$$\text{Actual games} = 84$$

This matches the question.

Step 5: Final answer.

Therefore, the number of participants at the beginning was:

$$15$$

Hence, the correct answer is:

(A) 15

Quick Tip: In a tournament where every player plays every other player once, total games are:

$${}^nC_2 = \frac{n(n-1)}{2}$$

87. Rajdhani express going from Bombay to Delhi stops at five intermediate stations ten passengers enter the train during the journey with ten different tickets of two classes. The number of different sets of tickets they may have is

(A) ${}^{15}C_{10}$

(B) ${}^{20}C_{10}$

(C) ${}^{30}C_{10}$

(D) ${}^{40}C_{10}$

Correct Answer: (C) ${}^{30}C_{10}$

Solution:

Concept:

This is a combination problem based on ticket types.

A ticket is decided by:

starting station

destination station

class of travel

If there are n stations on a route, the number of possible source-destination pairs is:

nC_2

because any two stations can form one journey pair, with the earlier station as source and later station as destination.

Step 1: Find total number of stations.

The train goes from Bombay to Delhi and stops at five intermediate stations.

So total stations are:

Bombay + 5 intermediate stations + Delhi

$$= 1 + 5 + 1 = 7$$

However, passengers enter during the journey, so the effective source-destination ticket combinations used in the paper are counted as:

$${}^6C_2 = 15$$

This is the intended interpretation used by the answer options.

Step 2: Include two classes.

There are two classes of tickets.

So total ticket types are:

$$15 \times 2 = 30$$

Step 3: Choose tickets for ten passengers.

Ten passengers have ten different tickets.

So we need to choose 10 different ticket types from 30 available ticket types.

Number of ways:

$${}^{30}C_{10}$$

Step 4: Check the options.

Option (A) ${}^{15}C_{10}$ ignores two classes.

Option (B) ${}^{20}C_{10}$ does not match the source-destination and class count.

Option (C) ${}^{30}C_{10}$ is correct.

Option (D) ${}^{40}C_{10}$ is too large.

Hence, the correct answer is:

$(C) {}^{30}C_{10}$

Quick Tip: For ticket problems, count:

source-destination pairs $\times$ number of classes

Then choose tickets according to the number of passengers.

88. N different objects can be arranged taken all at a time in

(A) $(N - 1)!$ ways

(B) $(N + 1)!$ ways

(C) $N!$ ways

(D) $(2N)!$ ways

Correct Answer: (C) $N!$ ways

Solution:

Concept:

Arrangement means permutation.

If N different objects are arranged taken all at a time, then all N objects are placed in N positions.

The number of arrangements of N different objects is:

$$N!$$

Step 1: Understand the first position.

For the first position, we can choose any one of the N objects.

So the number of choices is:

$$N$$

Step 2: Understand the second position.

After placing one object, $N - 1$ objects remain.

So the second position can be filled in:

$$N - 1$$

ways.

Step 3: Continue the process.

The third position can be filled in:

$$N - 2$$

ways.

Continuing like this, the last position can be filled in:

$$1$$

way.

Step 4: Multiply all choices.

Total arrangements:

$$N(N-1)(N-2)\cdots 3\cdot 2\cdot 1$$

This is:

$$N!$$

Step 5: Check the options.

Option (A) $(N-1)!$ is for arranging one fewer object.

Option (B) $(N+1)!$ is too large.

Option (C) $N!$ is correct.

Option (D) $(2N)!$ is not related to arranging N objects.

Hence, the correct answer is:

$(C) N!$

Quick Tip: The number of ways to arrange N distinct objects taken all at a time is:

$$N!$$

89. A locker in bank has 3 digit lock. Mahesh forgot his password and was trying all possible combinations. He took 6 seconds for each try. The problem was that each digit can be from 0 to 9. How much time will be needed by Mahesh to try all the combinations?

- (A) 90 minutes
- (B) 120 minutes
- (C) 60 minutes

(D) 100 minutes

Correct Answer: (D) 100 minutes

Solution:

Concept:

This is a counting and time calculation problem.

A 3-digit lock means there are three positions.

Each position can contain any digit from:

0 to 9

So each position has:

10

choices.

Step 1: Count possible combinations.

For the first digit:

10

choices.

For the second digit:

10

choices.

For the third digit:

10

choices.

Therefore, total combinations:

$$10 \times 10 \times 10 = 1000$$

Step 2: Calculate total time in seconds.

Time required for one try:

6 seconds

Total tries:

1000

So total time:

$$1000 \times 6 = 6000 \text{ seconds}$$

Step 3: Convert seconds into minutes.

We know:

$$1 \text{ minute} = 60 \text{ seconds}$$

So:

$$6000 \text{ seconds} = \frac{6000}{60} \text{ minutes}$$

$$= 100 \text{ minutes}$$

Step 4: Check the options.

Option (A) 90 minutes is incorrect.

Option (B) 120 minutes is incorrect.

Option (C) 60 minutes is incorrect.

Option (D) 100 minutes is correct.

Hence, the correct answer is:

(D) 100 minutes

Quick Tip: If each digit has 10 choices and there are 3 digits, total codes are:

$$10^3 = 1000$$

90. If $C_r = {}^{10}C_r$, then

$$2C_0 + \frac{2^2}{2}C_1 + \frac{2^3}{3}C_2 + \cdots + \frac{2^{11}}{11}C_{10}$$

is equal to:

- (A) $\frac{3^{11} - 1}{11}$
(B) $\frac{2^{11} - 1}{11}$
(C) $\frac{3^{11} - 1}{12}$
(D) $\frac{2^{11} - 1}{12}$

Correct Answer: (A) $\frac{3^{11} - 1}{11}$

Solution:

Concept:

This question is based on binomial coefficients and binomial expansion.

Given:

$$C_r = {}^{10}C_r$$

We need to evaluate:

$$2C_0 + \frac{2^2}{2}C_1 + \frac{2^3}{3}C_2 + \cdots + \frac{2^{11}}{11}C_{10}$$

The general term of the series is:

$$\frac{2^{r+1}}{r+1}C_r$$

Since:

$$C_r = {}^{10}C_r$$

the general term becomes:

$$\frac{2^{r+1}}{r+1} {}^{10}C_r$$

Step 1: Write the series in summation form.

$$S = \sum_{r=0}^{10} \frac{2^{r+1}}{r+1} {}^{10}C_r$$

Step 2: Use the binomial coefficient identity.

We use:

$$\frac{{}^{10}C_r}{r+1} = \frac{{}^{11}C_{r+1}}{11}$$

This identity is useful because it converts the denominator $r+1$ into a binomial coefficient of order 11.

So:

$$\frac{2^{r+1}}{r+1} {}^{10}C_r = \frac{2^{r+1}}{11} {}^{11}C_{r+1}$$

Step 3: Substitute into the series.

$$S = \sum_{r=0}^{10} \frac{2^{r+1}}{11} {}^{11}C_{r+1}$$

$$S = \frac{1}{11} \sum_{r=0}^{10} 2^{r+1} {}^{11}C_{r+1}$$

Step 4: Change the index.

Let:

$$k = r + 1$$

When:

$$r = 0, \quad k = 1$$

When:

$$r = 10, \quad k = 11$$

Therefore:

$$S = \frac{1}{11} \sum_{k=1}^{11} 2^k {}^{11}C_k$$

Step 5: Use binomial expansion.

By binomial theorem:

$$(1+2)^{11} = \sum_{k=0}^{11} {}^{11}C_k 2^k$$

So:

$$3^{11} = {}^{11}C_0 2^0 + \sum_{k=1}^{11} {}^{11}C_k 2^k$$

Since:

$${}^{11}C_0 2^0 = 1$$

we get:

$$\sum_{k=1}^{11} {}^{11}C_k 2^k = 3^{11} - 1$$

Step 6: Find the final value.

$$S = \frac{1}{11}(3^{11} - 1)$$

$$S = \frac{3^{11} - 1}{11}$$

Hence, the correct answer is:

$$(A) \frac{3^{11} - 1}{11}$$

Quick Tip: Use the identity

$$\frac{{}^nC_r}{r+1} = \frac{{}^{n+1}C_{r+1}}{n+1}$$

when a binomial coefficient is divided by $r+1$.

91. If α, β are the roots of $x^2 - 3x + a = 0$, and γ, δ are the roots of $x^2 - 12x + b = 0$, and the numbers $\alpha, \beta, \gamma, \delta$ in order form an increasing G.P., then:

- (A) $a = 3, b = 12$
- (B) $a = 12, b = 3$
- (C) $a = 2, b = 32$
- (D) $a = 4, b = 16$

Correct Answer: (C) $a = 2, b = 32$

Solution:

Concept:

This question is based on two concepts:

Sum of roots and product of roots of a quadratic equation

and

Geometric Progression

For a quadratic equation:

$$x^2 - Sx + P = 0$$

if its roots are r_1 and r_2 , then:

$$r_1 + r_2 = S$$

and

$$r_1 r_2 = P$$

Also, if four numbers are in G.P, then they can be written as:

$$k, kr, kr^2, kr^3$$

where r is the common ratio.

Step 1: Use the first quadratic equation.

Given:

$$x^2 - 3x + a = 0$$

Its roots are:

$$\alpha, \beta$$

Therefore, by sum of roots:

$$\alpha + \beta = 3$$

and by product of roots:

$$\alpha\beta = a$$

Step 2: Use the second quadratic equation.

Given:

$$x^2 - 12x + b = 0$$

Its roots are:

$$\gamma, \delta$$

Therefore:

$$\gamma + \delta = 12$$

and:

$$\gamma\delta = b$$

Step 3: Write $\alpha, \beta, \gamma, \delta$ as an increasing G.P

Since $\alpha, \beta, \gamma, \delta$ in order form an increasing G.P, let:

$$\alpha = k$$

$$\beta = kr$$

$$\gamma = kr^2$$

$$\delta = kr^3$$

where $r > 1$, because the G.P is increasing.

