Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Physical Quantities

PQ

- Direction
  - Scalar
  - Vector Qty.
- Dependence.
  - Fundamental (7)
  - Derived.

Units:

2 m
5 °C
7 A

System of units

	FPS	MKS	CGS
Mass	Pound	kg	gm
Length	Foot	metre	cm
Time	Second.	s	s.

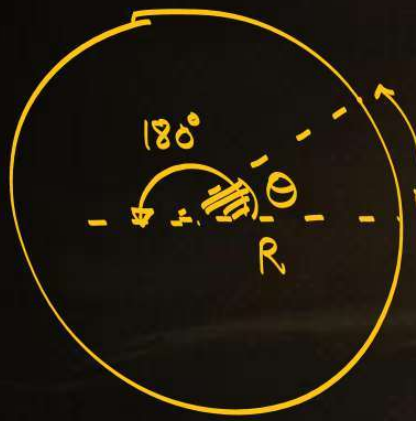
SI unit System.

(MKS + 2 Supplementary unit)

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Supplementary units

Angle "θ"



$$\theta = \frac{\text{Arclength}}{\text{Radius}}$$

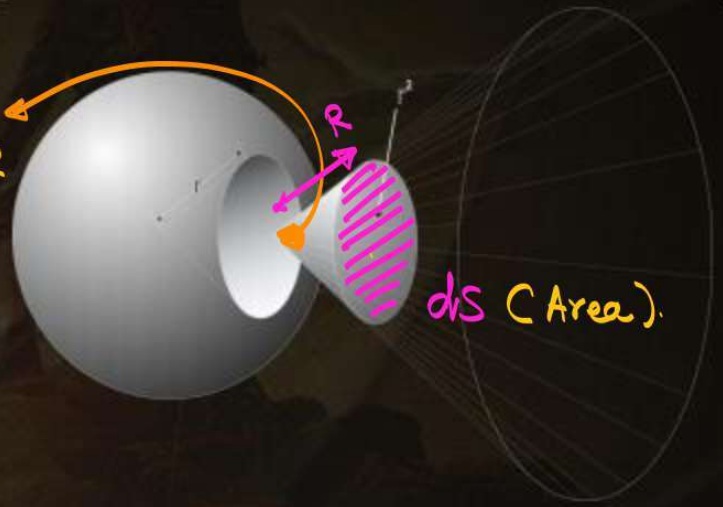
units ⇒ Radians

(180° = π radians)

Solid Angle

Ω

$$\Omega = \frac{dS}{R^2}$$



unit = Steradians

$$\Omega = \frac{2\pi R^2}{R^2} = 2\pi \text{ Str}$$

$$\Omega = \frac{4\pi R^2}{R^2} = 4\pi \text{ Str.}$$

Relation between θ & Ω

$$\Omega = 2\pi(1 - \cos\theta)$$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Dimensions

Speed = $\frac{\text{distance}}{\text{Time}} = \frac{L}{T} = [LT^{-1}]$.

The dimension of a physical quantity is defined as the power to which the fundamental quantities are raised to express the physical quantity.

SI BASE QUANTITIES AND THEIR UNITS			
S. No.	Physical quantity	Unit	Dimensions
1.	Mass	Kg	M
2.	Length	m	L
3.	Time	S	T
4.	Current	A	A or I
5.	Temperature	Kelvin	K
6.	Amount of Substance	Mol	Mol
7.	Luminous Intensity	Candela (Cd)	Cd.

Supplementary Units

- Angle → Radians ($180^\circ = \pi$ rad).
- Solid Angle → Steradians.

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

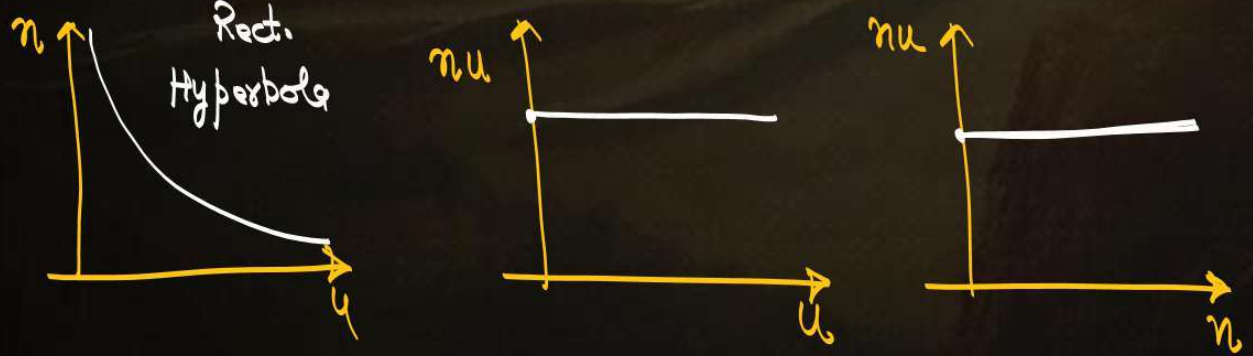
Conversions of units

Experiment → 1 Km = 1000 m (Conversion) ⟹ $n_1u_1 = n_2u_2$

Mag unit

nu = Constant

done



Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 01

Convert 1 Newton of force to CGS System

(MKS)

$F = ma = Kg\,\frac{m}{s^2}$

$1\,Newton = 1\,\frac{Kg\,m}{s^2}$

$1Kg = 1000gm$

$1m \rightarrow 100cm$

$= 1 \times 10^3 gm \times 10^2 cm \,/\, s^2$

$= 10^5 \left(\frac{gm\,cm}{s^2}\right)$

$= 10^5$ dynes

$\boxed{1N = 10^5 \text{ dynes}}$

Question - 02

Convert 1 Joules of work to CGS System

unit of work = erg.

$1J = 1 \times Kg\,\frac{m^2}{s^2}$

$= 1 \times 10^3 g \times 10^4 \frac{cm^2}{s^2}$

$= 10^7\ g\,\frac{cm^2}{s^2}$

$\boxed{1\text{ Joules} = 10^7 \text{ erg.}}$

$W = f \cdot s$

$= Kg\,\frac{m}{s^2} \cdot m$

$= Kg\,\frac{m^2}{s^2}$

$1Kg = 10^3 gm$

$1m = 10^2 cm$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 3

The density of a material in CGS system of units is 4 g/cm^3. In a system of units in which unit of length is 10 cm and unit of mass is 100 g, the value of density of material will be:

(2011 Mains)

A. 0.4

B. 40 Ans

C. 400

D. 0.04

$$\text{Density} = 4\ \frac{gm}{cm^3} \quad (SI)$$

$$= 4 \times \frac{M_{new}}{100} \Big/ \left(\frac{L_{new}}{10}\right)^3$$

$$= 4 \times \frac{1000}{100} \left(\frac{M_{new}}{(L_{new})^3}\right)$$

$$= 40$$

Unit of density in your world.

$L_{new} = 10cm$

$M_{new} = 100\,gm.$

$1\,gm = \frac{M_{new}}{100}$

$1\,cm = \frac{L_{new}}{10}$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 4

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{Kg\,m^2}{s^2 \cdot s} = \frac{Kg\,m^2}{s^3}$$

In a certain system of units, 1 unit of time is 5 sec, 1 unit of mass is 20 kg and unit of length is 10 m. In this system, one unit of power will correspond to

A) 16 watts

B) 1/16 watts

C) 25 watts

D) None of these

Ans

$$1\,\text{Watt} = 1 \times \frac{Kg\,m^2}{s^3}$$

$$= 1 \times \frac{\frac{M_{new}}{20} \times \frac{L_{new}^2}{100}}{\frac{T_{new}^3}{125}}$$

$$1\,\text{Watt} = \frac{125}{2000} \times \frac{M_{new}\,L_{new}^2}{T_{new}^3}$$

$$= \frac{1}{16} \times \frac{M_{new}\,L_{new}^2}{T_{new}^3}$$

Power unit in new System

$$1\,\text{Watt} = \frac{1}{16}\,P_{new\,system}$$

$$P_{new\,syst} = 16\,\text{Watts}$$

$T_{new} = 5\,\text{Sec}$

$M_{new} = 20\,Kg$

$L_{new} = 10\,m$

$1m = \frac{L_{new}}{10}$

$1Kg = \frac{M_{new}}{20}$

$1\,\text{Sec} = \frac{T_{new}}{5}$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Some Important Dimensions Formula

Physical Quantity	Dimensions
Distance, Displacement, Radius of gyration, Radius, Light year, Parsec, Astronomical unit	$[L]$
Speed, Velocity, Average speed, Average velocity, Terminal velocity, Critical velocity, Velocity of light, Instantaneous velocity, Escape velocity, Orbital velocity, relative velocity, Drift velocity	$[LT^{-1}]$
Acceleration, Average acceleration, Instantaneous acceleration, Acceleration due to gravity, Intensity of gravitational field, Centripetal acceleration, Centrifugal acceleration	$[LT^{-2}]$

⊛ angular Velocity

⊛ angular accelerati-ons

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Some Important Dimensions Formula

Physical Quantity	Dimensions
Force, Tension, Centripetal force, Centrifugal ~~acceleration~~ force, Friction, Normal reaction, Gravitational force , Weight, Thrust, Viscous force, Viscous drag, Restoring force, Spring force, Electrostatic force, Magnetic force, Conservative force, Non-conservative force, Lorentz force, Radiation force, Buoyant force	$[MLT^{-2}]$
Work, Energy, Kinetic energy , Potential energy, Heat energy , Thermal energy, Vibrational energy, Moment of force, Torque or couple , Strain energy, Surface energy, Work Function	$[ML^2T^{-2}]$
Pressure, Stress, Young modulus, Bulk modulus, Shear modulus, Modulus of rigidity	$\frac{F}{A} = \frac{MLT^{-2}}{L^2} = (ML^{-1}T^{-2})$
Velocity gradient, Temperature gradient, Pressure gradient, Potential gradient, , Energy gradient, Force gradient, Surface tension = $\frac{\text{Force}}{\text{Length}}$	

* Surface Tension

divide by Length.

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Some Important Dimensions Formula

Strain, Poisson's ratio, Refractive index, Dielectric constant, Coefficient of friction, Relative permeability, ,Magnetic susceptibility, Angle, Solid angle, Trigonometric ratios, Exponential constant are all dimensionless.	$[M^0L^0T^0]$
Momentum, impulse $P=mv$	
Power → work/time Latent Heat → $Q=mL$ Specific heat → $Q=ms\Delta T$	$L=\frac{Q}{m}=\frac{\text{Heat Energy}}{\text{mass}}$
Time, RC, (L/R), # ⊛ R = Resistance C = Capacitance L = Inductance.	$[T]$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

- Time period $= T$
- Frequency $= \frac{1}{T}$
- Angular displacement $\theta = M^0L^0T^0$
- Angular velocity $\omega = \frac{\theta}{T} = T^{-1}$
- Angular acceleration $\alpha = \frac{\omega}{T} = T^{-2}$
- ✗ Moment of inertia $I = mr^2$
- ✗ Angular momentum $L = mvr$.

- Charge $I = \frac{Q}{t} \Rightarrow [AT]$
- Current $= I$
- Voltage/ potential Difference $V = \frac{\text{Work}}{q}$
- Resistance $V = IR$
- Capacitance $RC = \text{Time}$
- Inductance $\frac{L}{R} = \text{time}$
- (E) Electric field $F = qE$
- (B) Magnetic field $E = BC$

C → Speed of light.

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Speed of light in terms of Permittivity and Permeability.

ε_0 μ_0

Charges

$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$

$\varepsilon_0 = \frac{q^2}{Fr^2} = \frac{A^2T^2}{MLT^{-2}L^2} =$

(*) $\text{Speed} = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$

$LT^{-1} = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$

Exponents and trigonometric ratios

$\sin\square = M^0L^0T^0$

Angle

$M^0L^0T^0$

$\cos\square = \square$

$M^0L^0T^0$ $M^0L^0T^0$

$2^{2kg} \Rightarrow X$

$2^2\ kg \Rightarrow 4\ kg$

$(M^0L^0T^0)$

Power

number

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

5

Mass Density

- Linear: $\lambda = \frac{m}{L}$
- Areal: $\sigma = \frac{m}{\text{Area}}$
- Volumetric: $\rho = \frac{m}{\text{Volume}}$

Charge Density

- Linear: $\lambda = \frac{Q}{L}$
- Areal: $\sigma = \frac{Q}{A}$
- Volumetric: $\rho = \frac{Q}{V}$

Current Density

- Linear Current: $\lambda = \frac{I}{L}$
- Areal: $J = \frac{I}{A}$ (Current / Area)

$\frac{1}{2}\varepsilon_0 E^2$ = Electric Energy density

$\frac{B^2}{2\mu_0}$ = Magnetic Energy density

Energy density

$\frac{\text{Energy}}{\text{Volume}} = \frac{ML^2T^{-2}}{L^3}$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Important Dimensions

- Gravitational constant "G" $F = G\frac{m_1 m_2}{r^2}$
- Coefficient of viscosity "η" $F = \eta r v$ $\eta = ML^{-1}T^{-1}$
- Planck's constant "h" $E = h\nu$
- Boltzmann Constant $E = K_B T$ → Temperature.

