Physical world and Measurements

Question1

Identify the physical quantity that cannot be measured using spherometer :

[27-Jan-2024 Shift 1]

Options:

A.

Radius of curvature of concave surface

B.

Specific rotation of liquids

C.

Thickness of thin plates

D.

Radius of curvature of convex surface

Answer: B

Solution:

Spherometer can be used to measure curvature of surface.

Question2

Given below are two statements: one is labelled as Assertion(A) and the other is labelled as Reason (R).

Assertion (A) : In Vernier calliper if positive zero error exists, then while taking measurements, the reading taken will be more than the actual reading.
Reason (R) : The zero error in Vernier Calliper might have happened due to manufacturing defect or due to rough handling.

In the light of the above statements, choose the correct answer from the options given below :

[27-Jan-2024 Shift 2]

Options:

A.

Both (A) and (R) are correct and (R) is the correct explanation of (A)

B.

Both (A) and (R) are correct but (R) is not the correct explanation of (A)

C.

(A) is true but (R) is false

D.

(A) is false but (R) is true

Answer: B

Solution:

Assertion & Reason both are correct Theory

Question3

If 50 Vernier divisions are equal to 49 main scale divisions of a travelling microscope and one smallest reading of main scale is 0.5 mm, the Vernier constant of travelling microscope is:

[30-Jan-2024 Shift 2]

Options:

A.

0.1 mm

B.

0.1 cm

C.

0.01 cm

D.

0.01 mm

Answer: D

Solution:

$50V + S = 49S + S$

$S = 50(S - V)$

$.5 = 50(S - V)$

$S - V = \frac{0.5}{50} = \frac{1}{100} = 0.01\ mm$

Question4

The measured value of the length of a simple pendulum is 20cm with 2mm accuracy. The time for 50 oscillations was measured to be 40 seconds with 1 second resolution. From these measurements, the accuracy in the measurement of acceleration due to gravity is N%. The value of N is:

[31-Jan-2024 Shift 2]

Options:

A.

4

B.

8

C.

6

D.

5

Answer: C

Solution:

$T = 2\pi \sqrt{\frac{\ell}{g}}$

$g = \frac{4\pi^2 \ell}{T^2}$

$\frac{\Delta g}{g} = \frac{\Delta \ell}{\ell} + \frac{2\Delta T}{T}$

$= \frac{0.2}{20} + 2\left(\frac{1}{40}\right)$

$= \frac{0.3}{20}$

Percentage change $= \frac{0.3}{20} \times 100 = 6\%$

Question5

The resistance R = V/1 where V = (200 ± 5)V and I = (20 ± 0.2)A, the percentage error in the measurement of R is :

[29-Jan-2024 Shift 1]

Options:

A.

3.5%

B.

7%

C.

3%

D.

5.5%

Answer: A

Solution:

$R = \frac{V}{1}$

According to error analysis

$\frac{dR}{R} = \frac{dV}{V} + \frac{dI}{I}$

$\frac{dR}{R} = \frac{5}{200} + \frac{0.2}{20}$

$\frac{dR}{R} = \frac{7}{200}$

% error $\frac{dR}{R} \times 100 = \frac{7}{200} \times 100 = 3.5\%$

Question6

A physical quantity Q is found to depend on quantities a, b, c by the relation $Q = a^4b^3/c^2$. The percentage error in a, b and c are 3%,4% and 5% respectively. Then, the percentage error in Q is :

[29-Jan-2024 Shift 2]

Options:

A.

66%

B.

43%

C.

34%

D.

14%

Answer: C

Solution:

Sol. $Q = \frac{a^4 b^3}{c^2}$

$$\frac{\Delta Q}{Q} = 4\frac{\Delta a}{a} + 3\frac{\Delta b}{b} + 2\frac{\Delta c}{c}$$

$$\frac{\Delta Q}{Q} \times 100 = 4\left(\frac{\Delta a}{a} \times 100\right) + 3\left(\frac{\Delta b}{b} \times 100\right) + 2\left(\frac{\Delta c}{c} \times 100\right)$$

$\%$ error in $Q = 4 \times 3\% + 3 \times 4\% + 2 \times 5\%$

$= 12\% + 12\% + 10\%$

$= 34\%$

Question7

A vector has magnitude same as that of $\vec{A} = 3\hat{j} + 4\hat{j}$ and is parallel to $\vec{B} = 4\hat{i} + 3\hat{j}$. The x and y components of this vector in first quadrant are x and 3 respectively where x =____

[30-Jan-2024 Shift 2]

Options:

Answer: 4

Solution:

$$\overline{N} = |\overline{A}|\hat{B} = \frac{5(4\hat{i} + 3\hat{j})}{5} = 4\hat{i} + 3\hat{j}$$

$\therefore x = 4$

Question8

If the percentage errors in measuring the length and the diameter of a wire are 0.1% each. The percentage error in measuring its resistance

will be:

[31-Jan-2024 Shift 1]

Options:

A.

0.2%

B.

0.3%

C.

0.1%

D.

0.144%

Answer: B

Solution:

$$R = \frac{\rho L}{\pi \frac{d^2}{4}}$$

$$\frac{\Delta R}{R} = \frac{\Delta L}{L} + \frac{2\,\Delta\,d}{d}$$

$$\frac{\Delta L}{L} = 0.1\% \text{ and } \frac{\Delta d}{d} = 0.1\%$$

$$\frac{\Delta R}{R} = 0.3\%$$

Question9

If two vectors $\vec{A}$ and $\vec{B}$ having equal magnitude R are inclined at an angle θ, then

[31-Jan-2024 Shift 2]

Options:

A.

$\left|\vec{A} - \vec{B}\right| = \sqrt{2} R sin\left(\frac{\theta}{2}\right)$

B.

$\left|\vec{A} + \vec{B}\right| = 2R sin\left(\frac{\theta}{2}\right)$

C.

$\left|\vec{A}+\vec{B}\right| = 2R\cos\left(\frac{\theta}{2}\right)$

D.

$\left|\vec{A}-\vec{B}\right| = 2R\cos\left(\frac{\theta}{2}\right)$

Answer: C

Solution:

The magnitude of resultant vector

$R' = \sqrt{a^2+b^2+2ab\cos\theta}$

Here $a=b=R$

Then $R' = \sqrt{R^2+R^2+2R^2\cos\theta}$

$= R\sqrt{2}\sqrt{1+\cos\theta}$

$= \sqrt{2}R\sqrt{2\cos^2\frac{\theta}{2}}$

$= 2R\cos\frac{\theta}{2}$

Question10

Given below are two statements :

Statement (I) : Planck's constant and angular momentum have same dimensions.
Statement (II) : Linear momentum and moment of force have same dimensions.

In the light of the above statements, choose the correct answer from the options given below :

[27-Jan-2024 Shift 1]

Options:

A.

Statement I is true but Statement II is false

B.

Both Statement I and Statement II are false

C.

Both Statement I and Statement II are true

D.

Statement I is false but Statement II is true

Answer: A

Solution:

$[h] = ML^2T^{-1}$

$[L] = ML^2T^{-1}$

$[P] = MLT^{-1}$

$[\tau] = ML^2T^{-2}$

(Here h is Planck's constant, L is angular momentum, P is linear momentum and τ is moment of force)

Question11

The equation of state of a real gas is given by $\left(P + \frac{a}{V^2}\right)$ (V − b) = RT, where P,V and T are pressure. volume and temperature respectively and R is the universal gas constant. The dimensions of a/b^2 is similar to that of :

[27-Jan-2024 Shift 2]

Options:

A.

PV

B.

P

C.

RT

D.

R

Answer: B

Solution:

$[P] = \left[\frac{a}{V^2}\right] \Rightarrow [a] = [PV^2]$

And $[V] = [b]$

$\frac{[a]}{[b^2]} = \frac{[PV^2]}{[V^2]} = [P]$

Question12

Match List-I with List-II.

	List-I		List-II
A.	Coefficient of viscosity	I.	$\{[ML^2T^{-2}]\}$
B.	Surface Tension	II.	$\{[ML^2T^{-1}]\}$
C.	Angular momentum	III.	$\{[ML^{-1}T^{-1}]\}$
D.	Rotational kinetic energy	IV.	$\{[ML^0T^{-2}]\}$

[30-Jan-2024 Shift 1]

Options:

A.

A-II, B-I, C-IV, D-III

B.

A-I, B-II, C-III, D-IV

C.

A-III, B-IV, C-II, D-I

D.

A-IV B-III C-II. D-I

Answer: C

Solution:

$$F = \eta A \frac{dv}{dy}$$

$$[MLT^{-2}] = \eta[L^2][T^{-1}]$$

$$\eta = [ML^{-1}T^{-1}]$$

$$S.T = \frac{F}{\ell} = \frac{[MLT^{-2}]}{[L]} = [ML^0T^{-2}]$$

$$L = mvr = [ML^2T^{-1}]$$

$$K.E = \frac{1}{2}I\omega^2 = [ML^2T^{-2}]$$

Question13

If mass is written as $m = kc^P G^{-1/2} h^{1/2}$ then the value of P will be : (Constants have their usual meaning with k a dimensionless constant)

[30-Jan-2024 Shift 2]

Options:

A.

1/2

B.

1/3

C.

2

D.

1/4

Answer: A

Solution:

$m = kc^{P}G^{-1/2}h^{1/2}$

$M^{1}L^{0}T^{0} = [LT^{-1}]^{P}[M^{-1}L^{3}T^{-2}]^{-1/2}[ML^{2}T^{-1}]^{1/2}$

By comparing $P = 1/2$

Question14

A force is represented by $F = ax^2 + bt^{1/2}$

Where x = distance and t = time. The dimensions of b^2/a are :

[31-Jan-2024 Shift 1]

Options:

A.

$[ML^{3}T^{-3}]$

B.

$[MLT^{-2}]$

C.

$[ML^{-1}T^{-1}]$

D.

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

Answer: A

Solution:

$F = ax^2 + bt^{1/2}$

$[a] = \frac{[F]}{[x^2]} = [M^1L^{-1}T^{-2}]$

$[b] = \frac{[F]}{[t^{1/2}]} = [M^1L^1T^{-5/2}]$

$\left[\frac{b^2}{a}\right] = \frac{[M^2L^2T^{-5}]}{[M^1L^{-1}T^{-2}]} = [M^1L^3T^{-3}]$

Question15

Consider two physical quantities A and B related to each other as E = $\frac{B - x^2}{At}$ where E, x and t have dimensions of energy,

[31-Jan-2024 Shift 2]

Options:

A.

$L^{-2}M^1T^0$

B.

$L^2M^{-1}T^1$

C.

$L^{-2}M^{-1}T^1$

D.

$L^0M^{-1}T^1$

Answer: B

Solution:

$[B] = L^2$

$A = \frac{x^2}{tE} = \frac{L^2}{TML^2T^{-2}} = \frac{1}{MT^{-1}}$

$[A] = M^{-1}T$

$[AB] = [L^2M^{-1}T^1]$

Question16

The dimensional formula of angular impulse is :

[1-Feb-2024 Shift 1]

Options:

A.

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

B.

$[ML^{2}T^{-2}]$

C.

$[MLT^{-1}]$

D.

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

Answer: D

Solution:

Angular impulse = change in angular momentum.

[Angular impulse] = [Angular momentum] = $[mvr]$

$= [ML^{2}T^{-1}]$

Question17

10 divisions on the main scale of a Vernier calliper coincide with 11 divisions on the Vernier scale. If each division on the main scale is of 5 units, the least count of the instrument is :

[1-Feb-2024 Shift 1]

Options:

A.

1/2

B.

10/11

C.

50/11

D.

5/11

Answer: D

Solution:

$10\,MSD = 11\,VSD$

$1\,VSD = \frac{10}{11}MSD$

$LC = 1\,MSD - 1\,VSD$

$= 1\,MSD - \frac{10}{11}MSD$

$= \frac{1\,MSD}{11}$

$= \frac{5}{11}$ units

Question18

The radius (r), length (l) and resistance (R) of a metal wire was measured in the laboratory as

$r = (0.35 \pm 0.05)\,cm$

$R = (100 \pm 10)\,ohm$

$l = (15 \pm 0.2)\,cm$

The percentage error in resistivity of the material of the wire is :

[1-Feb-2024 Shift 1]

Options:

A.

25.6%

B.

39.9%

C.

37.3%

D.

35.6%

Answer: B

Solution:

$$\rho = R\frac{\rho}{\ell}$$

$$\frac{\Delta\rho}{\rho} = \frac{\Delta R}{R} + 2\frac{\Delta r}{r} + \frac{\Delta\ell}{\ell}$$

$$= \frac{10}{100} + 2\times\frac{0.05}{0.35} + \frac{0.2}{15}$$

$$= \frac{1}{10} + \frac{2}{7} + \frac{1}{75}$$

$$\frac{\Delta\rho}{\rho} = 39.9\%$$

Question19

Choose the correct answer from the options given below :

Match List - I with List - II.

List - I (Number)	**List - II (Significant figure)**
(A) 1001	(I) 3
(B) 010.1	(II) 4
(C) 100.100	(III) 5
(D) 0.0010010	(IV) 6

[1-Feb-2024 Shift 2]

Options:

A.

(A)-(III), (B)-(IV), (C)-(II), (D)-(I)

B.

(A)-(IV), (B)-(III), (C)-(I), (D)-(II)

C.

(A)-(II), (B)-(I), (C)-(IV), (D)-(III)

D.

(A)-(I), (B)-(II), (C)-(III), (D)-(IV)

Answer: C

Solution:

Theoretical

Question20

Match List I with List II

	LIST I		LIST II
A.	Planck's constant (h)	I.	$[M^1L^2T^{-2}]$
B.	Stopping potential (Vs)	II.	$[M^1L^1T^{-1}]$
C.	Work function (Ø)	III.	$[M^1L^2T^{-1}]$
D.	Momentum (p)	IV.	$[M^1L^2T^{-3}A^{-1}]$

[24-Jan-2023 Shift 1]

Options:

A. A-III, B-I, C-II, D-IV

B. A-III, B-IV, C-I, D-II

C. A-II, B-IV, C-III, D-I

D. A-I, B-III, C-IV, D-II

Answer: B

Solution:

(A) Planck's constant

$h\nu = E$

$h = \frac{E}{\nu} = \frac{M^1L^2T^{-2}}{T^{-1}} = M^1L^2T^{-1}$

(B) $E = qV$

$V = \frac{E}{q} = \frac{M^1L^2T^{-2}}{A^1T^1} = M^1L^2T^{-3}A^{-1}$ (I V)

(C) φ(work function) = energy

$= M^1L^2T^{-2}$

(D) Momentum (p) = F.t

$= M^1L^1T^{-2}T^1$

$= M^1L^1T^{-1}$

Question21

The frequency (v) of an oscillating liquid drop may depend upon radius (r) of the drop, density (ρ) of liquid and the surface tension (s) of the liquid as : $v = r^a\rho^b s^c$. The values of a, b and c respectively are [24-Jan-2023 Shift 2]

Options:

A. $\left(-\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}\right)$

B. $\left(\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}\right)$

C. $\left(\frac{3}{2}, \frac{1}{2}, -\frac{1}{2}\right)$

D. $\left(-\frac{3}{2}, \frac{1}{2}, \frac{1}{2}\right)$

Answer: A

Solution:

Solution:

$[T^{-1}] = [L^1]^a[M^1L^{-3}]^b\left[\frac{MLT^{-2}}{L}\right]^c$

$\Rightarrow T^{-1} = M^{b+c} \cdot L^{a-3b} \cdot T^{-2c}$

$c = \frac{1}{2}, b = -\frac{1}{2}, \quad a - 3b = 0$

$a + \frac{3}{2} = 0 \Rightarrow a = -\frac{3}{2}$

Question22

Match List I with List II

List - I	List - II
A. Surface tension	I. $Kg\,m^{-1}\ s^{-1}$
B. Pressure	II. $Kg\,ms^{-1}$
C. Viscosity	III. $Kg\,m^{-1}\ s^{-2}$
D. Impulse	IV. $Kg\ s^{-2}$

Choose the correct answer from the options given below : [25-Jan-2023 Shift 1]

Options:

A. A-IV, B-III, C- II, D- I

B. A-IV, B-III, C-I, D-II

C. A-III, B-IV, C-I, D-II

D. A-II, B-I, C-III, D-IV

Answer: B

Solution:

(A) Surface Tension $= \frac{F}{\ell} = \frac{MLT^{-2}}{L} = ML^{-1}T^{-2}$

$= Kgs^{-2}$(IV)

(B) Pressure $= \frac{F}{A} = \frac{MLT^{-2}}{L^2}$

$= kg\,m^{-1}\ s^{-2}$ (III)

(C) Viscosity $= = \frac{F}{A\left(\frac{dV}{dz}\right)} = \frac{MLT^{-2}}{L^2\left(\frac{LT^{-1}}{L}\right)}$

$= ML^{-1}T^{-1} = kg\,m^{-1}\ s^{-1}$(I)

(D) Impulse $= \int Fdt = MLT^{-2} \times T$

$= MLT^{-1} = Kgms^{-1}$ (II)

So A-(IV), B-(III), C-(I), D- (II)

Question23

Match List I with List II

List	List II
A. Young's Modulus (Y)	I. $[ML^{-1}T^{-1}]$
B. Co-efficient of Viscosity (η)	II. $[ML^{2}T^{-1}]$
C. Planck's Constant (h)	III. $[ML^{-1}T^{-2}]$
D. Work Function (φ)	IV. $[ML^{2}T^{-2}]$

Choose the correct answer from the options given below: [25-Jan-2023 Shift 2]

Options:

A. A-II, B-III, C-IV, D-I

B. A-III, B-I, C-II, D-IV

C. A-I, B-III, C-IV, D-II

D. A-I, B-II, C-III, D-IV

Answer: B

Solution:

Solution:

$Y = \frac{\text{Stress}}{\text{Strain}} = \frac{F/A}{\Delta\ell/\ell} = \frac{[MLT^{-2}]}{[L^2]} = [ML^{-1}T^{-2}]$

$F = 6\pi\eta rv \Rightarrow \eta = \frac{F}{6\pi rv}$

$[\eta] = \frac{[MLT^{-2}]}{[L][LT^{-1}]} = [ML^{-1}T^{-1}]$

$E = hv \Rightarrow h = \frac{E}{v} = \frac{[ML^2T^{-2}]}{[T^{-1}]} = [ML^2T^{-1}]$

Work function has same dimension as that of energy, so $[\varphi] = [ML^2T^{-2}]$

Question24

Match List I with List II :

List-I (PhysicalQuantity)	List-II (Dimensional Formula)
A Pressure gradient	I $[M^0L^2T^{-2}]$
B Energy density	II $[M^1L^{-1}T^{-2}]$
C Electric Field	III $[M^1L^{-2}T^{-2}]$
D Latent heat	IV $[M^1L^1T^{-3}A^{-1}]$

Choose the correct answer from the options given below:
[29-Jan-2023 Shift 1]

Options:

A. A-III, B-II, C-I, D-IV

B. A-II, B-III, C-IV, D-I

C. A-III, B-II, C-IV, D-I

D. A-II, B-III, C-I, D-IV

Answer: C

Solution:

Solution:

Pressure gradient $= \frac{dp}{dx} = \frac{[ML^{-1}T^{-2}]}{[L]}$
$= [M^1L^{-2}T^{-2}]$

Energy density $= \frac{\text{energy}}{\text{volume}} = \frac{[ML^2T^{-2}]}{[L^3]}$
$= [M^1L^{-1}T^{-2}]$

Electric field $= \frac{\text{Force}}{\text{charg e}} = \frac{[MLT^{-2}]}{[A \cdot T]}$
$= [M^1L^1T^{-3}A^{-1}]$

Latent heat $= \frac{\text{heat}}{\text{mass}} = \frac{[ML^2T^{-2}]}{[M]}$
$= [M^0L^2T^{-2}]$

Question25

The equation of a circle is given by $x^2 + y^2 = a^2$, where a is the radius. If the equation is modified to change the origin other than (0, 0), then find out the correct dimensions of A and B in a new equation:
$(x - At)^2 + \left(y - \frac{t}{B}\right)^2 = a^2$.

The dimensions of t is given as $[T^{-1}]$.
[29-Jan-2023 Shift 2]

Options:

A. $A = [L^{-1}T]$, $B = [LT^{-1}]$

B. $A = (LT]$, $B = [L^{-1}T^{-1}]$

C. $A = [L^{-1}T^{-1}]$, $B = [LT^{-1}]$

D. $A = [L^{-1}T^{-1}]$, $B = [LT]$

Answer: B

Solution:

Solution:

$(x - At)^2 + \left(y - \frac{t}{B}\right)^2 = a^2$

$[At] = A \times \frac{1}{T} = L$

$\therefore\ [A] = T^1L^1$

$\frac{t}{B}$ is in meters

$\therefore\ \frac{1}{T[B]} = L$

$\therefore\ [B] = T^{-1}L^{-1}$

$\therefore$ Correct Ans. (2)

Question26

Electric field in a certain region is given by $\vec{E} = \left(\frac{A}{x^2}\hat{i} + \frac{B}{y^3}\hat{j}\right)$. The SI unit of A and B are :
[30-Jan-2023 Shift 1]

Options:

A. Nm^3C^{-1}; Nm^2C^{-1}

B. Nm^2C^{-1}; Nm^3C^{-1}

C. Nm^3C; Nm^2C

D. Nm^2C; Nm^3C

Answer: B

Solution:

Solution:

$\vec{E} = \frac{A}{x^2}\hat{i} + \frac{B}{y^3}\hat{j}$

$\left[\frac{A}{x^2}\right] = NC^{-1} \Rightarrow [A] = Nm^2C^{-1}$

$\left[\frac{B}{y^3}\right] = NC^{-1} \Rightarrow [B] = Nm^3C^{-1}$

Question27

Match List I with List II.

List I	List II
A. Torque	I. $kg\,m^{-1}\,s^{-2}$
B. Energy density	II. $kg\,ms^{-1}$
C. Pressure gradient	III. $kg\,m^{-2}\,s^{-2}$
D. Impulse	IV. $kg\,m^2\,s^{-2}$

Choose the correct answer from the options given below :
[30-Jan-2023 Shift 2]

Options:

A. A-IV, B-III, C-I, D-II

B. A-I, B-IV, C-III, D-II

C. A-IV, B-I, C-II, D-III

D. A-IV, B-I, C-III, D-II

Answer: D

Solution:

Solution:

Question28

If R, X_L and X_C represent resistance, inductive reactance and capacitive reactance. Then which of the following is dimensionless:
[31-Jan-2023 Shift 1]

Options:

A. RX_LX_C

B. $\frac{R}{\sqrt{X_LX_C}}$

C. $\frac{R}{X_LX_C}$

D. $R \frac{X_L}{X_C}$

Answer: B

Solution:

Solution:

All three have same dimension therefore $\frac{R}{\sqrt{X_L X_C}}$ is dimensionless.

