Agniveer Vayu Science (Group X) - 18 July 2021 - Memory Based Paper

Physics

Question 1

The dimensional formula for angular momentum is

Options:

A. $[M^1L^2T^{-2}]$

B. $[M^1L^2T^{-1}]$

C. $[M^0L^2T^{-2}]$

D. $[M^1L^1T^{-1}]$

Answer: B

Solution:

Concept:

- the dimensional formula is defined as the expression of the physical quantity in terms of mass, length, and time.
- The turning momentum of the particle about the axis of rotation is called the angular momentum of the particle. Mathematically angular momentum can be written as
- Either **Angular momentum** is the rotational analogue of linear momentum. The angular momentum of an object can also be connected to the angular velocity ω of the object via the moment of inertia I.
- **∴ L = I x ω = r x p**

  Where,**L**= angular momentum,**I**= moment of inertia,**ω**= angular momentum,

  r= distance and**p**= linear momentum = (m × v).

Explanation:

Now,

Dimensional formulaof (**r**) = **[L]**,

Dimensional formulaof (**p**) = **[MLT^{-1}]**,

Therefore, the dimensional formulaof L is

$L = [L] \times [MLT^{-1}]$

∴ L = [ML^2T^{-1}]

∴ Dimensional formula of angular momentum ***L*** is **[ML^2T^{-1}].**

Theseare some of the useful dimensions of the basic physical quantity, Here M, L, T & Q represent Mass, Length, Time and Chargerespectively.

Physical quantity	Formula	Dimension
Velocity(v)	v = dx/dt	$[L^1T^{-1}]$
Angular velocity (ω)	ω = dθ/dt	$[T^{-1}]$
Acceleration (a)	a =dv/dt	$[L^1T^{-2}]$
Momentum (p)	p = mv	$[M^1L^1T^{-1}]$
Angular momentum (L)	L = rp = mvr	$[M^1L^2T^{-1}]$
Force(F)	F = ma	$[M^1L^1T^{-2}]$
Torque(τ)	τ = r × F	$[M^1L^2T^{-2}]$
Work (W)/Energy(E)	W = Fx =1/2 mv^2	$[M^1L^2T^{-2}]$
Pressure (P)/stress	Pressure = Stress = F/Area	$[M^1L^{-1}T^{-2}]$
Electric current (I)	I = dq/dt	$[QT^{-1}]$
Power	P = Work/time = VI	$[M^1L^2T^{-3}]$
Area	A = x^2	$[L^2]$

Question 2

n-type semiconductor is:

Options:

A. positively charged

B. neutral

C. negatively charged

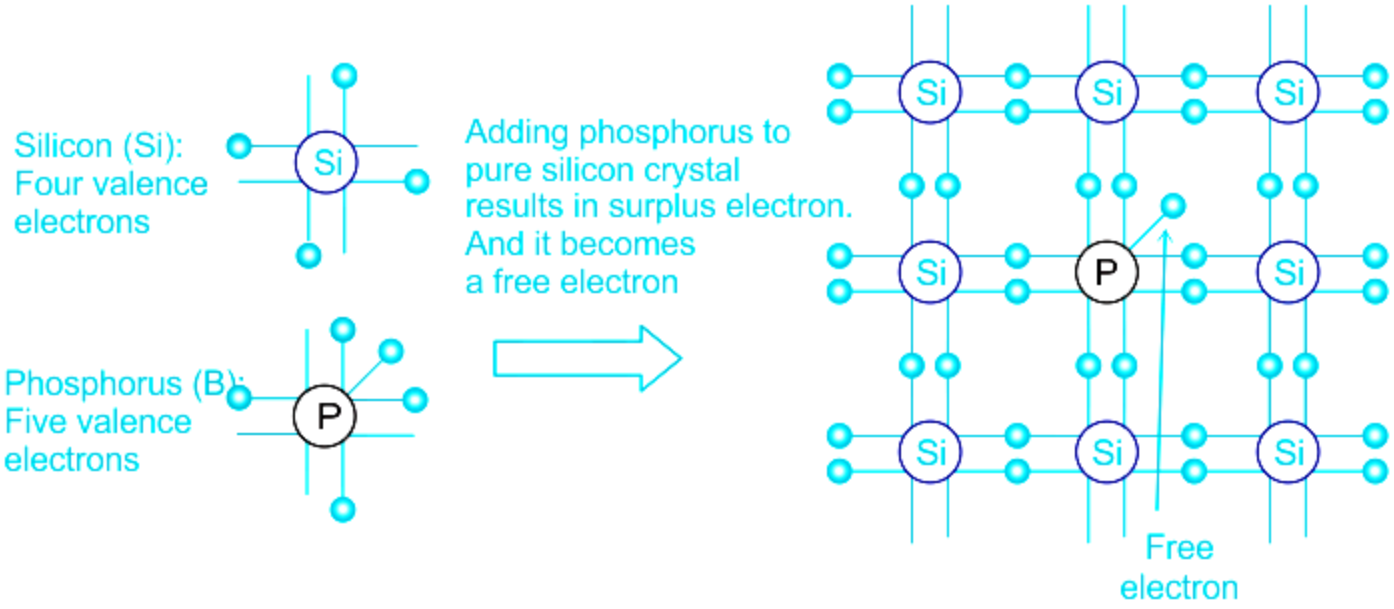
D. none of these

Answer: B

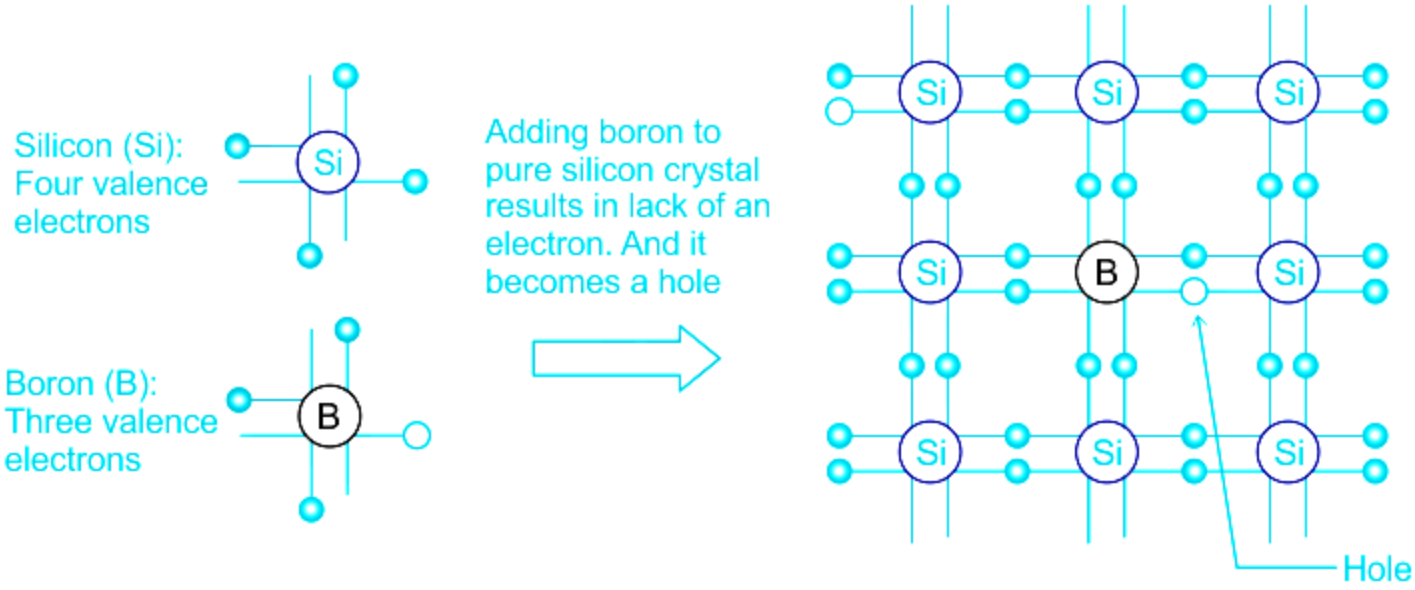
Solution:

CONCEPT:

- **Semiconductor:**A solid substance that has a conductivity between an insulator andmetals.
  - Semiconductorshaveconductivitydue to many factors like**the addition of an impurity or because of temperature effects.**
- **N-type semiconductors**:Anextrinsicsemiconductorwhere the dopant atoms provide extra conduction electrons to the host material like Phosphorus P in Silicon Si.
  - This creates an excess of negative (n-type) electron charge carriers that are able to move freely.



- **P-type semiconductors:**Asemiconductor, when the impurity with**trivalencyis added to puresemiconductors**, then it is known as ap-type semiconductor.
  - Impurities with trivalencysuch as Boron (B), Gallium (Ga), Indium(In), Aluminium(Al), etc are called acceptor impurity.



EXPLANATION:

- **P-type and N-typematerials are NOT positively andnegatively charged.**
  - because atoms are**electrically neutral**.

- **N-type**materials have electrons or negative charges that are majority carriers and holes are minority carriers.
- So it has mainly electrons or negative chargecarriers that can move freely, but it is**still neutral because the fixed donor atoms**, having donated electrons, are positive.
- Thus we can say that**the n-type of semiconductor is neutral**.
- Hence**option 2**is correct.

Question 3

Which among the following statements is true about Huygen's principle

Options:

A. Each point on a wavefront is a source of secondary waves

B. Each point on a wavefront is a sink of secondary waves

C. No point on a wavefront is a source of secondary waves

D. None of the above

Answer: A

Solution:

The correct answer is **option 1)** i.e. **Each point in a wavefront is a source of secondary waves.**

CONCEPT:

Huygens' concepts of secondary wavelets:

- Huygen's principle states that every point on the wavefront may be considered as a source of secondary spherical wavelets that spread out in the forward direction at the speed of light.
    - The new wavefront is the tangential surface of all these secondary wavelets.
    - Secondary sources start making their own wavelets, these waves are similar to that of the primary source
    - It states that each point on a wavefront is a source of wavelets, which spread forward with the same speed.

- **Wavefront:** A wavefront is a surface or a line on which the disturbance at every point has the same phase.
- **Wavelets:** It is a wave-like oscillation with an amplitude that starts at zero, increases, and then decreases back to zero.

EXPLANATION:

- **Huygens's principle** states that each point on a **wavefront** is a source of **wavelets,** which spread forward with the **same speed.**

Question 4

In a series RLC circuit, the values of R, L, and C are 1000 Ω, 4 H, and 10^{-6} F respectively. What will happen to the resonant frequency of the circuit if the value of R is decreased by 20 Ω ?

Options:

A. It will decrease

B. It will increase

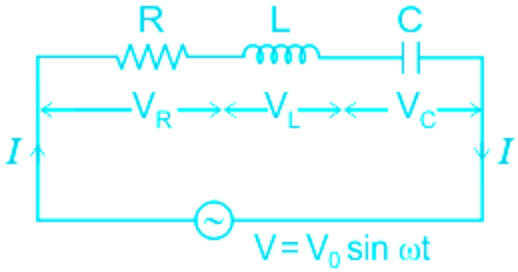
C. Initially it will increase and thendecrease

D. No change

Answer: D

Solution:

CONCEPT:



- The**ac circuit**containing the**capacitor**,**resistor,**and**inductor**is calledan**LCR circuit**.
- For a**series LCR circuit**, the**total potential differenceof the circuit**is given by:

$\Rightarrow V = \sqrt{V_R^2 + (V_L - V_C)^2}$

Where V_R= potential difference across R, V_L=potential difference across L and V_C=potential difference across C

- For a**series LCR circuit**,**Impedance (Z) of the circuit**is given by:

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

Where R = resistance, X_L=induvtive reactance and X_C= capacitive reactive

- When the**LCR circuit is set to resonance**, the resonant frequency is

$\Rightarrow f = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}$

CALCULATION:

- From the above, it is clear that theresonant frequency is given by

$\Rightarrow f = \frac{1}{2\pi\sqrt{LC}}$

- From the above equation, it is clear thatthe**resonant frequency is independent of resistance**, soif the value of R is decreased by 20 Ωthen **there will be no change in the value ofresonant frequency**. Therefore the correct answer is option 4.

Question 5

The heat given to a thermodynamic system is 1 kCal and work done by the system is 200 J. Find the change in internal energy of the system.

Options:

A. 1000 J

B. 2000 J

C. 4000 J

D. 3000 J

Answer: C

Solution:

CONCEPT:

- The**first law of thermodynamics**givesthe relationship between heat, work, and internal energy.
- The**first law of thermodynamics**applies theconservation of energyprinciple to systems.
- The**first law of thermodynamics**states that the change in internal energy of a closed system equals the net heat transferintothe system minus the net work donebythe system.
- In equation form, the**first law of thermodynamics**is given by:

⇒Q =ΔU + W

where Qis the sum of all heat transfers into and out of the system, Wis thenet work done by the system and**ΔU is the change in internal energy**.

CALCULATION:

Given that:

Heat supplied to the system Q = +1 kCal = $1\times 10^3 \times 4.2$= 4200 J

Work done by the system W = +200J

- By the**first law of thermodynamicsQ =ΔU + W**

⇒ 4200=ΔU + 200

⇒ΔU = 4000 J

- So the correct answer is**option 3.**

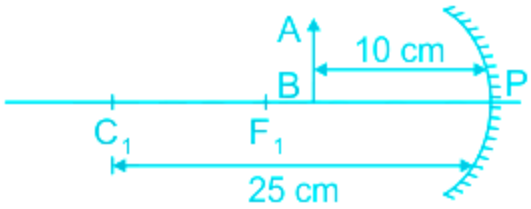
📌 Important Points

Sign convention:

- ΔQ = Positive (Heat supplies to the system)
- ΔQ = Negative (Heat rejected from the system)
- ΔW = Positive (Work done by the system)
- ΔW = Negative (Work done on the system).

