# Agniveer Vayu Science (Group X) - 18 Jan 2023 -Memory Based Paper

# **Physics**

# **Question 1**

# Which of the following has dimension equal to pressure:

# **Options:**

- A. Energy/Area
- B. Energy/Volume
- C. Energy × Area
- D. Energy × Volume

# Answer: B

# Solution:

## CONCEPT:

• **Dimensions:Dimensions** of a physical quantity are the powers to which the fundamental units are raised to obtain one unit of that quantity.

## CALCULATION:

The dimension of pressure is given as,

 $\Rightarrow$  [P] = [M<sup>1</sup> L<sup>-1</sup> T<sup>-2</sup>] -----(1)

• The dimension of energy is given as,

 $\Rightarrow [E] = [M^1 L^2 T^{-2}] ----(2)$ 

• The dimension of the area is given as,

 $\Rightarrow [A] = [M^0 L^2 T] ----(3)$ 

• The dimension of the volume is given as,

 $\Rightarrow [V] = [M^0 L^3 T] ----(4)$ 

[Energy/Area]	[Energy/Volume]	[Energy×Area]	[Energy×Volume]
$[M^{1}L^{0}T^{-2}]$	$[M^{1}L^{-1}T^{-2}]$	$[M^{1}L^{4}T^{-2}]$	$[M^1L^5T^{-2}]$

- From the above table, it is clear that the **dimension of energy/volume is equal to the pressure**.
- Hence, option 2 is correct.

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# **Question 2**

# The heat supplied and the work done of a Carnot engine are 4 kJ and 2 kJ respectively. If the minimum temperature is 127°C, then find the maximum temperature.

## **Options:**

- A. 527°C
- B. 627°C
- C. 227°C
- D. 300°C

## Answer: A

# Solution:

#### **CONCEPT:**

#### **Carnot engine:**

- Carnot engine is a theoretical thermodynamic cycle.
- It consists of two isothermal processes and two adiabatic processes.
- It gives an estimate of the maximum possible efficiency that a heat engine can achieve during the conversion process of heat into work.
- The efficiency of the Carnot engine is given as,

 $\Rightarrow \eta = rac{W}{Q_1} = rac{Q_1-Q_2}{Q_1} = 1 - rac{T_2(K)}{T_1(K)}$ 

Where  $\eta = \text{efficiency}, W = \text{work output}, Q_1 = \text{heat supplied}, Q_2 = \text{heat rejected}, T_1 = \text{source temperature in K and } T_2 = \text{sink temperature in K}$ 



#### **CALCULATION:**

Given  $Q_1 = 4 \text{ kJ} = 4 \times 10^3 \text{ J}$ ,  $W = 2 \text{ kJ} = 2 \times 10^3 \text{ J}$ , and  $T_2 = 127^{\circ}\text{C} = 273 + 127 = 400 \text{ K}$ 

• The efficiency of the Carnot engine is given as,

 $\Rightarrow \eta = rac{W}{Q_1} = rac{Q_1 - Q_2}{Q_1} = 1 - rac{T_2(K)}{T_1(K)}$  ----(1)

Where  $\eta = \text{efficiency}, W = \text{work}$  output,  $Q_1 = \text{heat supplied}, Q_2 = \text{heat rejected}, T_1 = \text{source temperature in K}$  and  $T_2 = \text{sink temperature in K}$ 

By equation 1,

 $\Rightarrow$  T<sub>1</sub>= 800 K

 $\Rightarrow T_1 = 800 - 273 = 527^{\circ}C$ 

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# **Question 3**

A capillary tube of diameter 2 mm is dipped in a liquid of specific gravity 0.8. The liquid rises in tube by 15 mm making an angle of contact of zero with the tube. Determine the surface tension of the liquid in contact with air and glass tube.

## **Options:**

A. 1 kN/m

B. 0.05 kN/m

C. 0.06 N/m

D. 1 N/m

## Answer: C

# Solution:

#### Concept:

#### **Capillary Action**

- When one end of a tube of small radius (known as a capillary tube) is dipped into a liquid, the liquid rises or is depressed in the tube.
- If the contact angle is less than 90°, the liquid rises.
- If it ismore than 90°, it is depressed.
- Adhesive and cohesive forces are the main causes of this.
- Capillary rise or fall is given by,

• 
$$h = \frac{4\sigma \cos\theta}{\rho ad} - - (1)$$

• Where, h = Height of liquid column,  $\sigma$ = Surface Tension, d= diameter of capillary tube,  $\theta$  = Angle of contact of the liquid,  $\rho$  = Density of liquid, g = Acceleration due to gravity = 9.81 m/s<sup>2</sup>

#### **Calculation:**

Given, diameter of capillary tube, d = 2 mm = 0.002 m, liquidrises in tube, h = 15 mm = 0.015 m, angle of contact,  $\theta = 0$ 

Specific gravity of the liquid = 0.8

Then the density of the liquid =  $0.8 \times 1000 = 800 \text{ kg/m}^3$ 

From equation 1,

 $\Rightarrow 0.015 = rac{4\sigma cos \, 0}{800 imes 9.81 imes 0.002}$ 

 $\Rightarrow \sigma = 0.05886 \approx 0.06 \text{ N/m}$ 

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# **Question 4**

What happens to the potential difference between the capacitors parallel plates as the distance between parallel plates halved?

**Options:** 

## A. Decreased

- B. Increased
- C. Remains constant
- D. None of the above

# Answer: A

# Solution:

# Concept:

A parallel plate capacitor consists of two large plane plates placed parallel to each other with a small separation betweenthem.

- The potential differences between the plates is,
- $V = \frac{Qd}{\epsilon_0 A}$
- Where Q = charge on the plate, d = distance between them,  $A = area of the plate. \epsilon_0$  is the permittivity of the space.

## Explanation:

Let, the initial potential difference between the parallel plates is  $V = \frac{Qd}{\epsilon_0 A}$ 

When, the distance between parallel plates halved, d'  $=\frac{d}{2}$ 

Then the final potential difference between the parallel plates is  $V' = \frac{Qd}{2\epsilon_0 A}$ 

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

The potential difference between the parallel plates as the distance between parallel plates halved then the**potential difference is decreased.** 

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# **Question 5**

# The ratio between the electric field and the magnetic field is

# **Options:**

A.  $\mu_0 \varepsilon_0$ 

B.  $\frac{1}{\mu_o\epsilon_o}$ 

C. 
$$\frac{1}{\sqrt{\mu_o \epsilon_o}}$$

D.  $\sqrt{\mu_o \epsilon_o}$ 

Answer: C

# **Solution:**

#### CONCEPT:

- Whenmoving through the electric field and magnetic field in mutually perpendicular directions:
- Due to the electric field Forceis always in the direction of the electric field and force

F = qE

where F is the force due to the electric field, q is the charge, and E is the electric field.

- When the direction of the velocity of the charged particle is perpendicular to the magnetic field:
- Magnetic force is always perpendicular to velocity and magnetic fieldby Right-Hand Rule.

F = qvB

where F is the force due to the magnetic field, q is the charge, v is the velocity and Bis the magnetic field.



#### **CALCULATION**:

• As the particle passes undeflected, thus the electric force will be equal to the magnetic force acting on the particle.

 $\Rightarrow$  qE = qvB

⇒E= vB

 $\Rightarrow v = \frac{E}{B}$ 

• We know that the **speed of the electromagnetic wave infree space** is given by

 $\Rightarrow v = rac{1}{\sqrt{\mu_0 \epsilon_0}}$ 

 $\Rightarrow \frac{E}{B} = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$ 

# **Question 6**

# Variation of acceleration due to gravity (g) with distance x from the centre of the earth is best represented by $(R \rightarrow Radius of the earth)$

**Options:** 



#### Answer: D

# Solution:

#### **CONCEPT:**

- Theacceleration achieved by any object due to the gravitational force of attraction by the earth is called **acceleration due to gravity** by the earth.
- As each planet has different mass and radius so the acceleration due to gravity will be different for different planet.

Acceleration due to gravity of the earth having mass M and radius Ron earth surface is given by:

$$g = rac{GM}{R^2}$$

Acceleration due to gravity at any depth (h) of the earth's surface whose distance from centre of earth is x is given by:

Acceleration due to gravity at depth  $(g') = \frac{g x}{R}$ 

Acceleration due to gravity at height (h') whose distance from the centre of earth is x is given by:

Acceleration due to gravity at height  $(g'') = rac{g R^2}{x'^2}$ 

Where **G** is Universal gravitational constant, x = (R - h) and x' = (R + h).

#### **EXPLANATION:**



According to the given formula of acceleration due to gravity:

Acceleration due to gravity at depth  $(g') = \frac{g x}{R}$  For x < R

• As this is a straight line, so curve of g versus x will be a **straight line for x less than the radius** of the earth(R).

Acceleration due to gravity at height  $(g'') = \frac{g R^2}{x'^2}$  For x' > R

It is a hyperbolic curve which is shown in the diagram. Hence option 4 is correct.

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# **Question 7**

# In the Stoke's Law formula (F = $-6\pi\eta av$ ), ' $\eta$ ' represents

## **Options:**

- A. Reynold's number
- B. pressure
- C. viscosity
- D. relative density

# Answer: C

# Solution:

#### Concept:

#### Stokes's law

According to Stokes' law, the backward dragging force (F) acting on a small spherical body of radius r moving with a velocity v through a viscous medium of the coefficient of **viscosity**  $\eta$  is given by

 $F = 6\pi\eta rv$ 



#### Explanation:

From the above explanation, we can see that, stroke's law is used for determining drag force acted by liquid on a spherical body

#### And viscosity is represented by symbol $\boldsymbol{\eta}$ in the given equation

Hence, **option 3** is correct among all.

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# **Question 8**

Mutual inductance of a coil is 5H, if current changes from 0 amp to 5 amp. in10<sup>-3</sup> sec. then the emf induced in secondary coil-

# **Options:**

A. 10 kV

- B. 20 kV
- C. 25 kV
- D. 40 kV

## Answer: C

# Solution:

#### CONCEPT:

- **Mutual Induction:** Whenever the current passing through a coil or circuit changes, the magnetic fluxlinked with an eighboring coil or circuit will also change.
- Hence anemf will be induced in the neighboring coil or circuit. This phenomenon is called 'mutual induction'.
- Mutual induction between the two coils of area A, number of turns N1 and N2 with the length of secondary or primary l is given by:

$$M = -rac{e_2}{rac{dI_1}{dt}} = -rac{e_1}{rac{dI_2}{dt}}$$

Here M is mutual inductance, I<sub>1</sub>and I<sub>2</sub>are electric currents in two coils, e<sub>1</sub>and e<sub>2</sub>are emf induced in two coils.

#### CALCULATION:

Given that:

Mutual inductance (M) = 5 H

Initial current  $(I_1) = 0 A$ 

Final current  $(I_2) = 5A$ 

Change in current ( $\Delta I$ ) =  $I_2$ -  $I_1$ = 5 - 0 = 5 A

Time taken ( $\Delta t$ ) =10<sup>-3</sup>sec

Emf induced (e) = M ( $\Delta I/\Delta t$ ) = 5× (5/10<sup>-3</sup>) = 25000 = 25 kV

Hence option 3 is correct.