Option 2

Question29

Match List-I with List-II.

List-I	List-II
A. Angular momentum	I. $[ML^2T^{-2}]$.
B. Torque	II. $[ML^{-2}T^{-2}]$
C. Stress	III. $[ML^2T^{-1}]$
D. Pressure gradient	IV. $[ML^{-1}T^{-2}]$.

Choose the correct answer from the options given below:
[31-Jan-2023 Shift 2]

Options:

A. A-I, B-IV, C-III, D-II

B. A-III, B-I, C-IV, D-II

C. A-II, B-III, C-IV, D-I

D. A-IV, B-II, C-I, D-III

Answer: B

Solution:

Solution:

$\vec{L} = \vec{r} \times \vec{p} \Rightarrow [L] = [M^0L^1T^0][M^1L^1T^{-1}]$

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

$\vec{\tau} = \vec{r} \times \vec{F} \Rightarrow [\tau] = [L^1][MLT^{-2}]$

$= [ML^2T^{-2}]$

$\text{Stress} \equiv \text{Pressure} = \frac{F}{A} \Rightarrow [\text{ Stress }] = [ML^{-1}T^{-2}]$

$\text{Pressure Gradient} = \frac{dP}{dx} \Rightarrow [\text{Pressure Gradient}] = [ML^{-2}T^{-2}]$

Question30

Vectors $a\hat{i} + b\hat{j} + \hat{k}$ and $2\hat{i} - 3\hat{j} + 4\hat{k}$ are perpendicular to each other when $3a + 2b = 7$, the ratio of a to b is $\frac{x}{2}$. The value of x is____
[24-Jan-2023 Shift 1]

Answer: 1

Solution:

For two perpendicular vectors
$\left(a\hat{i} + b\hat{j} + \hat{k}\right) \cdot \left(2\hat{i} - 3\hat{j} + 4\hat{k}\right) = 0$
$2a - 3b + 4 = 0$
On solving, $2a - 3b = -4$
Also given
$3a + 2b = 7$
We get $a = 1$, $b = 2$
$\frac{a}{b} = \frac{x}{2} \Rightarrow x = \frac{2a}{b} = \frac{2 \times 1}{2}$
$\Rightarrow x = 1$

Question31

If two vectors $\vec{P} = \hat{i} + 2m\hat{j} + mk$ and $\vec{Q} = 4\hat{i} - 2\hat{j} + mk$ are perpendicular to each other.
Then, the value of m will be :
[24-Jan-2023 Shift 2]

Options:

A. 1

B. -1

C. -3

D. 2

Answer: D

Solution:

$\vec{P} \cdot \vec{Q} = 0$
$\left(\hat{i} + 2m\hat{j} + m\hat{k}\right) \cdot \left(4\hat{i} - 2\hat{j} + m\hat{k}\right) = 0$
$\Rightarrow 4 - 4m + m^2 = 0$
$\Rightarrow (m - 2)^2 = 0 \Rightarrow m = 2$

Question32

If $\vec{P} = 3\hat{i} + \sqrt{3}\hat{j} + 2\hat{k}$ and $\vec{Q} = 4\hat{i} + \sqrt{3}\hat{j} + 2.5\hat{k}$ then, The unit vector in the direction of $\vec{P} \times \vec{Q}$ is $\frac{1}{x}\left(\sqrt{3}\hat{i} + \hat{j} - 2\sqrt{3}\hat{k}\right)$. The value of x is
[25-Jan-2023 Shift 1]

Answer: 4

Solution:

Solution:

$$\vec{P} \times \vec{Q} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & \sqrt{3} & 2 \\ 4 & \sqrt{3} & 2.5 \end{vmatrix} = \sqrt{3}\frac{\hat{i}}{2} + \frac{\hat{j}}{2} - \sqrt{3}\hat{k}$$

$$\Rightarrow \frac{\vec{P} \times \vec{Q}}{\left|\vec{P} \times \vec{Q}\right|} = \frac{1}{2}\left(\sqrt{3}\frac{\hat{i}}{2} + \frac{\hat{j}}{2} - \sqrt{3}\hat{k}\right)$$

$$= \frac{1}{4}\left(\sqrt{3}\hat{i} + \hat{j} - 2\sqrt{3}\hat{k}\right) \quad x = 4$$

Question33

In an experiment of measuring the refractive index of a glass slab using travelling microscope in physics lab, a student measures real thickness of the glass slab as 5.25 mm and apparent thickness of the glass slab at 5.00 mm. Travelling microscope has 20 divisions in one cm on main scale and 50 divisions on Vernier scale is equal to 49 divisions on main scale. The estimated uncertainty in the measurement of refractive index of the slab is $\frac{x}{10} \times 10^{-3}$, where x is ________
[29-Jan-2023 Shift 2]

Answer: 41

Solution:

$$u = \frac{h}{h'} = \frac{5.25}{5.00}$$

$$\text{Least count} = \frac{1}{20}\text{cm} - \frac{49}{50} \cdot \frac{1}{20}\text{cm}$$

$$= \frac{1}{50} \times \frac{1}{20}\text{cm} = 0.01\text{ mm}$$

$$\ln u = \ln h - \ln h'$$

$$\frac{du}{u} = \frac{dh}{h} - \frac{dh'}{h'}$$

$$du = \left[\frac{0.01}{5.25} + \frac{0.01}{5.00} \right] \frac{5.25}{5.00}$$

$$= \frac{41}{10} \times 10^{-3}$$

Ans. = 41

Question34

In a metre bridge experiment the balance point in obtained if the gaps are closed by 2Ω and 3Ω. A shunt of X Ω is added to 3Ω resistor to shift the balancing point by 22.5 cm. The value of X is _______
[29-Jan-2023 Shift 1]

Answer: 2

Solution:

Solution:

$$\frac{2}{\left(\frac{3x}{3+x}\right)} = \frac{40+22.5}{60-22.5} = \frac{62.5}{37.5} = \frac{5}{3}$$

$$\frac{6}{5} = \frac{3x}{3+x}$$

$$6 + 2x = 5x \Rightarrow x = 2$$

Question35

A null point is found at 200 cm in potentiometer when cell in secondary circuit is shunted by 5Ω. When a resistance of 15Ω is used for shunting null point moves to 300 cm. The internal resistance of the cell is ______ Ω.
[29-Jan-2023 Shift 2]

Answer: 5

Solution:

$$\frac{\varepsilon}{r+5} \times 5 = 200x \ldots (1)$$

$$\frac{\varepsilon \times 15}{r+15} = 300x \ldots (2)$$

$$\Rightarrow r = 5\Omega$$

Ans. 5

Question36

In a screw gauge, there are 100 divisions on the circular scale and the main scale moves by $0.5\,\text{mm}$ on a complete rotation of the circular scale. The zero of circular scale lies 6 divisions below the line of graduation when two studs are brought in contact with each other. When a wire is placed between the studs, 4 linear scale divisions are clearly visible while 46^{th} division the circular scale coincide with the reference line. The diameter of the wire is _______ $\times 10^{-2}\,\text{mm}$.
[30-Jan-2023 Shift 1]

Answer: 220

Solution:

$$\text{Least count} = \frac{\text{Pitch}}{\text{No. of circular divisions}}$$
$$= \frac{0.5\,\text{mm}}{100}$$
$$\text{Least count} = 5 \times 10^{-3}\,\text{mm}$$
$$\text{Positive Error} = \text{MSR} + \text{CSR(LC)}$$
$$= 0\,\text{mm} + 6(5 \times 10^{-3}\,\text{mm})$$
Reading of Diameter = MSR + CSR (LC) − Positive zero error
$$= 4 \times 0.5\,\text{mm} + (46(5 \times 10^{-3})) - 6(5 \times 10^{-3})\,\text{mm}$$
$$= 2\,\text{mm} + 40 \times 5 \times 10^{-3}\,\text{mm} = 2.2\,\text{mm} \text{ (Ans.)}$$

Question37

$\left(P + \frac{a}{V^2}\right)(V - b) = RT$ represents the equation of state of some gases. Where P is the pressure, V is the volume, T is the temperature and a, b, R are the constants. The physical quantity, which has dimensional formula as that of $\frac{b^2}{a}$, will be :
[1-Feb-2023 Shift 1]

Options:

A. Bulk modulus

B. Modulus of rigidity

C. Compressibility

D. Energy density

Answer: C

Solution:

Solution:

$[b] = [V]$

$\left[\frac{a}{b^2}\right] = [P] \therefore \left[\frac{b^2}{a}\right] = \frac{1}{[P]} = \frac{1}{[B]} = [K]$

Question38

If the velocity of light c, universal gravitational constant G and planck's constant h are chosen as fundamental quantities. The dimensions of mass in the new system is:

[1-Feb-2023 Shift 2]

Options:

A. $\left[h^{\frac{1}{2}} c^{\frac{1}{2}} G^{1}\right]$

B. $[h^1 c^1 G^{-1}]$

C. $\left[h^{\frac{1}{2}} c^{\frac{1}{2}} G^{\frac{1}{2}}\right]$

D. $\left[h^{\frac{1}{2}} c^{\frac{1}{2}} G^{-\frac{1}{2}}\right]$

Answer: D

Solution:

Say dimensional formale of mass is $H^x C^y G^z$

$M^1 = (ML^2T^{-1})^x (LT^{-1})(M^{-1}L^3T^{-2})^z$

$M^1L^0T^0 = M^{x-z}L^{2x+y+3z}T^{-x-y-2z}$

on comparing both side

$x - z = 1$

$2x + y + 3z = 0$

$-x - y - 2z = 0$

On solving above equations we get

$x = \frac{1}{2}\ y = \frac{1}{2}\ z = \frac{-1}{2}$

Question39

In an experiment to find emf of a cell using potentiometer, the length of null point for a cell of emf 1.5V is found to be 60 cm. If this cell is replaced by another cell of emf E . the length-of null point increases by 40 cm. The value of E is $\frac{x}{10}$V. The value of x is ________.

[1-Feb-2023 Shift 1]

Answer: 25

Solution:

Solution:

$$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$

$$\frac{1.5}{E_2} = \frac{60}{60+40} = \frac{6}{10} = \frac{3}{5}$$

$$E_2 = \frac{5}{2} = \frac{x}{10}$$

$$x = 25$$

Question40

Dimension of $\frac{1}{\mu_0 \in_0}$ should be equal to [8-Apr-2023 shift 1]

Options:

A. T / L

B. T^2 / L^2

C. L / T

D. L^2 / T^2

Answer: D

Solution:

Solution:

Dimension of $\frac{1}{\mu_0 \varepsilon_0}$

$$C = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \Rightarrow \frac{1}{\mu_0 \varepsilon_0} = c^2$$

$$\left[\frac{1}{\mu_0 \varepsilon_0}\right] = [c^2]$$

$$= \left[\frac{L^2}{T^2}\right]$$

Question41

Match List I with List II

LIST - I	LIST - II
A. Torque	I. $ML^{-2}T^{-2}$
B. Stress	II. $ML^{2}T^{-2}$
C. Pressure gradient	III. $MLL^{-1}t^{-1}$
D. Coefficient of viscosity	IV. $ML^{-1}T^{-2}$

Choose the correct answer from the options given below:
[8-Apr-2023 shift 2]

Options:

A. A-III, B-IV, C-I, D-II

B. A-II, B-I, C-IV, D-III

C. A-IV, B-II, C-III, D-I

D. A-II, B-IV, C-I, D-III

Answer: D

Solution:

Solution:

$[\text{ Torque }] = \text{ F.L}$

$MLT^{-2} \cdot L = ML^{2}T^{-2}$

$[\text{ Stress }] = \frac{F}{A}$

$\frac{M\,LT^{-2}}{L^{2}} = ML^{-1}T^{-2}$

$[\text{ Pressure gradient }] = \frac{\Delta P}{\Delta L} = \frac{F}{A^{2}\,.\,L}$

$= \frac{MLT^{-2}}{L^{3}}$

$= ML^{-2}T^{-2}$

$F = nA\frac{dv}{dy}$

$\eta = ML^{-1}T^{-1}$

Question42

Given below are two statements :
Statements I : Astronomical unit (Au), Parsec (Pc) and Light year (ly) are units for measuring astronomical distances.
Statements II : Au< Parsec (Pc)< ly
In the light of the above statements, choose the most appropriate answer from the options given below :
[11-Apr-2023 shift 1]

Options:

A. Both Statements I and Statements II are incorrect.

B. Both Statements I and Statements II are correct.

C. Statements I is incorrect but Statements II are correct.

D. Statements I is correct but Statements II are incorrect.

Answer: D

Solution:

A.V., Par sec and light year are the unit of distance
Light year → distance travelled by light in one year
$1\,\text{ly} = 9.5 \times 10^{15}\text{m}$
parcec $= 3.262$ light year
A.V. $= 1.58 \times 10^{-5}$ light year
A. V. $< 1\text{y} <$ Parsec.
Statement I correct and statement II incorrect.

Question43

If force (F), velocity (V) and time (T) are considered as fundamental physical quantity, then dimensional formula of density will be: [11-Apr-2023 shift 2]

Options:

A. $FV^{-2}T^{2}$

B. $FV^{4}T^{-6}$

C. $FV^{-4}T^{-2}$

D. $F^{2}V^{-2}T^{6}$

Answer: C

Solution:

Solution:
$\rho = F^{x}V^{y}T^{z}$
$[ML^{-3}] = [MLT^{-2}]^{x}[LT^{-1y}]^{y}[T]^{z}$
$1 = x \quad x = 1$
$-3 = x + y \quad y = -4$
$0 = -2x - y + z \quad z = 2x + 4 = 2 - 4 = -2$
$\rho = FV^{-4}T^{-2}$ Ans. (3)

Question44

LIST I	LIST II
A. Spring constant	I. $[T^{-1}]$
B. Angular speed	II. $[MT^{-2}]$
C. Angular momentum	III. $[ML^{2}]$
D. Moment of Inertia	IV. $[ML^{2}T^{-1}]$

Choose the correct answer from the options given below :
[12-Apr-2023 shift 1]

Options:

A. A-II, B-III, C-I, D-IV

B. A-IV, B-I, C-III, D-II

C. A-I, B-III, C-II, D-IV

D. A-II, B-I, C-IV, D-III

Answer: D

Solution:

Solution:
(i) Spring constant
$F = Kx$
$K = \frac{F}{x} = \frac{\text{kgm sec}}{m} = \text{kg} \cdot \text{sec}^{-2} = [ML^{0}T^{-2}]$
(ii) Angular speed : (ω)
$\omega = \frac{2\pi}{T}$
$\omega = [M^{0}L^{0}T^{-1}]$
(iii) Angular momentum
$L = MVR \Rightarrow \text{Kg} \cdot \text{m sec}^{-1}\text{m} = \text{kgm}^{2}\ \text{sec}^{-1}$
$= [ML^{2}T^{-1}]$
(iv) Moment of Inertia
$I = MR^{2} = \text{Kg} \cdot \text{m}^{2}$
$= [ML^{2}T^{0}]$

Question45

In the equation $\left[x + \frac{a}{y^{2}}\right][Y - b] = RT$, X is pressure, Y is volume, R is universal gas constant ant T is temperature. The physical quantity equivalent to the ratio $\frac{a}{b}$ is :
[13-Apr-2023 shift 2]

Options:

A. Coefficient of viscosity

B. Energy

C. Impulse

D. Pressure gradient

Answer: B

Solution:

Solution:

x and $\frac{a}{y^2}$ have same dimensions

y and b have same dimensions

$[a] = [ML^5T^{-2}]$

$[b] = [L^3]$

$\frac{[a]}{[b]} = ML^2T^{-2}$ has dimension of energy

Question46

The speed of a wave produced in water is given by $v = \lambda^a g^b \rho^c$. Where λ, g and ρ are wavelength of wave, acceleration due to gravity and density of water respectively. The values of a, b and c respectively, are : [15-Apr-2023 shift 1]

Options:

A. $\frac{1}{2}, 0, \frac{1}{2}$

B. 1, −1, 0

C. $\frac{1}{2}, \frac{1}{2}, 0$

D. 1, 1, 0

Answer: C

Solution:

Solution:

By dimensional analysis,

$V = \lambda^a g^b \rho^c$

$[L^1T^{-1}] = [L^1]^a[L^1T^{-2}]^b[M^1L^{-3}]^c$

$[L^1T^{-1}] = [M^cL^{a+b-3c}T^{-2b}]$

On comparing respective powers,

$c = 0, -2b = -1, a + b - 3c = 1,$

$b = \frac{1}{2}, a = \frac{1}{2}$

Question47

Two resistances are given as $R_1 = (10 \pm 0.5)\Omega$ and $R_2 = (15 \pm 0.5)\Omega$. The

percentage error in the measurement of equivalent resistance when they are connected in parallel is -
[6-Apr-2023 shift 1]

Options:

A. 2.33

B. 4.33

C. 5.33

D. 6.33

Answer: B

Solution:

Solution:

In parallel combination, $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{10} + \frac{1}{15} = \frac{5}{30} = \frac{1}{6}$

Now, for error calculation,

$\frac{dR_{eq}}{R_{eq}^2} = \frac{dR_1}{R_1^2} + \frac{dR_2}{R_2^2}$

$\Rightarrow \frac{dR_{eq}}{36} = \frac{0.5}{100} + \frac{0.5}{225}$

$dR_{eq} = 36 \times 0.5 \times \left(\frac{13}{900} \right) = 18 \times \frac{13}{900} = \frac{26}{100} = 0.26$

Now, $\frac{dR_{eq}}{R_{eq}} \times 100 = \frac{0.26}{6} \times 100 = \frac{26}{6} = 4.33$

Question48

The length of a metallic wire is increased by 20% and its area of cross section is reduced by 4%. The percentage change in resistance of the metallic wire is ________
[6-Apr-2023 shift 1]

Answer: 25

Solution:

Solution:

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

$R' = \frac{\rho \times 1.2l}{0.96A} = \frac{10}{8} \times R = 1.25R$

It means 25% increase in Resistance.

Question49

Two forces having magnitude A and $\frac{A}{2}$ are perpendicular to each other. The magnitude of their resultant is:
[8-Apr-2023 shift 1]

Options:

A. $\frac{5A}{2}$

B. $\frac{\sqrt{5}A^2}{2}$

C. $\frac{\sqrt{5}A}{4}$

D. $\frac{\sqrt{5}A}{2}$

Answer: D

Solution:

Solution:

$\left|\vec{F}_1\right| = A, \left|\vec{F}_2\right| = \frac{A}{2}\ \theta = \frac{\pi}{2}$

$\left|\vec{F}_{net}\right| = \sqrt{F_1^{\ 2} + F_2^{\ 2}}$

$= \sqrt{A^2 + \left(\frac{A}{2}\right)^2}$

$\left|\vec{F}_{net}\right| = \frac{\sqrt{5}A}{2}$

Question50

A physical quantity P is given as
P = $\frac{a^2b^3}{c\sqrt{d}}$
The percentage error in the measurement of a, b, c and d are 1%, 2%, 3% and 4% respectively. The percentage error in the measurement of quantity P will be
[10-Apr-2023 shift 1]

Options:

A. 14%

B. 13%

C. 16%

D. 12%

Answer: B

Solution:

Solution:

$$\frac{dP}{P} \times 100 = \left(2\frac{da}{a} + 3\frac{db}{b} + \frac{dc}{c} + \frac{1}{2}\frac{d(d)}{d}\right) \times 100$$

$= 2 \times 1 + 3 \times 2 + 3 + \frac{1}{2} \times 4$

$= 2 + 6 + 3 + 2$

$= 13\%$

Question51

Three forces $F_1 = 10N$, $F_2 = 8N$, $F_3 = 6N$ are acting on a particle of mass 5 kg. The forces F_2 and F_3 are applied perpendicularly so that particle remains at rest. If the force F_1 is removed, then the acceleration of the particle is :
[12-Apr-2023 shift 1]

Options:

A. $4.8ms^{-2}$

B. $0.5ms^{-2}$

C. $7ms^{-2}$

D. $2ms^{-2}$

Answer: D

Solution:

Solution:

$F_1 = 10N$

$F_2 = 8N$

$F_3 = 6N$

$\vec{a} = \frac{F_2\hat{i} + F_3\hat{j}}{5}$

$\vec{a} = \frac{8\hat{i} + 6\hat{j}}{5}$

$|\vec{a}| = \frac{\sqrt{64 + 36}}{5}$

$= \frac{10}{5} = 2m/\sec^2$

OR

$F_1^2 = F_2^2 + F_3^2$

Now F1 is removed then net force

$F_{net} = \sqrt{F_2^2 + F_3^2}$

$= \sqrt{64 + 36}$

Question52

A vector in $x - y$ plane makes an angle of 30° with y-axis. The magnitude of y-component of vector is $2\sqrt{3}$. The magnitude of x-component of the

vector will be :
[15-Apr-2023 shift 1]

Options:

A. 2

B. $\sqrt{3}$

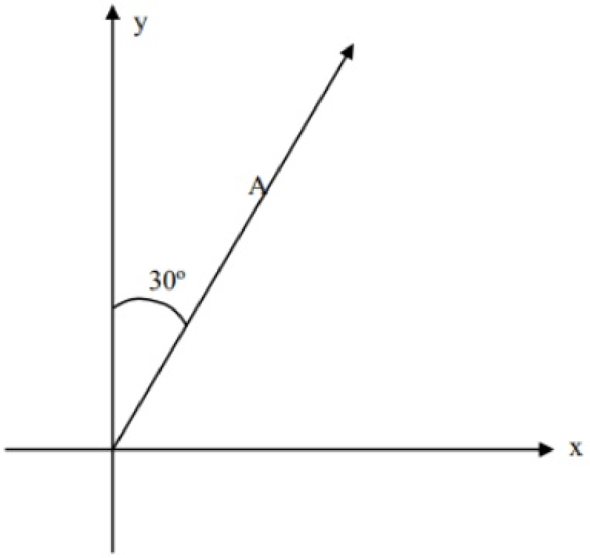
C. $\frac{1}{\sqrt{3}}$

D. 6

Answer: A

Solution:

Solution:
$A_y = A\cos 30^{\circ} = 2\sqrt{3}$
$A = 4$
$A_x = A\sin 30^{\circ} = 2$



Question53

In an experiment with vernier calipers of least count 0.1 mm, when two jaws are joined together the zero of vernier scale lies right to the zero of the main scale and 6^{th} division of vernier scale coincides with the main scale division. While measuring the diameter of a spherical bob, the zero of vernier scale lies in between 3.2 cm and 3.3 cm marks, and 4^{th} division of vernier scale coincides with the main scale division. The diameter of bob is measured as
[10-Apr-2023 shift 2]

Options:

A. 3.25 cm

B. 3.22 cm

C. $3.18\,\mathrm{cm}$

D. $3.26\,\mathrm{cm}$

Answer: C

Solution:

Solution:
The zero error in verniel scale is $= 6 \times 0.1\,\mathrm{mm} = 0.6\,\mathrm{mm}$ (+ve zero error)
Note: +ve zero error will have to be subtracted
From the reading of the object.
Now, the diameter measured with the help of Vernier scale is
Given by → M.S.D + V.S.D × L.S
$\Rightarrow 3.2\,\mathrm{cm} + 0.1\,\mathrm{mm} \times 4$
$= 3.24\,\mathrm{cm}$
The actual diameter is $\Rightarrow 3.24\,\mathrm{mm}$ - (zero error) $= 3.24 - 0.6 = 3.18\,\mathrm{cm}$

Question54

Identify the pair of physical quantities which have different dimensions: [24-Jun-2022-Shift-1]

Options:

A. Wave number and Rydberg's constant

B. Stress and Coefficient of elasticity

C. Coercivity and Magnetisation

D. Specific heat capacity and Latent heat

Answer: D

Solution:

Solution:
$[S] = \frac{[C]}{[m] \times [\Delta T]}$
and, $[L] = \frac{[Q]}{[m]}$
⇒ They have different dimensions.