Question 6

refer to following diagram to calculate how far (in cm) will the image be formed from the mirror. AB is the object.



Options:

A. 40

B. 25

C. 50

D. 30

Answer: C

Solution:

CONCEPT:

- **Mirror**: The optical instrument which reflects the light and makes the image of the object is called a**mirror**.
  - The mirror having a spherically curved reflecting surface is called a**spherical mirror**.

There are**two types of spherical mirror**:

- **Concave mirror:**The spherical mirror having an inward reflecting surface is called a**concave mirror**.
  - The images form by the**concave mirror can be real as well as virtual**.
- **Convex mirror**: The mirror whose reflecting surface is outward is called a**convex mirror**.
  - The images formed by the**convex mirror is always virtual**.

The**mirror formula**is given by:

$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

Where u is object distance, v is image distance and f is the focal length of the mirror

CALCULATION:

Given that:

Object distance (u) = - 10cm

Radius of curvature (R) = - 25 cm

Focal length of the concave mirror (f) = R/2 = - 25/2 =- 12.5cm

Use mirror formula:

$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

$\frac{1}{-10} + \frac{1}{v} = \frac{1}{-12.5}$

$\frac{1}{v} = \frac{1}{10} - \frac{1}{12.5} = \frac{12.5-10}{125} = \frac{2.5}{125} = 1/50$

Image distance (v)= 50cm

So option 3 is correct.

Question 7

A force$\vec{F} = (5\hat{i} + 3\hat{j})$newton displaces a body by$(2\hat{i} - \hat{j})$metre. The work done by the force is:

Options:

A. Zero

B. 12 Joules

C. 7 Joules

D. 13 Joules

Answer: C

Solution:

CONCEPT:

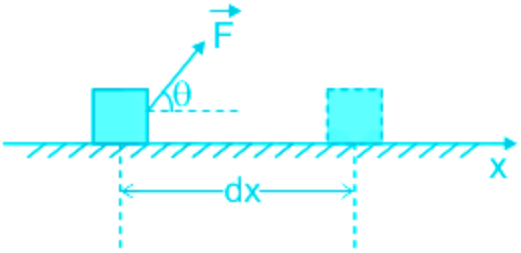
- **Work:**Work is said to be done by a force on an object if the **force applied causes a displacement in the object**.
- The work done by the force is equal to the **product of force and the displacement in the direction of the force**.
- Work is a **scalar quantity**.
- Its SI unit is Joule(J).

$\Rightarrow W = Fx \times cos\theta$

In vector form,

$\Rightarrow W = \overrightarrow{F}.\overrightarrow{x}$

Where W = work done, F = force, x= displacement andθ = angle between F and x



CALCULATION:

Given$\vec{F} = (5\hat{i} + 3\hat{j})and\overrightarrow{x} = (2\hat{i} - \hat{j})$

The work done by the force is:

$\Rightarrow W = \overrightarrow{F}.\overrightarrow{x}$

$\Rightarrow W = (5\hat{i} + 3\hat{j}).(2\hat{i} - \hat{j})$

$\Rightarrow W = 10 - 3$

$\Rightarrow W = 7J$

Hence, option 3 is correct.

Question 8

If the temperature of the source is increased, the efficiency of the Carnot engine

Options:

A. Increases

B. Decreases

C. Remains Constant

D. First increases and then becomes constant

Answer: A

Solution:

CONCEPT:

- **Carnot engine:**The theoretical engine which works on**the Carnot cycle**is called**a Carnot engine.**

- It gives the maximum possible efficiency among all types of**heat engines.**
- The part of the**Carnot engine**which provides heat to the engine is called a**heat source.**
- The temperature of the source is maximum among all the parts.
- The part of the Carnot engine in which an extra amount of heat is rejected by the engine is called as a**heat sink**.
- The amount of work which is done by the engine is called as workdone.

The**efficiency (η)**of a**Carnot engine**is given by:

$$\eta = 1 - \frac{T_C}{T_H} = \frac{Work\ done(W)}{Q_{in}} = \frac{Q_{in} - Q_R}{Q_{in}}$$

Where $T_C$is the temperature of the sink, $T_H$is the temperature of the source, W is work done by the engine, $Q_{in}$is the heat given to the engine/heat input and $Q_R$is heat rejected.

EXPLANATION:

The **efficiency (η) of the Carnot engine** is given by:

$\eta = 1 - T_C/T_H$

- Here if $T_H$increases, the value of T_C/T_Hdecreases, and hence the value of $(1 - T_C/T_H)$increases.
- If the **temperature of the source (T_H) is increased then the efficiency of the Carnot engine increases**. So option 1is correct.

Question 9

If the radius of the earth is reduced to 2/3rd of its initial value keeping its mass constant, then acceleration due to gravity becomes-

Options:

A. 4/9

B. 9/4

C. 2/3

D. 3/2

Answer: B

Solution:

CONCEPT:

- **Acceleration Due to Gravity (g)**: Theforce of attractionexerted by the earthon a body is called agravitational pull or gravity.
    - We know that when aforce acts on a body, itproduces**acceleration**. Therefore, a body under the**effect of gravitational pull**must**accelerate**.
    - The**acceleration**produced in the motion of a bodyunder the**effect of gravity**is called**acceleration due to gravity.**

$\Rightarrow g = \frac{GM}{R^2}$

Where G = universal gravitational constant, M = mass of the earth, and R = radius of the earth

CALCULATION:

Given that:

Mass is constant:

New radius (R') = 2R/3

The**acceleration due to gravity on the earth**is given as:

$\Rightarrow g = \frac{GM}{R^2}$

The**new acceleration due to gravity (g')**:

$\Rightarrow g' = \frac{GM}{(\frac{2R}{3})^2} = \frac{9}{4}\frac{GM}{R^2} = \frac{9}{4}g$

- The**acceleration due to gravity becomes 9/4 times the initial value**. Hence**option 2**is correct

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Question 10

A body executing simple harmonic motion has an amplitude of 0.01 m and a frequency of 50 Hertz. The ratio of the magnitude of maximum acceleration and maximum velocity of the body is

Options:

A. 25π

B. 50π

C. 100π

D. 200π

Answer: C

Solution:

The correct answer is option 3) i.e. 100π

CONCEPT:

- **Simple harmonic motion(SHM)**: It is a type of oscillatorymotionin which the restoring force is directly proportional to the displacement of the body from its mean position.
    - This means that thenet forcewhich in turn is theaccelerationisproportionalto thedisplacementof the object and acts in theopposite directionof the displacement.
    - The displacement in an SHM for a system starting at equilibrium (x = 0) is given by the equation:

$x = Asin\omega t$

Where**x**is the**displacement**,**A**is the**amplitude**,**ω**is the**angular frequency**and**t**is the**time taken**.

The velocity of a particle in SHM, v = $\frac{dx}{dt} = A\omega cos\omega t$

Acceleration of a particle in SHM, a = $\frac{d(dx/dt)}{dt} = -A\omega^2 sin\omega t$

CALCULATION:

Given that:

Frequency, f = 50 Hz⇒ω = 2πf = 2π× 50 = 100π rad/s

Amplitude, A = 0.01 m

Velocity, v = aωcosωt

Maximum velocity occurs when cosωt = 1.

Therefore, **maximum velocity**, $\mathbf{v_{max}}$= Aω = 0.01× 100π =1π m/s

Acceleration, a = -$A\omega^2$sinωt

Maximum acceleration occurs when sinωt = 1.

Therefore,**maximum acceleration**,$\mathbf{a_{max}}$= $A\omega^2$= 0.01× $(100\pi)^2$= $100\pi^2$ m/s^2

Ratio = $\frac{a_{max}}{v_{max}} = \frac{100\pi^2}{1\pi}$= **100π**

Question 11

If ΔU is the increase in internal energy and W is the work done by a system, then which of the following statements is true?

Options:

A. ΔU= W in an adiabatic process

B. ΔU = -W in an isothermal process

C. ΔU= -W in an adiabatic process

D. ΔU= W in an isothermal process

Answer: C

Solution:

The correct answer is option 3) i.e.ΔU= -W in an adiabatic process

CONCEPT:

- **Adiabatic expansion:**An adiabatic process is where**no heat is exchanged between the system and surroundings**.
- **The first law of thermodynamics:**It states thatenergy can neither be created nor destroyed; energy can only be transferred or changed from one form to another.
    - For a system at **thermodynamic equilibrium**, the change in internal energy is equal to the difference in heat transfer of the system and work done on it.

This is given by:

ΔU = Q - W

WhereΔU is the change in internal energy, Q is the heat exchanged in the system and W is the work done during the thermodynamic process.

EXPLANATION:

- From the first law of thermodynamics,**ΔU = Q -W**
- In an **adiabatic process**, the heat exchanged will bezero⇒ Q = 0.
- Thus,**ΔU = -Win an adiabatic process.**

Additional Information

- An **isothermal process**is a thermodynamicprocessin which the temperature of a system remains constant. So, the internal energy will be constant i.e.ΔU = 0.

Question 12

The viscous force between the layers of a liquid does NOT depend on which of the following?

Options:

A. Contact area of the layers

B. Nature of the liquid

C. Velocity gradient

D. Density of the liquid

Answer: D

Solution:

CONCEPT:

- **Viscosity is** the **property of the liquid** due to **which it opposes the relative motion between the layers of the liquid**.
- **Viscous force is the resistive force that** is acting between the layers of liquid and **opposes the relative motion**between the layers and is given by

$\Rightarrow F = -\eta A\frac{dV}{dx}$

Whereη = Coefficient of viscosity, A = Area, and$\frac{dV}{dx} = Velocity\ gradient$

- In the SI system of units, **viscosity is measured in Pascal second,**and in the CGS system of units, it is **measured inPoise**.

EXPLANATION :

- The viscous force acting between the layers of the liquid is given by

$\Rightarrow F = -\eta A\frac{dV}{dx}$

- From the above equation, it is clear that**the frictional force depends on the following factors**

    1. Area
    2. Coefficient of viscosity
    3. Velocity gradient

- From the above discussion, it is clear that the **viscous force depends on the velocity gradient** i.e.,the **viscous force will depend on the velocity of the liquid**.
- The **viscous force also depends on the nature of the liquid**. If the intermolecular force is high then the liquid has more viscosity or vice versa.
- The **viscous force will not be depending on the density** of the liquid
- Hence, **option 4 is the answer**

Question 13

What is the SI unit of resistivity?

Options:

A. Ohm-meter

B. Ohm-meter^2

C. Ohm

D. Ohm/m

Answer: A

Solution:

CONCEPT:

Resistivity (ρ):

- **Resistivity** is numerically equal to the **resistance of a substance** having a **unit area of cross-section and unit length**.
- Mathematically it can be written as,

$\rho = \frac{RA}{l}$

EXPLANATION:

SI unit of resistance = ohm

SI unit of area = meter^2

SI unit of length = meter

SI unit of resistivity is -

$\therefore \rho = \frac{ohm - meter^2}{meter} = ohm - meter$

📌 Important Points

Quantity	Unit	Dimension
Resistance (R)	ohm	$[ML^2T^{-3}A^{-2}]$
Capacitance (C)	Coulomb/volt or Farad	$[M^{-1}L^{-2}T^4A^2]$
Resistivity or Specific resistance (ρ)	Ohm-meter	$[ML^3T^{-3}A^{-2}]$
Electric current (I)	Ampere	[A]

Electric charge (q)	Coulomb	[AT]
Inductance (H)	henry	$[ML^2T^{-2}A^{-2}]$

Question 14

Three capacitances of 4μF, 6μF and 12μF are connected (I) in series and then (II) in parallel. The ratio of equivalent capacitance in case (I) to that in case (II) is:

Options:

A. 1 : 11

B. 11 : 1

C. 1 : 1

D. 1 : 3

Answer: A

Solution:

CONCEPT:

Capacitor:

- The capacitor is a device in which **electrical energy can be stored**.
  - In a capacitor **two conducting plates are connected parallel** to each other and carrying charges of equal magnitudes and opposite sign and separated by an insulating medium.
  - The space between the two plates can either be a vacuum or an electric insulator such as glass, paper, air, or semi-conductor called a dielectric.

1.Capacitors in series

- When **two or more capacitors are connected one after another** such that the **same charge gets generated on all of them,** then it is called **capacitors in series**.
- The **net capacitance/equivalent capacitance (C)** of capacitors in series is given by,

$\Rightarrow \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots + \frac{1}{C_n}$

2.Capacitors in parallel

- When the **plates of two or more capacitors are connected at the same two points** and **the potential difference across them is equal**, then it is called **capacitors in parallel.**

- The**net capacitance/equivalentcapacitance(C)**of capacitors in parallel is given by,

$\Rightarrow C = C_1 + C_2 + \ldots + C_n$

CALCULATION:

Given C_1= 4μF, C_2= 6μF and C_3=12μF

- When they are connected in series theequivalent capacitance is given as,

$\Rightarrow \frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

$\Rightarrow \frac{1}{C_S} = \frac{1}{4} + \frac{1}{6} + \frac{1}{12}$

$\Rightarrow C_S = 2\mu F$ -----(1)

- When they are connected in parallel theequivalent capacitance is given as,

$\Rightarrow C_P = C_1 + C_2 + C_3$

$\Rightarrow C_P = 4 + 6 + 12$

$\Rightarrow C_P = 22\mu F$ -----(2)

By dividing equation 1 and equation 2,

$\Rightarrow \frac{C_S}{C_P} = \frac{2\mu F}{22\mu F}$

$\Rightarrow \frac{C_S}{C_P} = \frac{1}{11}$

- Hence, option 1 is correct.