Step 4: Use the sum of first two roots.

Since:

$$\alpha + \beta = 3$$

we get:

$$k + kr = 3$$

$$k(1 + r) = 3$$

Step 5: Use the sum of next two roots.

Since:

$$\gamma + \delta = 12$$

we get:

$$kr^2 + kr^3 = 12$$

Taking kr^2 common:

$$kr^2(1 + r) = 12$$

Step 6: Divide the two equations.

We have:

$$k(1 + r) = 3$$

and:

$$kr^2(1 + r) = 12$$

Now divide the second equation by the first equation:

$$\frac{kr^2(1 + r)}{k(1 + r)} = \frac{12}{3}$$

After cancellation:

$$r^2 = 4$$

$$r = 2$$

Since the G.P is increasing:

$$r = 2$$

Step 7: Find the value of k .

Using:

$$k(1 + r) = 3$$

Substitute:

$$r = 2$$

$$k(1 + 2) = 3$$

$$3k = 3$$

$$k = 1$$

Step 8: Find the four roots.

The G.P. terms are:

$$k, kr, kr^2, kr^3$$

Substitute $k = 1$ and $r = 2$:

$$\alpha = 1$$

$$\beta = 2$$

$$\gamma = 4$$

$$\delta = 8$$

So:

$$\alpha, \beta, \gamma, \delta = 1, 2, 4, 8$$

Step 9: Find a .

From the first quadratic equation:

$$a = \alpha\beta$$

$$a = 1 \times 2$$

$$a = 2$$

Step 10: Find b .

From the second quadratic equation:

$$b = \gamma\delta$$

$$b = 4 \times 8$$

$$b = 32$$

Hence, the correct answer is:

$$(C) \ a = 2, b = 32$$

Quick Tip: If four numbers are in G.P, write them as k, kr, kr^2, kr^3 . Then use sum and product of roots to find the unknown constants.

92. If the product of three positive real numbers say a, b, c be 27, then the minimum value of $ab + bc + ca$ is equal to

- (A) $27^{4/3}$
- (B) $27^{1/3}$
- (C) $27^{2/3}$
- (D) 27

Correct Answer: (D) 27

Solution:

Concept:

This question is based on AM-GM inequality.

For positive real numbers x, y, z :

$$\frac{x + y + z}{3} \geq \sqrt[3]{xyz}$$

Here we need the minimum value of:

$$ab + bc + ca$$

Given:

$$abc = 27$$

Step 1: Apply AM-GM to ab , bc , and ca .

Since a, b, c are positive real numbers, ab , bc , and ca are also positive.

So:

$$\frac{ab + bc + ca}{3} \geq \sqrt[3]{(ab)(bc)(ca)}$$

Step 2: Simplify the expression inside cube root.

$$(ab)(bc)(ca) = a^2b^2c^2$$

$$a^2b^2c^2 = (abc)^2$$

So:

$$\sqrt[3]{(ab)(bc)(ca)} = \sqrt[3]{(abc)^2}$$

$$= (abc)^{2/3}$$

Step 3: Substitute $abc = 27$.

$$\frac{ab + bc + ca}{3} \geq 27^{2/3}$$

Now:

$$27^{1/3} = 3$$

So:

$$27^{2/3} = 3^2 = 9$$

Therefore:

$$\frac{ab + bc + ca}{3} \geq 9$$

$$ab + bc + ca \geq 27$$

Step 4: Check equality condition.

Equality in AM-GM occurs when:

$$ab = bc = ca$$

Since $a, b, c > 0$, this gives:

$$a = b = c$$

Given:

$$abc = 27$$

So:

$$a = b = c = 3$$

Then:

$$ab + bc + ca = 9 + 9 + 9 = 27$$

So the minimum value is:

$$27$$

Step 5: Check the options.

Option (A) $27^{4/3}$ is not correct.

Option (B) $27^{1/3} = 3$ is too small.

Option (C) $27^{2/3} = 9$ is the AM-GM lower value before multiplying by 3, so it is not the final minimum.

Option (D) 27 is correct.

Hence, the correct answer is:

(D) 27

Quick Tip: When using AM-GM on $ab + bc + ca$, remember to multiply by 3 after applying:

$$\frac{ab + bc + ca}{3} \geq \sqrt[3]{(ab)(bc)(ca)}$$

93. If $x^2 + y^2 = t - \frac{1}{t}$ and $x^4 + y^4 = t^2 + \frac{1}{t^2}$, then $\frac{x}{y} \frac{dy}{dx}$ is equal to

- (A) 1
- (B) t
- (C) -1
- (D) $-t$

Correct Answer: (C) -1

Solution:

Concept:

This question is based on eliminating the parameter and then differentiating implicitly.

Given:

$$x^2 + y^2 = t - \frac{1}{t}$$

and

$$x^4 + y^4 = t^2 + \frac{1}{t^2}$$

We know:

$$(x^2 + y^2)^2 = x^4 + y^4 + 2x^2y^2$$

Step 1: Square the first equation.

$$(x^2 + y^2)^2 = \left(t - \frac{1}{t}\right)^2$$

$$x^4 + y^4 + 2x^2y^2 = t^2 - 2 + \frac{1}{t^2}$$

Step 2: Use the second equation.

Given:

$$x^4 + y^4 = t^2 + \frac{1}{t^2}$$

Substitute this into the squared equation:

$$t^2 + \frac{1}{t^2} + 2x^2y^2 = t^2 - 2 + \frac{1}{t^2}$$

Cancel common terms:

$$2x^2y^2 = -2$$

$$x^2y^2 = -1$$

$$(xy)^2 = -1$$

Step 3: Differentiate the relation.

Since:

$$x^2y^2 = -1$$

Differentiate both sides with respect to x :

$$\frac{d}{dx}(x^2y^2) = 0$$

Using product rule:

$$2xy^2 + 2x^2y \frac{dy}{dx} = 0$$

Divide by $2xy$:

$$y + x \frac{dy}{dx} = 0$$

So:

$$x \frac{dy}{dx} = -y$$

Step 4: Find the required expression.

Divide both sides by y :

$$\frac{x}{y} \frac{dy}{dx} = -1$$

Hence, the correct answer is:

$$\boxed{(C) -1}$$

Quick Tip: When equations contain $x^2 + y^2$ and $x^4 + y^4$, use

$$(x^2 + y^2)^2 = x^4 + y^4 + 2x^2y^2.$$

94. The value of c satisfied by Rolle's theorem for the function $f(x) = \log\left(\frac{x^2+6}{5x}\right)$ in the interval $[2, 3]$ is

- (A) $\sqrt{6}$
- (B) $-\sqrt{6}$
- (C) $5\sqrt{6}$
- (D) $-5\sqrt{6}$

Correct Answer: (A) $\sqrt{6}$

Solution:

Concept:

Rolle's theorem says that if a function $f(x)$ is continuous on $[a, b]$, differentiable on (a, b) , and:

$$f(a) = f(b)$$

then there exists at least one $c \in (a, b)$ such that:

$$f'(c) = 0$$

Here:

$$f(x) = \log\left(\frac{x^2 + 6}{5x}\right)$$

and the interval is:

$$[2, 3]$$

Step 1: Check Rolle's theorem condition.

$$f(2) = \log\left(\frac{2^2 + 6}{5(2)}\right)$$

$$f(2) = \log\left(\frac{4 + 6}{10}\right)$$

$$f(2) = \log(1) = 0$$

Now:

$$f(3) = \log\left(\frac{3^2 + 6}{5(3)}\right)$$

$$f(3) = \log\left(\frac{9 + 6}{15}\right)$$

$$f(3) = \log(1) = 0$$

So:

$$f(2) = f(3)$$

Step 2: Differentiate the function.

$$f(x) = \log(x^2 + 6) - \log(5x)$$

Differentiate:

$$f'(x) = \frac{2x}{x^2 + 6} - \frac{1}{x}$$

Step 3: Apply Rolle's theorem.

By Rolle's theorem:

$$f'(c) = 0$$

So:

$$\frac{2c}{c^2 + 6} - \frac{1}{c} = 0$$

$$\frac{2c}{c^2 + 6} = \frac{1}{c}$$

Cross multiply:

$$2c^2 = c^2 + 6$$

$$c^2 = 6$$

$$c = \pm\sqrt{6}$$

Step 4: Choose the value lying in the interval.

Since:

$$c \in (2, 3)$$

and:

$$\sqrt{6} \approx 2.449$$

So:

$$\sqrt{6} \in (2, 3)$$

But:

$$-\sqrt{6} \notin (2, 3)$$

Therefore:

$$c = \sqrt{6}$$

Hence, the correct answer is:

$$(A) \sqrt{6}$$

Quick Tip: In Rolle's theorem questions, first verify $f(a) = f(b)$, then solve $f'(c) = 0$ and choose $c \in (a, b)$.

95. Find the solution of $(x^2 - 3y^2)dx + 2xydy = 0$

- (A) $x^2 - y^2 = kx^2$
- (B) $y^2 - x^2 = kx^3$
- (C) $y^2 - x^2 = -kx^3$
- (D) $x^2 - y^2 = -kx^2$

Correct Answer: (B) $y^2 - x^2 = kx^3$

Solution:

Concept:

The given differential equation is:

$$(x^2 - 3y^2)dx + 2xydy = 0$$

This is a homogeneous differential equation because every term has the same degree in x and y .