#### EXTRA POINTS:

- Self-Induction: Whenever the electric current passing through a coil changes, the magnetic flux linked with it will also change.
  - As a result of this, in accordance with **Faraday's laws of electromagnetic induction**, an emf is induced in the coil which opposes the change that causes it.
- This phenomenon is called '**self-induction**' and the emf induced is called**back emf**, current so produced in the coil is called**induced current**.

Theself-inductance (L) of a solenoid is given by:

 $L = rac{\mu_o N^2 A}{l}$ 

Where N is the number of turns, A is cross-sectional area and l is the length.

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# **Question 9**

# If the mean life of the radioactive element is 50 days then the half-life of the element will be:

#### **Options:**

A. 72 days

B. 25 days

C. 50 days

D. 34.65 days

Answer: D

# Solution:

#### CONCEPT:

#### Half-life (t<sub>1/2</sub>):

- Half-life is the time period after which half of the quantity of the radioactive element gets decayed.
- It is given as,

 $\Rightarrow T_{1/2} = rac{0.693}{\lambda}$ 

**Mean-life** (τ):

- The time for which a **radioactive material remains active** is defined as the mean life of the radioactive material.
- It is the sum of lives of all atoms divided by the total number of atoms.
- It is given as,

 $\Rightarrow \tau = \frac{1}{\lambda}$ 

Where  $\lambda = \text{decay constant}$ 

#### **CALCULATION:**

Given  $\tau = 50$  days

• We know that the mean life of the radioactive element is given as,

$$\Rightarrow \tau = \frac{1}{\lambda}$$
 -----(1)

• We know that the half-life of the radioactive element is given as,

$$\Rightarrow T_{1/2} = rac{0.693}{\lambda}$$
 -----(2)

By equation 1 and equation 2,

 $\Rightarrow$  T<sub>1/2</sub>= 0.693  $\times \tau$ 

 $\Rightarrow$  T<sub>1/2</sub>= 0.693 × 50

 $\Rightarrow$  T<sub>1/2</sub>= 34.65 days

• Hence, option 4is correct.

# 눩 Additional Information

#### **Radioactivity:**

- Radioactivity is a process by which the **nucleus of an unstable atom loses energy by emitting radiation**.
  - Two forces, namely the force of repulsion that is electrostatic and the powerful forces of attraction of the nucleus acts in the nucleus.
  - These two forces are considered extremely strong in nature.
  - The instability of the nucleus increases as the size of the nucleus increases because the mass of the nucleus becomes a lot to concentrate on.
  - That's the reason why atoms of Plutonium, Uranium are extremely unstable and showradioactivity

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# **Question 10**

# The SI unit of current is:

# **Options:**

A. Ohm  $(\Omega)$ 

B. Volt (V)

C. Ampere (A)

D. Joule (J)

# Answer: C

# Solution:

# 🔗 <u>Key Points</u>

- Current: The rate of flow of electric charge is called current.
- The SI unit of current is Ampere.
- The name has been given after the famousFrench physicist and mathematicianAndré-Marie Ampère.
- He is known for his work in Electromagnetism.
- The current is a fundamental unit.
- One ampere of current flows when one coulomb of charge flows through a wire in one second. Coulomb is the SI unit of electric charge.

#### <u>So the correct option is Ampere (A).</u>

# 誟 Additional Information

- Ohm is the unit of resistance.
- Volt is the unit of potential difference
- Joule is the unit of energy and work.

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# **Question 11**

# Which of the following electromagnetic waves have the maximum wavelength:

# **Options:**

A. Ultraviolet

B. X-Rays

C. Microwaves

D. Gamma Rays

# Answer: C

# Solution:

#### CONCEPT:

#### **Electromagneticwavesor EMwaves:**

- Thewavesthat are formed as a result of vibrations between an electric field and a magnetic field and they are perpendicular to each other and to the direction of the wave is called an electromagnetic wave.
- The accelerating charged particle produces an electromagnetic (EM) wave.
- Acharged particle oscillating about an equilibrium position is anaccelerating charged particle.
- Electromagneticwaves**donot require any matter**to propagate from one place to another as it consists of photons. They can move in a**vacuum**.



#### **EXPLANATION:**

The wavelength of different electromagnetic waves:

Type of Radiation	Frequency Range (Hz)	Wavelength Range
gamma-rays	$10^{20} - 10^{24}$	$< 10^{-12}$ m
x-rays	$10^{17} - 10^{20}$	1 nm – 1 pm
ultraviolet	$10^{15} - 10^{17}$	400  nm - 1  nm
microwaves	$3 \ge 10^{11} - 10^{13}$	$1 \text{ mm} - 25 \mu \text{m}$

• From the above table, it is clear that the **wavelength of microwaves is maximum among the gamma rays, x-rays, and ultraviolet rays**. Hence, option 3 is correct.

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# **Question 12**

The escape velocity on earth is 11.2 km/s. Find the escape velocity on a planet having mass twice that of earth and radius half that of the

# earth.

# **Options:**

A. 11.2 km/s

B. 22.4 km/s

C. 5.6 km/s

D. 0

Answer: B

# Solution:

#### CONCEPT:

• Escape velocity: The minimum velocity required to escape the gravitational field of earth is called escape velocity. It is denoted by V<sub>e</sub>.

The escape velocity on earth is given by:

 $V_e=\sqrt{rac{2~G~M}{R}}=11.2~km/s$ 

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

#### **EXPLANATION:**

Given that:

Mass of the planet (M') = 2 M

Radius of the planet (R') = R/2

The escape velocity on the planet is given by:

$${V}'_e = \sqrt{rac{2\;G\;M'}{R'}} = \sqrt{rac{2\;G imes 2\;M}{rac{R}{2}}} = 2 imes \sqrt{rac{2\;G\;M}{R}} = 2 imes 11.2 = 22.4\;km/s$$

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# **Question 13**

# What is the CGS unit of electric dipole moment?

# **Options:**

## A. Coulomb meter

- B. statcoulomb-centimetre
- C. Joule-centimeter
- D. Newton

# Answer: B

# Solution:

#### CONCEPT:

#### **Electric dipole:**

- When two equal and opposite charges are separated by a small distance then this combination of charges is called an **electric dipole**.
- The multiplication of charge and the distance between them is called as **electric dipole moment**.
- electric dipole moment is denoted by P and the SI unit of dipole moment is Coulombmeter (Cm)

# Strength of Dipole moment ( $\vec{P}$ )= q × d

Where q is charge and d is the distance between two charged particles.

#### Unit:

- The standard measurement of a quantity is called a **unit**.
- For example- mass is measured in kilogram.
- There are three types of unit system:

SI /MKS unit system:	CGS unit system:	FPS unit system;
• In this system, the length is measured in meter (m), mass is measured in kilogram (kg) and time is measured in second (s).	• In this system, length is measured in <b>centimeter</b> (cm), mass is measured in <b>gram</b> (g) and time is taken in second (s).	• In this system, length is measured <b>in the foot</b> , mass is measured in the <b>pound</b> ,and time is measured in second (s).
• For example: theSI unit of velocity is m/s	• For example: the CGS unit of density is g/cm <sup>3</sup> .	• For example: the FPS unit of volume is foot <sup>3</sup>

#### **EXPLANATION:**

- The CGS unit of charge is stat coulomb and CGS unit of distance is centimeter.
- Thus CGS unit of dipole moment will be stat coulomb-centimeter.

**Question 14** 

# Which phenomena show the particle nature of light?

# **Options:**

- A. Diffraction
- B. Interference
- C. Photoelectric effect
- D. Polarization

# Answer: C

# Solution:

#### CONCEPT:

- **Photoelectric effect**: The phenomenon in which the light energy forces a metal surface to release electrons is called the photoelectric effect.
- When the light hits, it shows the particle theory of light, and light is defined as a stream of photons or energy packets.
- The other phenomena such as interference, diffraction, and polarization can only be explained when the light is treated as a wave wherein the photoelectric effect, line spectra, and the production and scattering of x rays demonstrate the particle nature of light.

## EXPLANATION:

• From the above discussion, the **photoelectric effect shows the particle nature of light**. So option 3 is correct.

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# **Question 15**

The velocity of a particle, executing S.H.M, is \_\_\_\_\_at its mean position.

# **Options:**

A. maximum

B. minimum

C. infinity

## D. zero

# Answer: A

# Solution:

#### <u>Concept</u>

**Simple Harmonic Motion** or SHM is a specific type of oscillation in which the restoring force is directly proportional to the displacement of the particle from the mean position.

- Velocity of SHM,  $v = \omega \sqrt{A^2 x^2}$
- Where, x =displacement of the particle from the mean position,
- A = maximum displacement of the particle from the mean position.
- $\omega =$  Angular frequency



acceleration is zero velocity maximum

#### **Calculation:**

Velocity of SHM,  $v = \omega \sqrt{A^2 - x^2}$ --- (1)

At its mean position x = 0

Putting the value in equation 1,

 $\Rightarrow \! v = \omega \sqrt{A^2 - 0^2}$ 

 $\Rightarrow$ v = $\omega$ A, which is maximum.

#### So,velocity is maximumat meanposition.

At extreme position,  $x = \pm A$ , v = 0

So, velocity is minimum or zero at extreme position.

# 誟 Additional Information

- Acceleration,  $a = \omega^2 x$
- Acceleration is maximum at the extreme position,  $x = \pm A$

• Acceleration is minimum or zeroat the meanposition, a = 0

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# **Question 16**

# Which of the following relationship is incorrect? (k is wave number, $\lambda$ is wavelength, T is time period, $\omega$ is angular frequency, and v is wave speed)

**Options:** 

A.  $k = 2\pi/\lambda$ 

B.  $\omega = 2\pi/T$ 

C.  $\omega = vk$ 

D.  $\omega = 2\pi\lambda$ 

# Answer: D

# Solution:

#### CONCEPT:

Thegeneral equation of wave motion is given by:

 $y = Asin (kx - \omega t)$ 

where A= amplitude,  $\omega$  = angular frequency,k = angular wave number, t = time, and x is position

- Wavelength ( $\lambda$ ):Distance between two nearest particles vibrating in the same phase.
- Frequency (f):Number of vibration complete by a particle in one second.
- Time Period (T): Time taken by the wave to travel a distance equal to one wavelength.
- Amplitude (A): Maximum displacement of vibrating particle from mean position.

The relationship between frequency (f), wavelength ( $\lambda$ ), and velocity (v) of a wave is given by:

 $f\!\!\times\!\!\lambda\!=v$ 

#### **EXPLANATION**:

We know that

 $1/\lambda = k/2\pi$ 

 $\mathbf{k} = 2\pi/\lambda$  ....eq(i)

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Also \boldsymbol{\omega} = 2\pi \mathbf{f} \dots eq(ii)

f = 1/T \dots eq(iii)

From eq(ii) and eq(iii) we get

\boldsymbol{\omega} = 2\pi/T \dots eq(iv)

We know the relation

\mathbf{f} \times \boldsymbol{\lambda} = \mathbf{v}

f = v/\lambda \dots eq(v)

From eq(v) and eq(ii) we get

\boldsymbol{\omega} = 2\pi \mathbf{v}/\lambda \dots eq(vi)

From eq(i) and eq(vi) we get

\boldsymbol{\omega} = \mathbf{k}\mathbf{v}
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• Since the formula given in the 4th option is wrong. Hence **option 4**is correct.

