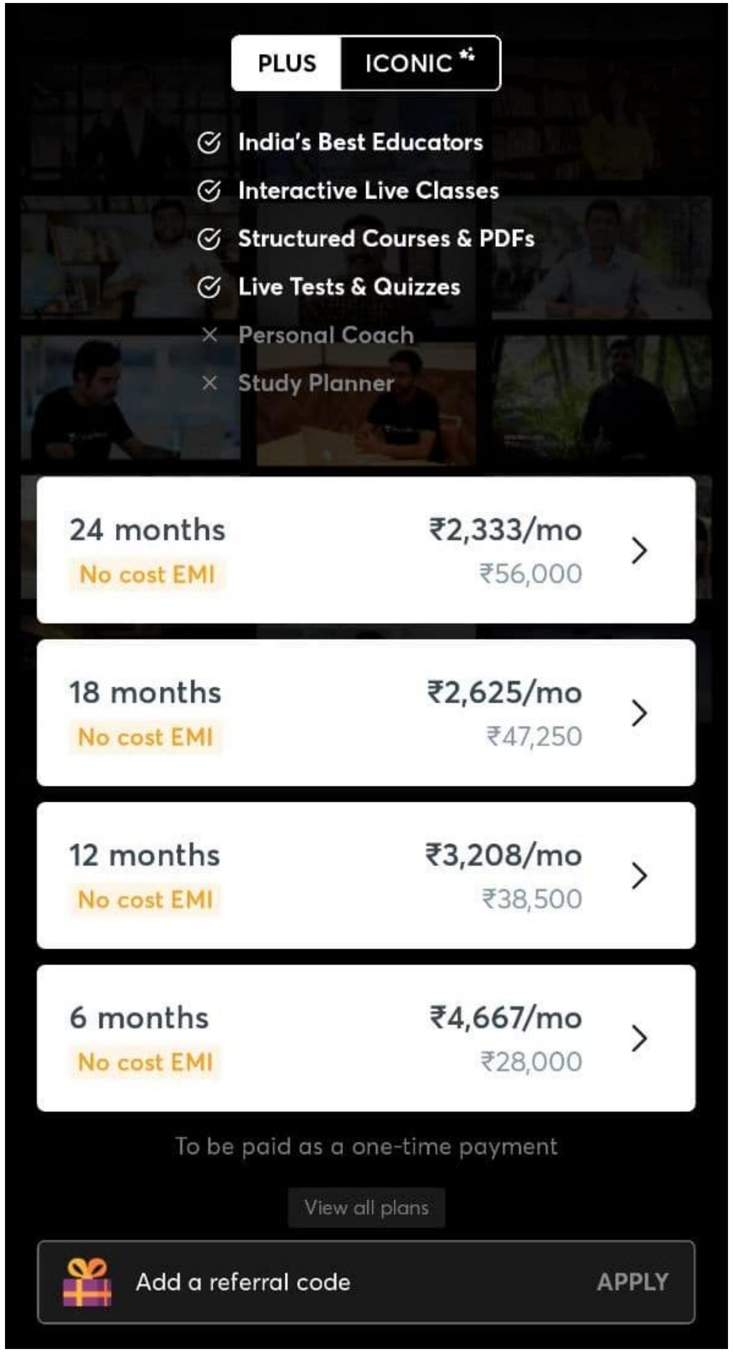
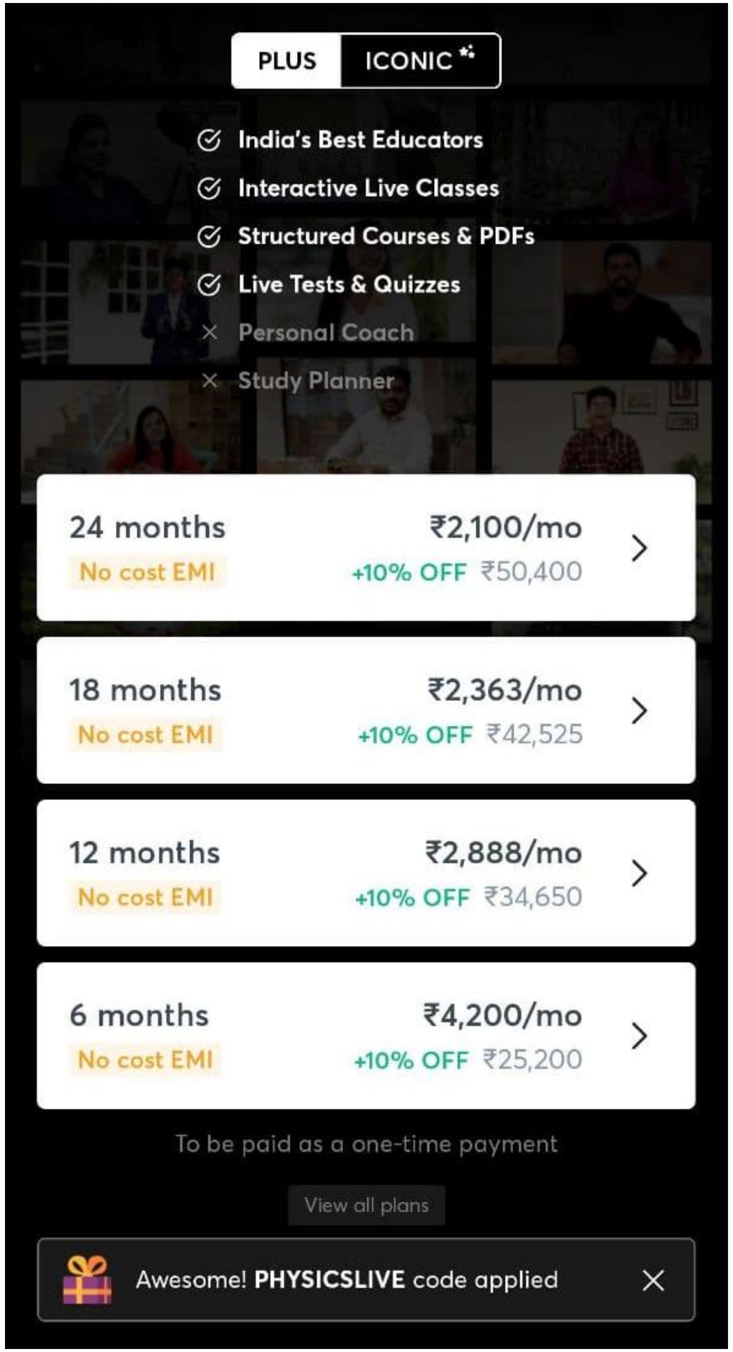
SIR PRATEEK JAIN