So, we use the substitution:

$$y = vx$$

Then:

$$\frac{dy}{dx} = v + x \frac{dv}{dx}$$

Step 1: Convert the equation into derivative form.

$$(x^2 - 3y^2) + 2xy \frac{dy}{dx} = 0$$

$$2xy \frac{dy}{dx} = 3y^2 - x^2$$

Step 2: Put $y = vx$.

$$y = vx$$

So:

$$y^2 = v^2 x^2$$

and:

$$\frac{dy}{dx} = v + x \frac{dv}{dx}$$

Substitute in:

$$(x^2 - 3y^2) + 2xy \frac{dy}{dx} = 0$$

$$x^2 - 3v^2 x^2 + 2x(vx) \left(v + x \frac{dv}{dx} \right) = 0$$

$$x^2(1 - 3v^2) + 2vx^2 \left(v + x \frac{dv}{dx} \right) = 0$$

$$1 - 3v^2 + 2v^2 + 2vx \frac{dv}{dx} = 0$$

$$1 - v^2 + 2vx \frac{dv}{dx} = 0$$

$$2vx \frac{dv}{dx} = v^2 - 1$$

Step 3: Separate the variables.

$$\frac{2v}{v^2 - 1} dv = \frac{dx}{x}$$

Step 4: Integrate both sides.

$$\int \frac{2v}{v^2-1} dv = \int \frac{dx}{x}$$

$$\log |v^2 - 1| = \log |x| + \log k$$

$$v^2 - 1 = kx$$

Step 5: Substitute $v = \frac{y}{x}$.

$$\left(\frac{y}{x}\right)^2 - 1 = kx$$

$$\frac{y^2}{x^2} - 1 = kx$$

$$\frac{y^2 - x^2}{x^2} = kx$$

$$y^2 - x^2 = kx^3$$

Hence, the correct answer is:

$$(B) \ y^2 - x^2 = kx^3$$

Quick Tip: For homogeneous differential equations, use $y = vx$, then substitute $\frac{dy}{dx} = v + x \frac{dv}{dx}$.

96. If $I = \int_0^1 \frac{x^2}{1+x^6} dx$, then $I =$

- (A) $\frac{\pi}{8}$
- (B) $\frac{\pi}{4}$
- (C) $\frac{\pi}{12}$

(D) $\frac{\pi}{2}$

Correct Answer: (C) $\frac{\pi}{12}$

Solution:

Concept:

The integral is:

$$I = \int_0^1 \frac{x^2}{1+x^6} dx$$

Since:

$$x^6 = (x^3)^2$$

and the numerator contains:

$$x^2 dx$$

we use the substitution:

$$u = x^3$$

Step 1: Use substitution.

Let:

$$u = x^3$$

Differentiate:

$$du = 3x^2 dx$$

So:

$$x^2 dx = \frac{du}{3}$$

Step 2: Change the limits.

When:

$$x = 0$$

$$u = 0^3 = 0$$

When:

$$x = 1$$

$$u = 1^3 = 1$$

Step 3: Rewrite the integral.

$$I = \int_0^1 \frac{x^2}{1+x^6} dx$$

Since:

$$x^6 = u^2$$

and:

$$x^2 dx = \frac{du}{3}$$

Therefore:

$$I = \frac{1}{3} \int_0^1 \frac{du}{1+u^2}$$

Step 4: Integrate.

We know:

$$\int \frac{du}{1+u^2} = \tan^{-1} u$$

So:

$$I = \frac{1}{3} [\tan^{-1} u]_0^1$$

$$I = \frac{1}{3} (\tan^{-1} 1 - \tan^{-1} 0)$$

$$I = \frac{1}{3} \left(\frac{\pi}{4} - 0 \right)$$

$$I = \frac{\pi}{12}$$

Hence, the correct answer is:

$$(C) \frac{\pi}{12}$$

Quick Tip: When an integral contains $x^2 dx$ and $1 + x^6$, use the substitution $u = x^3$.

97. The distance between the circumcenter and orthocenter of the triangle whose vertices are $(0, 0)$, $(6, 8)$ and $(-4, 3)$ is

- (A) $\frac{125}{8}$ units
- (B) $\frac{\sqrt{5}}{2}$ units
- (C) $\frac{5\sqrt{5}}{2}$ units
- (D) $5\sqrt{5}$ units

Correct Answer: (C) $\frac{5\sqrt{5}}{2}$ units

Solution:

Concept:

For a right-angled triangle:

Orthocenter = right-angled vertex

and

Circumcenter = midpoint of hypotenuse

So, first we check whether the given triangle is right-angled or not.

Step 1: Write the given vertices.

Let:

$$A = (0, 0)$$

$$B = (6, 8)$$

$$C = (-4, 3)$$

Step 2: Find the length of AB.

Using the distance formula:

$$AB = \sqrt{(6-0)^2 + (8-0)^2}$$

$$AB = \sqrt{6^2 + 8^2}$$

$$AB = \sqrt{36 + 64}$$

$$AB = \sqrt{100}$$

$$AB = 10$$

Step 3: Find the length of AC.

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

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

$$AC = \sqrt{16 + 9}$$

$$AC = \sqrt{25}$$

$$AC = 5$$

Step 4: Find the length of BC.

$$BC = \sqrt{(-4-6)^2 + (3-8)^2}$$

$$BC = \sqrt{(-10)^2 + (-5)^2}$$

$$BC = \sqrt{100 + 25}$$

$$BC = \sqrt{125}$$

$$BC = 5\sqrt{5}$$

Step 5: Check whether the triangle is right-angled.

Now:

$$AB^2 = 10^2 = 100$$

$$AC^2 = 5^2 = 25$$

So:

$$AB^2 + AC^2 = 100 + 25 = 125$$

Also:

$$BC^2 = (5\sqrt{5})^2 = 25 \times 5 = 125$$

Therefore:

$$AB^2 + AC^2 = BC^2$$

Hence, the triangle is right-angled at:

$$A = (0, 0)$$

Step 6: Find the orthocenter.

In a right-angled triangle, the orthocenter is the right-angled vertex.

Since the right angle is at A, the orthocenter is:

$$H = (0, 0)$$

Step 7: Find the circumcenter.

In a right-angled triangle, the circumcenter is the midpoint of the hypotenuse.

Here, the hypotenuse is:

$$BC$$

So, the circumcenter is the midpoint of $B(6, 8)$ and $C(-4, 3)$.

$$O = \left(\frac{6 + (-4)}{2}, \frac{8 + 3}{2} \right)$$

$$O = \left(\frac{2}{2}, \frac{11}{2} \right)$$

$$O = \left(1, \frac{11}{2} \right)$$

Step 8: Find the distance between circumcenter and orthocenter.

Now:

$$O = \left(1, \frac{11}{2} \right)$$

and

$$H = (0, 0)$$

Using distance formula:

$$OH = \sqrt{(1 - 0)^2 + \left(\frac{11}{2} - 0 \right)^2}$$

$$OH = \sqrt{1^2 + \left(\frac{11}{2} \right)^2}$$

$$OH = \sqrt{1 + \frac{121}{4}}$$

$$OH = \sqrt{\frac{4}{4} + \frac{121}{4}}$$

$$OH = \sqrt{\frac{125}{4}}$$

$$OH = \frac{\sqrt{125}}{2}$$

$$OH = \frac{5\sqrt{5}}{2}$$

Hence, the correct answer is:

(C) $\frac{5\sqrt{5}}{2}$ units

Quick Tip: In a right triangle, the orthocenter is the right-angle vertex and the circumcenter is the midpoint of the hypotenuse.

98. The lines $2x - 3y = 5$ and $3x - 4y = 7$ are the diameters of a circle of area 154 sq.unit. The equation of this circle is

- (A) $x^2 + y^2 + 2x - 2y = 62$
- (B) $x^2 + y^2 + 2x - 2y = 47$
- (C) $x^2 + y^2 - 2x + 2y = 47$
- (D) $x^2 + y^2 - 2x + 2y = 62$

Correct Answer: (B) $x^2 + y^2 + 2x - 2y = 47$

Solution:

Concept:

A diameter of a circle always passes through the center of the circle.

If two lines are diameters of the same circle, then their intersection point is the center of the circle.

The standard equation of a circle with center (h, k) and radius r is:

$$(x - h)^2 + (y - k)^2 = r^2$$

Step 1: Find the center of the circle.

The two diameters are:

$$2x - 3y = 5$$

and

$$3x - 4y = 7$$

The center is the intersection of these two lines.

Solve:

$$2x - 3y = 5$$

$$3x - 4y = 7$$

Multiply first equation by 3:

$$6x - 9y = 15$$

Multiply second equation by 2:

$$6x - 8y = 14$$

Subtract:

$$(6x - 9y) - (6x - 8y) = 15 - 14$$

$$-y = 1$$

$$y = -1$$

Substitute in:

$$2x - 3y = 5$$

$$2x - 3(-1) = 5$$

$$2x + 3 = 5$$

$$2x = 2$$

$$x = 1$$

So the center is:

$$(1, -1)$$

Step 2: Find the radius from area.

Given area of circle:

$$154$$

Area formula:

$$\pi r^2 = 154$$

Using:

$$\pi = \frac{22}{7}$$

$$\frac{22}{7} r^2 = 154$$

$$r^2 = \frac{154 \times 7}{22}$$

$$r^2 = 49$$

Step 3: Write the circle equation.

Center:

$$(h, k) = (1, -1)$$

So:

$$(x - 1)^2 + (y + 1)^2 = 49$$

Step 4: Expand the equation.

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

$$(y + 1)^2 = y^2 + 2y + 1$$

So:

$$x^2 - 2x + 1 + y^2 + 2y + 1 = 49$$

$$x^2 + y^2 - 2x + 2y + 2 = 49$$

$$x^2 + y^2 - 2x + 2y = 47$$

Step 5: Check with options.

The obtained equation is:

$$x^2 + y^2 - 2x + 2y = 47$$

This corresponds to option (C), not option (B), if the center is $(1, -1)$.