Question 15

An object is moving in a circle with uniform angular speed. If the radius of the circle is doubled, then its centripetal acceleration will

Options:

A. be tripled

B. be quadrupled

C. be doubled

D. remain the same

Answer: C

Solution:

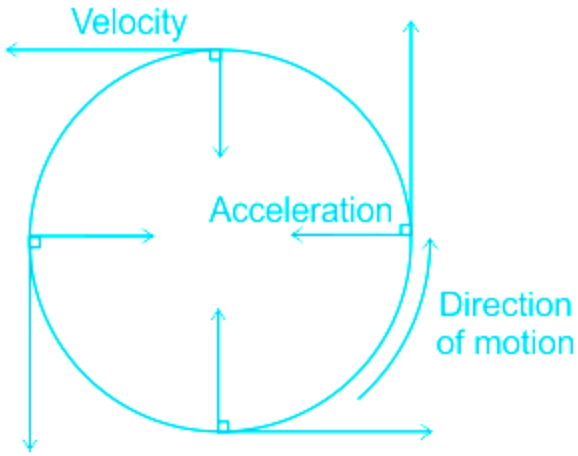
CONCEPT:

- **Circular Motion**: Circular motion is amovementof anobjectalongthecircumferenceof acircleorrotationalongacircularpath.
- Theforceactscontinuouslyatrightanglesto thevelocityof theparticle.
- **Uniform circular motion**: The circular motion in which the speed of the particle remains constant is called uniform circular motion.
    - In auniform circular motion,forcesupplies the**centripetalacceleration**.

$a_c = \frac{v^2}{r} = \omega^2 r$

Where $a_c$is**centripetal acceleration**, v is velocity, r is the radius andω is angular velocity.

- The**speed**and**kineticenergy**of the particle**remainsconstant**.



- **Non-uniform circular motion:**The circular motion in which the speed of the particles changes by time is called non-uniform circular motion.

EXPLANATION:

Given that:

The radius of the circular pathis doubled: r' = 2r

Initial centripetal acceleration (a_c) =ω^2r

Final centripetal acceleration (a'_c) =ω^2r' =ω^2(2r) = 2ω^2r = 2a_c

So option 3 is correct.

Question 16

The dimensional formula of constant a in van der Waals gas equation $(p + \frac{a}{V^2})(V - b) = RT$:

Options:

A. $[ML^3T^{-2}]$

B. $[ML^5T^{-2}]$

C. $[ML^2T^{-1}]$

D. $[ML^2T^{-5}]$

Answer: B

Solution:

CONCEPT:

Real Gas: It will obey the gas rule only at high temperature and low pressure.

- The molecules are not having a negligible volume.
- They can be repulsive and attractive between the molecules.
- It obeys**Van der Waals**equation: $\left(P + \frac{a}{V^2}\right)(v - b) = RT$

Where P = pressure, V = volume, R = universal gas constant and T = temperarure.

EXPLANATION:

- **Van der Waals**equation:

$\Rightarrow \left(P + \frac{a}{V^2}\right)(v - b) = RT$

As pressure can be added only to pressure, therefore, a/v^2represents pressure P i.e.,

$\Rightarrow \frac{a}{V^2} = P$or,

$\Rightarrow a = PV^2$

- Therefore the**dimension of a**is

$\Rightarrow a = [ML^{-1}T^{-2}][L^3]^2 = [M^1L^5T^{-2}]$

- Again volume can be subtracted only by the volume. Therefore, b must be representing volume only i.e.,

$\Rightarrow b = V = [L^3] = [M^0L^3T^0]$

Additional Information

- **Ideal gas:**It is a hypothetical gas, consisting of molecules that are having**negligible volume**and their**collision is perfectly elastically**(means no loss of energy) and**obeys gas law.**
- The**properties of an ideal gas**are:
  - They are having**negligible volume, point size molecules**.
  - There is**no attractive or repulsive force**between the particles of gas
  - The**collision between**the gases and the walls of the container should be**perfectly elastic**(there is no loss of energy).
  - It follows the gas law**P V = n R T**[P = pressure of the gas, V = volume of the gas, n = moles of the gas, R = 8.314 J/mol-K (Universal gas constant), T = temperature of the gas].

Question 17

The angle of incidence for a light ray falling on a plane mirror is 30°. Find the angle of deviation of this light ray.

Options:

A. 30°

B. 60°

C. 120°

D. 180°

Answer: C

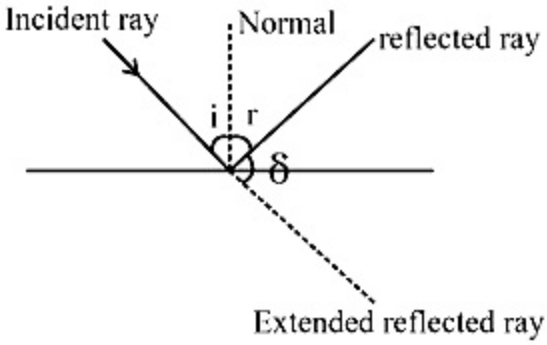
Solution:

CONCEPT:

- **Plane Mirror:**Amirrorwith aflat reflective surface is known as a plane mirror.
  - According to the**law of reflection:**
    1. The incident ray, reflected ray, and the normal to the mirror, all lie on the same plane.
    2. The**angle of the incident (i) = angle of reflection (r)**

The**deviation angle (δ)**is given by:

⇒ δ = 180 - (i + r)



CALCULATION:

Given that i = 30°

so angle of the incident (i) = angle of reflection (r)

⇒**Reflected angle (r) = i = 30°**

⇒**Deviation angle**(δ) = 180 - (i + r)

⇒δ = 180 - (**30°**+**30°**)

⇒**δ =180 - 60° = 120°**

- So the correct answer is**option 3.**

Question 18

The displacement of a particle is given by

$$x = 2 + 5t + 3t^2$$

What will be the magnitude and its initial velocity?

Options:

A. 6 m/s

B. 2 m/s

C. 5 m/s

D. None of the above

Answer: C

Solution:

CONCEPT:

- **The velocity**of the particle is defined as the rate of change of its displacement
- And can be expressed as

$\vec{v} = \frac{\overrightarrow{dx}}{dt}$

Equation of Kinematics:

- These are the various relations between u, v, a, t, and s for the particle moving with**uniform acceleration**where the notations are used as:
- Equations of motion can be written as

⇒ v = u+ at

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

⇒ $v^2 = u^2 + 2as$

where, u= Initial velocity, v= Final velocity, g = Acceleration due to gravity, t = time, and h = height/Distance covered

CALCULATION:

Given that- Equation of displacement, $x = 2 + 5t + 3t^2$

- Now from the above explanation, we know that the velocity of a particle at any instance is the rate of change of displacement.

$\Rightarrow \frac{dx}{dt} = v = 5 + 6t$ ------ (1)

- Kinematic equation

⇒ v = u+ at ----- (2)

- Now comparing this equation with kinematic equation, we can see that**initial velocity, u = 5 m/s** and acceleration, **a = 6 m/s^2**
- Hence option 3 is correct among all

Question 19

The magnetic field intensity at the center of the circular coil depends on the:

Options:

A. Current in the coil

B. Number of turns

C. Radius of the coil

D. All of these

Answer: D

Solution:

CONCEPT:

Magnetic field:

- A magnetic field is a**vector field**in the neighborhood of a magnet, electric current, or changing electric field, in which**magnetic forces are observable**.

Magnetic field intensity:

- Magnetic field intensity at any point in the magnetic field is defined as the**force experienced by the unit north pole**at that point.

EXPLANATION:

We know that the magnetic field intensity at thecenter of the circular coil is given as,

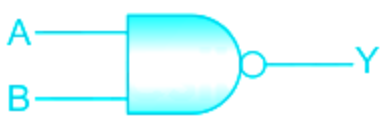
$\Rightarrow B = \frac{\mu_o NI}{2R}$ -----(1)

Whereμ_o= permeability, N = number of turns in the coil, I = current, and R = radius of the coil

- Thepermeability depends on the medium.
- By equation 1 it is clear that the **magnetic field intensity at the center of the circular coil depends on the medium**, the **current in the coil**, the **number of turns**, and the **radius of the coil**. Hence, option 4 is correct.

Question 20

Identify the logic gate?



Options:

A. OR gate

B. AND gate

C. NOT gate

D. NAND gate

Answer: D

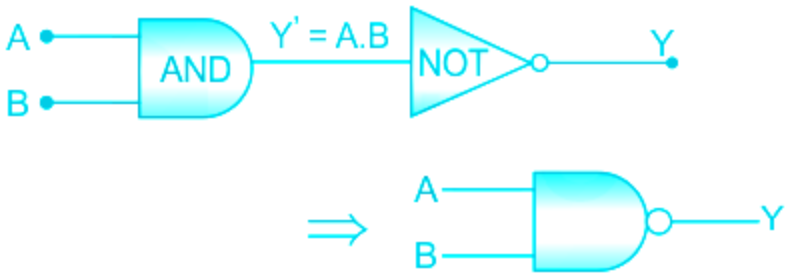
Solution:

CONCEPT:

- **Logic gate**: The digital circuit that can be analyzed with the help of **Boolean algebra** is called a **logic gate** or **logic circuit**.
- A **logic gate** has **two or more inputs** but only **one output**.

EXPLANATION:

- **NAND gate:** It a combination of an **AND and a NOT gate**.



- It is obtained by **connecting the output fo an AND gate to the input of a NOT gate**.
- It is described by the **Boolean expression:** $Y = \overline{A \cdot B}$
- The above logic gate is the **NAND gate**.
- The truth table of **NAND gate**:

A	B	A·B = Y'	Y
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

Question 21

Choose the correct statement from the following.

Options:

A. Electromagnetic waves can travel in a vacuum

B. The electric and magnetic field of an electromagnetic wave are always in phase

C. Accelerated charges produce electromagnetic waves

D. All of the above

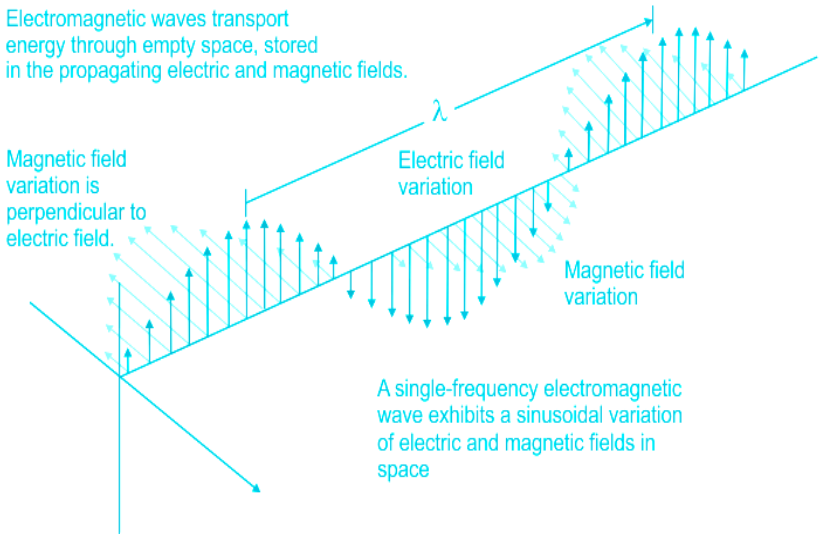
Answer: D

Solution:

The correct answer is option 4) i.e.All of the above

CONCEPT:

- **Electromagneticwaves**are composed of oscillating magnetic and electric fields.
  - The electric field and magnetic field of an electromagnetic wave are perpendicular to each other.
  - These waves do not require a medium to travel.**EM waves** travel at a constant velocity of 3 x 10^8m/s in a vacuum.



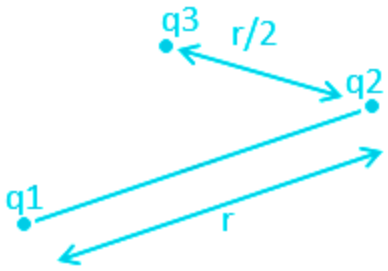
EXPLANATION:

- Electromagnetic waves are a stream of mass-less particles, calledphotons. These serve as the particles in a medium as the wave propagates withenergy. Hence, **they can travel even in a vacuum**.
- **Electromagneticwaves** consist of bothelectric and magnetic fieldwaves that oscillate in **mutually perpendicular planes and a**re **in** the **same phase.**
- A charge moving at constant velocity produces a static magnetic field. To have a varying field with time like in an electromagnetic wave, the charges must not be at rest or moving at a constant velocity. So, they must be **accelerating**. Hence, an **accelerated charge produces EM wave**s.

Thus, all the given statements are correct.

Question 22

Two charges q_1 and q_2 are placed as shown in the figure. The force exerted by q_1 on q_2 is F_{12}. When a new charge q_3 is brought nearby, the magnitude of F_{12} will be



Options:

A. 3 times greater

B. reduces to half

C. same

D. increases

Answer: C

Solution:

The correct answer is option 3) i.e.same

Concept:

Electric charge is a **property** of particles by which they have a tendency to **attract or repel** each other **without touching**.

Electric force: Particles possessing opposite charges attract each other and particles possessing like charges repel each other. This force of attraction or repulsion is called electric force.

The relationship between the electric charges and electric force is given by Coulomb's law.

Coulomb's law states that the electrical force between two charged objects is directly proportional to the product of the quantity of charge on the objects and inversely proportional to the square of the distance between the two objects.