- IIT JEE & NEET FACULTY (KOTA)
- TOP PHYSICS FACULTY ON UNACADEMY.
- 8+ YEARS OF TEACHING EXPERIENCE
- RESEARCH WORK WITH HC VERMA SIR AT IIT KANPUR
- PRODUCED RANKS LIKE AIR 6, AIR 10 ETC.



PHYSICSLIVE



Use code PHYSICSLIVE to get 10% OFF on Unacademy PLUS.

SUBSCRIBE

@Physicsaholics

@Physicsaholics_prateek

@NEET_Physics
@IITJEE_Physics

physicsaholics.com

CLICK

Links are also in the description of the video.

For Video Solution of this DPP, Click on below link

https://physicsaholics.com/home/courseDetails/50

JEE Advanced, NSEP, INPhO, IPhO
Physics DPP

DPP-3 Units & Measurements: Deriving Physical relations and Unit Conversion

By Physicsaholics Team

Q) In a system of units if force (F), acceleration (A) and time (T) are taken as fundamental units, then the dimensional formula of energy is:

(a) FA^2T (b) FAT^2

(c) FA^2T^3 (d) FAT

Ans. b

Solution: Force = F, acceleration = A, Time = T, Energy = E

M-1

let; $E \propto F^a A^b T^c$

$$[E] = [F]^a [A]^b [T]^c$$

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

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

$M \Rightarrow \boxed{1 = a}$

$L \Rightarrow 2 = a + b \Rightarrow 2 + 1 = b \Rightarrow \boxed{b = 1}$

$T \Rightarrow -2 = -2a - 2b + c = -2(1) - 2(1) + c$

$\boxed{c = 2}$

so; $\boxed{E \propto F^1 A^1 T^2}$ Ans

M-2

Dimensionally;

$[\text{Energy}, E] = [\text{work}, W] = F \times d$

Unit of Acceleration; $A = m/s^2$

$[A] = \left[\frac{d}{T^2}\right] \Rightarrow [d] = [A T^2]$ (Dimensionally)

so; $[E] = [F \times d] = [F \times A \times T^2]$

so; $\boxed{[E] = [F^1 A^1 T^2]}$ Ans

Q) The velocity of surface waves depends upon surface tension (unit S is= N/m), coefficient of viscosity (Unit of η = N-s-m^{-2}) and density (ρ). The relation is

(a) $s^2/\rho\eta$

(b) s/η

(c) $\eta\rho/s^2$

(d) ρ/η

Ans. b

Solution:

M-1

velocity of wave (V_s) ; $[V_s] = LT^{-1}$

surface tension (S) ; unit $= N/m$

$[S] = \frac{MLT^{-2}}{L} \Rightarrow [S] = MT^{-2}$

viscosity (η) ; unit $= N\text{-}s\ m^{-2}$;

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

density (ρ) ; $[\rho] = ML^{-3}$

let; $V \propto S^a \eta^b \rho^c$

$LT^{-1} = [MT^{-2}]^a [ML^{-1}T^{-1}]^b [ML^{-3}]^c$

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

$M \Rightarrow 0 = a + b + c$ — ①

$L \Rightarrow 1 = -b - 3c$ — ②

$T \Rightarrow -1 = -2a - b + 3c$ — ③

after solving eq ①, ② & ③

$a = 1$; $b = -1$; $c = 0$

so; $V \propto S^1 \eta^{-1} \rho^0 \Rightarrow$ $\boxed{V \propto \frac{S}{\eta}}$ Ans

M-2

$F = 6\pi\eta r V$ (viscous force)

$S = \frac{F}{r}$ [surface tension]

$F = Sr$

$Sr = 6\pi\eta r V$

$[V] = \left[\frac{S}{6\pi\eta}\right]$ [Dimensionally]

as; 6π is dimensionless

so; $\boxed{[V] = \left[\frac{S}{\eta}\right]}$ [Dimensionally]

Ans

Q) The velocity of a body falling under gravity is directly proportional to $g^a h^b$. If g and h are the acceleration due to gravity and height covered by the body, respectively, then determine the values of a and b.

(a) 1/2 and 1/2

(b) – 1/2 and -1/2

(c) 1/2 and – 1/2

(d) -1/2 and 1/2

Ans. a

velocity (v) ; g = acceleration due to gravity (m/s^2)

Solution: h = height (m)

M-1

$[v] = LT^{-1}$; $[g] = LT^{-2}$

And; $[h] = L$

let; $v \propto g^a h^b$

$[LT^{-1}] = [LT^{-2}]^a [L]^b$

$LT^{-1} = L^{a+b} T^{-2a}$

$L \Rightarrow 1 = a+b$ — ①

$T \Rightarrow -1 = -2a$

$\Rightarrow \boxed{a = 1/2} \Rightarrow \boxed{b = \frac{1}{2}}$ Ans

M-2

$[v] = \left[\frac{h}{t}\right]$ (Dimensionally) — ①

and $[g] = \left[\frac{h}{t^2}\right]$ (Dimensionally) — ②

from eqn ① $\Rightarrow [t] = \left[\frac{h}{v}\right]$

$[t^2] = [h^2/v^2]$

Put in eqn ②

$[g] = \left[\frac{h\, v^2}{h^2}\right] \Rightarrow [v^2] = [hg]$

$[v] = [\sqrt{gh}]$ (Dimensionally)

$[v] = [g^{1/2}\, h^{1/2}]$

so; $\boxed{a = \frac{1}{2}}$ & $\boxed{b = \frac{1}{2}}$ Ans

Q) If Energy (E), velocity (v) and time (T) are fundamental units. What will be the dimension of surface tension (Unit = N/m)?

(a) $EV^{2}T^{-1}$

(b) $E^{0}V^{2}T^{-1}$

(c) $E^{-1}V^{0}T^{2}$

(d) $EV^{-2}T^{-2}$

Ans. d

Solution: $[E] = ML^2T^{-2}$; $[v] = LT^{-1}$; $[T] = T$

surface; $(S) = N/m$; $[S] = \frac{MLT^{-2}}{L} = MT^{-2}$

M-1

Let; $S \propto E^a v^b T^c$

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

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

$M \Rightarrow \boxed{1 = a}$

$L \Rightarrow 0 = 2a + b = 2(1) + b$

$\boxed{b = -2}$

$T \Rightarrow -2 = -2a - b + c = -2 + 2 + c$

$\boxed{c = -2}$

$\boxed{S = E V^{-2} T^{-2}}$ Ans

M-2

Power; $P = F \times V = \frac{E}{T}$

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

surface tension; $S = \frac{F}{d}$

$[d] = [V T]$

so; $[S] = \left[\frac{F}{VT}\right] = \left[\frac{E/VT}{VT}\right]$

$[S] = \left[\frac{E}{V^2T^2}\right]$

so; $\boxed{[S] = [E V^{-2} T^{-2}]}$ (Dimensionally)