Question55

Identify the pair of physical quantities that have same dimensions: [24-Jun-2022-Shift-2]

Options:

A. velocity gradient and decay constant

B. Wien's constant and Stefan constant

C. angular frequency and angular momentum

D. wave number and Avogadro number

Answer: A

Solution:

Solution:

Velocity gradient $= \frac{dv}{dx}$

⇒ Dimensions are $\frac{[LT^{-1}]}{[L]} = [T^{-1}]$

Decay constant λ has dimensions of $[T^{-1}]$ because of the relation $\frac{dN}{dt} = -\lambda N$

⇒ Velocity gradient and decay constant have same dimensions.

Question56

An expression for a dimensionless quantity P is given by P = $\frac{\alpha}{\beta}\log_e\left(\frac{kt}{\beta x}\right)$; where α and β are constants, x is distance; k is Boltzmann constant and t is the temperature. Then the dimensions of α will be : [26-Jun-2022-Shift-1]

Options:

A. $[M^0L^{-1}T^0]$

B. $[ML^0T^{-2}]$

C. $[MLT^{-2}]$

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

Answer: C

Solution:

$[P] = \frac{[\alpha]}{[\beta]} \Rightarrow 1\ \frac{[\alpha]}{[\beta]}$

$\Rightarrow [\alpha] = [\beta] \ldots\ldots (1)$

Now, $\left[\frac{kt}{\beta t}\right] = 1$

We know, $E = \frac{3}{2}kT\ (KTG)$

$\therefore$[Energy] $= [KT]$

$\therefore [\beta x] = [kT]$

$[\beta] = \frac{ML^2T - 2}{[x]} = \frac{ML^2T^{-2}}{L}$

$\therefore [\alpha] = [\beta] = MLT^{-2}$

Question57

The dimension of mutual inductance is :
[26-Jun-2022-Shift-2]

Options:

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

B. $[M L^2 T^{-3} A^{-1}]$

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

D. $[M L^2 T^{-3} A^{-2}]$

Answer: C

Solution:

Solution:

$\because U = \frac{1}{2} M i^2$

$\Rightarrow [M] = \frac{[U]}{[i^2]} = \frac{M L^2 T^{-2}}{A^2}$

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

Question58

The SI unit of a physical quantity is pascal-second. The dimensional formula of this quantity will be :
[27-Jun-2022-Shift-2]

Options:

A. $[ML^{-1}T^{-1}]$

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

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

D. $[M^{-1}L^3T^0]$

Answer: A

Solution:

Solution:

$[\text{pascal-second}] = \frac{M L T^{-2}}{L^2} \times T$

$= M L^{-1} T^{-1}$

Question59

If L, C and R are the self inductance, capacitance and resistance

respectively, which of the following does not have the dimension of time?
[27-Jun-2022-Shift-2]

Options:

A. RC

B. $\frac{L}{R}$

C. $\sqrt{LC}$

D. $\frac{L}{C}$

Answer: D

Solution:

Solution:
$\left(\frac{L}{C}\right)$ does not have dimension of time.
RC, $\frac{L}{R}$ are time constant while $\sqrt{LC}$ is reciprocal of angular frequency or having dimension of time.
$U = \frac{1}{2}Li^2 = \frac{1}{2}CV^2$
So, $\left[\frac{L}{C}\right] = \frac{V^2}{i^2} = R^2$ is not the dimension of time.

Question60

In van der Waal equation $\left[P + \frac{a}{V^2}\right][V - b] = RT$; P is pressure, V is volume, R is universal gas constant and T is temperature. The ratio of constants $\frac{a}{b}$ is dimensionally equal to:
[29-Jun-2022-Shift-1]

Options:

A. $\frac{P}{V}$

B. $\frac{V}{P}$

C. PV

D. PV^3

Answer: C

Solution:

From the equation
$[a] \equiv [PV^2]$

$[b] \equiv [V]$
$\Rightarrow \left[\frac{a}{b}\right] \equiv [PV]$

Question61

If $Z = \frac{A^2B^3}{C^4}$, then the relative error in Z will be :
[25-Jun-2022-Shift-1]

Options:

A. $\frac{\Delta A}{A} + \frac{\Delta B}{B} + \frac{\Delta C}{C}$

B. $\frac{2\,\Delta A}{A} + \frac{3\,\Delta B}{B} - \frac{4\,\Delta C}{C}$

C. $\frac{2\,\Delta A}{A} + \frac{3\,\Delta B}{B} + \frac{4\,\Delta C}{C}$

D. $\frac{\Delta A}{A} + \frac{\Delta B}{B} - \frac{\Delta C}{C}$

Answer: C

Solution:

Solution:
$Z = \frac{A^2B^3}{C^4}$
$\therefore \frac{\Delta Z}{Z} = \frac{2\,\Delta A}{A} + 3 \times \frac{\Delta B}{B} + \frac{4\,\Delta C}{C}$

Question62

$\vec{A}$ is a vector quantity such that $|\vec{A}|$ = non-zero constant. Which of the following expression is true for $\vec{A}$?
[25-Jun-2022-Shift-1]

Options:

A. $\vec{A} \cdot \vec{A} = 0$

B. $\vec{A} \times \vec{A} < 0$

C. $\vec{A} \times \vec{A} = 0$

D. $\vec{A} \times \vec{A} > 0$

Answer: C

Solution:

$\vec{A} \times \vec{A} = A \times A \times \sin 0^{\circ}$
$= 0$

Question63

Which of the following relations is true for two unit vector $\hat{A}$ and $\hat{B}$ making an angle θ to each other?
[25-Jun-2022-Shift-1]

Options:

A. $\left|\hat{A} + \hat{B}\right| = \left|\hat{A} - \hat{B}\right| \tan \frac{\theta}{2}$

B. $\left|\hat{A} - \hat{B}\right| = \left|\hat{A} + \hat{B}\right| \tan \frac{\theta}{2}$

C. $\left|\hat{A} + \hat{B}\right| = \left|\hat{A} - \hat{B}\right| \cos \frac{\theta}{2}$

D. $\left|\hat{A} - \hat{B}\right| = \left|\hat{A} + \hat{B}\right| \cos \frac{\theta}{2}$

Answer: B

Solution:

Solution:

$\because \left|\hat{A} - \hat{B}\right| = 2 \sin\left(\frac{\theta}{2}\right)$

and, $\left|\hat{A} + \hat{B}\right| = 2 \cos\left(\frac{\theta}{2}\right)$

$\Rightarrow \frac{\left|\hat{A} - \hat{B}\right|}{\left|\hat{A} + \hat{B}\right|} = \tan\left(\frac{\theta}{2}\right)$

Question64

For $z = a^{2}x^{3}y^{\frac{1}{2}}$, where 'a' is a constant. If percentage error in measurement of ' x ' and ' y ' are 4% and 12% respectively, then the percentage error for 'z' will be ______ %
[25-Jun-2022-Shift-2]

Answer: 18

Solution:

% error in z = $3 \times 4 + \frac{1}{2} \times 12$
$= 12 + 6 = 18\%$

Question65

A silver wire has a mass (0.6 ± 0.006)g, radius (0.5 ± 0.005) mm and length (4 ± 0.04) cm. The maximum percentage error in the measurement of its density will be : [27-Jun-2022-Shift-1]

Options:

A. 4%

B. 3%

C. 6%

D. 7%

Answer: A

Solution:

$$\rho = \frac{m}{V} = \frac{m}{\pi r^2 \times l}$$

$$\therefore \% \text{ error in } \rho = \left(\frac{0.006}{0.6} + 2 \times \frac{0.005}{0.5} + \frac{0.04}{4} \right) \times 100$$

$= 4\%$

Question66

The distance of the Sun from earth is 1.5×10^{11}m and its angular diameter is (2000) s when observed from the earth. The diameter of the Sun will be : [27-Jun-2022-Shift-2]

Options:

A. 2.45×10^{10}m

B. 1.45×10^{10}m

C. 1.45×10^{9}m

D. 0.14×10^{9}m

Answer: C

Solution:

Diameter $= r \times \delta$
$= 1.5 \times 10^{11} \times (2000) \times \left(\frac{1}{3600}\right) \times \left(\frac{\pi}{180}\right)$
$= 1.45 \times 10^{9} m$

Question67

Two vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes. If magnitude of $\vec{A} + \vec{B}$ is equal to two times the magnitude of $\vec{A} - \vec{B}$, then the angle between $\vec{A}$ and $\vec{B}$ will be :
[29-Jun-2022-Shift-1]

Options:

A. $\sin^{-1}\left(\frac{3}{5}\right)$

B. $\sin^{-1}\left(\frac{1}{3}\right)$

C. $\cos^{-1}\left(\frac{3}{5}\right)$

D. $\cos^{-1}\left(\frac{1}{3}\right)$

Answer: C

Solution:

Solution:
$\sqrt{A^2 + A^2 + 2A^2\cos\theta} = 2\sqrt{A^2 + A^2 + 2A^2(-\cos\theta)}$
$\Rightarrow 2A^2 + 2A^2\cos\theta = 8A^2 + 8A^2 - (-\cos\theta)$
$\Rightarrow 5\cos\theta = 3$
$\Rightarrow \theta = \cos^{-1}\left(\frac{3}{5}\right)$

Question68

In a vernier callipers, each cm on the main scale is divided into 20 equal parts. If tenth vernier scale division coincides with nineth main scale division. Then the value of vernier constant will be _____ $\times 10^{-2}$ mm
[26-Jun-2022-Shift-1]

Answer: 5

Solution:

$1\,\text{MSD} = \frac{1}{20}\,\text{cm}$
$\because 10\,\text{VSD} = 9\,\text{MSD}$
$1\,\text{VSD} = \frac{9}{10} \times \frac{1}{20}\,\text{cm} = \frac{9}{200} \times 10\,\text{mm} = 0.45\,\text{mm}$
Now, $1\,\text{MSD} = \frac{1}{20} \times 10\,\text{mm} = 0.50\,\text{mm}$
$\text{LC} = (0.50 - 0.45)\,\text{mm} = 0.05\,\text{mm}$
$= 5 \times 10^{-2}\,\text{mm}$

Question69

A travelling microscope is used to determine the refractive index of a glass slab. If 40 divisions are there in 1 cm on main scale and 50 Vernier scale divisions are equal to 49 main scale divisions, then least count of the travelling microscope is ____ $\times 10^{-6}$ m.
[26-Jun-2022-Shift-2]

Answer: 5

Solution:

$40\text{M} = 1\,\text{cm}$
$\Rightarrow \text{M} = 0.025\,\text{cm} \ldots\ldots\ldots (1)$
Also, $50\text{V} = 49\text{M}$
$\Rightarrow$ Least count $= \text{M} - \text{V} = \text{M} - \frac{49}{50}\text{M} = \frac{\text{M}}{50}$
$\Rightarrow \text{LC} = \frac{0.025}{50}\,\text{cm}$
$= \frac{250}{50} \times 10^{-6}\,\text{m}$
$\Rightarrow \text{LC} = 5 \times 10^{-6}\,\text{m}$

Question70

A student in the laboratory measures thickness of a wire using screw gauge. The readings are 1.22 mm, 1.23 mm, 1.19 mm and 1.20 mm. The percentage error is $\frac{x}{121}$%. The value of x is
[28-Jun-2022-Shift-2]

Answer: 150

Solution:

$I_{mean} = \frac{1.22 + 1.23 + 1.19 + 1.20}{4} = 1.21$

$\Delta I_{mean} = \frac{0.01 + 0.02 + 0.02 + 0.01}{4} = 0.015$

So $\%I = \frac{\Delta I_{mean}}{I_{mean}} \times 100 = \frac{0.015}{1.21} \times 100 = \frac{150}{121}\%$

$x = 150$

Question71

The Vernier constant of Vernier callipers is 0.1 mm and it has zero error of (−0.05) cm. While measuring diameter of a sphere, the main scale reading is 1.7 cm and coinciding vernier division is 5 . The corrected diameter will be ____ $\times 10^{-2}$ cm
[29-Jun-2022-Shift-2]

Answer: 180

Solution:

Since zero error is negative, we will add 0.05 cm.

$\Rightarrow$ Corrected reading $= 1.7\,cm + 5 \times 0.1\,mm + 0.05\,cm$

$= 180 \times 10^{-2}\,cm$

Question72

If momentum [P], area [A] and time [T] are taken as fundamental quantities, then the dimensional formula for coefficient of viscosity is:
[25-Jul-2022-Shift-1]

Options:

A. $[PA^{-1}T^{0}]$

B. $[PAT^{-1}]$

C. $[PA^{-1}T]$

D. $[PA^{-1}T^{-1}]$

Answer: A

Solution:

$[\eta] = [M L^{-1}T^{-1}]$
Now if $[\eta] = [P]^a[A]^b[T]^c$
$\Rightarrow [M L^{-1}T^{-1}] = [M L^1T^{-1}]^a[L^2]^b[T]^c$
$\Rightarrow a = 1, a + 2b = -1, -a + c = -1$
$\Rightarrow a = 1, b = -1, c = 0$
$\Rightarrow [\eta] = [P][A]^{-1}[T]^0$
$= [PA^{-1}T^0]$

Question73

A torque meter is calibrated to reference standards of mass, length and time each with 5% accuracy. After calibration, the measured torque with this torque meter will have net accuracy of :
[27-Jul-2022-Shift-1]

Options:

A. 15%

B. 25%

C. 75%

D. 5%

Answer: B

Solution:

Solution:
Dimensional formula for Torque
$[\tau] = [ML^2T^{-2}]$
Now
Percentage error in torque $= \%\tau = \%M + 2\%L$
$2\%T$
$\%\tau = 25\%$

Question74

An expression of energy density is given by u = $\frac{\alpha}{\beta}\sin\left(\frac{\alpha x}{kt}\right)$, where α, β are constants, x is displacement, k is Boltzmann constant and t is the temperature. The dimensions of β will be :
[27-Jul-2022-Shift-2]

Options:

A. $[ML^2T^{-2}\theta^{-1}]$

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

C. $[M^0L^0T^0]$

D. $[M^0L^2T^0]$

Answer: D

Solution:

Solution:

$u = \frac{\alpha}{\beta} \sin\left(\frac{\alpha x}{kt}\right)$

$[\alpha] = \left[\frac{kt}{x}\right] = \frac{[\text{ Energy }]}{[\text{ Dis tan c e}]}$

$[\beta] = \frac{[\alpha]}{[u]}$

$= \frac{[\text{ Energy }]/[\text{ Distan ce}]}{[\text{ Energy }]/\text{ Volume }]}$

$= [L^2]$

Question75

The dimensions of $\left(\frac{B^2}{\mu_0}\right)$ will be :

(if μ_0 : permeability of free space and B : magnetic field)
[28-Jul-2022-Shift-1]

Options:

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

B. $[MLT^{-2}]$

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

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

Answer: C

Solution:

$$\left[\frac{B^2}{\mu_0}\right] = [\text{Energy density}] = \frac{ML^2T^{-2}}{L^3} = ML^{-1}T^{-2}$$

Question76

Consider the efficiency of carnot's engine is given by $\eta = \frac{\alpha\beta}{\sin\theta} \log_e \frac{\beta x}{kT}$, where α and β are constants. If T is temperature, k is Boltzmann constant, θ is angular displacement and x has the dimensions of length. Then, choose the incorrect option:
[28-Jul-2022-Shift-2]

Options:

A. Dimensions of β is same as that of force.

B. Dimensions of $\alpha^{-1}x$ is same as that of energy.

C. Dimensions of $\eta^{-1}\sin\theta$ is same as that of $\alpha\beta$

D. Dimensions of α is same as that of β.

Answer: D

Solution:

Solution:

(A) $[\beta] = \left[\frac{kT}{x}\right] = \left[\frac{E}{x}\right] = [MLT^{-2}] = [F]$

(B) $[\alpha\beta] = [M^0L^0T^0]$

$[\alpha]^{-1} = [\beta] = \left[\frac{kT}{x}\right]$

So $[\alpha]^{-1}[x] = [kT] = [ML^2T^{-2}]$

(C) $\eta \sin\theta = \alpha\beta$

So $[\eta \sin\theta] = [\alpha\beta]$

$[\eta] = [M^0L^0T^0]$ it is dimensionless quantity

(D) $[\alpha] \neq [\beta]$

Question77

Match List I with List II.

List I	List II
A.Torque	I. Nms^{-1}
B.Stress	II. Jkg^{-1}
C.Latent Heat	III.Nm
D.Power	IV. Nm^{-2}

Choose the correct answer from the options given below : [29-Jul-2022-Shift-2]

Options:

A. A-III, B-II, C-I, D-IV

B. A-III, B-IV, C-II, D-I

C. A-IV, B-I, C-III, D-II

D. A-II, B-III, C-I, D-IV

Answer: B

Solution:

Solution:

Torque → Nm

Stress → N/m^2

Latent heat →J / kg
Power →Nm / s
A-III, B-IV, C-II, D-I

Question78

The maximum error in the measurement of resistance, current and time for which current flows in an electrical circuit are 1%, 2% and 3% respectively. The maximum percentage error in the detection of the dissipated heat will be : [25-Jul-2022-Shift-2]

Options:

A. 2

B. 4

C. 6

D. 8

Answer: D

Solution:

Solution:
$\because H = i^2 Rt$
$\because$% error in H $= 2 \times 2\% + 1\% + 3\% = 8\%$

Question79

If $\vec{A} = (2\hat{i} + 3\hat{j} - \hat{k})$m and $\vec{B} = (\hat{i} + 2\hat{j} + 2\hat{k})$m. The magnitude of component of vector $\vec{A}$ along vector $\vec{B}$ will be m. [26-Jul-2022-Shift-2]

Answer: 2

Solution:

$\vec{A} = (2\hat{i} + 3\hat{j} - \hat{k})$ m and $\vec{B} = (\hat{i} + 2\hat{j} + 2\hat{k})$ m
Component of $\vec{A}$ along $\vec{B} = \vec{A} \cdot \hat{B}$

$$= \vec{A} \cdot \frac{\vec{B}}{|\vec{B}|} = \frac{2 + 6 - 2}{\sqrt{1^2 + 2^2 + 2^2}}$$

$= \frac{6}{3} = 2$

Question80

The one division of main scale of Vernier callipers reads $1\,mm$ and 10 divisions of Vernier scale is equal to the 9 divisions on main scale. When the two jaws of the instrument touch each other, the zero of the Vernier lies to the right of zero of the main scale and its fourth division coincides with a main scale division. When a spherical bob is tightly placed between the two jaws, the zero of the Vernier scale lies in between $4.1\,cm$ and $4.2\,cm$ and 6^{th} Vernier division coincides scale division. The diameter of the bob will be ________ $\times 10^{-2}\,cm$.
[27-Jul-2022-Shift-1]

Answer: 412

Solution:

$10\,VSD = 9\,MSD$
$1\,VST = .9\,MSD$
L.C. $= .1\,mm = .01\,cm$
+ ve zero error $= .4\,mm$
$= 0.04\,cm$
Negative zero error $= 4.1\,cm + 6 \times .01 = 4.12\,cm$
$= 412 \times 10^{-2}\,cm$

Question81

If the projection of $2\hat{i} + 4\hat{j} - 2\hat{k}$ on $\hat{i} + 2\hat{j} + \alpha\hat{k}$ is zero. Then, the value of α will be _______.
[28-Jul-2022-Shift-1]

Answer: 5

Solution:

$\vec{a} \cdot \vec{b} = 0$
$\therefore \vec{a} \cdot \vec{b} = 0$
$\therefore 2 \times 1 + 4 \times 2 - 2 \times \alpha = 0$
$\therefore \alpha = 5$

Question82

In an experiment to find acceleration due to gravity (g) using simple pendulum, time period of 0.5 s is measured from time of 100 oscillation with a watch of 1 s resolution. If measured value of length is 10 cm known to 1 mm accuracy, The accuracy in the determination of g is found to be x%. The value of x is________.
[28-Jul-2022-Shift-2]

Answer: 5

Solution:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$\frac{dg}{g} \times 100 = \frac{2dT}{T} \times 100 + \frac{dl}{l} \times 100$$

$$= 2 \times \frac{1}{50} \times 100 + \frac{1}{100} \times 100 = 5\%$$

Question83

A screw gauge of pitch 0.5 mm is used to measure the diameter of uniform wire of length 6.8 cm, the main scale reading is 1.5 mm and circular scale reading is 7 . The calculated curved surface area of wire to appropriate significant figures is :
[Screw gauge has 50 divisions on its circular scale]
[26-Jul-2022-Shift-1]

Options:

A. $6.8 cm^2$

B. $3.4 cm^2$

C. $3.9 cm^2$

D. $2.4 cm^2$

Answer: B

Solution:

Solution:

Least count $= \frac{0.5}{50} mm = 0.01 mm$

$\therefore$ Diameter, $d = 1.5 mm + 7 \times 0.01$

$= 1.57\,\text{mm}$
$\therefore$ Surface area $= (2\pi r) \times l$
$= \pi d\, l$
$= 3.142 \times \frac{1.57}{10} \times 6.8\text{cm}^2$
$= 3.354\text{cm}^2 = 3.4\text{cm}^2$

Question84

In a Vernier Calipers, 10 divisions of Vernier scale is equal to the 9 divisions of main scale. When both jaws of Vernier calipers touch each other, the zero of the Vernier scale is shifted to the left of zero of the main scale and 4^{th} Vernier scale division exactly coincides with the main scale reading. One main scale division is equal to $1\,\text{mm}$. While measuring diameter of a spherical body, the body is held between two jaws. It is now observed that zero of the Vernier scale lies between 30 and 31 divisions of main scale reading and 6^{th} Vernier scale division exactly coincides with the main scale reading. The diameter of the spherical body will be :
[26-Jul-2022-Shift-2]

Options:

A. $3.02\,\text{cm}$

B. $3.06\,\text{cm}$

C. $3.10\,\text{cm}$

D. $3.20\,\text{cm}$

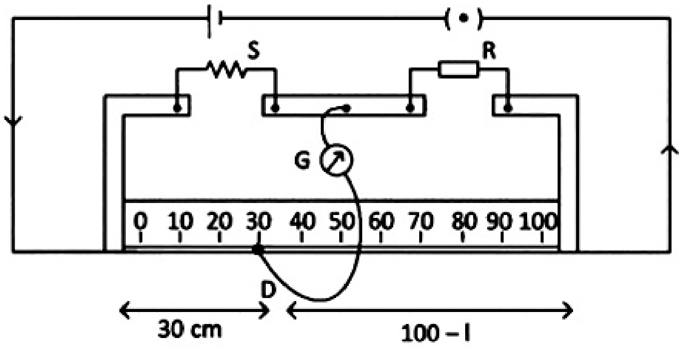
Answer: C

Solution:

$1\text{ M.S.D} = 1\,\text{mm}$
$9\text{ M.S.D} = 10\text{V.S.D}$
$1\text{ V.S.D} = 0.9\text{ M.S.D} = 0.9\,\text{mm}$
$\text{L.C of vernier caliper} = 1 - 0.9 = 0.1\,\text{mm} = 0.01\,\text{cm}$
$\text{zero error} = (10 - 4) \times 0.1\,\text{mm} = -0.6\,\text{mm}$
$\text{Reading} = \text{M.S.R} + \text{V.S.R} - \text{Zero error}$
$= 3\,\text{cm} + 6 \times 0.01 - [-0.06]$
$= 3 + 0.06 + 0.06$
$= 3.12\,\text{cm}$
Nearest given answer in the options is 3.10

Question85

In a meter bridge experiment, for measuring unknown resistance ' S ', the null point is obtained at a distance $30\,\text{cm}$ from the left side as shown at point D. If R is $5.6\text{k}\Omega$, then the value of unknown resistance 'S' will be _______ Ω.