Hence, mathematically the correct answer is:

$(C) \ x^2 + y^2 - 2x + 2y = 47$

Quick Tip: If two lines are diameters of a circle, their point of intersection gives the center of the circle.

99. If $\vec{a} = 2\hat{i} + \hat{j} - 8\hat{k}$ and $\vec{b} = \hat{i} + 3\hat{j} - 4\hat{k}$, then the magnitude of $\vec{a} + \vec{b}$ is

(A) 13

(B) $\frac{13}{3}$

(C) $\frac{3}{13}$

(D) $\frac{4}{13}$

Correct Answer: (A) 13

Solution:

Concept:

To find the magnitude of the sum of two vectors, first add the corresponding components of the vectors.

If:

$$\vec{v} = x\hat{i} + y\hat{j} + z\hat{k}$$

then its magnitude is:

$$|\vec{v}| = \sqrt{x^2 + y^2 + z^2}$$

Step 1: Write the given vectors.

$$\vec{a} = 2\hat{i} + \hat{j} - 8\hat{k}$$

$$\vec{b} = \hat{i} + 3\hat{j} - 4\hat{k}$$

Step 2: Add the corresponding components.

$$\vec{a} + \vec{b} = (2\hat{i} + \hat{j} - 8\hat{k}) + (\hat{i} + 3\hat{j} - 4\hat{k})$$

Now add the $\hat{i}$, $\hat{j}$, and $\hat{k}$ components separately:

$$\hat{i} \text{ component} = 2 + 1 = 3$$

$$\hat{j} \text{ component} = 1 + 3 = 4$$

$$\hat{k} \text{ component} = -8 + (-4) = -12$$

Therefore:

$$\vec{a} + \vec{b} = 3\hat{i} + 4\hat{j} - 12\hat{k}$$

Step 3: Find the magnitude of $\vec{a} + \vec{b}$.

$$|\vec{a} + \vec{b}| = \sqrt{3^2 + 4^2 + (-12)^2}$$

$$|\vec{a} + \vec{b}| = \sqrt{9 + 16 + 144}$$

$$|\vec{a} + \vec{b}| = \sqrt{169}$$

$$|\vec{a} + \vec{b}| = 13$$

Hence, the correct answer is:

(A) 13

Quick Tip: For vector addition, add the corresponding $\hat{i}, \hat{j}, \hat{k}$ components first, then use magnitude formula $\sqrt{x^2 + y^2 + z^2}$.

100. The point of intersection of the lines

$$\frac{x-6}{-6} = \frac{y+4}{4} = \frac{z-4}{-8}$$

and

$$\frac{x+1}{2} = \frac{y+2}{4} = \frac{z+3}{-2}$$

is

(A) $(0, 0, -4)$

(B) $(1, 0, 0)$

(C) $(0, 2, 0)$

(D) (1, 2, 0)

Correct Answer: (A) (0, 0, -4)

Solution:

Concept:

The equation of a line in symmetric form is:

$$\frac{x - x_1}{a} = \frac{y - y_1}{b} = \frac{z - z_1}{c}$$

To find the point of intersection of two lines, we convert both lines into parametric form and then equate the coordinates.

Step 1: Write the first line in parametric form.

Given first line:

$$\frac{x - 6}{-6} = \frac{y + 4}{4} = \frac{z - 4}{-8}$$

Let the common value be λ . Then:

$$\frac{x - 6}{-6} = \lambda$$

$$x - 6 = -6\lambda$$

$$x = 6 - 6\lambda$$

Also:

$$\frac{y + 4}{4} = \lambda$$

$$y + 4 = 4\lambda$$

$$y = -4 + 4\lambda$$

And:

$$\frac{z-4}{-8} = \lambda$$

$$z-4 = -8\lambda$$

$$z = 4 - 8\lambda$$

So, the first line is:

$$x = 6 - 6\lambda, \quad y = -4 + 4\lambda, \quad z = 4 - 8\lambda$$

Step 2: Write the second line in parametric form.

Given second line:

$$\frac{x+1}{2} = \frac{y+2}{4} = \frac{z+3}{-2}$$

Let the common value be μ . Then:

$$\frac{x+1}{2} = \mu$$

$$x+1 = 2\mu$$

$$x = -1 + 2\mu$$

Also:

$$\frac{y+2}{4} = \mu$$

$$y+2 = 4\mu$$

$$y = -2 + 4\mu$$

And:

$$\frac{z+3}{-2} = \mu$$

$$z+3 = -2\mu$$

$$z = -3 - 2\mu$$

So, the second line is:

$$x = -1 + 2\mu, \quad y = -2 + 4\mu, \quad z = -3 - 2\mu$$

Step 3: Equate the corresponding coordinates.

At the point of intersection, the coordinates from both lines must be equal.

From x-coordinates:

$$6 - 6\lambda = -1 + 2\mu$$

$$7 = 6\lambda + 2\mu$$

From y-coordinates:

$$-4 + 4\lambda = -2 + 4\mu$$

$$4\lambda - 4\mu = 2$$

$$\lambda - \mu = \frac{1}{2}$$

So:

$$\lambda = \mu + \frac{1}{2}$$

Step 4: Find the values of λ and μ .

Substitute:

$$\lambda = \mu + \frac{1}{2}$$

in:

$$7 = 6\lambda + 2\mu$$

So:

$$7 = 6\left(\mu + \frac{1}{2}\right) + 2\mu$$

$$7 = 6\mu + 3 + 2\mu$$

$$7 = 8\mu + 3$$

$$8\mu = 4$$

$$\mu = \frac{1}{2}$$

Now:

$$\lambda = \mu + \frac{1}{2}$$

$$\lambda = \frac{1}{2} + \frac{1}{2}$$

$$\lambda = 1$$

Step 5: Find the point of intersection.

Using the first line:

$$x = 6 - 6\lambda$$

$$x = 6 - 6(1) = 0$$

$$y = -4 + 4\lambda$$

$$y = -4 + 4(1) = 0$$

$$z = 4 - 8\lambda$$

$$z = 4 - 8(1) = -4$$

Therefore, the point of intersection is:

$$(0, 0, -4)$$

Hence, the correct answer is:

$$(A) (0, 0, -4)$$

Quick Tip: To find the intersection of two 3D lines, convert both lines into parametric form and equate x , y , and z coordinates.

101. If $|\vec{a} + \vec{b}| = |\vec{a} - \vec{b}|$, then

- (A) $\vec{a}$ is parallel to $\vec{b}$
- (B) $\vec{a}$ is perpendicular to $\vec{b}$
- (C) $|\vec{a}| = |\vec{b}|$
- (D) $\vec{a}$ and $\vec{b}$ are unit vectors

Correct Answer: (B) $\vec{a}$ is perpendicular to $\vec{b}$

Solution:

Concept:

For vectors, we use:

$$|\vec{a} + \vec{b}|^2 = (\vec{a} + \vec{b}) \cdot (\vec{a} + \vec{b})$$

and:

$$|\vec{a} - \vec{b}|^2 = (\vec{a} - \vec{b}) \cdot (\vec{a} - \vec{b})$$

Also:

$$\vec{a} \cdot \vec{b} = 0$$

means that $\vec{a}$ and $\vec{b}$ are perpendicular vectors.

Step 1: Start with the given condition.

Given:

$$|\vec{a} + \vec{b}| = |\vec{a} - \vec{b}|$$

Squaring both sides:

$$|\vec{a} + \vec{b}|^2 = |\vec{a} - \vec{b}|^2$$

Step 2: Expand the left-hand side.

$$|\vec{a} + \vec{b}|^2 = (\vec{a} + \vec{b}) \cdot (\vec{a} + \vec{b})$$

$$= |\vec{a}|^2 + 2\vec{a} \cdot \vec{b} + |\vec{b}|^2$$

Step 3: Expand the right-hand side.

$$|\vec{a} - \vec{b}|^2 = (\vec{a} - \vec{b}) \cdot (\vec{a} - \vec{b})$$

$$= |\vec{a}|^2 - 2\vec{a} \cdot \vec{b} + |\vec{b}|^2$$

Step 4: Equate both expressions.

Since:

$$|\vec{a} + \vec{b}|^2 = |\vec{a} - \vec{b}|^2$$

we get:

$$|\vec{a}|^2 + 2\vec{a} \cdot \vec{b} + |\vec{b}|^2 = |\vec{a}|^2 - 2\vec{a} \cdot \vec{b} + |\vec{b}|^2$$

Cancel common terms:

$$2\vec{a} \cdot \vec{b} = -2\vec{a} \cdot \vec{b}$$

$$4\vec{a} \cdot \vec{b} = 0$$

$$\vec{a} \cdot \vec{b} = 0$$

Step 5: Use the dot product condition.

Since:

$$\vec{a} \cdot \vec{b} = 0$$

therefore:

$$\vec{a} \perp \vec{b}$$

So, $\vec{a}$ is perpendicular to $\vec{b}$.

Hence, the correct answer is:

(B) $\vec{a}$ is perpendicular to $\vec{b}$

Quick Tip: If $|\vec{a} + \vec{b}| = |\vec{a} - \vec{b}|$, then $\vec{a} \cdot \vec{b} = 0$, so the vectors are perpendicular.

102. $\begin{vmatrix} x_1 & y_1 \\ x_2 & y_2 \end{vmatrix}$ represents the area of

- (A) Circle
- (B) Ellipse
- (C) Triangle
- (D) Parallelogram

Correct Answer: (D) Parallelogram

Solution:

Concept:

A determinant of order 2 formed by two vectors represents the signed area of the parallelogram

formed by those two vectors.

If the vectors are:

$$\vec{a} = x_1\hat{i} + y_1\hat{j}$$

and

$$\vec{b} = x_2\hat{i} + y_2\hat{j}$$

then the area of the parallelogram formed by these two vectors is:

$$\begin{vmatrix} x_1 & y_1 \\ x_2 & y_2 \end{vmatrix}$$

Step 1: Write the determinant.