Ans

Q) If force (F), acceleration (A) and time (T) are taken as fundamental quantities, then the dimensions of length (L) will be:

(a) FT^2

(b) $F^{-1}A^2T^{-1}$

(c) FA^2T

(d) AT^2

Ans. d

Solution: $[F] = MLT^{-2}$; $[A] = LT^{-2}$; $[L] = L$; $[T] = T$

M-1

Let; $L \propto F^a A^b T^c$

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

$$M^0 L^1 T^0 = M^a L^{a+b} T^{-2a-2b+c}$$

$M \Rightarrow$ $\boxed{0 = a}$

$L \Rightarrow$ $1 = a+b = 0+b$

$\boxed{b = 1}$

$T \Rightarrow$ $0 = -2a-2b+c = 0-2+c$

$\boxed{c = 2}$

$$L \propto F^0 A^1 T^2$$

$\boxed{L \propto AT^2}$ Ans

M-2

$$F = mA$$

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

$$[L] = [AT^2]$$

$\boxed{[L] = [AT^2]}$ Dimensionally

Ans

Q) The frequency(n; unit = s^{-1}) of a tuning fork depends upon the length (l) of its prong, the density (d) and Young's modulus (Y; unit = N/m^2) of its material. Using dimensional consideration, find a relation of n in terms of l, d and Y?

(a) $n = \frac{k}{l}\sqrt{\frac{Y}{d}}$

(b) $n = \frac{k}{d}\sqrt{\frac{Y}{l}}$

(c) $n = \frac{Y}{l}\sqrt{\frac{K}{d}}$

(d) $n = \frac{kd}{l}\sqrt{Y}$

Ans. a

$[n] = T^{-1}$; $[l] = L$; $[d] = ML^{-3}$; $[Y] = \frac{[N]}{[m^2]} = \frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$

Solution:

M-1

Let; $n \propto Y^a d^b l^c$

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

$M^0 L^0 T^{-1} = M^{a+b} L^{-a-3b+c} T^{-2a-3b}$

$M \Rightarrow 0 = a+b$ — (1)

$L \Rightarrow 0 = -a-3b+c$ — (2)

$T \Rightarrow -1 = -2a$ — (3)

after solving (1), (2) & (3)

$a = \frac{1}{2}$; $b = \frac{-1}{2}$; $c = -1$

$n \propto Y^{1/2} d^{-1/2} l^{-1} \Rightarrow n \propto \frac{1}{l}\sqrt{\frac{Y}{d}}$

$$\boxed{n = \frac{K}{l}\sqrt{\frac{Y}{d}}}$$ Ans

M-2

$[Y] = \left[\frac{Fl}{A x}\right] \Rightarrow F = \frac{YAx}{l}$

frequency; $[n] = \left[\frac{1}{2l}\sqrt{\frac{F}{\mu}}\right]$ (μ = mass per unit length)

$[\mu] = \left[\frac{m}{l}\right]$; $\frac{\mu}{l^2} = \frac{m}{l^3} = \frac{m}{V} = d$

so, $d = \frac{\mu}{l^2} \Rightarrow [\mu] = [d l^2]$

Dimensionally:

so; $[n] = \left[\frac{1}{l}\sqrt{\frac{F}{dl^2}}\right] = \left[\frac{1}{l^2}\sqrt{\frac{F}{d}}\right]$

$[n] = \left[\frac{1}{l^2}\sqrt{\frac{YAx}{xd}}\right]$ [$\because x = l$ dimensionally]

$[n] = \left[\frac{1}{l^2}\sqrt{\frac{Yl^2}{d}}\right]$ ($A = l^2$)

$[n] = \left[\frac{l}{l^2}\sqrt{\frac{Y}{d}}\right] = \left[\frac{1}{l}\sqrt{\frac{Y}{d}}\right]$

so; Dimensionally;

$[n] = \left[\frac{1}{l}\sqrt{\frac{Y}{d}}\right]$

so, formula.

$$\boxed{n = \frac{K}{l}\sqrt{\frac{Y}{d}}}$$ Ans

Q) 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 (P = Force × Velocity) will correspond to

(a) 16 watts

(b) $\frac{1}{16}$ watts

(c) 25 watts

(d) None of these

Ans. a

Solution:

Let; in new system.