[27-Jul-2022-Shift-1]

Answer: 2400

Solution:

$$\frac{S}{30} = \frac{5.6 \times 10^3}{70}$$

$$S = \frac{3}{7} \times 5.6 \times 10^3 = 2400$$

Question86

In an experiment with a convex lens, The plot of the image distance (v') against the object distance (μ') measured from the focus gives a curve $v'\mu' = 225$. If all the distances are measured in cm. The magnitude of the focal length of the lens is ____cm
[28-Jul-2022-Shift-2]

Answer: 15

Solution:

$ru = f^2$ (by Newton's formula)
$f^2 = 225$
$f = 15\,cm$

Question87

A travelling microscope has 20 divisions per cm on the main scale while its vernier scale has total 50 divisions and 25 vernier scale divisions are equal to 24 main scale divisions, what is the least count of the travelling microscope?
[29-Jul-2022-Shift-1]

Options:

A. 0.001 cm

B. 0.002 mm

C. 0.002 cm

D. 0.005 cm

Answer: C

Solution:

$1 \text{ MSD} = \frac{1}{20} \text{ cm}$

$1 \text{ VSD} = \frac{24}{25} \text{ MSD} = \frac{24}{25} \times \frac{1}{20} \text{ cm}$

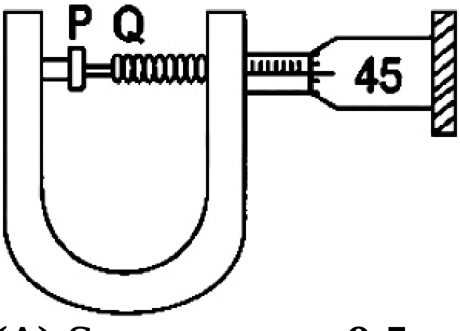
$\therefore \text{ Least count } = \frac{1}{20}\left(1 - \frac{24}{25}\right) \text{ cm}$

$= \frac{1}{20} \times \frac{1}{25} = \frac{1}{500} \text{ cm}$

$= 0.002 \text{ cm}$

Question88

In an experiment to find out the diameter of wire using screw gauge, the following observations were noted :



(A) Screw moves 0.5 mm on main scale in one complete rotation
(B) Total divisions on circular scale = 50
(C) Main scale reading is 2.5 mm
(D) 45^{th} division of circular scale is in the pitch line
(E) Instrument has 0.03 mm negative error
Then the diameter of wire is :
[29-Jul-2022-Shift-1]

Options:

A. 2.92 mm

B. 2.54 mm

C. 2.98 mm

D. 3.45 mm

Answer: C

Solution:

$\mathrm{MSR} = 2.5\,\mathrm{mm}$

$\mathrm{CSR} = 45 \times \frac{0.5}{50}\,\mathrm{mm}$

$= 0.45\,\mathrm{mm}$

$\text{Diameter reading} = \mathrm{MSR} + \mathrm{CSR} - \text{zero error}$

$= 2.5 + 0.45 - (-0.03)$

$= 2.98\,\mathrm{mm}$

Question89

The pitch of the screw gauge is 1mm and there are 100 divisions on the circular scale. When nothing is put in between the jaws, the zero of the circular scale lies 8 divisions below the reference line. When a wire is placed between the jaws, the first linear scale division is clearly visible while 72 nd division on circular scale coincides with the reference line. The radius of the wire is
[25 Feb 2021 Shift 1]

Options:

A. 1.64mm

B. 0.82mm

C. 1.80mm

D. 0.90mm

Answer: B

Solution:

Given, pitch of screw gauge, $\mathrm{P} = 1\mathrm{mm}$
Number of division, $\mathrm{n} = 100$
∴ Least count (LC) = $\frac{\mathrm{P}}{\mathrm{n}} = 1 / 100 = 0.01\mathrm{mm}$
As, zero of circular division lies 8 divisions below.
∴ Zero error $= 8 \times \mathrm{LC} = 8 \times 0.01 = 0.08\mathrm{mm}$
Since, 1st linear scale division coinside with 72nd circular scale division.

$\therefore \mathrm{Radius(r)} = \frac{[\mathrm{P} + (72 \times \mathrm{LQ} - \text{Zero error}]}{2}$

$= [1 + (72 \times 0.01) - 0.08] / 2$

$= (1.72 - 0.08) / 2 = 1.64 / 2$

$= 0.82\mathrm{mm}$

Question90

A large number of water drops, each of radius r, combine to have a drop of radius R. If the surface tension is T and mechanical equivalent of heat is J, the rise in heat energy per unit volume will be
[26 Feb 2021 Shift 1]

Options:

A. $\frac{2T}{J}\left(\frac{1}{r}-\frac{1}{R}\right)$

B. $\frac{2T}{r}$

C. $\frac{3T}{rJ}$

D. $\frac{3T}{J}\left(\frac{1}{r}-\frac{1}{R}\right)$

Answer: D

Solution:

Given, radius of small drop $= r$
Radius of big drop $= R$
Surface tension $= T$
and mechanical equivalent of heat $= J$
As, small drops combine to form big drop.
∴ Volume of big drop $(V_B) = n \times$ Volume of small drop (V_S)

$\Rightarrow \frac{4}{3}\pi R^3 = n \cdot \frac{4}{3}\pi r^3$

$\Rightarrow nr^3 = R^3$

$\Rightarrow r = \frac{R}{n^{1/3}}$ . . . (i)

Surface energy of small drop $(E_S) =$ Surface tension $(T) \times$ Area (A)

$\Rightarrow E_S = n \times 4\pi r^2 T$ and $E_B = 4\pi R^2 T$

Now, change in energy will be

$\Delta E = E_B - E_S = 4\pi T(nr^2 - R^2)$

∴ Heat energy per unit volume $= \frac{\Delta E}{V} = \frac{4\pi T(nr^2 - R^2)}{J \times \frac{4}{3}\pi R^3}$

$= \frac{3T}{J}\left(\frac{nr^2}{R^3} - \frac{1}{R}\right) = \frac{3T}{J}\left(n\frac{R^2}{n^{2/3}R^3} - \frac{1}{R}\right)$

$= \frac{3T}{J}\left[\frac{n^{1/3}}{R} - \frac{1}{R}\right]$ [from Eq. (i)]

$= \frac{3T}{J}\left[\frac{1}{r} - \frac{1}{R}\right]$

Question91

The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of L is 1.0m from metre scale having a minimum division of 1mm and time of one complete oscillation is 1.95s measured from stopwatch of 0.01s resolution. The percentage error in the determination of g will be

[24 Feb 2021 Shift 2]

Options:

A. 1.13%

B. 1.03%

C. 1.33%

D. 1.30%

Answer: A

Solution:

Solution:

Given, $T = 2\pi\sqrt{\frac{L}{g}}$ ... (i)

where, time period, $T = 1.95s$

Length of string, $I = 1m$

Acceleration due to gravity $= g$

Error in time period, $\Delta T = 0.01s = 10^{-2}s$

Error in length, $\Delta L = 1mm = 1 \times 10^{-3}m$

Squaring Eq. (i) on both sides, we get

$T^2 = 4\pi^2 \frac{L}{g}$

$g = 4\pi^2 \frac{L}{T^2}$

$\Rightarrow \frac{\Delta g}{g} = \frac{\Delta L}{L} + \frac{2\,\Delta T}{T} = \frac{10^{-3}}{1} + \frac{2 \times 10^{-2}}{1.95}$

$= 10^{-3} + 1.025 \times 10^{-2}$

$= 10^{-3} + 10.25 \times 10^{-3}$

$= 11.25 \times 10^{-3}$

$\because\ \Delta g / g \times 100 = 11.25 \times 10^{-3} \times 10^2$

$= 1.125\% = 1.13\%$

Question92

If C and V represent capacity and voltage respectively, then what are the dimensions of λ, where $\frac{C}{V} = \lambda$?
[26 Feb 2021 Shift 2]

Options:

A. $[M^{-2}L^{-3}I^{2}T^{6}]$

B. $[M^{-3}L^{-4}I^{3}T^{7}]$

C. $[M^{-1}L^{-3}I^{-2}T^{-1}]$

D. $[M^{-2}L^{-4}I^{3}T^{7}]$

Answer: D

Solution:

Given, C and V represent capacity and voltage, respectively.
Dimensional formula of $[C] = [M^{-1}L^{-2}T^{4}I^{2}]$
Dimensional formula of $[V] = [ML^{2}T^{-3}I^{-1}]$
Therefore, dimensional formula of $[C/V] = \frac{[M^{-1}L^{-2}T^{4}I^{2}]}{[ML^{2}T^{-3}I^{-1}]}$
$= [M^{-2}L^{-4}T^{7}I^{3}]$

Question93

In a typical combustion engine, the work done by a gas molecule is given $W = \alpha^2\beta e^{\frac{-\beta x^2}{kT}}$, where x is the displacement, k is the Boltzmann constant and T is the temperature. If α and β are constants, dimensions of α will be [26 Feb 2021 Shift 1]

Options:

A. $[MLT^{-2}]$

B. $[M^{0}LT^{0}]$

C. $[M^{2}LT^{-2}]$

D. $[MLT^{-1}]$

Answer: B

Solution:

Given, work done by gas molecule,
$W = \alpha^2\beta e^{-\beta x^2/kT}$
Here, x is displacement, k is Boltzmann constant, α and β are constants and T is temperature.
Dimensional formula of $[W] = [ML^{2}T^{-2}]$
$\therefore$ Dimensions of $[\alpha^2\beta] = [ML^{2}T^{-2}]$
$\Rightarrow \alpha = \left[\frac{ML^{2}T^{-2}}{\beta}\right]^{1/2}$ . . . (i)
The term $[e^{-\beta x^2/kT}]$ should be dimensionless, i.e. $[M^{0}L^{0}T^{0}]$.
$\Rightarrow \left[\frac{\beta x^2}{kT}\right] = [M^{0}L^{0}T^{0}]$
$\Rightarrow [\beta] = \frac{[k][T]}{[x^2]}$ . . . (ii)
Energy of gaseous molecule $(E) = \frac{7}{2}kT$
$[k] = [E]/[T] = [ML^{2}T^{-2}K^{-1}]$
Substituting the value of k in Eq. (ii), we get
$[\beta] = \frac{[ML^{2}T^{-2}K^{-1}][K]}{[L^{2}]} = [MT^{-2}]$
Substituting the value of β in Eq. (i), we get
$[\alpha] = \left\{\frac{[ML^{2}T^{-2}]}{[MT^{-2}]}\right\}^{1/2} = [ML^{1}T^{0}]$

Question94

Match List-I with List-II

List-I	List-II
A. h (Planck's constant)	1. $[MLT^{-1}]$
B. E (kinetic energy)	2$[ML^2T^{-1}]$
C. V (electric potential)	3. $[ML^2T^{-2}]$
D. P (linear momentum)	4. $[ML^2I^{-1}T^{-3}]$

Choose the correct answer from the options given below.
[25 Feb 2021 Shift 1]

Options:

A. (A-3), (B-4), (C-2), (D-1)

B. (A-2), (B-3), (C-4), (D-1)

C. (A-1), (B-2), (C-4), (D-3)

D. (A-3), (B-2), (C-4), (D-1)

Answer: B

Solution:

The dimensional formulae of given terms are
Planck's constant (h) = $[ML^2T^{-1}]$
Kinetic energy (E) = $[ML^2T^{-2}]$
Electric potential (V) = $[ML^{2-11}T^{-3}]$
Linear momentum (p) = $[MLT^{-1}]$
So, the correct match is
A → 2, B → 3, C → 4, D → 1.

Question95

The work done by a gas molecule in an isolated system is given by,
$W = \alpha\beta^2 e^{-\frac{x^2}{\alpha kT}}$, where x is the displacement k is the Boltzmann constant and T is the temperature, α and β are constants. Then the dimension of β will be :
24Feb2021

Options:

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

B. $[MLT^{-2}]$

C. $[M^2LT^2]$

D. $[M^0LT^0]$

Answer: B

Solution:

Solution:

$\frac{x^2}{\alpha kT} \to$ dimensionless

$\Rightarrow [\alpha] = \frac{[x^2]}{[kT]} = \frac{L^2}{ML^2T^{-2}} = M^{-1}T^2$

Now, $[W] = [\alpha][\beta]^2$

$[\beta]^2 = \frac{[W]}{[\alpha]}$

$[\beta] = \left(\frac{ML^2T^{-2}}{M^{-1}T^2}\right)^{\frac{1}{2}} = MLT^{-2}$

Question96

Suppose you have taken a dilute solution of oleic acid in such a way that its concentration becomes $0.01cm^3$ of oleic acid per cm^3 of the solution. Then, you make a thin film of this solution (monomolecular thickness) of area $4cm^2$ by considering 100 spherical drops of radius $\left(\frac{3}{40\pi}\right)^{\frac{1}{3}} \times 10^{-3}$ cm^2. Then, the thickness of oleic acid layer will be $x \times 10^{-14}$m, where x is
[17 Mar 2021 Shift 2]

Answer: 25

Solution:

Given, the radius of the spherical drop

$r = \left(\frac{3}{40\pi}\right)^{1/3} \times 10^{-3}cm$

The volume of 100 spherical drops, $V = 100 \times \frac{4\pi r^3}{3}$

Substituting the value of the radius in the above equation, we get

$V = 100 \times \frac{4\pi}{3} \times \frac{3}{40\pi} \times 10^{-9}$

$V = 10^{-8}cm^3$

Now, Volume of the film = Area of the film × Thickness of the film

⇒ Volume of the film $= 4 \times t$

The film is made up of 100 spherical drops.

∴ The volume of the film = Volume of 100 spherical drops

$4t = 10^{-8} \Rightarrow t = 25 \times 10^{-12}m$

The thickness of the oleic layer,

$t_0 = 0.01 \times t = 25 \times 10^{-14}m$

Comparing with $x \times 10^{-14}$, we get $x = 25$

Question97

In order to determine the Young's modulus of a wire of radius 0.2cm (measured using a scale of least count = 0.001cm) and length 1m (measured using a scale of least count = 1mm), a weight of mass 1kg (measured using a scale of least count = 1g) was hanged to get the elongation of 0.5cm (measured using a scale of least count 0.001cm). What will be the fractional error in the value of Young's modulus determined by this experiment?
[16 Mar 2021 Shift 2]

Options:

A. 0.14%

B. 0.9%

C. 9%

D. 1.4%

Answer: D

Solution:

Young's modulus, $Y = \frac{\text{Stress}}{\text{Strain}} = \frac{F L}{Al}$

$\Rightarrow Y = \frac{mgL}{\pi R^2 I}$.....(i)

[$\because F = mg$ and $A = \pi R^2$]

To determine the fractional errors, we can write Eq. (i) as follows

$\frac{\Delta Y}{Y} = \frac{\Delta m}{m} + \frac{\Delta L}{I} + \frac{2 \cdot \Delta R}{R} + \frac{\Delta l}{I}$

$\Rightarrow \frac{\Delta Y}{Y} \times 100 = \frac{\Delta m}{m} \times 100 + \frac{\Delta L}{L} \times 100 + \frac{2 \Delta R}{R} \times 100 + \frac{\Delta l}{l} \times 100$

$\Rightarrow \frac{\Delta Y}{Y} \times 100 = 100\left[\frac{\Delta m}{m} + \frac{\Delta L}{L} + \frac{2 \Delta R}{R} + \frac{\Delta l}{I} \right]$

$= 100\left[\frac{1}{1000} + \frac{1}{1000} + 2\left(\frac{0.001}{0.2} \right) + \frac{0.001}{0.5} \right]$

$= \frac{1}{10} + \frac{1}{10} + 1 + \frac{1}{5} = \frac{14}{10} = 1.4\%$

Question98

One main scale division of a vernier callipers is acm and nth division of the vernier scale coincide with (n − 1) th division of the main scal
[16 Mar 2021 Shift 1]

Options:

A. The least count of the callipers (in mm) is

B. $\frac{10na}{(n-1)}$

C. $\frac{10a}{(n-1)}$

D. $\left(\frac{n-1}{10n}\right)a$

E. $\frac{10a}{n}$

Answer: E

Solution:

According to the question,
One division of main scale reading = a cm
nth vernier scale division = $(n-1)$ th main scale division
∴ One division of vernier scale reading $= \frac{(n-1) \times a}{n}$...(i)
We know that,
Least count (LC) =
[1 main scale division −1 vernier scale division] cm

$= a - \frac{(n-1)a}{n}$ [using Eq. (i)]

$= \frac{a(n-n+1)}{n} = \frac{a}{n}\mathrm{cm} = \frac{a}{n} \times 10\mathrm{mm}$

$\Rightarrow LC = \frac{10a}{n}\mathrm{mm}$

Question99

The resistance $R = \frac{V}{I}$, where $V = (50 \pm 2)V$ and $I = (20 \pm 0.2)$ A. The percentage error in R is x%. The value of x to the nearest integer is..........
[16 Mar 2021 Shift 1]

Answer: 5

Solution:

Given, $R = \frac{V}{I}$....(i)
where, &$V = (50 \pm 2)V$
$I = (20 \pm 0.2)A$
From Eq. (i)

$\frac{\Delta R}{R} \times 100 = \frac{\Delta V}{V} \times 100 + \frac{\Delta l}{l} \times 100$

% error in $R = \left[\frac{2}{50} \times 100 + \frac{0.2}{20} \times 100\right]\%$

$= [2 \times 2 + 0.2 \times 5]\%$
$= 5\%$

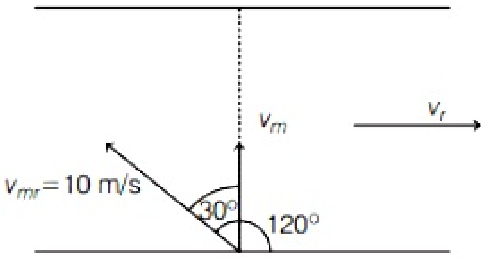
Question100

A person is swimming with a speed of 10m/s at an angle of 120° with the flow and reaches to a point directly opposite on the other side of the river. The speed of the flow is xm/s. The value of x to the nearest integer is ....
[18 Mar 2021 Shift 1]

Answer: 5

Solution:

Given,
A person's swimming speed with respect to the river, $v_{mr} = 10 \mathrm{m/s}$
As shown in the figure,



Let's determine the speed of the river flow, v_r
In X-direction,
$v_r = v_{mr} \sin 30^{\circ}$
$v_r = 10 \times \sin 30^{\circ}$
$v_r = 5 \mathrm{m/s}$
Hence, the speed of the river flow is $5 \mathrm{m/s}$. So, the value of the x to the nearest integer is 5 .