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 5

Match List-I with List-II :

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

[30 Jan, 2024 (Shift-II)]

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

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 6

Match List-I with List-II.

List-I	List-II
(a) Torque	(i) MLT^{-1}
(b) Impulse	(ii) MT^{-2}
(c) Tension	(iii) ML^2T^{-2}
(d) Surface Tension	(iv) MLT^{-2}

Energy

Momentum.

Force

Force/L = MLT⁻²/L = MT⁻²

Choose the most appropriate answer from the option given below:

Jee Main 2021 (Online) 31st Aug. Ev. Shift

Army

A (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

B (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)

C (a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)

D (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 7

Match List-I with List-II.

List-I	List-II
(a) R_H (Rydberg constant)	(i) $kg\ m^{-1}\ s^{-1}$
(b) h (Planck's constant)	(ii) $kg\ m^2\ s^{-1}$
(c) μ_B (Magnetic field) energy density)	(iii) m^{-1}
(d) η (coefficient of viscosity)	(iv) $kg\ m^{-1}\ s^{-2}$

Choose the most appropriate answer from the options given below :

Jee Main 2021 (Online) 27th Aug. Ev. Shift

A (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)

B (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)

C (a)-(iv), (b)-(ii), (c)-(i), (d)-(iii)

D (a)-(iii), (b)-(ii), (c)-(i), (d)-(iv)

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 8

Match List-I with List-II :

List I	List II
(a) h (Planck's constant)	(i) $[MLT^{-1}]$
(b) E (kinetic energy)	(ii) $[ML^2T^{-1}]$
(c) V (electric potential)	(iii) $[ML^2T^{-2}]$
(d) P (linear momentum)	(iv) $[ML^2I^{-1}T^{-3}]$

Choose the correct answer from the options given below :

Jee Main 2023 (Online) 25th February. Morning Shift

A (a)→(ii), (b)→(iii), (c)→(iv), (d)→(i)

B (a)→(i), (b)→(ii), (c)→(iv), (d)→(iii)

C (a)→(iii), (b)→(ii), (c)→(iv), (d)→(i)

D (a)→(iii), (b)→(iv), (c)→(ii), (d)→(i)

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 9

Match List-I with List-II :

List I	List II
(A) Planck's constant (h)	(I) $[M^1 L^2 T^{-2}]$
(B) Stopping Potential (Vs)	(I) $[M^1 L^1 T^{-1}]$
(C) Work Function (ϕ) = work	(III) $[M^1 L^2 T^{-1}]$
(D) Momentum (p)	(IV) $[M^1 L^2 T^{-3} A^{-1}]$

[27 Jan, 2024 (Shift-I)]

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

Ans 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

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 10

Dimensions of $\frac{1}{\mu_0 \varepsilon_0}$, where symbols have their usual meaning, are: [2023]

A $[L^{-1} T]$

B $[L^{-2} T^2]$

C $[L^2 T^{-2}]$

Ans

D $[LT^{-1}]$

$$\text{Speed} = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

$$\text{Speed}^2 = \frac{1}{\mu_0 \varepsilon_0}$$

$$(LT^{-1})^2 =$$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 11

Given below are two statements:

(T) **Statement (I):** Planck's constant and angular momentum have same dimensions.

(F) **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: **[2023]**

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

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 12

The dimension of $\frac{B^2}{2\mu_0}$, where B is magnetic field and μ_0 is the magnetic permeability of vacuum, is:

Jee Main 2024 (Online)

$\frac{B^2}{2\mu_0} \rightarrow \frac{\text{Energy}}{\text{Volume}} = \frac{ML^2T^{-2}}{L^3} = ML^{-1}T^{-2}$

A ML^2T^{-2}

B MLT^{-2}

C $ML^{-1}T^{-2}$ ✓ Ans

D ML^2T^{-1}

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Principle of Homogeneity

Same PQ $(+, -, =, >, <, \geq, \leq)$.

$L + L = L$

$L - L = L$

$L = L$

$L > L$

$L < L$

$L \geq L$

$L \leq L$

$(+, -, =)$
Ko
dhK Kar
Socho / Ratto.

Multiply & divide aap Kiso Ko bhi Kar Sakte hai

$$I = \frac{\text{Charge}}{\text{time}}$$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 13

Force Force Force

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

Where x = distance and t = time. The dimension of b^2/a are: **[31st Jan 2024 Shift-1]**

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

B $[MLT^{-2}]$

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

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

$ax^2 = F$

$aL^2 = MLT^{-2}$

$a = ML^{-1}T^{-2}$

$bT^{1/2} = MLT^{-2}$

$b = \frac{MLT^{-2}}{T^{1/2}}$

$= MLT^{-2-1/2}$

$= MLT^{-5/2}$

$\frac{b^2}{a} = \frac{M^2L^2T^{-5}}{ML^{-1}T^{-2}}$

$= ML^3T^{-3}$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 14

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, length and time respectively. The dimension of AB is

[31st Jan 2024 Shift-2]

$E = \frac{B - x^2}{At} \Rightarrow ML^2T^{-2} = \frac{L^2}{A \cdot T}$

$[B] = L^2$

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

$A \cdot B = L^2 \cdot M^{-1}T$

=

(A) $L^{-2} M^1 T^0$

(B) $L^2 M^{-1} T^1$ ✓ Ans

(C) $L^{-2} M^{-1} T^1$

(D) $L^0 M^{-1} T^2$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 15

A quantity x is given by $\left(\frac{IFv^2}{WL^4}\right)$ 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

Jee Main 2020 (Online) 4th Sept., Ev. Shift

A Coefficient of viscosity

B Force constant

C Energy density

D Planck's constant

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 16

The equation $\left(P + \frac{a}{V^2}\right)(V - b)$ constant. The units of a are

A. Dyne × cm^5

B. Dyne × cm^4

C. Dyne/cm^3

D. Dyne/cm^2

×4.

$P = \frac{F}{Area} = \frac{dyne}{cm^2}$

$\frac{a}{(cm^3)^2}$

$\frac{dyne}{cm^2} = \frac{a}{cm^6}$

$dyne \times cm^4 = a$

b = unit = ?

[V] = [b]

$cm^3 = b$

Any

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 17

In the formula $P = P_0\, e^{\frac{-hc}{x}}$, h is Planck's constant and c is speed of light. The dimensional formula for x is

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

B $[M^0 L^1 T^0]$

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

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

$P = P_0 e^{-\left(\frac{hc}{x}\right)}$ $M^0L^0T^0$

$\frac{hc}{x} = M^0L^0T^0$

$\lambda \cdot \left(\frac{hc}{\lambda}\right) = X$

$E \cdot \lambda = X$

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

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 18

Comprehension Type:

According to coulombs law of electrostatics there is a force between two charged particles q_1 and q_2 separated by a distance r such that $F \propto q_1$, $F \propto q_2$ & $F \propto \frac{1}{r^2}$; combining all three we get $F = \frac{q_1 q_2}{r^2}$ or $F = \frac{kq_1 q_2}{r^2}$, where k is a constant which depends on the medium and is given by $1/4\pi\varepsilon_0\varepsilon_r$ where ε_0 is absolute permittivity & ε_r is relative permittivity.

But in case of protons of a nucleus there exists another force called nuclear force; which is much higher in magnitude in comparison to electrostatic force and is given by $F = \frac{Ce^{-kr}}{r^2}$.

$F = \frac{Ce^{-kr}}{r^2}$

(2009 Adv)

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question – 18a

What are the dimensions of C-

(A) $M^2L^3T^{-1}$

(B) ML^3T^{-3}

(C) ML^3T^{-2} ✓

(D) ML^2T^{-3}

Question – 18b

What are the dimensions of k -

(A) L

(B) L^2

(C) L^{-3}

(D) L^{-1} ✓

$F = \frac{C e^{-kr}}{r^2}$, $[e^{-kr}] = M^0L^0T^0$

$kr = M^0L^0T^0$

$k = L^{-1}$

$[e^{-kr}] = M^0L^0T^0$

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

$MLT^{-2} = \frac{C}{L^2}$ $\Rightarrow C \Rightarrow ML^3T^{-2}$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 19

Passage:

In electromagnetic theory, the electric and magnetic phenomena are related to each other. Therefore, the dimensions of electric and magnetic quantities must also be related to each other. In the questions below, [E] and [B] stand for dimensions of electric and magnetic fields respectively, while $[\varepsilon_0]$ and $[\mu_0]$ stand for dimensions of the permittivity and permeability of free space, respectively. [L] and [T] are dimensions of length and time, respectively. All the quantities are given in SI units.

(There are two questions based on PARAGRAPH "X", the question given below is one of them)

(2018 Adv.)

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question – 19a

The relation between [E] and [B] is

$E = BC$

$E = BLT^{-1}$

$E = EF$

B = Magnetic.

$\mu_0 =$

$\varepsilon_0 =$

(A) $[E] = [B] [L] [T]$

(B) $[E] = [B] [L]^{-1} [T]$

(C) $[E] = [B] [L] [T]^{-1}$

(D) $[E] = [B] [L]^{-1} [T]^{-1}$

Question – 19b

The relation between $[\varepsilon_0]$ and $[\mu_0]$ is

$\text{Speed} = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

$L^2T^{-2} = \frac{1}{\mu_0 \varepsilon_0}$

$\mu_0 = \frac{1}{\varepsilon_0 L^2 T^{-2}} = \varepsilon_0^{-1} L^{-2} T^2$

(A) $[\mu_0] = [\varepsilon_0] [L]^2 [T]^{-2}$

(B) $[\mu_0] = [\varepsilon_0] [L]^{-2} [T]^2$

(C) $[\mu_0] = [\varepsilon_0]^{-1} [L]^2 [T]^{-2}$

(D) $[\mu_0] = [\varepsilon_0]^{-1} [L]^{-2} [T]^2$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 20

The force is given in terms of time t and displacement x by the equation

$F = A \cos Bx + C \sin Dt$

The dimensional formula of $\frac{AD}{B}$ is :

$\frac{MLT^{-2} \cdot T^{-1}}{L^{-1}} = ML^2T^{-3}$

Jee Main 2021 (Online) 25th July. Ev. Shift

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

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

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

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

$F = A \cos(Bx) + C \sin(Dt)$

$= \frac{M^0L^0T^0}{\text{Force}}$

$Bx = M^0L^0T^0$

$B = L^{-1}$

$DT = M^0L^0T^0$

$D = (T^{-1})$

$F = A$

$MLT^{-2} = A.$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 21

In a typical combustion engine the workdone by a gas molecule is given by $W = \alpha^2 \beta e^{\frac{-\beta x^2}{kT}}$, 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 :

Jee Main 2021 (Online) 26th February. Morning Shift

(A) $[M^0 LT^0]$

(B) $[MLT^{-1}]$

(C) $[MLT^{-2}]$

(D) $[M^2 LT^{-2}]$

$\dot{W} = \alpha^2 \beta e^{-\frac{\beta x^2}{kT}}$

$E = k_B T$

$ML^2T^{-2} = \alpha^2 \cdot MT^{-2}$

$\alpha = L$

$\frac{\beta L^2}{ML^2T^{-2}} = M^0L^0T^0$

$\beta = MT^{-2}$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 22

$\alpha = \frac{Fv^2}{\beta^2} \log_e\left(\frac{2\pi\beta}{v^2}\right)$ (where v = velocity, F = force)

Find the dimensions of α and β

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

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

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

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

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Application of dimensions

Correctness of formula

Correct/ Incorrect.

$KE = \frac{1}{2}mv^3$

(Dimensionally Check)

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

$D_{RHS} = ML^3T^{-3}$

$D_{LHS} \neq D_{RHS}$ (Incorrect).

Derivation.

Ex:- T depends on length & acc due to gravity

derive formula.

$T = l^2 g^3$

$T = lg$

$T = \frac{l}{g}$

$T = l^2/g^3$

$T \propto l^a$

$T \propto g^b$

$T = K l^a g^b$

$[T] = K[L]^a[LT^{-2}]^b$

$[T] = K[L^{a+b} T^{-2b}]$

$a + b = 0$

$-2b = 1$

$b = -1/2$

$a = +1/2$

$T = K l^{1/2} g^{-1/2}$

$S_{n^{th}} = u + \frac{a}{2}(2n-1)$ ⟹ "Dimensionally Correct"

$S_{n^{th}}$ → displacement in n^{th} Second.

Actual formula.

$$S_{n^{th}} = S_n - S_{n-1} = u(1\,sec) + \frac{a}{2}(2n(1\,sec) - (sec)^2)$$

u = velocity

a = acc.

n = time.