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# **Question 17**

# The physical quantities not having same dimensions, are:

# **Options:**

- A. Stress and Young's Modulus
- B. Speed and  $(\mu_0 \varepsilon_0)^{-1/2}$
- C. Torque and work
- D. Momentum and Plank's constant

# Answer: D

# Solution:

## Concept:

- **Dimensional analysis**: The study of relationships between**physical quantities**with the help of their**dimensions and units of measurements** is called dimensional analysis.
- Advantages of dimensional analysis:

- **Consistency**of adimensional equation.
- Derivation of the relation between physical quantities in physical phenomena.
- To changeunits from one system to another.
- Limitations of dimensional analysis:
  - By this method, the value of adimensionless constant cannot be calculated.
  - By this method, the equation containing trigonometrical, exponential, and logarithmic terms cannot be analysed.
  - In a physical quantity depends on**more than three factors**, and then relation among them cannot be established.

#### Explanation:

The dimensional formula of given pairs of physical quantities are:

Stress:  $[M L^{-1}T^{-2}]$  & Young's Modulus:  $[M L^{-1}T^{-2}]$ 

Speed:  $[LT^{-1}]\& (\mu_0 \epsilon_0)^{-1/2}: [LT^{-1}]$ 

Torque:  $[M L^2 T^{-2}]$  & Work:  $[M^1 L^2 T^{-2}]$ 

Momentum: [M<sup>1</sup>L<sup>1</sup>T<sup>-1</sup>] & Plank's constant: [M<sup>1</sup>L<sup>2</sup>T<sup>-1</sup>]

So, Momentum and Plank's constant is not having the same dimensions.

# Additional Information

• The dimension of Fundamental units are

<b>Physical Quantity</b>	Dimension
Mass	М
Length	L
Current	A
Time	Т
Temperature	K

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# **Question 18**

# Excess pressure in a soap bubble of radius r is proportional to

# **Options:**

A. 1/r

B.  $\frac{1}{r^2}$ 

C. r

D. r<sup>2</sup>

Answer: A

# Solution:

#### CONCEPT:

- Surface tension: Surface tension is aforce per unit length acting in the plane of interface between the liquid and the bounding surface.
  - Its unit is 'N/m' and the dimensions are  $[MT^{-2}]$ .
- Excess pressure: The pressure inside a bubble and outside it is not identical due to the surface of the tension of the bubble.
- The excess pressure for the oil bubble is given by:

 $\Rightarrow$ P<sub>oil</sub>= 2T/r,

Where,  $P_{oil}$  = excess pressure of oil, T = surface tension of the oil bubble, and r = radius of the bubble.

• The excess pressure for the soap bubble is given by:

 $P_{Bubble} = 4T/r$ ,

Where  $P_{Bubble}$  = excess pressure of oil bubble, T = surface tension of soap bubble, r = radius.

#### **EXPLANATION:**

• The excess pressure for the soap bubble is given by:

 $\Rightarrow P_{Bubble} = \frac{4T}{r}$ 

• From the above, it is clear that at constant surface tension, the excess pressure in a soap bubble of radius r is inversely proportional to r i.e.,

 $\Rightarrow P_{Bubble} \propto \frac{1}{r}$ 

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# **Question 19**

Entropy change depends on \_\_\_\_\_.

# **Options:**

A. Heat transfer

B. Mass transfer

# C. Change of temperature

## D. Thermodynamic state

## Answer: A

# **Solution:**

#### **CONCEPT:**

- Entropy (S): It is a measure of the disorder of the molecular motion of a system.
- Greater is the disorder, greater is the entropy. The change in entropy is,

 $\Delta S = \frac{\Delta \widetilde{Q}}{T}$ 

Where  $\Delta Q$  = Heat absorbed by the system and T = Absolute temperature

#### **EXPLANATION:**

• Absolute entropy (S) or entropy is a measure of energy dispersion in a system.

Following are basic features of entropy:

- Entropy transfer is associated with heat transfer (direction of flow of entropy is the same as that of heat flow). Therefore option 1 is correct.
- Entropy is proportional to mass flow in an open system.
- Entropy does not transfer with work.
- Entropy linked with energy

$Heat \rightarrow Work$	Entropy transfers
Work $\rightarrow$ Work	No entropy transfer
Work $\rightarrow$ Heat	No entropy transfers; Entropy generates

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# **Question 20**

# What is the statement for the second law of thermodynamics?

# **Options:**

- A. Energy of a system is conserved.
- B. All the spontaneous processes result in decreased total entropy of a system.
- C. All the spontaneous processes result in increased total entropy of a system.
- D. There is no second law of thermodynamics.

## Answer: C

# Solution:

#### CONCEPT:

- The **second law of thermodynamics:** Itstates that the total entropy of a system either increases or remains constant in any spontaneous process; it never decreases.
- An important implication of this law is that heat transfers energy spontaneously from higher- to lower-temperature objects, but never spontaneously in the reverse direction.
- This is because entropy increases for heat transfer of energy from hot to cold.

#### **EXPLANATION**:

- Option 1:First law of thermodynamics states that energy is conserved.
- It says heat given to a system is converted into work done and internal energy.
  So this is not the correct answer.
- Option 2 and 3: According to the second law of thermodynamics, The final entropy of a system never decreases.
- It states that the total entropy of the universe (system + surrounding) **must increase** in every spontaneous process.
- So the correct answer is **option 3**.

\_\_\_\_\_

# **Question 21**

A stone is tied at the end of a string of 2m length and then rotated with a constant angular velocity of 10 rad/sec. The centripetal acceleration of the stone will be:

## **Options:**

A. 200 m/s<sup>2</sup>

B. 20 m/s<sup>2</sup>

C. 2000 m/s<sup>2</sup>

D.  $2m/s^2$ 

## Answer: A

# Solution:

CONCEPT:

- Centripetal acceleration: In a circular motion, the component of the acceleration directed along the radius of the circle is called centripetal acceleration.
  - It is responsible for the change in direction of velocity.
  - It is always variable because due to this **acceleration** the direction of the particle changes continuously.

$$\Rightarrow a_c = rac{v^2}{r} = \omega^2 r$$

Where v = velocity, r = radius,  $a_c = Centripetal acceleration$ ,  $\omega = angular velocity$ 



#### CALCULATION:

Given that:

 $r = 2 m and\omega = 10 rad/sec$ 

We know that the **centripetal acceleration** is given as:

 $\Rightarrow a_c = \omega^2 r$ 

 $\Rightarrow a_c = 10^2 \times 2 = 200 \text{ m/s}^2$ 

• Hence**option 1** is correct.

\_\_\_\_\_

# **Question 22**

# Poisson ratio is defined as

# **Options:**

- A. Lateral strain divided by longitudinal strain
- B. Longitudinal strain divided by lateral strain
- C. Longitudinal strain divided by shearing strain
- D. Lateral strain times longitudinal strain

#### Answer: A

# Solution:

#### Concept:

**Poisson's Ratio**: Simon Poisson pointed out that within the elastic limit, lateral strain is directly proportional to the longitudinal strain. The ratio of the lateral strain to the longitudinal strain in a stretched wire is called **Poisson's ratio**.

Here lateral strain the strain perpendicular to the applied force and its is given as  $(\Delta R/R)$ 

$$\sigma = -rac{laterial\ strain}{longitudinal\ strain} = -rac{\Delta R}{rac{\Delta L}{L}} = -rac{\Delta R}{R} imes rac{L}{\Delta L}$$

Here negative sign shows that as length of wire increases, the radius of wire will decrease.

The normal value of  $\sigma$  lies between -1 and +1/2

Whereas practical value of  $\sigma$  lies between 0 to +1/2

And just like strain Poisson's ratio is also Dimensionless.

#### Note:

For a rigid body, the value of Poisson's ratio is zero. A zero Poisson's ratio means that there is no transverse deformation resulting from an axial strain.

- Most materials have Poisson's ratio values ranging between 0.0 and 0.5.
- A perfectly incompressible material deformed elastically at small strains would have a Poisson's ratio of exactly 0.5.
- Most steels and rigid polymers when used within their design limits (before yield) exhibit values of about 0.3, increasing to 0.5 for post-yield deformation which occurs largely at constant volume.
- Rubber has a Poisson ratio of nearly 0.5.
- Cork's Poisson ratio is close to 0, showing very little lateral expansion when compressed.

#### **Explanation:**

From the above explanation we can see that Poisson's ration is define as lateral strain upon longitudinal strain

i.e., 
$$\sigma = -rac{laterial\ strain}{longitudinal\ strain}$$

#### Thus option 1 is correct among all

\_\_\_\_\_

# **Question 23**

Spherical mirror formula relating an object distance 'u', image distance 'v' and focal length of mirror 'f' may be applied to a plane

# mirror when

# **Options:**

- A. focal length goes to infinity.
- B. focal length goes to zero.
- C. image distance goes to zero.
- D. image distance goes to infinity.

## Answer: A

# Solution:

#### CONCEPT:

• Mirror Formula: The following formula is known as the mirror formula, which provided a relationship between focal length (f), image distance (v), and objects distant (u) as shown below

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

#### **EXPLANATION**:

• Plane Mirror is a part of the infinitely large spherical mirror:



- Since the plane mirror is a part of an infinitely large spherical mirror, therefore the radius of curvature and focal length of the plane mirror is Infinity.
- Spherical mirror formula relating an object distance 'u', image distance 'v' and focal length of mirror 'f' may be applied to a **plane mirror whenfocal length goes to infinity**. Therefore option 1 is correct.



Sign convention in mirrors



- All distances are measured from the **pole of the mirror**.
- The distance measured from the pole (p) to the leftside of the mirror is taken as negative.
- The distance measured from the pole (p) to the **rightside** of the mirroris taken aspositive.
- The heights measured upwards and perpendicular to the principal axis of the mirror is taken as positive.
- The heights measured downwards and perpendicular to the principal axis of the mirror is taken as negative.

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# **Question 24**

# A constant force acting on a moving particle does not work on it. It can be necessary inferred that

# **Options:**

- A. the change in its velocity is zero
- B. the change in its acceleration is zero
- C. the change in its linear momentum is zero
- D. None of these

# Answer: A

# Solution:

#### **CONCEPT:**

- Work is the product of the force applied to a body and the displacement i.e.,  $W = F \cdot x$
- Work-Energy Theorem states that the change in kinetic energy of a particle is equal to the work done on it by the net force.

 $\Rightarrow \Delta K.E. = Work Done$ 

#### **SOLUTION:**

**Given:**Force is Constant  $(\Delta F) = 0$  and Work Done (W) = 0

$$\Rightarrow \Delta KE = rac{1}{2}m({v_f}^2 - {v_i}^2) = W = 0$$

```
\Rightarrow V_f = V_i
```

i.e., No Change in velcoity.

- No change in acceleration means a constant change in velocity which further implies that it's kinetic energy is changing, hence **work done can not be zero**. So, option 2 is incorrect.
- From Newton's second law we see that **force is equal to the change in momentum per unit of time**. So, if linear momentum is not changing that means the force is zero which is not the case here. Hence, option 3 is also incorrect.

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# **Question 25**

# The volume occupied by a given mass of a gas at 298 K is 25 mL at 1 atmospheric pressure. Calculate the volume of the gas if the pressure is increased to 1.25 atmosphere keeping temperature constant.