Question101

The vernier scale used for measurement has a positive zero error of 0.2mm. If while taking a measurement, it was noted that ' 0 ' on the vernier scale lies between 8.5cm and 8.6cm, vernier coincidence is 6 , then the correct value of measurement is .... cm.
[17 Mar 2021 Shift 1]

Options:

A. 8.36

B. 8.54

C. 8.58

D. 8.56

Answer: B

Solution:

Given, positive zero error $= 0.2\text{mm} = 0.02\text{cm}$
[$\therefore$ Least count $\text{LC} = 0.01\text{cm}$]
Main scale reading $= 8.5\text{cm}$
Vernier scale reading
= Vernier scale coincidence × Least count
$= 6 \times 0.01 = 0.06\text{cm}$
Final reading = Main scale reading + Vernier scale reading - Zero error
$= 8.5 + 0.06 - 0.02$
$= 8.54\text{cm}$

Question102

Assertion A : If in five complete rotations of the circular scale, the distance travelled on main scale of the screw gauge is 5 mm and there are 50 total divisions on circular scale, then least count is 0.001 cm.
Reason R :
Least Count $= \frac{\text{Pitch}}{\text{Total divisionson circular scale}}$
In the light of the above statements, choose the most appropriate answer from the options given below :
[27 Jul 2021 Shift 1]

Options:

A. A is not correct but R is correct.

B. Both A and R are correct and R is the correct explanation of A.

C. A is correct but R is not correct.

D. Both A and R are correct and R is NOT the correct explanation of A.

Answer: A

Solution:

Solution:
Least Count $= \frac{\text{Pitch}}{\text{Total divisionson circular scale}}$
In 5 revolution, distance travel, 5 mm
In 1 revolution, it will travel 1 mm.
So least count $= \frac{1}{50} = 0.02$

Question103

The force is given in terms of time t and displacement x by the equation
$\mathbf{F = A\cos Bx + C\sin Dt}$
The dimensional formula of $\frac{AD}{B}$ is :
[25 Jul 2021 Shift 2]

Options:

A. $[M^{0}LT^{-1}]$

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

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

D. $[M^{2}L^{2}T^{-3}]$

Answer: B

Solution:

$[A] = [MLT^{-2}]$
$[B] = [L^{-1}]$
$[D] = [T^{-1}]$
$$\left[\frac{AD}{B}\right] = \frac{[MLT^{-2}][T^{-1}]}{[L^{-1}]}$$
$$\left[\frac{D}{B}\right] = [ML^{2}T^{-3}]$$

Question104

If time (t), velocity (v), and angular momentum (l) are taken as the fundamental units. Then thedimension of mass (m) in terms of t, v and l is :
[20 Jul 2021 Shift 2]

Options:

A. $[t^{-1}v^{1}l^{-2}]$

B. $[t^{1}v^{2}l^{-1}]$

C. $[t^{-2}v^{-1}l^{1}]$

D. $[t^{-1}v^{-2}l^{1}]$

Answer: D

Solution:

Solution:
$m \propto t^{a}v^{b}l^{c}$
$m \propto [T]^{a}[LT^{-1}]^{b}[ML^{2}T^{-1}]^{c}$
$M^{1}L^{0}T^{0} = M^{c}L^{b+2c}T^{a-b-c}$
comparing powers
$c = 1, b = -2, a = -1$
$m \propto t^{-1}v^{-2}l^{1}$

Question105

The entropy of any system is given by

$$S = \alpha^2 \beta \ln\left[\frac{\mu k R}{J \beta^2} + 3\right]$$

where α and beta are the constants. mu, J , k and R are no. of moles, mechanical equivalent of heat, Boltzmann constant and gas constant respectively.

$$\left[\text{Take } S = \frac{dQ}{T}\right]$$

Choose the incorrect option from the following :
[20 Jul 2021 Shift 1]

Options:

A. α and J have the same dimensions.

B. S, β, k and μR have the same dimensions.

C. S and α have different dimensions.

D. α and k have the same dimensions.

Answer: D

Solution:

Solution:

$S = \alpha^2 \beta \ln\left(\frac{\mu K R}{J \beta^2} + 3\right)$

$S = \frac{Q}{T} =$ joulek /k

$[\alpha^2 \beta] =$ Joule /k

$PV = nRT \quad \left[\frac{\mu K R}{J \beta^2}\right] = 1$

$R = \frac{\text{Joule}}{K}$

$\Rightarrow R = \frac{\text{Joule}}{K}, K = \frac{\text{Joule}}{R}$

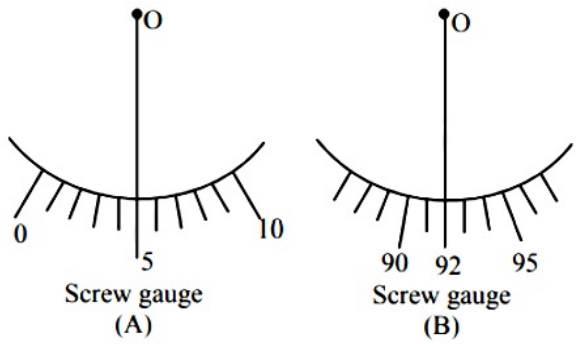
$\Rightarrow \beta = \left(\frac{\text{Joule}}{K}\right)$

$\alpha^2 \beta = \left(\frac{J_0 cle}{K}\right)$

$\Rightarrow \alpha =$ dimensionless

Question106

Student A and Student B used two screw gauges of equal pitch and 100 equal circular divisions to measure the radius of a given wire. The actual value of the radius of the wire is 0.322 cm. The absolute value of the difference between the final circular scale readings observed by the students A and B is ________.
[Figure shows position of reference 'O' when jaws of screw gauge are closed]
Given pitch = 0.1 cm.



[25 Jul 2021 Shift 1]

Answer: 13

Solution:

For (A)
Reading = MSR + CSR + Error
$0.322 = 0.300 + CSR + 5 \times LC$
$0.322 = 0.300 + CSR + 0.005$
$CSR = 0.017$
For B
Reading = MSR + CSR + Error
$0.322 = 0.200 + CSR + 0.092$
$CSR = 0.030$
Difference = 0.030 – 0.017 = 0.013 cm
Division on circular scale $= \frac{0.013}{0.001} = 13$

Question107

Three students S_1, S_2 and S_3 perform an experiment for determining the acceleration due to gravity (g) using a simple pendulum. They use different lengths of pendulum and record time for different number of oscillations. The observation same as shown in the table.

Student No.	Length of pendulum (cm	No. of oscillations (n)	Total time for n oscillations	Time period (s)
1.	64.0	8	128.0	16.0
2.	64.0	4	64.0	16.0
3.	20.0	4	36.0	9.0

(Least count of length = 0.1 m
least count for time = 0.1 s)
If E_1, E_2 and E_3 are the percentage errors in 'g' for students 1, 2 and 3 respectively, then the minimum percentage error is obtained by student no._____.
[22 Jul 2021 Shift 2]

Answer: 1

Solution:

$T = 2\pi\sqrt{\frac{l}{g}} \Rightarrow g = \frac{4\pi^2 l}{T^2}$

$\frac{\Delta g}{g} = \frac{\Delta l}{l} + \frac{2\Delta T}{T}$

$\Delta T = \frac{\text{least count of time } (\Delta T_0)}{\text{number of oscillations}(n)}$

$\frac{\Delta g}{g} = \frac{\Delta l}{l} + \frac{2\Delta T_0}{nT}$

As Δl and ΔT_0 are same for all observations so $\frac{\Delta g}{g}$ is minimum for highest value of l, n and T

⇒Minimum percentage error in $mathrm\, g$ is for student number-1

Question108

The diameter of a spherical bob is measured using a Vernier callipers. 9 divisions of the main scale, in the vernier calipers, are equal to 10 divisions of vernier scale. One main scale division is 1 mm. The main scale reading is 10 mm and 8thdivision of vernier scale was found to coincide exactly with one of the main scale division. If the given vernier callipers has positive zero error of 0.04 cm, then the radius of the bob is .... $\times 10^{-2}$ cm.
[31 Aug 2021 Shift 2]

Answer: 52

Solution:

Given, 9 divisions of main scale are equal to 10 divisions of Vernier scale.
i.e. 9 MSD = 10 VSD
$\Rightarrow \text{VSD} = \frac{9}{10}\text{MSD}$ ...(i)
Size of 1 main scale division,
1 MSD = 1 mm
Now, least count, LC = 1MSD − 1VSD ...(ii)
Using Eqs. (i) and (ii), we get
$\text{LC} = 1\,\text{MSD} - \frac{9}{10}\text{MSD} = \frac{1}{10}\text{MSD} = \frac{1}{10}\text{mm}$
While measuring the diameter of bob.
Main Scale Reading, MSR = 10 mm
Vernier Scale Reading, VSR = 8

Zero error, e = 0.04 cm
Now, diameter, d = [MSR + LC × VSR] − e

$= \left(10\,\text{mm} + \frac{1}{10} \times 8\,\text{mm}\right) - 0.04\,\text{cm}$

$= (10.8)\,\text{mm} - 0.04\,\text{cm}$

$= 1.08\,\text{cm} - 0.04\,\text{cm} = 1.04\,\text{cm}$

Radius, $r = \frac{d}{2} = \frac{1.04}{2}\,\text{cm} = 0.52\,\text{cm} = 52 \times 10^{-2}\,\text{cm}$

∴ Correct answer is 52.

Question109

If the length of the pendulum in pendulum clock increases by 0.1%, then the error in time per day is
[26 Aug 2021 Shift 2]

Options:

A. 86.4s

B. 4.32s

C. 43.2s

D. 8.64s

Answer: C

Solution:

Increase in length of pendulum is 0.1%.

i.e. $\frac{\Delta L}{L} \times 100 = 0.1$

Time period of pendulum is given by

$T = 2\pi\sqrt{\frac{L}{g}}$

Here, 2 π and g are constant.

$\frac{\Delta T}{T} \times 100 = \frac{1}{2}\frac{\Delta L}{L} \times 100$

$\Rightarrow \frac{\Delta T}{T} \times 100 = \frac{1}{2} \times 0.1$

$\Delta T = 0.05 \times \frac{T}{100}$

In one single day, the time in seconds is

$T = 24 \times 60 \times 60 = 86400\text{s}$

$\therefore \Delta T = 0.05 \times \frac{86400}{100} = 43.2\text{s}$

Thus, the error in time per day is 43.2 s.

Question110

In a screw gauge, 5th division of the circular scale coincides with the reference line when the ratchet is closed. There are 50 divisions on the circular scale, and the main scale moves by $0.5\,\text{mm}$ on a complete rotation. For a particular observation the reading on the main scale is $5\,\text{mm}$ and the 20th division of the circular scale coincides with reference

line. Calculate the true reading.
[26 Aug 2021 Shift 1]

Options:

A. 5.00 mm

B. 5.25 mm

C. 5.15 mm

D. 5.20 mm

Answer: C

Solution:

Least count of a screw gauge is given by
Least count (LC) = $\frac{\text{Pitch}}{\text{Number of circular scale divisions}}$
$\Rightarrow$LC = $\frac{0.5}{50}$ ...(i)
The actual reading (true reading)
= Main scale reading + Least count × Circular division − Zero error
$= 5 + \left(\frac{0.5}{50}\right) \times 20 - \frac{0.5}{50} \times 5$
[∴ Zero error = Least count × Coinciding division]
$= 5 + \frac{0.5}{50}(20 - 5)$
$= 5 + \frac{0.5}{50}(15)$
$= 5 + \frac{15}{100}$
$= \frac{515}{100}\,\text{mm} = 5.15\,\text{mm}$

Question111

Which of the following equations is dimensionally incorrect? Where, t = time, h = height, s = surface tension, θ = angle, ρ = density, a, r = radius, g = acceleration due to gravity, V = volume, p = pressure, W = work done, τ = torque,ε = permittivity, E = electric field, J = current density, L = length.
[31 Aug 2021 Shift 1]

Options:

A. $V = \frac{\pi p a^4}{8\eta L}$

B. $h = \frac{2s\cos\theta}{\rho r g}$

C. $J = \varepsilon\frac{\partial E}{\partial t}$

D. $W = \tau\theta$

Answer: A

Solution:

As we know that,
Dimensional formula of volume $= [M^0L^3T^0]$ ...(i)
Since, $F = 6\pi\eta rv$
$\therefore \eta \propto \frac{F}{rv}$
where, η is viscosity and F is force.
$\therefore [\eta] = \frac{[MLT^{-2}]}{[L.LT^{-1}]} = [ML^{-1}T^{-1}]$
So, $\left[\frac{\pi pa^4}{8\eta L}\right] = \frac{[ML^{-1}T^{-2}][L^4]}{[ML^{-1}T^{-1}][L^1]}$
$= [M^0L^3T^{-1}]$ ...(ii)
Since, Eq. (i) is not equal to Eq (ii), so option (a) is wrong.
Now, since formula of capillary rise in tube, $h = \frac{2s\cos\theta}{\rho gr}$
Dimensional formula of LHS part,
∴ [h] = [L]
Dimensional formula of RHS part
$= \frac{[s]}{[\rho][g][r]} = \frac{[MT^{-2}]}{[ML^{-3}][LT^{-2}][L]} = [L]$
Hence, $h = \frac{2s\cos\theta}{\rho rg}$ is dimensionally correct.
So, option (b) will also be dimensionally correct.
In option (c),
$J = \varepsilon\frac{dE}{\partial t}$ ...(iii)
$\Rightarrow J = \varepsilon\frac{E}{t}$
Dimension of current density J is calculated as
Since, $J = \frac{l}{A}$
$\therefore [J] = \frac{[l]}{[A]} = \frac{[A]}{[L^2]}$
$\Rightarrow [J] = [AL^{-2}]$ ...(iv)
Again, we know that
$E = \frac{1}{4\pi\varepsilon}\cdot\frac{q}{r^2}$
$\Rightarrow \varepsilon E = \frac{1}{4\pi}\cdot\frac{q}{r^2}$
$\frac{\Rightarrow \varepsilon E}{t} = \frac{1}{4\pi}\cdot\frac{q}{tr^2}$
$\Rightarrow \left[\frac{\varepsilon E}{t}\right] = \frac{[q]}{[t][r^2]} = \frac{[AT]}{[T][L^2]}$
$\left[\frac{\varepsilon E}{t}\right] = [AL^{-2}]$ ...(v)
Form Eqs. (iv) and (v), we see that Eq. (iii) is dimensionally correct.
In option (d) $W = \tau\theta$
and $\tau = r \times F$
So, dimensional formula of
$[\tau][\theta] = [r][F] = [L][MLT^{-2}] = [ML^2T^{-2}] = [W]$

Question112

If velocity [v], time [T] and force [F] are choosen as the base quantities, the dimensions of the mass will be [31 Aug 2021 Shift 2]

Options:

A. $[FT^{-1}v^{-1}]$

B. $[FTv^{-1}]$

C. $[FT^2v]$

D. $[FvT^{-1}]$

Answer: B

Solution:

When the velocity (v), time (T) and force (F) are chosen as base quantities. Then, mass is given by
$m \propto v^x T^y F^z$ ...(i)
Using dimensional formula of all quantities,
$[ML^0T^0] = [LT^{-1}]^x[T]^y[MLT^{-2}]^z$
$[M^1L^0T^0] = [M^Z L^{x+z} T^{-x+y-2z}]$
Comparing the powers of dimensions on both sides, we get
$z = 1$
$x + z = 0$ and $-x + y - 2z = 0$
$\Rightarrow x + 1 = 0$
$\Rightarrow x = -1$
and $-(-1) + y - 2(1) = 0$
$\Rightarrow 1 + y - 2 = 0$
$\Rightarrow y = 1$
Substituting these values in Eq. (i), we get
$m \propto v^{-1}T^1F^1$
$\Rightarrow m = [FTv^{-1}]$

Question113

If force (F), length (L) and time (T) are taken as the fundamental quantities. Then what will be the dimension of density:
[27 Aug 2021 Shift 2]

Options:

A. $[FL^{-4}T^2]$

B. $[FL^{-3}T^2]$

C. $[FL^{-5}T^2]$

D. $[FL^{-3}T^3]$

Answer: A

Solution:

As we know that, the dimensional formula of
density $[D] = [M L^{-3} T^0]$
Since, dimensional formula of force
$[F] = [M L T^{-2}]$
Dimensional formula of length
$[L] = [M^0 L^1 T^0]$
Dimensional formula of time
$[T] = [M^0 L^0 T^1]$
$\therefore [D] = [F]^a [L]^b [T]^c$
$\Rightarrow [M L^{-3} T^0] = [M L^{-2}]^a$

$[M^0L^1T^0]^b[M^0L^0T^1]^c$
$= [M^aL^{a+b}T^{-2a+c}]$
Comparing powers of dimensions on both sides, we get
$ca = 1$
$a + b = -3$
$\Rightarrow b = -3 - 1 = -4$
and $-2a + c = 0$
$c = 2a$
$\Rightarrow c = 2 \times 1 = 2$
∴ Dimensional formula of density will be
$[F^1L^{-4}T^2]$.

Question114

Which of the following is not a dimensionless quantity? [27 Aug 2021 Shift 1]

Options:

A. Relative magnetic permeability (μ_r)

B. Power factor

C. Permeability of free space (μ_0)

D. Quality factor

Answer: C

Solution:

Relative magnetic permeability (μ_r) It is the ratio of permeability of medium to the permeability of free space i.e.,

$$\mu_r = \frac{\mu_m}{\mu_0}$$

As, it is a ratio of permeabilities. So, it is unitless and dimensionless quantity.
Power factor ($\cos\phi$) It is cosine of phase difference between alternating current and alternating voltage. Hence, it has only a numerical value, so it is also a unitless and dimensionless quantity.
Permeability of free space (μ_0) It is the ratio of magnetising field induction (B) to magnetising field intensity (H)

i.e. $\mu_0 = \frac{B}{H}$

$\Rightarrow [\mu_0] = \frac{[B]}{[H]}$ ...(i)

Since, $H = nI$
where, n = number of turns per unit length
and I = current
$\therefore [H] = [n][I]$
$= [L^{-1}][A] = [AL^{-1}]$
We know that, force on a current carrying conductor in magnetic field B is given as
F = IBl
where, l = length of the conductor,
B = magnetic field
and I = current.

$\therefore B = \frac{F}{Il}$

$\Rightarrow [B] = \frac{[F]}{[I][l]} = \frac{[MLT^{-2}]}{[A][L]} = [MT^{-2}A^{-1}]$

∴From Eq. (i), we have

$[\mu_0] = \frac{[MT^{-2}A^{-1}]}{[AL^{-1}]} = [MLT^{-2}A^{-2}]$

Hence, permeability of free space is not a dimensionless quantity.
Quality factor It is the ratio of energy stored to the energy dissipated per cycle.

Quality factor $= \frac{\text{Energy stored}}{\text{Energy dissipated per cycle}}$
As, it is ratio of energies so, it will be unitless and dimensionless quantity.

Question115

Match List-I with List-II.

List - I	List - II
A. Magnetic induction	1.$[ML^2T^{-2}A^{-1}]$
B. Magnetic flux	2.$[ML^{-1}A]$
C. Magnetic permeability	3.$[MT^{-2}A^{-1}]$
D. Magnetisation	4.$[MLT^{-2}A^{-2}]$

Choose the most appropriate answer from the options given below. [26 Aug 2021 Shift 2]

Options:

A. A-2 B-4 C-1 D-3

B. A-2 B-1 C-4 D-3

C. A-3 B-2 C-4 D-1

D. None of the above

Answer: D

Solution:

Magnetic induction
Magnetic force of induction can be given as
$F = qvB$
$\Rightarrow B = \frac{F}{qv}$
$[B] = \frac{[F]}{[q][v]} = \frac{[MLT^{-2}]}{[AT][LT^{-1}]} = [M^1T^{-2}A^{-1}]$
Magnetic Flux Magnetic flux is the product of magnetic inductionand area.
$\phi = B \cdot A$
$[\phi] = [B][A] = [M^1T^{-2}A^{-1}][L^2]$
$= [ML^2T^{-2}A^{-1}]$
Magnetic permeability
We know that, magnetic field inside the solenoid.
$B = \mu_0 nI$
$\Rightarrow \mu_0 = \frac{B}{nI}$ (where, n is number of turns per unit length)
$\Rightarrow [\mu_0] = \frac{[B]}{[n][I]} = \frac{[MT^{-2}A^{-1}]}{[L^{-1}][A]} = [MLT^{-2}A^{-2}]$
Magnetisation The magnetic dipole moment acquired per unitvolume is known as magnetisation.
$I = \frac{M}{V}$
$[I] = \frac{[L^2A]}{[L^3]} = [L^{-1}A]$

Hence, no option is correct.

Question116

If E, L, M and G denote the quantities as energy, angular momentum, mass and constant of gravitation respectively, then the dimension of P in the formula $P = EL^2M^{-5}G^{-2}$ is
[26 Aug 2021 Shift 1]

Options:

A. $[M^0L^1T^0]$

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

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

D. $[M^0L^0T^0]$

Answer: D

Solution:

Dimension of energy, $E = [ML^2T^{-2}]$
Angular momentum, $L = [ML^2T^{-1}]$
Mass, M = [M]
and gravitational constant, $G = [M^{-1}L^3T^{-2}]$
The dimension of P in formula,
$P = EL^2M^{-5}G^{-2}$ is given as follows

$$[P] = \frac{[E][L^2]}{[M^5][C^2]}$$

$$= \frac{[ML^2T^{-2}] \times [M^2L^4T^{-2}]}{[M^5][M^{-2}L^6T^{-4}]}$$

$$= [M^0L^0T^0]$$

Question117

If E and H represent the intensity of electric field and magnetising field respectively, then the unit of E / H will be
[27 Aug 2021 Shift 1]

Options:

A. ohm

B. mho

C. joule

D. newton

Answer: A

Solution:

Unit of intensity of electric field E is Vm^{-1}.
Unit of intensity of magnetising field H is Am^{-1}.
Unit of E / H can be calculated as
$\frac{\text{Unit of E}}{\text{Unit of H}} = \frac{Vm^{-1}}{Am^{-1}} = VA = \text{ohm}.$
Thus, the unit of E / H will be ohm.

Question118

Match List-I with List-II.

List-I	List-II
A. R_H (Rydberg constant)	1. $kg\,m^{-1}\,s^{-1}$
B. h (Planck's constant)	2. $kg\,m^2\,s^{-1}$
C. μ_B (Magnetic field energy density)	3. m^{-1}
D. η (Coefficient of viscosity)	4. $kg\,m^{-1}\,s^{-2}$

Choose the most appropriate answer from the options given below. [27 Aug 2021 Shift 2]

Options:

A. A-2 B-3 C-4 D-1

B. A-3 B-2 C-4 D-1

C. A-4 B-2 C-1 D-3

D. A-3 B-2 C-1 D-4

Answer: B

Solution:

As we know that, SI unit of following terms are
(a) R_H (Rydberg constant) $= m^{-1}$
(b)h(Planck's constant)

$= J - s = kg - m^2 \cdot s^{-2} \cdot s = kg - m^2 s^{-1}$

(c) Magnetic field energy density

$(\mu_B) = \frac{\text{Energy}}{\text{Volume}}$

$= \frac{kg - m^2 s^{-2}}{m^3}$

$= kgm^{-1}s^{-2}$

(d) η (coefficient of viscosity)

$\because F = \eta A \frac{dv}{dx}$

$\therefore \eta = \frac{F\,dx}{A\,dv} = \frac{kg - ms^{-2} \cdot m}{m^2 \cdot ms^{-1}} = kgm^{-1}s^{-1}$

So, the correct match is A − 3, B − 2, C − 4 and D-1.