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

$$L = L + LT^{-2}T^2$$

$$L = L + L$$

$$L = L.$$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 23

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

A liquid of coefficient of viscosity flowing steadily through a capillary tube of radius 'r' and length 'l'. If V is volume of liquid flowing per second, the pressure difference 'P' at the end of tube is given by:

(A) $P = \frac{8\eta l v}{\pi r^4}$ Ans

(B) $P = \frac{8\eta r^4 l}{\pi v}$

(C) $P = \frac{8\pi l v}{\eta r^4}$

(D) $P = \frac{8\eta r^4 v}{\pi l}$

$[\gamma] = L$

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

$[l] = [L]$

$[V] = L^3T^{-1}$

$P = \frac{F}{A} = ML^{-1}T^{-2}$

Q) $D_{LHS} = ML^{-1}T^{-2}$

$D_{RHS} = \frac{MLT^{-1} \times L \times L^3T^{-1}}{L^4} = ML^{-1}T^{-2}$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 24

If energy (E), velocity (V) and force (F) be taken as fundamental quantity, then what are the dimensions of mass:

(A) $EV^2 = M$

(B) $EV^{-2} = M$

(C) $FV^{-1} = M$

(D) $FV^{-2} = M$

$M \propto E^a V^b F^c$

$M = K [ML^2T^{-2}]^a [LT^{-1}]^b [MLT^{-2}]^c$

$M^1 = K M^{a+c} L^{2a+b+c} T^{-2a-b-2c}$

$a + c = 1$

$2a + b + c = 0$

$-2a - b - 2c = 0$

$c = 1 - a$

$2a + b + 1 - a = 0$

$a + b = -1$

$a - 2 = -1$

$a = 1$

$-2a - b - 2(1-a) = 0$

$-2a - b - 2 + 2a = 0$

$-b - 2 = 0$

$b = -2$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 25

LT^{-1} $M^{-1}L^3T^{-2}$ $E=h\nu$ ML^2T^{-1}

The speed of light c, gravitational constant G and Planck's constant h are taken as fundamental units in a system. The dimensions of time in this new system should be:

(JEE Mains + Adv)

A $[G^{1/2}h^{1/2}c^{-5/2}]$ ✓

B ✗ $[G^{-1/2}h^{1/2}c^{-1/2}]$

C $[G^{-1/2}h^{1/2}c^{-3/2}]$

D $[G^{-1/2}h^{1/2}c^{1/2}]$

$x=y$

$-x+y=0$

$3x+2y+z=0$

$-2x-y-z=1.$

$T=G^x h^y c^z$

$T=[M^{-1}L^3T^{-2}]^x [ML^2T^{-1}]^y [LT^{-1}]^z$

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

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 26

If speed V, area A and force F are chosen as fundamental units, then the dimension of Young's modulus will be

Jee Main 2020 (Online) 2nd Sept., Morning. Shift

(A) $FA^{-1}V^{0}$

(B) $FA^{2}V^{-1}$

(C) $FA^{2}V^{-2}$

(D) $FA^{2}V^{-3}$

$Y = \text{pressure} = \frac{F}{A}$

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

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

$Y = K F^{a} A^{b} V^{c}$

$ML^{-1}T^{-2} = K [MLT^{-2}]^{a} [L^{2}]^{b} [LT^{-1}]^{c}$

$ML^{-1}T^{-2} = K M^{a} L^{a+2b+c} T^{-2a-c}$

$a = 1$

$a + 2b + c = -1$

$-2a - c = -2$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 27

HW

If surface tension (S), Moment of inertia (I) and Planck's constant (h), were to be taken as the fundamental units, the dimensional formula for linear momentum would be:

Jee Main 2019 (Online) 8th April, EV. Shift

(A) $S^{1/2} I^{1/2} h^0$

(B) $S^{3/2} I^{1/2} h^0$

(C) $S^{1/2} I^{1/2} h^{-1}$

(D) $S^{1/2} I^{3/2} h^{-1}$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 28

In dimension of critical velocity, of liquid flowing through a tube are expressed as $v_c \propto [\eta^x \rho^y r^z]$ where η, ρ and r are the coefficient of viscosity of liquid, density of liquid and radius of the tube respectively, then the values of x, y and z are given by:

A) 1, 1, 1

B) 1, –1, –1 Ans

C) –1, –1, 1

D) –1, –1, –1

$v_c = K \eta^x \rho^y r^z$

$LT^{-1} = K [ML^{-1}T^{-1}]^x [ML^{-3}]^y [L]^z$

$LT^{-1} = K M^{x+y} L^{-x-3y+z} T^{-x}$

$x + y = 0$

$-x - 3y + z = 1$

$-x = -1$

$x = 1$

$y = -1$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 29

Let us consider a system of units in which mass and angular momentum are dimensionless. If length has dimension of L, which of the following statement(s) is/are correct? **[JEE Adv, 2019]**

$ML^{-2} = \frac{L}{T^2} = \frac{L}{L^4} = L^{-3}$ → M → dimensionless.

Angular Momentum $= L' = mvr$

$L' = ML^{-1} \times L$

$L' = [ML^2T^{-1}]$

$L' = \frac{L^2}{T}$

$\because [L^2 = T]$

(A) The dimension of force is L^{-3}.

$ML^2T^{-2} = \frac{L^2}{T^2} = \frac{L^2}{L^4} = L^{-2}$

(B) The dimension of energy is L^{-2}.

$P = ML^2T^{-3} = \frac{L^2}{T^3} = \frac{L^2}{L^6} = L^{-4}$.

dimensionless $\leftarrow L^1$

(C) The dimension of power is L^{-5}.

(D) The dimension of linear momentum is L^{-1}.

$P = mv = ML^{-1} = \frac{L}{T} = \frac{L}{L^2} = L^{-1}$.

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question – 30 (Homework)

In a particular system of units, a physical quantity can be expressed in terms of the electric charge e, electron mass m_e, Planck's constant h, and coulomb's constant $k = \frac{1}{4\pi\varepsilon_0}$, where ε_0 is the permittivity of vacuum. In terms of these physical constants, the dimension of the magnetic field is $[B] = [e]^{\alpha}[m_e]^{\beta}[h]^{\gamma}[k]^{\delta}$. The value of $\alpha + \beta + \gamma + \delta$ is _____. [JEE Adv, 2022]

$E = Bc$

Charg m

$F = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2}$

$\frac{Fr^2}{q^2} = K$

Break nahi chaiye =  

Break chaiye = 

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Representation of Errors

Reading - $\overline{T}$ Galtiyaan.

S.no	Experimental reading	Error in each Reading	Magnitude of error
1.	1.98	−0.02	0.02
2.	1.99	−0.01	0.01
3.	2.00	0	0
4.	2.01	+0.01	0.01
5.	2.02	+0.02	0.02

Reported Value: $\overline{T} = \frac{1.98+1.99+2.00+2.01+2.02}{5}$

$= 2.00$ Sec. avg value.

Reported error: $\frac{0.02+0.01+0+0.01+0.02}{5}$

$= 0.012$

$T_{avg} = 2.00$ sec. $= \overline{T}$

Error in Experiment $= \pm 0.012 = \overline{\Delta T}$ (Mean Absolute Error).

Report = $\overline{T} \pm$ (Mean Absolute Error)

Report := Time period = 2.00 ± 0.012

$2.00 = \overline{T}$, $0.012 = \overline{\Delta T}$

Fractional Error $= \frac{\overline{\Delta T}}{\overline{T}} = \frac{0.012}{2} =$

% Error $= \frac{\overline{\Delta T}}{\overline{T}} \times 100 = \frac{0.012}{2} \times 100 =$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Progression of Error

Addition

$A = \dot{2} \pm 0.01$

$B = \dot{5} \pm 0.03$

$A+B \Rightarrow (\dot{2}+\dot{5}) \pm (0.01+0.03) = (\dot{7} \pm 0.04)$

{Mean Values alag se add, Errors alag se add}

Subtraction

$A = \dot{2} \pm 0.01$

$B = \dot{5} \pm 0.03$

$B-A = (5-2) \pm (0.01+0.03)$

$= 3 \pm 0.04$

(Mean Values Subtract, Error Ko add Karega)

Error are always Added.

Multiplication

$A = \bar{a} \pm \overline{\Delta a}$

$B = \bar{b} \pm \overline{\Delta b}$

$X = A \cdot B$

$$\frac{\Delta x}{x} = \frac{\Delta a}{a} + \frac{\Delta b}{b}$$

Division

$$X = \frac{A}{B}$$

$$\frac{\Delta x}{x} = \frac{\Delta a}{a} + \frac{\Delta b}{b}$$

Fractional Errors are added.

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Fractional error relation in Exponent relations

$$X = \frac{A^a B^b}{C^c D^d}$$

How to write fractional Error Relation.

$$\frac{\Delta x}{x} = a\frac{\Delta a}{a} + b\frac{\Delta b}{b} + c\frac{\Delta c}{c} + d\frac{\Delta d}{d}$$

C power aage karke fractional Errors add kardo).

[redacted]

Condition for error analysis: If Error is less than 5-6%

If % is more than this go by basics

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 31

A student measures the time period of 100 oscillations of a simple pendulum four times. The data set is 90s, 91s, 92s and 95s. If the minimum division in the measuring clock is 1s, then the reported mean time should be **(2016 Adv)**

(A) 92 ± 5.0 s

(B) 92 ± 1.5 s

(C) 92 ± 3 s

(D) 92 ± 2 s ✓ Ans

$\bar{T} = \frac{90+91+92+95}{4}$

$= 92$

Individual Error $= \frac{2+1+0+3}{4}$

$= \frac{6}{4} = 1.5$

$T_{Report} = 92 \pm 1.5$

Round off

$= 92 \pm 2$

Mean Error

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 32

What is the fractional error in g calculated from $T = 2\pi\sqrt{\ell/g}$? Given that fractional errors in T and ℓ are $\pm x$ and $\pm y$ respectively.

A $x + y$

B $x - y$

C $2x + y$

D $2x - y$

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

$\frac{\Delta T}{T} = \frac{1}{2}\frac{\Delta L}{L} + \frac{1}{2}\frac{\Delta g}{g}$

$x = \frac{y}{2} + \frac{1}{2}\left(\frac{\Delta g}{g}\right)$

fractional Error

$2x = \frac{\Delta g}{g} + y$

$2x + y = \frac{\Delta g}{g}$

$\frac{\Delta T}{T} = x$

$\frac{\Delta \ell}{\ell} = y$

$\frac{\Delta g}{g} = ?$

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

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

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

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

$\boxed{\frac{\Delta g}{g} = y + 2x}$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question – 33 (Error Failure case)

×3

$\frac{\Delta S}{S} \times 100 = ?$

No Error ⇒ $\Delta a = 0$

The displacement of a particle starting from rest and moving under a constant acceleration is calculated by the formula $S = \frac{1}{2} at^2$. If there occurs an error of 30% in the measurement of time interval t, what error will be introduced in the calculation of S?

A 15%

B 60% ✗

C 69% Ans

D 30%

$S = \frac{1}{2} a t^2$

Normal bacha.

$\frac{\Delta S}{S} = 2\frac{\Delta t}{t}$

$\% S = 2(\% t)$

$= 60\%$.

Jo "t"

$S = \frac{1}{2} a t^2$

$= 1 \times \left(\frac{1}{2} a t^2\right)$

$t_{new} = t + 0.3t$

$= 1.3t$

$S_{new} = \frac{1}{2} a (1.3)^2 t^2$

$= 1.69 \left(\frac{1}{2} a t^2\right)$

$\frac{\Delta S}{S} = \frac{S_{new} - S_{old}}{S_{old}} = \frac{1.69 - 1}{1} \times 100$

$= 69\%$

$= 69\%$.

$$S_{ne} = 1.69 S_i$$

$$\frac{\Delta S}{S} = \frac{S_f - S_i}{S_i} = \frac{1.69 S_i - S_i}{S_i} = 0.69.$$

$$\% \, s = 69\%.$$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question – 34 (Error Failure case)

If length of pendulum is decreased by 36 %. Find percentage decrease in time period.

A. 20%

B. 15%

C. 80%

D. 45%

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

$T_i = 2\pi\sqrt{\frac{L}{g}}$ given $L = L$

36% dec

$L_f = L - 0.36L = 0.64L$

$T_n = 2\pi\sqrt{\frac{L_n}{g}} = 2\pi\sqrt{\frac{0.64L}{g}} = 0.8\,T_i$

$T_{new} = 0.8\,T_i$

decrease = 0.2 ≈ 20%.

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 35

The inital and final temperatures of water as recorded by an observer are (50.3 ± 0.2) °C and (80.6 ± 0.3) °C. Calculate the rise in temperature with proper error limits.

$T_i = 50.3 \pm 0.2$

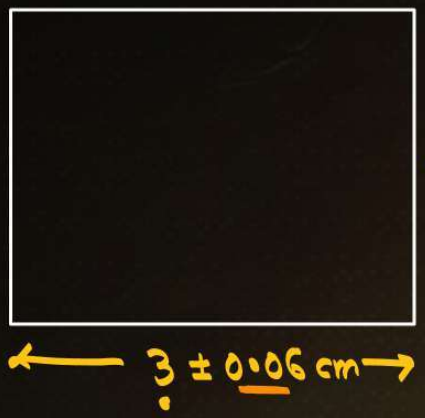
$T_f = 80.6 \pm 0.3$

Sum of Temp $= (50.3 + 80.6) \pm (0.2 + 0.3)$

$\Delta T = T_f - T_i = (80.6 - 50.3) \pm (0.3 + 0.2)$

$= 30.3 \pm 0.5$ Ans.

#



Find Area of Rectangle

$A = L \cdot B$

$\frac{\Delta A}{A} = \frac{\Delta L}{L} + \frac{\Delta B}{B}$

$\frac{\Delta A}{6} = \frac{0.06}{3} + \frac{0.08}{2}$

$\Delta A = 6\,[0.02 + 0.04]$

$= 6\,[0.06]$

$= 0.36.$

$\text{Area} = \bar{A} \pm \Delta\bar{A} = 6\,cm^2 \pm 0.36.$

Avg value

$\bar{A} = \bar{L}\bar{B}$

$= 6\,cm^2$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 36

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_____.