$F = \frac{kq_1q_2}{r^2}$

Where **F** is the **electric force** acting between the two charges

q_1 and **q_2** are the two **charges**

r is the centre to centre distance between the two objects and

k is the **proportionality constant** known as the **Coulomb's law constant** and is equal to $9 \times 10^9 Nm^2/C^2$.

Conclusion:

According to **Coulomb's law**, the force acting between two charges is only dependent on these two charges and is independent of any charge that is near it.

In the given question, F_{12} is the force due to q_1 on q_2.

This would remain the **same** always as $F = \frac{kq_1q_2}{r^2}$

Confusion Points

When a third charge is brought near them, the **net force** on q_1 and q_2 will change as it will now depend on the force exerted by q_3.

Question 23

When light passes through a glass slab, the property of light that changes is/are

Options:

A. Frequency

B. Wavelength

C. Both frequency and wavelength

D. There is no change in the property of the lightwave

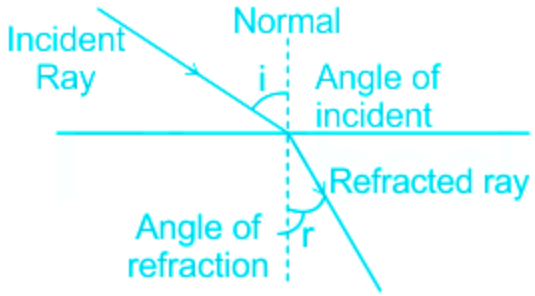
Answer: B

Solution:

CONCEPT:

- **Light:**The light is an electromagnetic wave that can travel in a vacuum.
- **Refraction of light:**When a light ray travels from one medium to another then the light ray gets deviated from its path. This phenomenon is called the**refraction of light**.
- **Refractive index:**The ratio of the speed of light in a vacuum to speed of light in a medium is called**the refractive index**of that medium. It is also called an**absolute refractive index**.

Refractive index $(\mu) = \frac{Speed\ of\ light\ in\ vaccum(C)}{Speed\ of\ light\ in\ a\ medium(v)}$



- **Frequency**: The number of waves per unit time is called frequency. The**frequency of light is the property of the source**from which the light is originating.
  - The**frequency of any wave doesn't depend on the medium**in which it is traveling.
- **Wavelength**: The distance between two adjacent maximaor two adjacent minima of a wave is called the**wavelength**of that wave. It is denoted byλ.

EXPLANATION:

- When a light ray travels from one medium/glassto another then its**velocity changes because of the property of the glass/medium.**
- When the light ray travels from one medium to another then due to a change in the refractive index, the**wavelength of the light changes**. So option 2 is correct.
- The **energy of light** doesn't change when **passing through different mediums**. Since we know the energy of light can be defined as **E = hf**, where h is Planck's constant and f is frequency, then we must conclude that frequency does not change. Therefore, **lights frequency remains constant when passing through different mediums.**
- So, the**frequency of any wave doesn't depend on the medium**in which it is traveling. The frequency depends on the source of the light.
- So the**frequency of the light ray remains the same**. So options 1 and 3arenot correct.

Question 24

A cup of water is filled to the brim, with an ice cube in it. The top of the ice cube sticks out of the surface. What happens when the ice melts?

Options:

A. the cup overflows

B. the water level remains the same

C. the water level decreases

D. none of the above

Answer: B

Solution:

The correct answer is option 2) i.e.the water level remains the same

CONCEPT:

- **Archimedes'principle:**A body at rest in a fluid is acted upon by a force pushing itupward called the**buoyant force**, which is equal to the weight of the fluid that the body**displaces**.

The**buoyant force (F_B)**is given by,

$F_B=\rho_{fluid}\times g\times V_{object}$

EXPLANATION:

Thefloating ice will displacesome volume of the water.

FromArchimedes'principle,$F_B=\rho_{water}\times g\times V_{ice}$ ----(1)

Weight of the displaced fluid (water) = mg =$\rho_{water}\times V_{dispalcedwater}\times g$ ----(2)

For an object to stay afloat, the forces acting on it must be**balanced⇒(1) = (2)**

$\rho_{water}\times g\times V_{ice}=\rho_{water}\times V_{water}\times g$

$\Rightarrow V_{ice}=V_{dispalcedwater}$

Therefore,**when the ice melts, there will beno change in thewater levelas themelted ice willoccupy the same volume as that of displaced water.**

Question 25

The statement "The loss of weight of a body submerged (partially or fully) in a fluid is equal to the weight of the fluid displaced" represents which of thefollowing?

Options:

A. Archimedes' principle

B. Boyle's law

C. Pascal's Law

D. Bernoulli's principle

Answer: A

Solution:

CONCEPT:

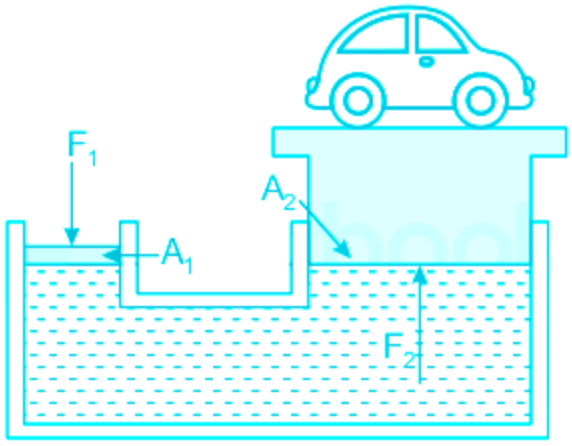
Pascal's Law:it is the principle oftransmission of fluid-pressure.

- It says that "a**pressure exertedanywhere in a point of the confined fluid is transmitted equally in all directions throughout the fluid**".

i.e., the pressure exerted by the fluid on an object at a certain height will be the same in all direction

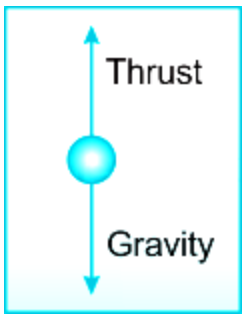
and hence it can be expressed as

$P_a = P_b = p_c \Rightarrow \frac{F_a}{A_a} = \frac{F_b}{A_b} = \frac{F_c}{A_c}$



Archimedes principle: It is used to explain law of flotationor upward thrust experienced when immersed in a fluid

- the principle of Archimedes states**"When a body is immersed in a liquid, an upward thrust, equal to the weight of the liquid displaced, acts on it."**



i.e., weight of an object = Upward thrust

If the weight of the water displaced is less than the weight of the object, the object will sink.

Here,

F_1, F_2= force exerted on area $A_1$and A_2respectively

P_1, P_2= Pressure exerted on area $A_1$and A_2respectively

Explanation:

From the above explanation, we can see that according to **Archimedes principle, "The loss of weight of a body submerged (partially or fully) in a fluid is equal to the weight of the fluid displaced"**

i.e., Loss of weight = weigh of fluid displaced

Extra point:

- **Bernoulli's Principle:**In fluid dynamics, Bernoulli's principle states thatan increase in the speed of a fluid occurs simultaneously with a decrease in pressure or a decrease in the fluid's potential energy.
- **Boyle's law:** For a fixed mass of gas at constant temperature, the volume is inversely proportional to the pressure.
- $P \propto \frac{1}{V}$

PV = constant (If the temperature remains constant, the product of pressure and volume of a given mass of a gas is constant.)

Mathematics

Question 26

If x = A cos 4t + B sin 4t, then $\frac{d^2x}{dt^2}$ is equal to -

Options:

A. -16 x

B. 16 x

C. x

D. -x

Answer: A

Solution:

CONCEPT:

- $\frac{d}{dx}\{f\left(x\right) \pm g\left(x\right)\} = \frac{d\{f(x)\}}{dx} \pm \frac{d\{g(x)\}}{dx}$
- $\frac{d(\sin x)}{dx} = \cos x$
- $\frac{d(\cos x)}{dx} = \ -\sin x$
- **Chain Rule**:

- Let y = f(v) be a differentiable function of v and v = g(x) be a differentiable function of x. Then $\frac{dy}{dx} = \frac{dy}{dv} \cdot \frac{dv}{dx}$

CALCULATION:

Given:x = A cos 4t + B sin 4t

Let's differentiate the given function with respect to t

As we know that, $\frac{d}{dx}\{f\left(x\right) \pm g\left(x\right)\} = \frac{d\{f(x)\}}{dx} \pm \frac{d\{g(x)\}}{dx}$

$\Rightarrow \frac{dx}{dt} = \frac{d(A\cos 4t)}{dt} + \frac{d(B\sin 4t)}{dt}$

As we know that, $\frac{d(\sin x)}{dx} = \cos x \text{and} \frac{d(\cos x)}{dx} = \ -\sin x$

$\Rightarrow \frac{dx}{dt} = 4A \cdot (-\sin 4t) + 4B \cdot (\cos 4t)$

Again by differentiating the above equationwith respect to t we get

$\Rightarrow \frac{d^2x}{dt^2} = \ -16A \cdot \cos 4t - 16B \cdot \sin 4t$

$\Rightarrow \frac{d^2x}{dt^2} = \ -16 \cdot [A\cos 4t + B\sin 4t] = \ -16 \cdot x$

Hence, **option A** is the correct answer.

Question 27

$$\int_0^1 \frac{1}{1+\mathrm{x}^2}\mathrm{dx} =$$

Options:

A. $\frac{\pi}{4}$

B. 0

C. $\frac{\pi}{2}$

D. $\frac{\pi}{3}$

Answer: A

Solution:

Concept:

$\int \frac{1}{1+x^2} dx = \tan^{-1}x$

Calculation:

$$\int_0^1 \frac{1}{1+x^2} dx = [\tan^{-1}x]_0^1 = [\tan^{-1}1 - \tan^{-1}0] = \frac{\pi}{4}$$

Question 28

Find the value of∫cosec^{2}x dx

Options:

A. cot x + c

B. -cot x + c

C. tan x + c

D. tan x + x + c

Answer: B

Solution:

Concept:

∫cosec^{2}x dx = -cot x + c

Question 29

If $f(x) = \frac{\sin x}{x}$, where x∈ R, is to be continuous at x = 0, then the value of the function at x = 0

Options:

A. should be 0

B. should be 1

C. should be 2

D. cannot be determined

Answer: B

Solution:

Concept:

L-Hospital Rule: Let f(x) and g(x) be two functions

Suppose that we have one of the following cases,

I.$\lim_{x\to a} \frac{f(x)}{g(x)} = \frac{0}{0}$

II.$\lim_{x\to a} \frac{f(x)}{g(x)} = \frac{\infty}{\infty}$

Then we can apply L-Hospital Rule$\Leftrightarrow \lim_{x\to a} \frac{f(x)}{g(x)} = \lim_{x\to a} \frac{f'(x)}{g'(x)}$

Note: We have to differentiate both the numerator and denominator with respect to x unless and until $\lim_{x\to a} \frac{f(x)}{g(x)} = l \neq \frac{0}{0}$ where l is a finite value.

A function f(x) is said to**be continuous**at a point x = a, in its domain if$\lim_{x\to a} f(x) = f(a)$exists

Calculation:

Given:$f(x) = \frac{\sin x}{x}$

To Find: f(0)

Function is continuous at x = 0

Therefore, f(0) =$\lim_{x\to 0} f(x)$

$= \lim_{x\to 0} \frac{\sin x}{x}$ (Form 0/0)

Apply L-Hospital Rule,

$= \lim_{x \to 0} \frac{\cos x}{1} = \frac{\cos 0}{1} = 1$

Question 30

Three numbers 3, q and 5are in arithmetic progression if q= ?

Options:

A. 4

B. 5

C. 3

D. None of these

Answer: A

Solution:

CONCEPT :

Three numbers x, y, and z are in arithmetic progression if and only if : 2y = x + z.

CALCULATION:

Given: Threenumbers 3, q and 5are in arithmetic progression

As we know that threenumbers x, y, and z are in arithmetic progression if and only if : 2y = x + z.

⇒ 2q = 3 + 5

⇒ 2q = 8

⇒ q = 4

Hence, option (1) is the correct answer.

Question 31

From a pack of playing card, one card is drawn randomly. What is the probability that the card is red color or king?

Options:

A. $\frac{1}{4}$

B. $\frac{1}{26}$

C. $\frac{3}{13}$

D. $\frac{7}{13}$

Answer: D

Solution:

Concept:

- Either event A alone**OR**event B alone:**m +n**.
- Both eventA**AND**event Btogether:**m× n**.

Calculation:

There are 26 red cards out of total of 52 cards which also include 2 kings

So the probability of getting a red card (P_1) = $\frac{26}{52}$

Now from 4 kingsas 2 kings are already counted there 2 kings are left

So the probability of getting either of them (P_2) = $\frac{2}{52}$

∴ The probability that the card is red colour or king (P) = $P_1 + P_2$

P = $\frac{26+2}{52}$

P = $\frac{28}{52} = \frac{\mathbf{7}}{\mathbf{13}}$

Question 32

C (n, r – 1) + 2C (n, r – 2) + C (n, r – 3) = ?

Options:

A. C (n + 1, r)

B. C (n + 2, r)

C. C (n + 2, r – 1)

D. C (n + 1 , r – 1)

Answer: C

Solution:

Concept: C (n, r) + C (n, r – 1) = C (n + 1, r)

C (n, r – 1) + 2 c (n, r – 2) + C (n, r – 3)

= [C (n, r – 1)+ C (n, r – 2)] + [C (n, r – 2) + C (n, r – 3)]

= C (n + 1 , r – 1) + C (n + 1, r – 2)

= C (n + 2 , r – 1)

Question 33

Find the equation of the tangents to the parabola $y^2 = 4x$, which also passes from the point (3, 4).