Question119

Two resistors $R_1 = (4 \pm 0.8)\Omega$ and $R_2 = (4 \pm 0.4)\Omega$ are connected in parallel. The equivalent resistance of their parallel combination will be [1 Sep 2021 Shift 2]

Options:

A. $(4 \pm 0.4)\Omega$

B. $(2 \pm 0.4)\Omega$

C. $(2 \pm 0.3)\Omega$

D. $(4 \pm 0.3)\Omega$

Answer: C

Solution:

Given,

$R_1 = (4 \pm 0.8)\Omega$

$R_2 = (4 \pm 0.4)\Omega$

Equivalent resistance when the resistors are connected in parallel isgiven by

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{4} + \frac{1}{4}$

$R_{eq} = 2\Omega$

Now,

$\frac{\Delta R_{eq}}{R_{eq}{}^2} = \frac{\Delta R_1}{R_1{}^2} + \frac{\Delta R_2}{R_2{}^2}$

Substituting the values in the above equation, we get

$\frac{\Delta R_{eq}}{4} = \frac{0.8}{16} + \frac{0.4}{16}$

$\Delta R_{eq} = 0.3\Omega$

∴ The equivalent resistance in parallel combination is

$R_{eq} = (2 \pm 0.3)\Omega$.

Question120

A student determined Young's modulus of elasticity using the formula $Y = \frac{MgL^3}{4bd^3\delta}$.

The value of g is taken to be $9.8 m / s^2$, without any significant error, his observations are as following.

Physical quantity	Least count of the equipment used for measurement	Observed value
Mass (M)	1 g	2 kg
Length of bar (L)	1mm	1m
Breadth of bar (b)	0.1 mm	4 cm
Thickness of bar (d)	0.01 mm	0.4 cm
Depression (δ)	0.01 mm	5 mm

Then, the fractional error in the measurement of Y is
[1 Sep 2021 Shift 2]

Options:

A. 0.0083

B. 0.0155

C. 0.155

D. 0.083

Answer: B

Solution:

The given formula of Young's modulus of elasticity,

$$Y = \frac{mgL^3}{4bd^3\delta}$$

where, Y = Young's modulus of elasticity,
m = mass of the bar,
L = length of the bar
b = breadth of the bar
d = thickness of the bar
and δ = depression of the bar.
There is no error in the value of the g.
The fractional error in the measurement of Y,

$$\frac{\Delta Y}{Y} = \frac{\Delta M}{M} + 3\frac{\Delta L}{L} + \frac{\Delta b}{b} + 3\frac{\Delta d}{d} + \frac{\Delta \delta}{\delta}$$

Substituting the values in the above expression, we get

$$\frac{\Delta Y}{Y} = \frac{10^{-3}}{2} + 3\frac{(1 \times 10^{-3})}{1} + \frac{0.1 \times 10^{-3}}{4 \times 10^{-2}} + 3\frac{(0.01 \times 10^{-3})}{0.4 \times 10^{-2}} + \frac{(0.01 \times 10^{-3})}{5 \times 10^{-3}}$$

$$\frac{\Delta Y}{Y} = 0.0155$$

The fractional error in the measurement of the Young's modulus is 0.0155.

Question121

If the screw on a screw-gauge is given six rotations, it moves by 3 mm

on the main scale. If there are 50 divisions on the circular scale the least count of the screw gauge is:
[9 Jan. 2020 I]

Options:

A. 0.001 cm

B. 0.02 mm

C. 0.01 cm

D. 0.001 mm

Answer: A

Solution:

Solution:
When screw on a screw-gauge is given six rotations, it moves by 3mm on the main scale

$\therefore$ Pitch $= \frac{3}{6} = 0.5\,\text{mm}$

$\therefore$ Least count L.C. $= \frac{\text{Pitch}}{\text{CSD}} = \frac{0.5\,\text{mm}}{50}$

$= \frac{1}{100}\,\text{mm} = 0.01\,\text{mm} = 0.001\,\text{cm}$

Question122

For the four sets of three measured physical quantities as given below. Which of the following options is correct?
(A) $A_1 = 24.36$, $B_1 = 0.0724$, $C_1 = 256.2$
(B) $A_2 = 24.44$, $B_2 = 16.082$, $C_2 = 240.2$
(C) $A_3 = 25.2$, $B_3 = 19.2812$, $C_3 = 236.183$
(D) $A_A = 25$, $B_A = 236.191$, $C_A = 19.5$
[9 Jan. 2020 II]

Options:

A.

$A_4 + B_4 + C_4 < A_1 + B_1 + C_1 < A_3 + B_3 + C_3 < A_2 + B_2 + C_2$

B.

$A_1 + B_1 + C_1 = A_2 + B_2 + C_2 = A_3 + B_3 + C_3 = A_4 + B_4 + C_4$

C.

$A_4 + B_4 + C_4 < A_1 + B_1 + C_1 = A_2 + B_2 + C_2 = A_3 + B_3 + C_3$

D. $A_1 + B_1 + C_1 < A_3 + B_3 + C_3 < A_2 + B_2 + C_2 < A_4 + B_4 + C_4$

E. None of the above

Answer: E

Solution:

Solution:
$D_1 = A_1 + B_1 + C_1 = 24.36 + 0.0724 + 256.2 = 280.6$
$D_2 = A_2 + B_2 + C_2 = 24.44 + 16.082 + 240.2 = 280.7$
$D_3 = A_3 + B_3 + C_3 = 25.2 + 19.2812 + 236.183 = 280.7$
$D_4 = A_4 + B_4 + C_4 = 25 + 236.191 + 19.5 = 281$

Question123

A simple pendulum is being used to determine the value of gravitational acceleration g at a certain place. The length of the pendulum is 25.0 cm and a stop watch with 1 s resolution measures the time taken for 40 oscillations to be 50 s. The accuracy in g is:
[8 Jan. 2020 II]

Options:

A. 5.40%

B. 3.40%

C. 4.40%

D. 2.40%

Answer: C

Solution:

Given, Length of simple pendulum, l = 25.0 cm
Time of 40 oscillation, T = 50s
Time period of pendulum $T = 2\pi\sqrt{\frac{l}{g}}$
$\Rightarrow T^2 = \frac{4\pi^2 l}{g} \Rightarrow g = \frac{4\pi^2 l}{T^2}$
$\Rightarrow$ Fractional error in g $= \frac{\Delta g}{g} = \frac{\Delta l}{l} + \frac{2\Delta T}{T}$
$\Rightarrow \frac{\Delta g}{g} = \left(\frac{0.1}{25.0}\right) + 2\left(\frac{1}{50}\right) = 0.044$
$\therefore$ Percentage error in g $= \frac{\Delta g}{g} \times 100 = 4.4\%$

Question124

Quantities The quantities $x = 1\sqrt{\mu_0 \varepsilon_0}$, $y = \frac{E}{B}$ and $z = \frac{1}{CR}$ are defined where C -capacitance, R -Resistance, l -length, E -Electric field, B -magnetic field and ε_0, μ_0, − free space permittivity and permeability respectively. Then :

[Sep. 05,2020 (II)]

Options:

A. x, y and z have the same dimension.

B. Only x and z have the same dimension.

C. Only x and y have the same dimension.

D. Only y and z have the same dimension.

Answer: A

Solution:

(a) We know that

Speed of light, $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = x$

Also, $c = \frac{E}{B} = y$

Time constant, $\tau = Rc = t$

$\therefore z = \frac{l}{Rc} = \frac{l}{t} =$ Speed

Thus, x, y, z will have the same dimension of speed.

Question125

Dimensional formula for thermal conductivity is (here K denotes the temperature :
[Sep. 04, 2020 (I)]

Options:

A. $MLT^{-2}K$

B. $MLT^{-2}K^{-2}$

C. $MLT^{-3}K$

D. $MLT^{-3}K^{-1}$

Answer: D

Solution:

Solution:

From formula, $\frac{dQ}{dt} = kA\frac{dT}{dx}$

$\Rightarrow k = \frac{\left(\frac{dQ}{dt}\right)}{A\left(\frac{dT}{dx}\right)}$

$[k] = \frac{[ML^2 \sim T^{-3}]}{[L^2][KL^{-1}]} = [MLT^{-3}K^{-1}]$

Question126

A quantity x is given by $\left(\frac{I F v^2}{W L^4}\right)$ in terms of moment of inertia I , force F , velocity v, work W and Length L. The dimensional formula for x is same as that of :
[Sep. 04, 2020 (II)]

Options:

A. planck's constant

B. force constant

C. energy density

D. coefficient of viscosity

Answer: C

Solution:

Dimension of Force F $= M^1 L^1 T^{-2}$
Dimension of velocity V $= L^1 T^{-1}$
Dimension of work $= M^1 L^2 T^{-2}$
Dimension of length $= L$
Moment of inertia $= M L^2$
$\therefore x = \frac{I F v^2}{W L^4}$
$= \frac{(M^1 L^2)(M^1 L^1 T^{-2})(L^1 T^{-2})^2}{(M^1 L^2 T^{-2})(L^4)}$
$= \frac{M^1 L^{-2} T^{-2}}{L^3} = M^1 L^{-1} T^{-2} =$ Energy density

----

Question127

Amount of solar energy received on the earth's surface per unit area per unit time is defined a solar constant. Dimension of solar constant is :
[Sep. 03, 2020 (II)]

Options:

A. $M L^2 T^{-2}$

B. $M L^0 T^{-3}$

C. $M^2 L^0 T^{-1}$

D. $M L T^{-2}$

Answer: B

Solution:

Solution:

Solar constant $= \frac{\text{Energy}}{\text{Time Area}}$

Dimension of Energy, $E = M L^2 T^{-2}$

Dimension of Time $= T$

Dimension of Area $= L^2$

$\therefore$ Dimension of Solar constant $= \frac{M^1 L^2 T^{-2}}{T L^2} = M^1 L^0 T^{-3}$

Question128

If speed V, area A and force F are chosen as fundamental units, then the dimension of Young's modulus will be : [Sep. 02, 2020 (I)]

Options:

A. $F A^2 V^{-1}$

B. $F A^2 V^{-3}$

C. $F A^2 V^{-2}$

D. $F A^{-1} V^0$

Answer: D

Solution:

Solution:

Young's modulus, $Y = \frac{\text{stress}}{\text{strain}}$

$\Rightarrow Y = \frac{F / A}{\Delta l_0 / l_0} = F A^{-1} V^0$

Question129

If momentum (P), area (A) and time (T) are taken to be the fundamental quantities then the dimensional formula for energy is : [Sep. 02, 2020 (II)]

Options:

A. $[P^2 A T^{-2}]$

B. $[P A^{-1} T^{-2}]$

C. $\left[P A^{\frac{1}{2}} T^{-1}\right]$

D. $\left[P^{\frac{1}{2}} A T^{-1}\right]$

Answer: C

Solution:

Energy, $E \propto A^a T^b P^c$
Or, $E = kA^a T^b P^c$ ....(i)
where k is a dimensionless constant and a, b and c are the exponents.
Dimension of momentum, $P = M^1 L^1 T^{-1}$
Dimension of area, $A = L^2$
Dimension of time, $T = T^1$
Putting these value in equation (i), we get
$M^1 L^2 T^{-2} = M^c L^{2a+c} T^{b-c}$
by comparison
$c = 1$
$2a + c = 2$
$b - c = -2$
$c = 1, a = \frac{1}{2}, b = -1$
$\therefore E = A^{\frac{1}{2}} T^{-1} P^1$

Question130

A screw gauge has 50 divisions on its circular scale. The circular scale is 4 units ahead of the pitch scale marking, prior to use. Upon one complete rotation of the circular scale, a displacement of 0.5 mm is noticed on the pitch scale. The nature of zero error involved, and the least count of the screw gauge, are respectively : [Sep. 06, 2020 (I)]

Options:

A. Negative, 2 mm

B. Positive, 10 mm

C. Positive, 0.1 mm

D. Positive, 0.1 mm

Answer: B

Solution:

Solution:
Given : No. of division on circular scale of screw gauge = 50
Pitch = 0.5 mm
Least count of screw gauge $= \frac{\text{Pitch}}{\text{No. of division on circular scale}}$
$= \frac{0.5}{50} \text{mm} = 1 \times 10^5 \text{m} = 10 \mu\text{m}$
And nature of zero error is positive.

Question131

The density of a solid metal sphere is determined by measuring its mass

and its diameter. The maximum error in the density of the sphere is $\left(\frac{x}{100}\right)$% . If the relative errors in measuring the mass and the diameter are 6.0% and 1.5% respectively, the value of x is ______.
[NA Sep. 06, 2020 (I)]

Answer: 1050

Solution:

Solution:

Density, $\rho = \frac{M}{V} = \frac{M}{\frac{4}{3}\pi\left(\frac{D}{2}\right)^3} \Rightarrow \rho = \frac{6}{\pi} M\, D^{-3}$

$\therefore \% \left(\frac{\Delta\rho}{\rho}\right) = \frac{\Delta m}{m} + 3\left(\frac{\Delta D}{D}\right) = 6 + 3 \times 1.5 = 10.5\%$

$\% \left(\frac{\Delta\rho}{\rho}\right) = \frac{1050}{100}\% = \left(\frac{x}{100}\right)\%$

$\therefore x = 1050.00$

Question132

A student measuring the diameter of a pencil of circular cross-section with the help of a vernier scale records the following four readings 5.50 mm, 5.55 mm, 5.45 mm, 5.65 mm, The average of these four reading is 5.5375 mm and the standard deviation of the data is 0.07395 mm. The average diameter of the pencil should therefore be recorded as :
[Sep. 06, 2020 (II)]

Options:

A. (5.5375 ± 0.0739) mm

B. (5.5375 ± 0.0740) mm

C. (5.538 ± 0.074) mm

D. (5.54 ± 0.07) mm

Answer: D

Solution:

Solution:
Average diameter, $d_{av} = 5.5375$ mm
Deviation of data, $\Delta d = 0.07395$ mm
As the measured data are upto two digits after decimal, therefore answer should be in two digits after decimal.
$\therefore d = (5.54 \pm 0.07)$ mm

Question133

A physical quantity z depends on four observables a, b, c and d , as $z = \frac{a^2 b^{\frac{2}{3}}}{\sqrt{c}\, d^3}$. The percentages of error in the measurement of a, b, c and d are 2%, 1.5%, 4% and 2.5% respectively. The percentage of error in z is :
[Sep. 05, 2020 (I)]

Options:

A. 12.25%

B. 16.5%

C. 13.5%

D. 14.5%

Answer: D

Solution:

Solution:

Given : $z = \frac{a^2 b^{\frac{2}{3}}}{\sqrt{c}\, d^3}$

Percentage error in Z, $= \frac{\Delta Z}{Z} = \frac{2\Delta a}{a} + \frac{2}{3}\frac{\Delta b}{b} + \frac{1}{2}\frac{\Delta c}{c} + \frac{3\Delta d}{d}$

$= 2 \times 2 + \frac{2}{3} \times 1.5 + \frac{1}{2} \times 4 + 3 \times 2.5 = 14.5\%$

Question134

Using screw gauge of pitch 0.1 cm and 50 divisions on its circular scale, the thickness of an object is measured. It should correctly be recorded as :
[Sep. 03, 2020 (I)]

Options:

A. 2.121 cm

B. 2.124 cm

C. 2.125 cm

D. 2.123 cm

Answer: A

Solution:

Solution:
Thickness = M.S. Reading + Circular Scale Reading (L.C.)

Here LC $= \frac{\text{Pitch}}{\text{Circular scale division}} = \frac{0.1}{50}$ = 0.002 cm per division
So, correct measurement is measurement of integral multiple of L.C.

Question135

The least count of the main scale of a vernier callipers is 1 mm. Its vernier scale is divided into 10 divisions and coincide with 9 divisions of the main scale. When jaws are touching each other, the 7th division of vernier scale coincides with a division of main scale and the zero of vernier scale is lying right side of the zero of main scale. When this vernier is used to measure length of a cylinder the zero of the vernier scale between 3.1 cm and 3.2 cm and 4th VSD coincides with a main scale division. The length of the cylinder is : (VSD is vernier scale division)
[Sep. 02, 2020 (I)]

Options:

A. 3.2 cm

B. 3.21 cm

C. 3.07 cm

D. 2.99 cm

Answer: C

Solution:

Solution:
L.C. of vernier callipers = 1 MSD – 1 VSD $= \left(1 - \frac{9}{10}\right) \times 1 = 0.1\,\text{mm} = 0.01\,\text{cm}$
Here 7th division of vernier scale coincides with a division of main scale and the zero of vernier scale is lying right side of the zero of main scale.
Zero error = 7 × 0.1 = 0.7 mm = 0.07 cm.
Length of the cylinder = measured value – zero error = (3.1 + 4 × 0.01) – 0.07 = 3.07 cm.

Question136

The density of a material in SI unit is $128\,\text{kg}\,\text{m}^{-3}$. In certain units in which the unit of length is $25\,\text{cm}$ and the unit of mass is 50g, the numerical value of density of the material is:
[10 Jan. 2019 I]

Options:

A. 40

B. 16

C. 640

D. 410

Answer: A

Solution:

Solution:
Density of material in SI unit, = $128\,\mathrm{kg}/\mathrm{m}^3$
Density of material in new system $= \frac{128(50\mathrm{g})(20)}{(25\,\mathrm{cm})^3(4)^3} = \frac{128}{64}(20) = 40$ units

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Question137

Let l , r, c and v represent inductance, resistance, capacitance and voltage, respectively. The dimension of $\frac{l}{rcv}$ in SI units will be: [12 Jan. 2019 II]

Options:

A. $[LA^{-2}]$

B. $[A^{-1}]$

C. $[LTA]$

D. $[LT^2]$

Answer: B

Solution:

Solution:
As we know, $\left[\frac{l}{r}\right] = [T]$ and $[cv] = [AT]$
$\therefore \left[\frac{l}{rcv}\right] = \left[\frac{T}{AT}\right] = [A^{-1}]$

Question138

The force of interaction between two atoms is given by $F = \alpha\beta \exp\left(-\frac{x^2}{\alpha kT}\right)$; where x is the distance, k is the Boltzmann constant and T is temperature and alpha and β are two constants. The dimensions of beta is: [11 Jan. 2019 I]

Options:

A. $M^0L^2T^{-4}$

B. M^2LT^{-4}

C. MLT^{-2}

D. $M^2L^2T^{-2}$

Answer: B

Solution:

Solution:

Force of interaction between two atoms, $F = \alpha\beta e^{\left(\frac{-x^2}{\alpha kT}\right)}$
Since exponential terms are dimensionless
$\therefore \left[\frac{x^2}{\alpha kT}\right] = M^0L^0T^0$
$\Rightarrow \frac{L^2}{[\alpha]ML^2T^{-2}} = M^0L^0T^0$
$\Rightarrow [\alpha] = M^{-1}T^2$
$[F] = [\alpha][\beta]$
$MLT^{-2} = M^{-1}T^2[\beta]$
$\Rightarrow [\beta] = M^2LT^{-4}$

Question139

If speed (V), acceleration (A) and force (F) are considered as fundamental units, the dimension of Young's modulus will be: [11 Jan. 2019 II]

Options:

A. $V^{-2}A^2F^{-2}$

B. $V^{-2}A^2F^2$

C. $V^{-4}A^{-2}F$

D. $V^{-4}A^2F$

Answer: D

Solution:

Solution:
Let $[Y] = [V]^a[F]^b[A]^c$
$[ML^{-1}T^{-2}] = [LT^{-1}]^a[MLT^{-2}]^b[LT^{-2}]^c$
$[ML^{-1}T^{-2}] = [M^bL^{a+b+c}T^{-a-2b-2c}]$
Comparing power both side of similar terms we get,
$b = 1, a + b + c = -1, -a - 2b - 2c = -2$
solving above equations we get:
$a = -4, b = 1, c = 2$
so $[Y] = [V^{-4}FA^2] = [V^{-4}A^2F]$

Question140

A quantity f is given by f = $\sqrt{\frac{hc^5}{G}}$ where c is speed of light, G universal gravitational constant and h is the Planck's constant. Dimension of f is that of :
[9 Jan. 2019 I]

Options:

A. area

B. energy

C. momentum

D. volume

Answer: B

Solution:

Solution:
Dimension of [h] = $[M L^2 T^{-1}]$
$[C] = [LT^{-1}]$
$[G] = [M^{-1} L^3 T^{-2}]$
Hence dimension of $\left[\sqrt{\frac{hC^5}{G}}\right] = \frac{[M L^2 T^{-1}] . [L^5 T^{-5}]}{[M^{-1} L^3 T^{-2}]}$
$= [M L^2 T^{-2}] =$ energy

Question141

Expression for time in terms of G (universal gravitational constant), h (Planck's constant) and c (speed of light) is proportional to:
[9 Jan. 2019 II]

Options:

A. $\sqrt{\frac{hc^5}{G}}$

B. $\sqrt{\frac{c^3}{Gh}}$

C. $\sqrt{\frac{Gh}{c^5}}$

D. $\sqrt{\frac{Gh}{c^3}}$

Answer: C

Solution:

Let $t \propto G^x h^y C^z$
Dimensions of $G = [M^{-1} \sim L^3 T^{-2}]$
$h = [M L^2 T^{-1}]$ and $C = [L T^{-1}]$
$[T] = [M^{-1} L^3 T^{-2}]^x [M L^2 T^{-1}]^y [L T^{-1}]^z$
$[M^0 L^0 T^1] = [M^{-x+y} L^{3x+2y+z} T^{-2x-y-z}]$
By comparing the powers of M, L, T both the sides
$-x + y = 0 \Rightarrow x = y$
$3x + 2y + z = 0 \Rightarrow 5x + z = 0$ ......(i)
$-2x - y - z = 1 \Rightarrow 3x + z = -1$ .....(ii)
Solving eqns. (i) and (ii),
$x = y = \frac{1}{2}, z = -\frac{5}{2}$
$\therefore t \propto \sqrt{\frac{Gh}{C^5}}$