Jee Main 2021 (Online) 16th March. Ev. Shift

$V = 50 \pm 2$

$I = 20 \pm 0.2$

Find Resistance. $= \frac{V}{I}$

$\bar{R} = \frac{V}{I} = \frac{50}{20} = 2.5\ \Omega$

$\frac{\Delta R}{R} = \frac{\Delta V}{V} + \frac{\Delta I}{I}$

$\frac{\Delta R}{(5/2)} = \frac{2}{50} + \frac{0.2}{20}$

$\Delta R = 2.5\left[0.04 + 0.01\right]$

$= 2.5 \times 0.05$

$= 125 \times 10^{-3} = 0.125$

$R = \bar{R} \pm \Delta R$

$2.5 \pm 0.125\ \Omega$

$\% \frac{\Delta R}{R} \times 100 = \frac{0.125}{2.5} \times 100$

$R = \frac{V}{I}$ $\quad \%R = ?$

→ fractional Error

$V = 50 \pm 2$

$R \sim 20 \pm 0.2$

$$\frac{\Delta R}{R} = \frac{\Delta V}{V} + \frac{\Delta I}{I}$$

multiply 100

$$\%R = \left[\frac{\Delta V}{V} + \frac{\Delta I}{I}\right] \times 100$$

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

$$= [0.04 + 0.01] \times 100$$

$$= 5\%$$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 37

A physical quantity X is given by $X = \frac{2k^3\ell^2}{m\sqrt{n}}$ The percentage error in the measurements of k, ℓ, m and n are 1%, 2%, 3% and 4% respectively. The value of X is uncertain by

A 8%

B 10%

C 12%

D None

$X = \frac{2k^3l^2}{m n^{1/2}}$

$\frac{\Delta x}{x} = 3\frac{\Delta K}{K} + 2\frac{\Delta L}{L} + 1\frac{\Delta m}{m} + \frac{1}{2}\frac{\Delta n}{n}$

Multiply by 100

$\%x = 3(\%K) + 2(\%L) + (\%m) + \frac{1}{2}(\%n)$

$= 3 + 4 + 3 + 2$

$= 12\%$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 38

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:

Jee Main 2020 (Online) 5th Sept., Morning Shift

A 13.5%

B 14.5%

C 16.5%

D 12.25%

$Z = \frac{a^2 b^{2/3}}{c^{1/2} d^3}$

$\% z = 2(\%a) + \frac{2}{3}(\%b) + \frac{1}{2}(\%c) + 3(\%d)$

$= 2(2) + \frac{2}{3}\left(\frac{3}{2}\right) + \frac{1}{2}(4) + 3(2.5)$

$= 4 + 1 + 2 + 7.5$

$= 14.5$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 39

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_____.

Jee Main 2020 (Online) 6th Sept., Morning Shift

$$\rho = \frac{m}{V} = \frac{m}{\frac{4}{3}\pi R^3} = \frac{3m}{4\pi\left(\frac{D}{2}\right)^3}$$

$$\frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + 3\frac{\Delta D}{D}$$

$$\%\rho = 6 + 3\times 1.5$$

$$\frac{x}{100} = 10.5$$

$$x = 1050$$

$\%m = 6$

$\%D = 1.5$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 40

The relative error in the determination of the surface area of sphere is α. Then the relative error in the determination of its volume is:

Jee Main 2018 (Online) 15th April, Morning Shift

A $\frac{3}{2}\alpha$

B $\frac{2}{3}\alpha$

C $\frac{5}{2}\alpha$

D α

Ans

$S = 4\pi R^2$

$\frac{\Delta S}{S} = 2\frac{\Delta R}{R}$ $\Rightarrow$ $\alpha = 2\frac{\Delta R}{R}$

$\frac{\Delta S}{S} = \alpha$

$\frac{\alpha}{2} = \frac{\Delta R}{R}$

$V = \frac{4}{3}\pi R^3$

$\frac{\Delta V}{V} = 3\frac{\Delta R}{R} = \frac{3}{2}\alpha$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question – 41 (LC Error)

(Very Important)

The mass of a body is measured as 10.1 kg. The possible percentage error in the measurement is

(A) $\pm 1\%$ Ans

(B) $\pm 0.1\%$

(C) $\pm 10\%$

(D) $\pm 0.01\%$

10.1 → uncertain.

10.0 ⟷ 10.1

Ka Koi bhi data ho Sakta hai.

Possible Error = 0.1 ⇒ LC.

Avg value = 10 kg.

$$\% \text{ Error} = \frac{\Delta m}{m} \times 100 = \frac{0.1}{10} \times 100 = 1\%$$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 42

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 error, his observation are as following : Then the fractional error in the measurement of Y is:

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

JEE Main 2021 (Online) 1st Sept. Ev. Shift

A 0.0083

B 0.0155

C 0.155

D 0.083

Physical Quantity	Least count of the Equipment used for measurement	Observed value
Mass (M)	$\Delta m = 1\ g = 10^{-3}$ Kg	2 kg
Length of bar (L)	$\Delta l = 1$ mm $= 10^{-3}$ m	1 m
Breadth of bar (b)	Δb 0.1 mm $= 0.1 \times 10^{-1}$	4 cm
Thickness of bar (d)	Δd 0.01 mm $= 0.0 \times 10^{-1}$	0.4 cm
Depression (δ)	$\Delta\delta$ 0.01 mm	5 mm

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

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

$$= \frac{10^{-3}}{2} + 3\left[\frac{10^{-3}}{1}\right] + \left[\frac{0.1\times10^{-1}}{4}\right] + 3\left[\frac{0.01\times10^{-1}}{0.4}\right] + \left[\frac{0.01}{5}\right]$$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 43

The measured values of two resistance R_1 and R_2 are as $R_1 = (100 \pm 0.3)\Omega$, and $R_2 = (200 \pm 0.4)\Omega$. Then

$R_s = R_1 + R_2 = (100 + 200) \pm (0.3 + 0.4)$

$= 300 \pm 0.7$

A. The series resistance is $(300 \pm 0.7)\Omega$

B. The series resistance is $(100 \pm 0.1)\Omega$

C. The series resistance is $(100 \pm 0.7)\Omega$

D. The value of effective resistance R_{p_n} when connected in parallel, is given by $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$. Then $R_p = (66.7 \pm 0.18)\Omega$

NCERT Solved

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

differentiation (finding Error Relation)

$$-\frac{\Delta R_p}{R_p^2} = -\frac{\Delta R_1}{R_1^2} - \frac{\Delta R_2}{R_2^2}$$

yaad.

Error in R_p

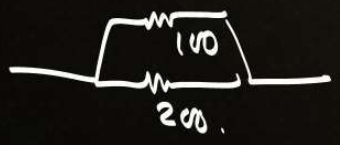
$$\frac{\Delta R_p}{R_p^2} = \frac{\Delta R_1}{R_1^2} + \frac{\Delta R_2}{R_2^2}$$

Error in R_1

Error in R_2

$R_1 = 100 \pm 0.3$

$R_2 = 200 \pm 0.4$



$$R_p = \frac{100 \times 200}{300} = \frac{200}{3} = 66.66\,\Omega.$$

$$\frac{\Delta R_p}{66.67^2} = \frac{0.3}{(100)^2} + \frac{0.4}{200^2} \Rightarrow \boxed{\Delta R_p = 0.18}$$

$$y = \frac{1}{x} = x^{-1}$$

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

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

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

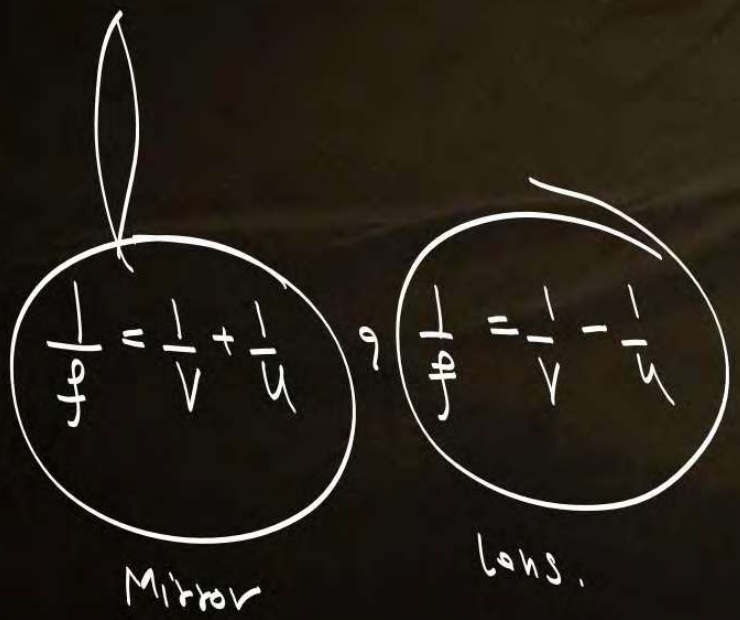
$$R_p = \underbrace{66.66}_{\text{avg}} \pm \underbrace{0.18}_{\text{Error.}}$$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question – 44 (Homework)

In an experiment for determination of the focal length of a thin convex lens, the distance of the object from the lens is 10 ± 0.1 cm and the distance of its real image from the lens is 20 ± 0.2 cm. The error in the determination of focal length of the lens is $n\%$. The value of n is _____ .

(JEE Advance 2023)



$R_1 =$

$R_2 =$

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{\Delta R_p}{}$

Break → 15 Mins.

8:20 PM
we will Resume

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question – 45 (Pendulum Problems) (NCERT Solved Example)

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 wrist watch of 1 s resolution. The accuracy in the determination of g is:

Jee Main 2015 (Offline)

$L = 20.0\ cm \quad \Delta L = 1mm = 0.1cm$

$T = 90\ sec \quad \Delta T = 1s.$

(A) 1%

(B) 5%

(C) 2%

(D) 3%

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

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

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

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

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

$\frac{\Delta g}{g} = \frac{0.1}{20} + 2\frac{1}{90}$ → Time period of 100 Oscillation

Time of 1 Oscillation $= \frac{90}{100} = T$.

Error in 1 Oscillation $= \frac{1}{100} = \Delta T$.

$$\boxed{\frac{\Delta g}{g} = \frac{0.1}{20} + 2\frac{1/100}{90/100}}$$

$\frac{\Delta g}{g} = \frac{0.1}{20} + 2\frac{1}{90}$

$\% = \left[\frac{0.1}{20} + 2\frac{1}{90}\right] \times 100 =$ ____.

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 46

$\varepsilon_{II} = \frac{0.1}{64} + 2\frac{0.1/4}{64/4} = \frac{0.1}{64} + 2\frac{(0.1)}{64}$ $\varepsilon_{III} = \frac{0.1}{20} + 2\frac{(0.1)}{36}$ (Max)

Students I, II and III perform an experiment for measuring the acceleration due to gravity (g) using a simple pendulum. They use different lengths of the pendulum and/or record time for different number of oscillations. The observations are shown in the table. Least count for length = 0.1 cm, Least count for time = 0.1 s $0.1 = \Delta T$

Student	Length of pendulum (cm)	Number of oscillations (n)	Total time for (n) Oscillations (s)	Time period (s)
I	64.0	8	128.0	16.0
II	64.0	4	64.0	16.0
III	20.0	4	36.0	9.0

$\varepsilon_I = \varepsilon_{II} = \varepsilon_{III}$

If E_I, E_{II} and E_{III} are the percentage errors in g, i.e. $\left(\frac{\Delta g}{g} \times 100\right)$ for students I, II and III, respectively **(2008 Adv)**

$\varepsilon_I = \frac{\Delta L}{L} + \frac{2\Delta T}{T} = \frac{0.1}{64} + 2\frac{0.1}{128}$

$= \frac{0.1}{64} + 2\frac{0.1}{128}$ Minimum

(A) $E_I = 0$

(B) E_I is minimum

(C) $E_I = E_{II}$

(D) E_{II} is maximum

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

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

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question – 47 (Homework)

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

Jee Main 2019 (Online) 8th April, EV. Shift

A 0.2%

B 3.5%

C 0.7%

D 6.8 %

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 48

The current voltage relation of diode is given by $I = (e^{1000\ \text{V}/T} - 1)\text{mA}$, where the applied voltage V is in volt and the temperature T is in kelvin. If a student makes an error measuring $\pm$ 0.01 V while measuring the current of 5 mA at 300 K, what will be the error in the value of current in mA ? **(2014 Advanced)**

$\Delta I = ?$

A 0.2 mA

B 0.02 mA

C 0.5 mA

D 0.05 mA

$I = e^{\frac{1000V}{T}} - 1$

diff

$dI = e^{\frac{1000V}{T}} \left(\frac{1000\, dV}{T}\right)$

$= \left(e^{\frac{1000V}{T}}\right) \cdot \frac{1000 \times 0.01}{300}$

6

$\Delta I = 6 \times \frac{1000 \times 0.01}{300}$

$\Delta V = 0.01$ ✓

$I = 5\text{mA}$ ✓

$T = 300\text{K}$ ✓ (Const)