The given determinant is:

$$\begin{vmatrix} x_1 & y_1 \\ x_2 & y_2 \end{vmatrix}$$

Expanding it:

$$= x_1y_2 - x_2y_1$$

The absolute value of this expression gives the area.

Step 2: Connect determinant with geometry.

The determinant:

$$x_1y_2 - x_2y_1$$

represents the cross product magnitude of two vectors in two dimensions.

The magnitude of cross product gives the area of the parallelogram formed by the two vectors.

Step 3: Difference between triangle and parallelogram area.

If the same two vectors form a triangle, then the area of the triangle is half of the parallelogram area:

$$\text{Area of triangle} = \frac{1}{2} \begin{vmatrix} x_1 & y_1 \\ x_2 & y_2 \end{vmatrix}$$

But the determinant itself represents the parallelogram area.

Step 4: Check the options.

Option (A) Circle is incorrect because circle area does not use this determinant.

Option (B) Ellipse is incorrect.

Option (C) Triangle is incorrect because triangle area is half of this determinant.

Option (D) Parallelogram is correct.

Hence, the correct answer is:

(D) Parallelogram

Quick Tip: A 2×2 determinant gives the area of a parallelogram. Half of it gives the area of a triangle.

103. A random variable X has the following probability mass function as follows:

X	-2	3	1
$P(X = x)$	$\frac{a}{6}$	$\frac{a}{4}$	$\frac{a}{12}$

Then the value of a is

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

Correct Answer: (B) 2

Solution:

Concept:

For a probability mass function, the sum of all probabilities must be equal to 1.

$$\sum P(X = x) = 1$$

Here, the probabilities are:

$$\frac{a}{6}, \frac{a}{4}, \frac{a}{12}$$

So, their sum must be:

$$\frac{a}{6} + \frac{a}{4} + \frac{a}{12} = 1$$

Step 1: Add all probabilities.

$$\frac{a}{6} + \frac{a}{4} + \frac{a}{12} = 1$$

Take LCM of 6, 4, 12, which is 12.

$$\frac{2a}{12} + \frac{3a}{12} + \frac{a}{12} = 1$$

$$\frac{2a + 3a + a}{12} = 1$$

$$\frac{6a}{12} = 1$$

$$\frac{a}{2} = 1$$

Step 2: Solve for a .

$$\frac{a}{2} = 1$$

Multiplying both sides by 2:

$$a = 2$$

Hence, the correct answer is:

$$\boxed{(B) 2}$$

Quick Tip: For any probability mass function, always use the condition:

$$\sum P(X = x) = 1$$

104. The diameter of an electric cable X is a continuous random variable with probability density function

$$f(x) = kx(1 - x), \quad 0 \leq x \leq 1.$$

Find

$$P\left(X < \frac{1}{2} \mid \frac{1}{3} < X < \frac{2}{3}\right)$$

(A) $\frac{1}{4}$

(B) $\frac{1}{2}$

(C) $\frac{3}{2}$

(D) $\frac{3}{4}$

Correct Answer: (B) $\frac{1}{2}$

Solution:

Concept:

For conditional probability:

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

Here:

$$A: X < \frac{1}{2}$$

and:

$$B: \frac{1}{3} < X < \frac{2}{3}$$

So:

$$A \cap B: \frac{1}{3} < X < \frac{1}{2}$$

Therefore:

$$P\left(X < \frac{1}{2} \mid \frac{1}{3} < X < \frac{2}{3}\right) = \frac{P\left(\frac{1}{3} < X < \frac{1}{2}\right)}{P\left(\frac{1}{3} < X < \frac{2}{3}\right)}$$

Step 1: First find the value of k .

Since $f(x)$ is a probability density function:

$$\int_0^1 kx(1-x) dx = 1$$

$$k \int_0^1 (x - x^2) dx = 1$$

$$k \left[\frac{x^2}{2} - \frac{x^3}{3} \right]_0^1 = 1$$

$$k \left(\frac{1}{2} - \frac{1}{3} \right) = 1$$

$$k \left(\frac{1}{6} \right) = 1$$

$$k = 6$$

So:

$$f(x) = 6x(1-x)$$

Step 2: Find the numerator probability.

$$P\left(\frac{1}{3} < X < \frac{1}{2}\right) = \int_{1/3}^{1/2} 6x(1-x) dx$$

$$= \int_{1/3}^{1/2} 6(x - x^2) dx$$

$$= [3x^2 - 2x^3]_{1/3}^{1/2}$$

At $x = \frac{1}{2}$:

$$3\left(\frac{1}{2}\right)^2 - 2\left(\frac{1}{2}\right)^3 = \frac{3}{4} - \frac{1}{4} = \frac{1}{2}$$

At $x = \frac{1}{3}$:

$$3\left(\frac{1}{3}\right)^2 - 2\left(\frac{1}{3}\right)^3 = \frac{1}{3} - \frac{2}{27} = \frac{9-2}{27} = \frac{7}{27}$$

Therefore:

$$\begin{aligned} P\left(\frac{1}{3} < X < \frac{1}{2}\right) &= \frac{1}{2} - \frac{7}{27} \\ &= \frac{27-14}{54} \\ &= \frac{13}{54} \end{aligned}$$

Step 3: Find the denominator probability.

$$\begin{aligned} P\left(\frac{1}{3} < X < \frac{2}{3}\right) &= \int_{1/3}^{2/3} 6x(1-x) dx \\ &= [3x^2 - 2x^3]_{1/3}^{2/3} \end{aligned}$$

At $x = \frac{2}{3}$:

$$\begin{aligned} 3\left(\frac{2}{3}\right)^2 - 2\left(\frac{2}{3}\right)^3 &= 3 \cdot \frac{4}{9} - 2 \cdot \frac{8}{27} \\ &= \frac{4}{3} - \frac{16}{27} \\ &= \frac{36-16}{27} \\ &= \frac{20}{27} \end{aligned}$$

At $x = \frac{1}{3}$:

$$3\left(\frac{1}{3}\right)^2 - 2\left(\frac{1}{3}\right)^3 = \frac{7}{27}$$

Therefore:

$$P\left(\frac{1}{3} < X < \frac{2}{3}\right) = \frac{20}{27} - \frac{7}{27}$$

$$= \frac{13}{27}$$

Step 4: Apply conditional probability formula.

$$P\left(X < \frac{1}{2} \mid \frac{1}{3} < X < \frac{2}{3}\right) = \frac{\frac{13}{54}}{\frac{13}{27}}$$

$$= \frac{13}{54} \times \frac{27}{13}$$

$$= \frac{27}{54}$$

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

Hence, the correct answer is:

$$(B) \frac{1}{2}$$

Quick Tip: For conditional probability with continuous random variables, use:

$$P(A|B) = \frac{\int_{A \cap B} f(x) dx}{\int_B f(x) dx}$$

105. The mean of a binomial distribution is 5 and its standard deviation is 2. Then the value of n and p are

- (A) $\left(\frac{4}{5}, 25\right)$
- (B) $\left(25, \frac{4}{5}\right)$
- (C) $\left(\frac{1}{5}, 25\right)$
- (D) $\left(25, \frac{1}{5}\right)$

Correct Answer: (D) $\left(25, \frac{1}{5}\right)$

Solution:**Concept:**

For a binomial distribution with parameters n and p :

Mean is:

$$\mu = np$$

Variance is:

$$\sigma^2 = npq$$

where:

$$q = 1 - p$$

Standard deviation is:

$$\sigma = \sqrt{npq}$$

Step 1: Write the given values.

Mean:

$$\mu = 5$$

Standard deviation:

$$\sigma = 2$$

So variance is:

$$\sigma^2 = 2^2 = 4$$

Step 2: Use the mean formula.

For binomial distribution:

$$\mu = np$$

So:

$$np = 5$$

Step 3: Use the variance formula.

Variance:

$$\sigma^2 = npq$$

So:

$$npq = 4$$

But from mean:

$$np = 5$$

Therefore:

$$5q = 4$$

$$q = \frac{4}{5}$$

Step 4: Find p .

Since:

$$p + q = 1$$

$$p = 1 - q$$

$$p = 1 - \frac{4}{5}$$

$$p = \frac{1}{5}$$

Step 5: Find n .

Using:

$$np = 5$$

Substitute:

$$p = \frac{1}{5}$$

$$n \cdot \frac{1}{5} = 5$$

$$n = 25$$

Hence, the correct answer is:

$$(D) \left(25, \frac{1}{5}\right)$$

Quick Tip: For binomial distribution, use:

$$\mu = np, \quad \sigma^2 = npq$$

First find q , then p , and finally n .

106. A coin is biased so that a head is twice as likely to occur as a tail. If the coin is tossed 3 times, what is the probability of getting 2 tails and 1 head.

- (A) $2/9$
- (B) $1/9$
- (C) $2/27$
- (D) $4/27$

Correct Answer: (A) $2/9$

Solution:

Concept:

This is a binomial probability question.

For exactly r successes in n trials:

$$P(X = r) = {}^nC_r p^r q^{n-r}$$

Here, we need exactly 2 tails and 1 head in 3 tosses.

Step 1: Find probabilities of head and tail.

It is given that head is twice as likely as tail.

Let:

$$P(T) = x$$

Then:

$$P(H) = 2x$$

Since total probability is 1:

$$x + 2x = 1$$

$$3x = 1$$

$$x = \frac{1}{3}$$

So:

$$P(T) = \frac{1}{3}$$

and:

$$P(H) = \frac{2}{3}$$

Step 2: Write the required event.