**Options:** 

A. 30 ml

B. 20 ml

C. 15 ml

D. 40 ml

Answer: B

# Solution:

#### Concept:

• Boyle's law: At constant temperature, pressure is inversely proportional to volume.

 $P_1V_1 = P_2V_2$ 

#### **Explanation:**

Information given in above problem is

- 1. Temperature = 298 K
- 2. Initial pressure  $(P_1) = 1$  atm
- 3. Final pressure  $(P_2) = 1.25$  atm
- 4. Initial Volume  $(V_1) = 25 \text{ ml}$
- 5. Final volume (V<sub>2</sub>) =?

 $P_1V_1 = P_2V_2$ 

$$V_2 = rac{P_1 V_1}{P_2}$$
  
 $V_2 = rac{1 imes 25}{1.25} = rac{25}{1.25}$ 

 $V_2 = 20 \text{ ml}$ 

• Volume of the gas if the pressure is increased to 1.25 atmosphere keeping temperature constantis 20ml.

# 눩 Additional Information

Ideal gasobeys gas equation given as

PV = nRT

- P Pressure
- V- Volume
- T- Temperature
- n- Amount of gas(in moles)
- R- Universal gas constant
- R = 8.314 J/(K mol)

# Maths

# **Question 26**

If  $\sin\theta + \csc\theta = 2$  then find  $|\sin^2\theta + \csc^2\theta| = ?$ 

# **Options:**

A. 1

B. 2

C. 0

D. 1/2

# Answer: B

# Solution:

## <u>Concept:</u>

 $\csc \theta = \frac{1}{\sin \theta}$ 

## **Calculation:**

Given:  $\sin\theta + \csc\theta = 2$ 

 $\Rightarrow \sin\theta + \frac{1}{\sin\theta} = 2$  $\Rightarrow \sin^2\theta - 2\sin\theta + 1 = 0$  $\Rightarrow (\sin\theta - 1)^2 = 0$  $\Rightarrow \sin\theta = 1$  $\Rightarrow \csc\theta = \frac{1}{\sin\theta} = 1$  $\Rightarrow |\sin^2\theta + \csc^2\theta| = |1 + 1| = 2$  $\therefore$  The correct option is (2).

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# **Question 27**

 $\int \log 2x \, dx =$ 

# **Options:**

A.  $x \log x + c$ 

B.  $x \log 2x + x + c$ 

C.  $x \log 2x - x + c$ 

D. None of these

## Answer: C

# Solution:

## <u>Concept:</u>

Integration by parts,

 $\int u. v \, dx = u. \int v \, dx - \int (u'. \int v \, dx) \, dx$ 

## **Calculation:**

Given,∫ log 2x dx

Let I =  $\int 1.\log 2x \, dx$ 

with  $u = \log 2x$  and v = 1

Integrating by parts,

 $\Rightarrow I = \log 2x \int 1 dx - \int (\log 2x)' \int 1 dx dx$ 

 $\Rightarrow I = x \log 2x - \int (2 \cdot \frac{1}{2x}) \cdot x \, dx$ 

 $\Rightarrow$  I = x log 2x -  $\int 1 dx$ 

 $\Rightarrow$  I = x log 2x - x + c

 $\therefore$  The correct option is (3).

-----

# **Question 28**

Find the area under the curve between  $y = x^2$  and  $y = x^3$ .

**Options:** 

A. 1/2 sq units

B. 1/3 sq units

C. 1/6 sq units

D. 1/12 sq units

Answer: D

# Solution:

#### Concept:

The area between the curves f(x) and g(x) from x = a to x = b { $f(x) \le g(x)$  for x = a to b} is

$$\int_{\mathrm{a}}^{\mathrm{b}}[\mathrm{g}(\mathrm{x})-\mathrm{f}(\mathrm{x})]\mathrm{d}\mathrm{x}$$

#### **Calculation:**

Given curvesy =  $x^2$  and  $y = x^3$ .

Plotting these graphs to see the required region,



So the required region is clearly between (0,0) and (1,1) with  $x^3 < x^2$ ,

The area of the required region will be,

 $A = \int_0^1 [x^2 - x^3] dx$   $\Rightarrow A = \frac{x^3}{3} - \frac{x^4}{4} |_0^1$   $\Rightarrow A = \frac{1}{3} - \frac{1}{4}$  $\Rightarrow A = \frac{1}{12} \text{ sq units}$ 

 $\therefore$  The correct option is (4).

\_\_\_\_\_

# **Question 29**

Let  $\vec{a} = 2\hat{i} - 3\hat{j} + 4\hat{k}$ ,  $\vec{b} = 7\vec{i} + 2\vec{j} - 3\vec{k}$ ,  $\vec{c} = \vec{i} + \vec{j} + \vec{k}$ . Then find the value of a.(b× c)

**Options:** 

A. 40

B. 0

C. 60

D. 85

## Answer: C

# Solution:

Concept:

If  $\vec{\mathbf{a}} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$  and  $\vec{\mathbf{b}} = b_1\vec{\mathbf{i}} + b_2\vec{\mathbf{j}} + b_3\vec{\mathbf{k}}$ ,then

- Dot product: $ec{\mathbf{a}}.$   $ec{\mathbf{b}}=a_1b_1+a_2b_2+a_3b_3$ and
- Cross product:  $\vec{a} \times \vec{b} = (a_2b_3 a_3b_2)\vec{i} + (a_3b_1 a_1b_3)\vec{j} + (a_1b_2 a_2b_1)\vec{k}$

#### **Calculation:**

Given, $\vec{a} = 2\hat{i} - 3\hat{j} + 4\hat{k}, \vec{b} = 7\vec{i} + 2\vec{j} - 3\vec{k}, \vec{c} = \vec{i} + \vec{j} + \vec{k}$   $\Rightarrow b \times c = (2(1) - (-3)(1))\vec{i} + ((-3)(1) - 7(1))\vec{j} + (7(1) - 2(1))\vec{k}$   $\Rightarrow b \times c = 5\vec{i} - 10\vec{j} + 5\vec{k}$   $\Rightarrow a.(b \times c) = 2(5) + (-3)(-10) + 4(5)$   $\Rightarrow a.(b \times c) = 10 + 30 + 20 = 60$  $\therefore$  The correct option is (3).

\_\_\_\_\_

# **Question 30**

If  $x^2 + y^2 = t + \frac{1}{t}$  and  $x^4 + y^4 = t^2 + \frac{1}{t^2}$ . then find the value of  $\frac{dy}{dx}$ 

**Options:** 

A.  $-\frac{1}{x^2}$ 

B. 0

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

D. 
$$-\frac{1}{x^3}$$

# Answer: A

# Solution:

Given:

 $x^{2} + y^{2} = t + \frac{1}{t} (1)$   $x^{4} + y^{4} = t^{2} + \frac{1}{t^{2}} (2)$ Squaring both sides in equation (1),  $(x^{2} + y^{2})^{2} = (t + \frac{1}{t})^{2}$   $\Rightarrow x^{4} + y^{4} + 2x^{2}y^{2} = t^{2} + \frac{1}{t^{2}} + 2$ Putting the values from equation (2),  $\Rightarrow t^{2} + \frac{1}{t^{2}} + 2x^{2}y^{2} = t^{2} + \frac{1}{t^{2}} + 2$   $\Rightarrow x^{2}y^{2} = 1$   $\Rightarrow y = \frac{1}{x}$ Differentiating both sides,

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

 $\therefore$  The correct option is (1).

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# **Question 31**

How many words can be made from the letters of the word BHARAT in which B and H never come together

**Options:** 

A. 360

B. 300

C. 240

D. 120

# Answer: C

# Solution:

#### Concept:

The number of words from n letters where a letter is repeated m times

= n!/m!

where n! = n(n - 1)(n - 2)....3.2.1

#### **Calculation:**

Number of wordswhen B and H did not come together

 $\Rightarrow$  Total number of words - Number of words when B and H come together

Now, Total number of words from the letters of the word BHARAT = 6!/2! = 360

{letter A has repeated two times and the total letters are 6}

And, when B and H come together,

let us consider B and Has a single letter (BH),

So, the number ofwords when B and H come together

= the number of words from the letters of the word (BH)ARAT =  $\frac{5!}{2!} \times 2 = 120$ 

 $\Rightarrow$ Number of wordswhen B and H did not come together = 360 - 120 = 240

 $\therefore$  The correct answer is option (3).

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# **Question 32**

# Find sin 15°.

# **Options:**

A. 
$$\frac{\sqrt{3}-1}{2\sqrt{2}}$$

B. 
$$\frac{\sqrt{3}-2}{\sqrt{2}}$$
C. 
$$\frac{\sqrt{3}}{2\sqrt{2}}$$

D. 
$$\frac{3-\sqrt{2}}{\sqrt{2}}$$

#### Answer: A

### Solution:

Concept:

 $\sin(A-B) = \sin A \cos B - \cos A \sin B$ 

#### **Calculation:**

 $\sin 15^\circ = \sin (45 - 30)$ 

 $\Rightarrow \sin (45-30) = \sin 45 \cos 30 - \cos 45 \sin 30$ 

 $\Rightarrow \sin (45-30) = (1/\sqrt{2}) \times (\sqrt{3}/2) - (1/\sqrt{2}) \times (1/2)$ 

 $\Rightarrow \sin (45 - 30) = \frac{\sqrt{3}}{2\sqrt{2}} - \frac{1}{2\sqrt{2}}$ 

 $\Rightarrow$  sin 15° =  $\frac{\sqrt{3}-1}{2\sqrt{2}}$ 

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# **Question 33**

## Find the domain and range of following function

$$f(x) = (x^2 - 1)/(x - 1)$$

**Options:** 

- A. Domain = Range
- B. D = [0, 4], R =  $(- , -1) \dot{E} (1, 4]$
- C.  $D = R \{1\}$ , Range =  $R \{2\}$

D. None of the above

Answer: C

## Solution:

f(x) assumes real values for value of x other than x = 1  $\therefore$  Domain of given function = R - {1}, where R is set of all real numbers  $\therefore$  f(x) =  $(x^2 - 1)/(x - 1)$ does not exist for x = 1  $\therefore$  f(x) = ((x - 1)(x + 1))/(x - 1)  $\therefore$  f(1) = 1 + 1 = 2 Range = R - {2}, where R is set of all real numbers

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# **Question 34**

Find 
$$\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} (\sin x + \tan x) dx$$

### **Options:**

A. 1

B.  $\pi/2$ 

C. 0

D. -1

Answer: C

### Solution:

Concept:

**Odd function:** f(-x) = -f(x)

**Even the function:** f(-x) = f(x)

 $\sin(-x) = -\sin x$ 

 $\cos\left(-x\right)=\cos x$ 

 $\tan(-x) = -\tan x$ 

#### Property of definte integral:

 $\int_{-a}^{a} f(x) dx = egin{cases} 2 \int_{0}^{a} f(x) dx &, \mbox{ Even function} \\ 0 &, \mbox{ Odd function} \end{cases}$ 

#### **Calculation:**

$$\begin{split} f(x) &= \sin x + \tan x \\ f(-x) &= \sin(-x) + \tan(-x) \\ f(-x) &= -[\sin(x) + \tan(x)] \end{split}$$

Hence f(x) is odd function

$$\therefore \int_{rac{\pi}{2}}^{rac{\pi}{2}} (\sin \mathrm{x} + \tan \mathrm{x}) \mathrm{d} \mathrm{x} = 0$$

Hence, option 3 is correct.