Options:

A. $y = x + 1$ & $y = \frac{x}{3} + 3$

B. $y = 5x - 11$ & $y = \frac{2x}{3} + 2$

C. $y = 3x - 5$ & $y = \frac{5x}{3} - 1$

D. $y = 2x - 2$ & $y = \frac{8x}{3} - 4$

Answer: A

Solution:

CONCEPT:

Equation of parabola	Point of contact in terms of slope (m)	Equation of tangent in terms of slope	Condition of tangency
$y^2 = 4ax$	$\left(\frac{a}{m^2}, \frac{2a}{m}\right)$	$y = mx + \frac{a}{m}$	$c = \frac{a}{m}$

CALCULATION:

Given parabola is $y^2 = 4x$

So equation of the tangent will be $y = mx + \frac{a}{m}$

Here 4a = 4 so a = 1

∴ Equation of the tangent = $y = mx + \frac{1}{m}$

∵ The tangent passes from the point (3, 4). So, x = 3 and y = 4 will satisfy the above equation.

$4 = m\,(3) + \frac{a}{m} \;\Rightarrow 3m^3 - 4m + 1 = 0$

$\therefore x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad m = 1\ \&\ \frac{1}{3}$

So equation of the tangents when m = 1/3

$\Rightarrow y = \left(\frac{1}{3}\right)x + \frac{1}{\frac{1}{3}} \quad \Rightarrow y = \left(\frac{1}{3}\right)x + 3$

Similarly equation of tangent when m = 1

⇒ y = x + 1

Question 34

Find the approximate value of f (3.01), where $f(x) = 3x^2 + 3$.

Options:

A. 30.18

B. 30.018

C. 30.28

D. 30.08

Answer: A

Solution:

Concept:

Let small charge in x be Δx and the corresponding change in y is Δy.

$$\Delta y = \frac{dy}{dx}\Delta x = f'(x)\Delta x$$

Now that Δy = f(x +Δx) - f(x)

Therefore, f(x +Δx) = f(x) +Δy

Calculation:

Given:f(x) = $3x^2$+ 3

Let x +Δx = 3.01= 3 + 0.01

Therefore, x = 3andΔx = 0.01

f(x +Δx) = f(x) +Δy

= f(x +Δx) = f(x) + f'(x)Δx

= f(3.01) =$3x^2$+ 3 + (6x)Δx

= f(3.01) = $3(3)^2$+ 3 + (6·3)(0.01)

= f(3.01) = 30 + 0.18

= f(3.01) = 30.18

Question 35

The value of sin (cot^{-1}x) is:

Options:

A. $\sqrt{1+x^2}$

B. x

C. $\frac{1}{\sqrt{1+x^2}}$

D. $\frac{1}{x}$

Answer: C

Solution:

Concept:

Trigonometric Identities:

- $\sin^2\theta + \cos^2\theta = 1$.

Inverse Trigonometry:

$\sin(\sin^{-1} x) = x \quad \csc(\csc^{-1} x) = x$
$\cos(\cos^{-1} x) = x \quad \sec(\sec^{-1} x) = x$
$\tan(\tan^{-1} x) = x \quad \cot(\cot^{-1} x) = x$

Calculation:

We know that$\sin^2\theta + \cos^2\theta = 1$.

$\Rightarrow 1 + \frac{\cos^2\theta}{\sin^2\theta} = \frac{1}{\sin^2\theta}$

$\Rightarrow 1 + \cot^2\theta = \frac{1}{\sin^2\theta}$

$\Rightarrow \sin\theta = \frac{1}{\sqrt{1+\cot^2\theta}}$

Let $\cot^{-1} x = \theta$.

$\Rightarrow \cot(\cot^{-1} x) = \cot\theta$

$\Rightarrow \cot\theta = x$

$\therefore \sin\theta = \frac{1}{\sqrt{1+\cot^2\theta}} = \frac{1}{\sqrt{1+x^2}}$

$\Rightarrow \sin(\cot^{-1} x) = \frac{1}{\sqrt{1+x^2}}$.

Question 36

If $y = e^{2x}$ then $\frac{d^2y}{dx^2}$ is equal to ?

Options:

A. y

B. 2y

C. 4y

D. 6y

Answer: C

Solution:

Concept:

Suppose that we have two functionsf(x) andg(x)and they are both differentiable.

- **Chain Rule:** $\frac{d}{dx}[f(g(x))] = f'(g(x))g'(x)$
- **Product Rule:** $\frac{d}{dx}[f(x)\,g(x)] = f'(x)\,g(x) + f(x)\,g'(x)$

Formula:

$\frac{de^x}{dx} = e^x$

Calculation:

Let $y = e^{2x}$ ..... (1)

Differentiatingwith respect to x, we get

$\frac{dy}{dx} = \frac{d}{dx}(e^{2x})$

$\Rightarrow \frac{dy}{dx} = 2e^{2x}$

Again, differentiating with respect to x, we get

$\frac{d^2y}{dx^2} = 4e^{2x}$

From equation (1), we get

$\therefore \frac{d^2y}{dx^2} = 4y$

Question 37

If $x = t^2$ and $y = t^3$, then $\frac{d^2y}{dx^2} = ?$

Options:

A. 0

B. t

C. $\sqrt{t}$

D. $\frac{3}{4t}$

Answer: D

Solution:

Concept:

Chain Rule of Derivatives: For two functions u and v of x, we have: $\frac{du}{dv} = \frac{du}{dx} \times \frac{dx}{dv}$.

Calculation:

We have $x = t^2$ and $y = t^3$.

$\Rightarrow \frac{dx}{dt} = 2t$ and $\frac{dy}{dt} = 3t^2$.

Using the chain rule of derivatives, we have:

$\frac{dy}{dx} = \frac{dy}{dt} \times \frac{dt}{dx}$

$= 3t^2 \times \frac{1}{2t}$

$= \frac{3t}{2}$

Now, $\frac{d^2y}{dx^2} = \frac{d}{dx}\left(\frac{dy}{dx}\right)$

$= \frac{d}{dx}\left(\frac{3t}{2}\right)$

$= \frac{3}{2}\left(\frac{dt}{dx}\right)$

$= \frac{3}{2}\left(\frac{1}{2t}\right)$

$= \frac{3}{4t}$

Question 38

If a + ib is the conjugate of 5 + 11i then a + b = ?

Options:

A. 6

B. -6

C. 5

D. -5

Answer: B

Solution:

CONCEPT:

- If z = x + iy then conjugate of z is given by$\bar{z} = x - iy$
- If x + iy = a + ib then x = a and y = b.

CALCULATION:

Given:a + ib is the conjugate of 5+ 11i

As we know that, ifz = x + iy then conjugate of z is given by$\bar{z} = x - iy$

So, the conjugate of 5 + 11i is 5- 11i

⇒ a + ib = 5- 11i

As we know thatx + iy = a + ib then x = a and y = b.

⇒ a = 5and b = - 11.

⇒ a + b = - 6

Hence, correct option is 2.

Question 39

The tenth term common to both the A. P. 3, 7, 11, ... and 1, 6, 11, ... is:

Options:

A. 171

B. 191

C. 211

D. None of these.

Answer: B

Solution:

Concept:

Arithmetic Progressions:

- The series of numbers where the difference of any two consecutive terms is the same, is called an Arithmetic Progression.
- If a be the first term, d be the common difference and n be the number of terms of an AP, then the sequence can be written as follows:

  a, a + d, a + 2d, ..., a + (n - 1)d
- Common Terms to two A. P.s form an A. P. themselves, with common difference equal to the LCM of the common difference of the two A. P.s.

Calculation:

For the given twoA. P.s 3, 7, 11, ... and 1, 6, 11, ..., the common differences are 4 and 5 respectively and 11 is the first common term.

The common difference of the terms common to both the series will be: LCM of (4 and 5) = 20.

The required 10th term common to both the A. P.s = a + (n - 1)d

= 11 + (10 - 1) × 20

= 11 + 180

= **191**.

Question 40

The Coefficient of $T_{14}$of the expression $(\sqrt{x} + \sqrt{y})^{17}$will be

Options:

A. $^{17}C_{14}$

B. $^{17}C_{3}$

C. $^{17}C_{5}$

D. $^{17}C_{13}$

Answer: D

Solution:

Concept:

Some useful formulas are:

The general term in the expansion of $(x + y)^n$ is given by, $T_{(r+1)} = {}^nC_r \times x^{(n-r)} \times y^r$

Calculation:

The given expression is $(\sqrt{x} + \sqrt{y})^{17}$

The 14^{th} term will be,

$T_{14} = T_{(13 + 1)}$

$= {}^{17}C_{13} \times (\sqrt{x}^{(17-13)}) \times (\sqrt{y}^{13})$

$= {}^{17}C_{13} \times (\sqrt{x}^{4}) \times (\sqrt{y}^{13})$

So, the coefficient $= {}^{17}C_{13}$

Question 41

Construct a 3 × 2 matrix whose elements are given by $a_{ij} = \frac{1}{3}|2i + j|$

Options:

A. $\begin{bmatrix} 1 & \frac{5}{3} \\ \frac{4}{3} & 2 \\ \frac{7}{3} & \frac{8}{3} \end{bmatrix}$

B. $\begin{bmatrix} 1 & \frac{4}{3} \\ \frac{7}{3} & 2 \\ \frac{5}{3} & \frac{8}{3} \end{bmatrix}$

C. $\begin{bmatrix} 1 & \frac{4}{3} \\ \frac{5}{3} & 2 \\ \frac{8}{3} & \frac{7}{3} \end{bmatrix}$

D. $\begin{bmatrix} 1 & \frac{4}{3} \\ \frac{5}{3} & 2 \\ \frac{7}{3} & \frac{8}{3} \end{bmatrix}$

Answer: D

Solution:

Concept:

In general, a 3 × 2 matrix is given by$A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ a_{31} & a_{32} \end{bmatrix}$

Calculation:

Given:$a_{ij} = \frac{1}{3}|2i + j|$ Here i = 1, 2, 3 and j = 1, 2

$a_{11} = \frac{1}{3}|2 + 1| = 1$,$a_{12} = \frac{1}{3}|2 + 2| = \frac{4}{3}$

$a_{21} = \frac{1}{3}|4 + 1| = \frac{5}{3}$,$a_{22} = \frac{1}{3}|4 + 2| = \frac{6}{3} = 2$

$a_{31} = \frac{1}{3}|6 + 1| = \frac{7}{3}$,$a_{32} = \frac{1}{3}|6 + 2| = \frac{8}{3}$

Hence the required matrix is $\begin{bmatrix} 1 & \frac{4}{3} \\ \frac{5}{3} & 2 \\ \frac{7}{3} & \frac{8}{3} \end{bmatrix}$

Question 42

Area of the triangle having the coordinates (4, 2), (-1, 2) and (3, a) is 10 sq. units. Find the value of 'a'.

Options:

A. -2 or 6

B. 6

C. - 2

D. 8

Answer: A

Solution:

Concept:

Area of a triangle with points (x_1, y_1), (x_2, y_2) and (x_3, y_3) $= \frac{1}{2}\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}$

Calculation

Givenarea of triangle= 10 sq. units

$\Rightarrow \frac{1}{2}\begin{vmatrix} 4 & 2 & 1 \\ -1 & 2 & 1 \\ 3 & a & 1 \end{vmatrix} = 10$

$R_1 = R_1 - R_2$

$\Rightarrow \begin{vmatrix} 5 & 0 & 0 \\ -1 & 2 & 1 \\ 3 & a & 1 \end{vmatrix} = 20$

$\Rightarrow |5 (2 - a) - 0 + 0| = 20$

$\Rightarrow |2 - a| = 4$

$\Rightarrow$ a = -2 or 6

Question 43

Determine the value of λ if planes 2x + 4y – 4z = 6 and λx + 3y + 9 = 0 make an angle of$\cos^{-1}\left(\frac{1}{\sqrt{2}}\right)$.

Options:

A. $1,\ \frac{4}{7}$

B. $2,\ \frac{2}{7}$

C. $3,\ \frac{3}{7}$

D. $2,\ \frac{3}{7}$

Answer: C

Solution:

CONCEPT:

- Let $A_1x + B_1y + C_1z + D_1 = 0$ and $A_2x + B_2y + C_2z + D_2 = 0$ are the equations of two planes aligned at an angle θ where A_1, B_1, $C_1$and A_2, B_2, $C_2$are the direction ratios of the normal to the planes, then the cosine of the angle between the two planes is given by:

$$cos\theta = \left|\frac{A_1A_2+B_1B_2+C_1C_2}{\sqrt{A_1^2+B_1^2+C_1^2}\sqrt{A_2^2+B_2^2+C_2^2}}\right|$$

CALCULATIONS:

Given planes are 2x + 4y – 4z = 6 and λx + 3y + 9 = 0,

Putting the value in equations –

$$\frac{1}{\sqrt{2}} = \left|\frac{2.\lambda+4.3-4.(0)}{\sqrt{2^2+(4)^2+(-4)^2}\sqrt{\lambda^2+3^2}}\right| \Rightarrow \frac{1}{\sqrt{2}} = \left|\frac{2.\lambda+12}{6.\sqrt{\lambda^2+3^2}}\right|$$

∴ $7\lambda^2$ -24λ + 9 = 0

On solving this quadratic equation, we get$\lambda = 3,\ \frac{3}{7}$

Question 44

Find the degree and order of given equation $\frac{dy}{dx} = -a\cos x$?

Options:

A. 1, 2

B. 2, 2

C. 1, 3

D. 1, 1

Answer: A

Solution:

Concept:

- The **degree** of differential equation is the power of its highest derivative.
- The **order of differential equation** is the order of highest derivative present in the equation.
  - Ex. $\frac{d^2y}{dx^2} + \frac{dy}{dx} + x = 0$this equation has order 2 and degree 1.