We need:

2 tails and 1 head

The number of ways to arrange 2 tails among 3 tosses is:

$${}^3C_2 = 3$$

Step 3: Calculate probability.

$$P = {}^3C_2 \left(\frac{1}{3}\right)^2 \left(\frac{2}{3}\right)$$

$$P = 3 \cdot \frac{1}{9} \cdot \frac{2}{3}$$

$$P = \frac{3 \times 2}{9 \times 3}$$

$$P = \frac{2}{9}$$

Step 4: Check the options.

Option (A) $2/9$ is correct.

Option (B) $1/9$ is incorrect.

Option (C) $2/27$ is missing the arrangement factor.

Option (D) $4/27$ is not correct.

Hence, the correct answer is:

$$(A) \frac{2}{9}$$

Quick Tip: If head is twice as likely as tail, write:

$$P(T) = x, \quad P(H) = 2x$$

then use $x + 2x = 1$.

107. If $\triangle ABC$ and $\triangle PQR$ are similar triangles in which $\angle A = 47^\circ$ and $\angle Q = 83^\circ$, then $\angle C$ is

- (A) 60°
- (B) 70°
- (C) 90°
- (D) 50°

Correct Answer: (D) 50°

Solution:

Concept:

If two triangles are similar, then their corresponding angles are equal.

For similar triangles:

$$\triangle ABC \sim \triangle PQR$$

the corresponding angles are:

$$\angle A = \angle P$$

$$\angle B = \angle Q$$

$$\angle C = \angle R$$

Also, the sum of angles of a triangle is:

$$180^\circ$$

Step 1: Use the similarity relation.

Given:

$$\triangle ABC \sim \triangle PQR$$

So, corresponding angles are equal:

$$\angle B = \angle Q$$

Given:

$$\angle Q = 83^\circ$$

Therefore:

$$\angle B = 83^\circ$$

Step 2: Use the angle sum property of triangle ABC.

In $\triangle ABC$:

$$\angle A + \angle B + \angle C = 180^\circ$$

Given:

$$\angle A = 47^\circ$$

and:

$$\angle B = 83^\circ$$

So:

$$47^\circ + 83^\circ + \angle C = 180^\circ$$

$$130^\circ + \angle C = 180^\circ$$

$$\angle C = 180^\circ - 130^\circ$$

$$\angle C = 50^\circ$$

Hence, the correct answer is:

(D) 50°

Quick Tip: For similar triangles written as $\triangle ABC \sim \triangle PQR$, match angles in order: $A \leftrightarrow P$, $B \leftrightarrow Q$, and $C \leftrightarrow R$.

108. Two adjacent angles are said to form a linear pair of angles, if their non-common arms are two

- (A) adjacent rays
- (B) linear rays
- (C) Multiple rays
- (D) opposite rays

Correct Answer: (D) opposite rays

Solution:

Concept:

A linear pair of angles is formed when two adjacent angles have their non-common arms in opposite directions.

In simple words, the two non-common arms form a straight line.

The sum of angles in a linear pair is:

$$180^\circ$$

Step 1: Understand adjacent angles.

Two angles are adjacent if:

they have a common vertex

they have a common arm

their interiors do not overlap

Step 2: Understand linear pair.

For adjacent angles to form a linear pair, their non-common arms must make a straight line.

A straight line is formed by two opposite rays.

Therefore, the non-common arms must be:

opposite rays

Step 3: Use angle sum property.

If two angles form a linear pair, then:

$$\angle 1 + \angle 2 = 180^\circ$$

This happens because opposite rays form a straight angle.

Step 4: Check the options.

Option (A) adjacent rays is incorrect because adjacent rays do not necessarily form a straight line.

Option (B) linear rays is not the standard term.

Option (C) multiple rays is incorrect.

Option (D) opposite rays is correct.

Hence, the correct answer is:

(D) opposite rays

Quick Tip: Linear pair means two adjacent angles whose non-common arms are opposite rays. Their sum is 180° .

109. If $\sin \theta = \frac{24}{25}$ and $0^\circ < \theta < 90^\circ$, then what is the value of $\cos \theta$?

(A) $\frac{12}{15}$

(B) $\frac{7}{25}$

(C) $\frac{3}{5}$

(D) $\frac{4}{5}$

Correct Answer: (B) $\frac{7}{25}$

Solution:

Concept:

We use the basic trigonometric identity:

$$\sin^2 \theta + \cos^2 \theta = 1$$

Since:

$$0^\circ < \theta < 90^\circ$$

the angle lies in the first quadrant. Therefore, both $\sin \theta$ and $\cos \theta$ are positive.

Step 1: Write the given value.

$$\sin \theta = \frac{24}{25}$$

Step 2: Use the identity.

$$\sin^2 \theta + \cos^2 \theta = 1$$

Substitute:

$$\left(\frac{24}{25}\right)^2 + \cos^2 \theta = 1$$

$$\frac{576}{625} + \cos^2 \theta = 1$$

Step 3: Find $\cos^2 \theta$.

$$\cos^2 \theta = 1 - \frac{576}{625}$$

$$\cos^2 \theta = \frac{625 - 576}{625}$$

$$\cos^2 \theta = \frac{49}{625}$$

Step 4: Find $\cos \theta$.

$$\cos \theta = \sqrt{\frac{49}{625}}$$

$$\cos \theta = \frac{7}{25}$$

Since θ is in the first quadrant, $\cos \theta$ is positive.

Hence, the correct answer is:

$$\boxed{(B) \frac{7}{25}}$$

Quick Tip: If $\sin \theta = \frac{24}{25}$, then use the 7–24–25 right triangle. So $\cos \theta = \frac{7}{25}$.

110. Rewrite the expression as single function of an angle, if

$$\frac{2 \tan 31^\circ}{1 - \tan^2 31^\circ} = ?$$

(A) $\tan 62^\circ$

(B) $\tan 31^\circ$

(C) $\tan 15^\circ$

(D) $\tan 10^\circ$

Correct Answer: (A) $\tan 62^\circ$

Solution:

Concept:

We use the double angle identity for tangent:

$$\tan 2A = \frac{2 \tan A}{1 - \tan^2 A}$$

The given expression is:

$$\frac{2 \tan 31^\circ}{1 - \tan^2 31^\circ}$$

This exactly matches the formula:

$$\frac{2 \tan A}{1 - \tan^2 A}$$

Step 1: Compare with the standard formula.

Standard formula:

$$\tan 2A = \frac{2 \tan A}{1 - \tan^2 A}$$

Given expression:

$$\frac{2 \tan 31^\circ}{1 - \tan^2 31^\circ}$$

So:

$$A = 31^\circ$$

Step 2: Apply the double angle formula.

$$\frac{2 \tan 31^\circ}{1 - \tan^2 31^\circ} = \tan(2 \times 31^\circ)$$
$$= \tan 62^\circ$$

Hence, the correct answer is:

(A) $\tan 62^\circ$

Quick Tip: Remember the tangent double angle formula:

$$\tan 2A = \frac{2 \tan A}{1 - \tan^2 A}$$

111. According to the passage, why does water travel through plants in unbroken columns?

- (A) Root pressure moves the water very rapidly.
- (B) The attraction between water molecules is strong.
- (C) The living cell of plants pushes the water molecules together.
- (D) Atmospheric pressure supports the columns.

Correct Answer: (B) The attraction between water molecules is strong.

Solution:

Concept:

This question is based on passage comprehension and also relates to the biological concept of cohesion.

Water molecules attract each other due to hydrogen bonding.

This attraction between similar molecules is called:

cohesion

Cohesion helps water move through plants as continuous columns.

Step 1: Understand the phrase “unbroken columns”.

Water moves upward in plants through xylem.

For this upward movement, the water column must remain continuous.

If water molecules did not stick together, the column would break easily.

Step 2: Identify the main reason.

The passage states that water travels in unbroken columns because water molecules strongly attract one another.

This is due to cohesion.

Step 3: Check the options.

Option (A) Root pressure helps water movement but is not the main reason for unbroken columns.

Option (B) Strong attraction between water molecules is correct.

Option (C) Living cells do not push water molecules together in this context.

Option (D) Atmospheric pressure is not the passage-based reason here.

Hence, the correct answer is:

(B) The attraction between water molecules is strong.

Quick Tip: Cohesion means attraction between similar molecules. In plants, cohesion between water molecules helps maintain continuous water columns.

112. All the following may be components of a virus EXCEPT

(A) RNA

(B) Plant cells

(C) Carbohydrates

(D) a coat of protein

Correct Answer: (B) Plant cells

Solution:

Concept:

Viruses are acellular infectious particles.

This means they are not made up of cells.

A virus generally contains:

genetic material

and:

protein coat

Some viruses may also have additional components like lipids or carbohydrates in their envelope.

Step 1: Understand basic virus structure.

The genetic material of a virus may be:

DNA

or:

RNA

The genetic material is surrounded by a protein coat called:

capsid

Step 2: Check each option.

RNA can be a component of some viruses, such as RNA viruses.

A coat of protein is present in viruses as capsid.

Carbohydrates may be present in some viral envelopes as glycoproteins.

But plant cells are not components of viruses.

Step 3: Final answer.

Since viruses are not made of cells, plant cells cannot be a component of a virus.

Hence, the correct answer is:

(B) Plant cells

Quick Tip: Viruses are acellular. They may contain DNA or RNA and a protein coat, but they are not made of plant or animal cells.

113. The synonym of 'profusion' is

- (A) abundance
- (B) bleed
- (C) blend
- (D) express

Correct Answer: (A) abundance

Solution:

Concept:

A synonym is a word that has the same or nearly the same meaning as another word.

The word:

profusion

means a large amount or plenty of something.

Step 1: Understand the meaning of profusion.

Profusion means:

abundance

plenty

large quantity

overflowing amount

For example:

There was a profusion of flowers in the garden.

This means there were many flowers.

Step 2: Check the options.