\_\_\_\_\_

# **Question 35**

## What is the period of the function $f(x) = 2\sin x \cos x$ ?

### **Options:**

Α. 2π

Β. π

C. 3π

D. None of these

Answer: B

### Solution:

#### Concept:

For a trigonometric function, the length of one complete cycle is called a period.

In general, we have three basic trigonometric functions likes in, cos, and tan functions, having  $2\pi$ ,  $2\pi$ , and  $\pi$  periods respectively.

• If a function f(x) is periodic with T, then the function f(ax + b) is periodic with  $\frac{T}{|a|}$ 

#### **Calculation:**

Given function:  $f(x) = 2\sin x \cos x = \sin 2x$ 

The period of sin function is  $2\pi$ .

We know, If a function f(x) is periodic with T, then the function f(ax + b) is periodic with  $\frac{T}{|a|}$ 

: The period of sin 2x will be  $\frac{2\pi}{2} = \pi$ 

# **Question 36**

 $\lim_{x
ightarrow 0}rac{1-\cos 2x}{x^2}$ is

### **Options:**

A. 2

B. 0

- C. 1
- D. 4

### Answer: A

### Solution:

#### Concept:

- Indeterminate Forms: Any expression whose value cannot be defined, like  $\frac{0}{0}$ ,  $\pm \frac{\infty}{\infty}$ ,  $0^0$ ,  $\infty^0$  etc.
- For the indeterminate form  $\frac{0}{0}$ , first try to rationalize by multiplying with the conjugate, or simplify by cancelling some terms in the numerator and denominator. Else, use the L'Hospital's rule.
- L'Hospital's Rule: For the differentiable functions f(x) and g(x), the  $\lim_{x\to c} \frac{f(x)}{g(x)}$ , if f(x) and g(x) are both 0 or  $\pm \infty$  (i.e. an Indeterminate Form) is equal to the  $\lim_{x\to c} \frac{f'(x)}{g'(x)}$  if it exists.
- $\frac{d}{dx}(cosx) = -sin x$

### **Calculations:**

 $\operatorname{Considerlim}_{x
ightarrow 0} rac{1-\cos 2x}{x^2}$ 

 $=\frac{0}{0}$  which is an indeterminate form.

Using the L'Hospital rule, we have

$$=\lim_{x \to 0} \frac{-(-\sin 2x) \times (2)}{2x}$$
$$=\lim_{x \to 0} \frac{\sin 2x}{x} |:: \sin 0 = 0$$
$$= \frac{0}{0}$$
 which is again an indeterminate form.

Again using the L'Hospital rule, we have

 $= \hspace{-1mm}\lim_{x \rightarrow 0} \frac{2 \cos 2x}{1}$ 

Applying limit as  $x \to 0$  we get

= 2

 $\div \lim_{x 
ightarrow 0} rac{1-\cos 2x}{x^2} = 2$ 

Hence, the correct answer is option 1).

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# **Question 37**

Central term in the expansion of  $\left(2x - \frac{1}{3x}\right)^{10}$  is:

**Options:** 

A. 
$$^{-10}C_4 \left(\frac{2}{3}\right)^4$$
  
B.  $^{10}C_4 \left(\frac{2}{3}\right)^5$   
C.  $^{10}C_5 \left(\frac{2}{3}\right)^4$   
D.  $^{-10}C_5 \left(\frac{2}{3}\right)^5$   
Answer: D

## Solution:

#### Concept:

**General term:**General term in the expansion of  $(x + y)^n$  is given by

 $T_{(r\ +\ 1)}=\ ^{n}C_{r}{\times}x^{n-r}{\times}y^{r}$ 

Middle terms: The middle terms is the expansion of  $(x + y)^n$  depends upon the value of n.

If n is even, then the total number of terms in the expansion of  $(x + y)^n$  is n + 1. So there is only one middle term i.e.  $(\frac{n}{2} + 1)^{-th}$  term is the middle term.

If n is odd, then the total number of terms in the expansion of  $(x + y)^n$  is n + 1. So there are two middle terms i.e.  $\left(\frac{n+1}{2}\right)^{\text{th}}$  and  $\left(\frac{n+3}{2}\right)^{\text{th}}$  are two middle terms.

#### **Calculation:**

For the given expression  $\left(2x - \frac{1}{3x}\right)^{10}$ , n = 10 (even).

: The central term is  $T_{\frac{10}{2}+1} = T_6 = {}^{10}C_5(2x)^{10-5} \left(\frac{-1}{3x}\right)^5$ 

 $= -^{10}\mathbf{C_5} \left(\frac{2}{3}\right)^5.$ 

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# **Question 38**

# In a moderately skewed distribution, which of following equation indicates the relationship among mean, median and mode?

### **Options:**

A. Mean = 2 Mode - 3 Median

B. Mode = 3 Median - 2 Mean

C. Median = 3 Mean - 2 Mode

D. Mode = 3 Mean - 2 Median

### Answer: B

### Solution:

**Mean**: By 'mean' we refer to an**Arithmetic mean**. The arithmetic mean refers to the**average of a data set of numbers**. It can either be a simple average or a weighted average. To calculate a simple average, we add up all the numbers given in the data set and then divided by how many numbers there are.

**Median**:Median is the**middle number of a given data set**when it is arranged in either a descending order or in ascending order. If there is an odd amount of numbers, the median value is the number that is in the middle whereas if there is an even amount of numbers, the median is the simple average of the middle pair in the dataset. Median is much more effective than a mean because it eliminates the outliers.

**Mode**: The mode refers to the number that appears the most in a dataset. A set of numbers may have one mode, or more than one mode, or no mode at all.



The relationship between mean, median, and mode can be defined in four different cases:

In the case of a **moderately skewed distribution**, i.e. in general, *the difference between mean and mode is equal to three times the difference between the mean and median*. Thus, the empirical relationship can be written as:

#### Mean – Mode = 3 (Mean – Median)

∴Mean - Mode = 3Mean - 3Median

:Mean - 3Mean = - 3Median + Mode

 $\therefore$  - 2Mean = - 3Median + Mode

∴Mode = 3Median - 2Mean.

Thus, Option 2 is the correct answer.



- 1. In the case of a frequency distribution that has a **symmetrical frequency curve**, the empirical relation states that **mean = median = mode**.
- 2. In the case of a **positively skewed** frequency distribution curve, mean > median > mode.
- 3. In the case of **negatively skewed** frequency distribution mean < median < mode.

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# **Question 39**

If the 4<sup>th</sup>, 7<sup>th</sup> and 10<sup>th</sup> terms of a G.P. be a, b, c respectively, then the relation between a, b, c is

**Options:** 

A.  $b = \frac{a+c}{2}$ B.  $a^2 = bc$  C.  $b^2 = ac$ 

D.  $c^2 = ab$ 

Answer: C

### Solution:

#### Concept:

#### **Geometric Progression**

The general form of Geometric Progression is:

a, ar,  $ar^2$ ,  $ar^3$ ,  $ar^4$ ,...,  $ar^{n-1}$ 

where, a = First term, r = common ratio,  $ar^{n-1} = nth$  term.

#### **Calculation:**

Let A be first term of GP with common ratio r.

The nth term,  $A_n = Ar^{n-1}$ 

Given 4th term = a

 $Ar^{3}=a...(i)$ 

Given 7th term = b

Ar<sup>6</sup>= b ...(ii)

Given 10th term = c

 $Ar^9 = c \dots (iii)$ 

Multiply (i) and (iii)

 $\Rightarrow ac = Ar^{3}(Ar^{9})$  $\Rightarrow ac = A^{2}r^{12}$  $\Rightarrow ac = (Ar^{6})^{2}$  $\Rightarrow ac = b^{2}$ 

 $\therefore b^2 = ac$ 

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# **Question 40**

Value of 
$$\int x \log x \, dx$$
 is

### **Options:**

A.  $\frac{x^2 \log x}{2} - \frac{x^2}{4} + C$ B.  $\frac{x \log x}{2} - \frac{x}{4} + C$ C.  $x^2 \log x - \frac{1}{4x} + C$ D.  $\frac{(\log x)^2}{2} - \frac{x^2}{4} + C$ 

### Answer: A

# Solution:

### <u>Concept-</u>

Integration by parts formula-:

 $\int uv \ dx = u \int v dx - \int (u' \int v dx) dx$ 

### Calculation-

$$\int x \log x \ dx$$

Taking log x as first function x as second and using by parts formula

\_\_\_\_\_

$$=\log \int x dx - \int \left(\frac{d}{dx}(\log x)\right) \left(\int x dx\right) dx$$
$$=\log \left(\frac{x^2}{2}\right) - \int \frac{1}{x} \times \frac{x^2}{2} dx$$
$$=\frac{x^2}{2}\log x - \frac{1}{2}\int x dx$$
$$=\frac{x^2\log x}{2} - \frac{x^2}{4} + C$$
$$\therefore \int x\log x \, dx = \frac{x^2\log x}{2} - \frac{x^2}{4} + C$$

# **Question 41**

$$\int rac{\cos 2x}{\cos^2 x . \sin^2 x} dx = ~?$$

### **Options:**

- A. -cot x tan x + c
- B.  $\cot x \tan x + c$
- C.  $\cot x + \tan x + c$
- D. tan x  $\cot x + c$

### Answer: A

# Solution:

### Concept:

•  $\cos 2x = \cos^2 x - \sin^2 x$ 

### **Calculation:**

 $\int \frac{\cos 2x}{\cos^2 x \cdot \sin^2 x} dx$ =  $\int \frac{\cos^2 x - \sin^2 x}{\cos^2 x \cdot \sin^2 x} dx$ =  $\int \left(\frac{1}{\sin^2 x} - \frac{1}{\cos^2 x}\right) dx$ =  $\int \frac{1}{\sin^2 x} dx - \int \frac{1}{\cos^2 x} dx$ =  $\int \csc^2 x dx - \int \sec^2 x dx$ =  $-\cot x - \tan x + C$ 

-----

# **Question 42**

# Find the number of terms in $(x + y)^{20}$

### **Options:**

B. 22

C. 23

D. 24

### Answer: A

### Solution:

#### Concept:

• The total number of terms in the expansion of  $(x + y)^n$  are (n+1)

#### **Calculation:**

Given expression:  $(x + y)^{20}$ 

To find: Number of terms

Here n = 20

: Total number of terms = n + 1 = 20 + 1 = 21.

Hence, option (1) is correct.

-----

# **Question 43**

What is  $\frac{\sin \theta + 1}{\cos \theta}$  equal to?

**Options:** 

A. 
$$\frac{\sin \theta + \cos \theta - 1}{\sin \theta + \cos \theta + 1}$$
  
B. 
$$\frac{\sin \theta + \cos \theta - 1}{\sin \theta + \cos \theta - 1}$$
  
C. 
$$\frac{\sin \theta - \cos \theta - 1}{\sin \theta + \cos \theta + 1}$$
  
D. 
$$\frac{\cos \theta - \sin \theta + 1}{\sin \theta + \cos \theta - 1}$$

#### Answer: D

### Solution:

#### Concept:

 ${
m sin}^2 heta+{
m cos}^2 heta=1$ 

#### **Calculation:**

 $\frac{\sin \theta + 1}{\cos \theta} = \frac{1 + \sin \theta}{\cos \theta} \times \frac{1 - \sin \theta}{1 - \sin \theta}$  $= \frac{1 - \sin^2 \theta}{\cos \theta (1 - \sin \theta)}$  $= \frac{\cos^2 \theta}{\cos \theta (1 - \sin \theta)}$  $= \frac{\cos \theta}{(1 - \sin \theta)}$ 

On applying componendo and dividendo, we get

 $\frac{\cos\theta + 1 - \sin\theta}{\cos\theta - (1 - \sin\theta)} = \frac{\cos\theta - \sin\theta + 1}{\sin\theta + \cos\theta - 1}$ 

Hence, option (4) is correct.