Units: 20kg, 10m, 5 sec

Unit of Power (P) = J/sec

$$[P] = \frac{ML^2T^{-2}}{T} = ML^2T^{-3}$$

$$\boxed{[P] = ML^2T^{-3}}$$

Let in new system;

unit of power = star

so; 1 star = n watt

$$1[M_2L_2^2T_2^{-3}] = n[M_1L_1^2T_1^{-3}]$$

$$n = \left[\left(\frac{M_2}{M_1}\right)\left(\frac{L_2}{L_1}\right)^2\left[\frac{T_2}{T_1}\right]^{-3}\right]$$

$$n = \left[\frac{20kg}{1kg} \times \left(\frac{10m}{1m}\right)^2\left(\frac{5\,sec}{sec}\right)^{-3}\right]$$

$$n = 20 \times 100 \times \frac{1}{5^3}$$

$$= \frac{2000}{125} = 16$$

$$n = 16$$

so; $\boxed{1\ \text{star} = 16\ \text{watt}}$ Ans

Q) In C.G.S system of units, the unit of pressure is dyne/cm^2. In a new system of units, the unit of mass is 1 milligram, unit of length is 1 mm and unit of time is 1 millisecond. Let the unit of pressure in this new system is marvel. The value of 1 marvel is:

(a) 10^4 dyne/cm^2

(b) 1 dyne/cm^2

(c) 10^{-2} dyne/cm^2

(d) 10^{-3} dyne/cm^2

Ans. a

Solution:

units in cgs system : 1 gm, 1 cm, 1 sec

units in new system : 10^{-3} gm, 10^{-1} cm, 10^{-3} sec

Dimensions of Pressure $= \frac{[F]}{[A]} = \frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$

let ; 1 marvel = n dyne/cm^2

$$1[M_2L_2^{-1}T_2^{-2}] = n[M_1L_1^{-1}T_1^{-2}]$$

$$n = 1\left[\left(\frac{M_2}{M_1}\right)\left(\frac{L_2}{L_1}\right)^{-1}\left(\frac{T_2}{T_1}\right)^{-2}\right]$$

$$n = 1\left[\left(\frac{10^{-3}\,gm}{gm}\right)\left(\frac{10^{-1}\,cm}{cm}\right)^{-1}\left(\frac{10^{-3}\,sec}{sec}\right)^{-2}\right]$$

$$= [10^{-3} \times 10^{1} \times 10^{6}] = 10^4 \Rightarrow \boxed{n = 10^4}$$

so; $\boxed{1 \text{ Marvel} = 10^4 \text{ dyne/cm}^2}$

Q) In system called the star system we have 1 star kilogram = 10^{20} kg. 1 starmetre = 10^8 m, 1 starsecond = 10^3 second then calculate the value of 1 joule in this system.

(a) 10^{13} starjoule

(b) 10^{-30} starjoule

(c) 10^{22} starjoule

(d) 10^{-23} starjoule

Ans. b

Solution: 1 star kg = 10^{20} kg ; 1 star m = 10^{8} m ; 1 star sec = 10^{3} sec

1 Joule = unit of Energy ; [Joule] = $M L^2 T^{-2}$

let ; unit of energy in new system = star J

then let ; 1 star J = n Joule.

$$1 [M_2 L_2^2 T_2^{-2}] = n [M_1 L_1^2 T_1^{-2}]$$

$$n = \frac{M_2}{M_1} \cdot \left(\frac{L_2}{L_1}\right)^2 \left(\frac{T_2}{T_1}\right)^{-2}$$

$$n = \left(\frac{10^{20}\,kg}{kg}\right)\left(\frac{10^{8}\,m}{m}\right)^2 \left(\frac{10^{3}\,sec}{sec}\right)^{-2}$$

$$n = 10^{20} \times 10^{16} \times 10^{-6} = 10^{30}$$

$\Rightarrow$ **1 Star J = 10^{30} Joule** $\Rightarrow$ **1 Joule = 10^{-30} star J**

Ans.

Q) What will be equivalent energy of 5eV in joule?

(a) 8.0×10^{-22}J
(b) 8.0×10^{-19}J
(c) 16×10^{18}J
(d) 8.0×10^{-26}J

Ans. b

Solution:

$1e = 1.6 \times 10^{-19}$ coulamb

as: $1\,eV = 1 \times 1.6 \times 10^{-19}$ Coulamb × Volt

$= 1 \times 1.6 \times 10^{-19}$ Joule [∵ Joule = Coulamb × Volt]

from $E = q \cdot V$

so; $1\,eV = 1.6 \times 10^{-19}$ Joule.

so: $5\,eV = 5 \times 1.6 \times 10^{-19}$ Joule

$5\,eV = 8 \times 10^{-19}$ Joule. Ans

For Video Solution of this DPP, Click on below link

https://physicsaholics.com/home/courseDetails/50

Chalo Niklo