$5 = e^{\frac{1000V}{T}} - 1$

$6 = e^{\frac{1000V}{T}}$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

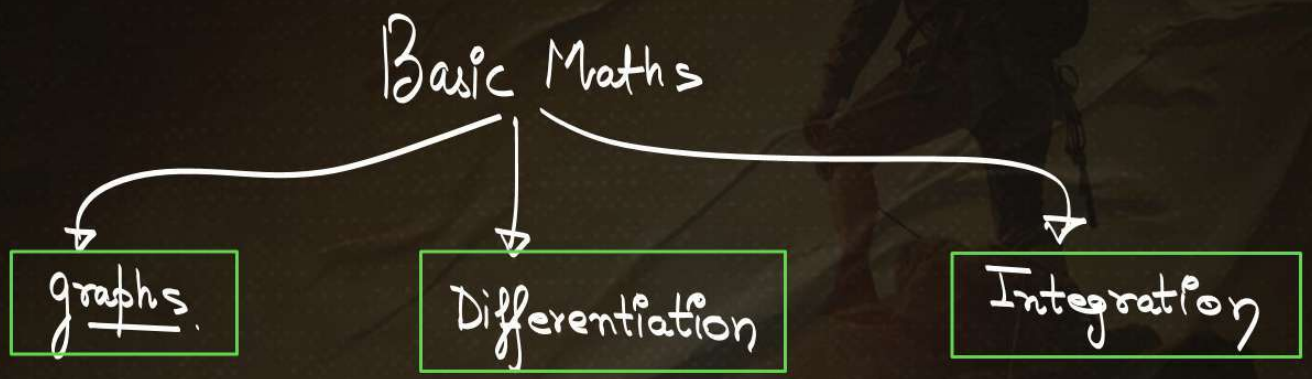
Question - 49

(HW)

The energy of a system as a function of time t is given as $E(t) = A^2 \exp(-\alpha t)$, where $\alpha = 0.2\ s^{-1}$. The measurement of A has an error of 1.25%. If the error in the measurement of time is 1.50%, the percentage error in the value of $E(t)$ at $t = 5$ s is

(2015 Adv.)

$E = A^2 e^{-\alpha t}$


Basic Maths
graphs
Differentiation
Integration

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Slope of a Line

⇒ Inclination.

$$\text{Slope} = \frac{\text{rise}}{\text{run}} = \left[\frac{y_2 - y_1}{x_2 - x_1}\right] = \tan\theta.$$

⇓ When two point given

Question - 51

Find the slope of a line whose coordinates are (2, 2) and (4, 8)?

$x_1\ y_1$ $\quad$ $x_2\ y_2$

$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{8-2}{4-2} = \frac{6}{2} = 3.$$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 52

Find value of slope at $x = 2$

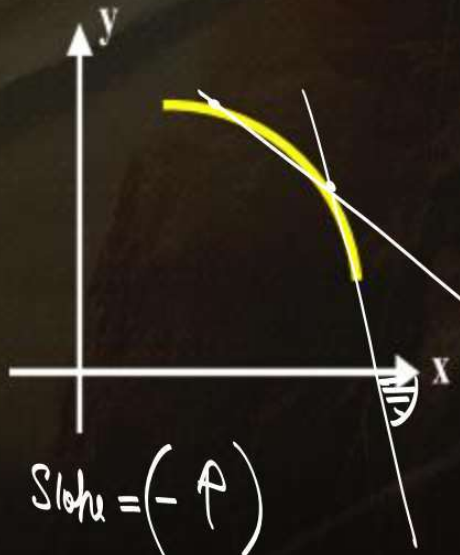
Slope $= -\tan\alpha = -\frac{20}{4} = -5$

Straight line
Slope = Constant

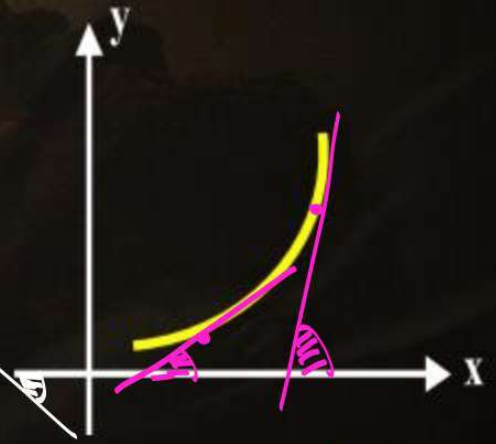
Slope Variation :-

Slope = -ve (↓)

Slope = (+ve ↓)

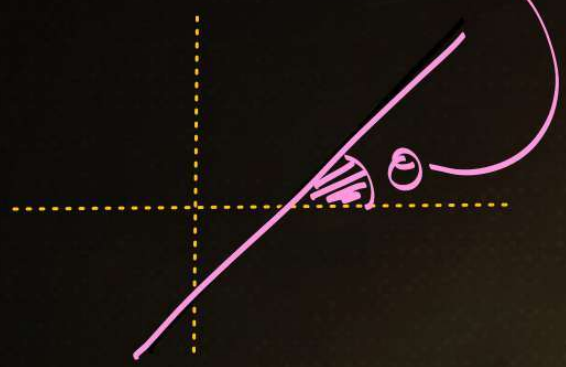


Slope = (- ↑)



Slope = (+ve ↑)

$m = \tan\theta$



θ = acute Slope = +ve

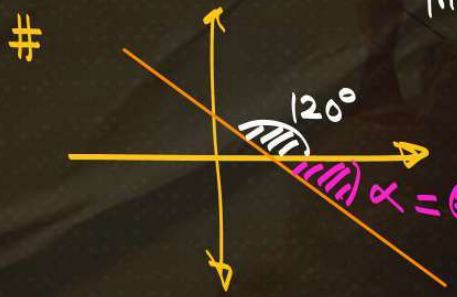
θ = obtuse Slope = -ve.

$\text{Slope}_1 = \tan 30 = +\frac{1}{\sqrt{3}}$

$\text{Slope}_2 = \tan 60 = +\sqrt{3}$

$\text{Slope}_2 > \text{Slope}_1$

More is Angle More is Slope.



Method-1

$\text{Slope} = \tan(120)$

$= \tan(90 \times 2 - 60)$

$= -\tan 60 = -\sqrt{3}.$

Method-2

$\text{Slope} = -\tan\alpha$

$= -\tan 60$

$= -\sqrt{3}.$

More is the α

More is -ve Slope

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

A. Graph of Straight Line

Slope and Intercept

$y = mx + c$

m : Slope, c : Intercept

Slope ↑ Intercept

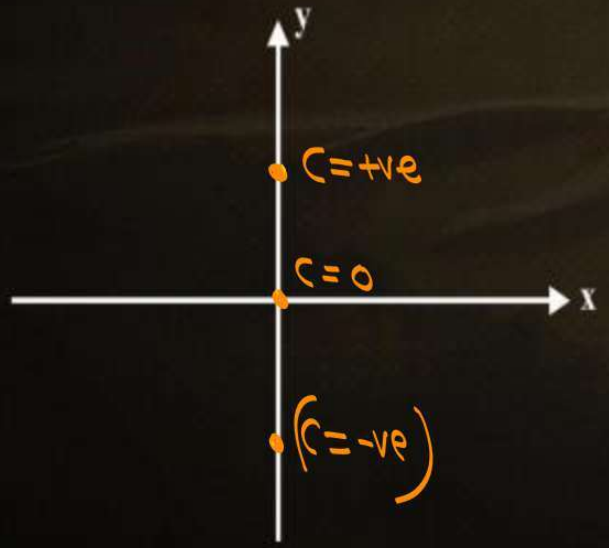
$y = 2x + 3$

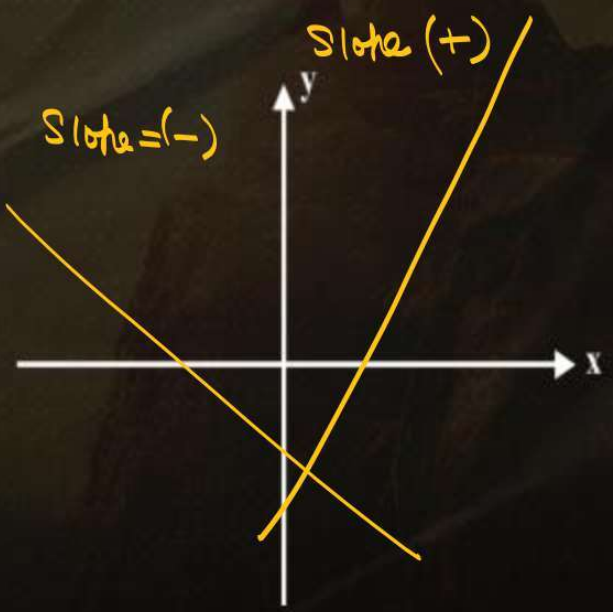
$y = -2x + 3$

$y = -2x - 3$

$y = 2x - 3$

Intercept $C = +ve$





Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 53

① $y = mx + c$ (form)

Draw graph between y and x for given equation :

(i) $y' = \sqrt{3}x' + 4$ $\quad m = \pm\sqrt{3}$, $c = +4$

$mx + c$

(ii) $y = -x$ $\quad m = -1$, $c = 0$

(iii) $y' = -x' + 5$

$m = -1$ (-ve)

$c = +5$ (+ve)

(iv) $\frac{x}{2} - \frac{y}{3} = 1$

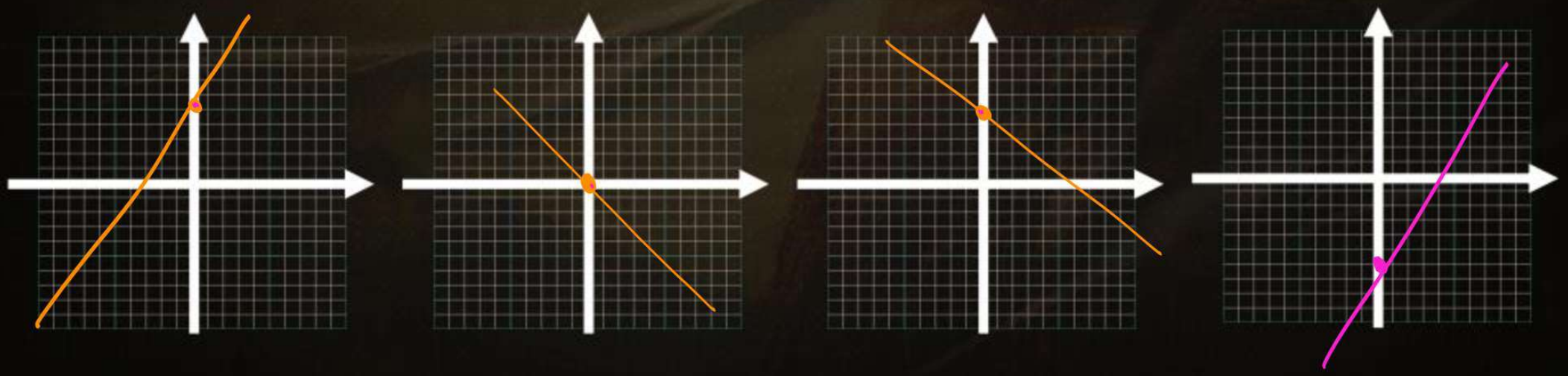
$\frac{x}{2} - 1 = \frac{y}{3}$

$\frac{x-2}{2} = \frac{y}{3}$

$y = \frac{3}{2}(x-2)$

$y = \frac{3}{2}x - 3$

$m = +ve$ $\quad c = -ve$

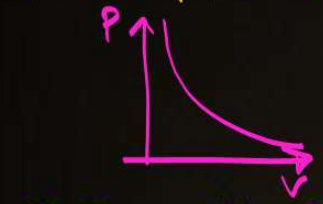


Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

2. Rectangular Hyperbola

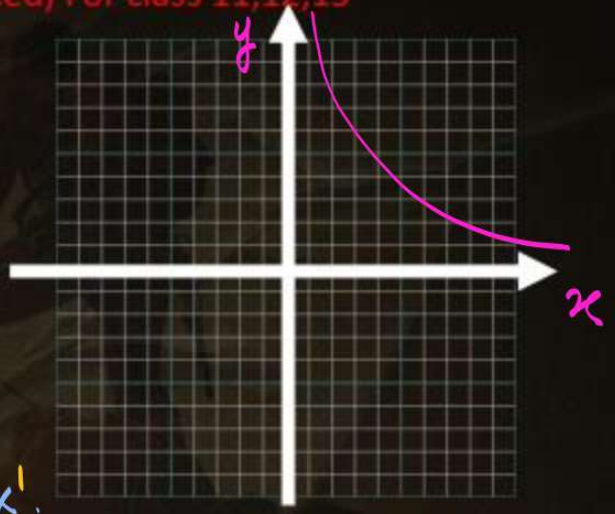
$xy = \text{Constant}$ $\quad y = \frac{\text{Const}}{x}$

Ex:- $PV = \text{Constant}$.