-----

# **Question 44**

If A is a square matrix such that  $A^2 = I$ , then  $(A - I)^3 + (A + I)^3 - 7A$  is equal to

**Options:** 

A. A

B. I - A

C. I + A

D. 3A

Answer: A

### Solution:

#### Concept:

Identity matrix: A square matrix in which elements in the main diagonal are all '1' and the rest are all zero is called an identity matrix or unit matrix.

Thus, the square matrix A = [ $a_{ij}$ ], if  $a_{ij} = \begin{cases} 1, if & i = j \\ 0, if & i \neq j \end{cases}$ 

e.g.,  $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ ,  $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$  are identity matrices of order2 and 3 respectively.

For any natural number  $n, I^n = I$ .

#### **Calculation:**

We have, A<sup>2</sup>=I

Also A and iare commutative, so we can expand  $(A + I)^n$  using the expansion of  $(a + b)^n$ .

 $\therefore (A - I)^{3+} (A + I)^{3-} 7A$ =  $A^{3} - 3A^{2+} 3A - I^{3+} A^{3} + 3A^{2+} 3A + I^{2-} 7A$ =  $2A^{3+} 6A - 7A$ =  $2A^{2} \cdot A + 6A - 7A$ =  $2I \cdot A + 6A - 7A$ = 2A + 6A - 7A= 8A - 7A= A

\_\_\_\_\_

# **Question 45**

For matrix  $\mathbf{A} = \begin{bmatrix} 2 & 5 \\ -11 & 7 \end{bmatrix}$ , (adj A)' is equal to :

**Options:** 

A. 
$$\begin{bmatrix} -2 & -5\\ 11 & -7 \end{bmatrix}$$

B. 
$$\begin{bmatrix} 7 & 5\\ 11 & 2 \end{bmatrix}$$
  
C. 
$$\begin{bmatrix} 7 & 11\\ -5 & 2 \end{bmatrix}$$
  
D. 
$$\begin{bmatrix} 7 & -5\\ 11 & 2 \end{bmatrix}$$

### Answer: C

# Solution:

### Concept:

Adjoint of matrix  $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$  is given by adj  $A = \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$ And Transpose of A is given by  $A' = \begin{bmatrix} a & c \\ b & d \end{bmatrix}$ 

### **Calculation:**

Given:

$$A = \begin{bmatrix} 2 & 5 \\ -11 & 7 \end{bmatrix}$$
  
Soadj 
$$A = \begin{bmatrix} 7 & -5 \\ 11 & 2 \end{bmatrix}$$
  
So(adj A)' 
$$= \begin{bmatrix} 7 & 11 \\ -5 & 2 \end{bmatrix}$$

# **Question 46**

The inverse of matrix A, where 
$$A = \begin{bmatrix} 2 & 5 \\ 1 & 3 \end{bmatrix}$$
 is

### **Options:**

A. 
$$\begin{bmatrix} 3 & 5 \\ -1 & 2 \end{bmatrix}$$



### Answer: B

### Solution:

Given:

$$\mathbf{A} = \begin{bmatrix} 2 & 5 \\ 1 & 3 \end{bmatrix}$$

#### **Calculation:**

We have,

 $\Rightarrow I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$   $\Rightarrow A = IA$   $\Rightarrow \begin{bmatrix} 2 & 5 \\ 1 & 3 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} A$   $R_1 \rightarrow R_1 - R_2$   $\Rightarrow \begin{bmatrix} 1 & 2 \\ 1 & 3 \end{bmatrix} = \begin{bmatrix} 1 & -1 \\ 0 & 1 \end{bmatrix} A$   $R_2 \rightarrow R_2 - R_1$   $\Rightarrow \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & -1 \\ -1 & 2 \end{bmatrix} A$   $R_1 \rightarrow R_1 - 2R_2$   $\Rightarrow \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 3 & -5 \\ -1 & 2 \end{bmatrix} A$  $\Rightarrow A^{-1} = \begin{bmatrix} 3 & -5 \\ -1 & 2 \end{bmatrix}$   $\therefore$  The inverse of the given matrix is  $\begin{bmatrix} 3 & -5 \\ -1 & 2 \end{bmatrix}$ 

# **Question 47**

### For two vectors

 $\vec{A}=2\hat{i}+2\hat{j}+3\hat{k}\text{and}\vec{B}=5\hat{i}+2\hat{j}+7\hat{k}\text{, find}\vec{A}.\,\vec{B}\text{.}$ 

\_\_\_\_\_

### **Options:**

A. 35

B. 37

- C. 27
- D. 53

### Answer: A

### Solution:

### Concept:

For two vectors,  $\vec{A} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$  and  $\vec{B} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}$ ,

 $\vec{A}.\,\vec{B}=a_1b_1+a_2b_2+a_3b_3$ 

### **Calculation:**

Given,  $\vec{A} = 2\hat{i} + 2\hat{j} + 3\hat{k}$  and  $\vec{B} = 5\hat{i} + 2\hat{j} + 7\hat{k}$ ,  $\Rightarrow \vec{A} \cdot \vec{B} = 2(5) + 2(2) + 3(7)$   $\Rightarrow \vec{A} \cdot \vec{B} = 10 + 4 + 21 = 35$  $\therefore$  The correct option is (1).

-----

# **Question 48**

# What is the perpendicular distance from the point (2, 3, 4) to the line $\frac{x-0}{1} = \frac{y-0}{0} = \frac{z-0}{0}$ ?

### **Options:**

A. 2

B. 5

C. 7

D. 4

Answer: B

### **Solution:**

#### Concept:

Dot product of two perpendicular lines is zero.

**Distance** between two points  $(x_1, y_1, z_1)$  and  $(x_2, y_2, z_2)$  is given by,  $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$ 

#### **Calculation:**

Let M be the foot of perpendicular drawn from the point P(2, 3, 4)

Let, 
$$\frac{x-0}{1} = \frac{y-0}{0} = \frac{z-0}{0} = k$$
  
x = k, y = 0, z = 0  
So M = (k, 0, 0)

Now direction ratios of PM = (2 - k, 3 - 0, 4 - 0) = (2 - k, 3, 4) and direction ratios of given line are 1, 0, 0 PM is perpedicular to the given line so,

$$(2 - k) (1) + 3(0) + 4 (0) = 0$$

$$\therefore k = 2$$

$$M = (2, 0, 0)$$

Perpendicular distance PM =

$$\sqrt{(2-2)^2 + (0-3)^2 + (0-4)^2} = \sqrt{9+16} = 5$$

Hence, option (2) is correct.

# **Question 49**

## Find the order and degree of the differential equation

$$rac{\mathrm{d}^2 y}{\mathrm{d} x^2} + 3 igg( rac{\mathrm{d} y}{\mathrm{d} x} igg)^2 + 4 y = 0$$

### **Options:**

- A. Order = 2 and Degree = 1
- B. Order = 1 and Degree = 2
- C. Order = 2 and Degree = 2
- D. Order = 1 and Degree = 1

### Answer: A

## Solution:

### Concept:

**Order of Differential Equation:** The order of highest order derivative involved in differential equation is called order of differential equation.

**Degree of Differential Equation:** The highest degree of highest order derivative involved in differential equation is said to be degree of differential equation.

### Solution:

$$rac{\mathrm{d}^2 y}{\mathrm{d} x^2} + 3 \Big( rac{\mathrm{d} y}{\mathrm{d} x} \Big)^2 + 4 y = 0$$

Highest order derivative is  $\frac{d^2y}{dx^2}$ . Order = 2

Power of the highest order derivative  $\frac{d^2y}{dx^2}$  is 1.  $\therefore$  Degree = 1

So, the correct option is (1).

-----

# **Question 50**

# If a coin is tossed thrice, find the probability of getting one or two heads.

**Options:** 

- A.  $\frac{4}{5}$ B.  $\frac{5}{8}$ C.  $\frac{3}{4}$
- D.  $\frac{6}{4}$

### Answer: C

# Solution:

### <u>Concept:</u>

 $P(A) = \frac{n(A)}{n(S)}$ 

Where n(A) = No. of favourable cases for event A and n(S) = cardinality of sample space.

### <u>Solution:</u>

If a coin is tossed thrice, possible outcomes are:

 $S = \{HHH, HHT, HTH, THH, THT, TTH, HTT, TTT\}$ 

Probability of getting one or two heads:

 $A = \{HHT, HTH, THH, THT, TTH, HTT\}$ 

 $P(A) = rac{6}{8}$  $= rac{3}{4}$ 

# English

# Question 51

Select the correctly spelt word.

### **Options:**

- A. Mathmetics
- B. Mathamatics
- C. Mathametics
- D. Mathematics

### Answer: D

# Solution:

The correct answer is'Mathematics'.

# 🔗 <u>Key Points</u>

- Out of the given options, only'Mathematics'is correctly spelt.
- 'Mathematics' means the abstract science of number, quantity, and space, either as abstract concepts (*pure mathematics*), or as applied to other disciplines such as physics and engineering(*applied mathematics*).
- So, 'Mathematics' is the correctly spelt word.

# र्म<u>ि</u> Hint

- Use the<u>elimination method</u> and try to eliminate the options.
- For elimination, search for the easiest word which is known to you and eliminate the wrong options with the help of that word.

\_\_\_\_\_

# **Question 52**

# Select the most appropriate synonym of the given word.

# AGONY

### **Options:**

A. Pain

B. Help

C. Risk

### D. Blame

### Answer: A

# Solution:

The correct answer is 'pain'

# 🔗 <u>Key Points</u>

Let's look at the given words and their meaning.

- Pain: A state of suffering of the body or mind.
- Help: making it easier for someone to do something by offering one's services or resources
- **Risk**: exposure to danger, harm, or loss
- Blame: responsibility for a fault or wrong

Hence, the correct synonym of **agony** is **pain** 

• **Example**: *The war veteran after getting injured on the battlefield exclaimed "Every moment I breathe is an <u>agony</u>"* 



• The synonyms of agony are: anguish, misery, torture, woe, and distress.

\_\_\_\_\_

# **Question 53**

## Select the most appropriate ANTONYM of the given word.

### LENIENT

### **Options:**

A. Generous

B. Helpful

C. Strict

D. Defensive

Answer: C

# Solution:

The correct answer isoption 3 i.e.Strict.

## 🔗 <u>Key Points</u>

- Let's look at the following points-
- Lenient-means(of punishment or person in authority) more merciful or tolerant than expected. ((दंड या अधिकार में व्यक्ति) अपेक्षा से अधिक दयालु या सहनशील)
- Strict-(of a rule or discipline) demanding total obedience or observance; rigidly enforced. (एक नियम या अनुशासन का) पूर्ण आज्ञाकारिता या पालन की मांग करना; सख्ती से लागू किया गया)
- Hence, both options i.e. Lenient and Strict express opposite meanings.