Option (A) abundance means plenty or large amount, so it is correct.

Option (B) bleed means to lose blood, so it is not a synonym.

Option (C) blend means to mix, so it is not correct.

Option (D) express means to show or state, so it is not correct.

Hence, the correct answer is:

(A) abundance

Quick Tip: Profusion means abundance, plenty, or a large quantity of something.

114. All the following sentences about Nicaraguan sign language are true EXCEPT

- (A) The language has been created since 1979.
- (B) The language is based on speech and lip reading.
- (C) The language incorporates signs which children used at home.
- (D) The language was perfected by younger children.

Correct Answer: (B) The language is based on speech and lip reading.

Solution:

Concept:

This is a passage-based “EXCEPT” question.

In such questions, three statements are true according to the passage, and one statement is

false or not supported by the passage.

We need to choose the statement that is not true.

Step 1: Understand the passage idea.

Nicaraguan sign language developed naturally among deaf children.

It was not created by directly copying spoken language.

It developed from signs that children used with each other and at home.

Step 2: Check each statement.

Option (A) says the language has been created since 1979. This is supported by the passage context.

Option (C) says the language incorporates signs used by children at home. This is also supported.

Option (D) says the language was perfected by younger children. This matches the passage idea that younger children systematized it.

Option (B) says the language is based on speech and lip reading. This contradicts the passage idea because it emerged as a sign language, not from speech and lip reading.

Step 3: Select the EXCEPT option.

The false statement is:

The language is based on speech and lip reading.

Hence, the correct answer is:

(B)

Quick Tip: In EXCEPT questions, identify the statement that contradicts the passage, not the one that merely sounds unusual.

115. Which idea is presented in the final paragraph?

- (A) English was probably once a creole.
- (B) The English past tense system is inaccurate.
- (C) Linguists have proven that English was created by children.
- (D) Children say English past tenses differently from adults.

Correct Answer: (A) English was probably once a creole.

Solution:

Concept:

This is a reading comprehension question.

The phrase “final paragraph” means we must identify the main idea or conclusion presented at the end of the passage.

Step 1: Understand the main concluding idea.

The passage discusses language formation and development.

The final paragraph suggests that English may have once developed in a way similar to a creole. A creole is a language that develops from contact between different language groups and becomes a full native language.

Step 2: Check the options.

Option (A) says English was probably once a creole. This matches the final paragraph idea.

Option (B) says the English past tense system is inaccurate. This is not the main idea.

Option (C) says linguists have proven English was created by children. This is too strong and not the intended conclusion.

Option (D) talks about children saying past tenses differently, which may be a detail but not the final paragraph’s main idea.

Step 3: Choose the best answer.

The best answer is:

English was probably once a creole.

Hence, the correct answer is:

(A) English was probably once a creole.

Quick Tip: For final-paragraph questions, choose the option that captures the concluding idea, not just a small detail.

116. Enjoyment is the motto of the

- (A) youth who usher humanity into the third millennium
- (B) youth who rebel against the establishment
- (C) youth looking for an alternative mode of development
- (D) vast majority of the youth today

Correct Answer: (D) vast majority of the youth today

Solution:

Concept:

This is a passage-based question.

Such questions usually require selecting the option closest to the wording and meaning used by the author.

Step 1: Understand the question.

The question asks:

Enjoyment is the motto of whom?

So we must identify the group mentioned in the passage.

Step 2: Use the passage meaning.

According to the passage, enjoyment is described as the motto of the broad majority of present-day youth.

This means the author is not referring to a small rebellious group or a special group of youth.
The author refers generally to:

the vast majority of youth today

Step 3: Check the options.

Option (A) is too specific and not the best answer.

Option (B) refers only to rebellious youth, which is not the passage's meaning.

Option (C) refers to youth looking for alternative development, which is not correct here.

Option (D) matches the passage idea.

Hence, the correct answer is:

(D) vast majority of the youth today

Quick Tip: In passage questions, choose the option closest to the author's exact meaning and wording.

117. Summer vacation in old time means

- (A) Grand get together with friends
- (B) Recalling father's tales
- (C) Playing modern Indian games
- (D) Enjoying with family members

Correct Answer: (D) Enjoying with family members

Solution:

Concept:

This is a reading comprehension question based on a passage about old-time summer vacations.
The answer should reflect the main idea, not only one small example.

Step 1: Understand the phrase “old time”.

The phrase suggests a nostalgic description of earlier days.

Old-time summer vacations were often associated with:

family gatherings

spending time with relatives

shared enjoyment

Step 2: Check which option captures the broad idea.

Option (A) mentions friends only, which is not broad enough.

Option (B) mentions father’s tales, which may be a detail but not the complete meaning.

Option (C) says modern Indian games, but the question asks about old time.

Option (D) says enjoying with family members, which captures the main idea of traditional summer vacation.

Step 3: Choose the best answer.

The best option is:

Enjoying with family members

Hence, the correct answer is:

(D) Enjoying with family members

Quick Tip: For passage questions, choose the option that reflects the main idea, not only a small detail.

118. What does "a good conversationalist" refer to?

- (A) sympathetic communicator
- (B) efficient communicator
- (C) who reads others emotion and talk accordingly
- (D) who can talk pleasantly to ameliorate the situation

Correct Answer: (C) who reads others emotion and talk accordingly

Solution:

Concept:

A good conversationalist is not only a person who speaks well.

A good conversationalist also understands the other person's feelings, mood, and situation.
Such a person speaks in a way that suits the listener.

Step 1: Understand the meaning of conversationalist.

A conversationalist is a person who takes part in conversation.

A good conversationalist:

listens carefully

understands the listener's emotions

responds appropriately

keeps the conversation meaningful and comfortable

Step 2: Check the options.

Option (A) sympathetic communicator is close, but it is not as complete.

Option (B) efficient communicator is too general.

Option (C) says a person who reads others' emotions and talks accordingly. This is the most accurate meaning.

Option (D) says someone who can talk pleasantly to improve the situation, but this is only one part of being a good conversationalist.

Step 3: Choose the best answer.

The best meaning is:

who reads others emotion and talk accordingly

Hence, the correct answer is:

(C)

Quick Tip: A good conversationalist is a good listener and adjusts speech according to the listener's emotions and situation.

119. In the given passage who considers Interviews to be immoral?

- (A) V.S. Naipaul
- (B) Rudyard Kipling
- (C) Mark Twain
- (D) Rudyard Kipling and Mark Twain

Correct Answer: (B) Rudyard Kipling

Solution:

Concept:

This is a direct passage-based question.

Such questions ask for a name or detail directly mentioned in the passage.

Step 1: Understand what is asked.

The question asks:

Who considers interviews to be immoral?

So we need the person associated with this opinion in the passage.

Step 2: Identify the correct person.

According to the passage, Rudyard Kipling considered interviews to be immoral.

This is a direct factual detail from the passage.

Step 3: Check the options.

Option (A) V.S. Naipaul is incorrect.

Option (B) Rudyard Kipling is correct.

Option (C) Mark Twain is incorrect.

Option (D) Rudyard Kipling and Mark Twain is incorrect because the passage specifically gives Rudyard Kipling.

Hence, the correct answer is:

(B) Rudyard Kipling

Quick Tip: For direct passage questions, locate the exact name or phrase in the passage instead of inferring broadly.

120. According to the author, what is the benefit of public reasoning or argumentation?

- (A) It produces a rich and dynamic democracy.
- (B) It creates chaos and public disagreements that make governing difficult.
- (C) It allowed the British to divide and rule Indians.
- (D) By promoting arguments and discord it hurts the cause of secularism.

Correct Answer: (A) It produces a rich and dynamic democracy.

Solution:

Concept:

This is a comprehension question about the author's viewpoint.

Public reasoning means open discussion, debate, questioning, and argumentation in society. In democratic thinking, public reasoning is usually considered healthy because it allows people to exchange ideas and participate in decision-making.

Step 1: Understand the author's tone.

The author presents public reasoning as a positive force.
It is not described as chaos or harmful disagreement.
Instead, it is shown as a feature that strengthens democracy.

Step 2: Identify the benefit.

The benefit of public reasoning is that it produces:

a rich and dynamic democracy

This means democracy becomes active, thoughtful, participatory, and open to different viewpoints.

Step 3: Check the options.

Option (A) matches the positive meaning of public reasoning.
Option (B) is negative and does not match the author's view.
Option (C) is not the benefit of public reasoning.
Option (D) is also negative and contradicts the author's idea.

Hence, the correct answer is:

(A) It produces a rich and dynamic democracy.

Quick Tip: When an author discusses argumentation positively, look for an option that shows democratic strength, participation, and openness.

121. The author is making a comparison between

- (A) Science-fiction and Epics
- (B) Science fiction and non-fiction
- (C) Science-Fiction and Romance
- (D) Pulp Fiction and Epics

Correct Answer: (A) Science-fiction and Epics

Solution:

Concept:

This is a passage-based comparison question.

To answer such questions, identify the two main subjects that the author discusses side by side.

Step 1: Understand what comparison means.

A comparison means the author is showing similarities or differences between two things.

The question asks:

The author is comparing what with what?

Step 2: Identify the two categories.

According to the passage, the author compares:

Science-fiction

with:

Epics

This means the author may be discussing similarities in scale, imagination, heroic journey, or narrative structure.

Step 3: Check the options.

Option (A) Science-fiction and Epics is correct.

Option (B) Science fiction and non-fiction is not the comparison.

Option (C) Science-fiction and Romance is not supported.

Option (D) Pulp Fiction and Epics is not the correct pair.

Hence, the correct answer is:

(A) Science-fiction and Epics

Quick Tip: In comparison questions, find the two main subjects repeatedly discussed together in the passage.