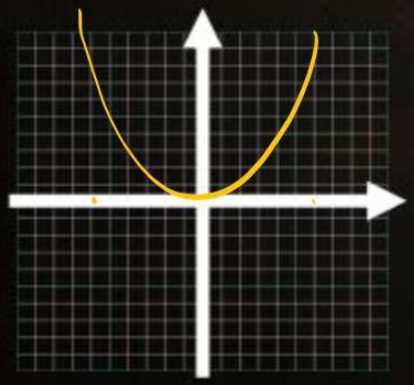
$x \to 0 \quad y \to \infty$

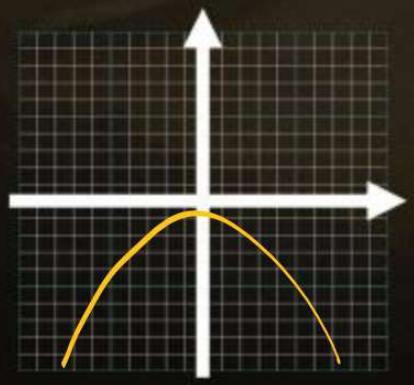
$x \to \infty \quad y \to 0$

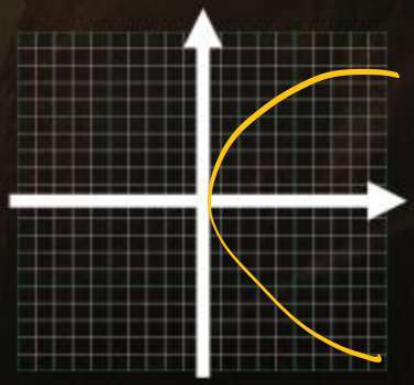


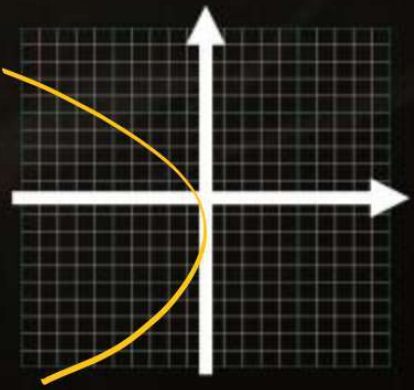
3.Parabola

$y = x^2$, $y = -x^2$, $y^2 = x$, $y^2 = -x$.



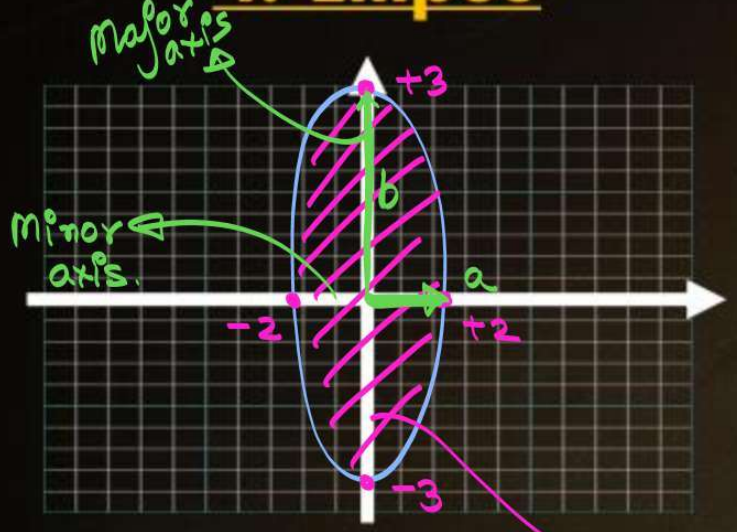






Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

4. Ellipse



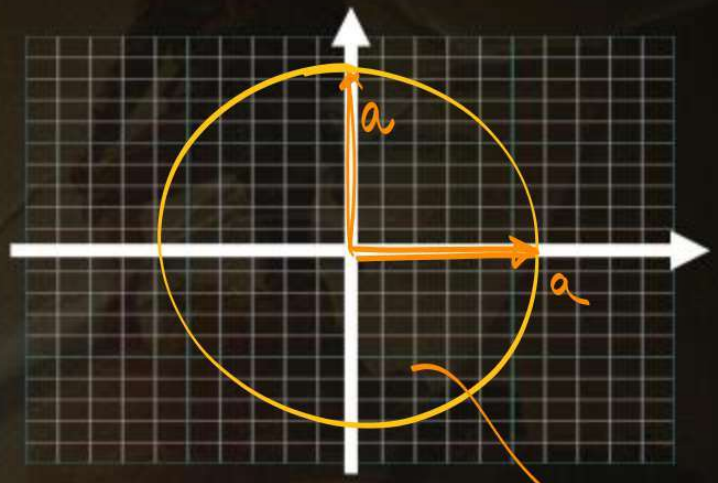
$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$$

$A=\pi ab.$

ex $\frac{x^2}{4}+\frac{y^2}{9}=1$ $\quad a=2,\ b=3$

Particular Case of Ellipse $(a=b)$

5.Circle



$$x^2+y^2=a^2$$

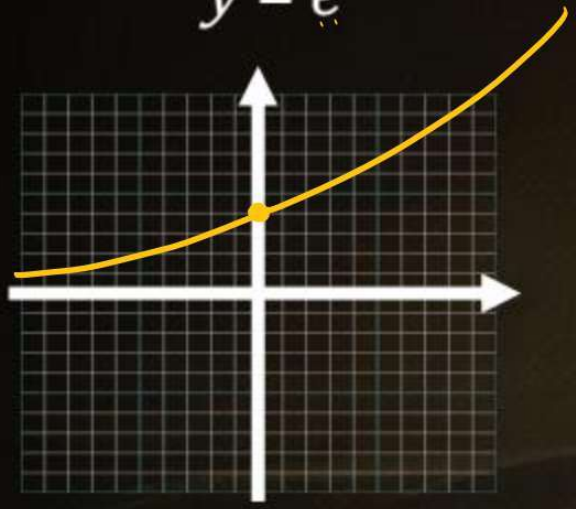
$Area=\pi a^2.$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

6.Exponential Function

$e = (2.7)$

$y = e^x$



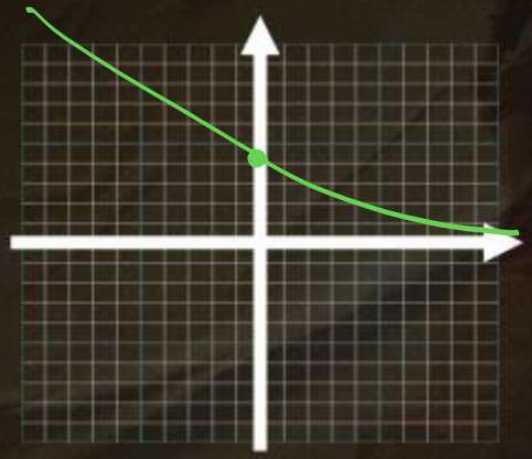
$x = 0 \quad y = 1$

$x \to +\infty \quad y \to \infty$

$x \to -\infty \quad y = \frac{1}{e^{\infty}} \to 0$

Very big

$y = e^{-x}$

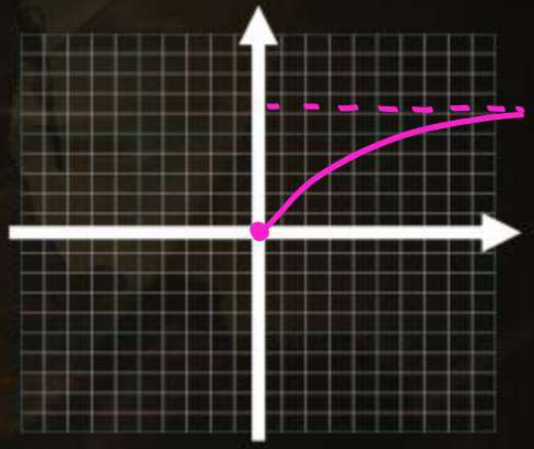


$x = 0 \quad y = 1$

$x \Rightarrow +\infty \quad y = \frac{1}{e^{\infty}} \to 0$

$x \Rightarrow -\infty \quad y \Rightarrow +\infty$

$y = 1 - e^{-x}$



$y = 1 - e^{-x}$

$x = 0 \quad y = 0$

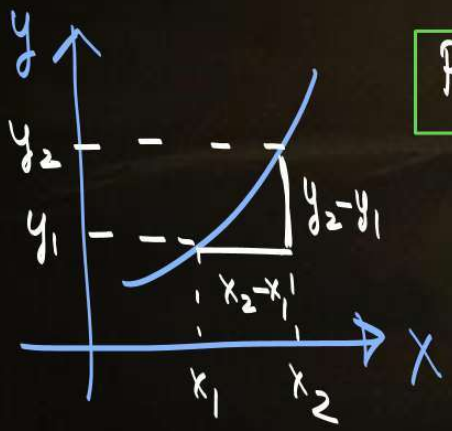
$x \to +\infty \quad y = 1 - \frac{1}{e^{\infty}} < 1$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Rate of Change

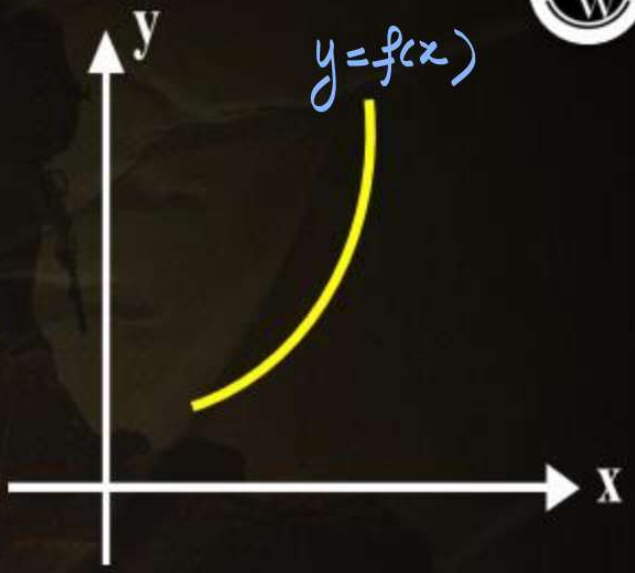
Velocity is rate of change of position with respect to time

acceleration is rate of change of velocity with respect to time



Rate of change of y wrt x (Position, time) $= \frac{y_2-y_1}{x_2-x_1} = d$

- Avg Rate of Change. $\frac{\Delta y}{\Delta x} = \frac{y_2-y_1}{x_2-x_1}$
- Instantaneous Change. $\frac{dy}{dx}$.



Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Rules of Differentiation

Differentiation Formulas :

1. $\frac{d}{dx}(a) = 0$
2. $\frac{d}{dx}(x^1) = 1x^{1-1} = 1$
3. $\frac{d}{dx}(ax) = a\frac{dx}{dx} = a$
4. $\frac{d}{dx}(x^n) = nx^{n-1}$
5. $\frac{d}{dx}(\cos x) = -\sin x$
6. $\frac{d}{dx}(\sin x) = \cos x$
7. $\frac{d}{dx}(\tan x) = \sec^2 x$
8. $\frac{d}{dx}(\ln x) = \frac{1}{x}$
9. $\frac{d}{dx}(e^x) = e^x$

Question - 57

$x=2 \quad y=2^4$

$x=1 \quad y=2$

If $y(x) = 2x^3$ then find relative change in y w.r.t. change in x

(i) When x changes from $x = 1$ to $x = 2$.

(ii) At $x = 2$

Interval bada

avg Rate of change $= \frac{y_2 - y_1}{x_2 - x_1} = \frac{16-2}{1} = 14.$

Instantaneous Rate of change

$$\frac{dy}{dx} = \frac{d}{dx}(2x^3) = 2(3x^2)$$

$$= 6x^2 = 6 \times 4 = 24.$$

at $x = 2$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Addition Rule	Subtraction Rule	Multiplication	Division
$Y = A + B$	$Y = A - B$	$Y = A \cdot B$	$Y = \frac{A}{B}$

$\frac{dy}{dx} = \frac{dA}{dx} + \frac{dB}{dx}$

Ex $y = x^3 + \sin x$

$\frac{dy}{dx} = 3x^2 + \cos x$

$\frac{dy}{dx} = \frac{dA}{dx} - \frac{dB}{dx}$

$y = \log x - e^x$

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

dy

Chain Rule

Multiplication $y = A \cdot B$

$$\frac{dy}{dx} = \left(\frac{dA}{dx}\right)(B) + (A)\left(\frac{dB}{dx}\right)$$

Ex :- $y = x^2 \sin x$

$$\frac{dy}{dx} = (2x)\sin x + x^2(\cos x)$$

Division $y = \frac{A}{B}$

$$\frac{dy}{dx} = \frac{B\left(\frac{dA}{dx}\right) - A\left(\frac{dB}{dx}\right)}{B^2}$$

Ex: $y = \frac{\sin x}{\log x}$

$$\frac{dy}{dx} = \frac{\log x(\cos x) - \sin x\left(\frac{1}{x}\right)}{(\log x)^2}$$

Chain Rule.