Calculation:

Given that,

$\Rightarrow \frac{\mathrm{dy}}{\mathrm{dx}} = \ - \ \mathrm{a}\cos \mathrm{x}$ …. (1)

We can't determine the order and degree because there is constant a so,

Differentiate both sides with respect to x

$\Rightarrow \frac{\mathrm{d}^2\mathrm{y}}{\mathrm{dx}^2} = \mathrm{asinx}$ .... (2) $[\because \frac{\mathrm{d}(\cos \mathrm{x})}{\mathrm{dx}} = \ - \sin \mathrm{x}]$

From equation 1st and 2nd,

$\frac{\left(\frac{\mathrm{d}^2\mathrm{y}}{\mathrm{dx}^2}\right)}{\left(\frac{\mathrm{dy}}{\mathrm{dx}}\right)} = \frac{\mathrm{a}\ \sin \mathrm{x}}{-\mathrm{a}\ \cos \mathrm{x}}$

$\Rightarrow \frac{\mathrm{d}^2\mathrm{y}}{\mathrm{dx}^2} = - \frac{\mathrm{dy}}{\mathrm{dx}}(\tan x)$

$\Rightarrow \frac{\mathrm{d}^2\mathrm{y}}{\mathrm{dx}^2} + \frac{\mathrm{dy}}{\mathrm{dx}}(\tan x) = 0$ .... (3)

Now we can say about the order and degree from equation 3 so,

Highest order is 2 and degree is 1 of highest degree term.

Question 45

If three vectors$\vec{a},\ \vec{b}\ and\ \vec{c}$ are represented by$\hat{i}\ +\ 2\hat{j}\ +\ 2\hat{k}$, $2\hat{i}\ -\ \hat{j}\ +\ \hat{k}and\hat{i}\ -\ \hat{j}\ +\ \hat{k}$ thenthe value of$(\vec{a}\ -\ 2\vec{b}).\ (2\vec{a}\ -\ \vec{c})$ will be:

Options:

A. 13

B. 19

C. 17

D. None of these

Answer: C

Solution:

Concept:

Dot Product:it is also called the inner product or scalar product

Let the two vectors are$\vec{a}$and$\vec{b}$

Dot Product of two vectors is given by:$\vec{a}.\ \vec{b}$= |a||b| cos θ

Where |$\vec{a}$| = Magnitudes of vectors a, |$\vec{b}$| = Magnitudes of vectors b and θ is the angle between a and b

Formulas ofDot Product:

$\vec{i}.\vec{i} = \vec{j}.\vec{j} = \vec{k}.\vec{k} = 1$

$\vec{i}.\vec{j} = \vec{j}.\vec{i} = \vec{i}.\vec{k} = \vec{k}.\vec{i} = \vec{j}.\vec{k} = \vec{k}.\vec{j} = 0$

Calculation:

Given that,

$\vec{a}\ =\ \hat{i}\ +\ 2\hat{j}\ +\ 2\hat{k}$

$\vec{b}\ =\ 2\hat{i}\ -\ \hat{j}\ +\ \hat{k}$

$\vec{c}\ =\ \hat{i}\ -\ \hat{j}\ +\ \hat{k}$

Therefore,

$(\vec{a}\ -\ 2\vec{b})\ =\ -\ 3\hat{i}\ +\ 4\hat{j}$

$(2\vec{a} - \vec{c}) = \hat{i} + 5\hat{j} - 3\hat{k}$

Hence the value of$(\vec{a} - 2\vec{b}).(2\vec{a} - \vec{c})$is

$= (-3\hat{i} + 4\hat{j}).(\hat{i} + 5\hat{j} - 3\hat{k})$

= - 3 + 20 = 17

Hence, option 3 is correct.

Question 46

Evaluate:$\lim_{x \to 3}\left(\frac{x^2-9}{x-3}\right)$

Options:

A. -3

B. 3

C. 6

D. 9

Answer: C

Solution:

Concept:

- **L' Hospital's Rule:**
- In this method, first we have to check whether the form of the function after substituting the limit is $\frac{0}{0}\ or \frac{\infty}{\infty}$.If$\lim_{x \to a} f(x) = \frac{0}{0}\ or \frac{\infty}{\infty}$then we have to differentiate both the numerator and denominator with respect to x unless and until$\lim_{x \to a} f(x) = l \neq \frac{0}{0}$where l is a finite value
- If f(x) is a rational function then factorize the numerator and denominator, cancel out the common factors and then evaluate the limit of the function f(x) by substituting x = a.

Calculation:

Here, we have to find the value of$\lim_{x \to 3}\left(\frac{x^2-9}{x-3}\right)$

Let$f(x) = \frac{x^2-9}{x-3}$as we can see that f(x) is a rational function.

As we know that, iff(x) is a rational function then factorize the numerator and denominator, cancel out the common factors and then evaluate the limit of the function f(x) by substituting x = a.

Numerator of f(x) can be factorized as:

$\Rightarrow x^2 - 9 = (x - 3)(x + 3)$

$$\Rightarrow \lim_{x\to 3}\left[\frac{x^2-9}{x-3}\right] = \lim_{x\to 3}\left[\frac{(x-3)\cdot(x+3)}{x-3}\right]$$

$$\Rightarrow \lim_{x\to 3}\left[\frac{x^2-9}{x-3}\right] = \lim_{x\to 3}(x+3) = 6$$

Alternate solution:

Here we can see that, $\lim_{x\to 3}\left[\frac{x^2-9}{x-3}\right] = \frac{0}{0}$

As we know that, if $\lim_{x\to a} f(x) = \frac{0}{0}\ or\ \frac{\infty}{\infty}$ then according to the L' Hospital's rule wehave to differentiate both the numerator and denominator with respect to x unless and until $\lim_{x\to a} f(x) = l \neq \frac{0}{0}$ where l is a finite value.

$$\lim_{x\to 3}\left[\frac{x^2-9}{x-3}\right] = \lim_{x\to 3}\left[\frac{\frac{d\left(x^2-9\right)}{dx}}{\frac{d(x-3)}{dx}}\right] = \lim_{x\to 3}(2x) = 6$$

Question 47

Which of the following points lies outside the circle $x^2 + y^2 - 2x + 6y + 1 = 0$?

Options:

A. (-1, -5)

B. (1, -5)

C. (-2, -6)

D. (2, -5)

Answer: C

Solution:

Concept:

If substituting the values (x_1, y_1) for x and y in the circle's equation $x^2 + y^2 + 2gx + 2fy + c = 0$, we get:

- $x_1^2 + y_1^2 + 2gx_1 + 2fy_1 + c = 0$, then (a, b) is on the circle.
- $x_1^2 + y_1^2 + 2gx_1 + 2fy_1 + c < 0$, then (a, b) is inside the circle.
- $x_1^2 + y_1^2 + 2gx_1 + 2fy_1 + c > 0$, then (a, b) is outsidethe circle.

Calculation:

Substituting the points in the equation of the circle, we get:

1) (-1, -5): $(-1)^2 + (-5)^2 - 2(-1) + 6(-5) + 1 = 1 + 25 + 2 - 30 + 1 = -1$.

2)(1, -5):$(1)^2 + (-5)^2 - 2(1) + 6(-5) + 1 = 1 + 25 - 2 - 30 + 1 = -5$.

3)(-2, -6):$(-2)^2 + (-6)^2 - 2(-2) + 6(-6) + 1 = 4 + 36 + 4 - 36 + 1 = 9$.

4)(2, -5):$(2)^2 + (-5)^2 - 2(2) + 6(-5) + 1 = 4 + 25 - 4 - 30 + 1 = -4$.

Hence, the correct answer is **3,(-2, -6)**is outside the circle.

Question 48

General solution of differential equation $\frac{dy}{dx} + y = 1, (y \neq 1)$, is:

Options:

A. $\log \left| \frac{1}{1-y} \right| = x + C$

B. $\log |1 - y| = x + C$

C. $\log |1 + y| = x + C$

D. $\log \left| \frac{1}{1-y} \right| = -x + C$

Answer: A

Solution:

Concept:

Differential Equations: Differential equations can be divided into several types:

- Ordinary Differential Equations.
- Partial Differential Equations.
- Linear Differential Equations.
- Non-linear Differential Equations.

- Homogeneous Differential Equations.
- Non-homogeneous Differential Equations.

Formula used:

$\frac{d}{dx}x^n = nx^{n-1}$

$\int \frac{1}{x}dx = log\ x + C$

Calculation:

The given differential equation $\frac{\mathrm{dy}}{\mathrm{dx}} + \mathrm{y} = 1, (\mathrm{y} \neq 1)$is in the variable separable form.

$\Rightarrow \frac{\mathrm{dy}}{\mathrm{dx}} = 1 - \mathrm{y}$

Separating the variables,we get:

$\Rightarrow \frac{\mathrm{dy}}{1-\mathrm{y}} = \mathrm{dx}$

On integrating, we get:

⇒ -log (1 - y) = x + C

⇒ $\log (1 - y)^{-1} = x + C$ [$m \log n = \log n^m$]

$\Rightarrow \log \left| \frac{1}{1-\mathrm{y}} \right| = \mathrm{x} + \mathrm{C}.$

Question 49

If$y = \sqrt{x + \sqrt{x + \sqrt{x+\ldots\infty}}}$, then $\frac{dy}{dx}$ is

Options:

A. 1

B. $\frac{1}{xy}$

C. $\frac{1}{2y-x}$

D. $\frac{1}{2y-1}$

Answer: D

Solution:

Given:

$y = \sqrt{x + \sqrt{x + \sqrt{x + \ldots \infty}}}$

Squaring on both sides;

$y^2 = x + \sqrt{x + \sqrt{x + \ldots \infty}}$

Above equation can be written as a:

$y^2 = x + y$ ---(1)

Now, Integrating equation (1)w.r.t. x

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

$(2y - 1)\frac{dy}{dx} = 1$

$\Rightarrow \frac{dy}{dx} = \frac{1}{2y-1}$

Question 50

The equation of the locus of a point equidistant from the point A(2, 3) and B(-1, 2) is

Options:

A. 2x + 6y = 8

B. 6x + 2y = 8

C. x + y = 8

D. 6x - 2y = 8

Answer: B

Solution:

Calculation:

Let P(h, k) be any point on the locus. Then

Given PA = PB

$\Rightarrow PA^2 = PB^2$

$\Rightarrow (h - 2)^2 + (k - 3)^2 = (h + 1)^2 + (k - 2)^2$

$\Rightarrow h^2 - 4h + 4 + k^2 - 6k + 9 = h^2 + 2h + 1 + k^2 - 4k + 4$

$\Rightarrow -4h - 6k + 9 = 2h - 4k + 1$

$\Rightarrow 6h + 2k = 8$

The equation of the locus of a point equidistant from the point A(2, 3) and B(-1, 2) is$6x + 2y = 8$

English

Question 51

Choose the word that means the same as the given word.

Rectify

Options:

A. Incorrect

B. Generate

C. Destroy

D. Correct

Answer: D

Solution:

The correct answer is**'Correct.'**

Key Points

- Let us see the meaning of**Rectify:**
  - **Rectify:**to correct something that is wrong. (अशुद्घ को शुद्घ करना।)
    - **Example:***I am determined to take whatever action is necessary to* ***rectify*** *the situation.*
- Let us see the meanings of the given options:
  - **Incorrect:**not right or true. (जो शुद्घ, सही या सच न हो; अशुद्घ, ग़लत।)

- **Generate:**to produce or create something. (किसी वस्तु का उत्पादन या निर्माण करना।)
- **Destroy:**to damage something so badly that it can no longer be used or no longer exists. (किसी वस्तु को इस तरह हानि पहुँचाना कि वह इस्तेमाल न हो सके या समाप्त हो जाए, नष्ट करना।)
- **Correct:**to make a mistake, fault, etc. right or better. (ग़लती को शुद्घ करना; सुधारना, सही करना।)

- From the**meanings**of the given words, we can say that the word**'Rectify'**is similarin meaning to the option**'Correct.'**
- Hence, the correct answer is**'Correct.'**

Additional Information

- L et us see the antonymof the given options:

Word	Antonym
Incorrect	Correct
Generate	Destroy
Destroy	Produce
Correct	Incorrect

Question 52

Select the most appropriate antonym of the given word.

Delay

Options:

A. Retard

B. Hinder

C. Hurry

D. Obstruct

Answer: C

Solution:

Here the correct answer is**Hurry**.

Key Points

- Let's look at the**meaning**of the given word:-

    - **Delay***(verb)*-make (someone or something) late or slow. (बनाना (किसी को या कुछ) देर से या धीमा)
        - For Example - The train was**delayed**.
- Let's look at the**meaning**of the correct answer:-
    - **Hurry***(verb)*-do something more quickly. (कुछ और जल्दी करो)
        - For Example -**Hurry**up and finish your meal.
- Let's look at the**meaning**of the other options:-
    - **Retard***(verb)*- delay or hold back in terms of progress or development. (प्रगति या विकास के मामले में देरी या रोक)
        - For Example - Our progress was**retarded**by unforeseen difficulties.
    - **Hinder***(verb)*-make it difficult for (someone) to do something or for (something) to happen. (किसी (या) के लिए कुछ करना या (कुछ) होना मुश्किल हो जाता है)
        - For Example - Language barriers**hindered**communication between scientists.
    - **Obstruct***(verb)*-deliberately make (something) difficult. (जानबूझकर (कुछ) मुश्किल करना)
        - For Example - Fears that the regime would**obstruct**the distribution of food.

Therefore, the correct antonym for the given word is*Hurry.*

Question 53

Directions. Select the “Noun” form of the given verb from the following options.