Question142

The dimensions of stopping potential V_0 in photoelectric effect in units of Planck's constant ' h ', speed of light ' c ' and Gravitational constant ' G ' and ampere A is: [8 Jan. 2019 I]

Options:

A. $h^{\frac{1}{3}} G^{\frac{2}{3}} c^{\frac{1}{3}} A^{-1}$

B. $h^{\frac{2}{3}} c^{\frac{5}{3}} G^{\frac{1}{3}} A^{-1}$

C. $h^{-\frac{2}{3}} e^{-\frac{1}{3}} G^{\frac{4}{3}} A^{-1}$

D. $h^0 A^{-1} G^{-1} C^5$

Answer: D

Solution:

Stopping potential $(V_0) \propto h^x A^y G^Z C^r$
Here, $h =$ Planck's constant $= [M L^2 T^{-1}]$
$I =$ current $= [A]$
$G =$ Gravitational constant $= [M^{-1} L^3 T^{-2}]$
and $c =$ speed of light $= [L T^{-1}]$
$V_0 =$ potential $= [M L^2 T^{-3} A^{-1}]$
$\therefore [M L^2 T^{-3} A^{-1}] = [M L^2 T^{-1}]^x [A]^y [M^{-1} L^3 T^{-2}]^2 [L T^{-1}] r$
$M^{x-z}; L^{2x+3z+r}; T^{-x-2z-r}; A^y$
Comparing dimension of M, L, T, A, we get
$y = -1, x = 0, z = -1, r = 5$
$\therefore V_0 \propto h^0 A^{-1} G^{-1} C^5$

Question143

The dimensions of $\frac{B^2}{2\mu_0}$, where B is magnetic field and μ_0 is the magnetic permeability of vacuum, is:
[8 Jan. 2019 II]

Options:

A. $M L T^{-2}$

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

C. $M L^2 T^{-2}$

D. $M L^{-1} T^{-2}$

Answer: D

Solution:

Solution:
The quantity $\frac{B^2}{2\mu_0}$ is the energy density of magnetic field

$$\Rightarrow \left[\frac{B^2}{2\mu_0}\right] = \frac{\text{Energy}}{\text{Volume}} = \frac{\text{Force} \times \text{displacement}}{(\text{displacement})^3} = \left[\frac{M L^2 T^{-2}}{L^3}\right] = M L^{-1} T^{-2}$$

Question144

The least count of the main scale of a screw gauge is 1 mm. The minimum number of divisions on its circular scale required to measure 5 μm diameter of a wire is:
[12 Jan. 2019 I]

Options:

A. 50

B. 200

C. 100

D. 500

Answer: B

Solution:

Solution:
Least count of main scale of screw gauge = 1 mm
Least count of screw gauge $= \frac{\text{Pitch}}{\text{Number of division on circular scale}}$

$5 \times 10^{-6} = \frac{10^{-3}}{N}$

$\Rightarrow N = 200$

Question145

The diameter and height of a cylinder are measured by a meter scale to be 12.6 ± 0.1 cm and 34.2 ± 0.1 cm, respectively. What will be the value of its volume in appropriate significant figures?
[10 Jan. 2019 II]

Options:

A. $4264 \pm 81\ cm^3$

B. $4264.4 \pm 81.0\ cm^3$

C. $4260 \pm 80\ cm^3$

D. $4300 \pm 80\ cm^3$

Answer: C

Solution:

Solution:

$v = \frac{\pi d^2}{4} h = 4260 cm^3$

$\frac{\Delta v}{v} = \frac{2 \Delta d}{d} + \frac{\Delta h}{h}$

$\Delta v = 2 \times \frac{0.1v}{12.6} + \frac{0.1v}{34.2} = \frac{0.2}{126} \times 4260 + \frac{0.1 \times 4260}{34.2} = 80$

$\therefore$ Volume $= 4260 \pm 80 cm^3$.

Question146

The pitch and the number of divisions, on the circular scale for a given screw gauge are 0.5 mm and 100 respectively. When the screw gauge is fully tightened without any object, the zero of its circular scale lies 3 division below the mean line.
The readings of the main scale and the circular scale, for a thin sheet, are 5.5 mm and 48 respectively, the thickness of the sheet is:
[9 Jan. 2019 II]

Options:

A. 5.755 mm

B. 5.950 mm

C. 5.725 mm

D. 5.740 mm

Answer: C

Solution:

Least count of screw gauge,
$LC = \frac{\text{Pitch}}{\text{No. of division}}$
$= 0.5 \times 10^{-3} = 0.5 \times 10^{-2}\,\text{mm} + \text{ve error}$
$= 3 \times 0.5 \times 10^{-2}\,\text{mm} = 1.5 \times 10^{-2}\,\text{mm} = 0.015\,\text{mm}$
Reading = MSR + CSR – (+ve error) $= 5.5\,\text{mm} + (48 \times 0.5 \times 10^{-2}) - 0.015$
= 5.5 + 0.24 – 0.015 = 5.725 mm

Question147

Which of the following combinations has the dimension of electrical resistance ($\in_0$ is the permittivity of vacuum and μ_0 is the permeability of vacuum)?
[12 April 2019 I]

Options:

A. $\sqrt{\frac{\mu_0}{\varepsilon_0}}$

B. $\frac{\mu_0}{\varepsilon_0}$

C. $\sqrt{\frac{\varepsilon_0}{\mu_0}}$

D. $\frac{\varepsilon_0}{\mu_0}$

Answer: A

Solution:

Solution:
$\sqrt{\frac{\mu_0}{\varepsilon_0}} = \sqrt{\frac{\mu_0^{\ 2}}{\varepsilon_0\mu_0}} = \mu_0 c\ \left(\frac{1}{\sqrt{\mu_0\varepsilon_0}} = c\right)$
$\mu_0 c \rightarrow M\,LT^{-2}A^{-2} \times LT^{-1}$
$M\,L^2T^{-3}A^{-2}$
Dimensions of resistance

Question148

In the formula $X = 5YZ^2$, X and Z have dimensions of capacitance and magnetic field, respectively. What are the dimensions of Y in SI units ?
[10 April 2019 II]

Options:

A. $[M^{-3}L^{-2}T^{8}A^{4}]$

B. $[M^{-1}L^{-2}T^{4}A^{2}]$

C. $[M^{-2}L^{0}T^{-4}A^{-2}]$

D. $[M^{-2}L^{-2}T^{6}A^{3}]$

Answer: A

Solution:

Solution:

$X = 5YZ^2$

$\Rightarrow Y \propto \frac{X}{Z^2}$ ....(i)

$X = \text{Capacitance} = \frac{Q}{V} = \frac{Q^2}{W} = \frac{[A^2T^2]}{[ML^2T^{-2}]}$

$X = [M^{-1}L^{-2}T^{4}A^{2}]$

$Z = B = \frac{F}{IL} [\because F = ILB]$

$Z = [MT^{-2}A^{-1}]$

$Y = \frac{[M^{-1}L^{-2}T^{4}A^{2}]}{[MT^{-2}A^{-1}]^2}$

$Y = [M^{-3}L^{-2}T^{8}A^{4}]$ (Using (i))

Question149

In SI units, the dimensions of $\sqrt{\frac{\epsilon_0}{\mu_0}}$ is:

[8 April 2019 I]

Options:

A. $A^{-1}TML^{3}$

B. $AT^{2}M^{-1}L^{-1}$

C. $AT^{-3}ML^{3/2}$

D. $A^{2}T^{3}M^{-1}L^{-2}$

Answer: D

Solution:

Solution:

$\left[\sqrt{\frac{\varepsilon_0}{\mu_0}}\right] = \sqrt{\frac{\varepsilon_0^2}{\mu_0\varepsilon_0}} = \left[\frac{\varepsilon_0}{\sqrt{\mu_0\varepsilon_0}}\right] = \varepsilon_0 C[LT^{-1}] \times [\varepsilon_0] \left[\because \frac{1}{\sqrt{\mu_0\varepsilon_0}} = C\right]$

$\because F = \frac{q^2}{4\pi\varepsilon_0 r^2}$

$\Rightarrow [\varepsilon_0] = \frac{[AT]^2}{[MLT^{-2}] \times [L^2]} = [A^2M^{-1}L^{-3}T^{4}]$

$\therefore \left[\sqrt{\frac{\varepsilon_0}{\mu_0}}\right] = [LT^{-1}] \times [A^2M^{-1}L^{-3}T^{4}]$

$= [M^{-1}L^{-2}T^{3}A^{2}]$

Question150

In the density measurement of a cube, the mass and edge length are measured as (10.00 ± 0.10) kg and (0.10 ± 0.01) m, respectively. The error in the measurement of density is:
[9 April 2019 I]

Options:

A. 0.01 kg/m^3

B. 0.10 kg/m^3

C. 0.013 kg/m^3

D. 0.31 kg/m^3

Answer: D

Solution:

Solution:

$\delta = \frac{M}{V} = \frac{M}{l^3} = M l^{-3}$

$\frac{\Delta\delta}{\delta} = \frac{\Delta M}{M} + 3\frac{\Delta l}{l} = \frac{0.10}{10.00} + 3\left(\frac{0.01}{0.10}\right) = 0.31 \text{ kg} / \text{m}^3$

Question151

The area of a square is 5.29 cm^2. The area of 7 such squares taking into account the significant figures is:
[9 April 2019 II]

Options:

A. 37 cm^2

B. 37.030 cm^2

C. 37.03 cm^2

D. 37.0 cm^2

Answer: D

Solution:

Solution:

A = 7 × 5.29 = 37.03 cm^2

The result should have three significant figures, so A = 37.0 cm^2

Question152

In a simple pendulum experiment for determination of acceleration due to gravity (g), time taken for 20 oscillations is measured by using a watch of 1 second least count. The mean value of time taken comes out to be 30 s. The length of pendulum is measured by using a meter scale of least count 1 mm and the value obtained is 55.0 cm. The percentage error in the determination of g is close to :
[8 April 2019 II]

Options:

A. 0.7%

B. 0.2%

C. 3.5%

D. 6.8%

Answer: D

Solution:

Solution:
We have

$T = 2\pi\sqrt{\frac{l}{g}}$ or $g = 4\pi^2\frac{l}{T^2}$

$\frac{\Delta g}{g} \times 100 = \frac{\Delta R}{Q} \times 100 + 2\frac{\Delta T}{T} \times 100$

$= \frac{0.1}{55} \times 100 + 2\left(\frac{1}{30}\right) \times 100$

$= 0.18 + 6.67 = 6.8\%$

Question153

The characteristic distance at which quantum gravitational effects are significant, the Planck length, can be determined from a suitable combination of the fundamental physical constants G, h and c. Which of the following correctly gives the Planck length?
[Online April 15, 2018]

Options:

A. G^2hc

B. $\left(\frac{Gh}{c^3}\right)^{\frac{1}{2}}$

C. $G^{\frac{1}{2}}h^2c$

D. Gh^2c^3

Answer: B

Solution:

Solution:
Plank length is a unit of length, $l_p = 1.616229 \times 10^{-35}$m

$l_p = \sqrt{\frac{hG}{c^3}}$

Question154

The density of a material in the shape of a cube is determined by measuring three sides of the cube and its mass. If the relative errors in measuring the mass and length are respectively 1.5% and 1%, the maximum error in determining the density is:
[2018]

Options:

A. 2.5%

B. 3.5%

C. 4.5%

D. 6%

Answer: C

Solution:

Solution:
1.5 % + 3 (1%) = 4.5%

Question155

The percentage errors in quantities P, Q, R and S are 0.5% 1%, 3% and 1.5% respectively in the measurement of aphysical quantity $A = \frac{P^3Q^2}{\sqrt{RS}}$. The maximum percentage error in the value of A will be
[Online April 16, 2018]

Options:

A. 8.5%

B. 6.0%

C. 7.5%

D. 6.5%

Answer: D

Solution:

Solution:

Maximum percentage error in A = + 3(% error in P) 2(% error in Q) + $\frac{1}{2}$(% error in R) + 1(% error in S)

$= 3 \times 0.5 + 2 \times 1 + \frac{1}{2} \times 3 + 1 \times 1.5$

$= 1.5 + 2 + 1.5 + 1.5 = 6.5\%$

Question156

The relative uncertainty in the period of a satellite orbiting around the earth is 10^{-2} . If the relative uncertainty in the radius of the orbit is negligible, the relative uncertainty in the mass of the earth is [Online April 16, 2018]

Options:

A. 3×10^{-2}

B. 10^{-2}

C. 2×10^{-2}

D. 6×10^{-2}

Answer: C

Solution:

Solution:
From Kepler's law, time period of a satellite,

$T = 2\pi\sqrt{\frac{r^3}{Gm}} \Rightarrow T^2 = \frac{4\pi^2}{GM}r^3$

Relative uncertainty in the mass of the earth

$\left|\frac{\Delta M}{M}\right| = 2\frac{\Delta T}{T} = 2 \times 10^{-2}$

($\because 4\pi$ & G constant and relative uncertainty in radius $\frac{\Delta r}{r}$ negligible)

Question157

The relative error in the determination of the surface area of a sphere is a. Then the relative error in the determination of its volume is [Online April 15, 2018]

Options:

A. $\frac{2}{3}\alpha$

B. 2α

C. $\frac{3}{2}\alpha$

D. α

Answer: C

Solution:

Solution:

Relative error in Surface area, $\frac{\Delta s}{s} = 2 \times \frac{\Delta r}{r} = \alpha$ and relative error in volume, $\frac{\Delta v}{v} = 3 \times \frac{\Delta r}{r}$

$\therefore$ Relative error in volume w.r.t. relative error in area, $\frac{\Delta v}{v} = \frac{3}{2}\alpha$

Question158

In a screw gauge, 5 complete rotations of the screw cause it to move a linear distance of 0.25 cm. There are 100 circular scale divisions. The thickness of a wire measured by this screw gauge gives a reading of 4 main scale divisions and 30 circular scale divisions. Assuming negligible zero error, the thickness of the wire is: [Online April 15, 2018]

Options:

A. 0.0430 cm

B. 0.3150 cm

C. 0.4300 cm

D. 0.2150 cm

Answer: D

Solution:

Solution:

Least count $= \frac{\text{Value of 1 part on main scale}}{\text{Number of parts on vernier scale}}$

$= \frac{0.25}{5 \times 100} \text{cm} = 5 \times 10^{-4} \text{cm}$

Reading $= 4 \times 0.05 \, \text{cm} + 30 \times 5 \times 10^{-4} \, \text{cm}$

$= (0.2 + 0.0150) \, \text{cm} = 0.2150 \, \text{cm}$ (Thickness of wire)

Question159

Time (T), velocity (C) and angular momentum (h) are chosen as fundamental quantities instead of mass, length and time. In terms of these, the dimensions of mass would be : [Online April 8, 2017]

Options:

A. $[M] = [T^{-1}C^{-2}h]$

B. $[M] = [T^{-1}C^{2}h]$

C. $[M] = [T^{-1}C^{-2}h^{-1}]$

D. $[M] = [T C^{-2} h]$

Answer: A

Solution:

Let mass, related as $M \propto T^{x} C^{y} h^{z}$
$M^{1} L^{0} T^{0} = (T^{1})^{x} (L^{1} T^{-1})^{y} (M^{1} L^{2} T^{-1})^{z}$
$M^{1} L^{0} T^{0} = M^{z} L^{y+2z} + T^{x-y-z}$
$\therefore z = 1$
$\Rightarrow y + 2z = 0$
$\therefore y = -2$
$x - y - z = 0$
$x + 2 - 1 = 0$
$\therefore x = -1$
$M = [T^{-1} C^{-2} h^{1}]$

Question160

The following observations were taken for determining surface tensiton T of water by capillary method :
Diameter of capilary, $D = 1.25 \times 10^{-2} m$
rise of water, $h = 1.45 \times 10^{-2} m$
Using $g = 9.80 m/s^{2}$ and the simplified relation $T = \frac{rhg}{2} \times 10^{3} N/m$, the possible error in surface tension is closest to :
[2017]

Options:

A. 2. 4 %

B. 10 %

C. 0.15%

D. 1.5%

Answer: D

Solution:

Solution:
Surface tension, $T = \frac{rhg}{2} \times 10^{3}$
Relative error in surface tension,
$\frac{\Delta T}{T} = \frac{\Delta r}{r} + \frac{\Delta h}{h} + 0$ ($\because g, 2 \& 10^{3}$ are constant)
Percentage error
$100 \times \frac{\Delta T}{T} = \left(\frac{10^{-2} \times 0.01}{1.25 \times 10^{-2}} + \frac{10^{-2} \times 0.01}{1.45 \times 10^{-2}} \right) 100$
$= (0.8 + 0.689)$
$= (1.489) = 1.489\% \cong 1.5\%$

Question161

A physical quantity P is described by the relation $P = a^{\frac{1}{2}} b^2 c^3 d^{-4}$
If the relative errors in the measurement of a, b, c and d respectively, are 2%, 1%, 3% and 5%, then the relative error in P will be :
[Online April 9, 2017]

Options:

A. 8%

B. 12%

C. 32%

D. 25%

Answer: C

Solution:

Solution:
Given, $P = a^{\frac{1}{2}} b^2 c^3 d^{-4}$
Maximum relative error,
$$\frac{\Delta P}{P} = \frac{1}{2}\frac{\Delta a}{a} + 2\frac{\Delta b}{b} + 3\frac{\Delta c}{c} + 4\frac{\Delta d}{d}$$
$$= \frac{1}{2} \times 2 + 2 \times 1 + 3 \times 3 + 4 \times 5 = 32\%$$

Question162

A, B, C and D are four different physical quantities having different dimensions. None of them is dimensionless. But we know that the equation AD = C ln (BD) holds true. Then which of the combination is not a meaningful quantity ?
[Online April 10, 2016]

Options:

A. $\frac{C}{BD} - \frac{AD^2}{C}$

B. $A^2 - B^2C^2$

C. $AB - C$

D. $\frac{(A - C)}{D}$

Answer: D

Solution:

Dimension of A ≠ dimension of (C)
Hence A – C is not possible.

Question163

In the following 'I' refers to current and other symbols have their usual meaning, Choose the option that corresponds to the dimensions of electrical conductivity :
[Online April 9, 2016]

Options:

A. $M^{-1}L^{-3}T^{3}I$

B. $M^{-1}L^{-3}T^{3}I^{2}$

C. $M^{-1}L^{3}T^{3}I$

D. $M L^{-3}T^{-3}I^{2}$

Answer: B

Solution:

Solution:

We know that resistivity $\rho = \frac{RA}{l}$

Conductivity $= \frac{1}{\text{resistivity}} = \frac{l}{RA}$

$= \frac{l\,I}{V\,A} (\because V = RI)$

$= \frac{[L][I]}{\left[\frac{[ML^{2}T^{-2}]}{[I][T]}\right] \times [L^{2}]} \left[\because V = \frac{W}{q} = \frac{W}{it}\right]$

$= [M^{-1}L^{-3}T^{3}][I^{2}] = [M^{-1}L^{-3}T^{3}I^{2}]$

Question164

A screw gauge with a pitch of 0.5 mm and a circular scale with 50 divisions is used to measure the thickness of a thin sheet of Aluminium. Before starting the measurement, it is found that wen the two jaws of the screw gauge are brought in contact, the 45th division coincides with the main scale line and the zero of the main scale is barely visible. What is the thickness of the sheet if the main scale reading is 0.5 mm and the 25th division coincides with the main scale line?
[2016]

Options:

A. 0.70 mm

B. 0.50 mm

C. 0.75 mm

D. 0.80 mm

Answer: D

Solution:

Solution:
$L.C. = \frac{0.5}{50} = 0.01\,mm$
Zero error = 5 × 0.01 = 0.05 mm (Negative)
Reading = (0.5 + 25 × 0.01) + 0.05 = 0.80 mm

Question165

A student measures the time period of 100 oscillations of a simple pendulum four times. The data set is 90 s, 91 s, 95 s, and 92 s. If the minimum division in the measuring clock is 1 s, then the reported mean time should be: [2016]

Options:

A. 92 ± 1.8 s

B. 92 ± 3s

C. 92 ± 1.5 s

D. 92 ± 5.0 s

Answer: C

Solution:

Solution:

$$\Delta T = \frac{|\Delta T_1| + |\Delta T_2| + |\Delta T_3| + |\Delta T_4|}{4}$$

$$= \frac{2+1+3+0}{4} = 1.5$$

As the resolution of measuring clock is 1.5 therefore the mean time should be 92 ± 1.5

Question166

If electronic charge e, electron mass m, speed of light in vacuum c and Planck's constant h are taken as fundamental quantities, the permeability of vacuum μ_0 can be expressed in units of : [Online April 11, 2015]

Options:

A. $\left(\frac{h}{me^2}\right)$

B. $\left(\frac{hc}{me^2}\right)$

C. $\left(\frac{h}{ce^2}\right)$

D. $\left(\frac{mc^2}{he^2}\right)$

Answer: C

Solution:

Solution:
Let μ_0 related with e, m, c and h as follows.
$\mu_0 = ke^a m^b c^c h^d$
$[MLT^{-2}A^{-2}] = [AT]^a[M]^b[LT^{-1}]^c[ML^2T^{-1}]^d$
$= [M^{b+d}L^{c+2d}T^{a-c-d}A^a]$
On comparing both sides we get
a = – 2 ...(i)
b + d = 1 ...(ii)
c + 2d = 1 ...(iii)
a – c – d = –2 ...(iv)
By equation (i), (ii), (iii) & (iv) we get,
a = – 2, b = 0, c = – 1, d = 1
$\therefore[\mu_0] = \left[\frac{h}{ce^2}\right]$

Question167

If the capacitance of a nanocapacitor is measured in terms of a unit ‘u’ made by combining the electric charge ‘e’, Bohr radius ‘a_0’ , Planck’s constant ‘h’ and speed of light ‘c’ then: [Online April 10, 2015]

Options:

A. $u = \frac{e^2h}{a_0}$

B. $u = \frac{hc}{e^2a_0}$

C. $u = \frac{e^2c}{ha_0}$

D. $u = \frac{e^2a_0}{hc}$

Answer: D

Solution:

Solution:
Let unit ' u ' related with e, a_0, h and c as follows.
$[u] = [e]^a[a_0]^b[h]^c[C]^d$

Using dimensional method,
$[M^{-1}L^{-2}T^{+4}A^{+2}] = [A^{1}T^{1}]^{a}[L]^{b}[M L2T^{-1}]^{c}[LT^{-1}]^{d}$
$[M^{-1}L^{-2}T^{+4}A^{+2}] = [M^{c}L^{b+2c+d}T^{a-c-d}A^{a}]$
$a = 2, b = 1, c = -1, d = -1$
$\therefore u = \frac{e^2 a_0}{hc}$