Ex: $y = x^3 \quad \frac{dy}{dx} = 3x^2$

$y = (\tan x)^3$

$$\frac{dy}{dx} = 3(\tan x)^2 \cdot \frac{d}{dx}(\tan x)$$

$$= 3(\tan x)^2 \sec^2 x.$$

$y = \sin(2x^3 + 3x - 6)$

$y = \sin x$

$$\frac{dy}{dx} = \cos x$$

$$\frac{dy}{dx} = \cos(2x^3 + 3x - 6) \cdot (6x^2 + 3)$$

$y = e^{\tan x}$

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

$$= e^{\tan x} \cdot \sec^2 x.$$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 58

$\sin^2 x$ $\quad (\sin x)^2$ $\quad \sin(x^2)$

Find $\frac{dy}{dx}$

x^5 $\quad \frac{dy}{dx} = 5x^4$

$10x^2$ $\quad \frac{dy}{dx} = 10(2x)$

$20x^{-4} + 9$ $\quad \frac{dy}{dx} = 20(-4x^{-5}) + 0$

$\ln(10)$ const $\quad \frac{dy}{dx} = 0$

$\frac{dy}{dx} = \cos(3x+5).3 \sin(3x+5)$

$y = (\tan x)^2$ $\quad \tan^2 x$

$\frac{dy}{dx} = 2\tan x . \sec^2 x$

$y = \sin(x^2)$ $\quad \sin^2 x^2$

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

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 59

$e^{\tan x}$

$y = [\sin(2x+1)]^2$ $\sin^2(2x+1)$

$\frac{dy}{dx} = 2\sin(2x+1)\cos(2x+1)\cdot 2$

$e^x \cdot \sin x$

$\frac{dy}{dx} = (e^x)\sin x + e^x \cos x$

$(x+1)/x$

$\frac{x}{x} + \frac{1}{x}$

$y = 1 + \frac{1}{x} = 1 + x^{-1}$

$\boxed{\frac{dy}{dx} = 0 - x^{-2}}$

$(\tan x)/\log x$

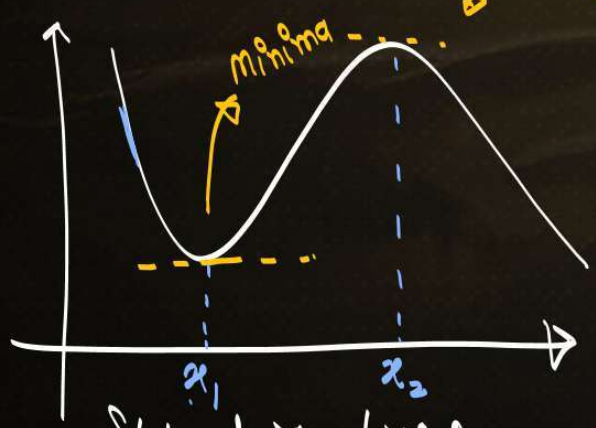
$\frac{dy}{dx} = \frac{\log x(\sec^2 x) - \tan x\left(\frac{1}{x}\right)}{(\log x)^2}$

Maxima & Minima.

differentiation = Rate of change.

$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1} = \text{differentiation}.$$

Jab differentiation kari jati hai toh wo graph mein slope ke baare mein hai.



Slope at Max / Minima := 0

1. Derive the function.

2. $\frac{dy}{dx}$ wrt Variable.

3. $\frac{dy}{dx} = 0$ (at Max/Min)
Slope = 0

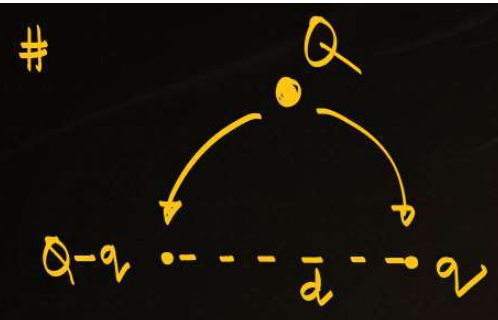
points where Slope = 0
(Critical points) x_1, x_2

4. Check

$\left.\frac{d^2y}{dx^2}\right|_{x_1} > 0$ Min

$\left.\frac{d^2y}{dx^2}\right|_{x_2} < 0$ Max

#

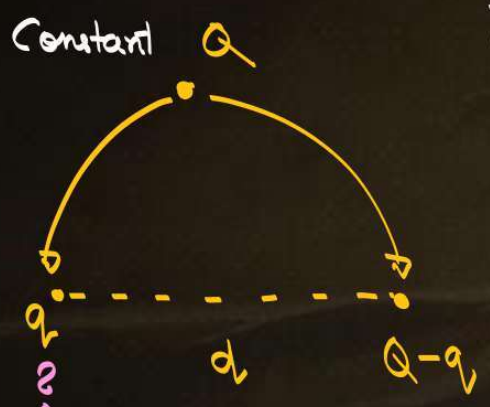


What is q so that F is max.

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 63

A point charge Q breaks into two parts. If both parts are separated by distance d. Find How the charge must break so that force is maximum



$\frac{dy}{dx}$

$$\frac{d^2F}{dq^2} = \frac{K}{d^2}(0-2)$$

$$= -ve$$

Max at $\frac{Q}{2}$.

$$F = \frac{Kq(Q-q)}{d^2} = \frac{K}{d^2}(Qq - q^2)$$

$$0 = \frac{dF}{dq} = \frac{K}{d^2}(Q-2q) \quad \boxed{q = Q/2}$$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 65

The velocity of particle is $v = 3t^2 - t^3$, Find the time when velocity is maximum

A 5

B 2 Ans

C 8

D 7

$v = 3t^2 - t^3$

$\frac{dv}{dt} = 6t - 3t^2$

$0 = 6t - 3t^2$

$0 = 3t(2 - t)$

$t = 0, t = 2$

Min, Max

$\frac{d^2v}{dt^2} = 6 - 6t$

$t = 0$ $\frac{d^2v}{dt^2} > 0$ Min

$\frac{d^2v}{dt^2} = 6 - 12$

$= -6 < 0$ Max

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Integration

$$y = \int f(x)\,dx$$

Integration

- **Indefinite** — where we dont Know limits
  $$y = \int f(x)\,dx$$
- **Definite** — where we Know from where (L.L) till where we to Integrate.
  $$y = \int_{0}^{\text{upper limit}} f(x)\,dx$$
  0 → Lower limit

Integrate.

- Indefinite
  1. formula lago
  2. +C add Kar do.
- Definite.
  1. formula Lago.
  2. $F(x=UL) - F(x=L.L)$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Integration

1. $\int x^n\,dx = \frac{x^{n+1}}{n+1} + C \quad (n \neq -1)$
2. $\int 1\,dx = \int x^0 dx = \frac{x^{0+1}}{0+1} = x + C$
3. $\int a\,dx = a\int x^0 dx = a\left[\frac{x^{0+1}}{0+1}\right] = ax + C$
4. $\int \sin x\,dx = -\cos x + C$
5. $\int \cos x\,dx = \sin x + C$
6. $\int \sec^2 x\,dx = \tan x + C$
7. $\int \frac{1}{x}dx = \ln x + C$
8. $\int e^x dx = e^x + C$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Question - 66

1. $f(x) = 7$ $\quad y = \int 7\,dx = 7\int x^0\,dx = 7x + C$

2. $f(x) = x^8 \Rightarrow \int x^8\,dx = \frac{x^9}{9} + C$

3. $f(x) = \frac{1}{x^3}$ $\quad y = \int x^{-3}\,dx = \frac{x^{-2}}{-2} + C$

4. $f(x) = \frac{1}{x^{1/2}} \Rightarrow y = \int x^{-1/2}\,dx = \frac{x^{1/2}}{1/2} + C$

5. $f(x) = e^x + x \Rightarrow \int e^x\,dx + \int x\,dx$
$= e^x + \frac{x^2}{2} + C$

6. $f(x) = x^2 + 3x$
$y = \int x^2\,dx + \int 3x\,dx$
$= \frac{x^3}{3} + 3\frac{x^2}{2} + C.$

7. $\cos x + 3x$
$y = \int \cos x\,dx + \int 3x\,dx$
$= \sin x + 3\frac{x^2}{2} + C.$

$$\int \sin(ax+b)\,dx = -\frac{\cos(ax+b)}{a} + C$$

$$\int \cos(ax+b)\,dx = \frac{\sin(ax+b)}{a} + C$$

$$\int e^{(ax+b)}\,dx = \frac{e^{ax+b}}{a} + C.$$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

8 $f(x) = e^{3x}$ $\int e^{3x}dx = \frac{e^{3x}}{3} + C$

9 $f(x) = e^{-2x}$ $\int e^{-2x}dx = \frac{e^{-2x}}{-2} + C$

10 $\sin(5x+4)$ $= \int \sin(5x+4)dx$

$= -\frac{\cos(5x+4)}{5} + C$

11 $\int_0^{\frac{\pi}{2}} \cos x\, dx$ Definite $= [\sin x]_0^{\pi/2}$

$= \sin[\pi/2] - \sin(0)$

$= 1 - 0 = 1.$

12 $\int_0^2 e^{2x}dx$ Definite. $= \left[\frac{e^{2x}}{2}\right]_0^2$

$= \frac{e^{2\cdot 2}}{2} - \frac{e^{2\cdot 0}}{2} = \frac{e^4}{2} - \frac{1}{2} = \frac{e^4-1}{2}.$

2 $\int_0^2 (x^2+1)^2 dx$ Definite $= \int_0^2 x^4dx + \int_0^2 1dx + \int_0^2 2x^2dx$

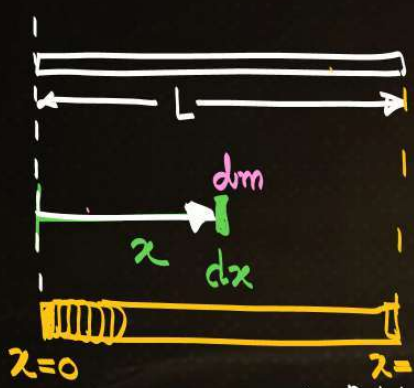
$= \left[\frac{x^5}{5}\right]_0^2 + [x]_0^5 + 2\left[\frac{x^3}{3}\right]_0^5.$

$$\left[\frac{x^5}{5}\right]_0^2 + [x]_0^2 + 2\left[\frac{x^3}{3}\right]_0^2$$

$$= \left[\frac{2^5}{5} - \frac{0^5}{5}\right] + [2-0] + \frac{2}{3}[2^3 - 0^3] = \_\_\_\_\_.$$

APPLICATION

Rod (Element → Coin)



"dx"

$L \rightarrow M$

$1 \rightarrow \frac{M}{L}$

$dx \rightarrow \frac{M}{L}dx$

$dm = \frac{M}{L}dx$ → Variable → Isi Ki Limits daalenge.

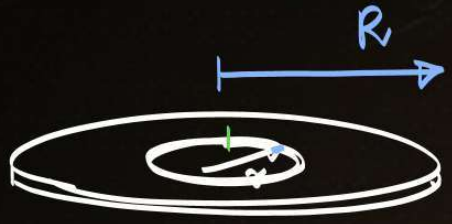
$$M_T = \int dm = \int_0^L \frac{M}{L}dx = \frac{M}{L}\int_0^L x^0 dx = \frac{M}{L}[x]_0^L$$

$$= \frac{M}{L}[L-0] = M$$

Disc (Ring)

$\pi R^2 \longrightarrow M$

$1 \longrightarrow \frac{M}{\pi R^2}$



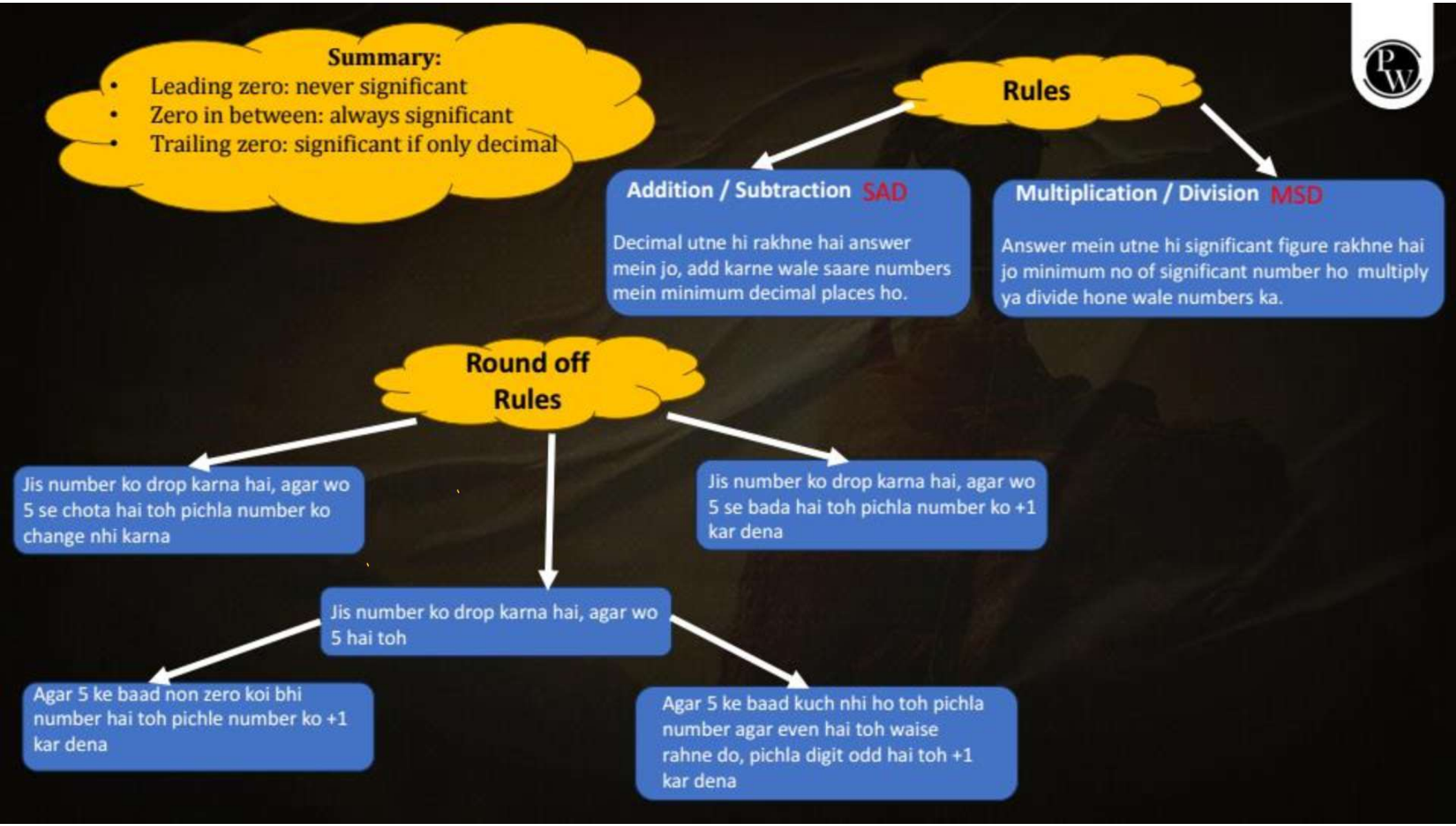
$\text{mass of Ring} = \frac{M}{\pi R^2} \cdot 2\pi r\,dr$