Admire

Options:

A. Admirable

B. Admiration

C. Admirably

D. None of the above

Answer: B

Solution:

The correct answer is**Admiration.**

Key-Points

- The word ‘Admirable’ is an **adjective** *meaning ‘commendable or worthwhile’.*

    - For example- That was quite an **admirable** achievement for the little kid.
- The word 'Admirably' is an **adverb** meaning *'in a praiseworthy manner'*.
    - For example- All of them danced **admirably**, considering it was the first stage performance of their life.
- The word 'Admiration' is a **noun** meaning *'appreciation or approbation'*.
    - Admire + suffix '-ation' = Admiration
    - For example- Ron has the greatest **admiration** for his elder brother and wants to be like him in the future.
- The word 'Admire' is a **verb** meaning *'to appreciate or to praise'*.
    - For example- Ron **admires** his elder brother more than anybody else.
- Therefore, **Option 2** is the correct answer.

So, the correct answer is: *"Admiration"* *is the Noun form of the verb Admire.*

Additional Information

Suffixes that make nouns are listed below with their examples:-

Suffix	***Noun***
-ance	Acceptance
-ship	Hardship
-tion	Completion
-ity/ty	Scarcity
-hood	Childhood
-ness	Sweetness
-age	Bondage
-ation	Admiration
-ledge	Knowledge
-red	Hatred
-cy	Urgency
-ment	Movement

Question 54

Identify the segment in the sentence which contains a grammatical error.

Miss Marple is neither a good singer or a good stage artist.

Options:

A. stage artist

B. neither a good singer

C. or a good

D. Miss Marple is

Answer: C

Solution:

The correct answer is**- or a good.**

Key Points

- In a sentence, the verb is used according to**person**and**number**.
- There are some **conjunctions** which are used in **pair**. Some of them are given below:
  - **Neither-nor, either-or, not only-but also, so-that, etc.**
- For example:
  - ***Either** Sam **nor** Eric is coming to the wedding.* ✗
  - ***Either** Sam **or** Eric is coming to the wedding.* ✓
- In the **3rd part** of the given question, '**nor**' will replace '**or**' as the sentence contains '**neither**' in the former part.

Correct Sentence:*Miss Marple is neither a good singer **nor** a good stage artist.*

Additional Information

- If an**article**is placed just before the**1st subject**only, it means the**person/thing**is the**same**for which**two nouns**are used.Hence**singular verb**will be used.
- Example:
  - *Jawaharlal Nehru was**a great orator and articulate**politician of his time.*

Question 55

Direction: Read the passage given below and answer the question that follows:

Goyal flagged off the train through video conferencing and during the ceremony, he expressed his gratitude to the railway employees who served the country during the Covid-19 pandemic by supplying medicines, coal and other essential items.Railway Minister Piyush Goyal on Wednesday flagged off Siddhabali Jan Shatabdi Special Train that will run between Kotdwar in Uttarakhand and Delhi junction.He said the Kotdwar-Delhi route electrification is almost complete with only around a 15 km stretch pending which is expected to be completed by this month. "After this, trains on electric traction will **ply** from Kotdwar to Delhi. It will also save the environment. Going forward all the trains will run on electric traction in the entire Uttarakhand. This will ensure net-zero carbon emission and protection of the environment in the state," the minister said.

What is the theme of the passage?

Options:

A. Trains between Kotdwar and Delhi

B. Flagging off theSiddhabali Jan Shatabdi Special Train

C. Electric traction

D. Zero carbon emission

Answer: B

Solution:

The correct answer is**'Flagging off the Siddhabali Jan Shatabdi Special Train'.**

Key Points

- **Let's have a look at thepassage:**
  - *The passage is about flagging off the SIddhabali Jan Shatabdi Special Train by Railway Minister Piyush Goyal. It also provides information about its route, insurances of zero carbon emission and protection of the environment.*
- After a complete analysis of the above statement,it can be concluded that***'Flagging off the Siddhabali Jan Shatabdi Special Train'is the themeof the passage.***
- Therefore,**'Flagging off the Siddhabali Jan Shatabdi Special Train'**is the correct answer**.**

Additional Information

1. Let us discuss the**SYNONYM**of some words from the passage:

Word	Synonym
Insurance	Indemnity
Emission	Discharge
Protection	Defence

Question 56

Direction: Read the passage given below and answer the question that follows:

Goyal flagged off the train through video conferencing and during the ceremony, he expressed his gratitude to the railway employees who served the country during the Covid-19 pandemic by supplying medicines, coal and other essential items.Railway Minister Piyush Goyal on Wednesday flagged off Siddhabali Jan Shatabdi Special Train that will run between Kotdwar in Uttarakhand and Delhi junction.He said the Kotdwar-Delhi route electrification is almost complete with only around a 15 km stretch pending which is expected to be completed by this month. "After this, trains on electric traction will **ply** from Kotdwar to Delhi. It will also save the

environment. Going forward all the trains will run on electric traction in the entire Uttarakhand. This will ensure net-zero carbon emission and protection of the environment in the state," the minister said.

Siddhabali Jan Shatabdi Special Train will run between which stations?

Options:

A. Kotdwar and Kanpur

B. Kotdwar and Delhi

C. Kotdwar and Mumbai

D. Kotdwar and Agra

Answer: B

Solution:

The correct answer is**'Kotdwar and Delhi'.**

Key Points

- **Let's have a look at the third line of the passage:**
  - *' Railway Minister Piyush Goyal on Wednesday flagged off Siddhabali Jan Shatabdi Special Train that will run between Kotdwar in Uttarakhand and Delhi junction.'*
- After a complete analysis of the above statement,it can be concluded that***Siddhabali Jan Shatabdi Special Train will run betweenKotdwar and Delhi***.
- Therefore,**'Kotdwar and Delhi'**is the correct answer**.**

Additional Information

- Let us discuss the**SYNONYM**of some words from the passage:

Word	Synonym
Flagged	Signalled, identified
Junction	Links
Run	Pass

Question 57

Direction: Read the passage given below and answer the question that follows:

Goyal flagged off the train through video conferencing and during the ceremony, he expressed his gratitude to the railway employees who served the country during the Covid-19 pandemic by supplying medicines, coal and other essential items.Railway Minister Piyush Goyal on Wednesday flagged off Siddhabali Jan Shatabdi Special Train that will run between Kotdwar in Uttarakhand and Delhi junction.He said the Kotdwar-Delhi route electrification is almost complete with only around a 15 km stretch pending which is expected to be completed by this month. "After this, trains on electric traction will **ply** from Kotdwar to Delhi. It will also save the environment. Going forward all the trains will run on electric traction in the entire Uttarakhand. This will ensure net-zero carbon emission and protection of the environment in the state," the minister said.

The electric traction will ensure:

Options:

A. net-zero Carbon emission

B. net-zero Oxygen emission

C. net-zero Nitrogen emission

D. net-zero Sulphur emission

Answer: A

Solution:

The correct answer is**'net-zero Carbon emission'.**

Key Points

- **Let's have a look at the last line of the passage:**
  - *'This will ensure net-zero carbon emission and protection of the environment in the state," the minister said.'*
- After a complete analysis of the above statement,it can be concluded that***the electric tractionwill ensurenet-zero Carbon emission***.
- Therefore,**'net-zero Carbon emission'**is the correct answer**.**

Additional Information

- Let us discuss the**SYNONYM**of some words from the passage:

Word	Synonym
Ensure	Confirm
Emission	Discharge
Environment	Surroundings, atmosphere

Question 58

Direction: Read the passage given below and answer the question that follows:

Goyal flagged off the train through video conferencing and during the ceremony, he expressed his gratitude to the railway employees who served the country during the Covid-19 pandemic by supplying medicines, coal and other essential items.Railway Minister Piyush Goyal on Wednesday flagged off Siddhabali Jan Shatabdi Special Train that will run between Kotdwar in Uttarakhand and Delhi junction.He said the Kotdwar-Delhi route electrification is almost complete with only around a 15 km stretch pending which is expected to be completed by this month. "After this, trains on electric traction will **ply** from Kotdwar to Delhi. It will also save the environment. Going forward all the trains will run on electric traction in the entire Uttarakhand. This will ensure net-zero carbon emission and protection of the environment in the state," the minister said.

Which of the following words could replace the word'ply'as used in the passage?

Options:

A. settle

B. join

C. organize

D. travel

Answer: D

Solution:

The correct answer is**'travel'**.

Key Points

- Let us look at the meaning of the word**'ply':**
  - **Ply:** when a boat, train, bus, etc. plies a particular route, it makes that journey or travelregularly, to move from one to another regularly
    - **Example:***This airline has been **plying** thetransatlantic route for many years.*
- Let us look at the meanings of words in the options:

Word	Meaning	Example
Settle	resolve or reach an agreement about (an argument or problem)	*The unions have **settled** their year-long dispute with producers.*
Join	link, connect	*The tap was **joined** to a pipe.*

Organize	arrange systematically; order	*They have **organized** a great party.*
Travel	**go from one place to another, typically over a distance of some length**	*We **travel** for four days.*

- Therefore, in the above passage, the word**'travel'**could replace the word**'ply'**in the passage.
- Hence, the correct answer is**'travel'**.

Additional Information

- Let us look at the**ANTONYM**of words in the option:

Word	Antonym
Settle	Prolong
Join	Separate
Organize	Disorganize

Question 59

In the following question, out of the four alternatives, select the alternative which best expresses the meaning of the idiom/phrase.

Call it a day

Options:

A. Someone who is not being realistic

B. To start doingsomething

C. To stop doing something for the day

D. To take steps towards achieving peace with an enemy

Answer: C

Solution:

The correct answer is**option 3)**

Key-Points

- The phrase**'call it a day'**means tostop doing something for the day, for example, work, either temporarily or to give it up completely.
- **For example:**
  - I can’t concentrate – let’s**call it a day**.

Additional Information

- **Synonyms-**end the day,retire.
- **Origin-**This phrase was born when a worker was leaving for home before doing his work accomplished and originally related to the phrase "call it half a day" initially found in 1838. It was used to say goodbye to work by employees before the working day was over.

Therefore, the correct answer is option 3.

Question 60

Select the correctly spelt word.

Options:

A.

Enterpreneur

B.

Entrepreneur

C.

Enterprenure

D.

Entreorenure

Answer: B

Solution:

The correct answer is**'Entrepreneur'.**

Key Points

- The correctly spelt word among the given Options is**'Entrepreneur'.**
- It means**someone who starts their own business, especially when this involves seeing a new opportunity.**
  - *Example:He was one of the**entrepreneurs**of the 80s who made their money in property.*
- Therefore, as per the points mentioned above, we find that the correct answer is**Option 2.**

- दिए गए विकल्पों में सही वर्तनी वाला शब्द **'Entrepreneur'** है।
- इसका मतलब है कि कोई है जो अपना खुद का व्यवसाय शुरू करता है, खासकर जब इसमें एक नया अवसर देखना शामिल होता है।
  - *Example:He was one of the**entrepreneurs**of the 80s who made their money in property.*
- इसलिए, ऊपर वर्णित बिंदुओं के अनुसार, हम पाते हैं कि सही उत्तर **विकल्प 2**है।

Question 61

Direction: Fill in the blank with the most appropriate option.

If I _____ an officer in the Archeological Survey of India, I would visit many historical monuments.

Options:

A. was

B. were been

C. am

D. were

Answer: D

Solution:

The correct answer is '**were'.**

Key Points

Conditional sentences are statements discussing known factors or hypothetical situations and their consequences.

- *One of the structures is mentioned below:*
  - ***This particular typeis followed when we talk about something in the past which is purely imaginary.***
  - ***If + Simple Past, Subject + Would+ V_1+ Object.***
- *For example:*
  - If I had wings, I**willfly**like a bird. ✗
  - If I had wings, I**would fly**like a bird. ✓
- *In theblank part of the given question,**'were'**will be used as per the rule given above.*

Additional Information

In case of imaginary sentences, 'were' is used with all subjects irrespective of their number.

- *Some imaginary phrases are given below:*
  - ***As though, if/as if, I wish, would that, etc.***
- *For example:*
  - *He shouted at me**as if he were**my coach.*

Correct Sentence: *"If I **were** an officer in the Archeological Survey of India, I would visit many historical monuments."*

Question 62

Direction: Choose the incorrect word among the followings:

Options:

A. Hindrance

B. Honour

C. Headache

D. Hieght

Answer: D

Solution:

The correct answer is**'Hieght.'**

Key Points

- Out of all the options,**'Hieght''**is the incorrect word.
- The correct spelling is **Height**.
- The meaning of**'Height'**isexisting only in part; incomplete.
  - **Example:***The nurse is going to check your **height** and weight.*
- Hence, the correct answer is**'Hieght.'**

Additional Information

- Let us discuss the**meaning**of some words:

Mis-spelt	Correct spelling	Meaning/अर्थ
Eagaling	Eagling	play (a hole) in two strokes under par. (बराबर के तहत दो स्ट्रोक में खेलना।)
Eagernes	Eagerness	enthusiasm to do or to have something; keenness. (कुछ करने या करने का उत्साह; उत्सुकता।)
Eccentrecity	Eccentricity	the state of being eccentric. (सनकी होने की अवस्था।)

Hinglish

- सभी विकल्पों में से **'Hieght'** गलत शब्द है।
- सही वर्तनी **Height**है।
- **'Height'**का अर्थ है, व्यक्ति या वस्तु की नीचे से ऊपर की माप; ऊँचाई, लंबाई।
  - **Example:***The nurse is going to check your**height**and weight.*

Question 63

Direction: Select the one-word replacement for the following phrase:

Tit for tat

Options:

A. revenge

B. accept

C. deny

D. approve

Answer: A

Solution:

The correct answer is **'revenge.'**

Key Points

- The meaning of the phrase **'Tit for tat'** issomething, especiallysomething annoying or unpleasant, done to someone because that person has done the same thing to youor to take revenge.
    - **'Tit for tat'** मुहावरे का अर्थ कुछ ऐसा है, जो विशेष रूप से किसी के लिए कष्टप्रद या अप्रिय है, क्योंकि उस व्यक्ति ने आपके साथ ऐसा ही किया है या बदला लेने के लिए किया है।
        - **Example**:*She would not continue to fight, and rejected returning **tit for tat**.*
- Therefore, the correct answer is **'revenge.'**

Additional Information

Phrase	Meaning	अर्थ
Double-dealing	the act of cheating or tricking someone by hiding your real intentions.	अपने वास्तविक इरादों को छिपाकर किसी को धोखा देने या बरगलाने की क्रिया।
It's a piece of cake	it's easy.	यह आसान है।

Question 64

Direction:Choose the appropriate answer for the givensentence:

He came here _____ day before.