## 誟 Additional Information

Now, let's look at the following points-

- Generous-showing a readiness to give more of something, especially money, than is strictly necessary or expected. (कड़ाई से आवश्यक या अपेक्षा से अधिक, विशेष रूप से धन देने के लिए तत्परता दिखाना)
- Helpful-giving or ready to give help. (मदददेने के लिए तैयार)
- Defensive-used or intended to defend or protect. (बचाव या रक्षा के लिए इस्तेमाल या इरादा)

Thus, the correct option is **Strict** and therefore the answer.

-----

# **Question 54**

### Complete the following sentence by choosing the correct option:

No sooner did we go out on the road \_\_\_\_\_\_ it began to rain heavily.

**Options:** 

A. when

B. than

C. then

D. but

Answer: B

## Solution:

The correct answer is 'than'.

# 🔗 <u>Key Points</u>

- <u>No sooner</u> is used to show that <u>one thing happens immediately after another thing</u>. It is often used with the past perfect (also with past indefinite), and usually **followed** by <u>than</u>.
  - <u>Structure</u>: No sooner + did + sub + V1 + extra info+ than + sub + V2 + extra info.
  - *Ex:* No sooner did they start their walk <u>than</u> it started to rain.
- It's clear that in the blank given in the sentence, '<u>than</u>' should be filled.

The complete sentence is: No sooner did we go out on the road than it began to rain heavily.

Therefore, the correct answer is option 2).

\_\_\_\_\_

# **Question 55**

### Select the most appropriate option to complete the sentence.

He shouted	the top of his voice, but nobody heard him.
Options:	
A. on	
B. upon	
C. with	
D. at	
Answer: D	
Solution:	

The correct answer is option 4, i.e., at.

- The sentence uses the blank after the verb and before the noun, which means that it must contain a preposition.
- Given the context, the blank should contain a preposition that means 'to' or 'at' the top of his voice, or the highest of his voice.
- The preposition 'at' meansdenoting a particular point or level on a scale. viz, here, the top of his voice.
- None of the other prepositions can make the sentence meaningful.

Thus, the complete sentence is: *He shouted*<u>at</u>the top of his voice, but nobody heard him.

# **Question 56**

Direction:Select a word or phrase from the given list to complete the sentence:

They needn't worry, \_\_\_\_?

### **Options:**

- A. isn't it
- B. doesn't it
- C. don't it
- D. need they

Answer: D

## Solution:

The correct answer is'need they.'

# 🔗 <u>Key Points</u>

- We need to identify the correct question tag.
- The given interrogative sentence consists of two parts.
- The first part is the statement"They needn't worry".
- The second part is the question tag.
- In such conditions, we need to use acomma (,)to separate the statement part from the question part.
- Rules for question tag:
  - The sentence and the question tag must be in the same tense.
  - If the sentence is positive, the question tag must be negative, and vice-versa.
  - Always use pronouns in the question tag.
  - The first part of the given sentence is a negative sentence.
    - Thus, a positive question tagshould be used.
  - The helping verb in the given sentence is "need."
  - So, we have to use the positive question tag "need they?" for the given sentence.
- Therefore, the correct answer is **Option 4**.

Correct sentence: They needn't worry, need they?

\_\_\_\_\_

# **Question 57**

A sentence has beengiven with a blank to be filled with an appropriate word. Choose thecorrect alternative.

More than a decade has passed since this house was \_\_\_\_\_

### **Options:**

A. build

B. built

C. is build

D. building

Answer: B

### Solution:

**Verb:** Verbs are used to indicate the actions, processes, conditions, or states of beings of people or things. They play an integral role in the structure of a sentence. They constitute the root of the predicate, which, along with the subject (the "doer" of the verb's action), forms a full clause or sentence— we cannot have a sentence without a verb. It has three forms:.

#### For Example: Build (Base form) - Built (Simple Past) - Built (Past Participle)

**Passive:** A passiveverbhas a subject which is undergoing the action of the verb, rather than carrying it out, e.g.An applewas eaten. The opposite of active (He ate an apple). It should be noted that passive verbs are always in past participle form.

So, a suitable word is built.

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# **Question 58**

# **DIRECTIONS:** Fill in the blank with correct preposition

Distribute the sweets equally \_\_\_\_\_ four children.

**Options:** 

A. Between

B. In

C. Among

D. Through

Answer: C

# Solution:

The correct answer is "**among**"

# 🔗 <u>Key Points</u>

- The correct **preposition** to use in this sentence is "**among**".
- "Among" is used when referring to distribution or distribution of something among a group of people or things.
  - **Example**: The teacher distributed the candy **among** the students.
- In this sentence, the sweets are being distributed among four children, so the correct **preposition** is "**among**."

Thus, *option 3* is the correct answer.

**<u>Correct sentence</u>**: Distribute the sweets equally **among** four children.

# 誟 Additional Information

- "Between" is used when referring to a specific relationship or comparison between two things.
   Example: The book is between the two chairs.
- "In" is used when referring to a specific location or container.
  - **Example**: The book is **in** the bag.
- "Through" is used when referring to movement or an action done in a specific direction.
  - **Example**: We walked **through** the park.

# A Hinglish

- "among" का अर्थ है किसी समूह के बीच या किसी समूह के बीच कुछ करने का है।
- "between" का अर्थ है किसी विशिष्ट संबंध या तुलना के बीच किसी दो चीजों के बीच का है।
- "in" का अर्थ है किसी विशिष्ट स्थान या कंटेनर के अंदर का है।
- "through" का अर्थ है किसी दिशा या किसी काम को करने के दौरान का है।

\_\_\_\_\_

# **Question 59**

# In the following question, out of the four alternatives, select the alternative which is the best substitute of the phrase.

# That which cannot be believed

**Options:** 

A. Awesome

B. Incredible

C. Credible

D. Ineffective

Answer: B

# Solution:

Incredible =>that which cannot be believed Awesome=>amazing, stunning Credible =>acceptable, trustworthy Ineffective=>something that is unsuccessful, useless.

So option 2 is the correct answer.

-----

# **Question 60**

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

Australia is one of the most prepossessing country in the Southern Hemisphere.

**Options:** 

A. Australia is one

- B. of the most prepossessing
- C. country in

D. the Southern Hemisphere.

### Answer: C

## Solution:

The erroneous part is"country in"

# 🔗 <u>Key Points</u>

- "countries" will replace "country"
- Whenever any noun comes after the phrase "one of the" it must be plural.
- Look at the following examples:
  - Porsche is one my favourite cars.
  - Porsche is one my favourite car.
  - She is one of the best **girls** in the town
  - She is one of the best girl in the town.

Hence, the correct sentence is: Australia is one of the most prepossessing countries in the Southern Hemisphere.

# 🚰 <u>Hinglish</u>

- जब भी किस सेंटेंस मेंone of the, most of theका उपयोग होता है तो उसके बाद आने वाला नाउन हमेशा प्लूरल होता है
- examples:
  - Tokyo is one of the large**cities**in Japan.
  - Most of the**students**do not follow the rules.
  - I am one of the most exquisite **boys**in my school
  - Most of the**girls**are ugly on the inside.

\_\_\_\_\_

# **Question 61**

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

Neither Elena nor they is going to win the lucrative basketball tournament.

### **Options:**

A. Neither Elena

B. nor they

C. is going to win

D. the lucrative basketball tournament

### Answer: C

# Solution:

The erroneous part is"is going to win"

# 🔗 <u>Key Points</u>

- "are" will replace "is"
- If two subjects are joined by –Not only.....but also Neither.....nor Either.....or then, the verb always follows its nearest subject.
- Look at the following Examples:
  - Neither you nor **I am going** to see him.
  - Neither you nor she is listening to music.
  - Either Nicole or they **are performing** tonight.
  - Either Goretzka or Gnabry is playing today

Hence, the correct sentence is: Neither Elena nor they are going to win the lucrative basketball tournament.

# A Hinglish

- जब कभी भी दो expression, Not only.....but also Neither.....nor Either.....or से जोड़े जाते हैं तो verb हमेशा पास वाले noune के हिसाब से लगता है
- जैसे इस सेंटेंस में they के हिसाब से लगा है:
  - Either Nicole or they are performing tonight.
- Examples:
  - Neither you nor **Iam going** to see him.
  - Neither you nor she**is listening**to music.

\_\_\_\_\_

# **Question 62**

Select the correct passive form of the given sentence.

He wrote a letter in verse form to his friend.

### **Options:**

A. A verse in letter form had been written by him to his friend.

- B. A letter in verse form was being written by him to his friend.
- C. A letter in verse form was written by him to his friend.
- D. A letter in verse form has been written by him to his friend.

### Answer: C

## Solution:

The passive voice of the given sentence is <u>A letter in verse form was written by him to his friend.</u>



#### <u>Simple Past Tense</u>

• Thesimple past is a verb tense that is used to talk about things that happened or existed before now.

Active	Passive
Subject + V2+ object	Object+ was//were+V <sub>3</sub> + by+ subject?

- The instructions given below should be followed while changing a simple past sentence to a passive voice.
  - Find**the subject and object** of the sentence and**exchange their places**; make changes in their**cases** as well if subject and object are**pronouns**.
  - Use the preposition 'by' before the agent.
  - Use an appropriatehelping verb(was) in the passive form at the start of the sentenceaccording to the tense of the active form. (Simple past- was//were +v3)
  - Always use the third form of the main verb(written) in passive form.
  - At last line up the remaining part.

So, the final sentence is-A letter in verse form was written by him to his friend.

\_\_\_\_\_

# **Question 63**

# Select the most appropriate indirect form of the given sentence.

He said, "Hurray! I have won the match."

**Options:** 

- A. He exclaimed with great sorrow that he had won the match.
- B. He exclaimed with great joy that he had won the match.
- C. He exclaimed with great joy that he would won the match.
- D. He exclaimed with great joy that he have won the match.

### Answer: B

## Solution:

# The correct answer is 'He exclaimed with great joy that he had won the match'.

# 🔗 <u>Key Points</u>

- The given sentence is an example of an**exclamatory sentence**.
- The given sentence is in the form of **direct speech**. As per the question we have to change it into indirect speech.
- Basic rules for changing or converting**direct speech into indirect speech**:
  - **'Comma'** and **'inverted comma'** are omitted in indirect speech and are often replaced by **'that'** clauses to form 'that clauses'.
  - According to the reporting verb, changes are made in the direct sentence or the sentence in inverted commas.
  - The interjectional words or phrases are omitted, and the emotion is expressed through other words (exclaim, cry out, pray, wish,).
  - 'Said' will be changed into 'exclaimed with great joy' in the indirect speech.
  - 'that' conjunction will be added to account for the comma and double-inverted commas (starting a direct speech)
  - In an indirect sentence, the exclamatory sentence becomes an assertive sentence because exclamation (!) is replaced by a Full Stop (.) in indirect speech.
- This is the direct and indirect speech rule for the exclamatory sentence.
- Example:
  - *He said*, *"Hurrah! My friend has come".(direct speech)*
  - *He exclaimed joyfully that his friend had come.(indirect speech)*
- Therefore, as per the points mentioned above, we find that "He exclaimed with great joy that he had won the match." is the correct indirect form of the given sentence.