$dA =$  dr $\quad dA = 2\pi r\,dr$

$$M_T = \int dm = \int \frac{M}{\pi R^2} \cdot 2\pi r\,dr \quad \text{(r: Variable)}$$

$$= \int_0^R \frac{2M}{R^2}\, r\,dr$$

$$= \frac{2M}{R^2}\left[\frac{r^2}{2}\right]_0^R = \frac{M}{R^2}\left[R^2 - 0^2\right] = M.$$


Summary:
Leading zero: never significant
Zero in between: always significant
Trailing zero: significant if only decimal
Rules
Addition / Subtraction SAD
Decimal utne hi rakhne hai answer mein jo, add karne wale saare numbers mein minimum decimal places ho.
Multiplication / Division MSD
Answer mein utne hi significant figure rakhne hai jo minimum no of significant number ho multiply ya divide hone wale numbers ka.
Round off Rules
Jis number ko drop karna hai, agar wo 5 se chota hai toh pichla number ko change nhi karna
Jis number ko drop karna hai, agar wo 5 se bada hai toh pichla number ko +1 kar dena
Jis number ko drop karna hai, agar wo 5 hai toh
Agar 5 ke baad non zero koi bhi number hai toh pichle number ko +1 kar dena
Agar 5 ke baad kuch nhi ho toh pichla number agar even hai toh waise rahne do, pichla digit odd hai toh +1 kar dena

Question – (HOMEWORK)

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 dimensions of β will be :

Jee Main 2021 (Online) 24th February, Morning Shift

A $[M^0 LT^0]$

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

C $[MLT^{-2}]$

D $[M^2 LT^2]$

Question – (HOMEWORK)

In the following dimensionally constant equations, we have $F = \frac{X}{\text{Linear density}} + Y$ where F = force. The dimensional formula of X are Y are: **(2003)**

A $[M\,L\,T^{-2}], [M^2\,L^0\,T^{-2}]$

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

C $[M\,L^2\,T^{-4}], [M^2\,L^{-2}\,T^{-2}]$

D None of these

Question – (HOMEWORK)

The equation of a wave is given by:

$$y = A \sin \omega \left(\frac{x}{v} - k \right)$$

Where ω is the angular velocity and v is the linear velocity. The dimension of k is:

(2007)

A LT

B T

C T^{-1}

D T^2

Question – (HOMEWORK)

The position x of a particle at time 't' is given by-

$$x = \frac{v_0}{a}(1 - e^{-at})$$

Where v_0 is a constant and $a > 0$. The dimensions of v_0 and a are: **(2009)**

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

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

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

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

Question – (HOMEWORK)

The dimensions of physical quantity X in the equation force = $\frac{X}{\sqrt{\text{Density}}}$ is given by:

(2014)

A $M^1L^4T^{-2}$

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

C $M^{3/2}L^{-1/2}T^{-2}$

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

Question – (HOMEWORK)

In the relation: = $2\omega \sin(\omega t + \phi_0)$, the dimensional formula for $(\omega t + \phi_0)$ is: **(2015)**

A $[MLT]$

B $[MLT^0]$

C $[ML^0T^0]$

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

Question – (HOMEWORK)

$\alpha = \frac{F}{V^2} \sin(\beta t)$ (here V = velocity, F = force, t = time):

Find the dimension of α and β:

A $\alpha = [M^1L^1T^0], \beta = [T^{-1}]$

B $\alpha = [M^1L^1T^{-1}], \beta = [T^1]$

C $\alpha = [M^1L^1T^{-1}], \beta = [T^{-1}]$

D $\alpha = [M^1L^{-1}T^0], \beta = [T^{-1}]$

Question – (HOMEWORK)

In the relation $\rho = \frac{\alpha}{\beta} e^{-\frac{a}{10}} \rho$ is pressure, Z is distance, k is Boltzmann constant and θ is the temperature. The dimensional formula of β will be

A $[M^0L^2T^0]$

B $[ML^2T]$

C $[ML^0T^{-1}]$

D $[M^0L^{-2}T^{-1}]$

Question – (HOMEWORK)

The density of a material in SI units is 128 kg m^{-3}. In certain units in which the unit of length is 25 cm and the unit of mass 50 g, the numerical value of density of the material is

[10 Jan, 2019 (Shift-I)]

A 40

B 16

C 640

D 410

Question – (HOMEWORK)

In SI units, the dimensions of $\sqrt{\frac{\epsilon_0}{\mu_0}}$ is :

Jee Main 2019 (Online) 8th April, Morning. Shift

A $A^{-1}TML^3$

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

C $AT^{-3}ML^{3/2}$

D $AT^2M^{-1}L^{-1}$

Question – (HOMEWORK)

If E, L, M and G denote the quantities as energy, angular momentum, mass and constant of gravitation respectively, then the dimensions of P in the formula $P = EL^2M^{-5}G^{-2}$ are:

Jee Main 2021 (Online) 26th Aug. Morning Shift

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

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

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

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

Question –(HOMEWORK)

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:

Jee Main 2020 (Online) 9th January, Morning Shift

A Energy

B Momentum

C Area

D Volume

Question –(HOMEWORK)

If velocity [V], time [T] and force [F] are chosen as the base quantities, the dimensions of the mass will be :

Jee Main 2021 (Online) 31st Aug. Ev. Shift

A $[FT^{-1} V^{-1}]$

B $[FTV^{-1}]$

C $[FT^{2} V]$

D $[FVT^{-1}]$

Question (HOMEWORK)

If force (F), length (L) and time (T) are taken as the fundamental quantities. Then what will be the dimension of density:

Jee Main 2021 (Online) 27th Aug. Ev. Shift

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

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

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

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

Question –(HOMEWORK)

If time (t), velocity (v), and angular momentum (1) are taken as the fundamental units. Then the dimension of mass (m) in terms of t, v and 1 is:

Jee Main 2021 (Online) 20th July. Ev. Shift

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

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

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

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

Question –(HOMEWORK)

If momentum (P), area (A) and time (T) are taken to be the fundamental quantities then the dimensional formula for energy is

Jee Main 2020 (Online) 2nd Sept., Ev. Shift

A $[P^2AT^{-2}]$

B $\left[P^{\frac{1}{2}}AT^{-1}\right]$

C $\left[PA^{\frac{1}{2}}T^{-1}\right]$

D $[PA^{-1}T^{-2}]$

Question –(HOMEWORK)

If momentum (p), area (A) and time (T) are taken to be fundamental quantities, then energy has the dimensional formula:

A $pA^{-1}T^{1}$

B $p^{2}AT$

C $pA^{-1/2}T$

D $pA^{1/2}T^{-1}$

Question – (HOMEWORK)

If force (F), Velocity (V) and Time (T) are taken as fundamental units, then the dimensions of mass are:

A $[F\ V\ T^{-1}]$

B $[F\ V\ T^{-2}]$

C $[F\ V^{-1}\ T^{-1}]$

D $[F\ V^{-1}\ T]$

Question – (HOMEWORK)

In a new system of units, the fundamental quantities mass, length and time are replaced by acceleration 'a', density 'ρ' and frequency 'f'. The dimensional formula for force in this system is

A $[\rho\, a^4 f]$

B $[\rho\, a^4 f^{-6}]$

C $[\rho^{-1} a^{-4} f^6]$

D $[\rho^{-1} a^{-4} f^{-1}]$

Question – (HOMEWORK)

If speed (V), acceleration (A) and force (F) are considered as fundamental units, the dimension of Youngs modulus will be:

Jee Main 2019 (Online) 11th January, Evening Shift

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

B $V^{-4}A^{-2}F$

C $V^{-4}A^{2}F$

D $V^{-2}A^{2}F^{-2}$

Question – (HOMEWORK)

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:

Jee Main 2017 (Online) 8th April Morning Shift

A $[M]=\left[T^{-1}C^{-2}h\right]$

B $[M]=\left[T^{-1}C^{-2}h\right]$

C $[M]=\left[T^{-1}C^{-2}h^{-1}\right]$

D $[M]=\left[TC^{-2}h\right]$

Question – (HOMEWORK)

The quantities $x = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}, y = \frac{E}{B}$ and $z = \frac{I}{CR}$ 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 **[5 Sep, 2020 (Shift-II)]**

A. Only x and y have the same dimension

B. Only x and z have the same dimension

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

D. Only y and z have the same dimension

Question – (HOMEWORK)

A student measures the distance traversed in free fall of a body, initially at rest in a given time. He uses this data to estimate g, the acceleration due to gravity. If the maximum percentage errors in measurement of the distance and the time are e_1 and e_2 respectively, the percentage error in the estimation of g is:

A $e_1 + 2e_2$

B $e_1 + e_2$

C $e_1 + 2e_2$

D $e_2 - e_1$

Question – (HOMEWORK)

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

[AIEEE 2012]

A) 6%

B) zero

C) 1%

D) 3%

Question – (HOMEWORK)

A quantity is represented by $X = M^aL^bT^c$. The percentage error in measurement of M, L and T are $\alpha\%$, $\beta\%$ and $\gamma\%$ respectively. The percentage error in X would be

A $(\alpha a + \beta b + \gamma c)\%$

B $(\alpha a - \beta b + \gamma c)\%$

C $(\alpha a - \beta b - \gamma c)\%$

D None of these

Question – (HOMEWORK)

The percentage errors in quantities P, Q, R and S are 0.5%, 1%, 3% and 1.5% respectively in the measurement of a physical quantity $A = \frac{P^3Q^2}{\sqrt{RS}}$.

The maximum percentage error in the value of A will be :

Jee Main 2018 (Online) 16th April, Morning Shift

A) 6.0%

B) 7.5%

C) 8.5%

D) 6.5%

Question – (HOMEWORK)

A physical quantity P is described by the relation $P = a^{1/2} b^2 c^3 d^{-4}$. 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 :

Jee Main 2017 (Online) 9th April Morning Shift

A) 8%

B) 12%

C) 32%

D) 25%

Question – (HOMEWORK)

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:

Jee Main 2018 (Offline)

A 6%

B 2.5%

C 3.5%

D 4.5%

Question – (HOMEWORK)

In an experiment to measure the focal length of an equiconvex lens, following measurements were made $|u| = 0.30$ cm, $|v| = 0.60$ cm. The image formed is real. The focal length of the lens withing error limits is

A (0.20 ± 0.01) cm

B (0.20 ± 0.02) cm

C (0.20 ± 0.0055) cm

D (0.20 ± 0.05) cm

Question – (HOMEWORK)

A copper wire is stretched to make it 0.5% longer. The percentage change in its electrical resistance if its volume remains unchanged is:

Jee Main 2019 (Online) 9th January, Morning Shift

(A) 2.0%

(B) 2.5%

(C) 1.0%

(D) 0.5%

Question – (HOMEWORK)

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 ? **Jee Main 2019 (Online) 10th January, Evening Shift**

A $4264.4 \pm 81.0\ cm^3$

B $4264 \pm 81\ cm^3$

C $4300 \pm 80\ cm^3$

D $4260 \pm 80\ cm^3$

Question – (HOMEWORK)

The following observations were taken for determining surface tension T of water by capillary method:

diameter of capillary, D = $1.25 \times 10^{-2}\ m$ rise of water, $h = 1.45 \times 10^{-2} m$

Using $g = 9.80\ \text{m/s}^2$ and the simplified relation $T = \frac{rhg}{2} \times 10^3\ \text{N/}m$, the possible error in surface tension is closest to :

Jee Main 2017 (Offline)

A 10%

B 0.15%

C 1.5%

D 2.4%