Question168

The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of L is 20.0 cm known to 1 mm accuracy and time for 100 oscillations of the pendulum is found to be 90 s using a wrist watch of 1s resolution. The accuracy in the determination of g is :
[2015]

Options:

A. 1%

B. 5%

C. 2%

D. 3%

Answer: D

Solution:

Solution:
As, $g = 4\pi^2 \frac{L}{T^2}$
So, $\frac{\Delta g}{g} \times 100 = \frac{\Delta L}{L} \times 100 + 2\frac{\Delta T}{T} \times 100$
$= \frac{0.1}{20} \times 100 + 2 \times \frac{1}{90} \times 100 = 2.72 \simeq 3\%$

Question169

Diameter of a steel ball is measured using a Vernier callipers which has divisions of 0.1 cm on its main scale (MS) and 10 divisions of its vernier scale (VS) match 9 divisions on the main scale. Three such measurements for a ball are given as:

S.No.	MS(cm)	VS divisions
1.	0.5	8
2.	0.5	4
3.	0.5	6

If the zero error is – 0.03 cm, then mean corrected diameter is: [Online April 10, 2015]

Options:

A. 0.52 cm

B. 0.59 cm

C. 0.56 cm

D. 0.53 cm

Answer: B

Solution:

Solution:

Least count $= \frac{0.1}{10} = 0.01$ cm

$d_1 = 0.5 + 8 \times 0.01 + 0.03 = 0.61$ cm

$d_2 = 0.5 + 4 \times 0.01 + 0.03 = 0.57$ cm

$d_3 = 0.5 + 6 \times 0.01 + 0.03 = 0.59$ cm

Mean diameter $= \frac{0.61 + 0.57 + 0.59}{3} = 0.59$ cm

Question170

From the following combinations of physical constants (expressed through their usual symbols) the only combination, that would have the same value in different systems of units, is: [Online April 12, 2014]

Options:

A. $\frac{ch}{2\pi\varepsilon_o^2}$

B. $\frac{e^2}{2\pi\varepsilon_o G m_e^2}$ (m_e = mass of electron)

C. $\frac{\mu_0\varepsilon_0}{c^2}\frac{G}{he^2}$

D. $\frac{2\pi\sqrt{\mu_o\varepsilon_o}}{ce^2}\frac{h}{G}$

Answer: B

Solution:

The dimensional formulae of
$e = [M^0L^0T^1A^1]$
$\varepsilon_0 = [M^{-1}L^3T^4A^2]$
$G = [M^{-1}L^3T^{-2}]$ and $m_e = [M^1L^0T^0]$
Now, $\frac{e^2}{2\pi\varepsilon_0 G m_e^2}$
$= \frac{[M^0L^0T^1A^1]^2}{2\pi[M^{-1}L^{-3}T^4A^2][M^{-1}L^3T^{-2}][M^1L^0T^0]^2}$
$= \frac{[T^2A^2]}{2\pi[M^{-1-1+2}L^{-3+3}T^{4-2}A^2]}$
$= \frac{[T^2A^2]}{2\pi[M^0L^0T^2A^2]} = \frac{1}{2\pi}$
$\because \frac{1}{2\pi}$ is dimensionless thus the combination $\frac{e^2}{2\pi\varepsilon_o G m_e^2}$

Question171

In terms of resistance R and time T, the dimensions of ratio $\frac{\mu}{\varepsilon}$ of the permeability m and permittivity ε is: [Online April 11, 2014]

Options:

A. $[RT^{-2}]$

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

C. $[R^2]$

D. $[R^2T^2]$

Answer: C

Solution:

Solution:
Dimensions of $\mu = [MLT^{-2}A^{-2}]$
Dimensions of $\varepsilon = [M^{-1}L^{-3}T^4A^2]$
Dimensions of $R = [ML^2T^{-3}A^{-2}]$
$\therefore \frac{\text{Dimensions of } \mu}{\text{Dimensions of } \varepsilon} = \frac{[MLT^{-2}A^{-2}]}{[M^{-1}L^{-3}T^4A^2]} = [M^2L^4T^{-6}A^{-4}] = [R^2]$

Question172

The current voltage relation of a diode is given by $I = (e^{1000V/T} - 1)$ mA, where the applied voltage V is in volts and the temperature T is in degree kelvin. If a student makes an error measuring ±0.01V while

measuring the current of 5 mA at 300 K, what will be the error in the value of current in mA?
[2014]

Options:

A. 0.2 mA

B. 0.02 mA

C. 0.5 mA

D. 0.05 mA

Answer: A

Solution:

The current voltage relation of diode is
$I = (e^{1000V/T} - 1)\,mA$ (given)
When, $I = 5mA$, $e^{1000V/T} = 6\,mA$
Also, $dI = (e^{1000V/T}) \times \frac{1000}{T}$
Error $= \pm 0.01$ (By exponential function)
$= (6\,mA) \times \frac{1000}{300} \times (0.01) = 0.2\,mA$

Question173

A student measured the length of a rod and wrote it as 3.50 cm. Which instrument did he use to measure it?
[2014]

Options:

A. A meter scale.

B. A vernier calliper where the 10 divisions in vernier scale matches with 9 division in main scale and main scale has 10 divisions in 1 cm.

C. A screw gauge having 100 divisions in the circular scale and pitch as 1 mm.

D. A screw gauge having 50 divisions in the circular scale and pitch as 1 mm.

Answer: B

Solution:

Measured length of rod = 3.50 cm
For Vernier Scale with 1 Main Scale Division = 1 mm
9 Main Scale Division = 10 Vernier Scale Division,
Least count = 1 MSD –1 VSD = 0.1 mm

Question174

Match List - I (Event) with List-II (Order of the time interval for happening of the event) and select the correct option from the options given below the lists:

List - I	List - II
(1) Rotation period of earth	(i) 10^5s
(2) Revolution period of earth	(ii) 10^7s
(3) Period of light wave	(iii) 10^{-15}s
(4) Period of sound wave	(iv) 10^{-3}s

[Online April 19, 2014]

Options:

A. (1)-(i), (2)-(ii), (3)-(iii), (4)-(iv)

B. (1)-(ii), (2)-(i), (3)-(iv), (4)-(iii)

C. (1)-(i), (2)-(ii), (3)-(iv), (4)-(iii)

D. (1)-(ii), (2)-(i), (3)-(iii), (4)-(iv)

Answer: A

Solution:

Rotation period of earth is about $24\,\text{hrs} \simeq 10^5\text{s}$
Revolution period of earth is about 365 days $\simeq 10^7\text{s}$
Speed of light wave $C = 3 \times 10^8 \text{m / s}$
Wavelength of visible light of spectrum $\lambda = 4000 - 7800\text{Å}$
$C = f\lambda \left(\text{and}\, T = \frac{1}{f}\right)$
Therefore period of light wave is 10^{-15}s (approx)

Question175

In the experiment of calibration of voltmeter, a standard cell of e.m.f. 1.1 volt is balanced against 440 cm of potential wire. The potential difference across the ends of resistance is found to balance against 220 cm of the wire. The corresponding reading of voltmeter is 0.5 volt. The error in the reading of voltmeter will be:
[Online April 12, 2014]

Options:

A. – 0. 15 volt

B. 0.15 volt

C. 0.5 volt

D. – 0.05 volt

Answer: D

Solution:

In a voltmeter
$V \propto l$
$V = kl$
Now, it is given $E = 1.1$ volt for $l_1 = 440\,cm$ and $V = 0.5$ volt for $l_2 = 220\,cm$
Let the error in reading of voltmeter be ΔV then,
$1.1 = 400K$ and $(0.5 - \Delta V) = 220K$
$\Rightarrow \frac{1.1}{440} = \frac{0.5 - \Delta V}{220}$
$\therefore \Delta V = -0.05\,volt$

Question176

An experiment is performed to obtain the value of acceleration due to gravity g by using a simple pendulum of length L. In this experiment time for 100 oscillations is measured by using a watch of 1 second least count and the value is 90.0 seconds. The length L is measured by using a meter scale of least count 1 mm and the value is 20.0 cm. The error in the determination of g would be: [Online April 9, 2014]

Options:

A. 1.7%

B. 2.7%

C. 4.4%

D. 2.27%

Answer: B

Solution:

Solution:
According to the question.
$t = (90 \pm 1)$ or, $\frac{\Delta t}{t} = \frac{1}{90}$
$l = (20 \pm 0.1)$ or, $\frac{\Delta l}{l} = \frac{0.1}{20}$
$\frac{\Delta g}{g}\% = ?$
As we know,
$t = 2\pi\sqrt{\frac{l}{g}} \Rightarrow g = \frac{4\pi^2 l}{t^2}$
or, $\frac{\Delta g}{g} = \pm\left(\frac{\Delta l}{l} + 2\frac{\Delta t}{t}\right) = \left(\frac{0.1}{20} + 2 \times \frac{1}{90}\right) = 0.027$

$\therefore \frac{\Delta g}{g}\% = 2.7\%$

Question177

A metal sample carrying a current along X -axis with density J_x is subjected to a magnetic field B_z (along z-axis). The electric field E_y developed along Y-axis is directly proportional to J_x as well as B_z. The constant of proportionality has SI unit
[Online April 25, 2013]

Options:

A. $\frac{m^2}{A}$

B. $\frac{m^3}{As}$

C. $\frac{m^2}{As}$

D. $\frac{As}{m^3}$

Answer: B

Solution:

Solution:
(b) According to question $E_y \propto J_x B_Z \therefore$ Constant of proportionality

$K = \frac{E_y}{B_Z J_x} = \frac{C}{J_x} = \frac{m^3}{As}$

[As $\frac{E}{B}$ = C(speed of light) and $J = I \ \text{Area}$]

Question178

Let $\in_0$ denote the dimensional formula of the permittivity of vacuum. If M = mass, L = length, T = time and A = electric current, then:
[2013]

Options:

A. $\in_0 = [M^{-1} L^{-3} T^2 A]$

B. $\in_0 = [M^{-1} L^{-3} T^4 A^2]$

C. $\in_0 = [M^1 L^2 T^1 A^2]$

D. $\in_0 = [M^1 L^2 T^1 A]$

Answer: B

Solution:

Solution:

As we know, $F = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{R^2}$

$\Rightarrow \epsilon_0 = \frac{q_1 q_2}{4\pi F R^2}$

Hence, $\epsilon_0 = \frac{C^2}{N \cdot m^2} = \frac{[AT]^2}{[MLT^{-2}][L^2]}$

$\Rightarrow \epsilon_0 = [M^{-1}L^{-3}T^4A^2]$

Question179

If the time period t of the oscillation of a drop of liquid of density d , radius r, vibrating under surface tension s is given by the formula $t = \sqrt{r^{2b}s^c d^{a/2}}$. It is observed that the time period is directly proportional to $\sqrt{\frac{d}{s}}$. The value of b should therefore be:

[Online April 23, 2013]

Options:

A. $\frac{3}{4}$

B. $\sqrt{3}$

C. $\frac{3}{2}$

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

Answer: C

Solution:

Question180

The dimensions of angular momentum, latent heat and capacitance are, respectively.
[Online April 22, 2013]

Options:

A. $ML^2T^1A^2$, L^2T^{-2}, $M^{-1}L^{-2}T^2$

B. ML^2T^{-2}, L^2T^2, $M^{-1}L^{-2}T^4A^2$

C. ML^2T^{-1}, L^2T^{-2}, ML^2TA^2

D. $ML^2T^{-1}, L^2T^{-2}, M^{-1}L^{-2}T^4A^2$

Answer: D

Solution:

Angular momentum $= m \times v \times r = ML^2T^{-1}$

Latent heat $L = \frac{Q}{m} = \frac{ML^2T^{-2}}{M} = L^2T^{-2}$

Capacitance $C = \frac{\text{Charge}}{P.d} = M^{-1}L^{-2}T^4A^2$

Question181

Given that K = energy, V = velocity, T = time. If they are chosen as the fundamental units, then what is dimensional formula for surface tension?
[Online May 7, 2012]

Options:

A. $[KV^{-2}T^{-2}]$

B. $[K^2V^2T^{-2}]$

C. $[K^2V^{-2}T^{-2}]$

D. $[KV^2T^2]$

Answer: A

Solution:

Solution:

Surface tension, $T = \frac{F}{l} = \frac{F}{l} \cdot \frac{l}{l} \cdot \frac{T^2}{T^2}$

(As, $F.l = K$ (energy) ; $\frac{T^2}{l^2} = V^{-2}$)

Therefore, surface tension $= [KV^{-2}T^{-2}]$

Question182

Resistance of a given wire is obtained by measuring the current flowing in it and the voltage difference applied across it. If the percentage errors in the measurement of the current and the voltage difference are 3% each, then error in the value of resistance of the wire is
[2012]

Options:

A. 6%

B. zero

C. 1%

D. 3%

Answer: A

Solution:

Solution:
According to ohm's law, $V = IR$
$R = \frac{V}{I}$
$\therefore$ Percentage error $= \frac{\text{Absolute error}}{\text{Measurement}} \times 10^2$
where, $\frac{\Delta V}{V} \times 100 = \frac{\Delta I}{I} \times 100 = 3\%$
then, $\frac{\Delta R}{R} \times 100 = \frac{\Delta V}{V} \times 10^2 + \frac{\Delta I}{I} \times 10^2$
$= 3\% + 3\% = 6\%$

Question183

A spectrometer gives the following reading when used to measure the angle of a prism.
Main scale reading : 58.5 degree
Vernier scale reading : 09 divisions
Given that 1 division on main scale corresponds to 0.5 degree. Total divisions on the Vernier scale is 30 and match with 29 divisions of the main scale. The angle of the prism from the above data is
[2012]

Options:

A. 58.59 degree

B. 58.77 degree

C. 58.65 degree

D. 59 degree

Answer: C

Solution:

Solution:
$\because$ Reading of Vernier = Main scale reading + Vernier scale reading × least count.
Main scale reading = 58.5
Vernier scale reading = 09 division
least count of Vernier = $\frac{0.5°}{30}$
Thus, $R = 58.5° + 9 \times \frac{0.5°}{30} = 58.65°$

Question184

N divisions on the main scale of a vernier calliper coincide with (N + 1) divisions of the vernier scale. If each division of main scale is ‘a’ units, then the least count of the instrument is [Online May 19, 2012]

Options:

A. a

B. $\frac{a}{N}$

C. $\frac{N}{N+1} \times a$

D. $\frac{a}{N+1}$

Answer: D

Solution:

Solution:
No. of divisions on main scale = N
No. of divisions on vernier scale = N + 1
size of main scale division = a
Let size of vernier scale division be b
then we have

$aN = b(N+1) \Rightarrow b = \frac{aN}{N+1}$

Least count is $a - b = a - \frac{aN}{N+1}$

$= a\left[\frac{N+1-N}{N+1}\right] = \frac{a}{N+1}$

Question185

A student measured the diameter of a wire using a screw gauge with the least count 0.001 cm and listed the measurements. The measured value should be recorded as [Online May 12, 2012]

Options:

A. 5.3200 cm

B. 5.3 cm

C. 5.32 cm

D. 5.320 cm

Answer: D

Solution:

The least count (L.C.) of a screw guage is the smallest length which can be measured accurately with it.
As least count is 0.001 cm $= \frac{1}{1000}$ cm
Hence measured value should be recorded upto 3 decimal places i.e., 5.320 cm

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Question186

A screw gauge gives the following reading when used to measure the diameter of a wire.
Main scale reading : 0 mm
Circular scale reading : 52 divisions
Given that 1mm on main scale corresponds to 100 divisions of the circular scale. The diameter of wire from the above data is
[2011]

Options:

A. 0.052 cm

B. 0.026 cm

C. 0.005 cm

D. 0.52 cm

Answer: A

Solution:

Solution:
Least count, L.C. $= \frac{1}{100}$ mm
Diameter of wire = MSR + CSR × L.C.
∵ 1 mm = 0.1 cm $= 0 + \frac{1}{100} \times 52$ = 0.52 mm = 0.052 cm

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Question187

The respective number of significant figures for the numbers 23.023, 0.0003 and 2.1×10^{-3} are
[2010]

Options:

A. 5, 1, 2

B. 5, 1, 5

C. 5, 5, 2

D. 4, 4, 2

Answer: A

Solution:

Solution:
Number of significant figures in 23.023 = 5
Number of significant figures in 0.0003 = 1
Number of significant figures in $2.1 \times 10^{-3} = 2$
So, the radiation belongs to X-rays part of the spectrum

Question188

In an experiment the angles are required to be measured using an instrument, 29 divisions of the main scale exactly coincide with the 30 divisions of the vernier scale. If the smallest division of the main scale is half- a degree (= 0.5°), then the least count of the instrument is: [2009]

Options:

A. half minute

B. one degree

C. half degree

D. one minute

Answer: D

Solution:

Solution:
30 Divisions of V.S. coincide with 29 divisions of M.S.
$\therefore$ 1 V.S.D $= \frac{29}{30}\text{MSD}$
L.C. = 1 MSD – 1VSD = 1 MSD - $\frac{29}{30}\text{MSD}$
$= \frac{1}{30}\text{MSD} = \frac{1}{30} \times 0.5° = 1 \text{ minute}$

Question189

The dimensions of magnetic field in M, L, T and C (coulomb) is given as [2008]

Options:

A. $[\text{M LT}^{-1}\text{C}^{-1}]$

B. $[\text{M T}^{2}\text{C}^{-2}]$

C. $[\text{M T}^{-1}\text{C}^{-1}]$

D. $[\text{M T}^{-2}\text{C}^{-1}]$

Answer: C

Solution:

Magnitude of Lorentz formula $F = qvB\sin\theta$

$B = \frac{F}{qv} = \frac{MLT^{-2}}{C \times LT^{-1}} = [MT^{-1}C^{-1}]$

Question190

A body of mass m = 3.513 kg is moving along the x-axis with a speed of 5.00 ms^{-1}. The magnitude of its momentum is recorded as [2008]

Options:

A. 17.6 kg ms^{-1}

B. 17.565 kg ms^{-1}

C. 17.56 kg ms^{-1}

D. 17.57 kg ms^{-1}

Answer: A

Solution:

Momentum, p = m × v
Given, mass of a body = 3.513 kg speed of body
= (3.513) × (5.00) = 17.565 kg m/s
= 17.6 (Rounding off to get three significant figures)

Question191

Two full turns of the circular scale of a screw gauge cover a distance of 1mm on its main scale. The total number of divisions on the circular scale is 50. Further, it is found that the screw gauge has a zero error of – 0.03 mm. While measuring the diameter of a thin wire, a student notes the main scale reading of 3 mm and the number of circular scale divisions in line with the main scale as 35. The diameter of the wire is [2008]

Options:

A. 3.32 mm

B. 3.73 mm

C. 3.67 mm

D. 3.38 mm

Answer: D

Solution:

Least count of screw gauge = 0.01 mm

$\because \frac{0.5}{50}$ mm

Reading = [M.S.R. + C.S.R. × L.C.] – (zero error)

= [3 + 35 × 0.01] – (–0.03) = 3.38 mm

Question192

Which of the following units denotes the dimension $\frac{ML^2}{Q^2}$, where Q denotes the electric charge? [2006]

Options:

A. $\frac{Wb}{m^2}$

B. Henry (H)

C. $\frac{H}{m^2}$

D. Weber (Wb)

Answer: B

Solution:

Solution:

Mutual inductance $= \frac{\phi}{I} = \frac{BA}{I}$

[Henry] $= \frac{[MT^{-1}Q^{-1}L^2]}{[QT^{-1}]} = ML^2Q^{-2}$

Question193

Out of the following pair, which one does NOT have identical dimensions ? [2005]

Options:

A. Impulse and momentum

B. Angular momentum and planck’s constant

C. Work and torque

D. Moment of inertia and moment of a force

Answer: D

Solution:

Moment of Inertia, $I = MR^2$
$[I] = [ML^2]$
Moment of force, $\vec{\tau} = \vec{r} \times \vec{F}$
$\vec{\tau} = [L][MLT^{-2}] = [ML^2T^{-2}]$

Question194

Which one of the following represents the correct dimensions of the coefficient of viscosity?
[2004]

Options:

A. $[ML^{-1}T^{-1}]$

B. $[MLT^{-1}]$

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

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

Answer: A

Solution:

Solution:
According to, Stokes law,
$F = 6\pi\eta rv \Rightarrow \eta = \frac{F}{6\pi rv}$
$\eta = \frac{[MLT^{-2}]}{[L][LT^{-1}]}$
$\Rightarrow \eta = [ML^{-1}T^{-1}]$

Question195

Dimensions of $\frac{1}{\mu_o \varepsilon_o}$, where symbols have their usual meaning, are
[2003]

Options:

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

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

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

D. $[LT^{-1}]$

Answer: C

Solution:

As we know, the velocity of light in free space is given by

$c = \frac{1}{\sqrt{\mu_o \varepsilon_o}}$

$\therefore \frac{1}{\mu_o \varepsilon_o} = e^2 = Z_1{}^2 T^2$

$\frac{1}{\sqrt{\mu_o \varepsilon_o}} = C^2 [m / s]^2 = [LT^{-1}]^2 = [M^0 L^2 T^{-2}]$

Question196

The physical quantities not having same dimensions are [2003]

Options:

A. torque and work

B. momentum and planck's constant

C. stress and young's modulus

D. speed and $(\mu_o \varepsilon_o)^{-1/2}$

Answer: B

Solution:

Solution:

Momentum, $= mv = [M LT^{-1}]$

Planck's constant,

$h = \frac{E}{v} = \frac{[M L^2 T^{-2}]}{[T^{-1}]} = [M L^2 T^{-1}]$

Question197

Identify the pair whose dimensions are equal [2002]

Options:

A. torque and work

B. stress and energy

C. force and stress

D. force and work

Answer: A

Solution:

Work $W = \vec{F} \cdot \vec{s} = F s \cos\theta$

$\because \vec{A} \cdot \vec{B} = AB \cos\theta$

$= [M LT^{-2}][L] = [M L^2 T^{-2}]$

Torque, $\vec{\tau} = \vec{r} \times \vec{F} \Rightarrow \tau = rF \sin\theta$

$\because \vec{A} \times \vec{B} = AB \sin\theta = [L][M LT^{-2}] = [M L^2 T^{-2}]$