\_\_\_\_\_

# **Question 64**

# Given here are four jumbled sentences. Pick the option that gives the correct order.

A. So I had to try this place out.

B. serves up the best Dutch apple pie in all of Utrecht.

C. This is a magnificent restaurant right here which

**D.** And I love Dutch apple pie.

**Options:** 

A. ABDC

B. CBDA

C. ABCD

D. DCBA

Answer: B

### Solution:

The correct answer is "CBDA"



- The first sentence will be C because it introduces a restaurant
  - This is a magnificent restaurant right here which
- The second sentence will be B because it states the restaurant serves apple pie.
   serves up the best Dutch apple pie in all of Utrecht.
- The third sentence will be D because it states that the doer loves apple pie.
  And I love Dutch apple pie.
- The last sentence will be A because it states he wants to try out the restaurant
  - So I had to try this place out.

Hence, the correct passage is: *This is a magnificent restaurant right here whichserves up the best Dutch apple pie in all of Utrecht.And I love Dutch apple pie. So I had to try this place out.* 

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# **Question 65**

Given here are four sentences. The first sentence is in the correct order, while the rest of the sentences are jumbled. Pick the option that gives the correct order.

A.This is the Residenz and actually, I have just learned B.which is very impressive given the fact the first structure

# C.was built in 1395 and it continued being bigger and bigger and bigger.

D.that this is the largest city palace in all of Germany.

**Options:** 

- A. ABCD
- B. ADBC
- C. ACDB
- D. ADCB

Answer: B

## Solution:

The correct answer is "ADBC"

# 🔗 <u>Key Points</u>

- It is given in the question that the first sentence is in the correct order:
  This is the Residenz and actually, I have just learned
- The next sentence will be Dbecause it describes that the place is the largest palace in Germany
  that this is the largest city palace in all of Germany.
- The next sentence will be B because it describes the impressiveness of the place
  - which is very impressive given the fact the first structure
- The last sentence will be Cbecause it completes the previous sentence
  - was built in 1395 and it continued being bigger and bigger and bigger.

**Hence, the correct passage:** *A. This is the Residenz and actually, I have just learned* **D.** *that this is the largest city palace in all of Germany.* **B.** *which is very impressive given the fact the first structure* **C.** *was built in 1395 and it continued being bigger and bigger and bigger.* 

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# **Question 66**

#### Directions: Read the following passage and answer the given questions:

Women's empowerment refers to the ability of women to have control over their own lives and make their own choices. This includes having equal access to education, employment opportunities, and the ability to participate in political and economic decision-making. To truly empower women, we must work to eliminate these attitudes and break down the systemic barriers that hold women back. This requires a multifaceted approach, including policies and programmes that promote gender equality and education and awareness campaigns that challenge stereotypes and biases. However, despite the progress that has been made in recent years, there remain indifferent attitudes towards women's empowerment. These individuals may not actively work to hold women

back, but they also do not actively work to promote equality and empowerment. It is important to actively work to change these attitudes and promote a culture of equality and empowerment for all women.

### What does "women's empowerment" refer to?

### **Options:**

- A. Women's rights are not treated with the same respect and importance as men's rights.
- B. Women are denied basic rights, such as access to education.
- C. The ability of women to have control over their own lives.
- D. Many women are vulnerable to exploitation and abuse.

### Answer: C

## Solution:

The correct answer is "The ability of women to have control over their own lives."

# 🔗 <u>Key Points</u>

- Option '3' is correct.
  - From the passage: '....Women's empowerment refers to the ability of women to have control over their own lives and make their own choices. <u>This includes having equal access to education</u>, <u>employment opportunities</u>, and the ability to participate in political and economic decision-<u>making</u>......'
  - This indicates that women's empowerment refers to **the ability of women to have control over their own lives and make decisions that affect them**. <u>It involves giving women equal</u> <u>opportunities and rights, and removing any barriers that prevent them from reaching their full</u> <u>potential</u>.
  - Thus, in this context, we can say that the correct answer is option "3".
- Options 1, 2, and 4 are incorrect because there isn't sufficient supportive information in the passage to consider them to be the right answers.

Hence, the correct answer is "The ability of women to have control over their own lives."

\_\_\_\_\_

# **Question 67**

#### Directions: Read the following passage and answer the given questions:

Women's empowerment refers to the ability of women to have control over their own lives and make their own choices. This includes having equal access to education, employment opportunities, and the ability to participate in political and economic decision-making. To truly empower women, we must work to eliminate these attitudes and break down the systemic barriers that hold women back. This requires a multifaceted approach, including policies and programmes that promote gender equality and education and awareness campaigns that challenge

stereotypes and biases. However, despite the progress that has been made in recent years, there remain <u>indifferent</u> attitudes towards women's empowerment. These individuals may not actively work to hold women back, but they also do not actively work to promote equality and empowerment. It is important to actively work to change these attitudes and promote a culture of equality and empowerment for all women.

### Select the most appropriate ANTONYM of the given word. "Indifferent"

### **Options:**

- A. Apathetic
- B. Attentive
- C. Insensible
- D. Incurious

### Answer: B

## Solution:

The correct answer is "Attentive."

# 🔗 <u>Key Points</u>

Indifferent means showing or feeling no interest or concern in something. It suggests a lack of engagement or investment in a particular situation or thing. (उदासीन का अर्थ है किसी चीज में कोई दिलचस्पी या चिंता न दिखाना या महसूस करना। यह किसी विशेष स्थिति या चीज़ में जुड़ाव या निवेश की कमी का दर्शाताहै।)
 For example, "He was indifferent to her proposal and didn't seem to care either way."

#### Let's see the meanings of the given words

- Apathetic: This means showing or feeling no interest or concern in something. (इसका अर्थ है किसी चीज़ में कोई दिलचस्पी या चिंता न दिखाना या महसूस करना।)
  - Example: The crowd was apathetic towards the speeches given by the candidates.
- Attentive: This means paying close attention to something or someone. (इसका अर्थ है किसी चीज या किसी पर पूरा ध्यान देना।)
  - **Example**: *The teacher was attentive to the needs of each student.*
- Insensible: This means lacking feeling, emotion, or sensitivity. (भावना, संवेदनशीलता की कमी।)
  - Example: The soldier was insensible to the horrors of war.
- Incurious: This means showing a lack of interest or desire to know or learn more about something. (इसका अर्थ है किसी चीज़ के बारे में अधिक जानने या सीखने में रुचि या इच्छा की कमी।)
  - **Example**: The child was incurious about the strange new toy.

According to the meanings of the given words, the correct answer is Option 2, i.e., Attentive.

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# **Question 68**

#### Directions: Read the following passage and answer the given questions:

Women's empowerment refers to the ability of women to have control over their own lives and make their own choices. This includes having equal access to education, employment opportunities, and the ability to participate in political and economic decision-making. To truly empower women, we must work to eliminate these attitudes and break down the systemic barriers that hold women back. This requires a multifaceted approach, including policies and programmes that promote gender equality and education and awareness campaigns that challenge stereotypes and biases. However, despite the progress that has been made in recent years, there remain <u>indifferent</u> attitudes towards women's empowerment. These individuals may not actively work to hold women back, but they also do not actively work to promote equality and empowerment. It is important to actively work to change these attitudes and promote a culture of equality and empowerment for all women.

# What is the importance of changing indifferent attitudes toward women's empowerment?

#### **Options:**

A. Women are not valuable members of society and are not worthy of the same rights and opportunities as men.

B. A culture of discrimination, where women are treated as second-class citizens.

C. Women are subject to physical, sexual, and emotional abuse.

D. It promotes a culture of equality and empowerment for all women.

### Answer: D

### Solution:

The correct answer is "It promotes a culture of equality and empowerment for all women."

## 🔗 <u>Key Points</u>

- Option '4' is correct.
- From the passage'.... However, despite the progress that has been made in recent years, there still remains an indifferent attitude towards women's empowerment. These individuals may not actively work to hold women back, but they also do not actively work to promote equality and empowerment. It is important to actively work to change these attitudes and promote a culture of equality and empowerment for all women.......'
- It helps to <u>break down societal barriers and stereotypes that limit women's potential. When women are empowered, they are able to participate fully in society, contribute to the economy, and make decisions that affect their own lives and the lives of those around them. Thus, in this context, we can say that the correct answer is option "4".</u>
- Options 1, 2, and 3 are incorrect because there isn't sufficient supportive information in the passage to consider them to be the right answers.
Hence, the correct answer is "It promotes a culture of equality and empowerment for all women."

\_\_\_\_\_

# **Question 69**

#### Directions: Read the following passage and answer the given questions:

Women's empowerment refers to the ability of women to have control over their own lives and make their own choices. This includes having equal access to education, employment opportunities, and the ability to participate in political and economic decision-making. To truly empower women, we must work to eliminate these attitudes and break down the systemic barriers that hold women back. This requires a multifaceted approach, including policies and programmes that promote gender equality and education and awareness campaigns that challenge stereotypes and biases. However, despite the progress that has been made in recent years, there remain <u>indifferent</u> attitudes towards women's empowerment. These individuals may not actively work to hold women back, but they also do not actively work to promote equality and empowerment. It is important to actively work to change these attitudes and promote a culture of equality and empowerment for all women.

## What is required to truly empower women?

#### **Options:**

A. An attitude shift and a shift in mindset towards gender equality.

B. To eliminate typical attitudes and break down the systemic barriers that hold women back.

C. Women have the same rights, abilities, and opportunities as men.

D. Tackling the underlying causes of gender inequality in our societies.

#### Answer: B

### Solution:

The correct answer is "To eliminate typical attitudes and break down the systemic barriers that hold women back."

## 🔗 <u>Key Points</u>

- Option '2' is correct.
  - From the passage'.... However, despite the progress that has been made in recent years, there still remains an indifferent attitude towards women's empowerment. These individuals may not actively work to hold women back, but they also do not actively work to promote equality and empowerment.......'
  - This indicates that <u>women's empowerment is about breaking down societal and cultural barriers that</u> <u>prevent women from achieving equality and achieving their full potential. It involves creating a</u> <u>level playing field for women, so they have the same opportunities and rights as men.</u> This can be

achieved through various means, such as education, policies, and programs that promote gender equality and women's rights.

- Thus, in this context, we can say that the correct answer is option "2".
- Options 1, 3, and 4 are incorrect because there isn't sufficient supportive information in the passage to consider them to be the right answers.

**Hence, the correct answer is** *"To eliminate typical attitudes and break down the systemic barriers that hold women back."* 

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## **Question 70**

## Select the verb form of theadjective.

## Pacific

#### **Options:**

A. pacify

- B. pacifying
- C. pacified

D. pacification

#### Answer: A

### Solution:

The correct answer is "pacify"

## 🔗 <u>Key Points</u>

- The correct verb form of the given word is "pacify".
- The adjective "pacific" means "peaceful in character or intent." it is also act as a noun.
- The verb form of this is "pacify" which means "quell the anger, agitation, or excitement of."
- "pacified" is a past participle and "pacifying" is a present participle.
- "pacification" is a noun that means "the action of bringing peace to a place or ending war in a place, often using military force"

#### 誟 Additional Information

Let's discuss the other options.

• Verb: It's an action word; it describes an action that someone does.

- Adverb: it modifies a verb, adjective, or another adverb and typically describes how, when, where, or to what extent something happens.
- Interjection: it's a word or phrase that expresses a strong feeling and is used to interrupt normal syntactical structure.

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