Options:

A. a

B. an

C. the

D. None of these

Answer: C

Solution:

The correct answer is**'the.'**

Key Points

- **'A'**is used with a singular countable noun that is random in nature and has a consonant sound.
- **'An'**is used with a singular countable noun that is random in nature and has a vowel sound.
- **'The'**refers to a particular object of which the reader is aware of.
- **'The'** is a definite article and refers to a specific noun, whose identity is made known. e.g. ***'The woman in that shop', 'the fruit from this tree'***, etc.
- In the given sentence, the noun **'day'** is a specific noun, hence **'the'** will be used.
- Therefore, the article**'the'**should be usedto make the sentence grammatically correct.
- Hence, the correct answer is**'the.'**
- **Correct sentence:***He came here **the** day before.*

Additional Information

- **'An/A'**is used as an indefinite article for a thing or person when the reader doesn't know which one we are referring to out of many nouns.
- It states the random nature of the subject.
- **'The'**is used as a definite article for a thing or person when the reader knows which one we are exactly referring to.
- It states the specific nature of the subject.
    - **Example:***He eats**an**apple.*
      *He eats**a**mango.*
      *He came into**the**room.*

Hinglish

- **'A'**का प्रयोग singular countable noun के साथ किया जाता है जो प्रकृति में random है और इसमें consonant sound है।
- **'An'**का प्रयोग singular countable noun के साथ किया जाता है जो प्रकृति में random है और इसमें vowel sound है।
- **'The'**एक विशेष वस्तु को संदर्भित करता है जिसके बारे में पाठक जानता है।

- **'The'** एक definite article है और एक specific noun को संदर्भित करता है, जिसकी पहचान ज्ञात की जाती है। जैसे ***'The woman in that shop', 'the fruit from this tree'*** आदि।
- दिए गए वाक्य में, the noun**'day',** एक specific noun है, इसलिए **'the'** का प्रयोग किया जाएगा।
- इसलिए वाक्य को व्याकरण की दृष्टि से शुद्ध करने के लिएarticle**'the'**का प्रयोग करना चाहिए।
- अत: सही उत्तर**'the'**है।

Question 65

Direction:Change the Voice -

The crown was being laughed at by them.

Options:

A. They are laughing at the crown.

B. Them were laughing at the crown.

C. They were laughing at the crown.

D. They were beinglaughing at the crown.

Answer: C

Solution:

The correct answer is**'They were laughing at the crown.'**

Key Points

- The given sentence is in**PastContinuousTense**and in**PassiveVoice.**
- The rule for changinga**PastContinuousTense**from Active voice to Passive voice or Passive to Active Voice:
  - Interchange the object and subject with each other, i.e. object of the active sentence become the subject of the passive sentence.
  - **Structure: Subject + was/were +V1 + ing + Object(Active Voice)**

Object + was/were + being + V3 + by Subject(Passive Voice)

- **Example:***Esha wassinging a song.***(Active Voice)**

*A song was being sung by Esha.***(Passive Voice)**

- Therefore, the correct answer is**'They were laughing at the crown.'**

Additional Information

- In**Active Voice**, a sentence emphasizes the subject performing an action.
- In**Passive Voice,**the sentence emphasizes the action or the object of the sentence.
  - **Example:***He reads a novel.***(Active Voice)**
    *A novel is readby him.***(Passive Voice)**

Hinglish

- दिया गया वाक्य**PastContinuousTense**और **Passive Voice**में है।
- **PastContinuousTense**को Active voice से Passivevoiceयाpassivevoice से Activevoice में बदलने का नियम:
  - Objectऔरsubjectको एक दूसरे के साथ बदलें, यानी Active Voiceका object,Passive Voiceका subjectबन जाती है।
  - **संरचना:Subject + was/were +V1+ ing + Object(Active Voice)**
    Object + was/were + being + V3 + by Subject(Passive Voice)

Question 66

Direction:Change the Narration-

He said to me, "I have no time for you."

Options:

A. He told me that she had no time for me.

B. He told me that he had no time for me.

C. He told me that he has no time for me.

D. He told me that he have no time for me.

Answer: B

Solution:

The correct answer is**'He told me that he had no time for me.'**

Key Points

- The rules for changing Direct Speech to Indirect Speech:
  - The given sentence is in**Present PerfectTense**.
  - **Present Perfect Tense changes to Past Perfect Tense.**

- The reporting verb**said/said to**is changed in**asked, demanded, ordered, enquired**as per the nature of the sentence.
- Remove the commas and inverted commas.
- The first person in reported speech changes according to the subject of reporting speech.
- Use**that**in the sentence of indirect speech.
  - **Example:***Isha said, "I have apretty face."*(**Direct speech**)
    Isha saidthat she had apretty face.(**Indirect speech**)

- Therefore, the correct answer is**'He told me that he had no time for me.'**

Additional Information

- If the sentence of Direct speech has a question that cannot be answered by saying yes or no then it does not use**"if"**or**"whether"**in its Indirect speech.
  - **Example:***She said to me, "Where did you buy this dress from?"***(Direct speech)**
    She asked me where I had bought thatdress from.(**Indirect speech**)

Hinglish

- Direct Speech को Indirect Speech में बदलने का नियम:
  - दिया गया वाक्य**Present PerfeTense**में है।
  - **Present PerfeTense, PastPerfeTense** में बदल जाता है।
  - **Said/said to**रिपोर्टिंग verb वाक्य की प्रकृति के अनुसार**asked, demanded, ordered, enquired**में बदल जाती है।
  - Commas और inverted commas हटा दे।
  - Reported speech में first person, reporting speech के subject के अनुसार बदलता है।
  - Indirect speech के वाक्य में **that**का प्रयोग करें।
    - **Example:***Isha said, "I have apretty face."*(**Direct speech**)
      Isha saidthat she had apretty face.(**Indirect speech**)

Question 67

Direction:Choose the most appropriate word and fill in the blank:

His _____ read arts confused us.

Options:

A. definite

B. vague

C. anxious

D. indecisive

Answer: B

Solution:

The correct answer is**'vague.'**

Key Points

- In the given blank, we need a wordwhose meaning is close to**unclear.**
- दिए गए रिक्त स्थान में, हमें एक word की आवश्यकता है जिसका अर्थ **unclear**के करीब है।
- Let us see the meanings of the given words**:**

Word	**Meaning**	**अर्थ**
Definite	clear; easy to see or notice.	स्पष्ट; निश्चयात्मक, प्रत्यक्ष।
Vague	not clear or definite.	अस्पष्ट या अनिश्चित।
Anxious	worried and afraid.	चिंतित या डरा हुआ; व्याकुल।
Indecisive	not able to make decisions easily.	शीघ्र निर्णय करने में असमर्थ।

- Hence, the word**'vague'**should be usedto make the sentence grammatically correct.
- Hence, the correct answer is**'vague.'**
    - **Correct sentence:***His **vague**read arts confused us.*

Additional Information

- Let us see the synonyms of the given words:

Word	**Synonym**
Definite	Explicit
Vague	Unclear
Anxious	Eager
Indecisive	Inconclusive

Question 68

Choose the appropriate answer for the givensentence:

We don't know the reason _____ his failure.

Options:

A. to

B. for

C. at

D. by

Answer: B

Solution:

The correct answer is**'for.'**

Key Points

- We can use**to**as a preposition to indicate a destination or direction.
  - **Example**:*We're going**to**Liverpool next week.*
- We use**for**to talk about a purpose or a reason for something.
  - **Example**:*I'm going**for**some breakfast. I'm really hungry.*
- We use**at**to talk about points in time, ages and some periods of time.
  - **Example**:*I was up**at**6 am this morning.*
- We use**by**meaning 'not later than' to refer to arrangements and deadlines.
  - **Example**:*The postman is always here**by**11 am.*
- Therefore, the preposition**'for'**should be usedto make the sentence grammatically correct.
- Hence, the correct answer is**'for.'**
- **Correct sentence:***We don't know the reason **for** his failure.*

Additional Information

- A**preposition**is a word or group of words used before a noun, pronoun, or noun phrase to show direction, time, place, location, spatial relationships, or to introduce an object.
- Some examples of prepositions are words like*"in," "at," "on," "of," and "to."*
  - **Example**:*I live**in**Raipur.*

Hinglish

- हम गंतव्य या दिशा को इंगित करने के लिए preposition**to**उपयोग कर सकते हैं।
  - **Example**:*We're going**to**Liverpool next week.*
- हम किसी उद्देश्य या किसी कारण के बारे में बात करने के लिए preposition**for**उपयोग करते हैं।
  - **Example**:*I'm going**for**some breakfast. I'm really hungry.*
- हम समय, उम्र और कुछ समय के बिंदुओं के बारे में बात करने के लिए preposition**at**उपयोग करते हैं।
  - **Example**:*I was up**at**6 am this morning.*
- व्यवस्थाओं और समय-सीमा को संदर्भित करने के लिए हम preposition**by,**'न कि बाद में'अर्थ सेउपयोग करते हैं
  - **Example**:*The postman is always here**by**11 am.*
- इसलिए वाक्य को व्याकरणिक रूप से शुद्ध करने के लिएpreposition**'for'**का प्रयोग करना चाहिए।
- इसलिए, सही उत्तर**'for'**है।

Question 69

Direction: Fill in the blank with the correct answer:

The robbers are sharing the money among _____ .

Options:

A. themselves

B. himself

C. ourselves

D. theirselves

Answer: A

Solution:

The correct answer is**'themselves.'**

Key Points

- Reflexive pronouns are words like **myself, yourself, himself, herself, itself, ourselves, yourselves and themselves.**
- They refer back to a person or thing.
- We often use reflexive pronouns when the subject and the object of a verb are the same.
  - **Example**:*I cut **myself** when I was making dinner last night.*
- As the subject **'robbers'** is plural, **the reflexive pronoun must be plural**.
- Therefore, the correctanswer is**'themselves.'**
  - **Correct sentence:***The robbers are sharing the money among **themselves**.*

Additional Information

- **Each, every, either and neither**aredistributive words that arenormally used with singular nouns and are placed before the noun
- **Each, either and neither**can be used with plural nouns but must be followed by**‘ of.‘**
- **Each**is a way of seeing the members of a group as individuals.
  - **Example:*Each**of the children received a present.*
- **Every**is a way of seeing a group as a series of members.
  - **Example:*Every**child in the world deserves affection.*

Hinglish

- Reflexive pronounsजैसे **myself, yourself, himself, herself, itself, ourselves, yourselves**और**themselves**शब्द हैं।
- वे किसी व्यक्ति या वस्तु को वापस संदर्भित करते हैं।
- हम अक्सर reflexive pronouns का उपयोग करते हैं जब क्रिया का विषय और वस्तु समान होती है।
  - **Example**:*I cut**myself**when I was making dinner last night.*
- चूंकि subject**'robbers'** बहुवचन है, रिफ्लेक्सिव सर्वनाम बहुवचन होना चाहिए।
- इसलिए, सही उत्तर**'themselves'**है।

Question 70

Direction: Fill in the blank with the correct answer:

He _____ the ground before the match started.

Options:

A. had cleaned

B. has cleaned

C. is cleaning

D. none of these

Answer: A

Solution:

The correct answer is **'had cleaned.'**

Key Points

- We sometimes use **before** clauses in a variety of tenses to say that the action or event in the before clause did not or may not happen.
- We use **before** as a subordinating conjunction.
- We commonly use **before, just before**the past simple tense.
- It suggests that the second event happened soon after the first one.
- The **before clause**, which indicates the second action, can be at the end or at the beginning of the sentence.
- **Structure: Subject + (had+ V3)first event + before + (past tense) second event.**
  - **Example:***He had left before the train departed from that station.*
- Therefore, the correct answer is **'had cleaned.'**
- **Correct sentence:** *He **had cleaned** the ground before the match started.*

Additional Information

- We use **before** to connect earlier events to the moment of speaking or to a point of time in the past.
    - **Example**:*I'm so looking forward to the trip. I haven't been to Latin America **before**.*

Hinglish

- हम कभी-कभी विभिन्न काल में **before**clauses का उपयोग यह कहने के लिए करते हैं कि पहले क्लॉज में कार्रवाई या घटना नहीं हुई थी या नहीं हो सकती है।
- हम **before** एक subordinating conjunction के रूप में उपयोग करते हैं।
- हम आमतौर पर पिछले साधारण काल से ठीक पहले, before का उपयोग करते हैं।
- इससे पता चलता है कि दूसरी घटना पहली घटना के तुरंत बाद हुई।
- **Structure: Subject + (had+ V3)first event + before + (past tense) second event.**
    - **Example:***He had left before the train departed from that station.*