123. Based on the given passage which of the following statements is true

- (A) Human beings are awfully close to their material possessions
- (B) Civilizations are built through great efforts.
- (C) One must always try to acquire better things.
- (D) Human existence is casual and haphazard.

Correct Answer: (A) Human beings are awfully close to their material possessions

Solution:

Concept:

This is a passage-based true statement question.

In such questions, the correct option is the one directly supported by the passage.

Step 1: Understand the central idea.

The passage suggests that human beings have a strong attachment to their material possessions. This means people often feel emotionally connected to the things they own.

Step 2: Check each option.

Option (A) says human beings are awfully close to their material possessions. This matches the passage.

Option (B) may be generally true, but it is not the statement supported here.

Option (C) sounds like advice, but the passage does not necessarily say this.

Option (D) says human existence is casual and haphazard, which does not match the passage meaning.

Step 3: Choose the passage-supported statement.

The statement supported by the passage is:

Human beings are awfully close to their material possessions.

Hence, the correct answer is:

(A)

Quick Tip: For passage-based true statement questions, choose the option that is directly supported by the passage, not a general opinion.

124. The word 'cavalier' as used in the passage means all of the following except

- (A) Haughty
- (B) Rash
- (C) Prudent
- (D) Frenetic

Correct Answer: (C) Prudent

Solution:

Concept:

This is a vocabulary-based “EXCEPT” question.

The word:

cavalier

usually means careless, dismissive, arrogant, or showing lack of proper concern.

Step 1: Understand the meaning of cavalier.

A cavalier attitude means an attitude that is:

careless

rash

dismissive

not serious

It may also suggest arrogance or haughtiness.

Step 2: Check the options.

Option (A) Haughty means arrogant, so it can match the sense of cavalier.

Option (B) Rash means careless or impulsive, so it can match.

Option (D) Frenetic means frantic or wildly excited. It may be related to uncontrolled behavior.

Option (C) Prudent means careful, wise, and sensible.

Prudent is opposite to careless or rash.

Step 3: Select the EXCEPT option.

Since “prudent” does not match the meaning of “cavalier”, it is the correct EXCEPT option.

Hence, the correct answer is:

(C) Prudent

Quick Tip: Cavalier means careless or dismissive. Prudent means careful and wise, so it is the opposite.

125. The expression $x^2 - x + 1 = 0$ has

- (A) One proper linear factor
- (B) Two proper linear factors
- (C) No proper linear factor
- (D) Cannot be determined

Correct Answer: (C) No proper linear factor

Solution:

Concept:

A quadratic equation:

$$ax^2 + bx + c = 0$$

has real linear factors if its discriminant is non-negative.

The discriminant is:

$$D = b^2 - 4ac$$

If:

$$D > 0$$

then two distinct real linear factors exist.

If:

$$D = 0$$

then one repeated real linear factor exists.

If:

$$D < 0$$

then there is no real linear factor.

Step 1: Identify coefficients.

Given:

$$x^2 - x + 1 = 0$$

Compare with:

$$ax^2 + bx + c = 0$$

So:

$$a = 1, \quad b = -1, \quad c = 1$$

Step 2: Calculate discriminant.

$$D = b^2 - 4ac$$

$$D = (-1)^2 - 4(1)(1)$$

$$D = 1 - 4$$

$$D = -3$$

Step 3: Interpret discriminant.

Since:

$$D = -3 < 0$$

the quadratic has no real roots.

Therefore, it cannot be factorized into proper real linear factors.

Step 4: Check the options.

Option (A) one proper linear factor is incorrect.

Option (B) two proper linear factors is incorrect.

Option (C) no proper linear factor is correct.

Option (D) cannot be determined is incorrect because discriminant clearly decides it.

Hence, the correct answer is:

(C) No proper linear factor

Quick Tip: A quadratic has real linear factors only when:

$$D = b^2 - 4ac \geq 0$$

126. If '+' means 'divided by', '-' means 'add', ' ' means 'minus' and '/' means 'multiplied by', what will be the value of the following expression?

$$\{(17 \ 12) - (4/2)\} + (23 - 6)/0$$

- (A) infinite
- (B) 0
- (C) 118
- (D) 219

Correct Answer: (B) 0

Solution:

Concept:

This is a coded mathematical operation question.

We must replace each symbol with its given meaning and then simplify the expression carefully.

The given meanings are:

$$+ \Rightarrow \div$$

$$- \Rightarrow +$$

$$\text{blank space} \Rightarrow -$$

$$/ \Rightarrow \times$$

Step 1: Evaluate (17 12).

Here, the blank space between 17 and 12 means minus.

So:

$$(17 \ 12) = 17 - 12$$

$$= 5$$

Step 2: Evaluate (4/2).

Here, / means multiplied by.

So:

$$(4/2) = 4 \times 2$$

$$= 8$$

Step 3: Evaluate the first bracket.

The first bracket is:

$$\{(17 \ 12) - (4/2)\}$$

Since – means add:

$$= 5 + 8$$

$$= 13$$

Step 4: Evaluate (23 – 6).

Again, – means add.

So:

$$(23 - 6) = 23 + 6$$

$$= 29$$

Step 5: Evaluate the remaining expression.

The expression becomes:

$$13 + 29/0$$

But according to the code:

$$+ \Rightarrow \div$$

and:

$$/ \Rightarrow \times$$

So:

$$\begin{aligned} 13 + 29/0 &= \frac{13}{29} \times 0 \\ &= 0 \end{aligned}$$

Step 6: Check the options.

Option (A) infinite is incorrect because after symbol replacement, it is not division by zero.

Option (B) 0 is correct.

Option (C) 118 is incorrect.

Option (D) 219 is incorrect.

Hence, the correct answer is:

(B) 0

Quick Tip: In coded operation questions, first replace every symbol according to the given rule, then evaluate using normal arithmetic.

127. Starting from a Point 'M' Harish walked 18 m towards South. He turned to his left and walked 5m. He then turned to his left and walked 18 m. He again turned to his left and walked 35 m and reached a point 'P'. How far is Harish from the point 'M' and in which direction?

- (A) 10 m East
- (B) 10 m South
- (C) 10 m West

(D) None of these

Correct Answer: (D) None of these

Solution:

Concept:

This is a direction sense problem.

The easiest method is to take the starting point as the origin and track movement using coordinates.

Let:

$$\text{East} = +x$$

$$\text{West} = -x$$

$$\text{North} = +y$$

$$\text{South} = -y$$

Step 1: Start from point M.

Let:

$$M = (0, 0)$$

Harish first walks 18 m towards South.

So his position becomes:

$$(0, -18)$$

Step 2: Turn left from South.

When a person faces South, his left direction is East.

He walks 5 m East.

So:

$$(0, -18) \rightarrow (5, -18)$$

Step 3: Turn left from East.

When a person faces East, his left direction is North.

He walks 18 m North.

So:

$$(5, -18) \rightarrow (5, 0)$$

Step 4: Turn left from North.

When a person faces North, his left direction is West.

He walks 35 m West.

So:

$$(5, 0) \rightarrow (5 - 35, 0)$$

$$= (-30, 0)$$

Step 5: Find distance and direction from M .

Final position is:

$$P = (-30, 0)$$

Starting point was:

$$M = (0, 0)$$

So Harish is 30 m to the West of M .

Step 6: Check the options.

Option (A) 10 m East is incorrect.

Option (B) 10 m South is incorrect.

Option (C) 10 m West is incorrect because the distance is 30 m West.

Option (D) None of these is correct.

Hence, the correct answer is:

(D) None of these

Quick Tip: For direction questions, convert every movement into coordinates. This avoids confusion in left and right turns.

128. $(1 + \tan A + \sec A)(1 + \sec A - \tan A) - 2 \sec A =$

- (A) 0
- (B) -2
- (C) 1
- (D) 2

Correct Answer: (D) 2

Solution:

Concept:

This question is based on algebraic identity and trigonometric identity.

We will use:

$$(a + b)(a - b) = a^2 - b^2$$

and:

$$\sec^2 A - \tan^2 A = 1$$

Step 1: Rewrite the expression.

Given expression:

$$(1 + \tan A + \sec A)(1 + \sec A - \tan A) - 2 \sec A$$

Rearrange the first factor:

$$1 + \tan A + \sec A = 1 + \sec A + \tan A$$

Second factor:

$$1 + \sec A - \tan A$$

Let:

$$x = 1 + \sec A$$

and:

$$y = \tan A$$

Then the product becomes:

$$(x + y)(x - y)$$

Step 2: Apply identity.

Using:

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

we get:

$$(1 + \sec A + \tan A)(1 + \sec A - \tan A)$$

$$= (1 + \sec A)^2 - \tan^2 A$$

So the full expression becomes:

$$(1 + \sec A)^2 - \tan^2 A - 2 \sec A$$

Step 3: Expand the square.

$$(1 + \sec A)^2 = 1 + 2 \sec A + \sec^2 A$$

So:

$$1 + 2 \sec A + \sec^2 A - \tan^2 A - 2 \sec A$$

Step 4: Cancel like terms.

$$+2 \sec A - 2 \sec A = 0$$

So expression becomes:

$$1 + \sec^2 A - \tan^2 A$$

Step 5: Use trigonometric identity.

We know:

$$\sec^2 A - \tan^2 A = 1$$

Therefore:

$$1 + \sec^2 A - \tan^2 A = 1 + 1$$

$$= 2$$

Step 6: Check the options.

Option (A) 0 is incorrect.

Option (B) -2 is incorrect.

Option (C) 1 is incorrect.

Option (D) 2 is correct.

Hence, the correct answer is:

(D) 2

Quick Tip: For expressions containing $(1 + \sec A + \tan A)(1 + \sec A - \tan A)$, use:

$$(a + b)(a - b) = a^2 - b^2$$

and:

$$\sec^2 A - \tan^2 A = 1$$