MEASUREMENT AND UNITS & DIMENSIONS

PREVIOUS EAMCET BITS

1. When a wave traverses a medium the displacement of a particle located at 'x' at a time 't ' is given by $\mathbf{y = a\sin(bt - cx)}$, where a, b, c are constants of the wave, which of the following is a quantity with dimensions ? **[EAMCET 2009 E]**

   1) y/a 2) bt   3) cx   4) b/c

   Ans: 4

Sol : 1. $\mathbf{\frac{y}{a} = \frac{Displacement}{amplitude} = \frac{L}{L} = No}$ dimensions.

2. bt = No dimension. Since angle has no dimensions.
3. cx = No dimensions. Since angle has no dimensions.
4. Angle has no dimensions, according to the principle of homogeneity of dimensions.

$\therefore$ bt = cx $\Rightarrow \frac{b}{c} = \frac{x}{t} = \frac{L}{T} = LT^{-1}$ = velocity

2. The energy $[\mathbf{E}]$, angular momentum $(\mathbf{L})$ and universal gravitational constant $(\mathbf{G})$ are chosen as fundamental quantities. The dimensions of universal gravitational constant in the dimensional formula of planks constant $(\mathbf{h})$ is. [EAMCET 2008 E]

   1) 0   2) -1   3) $\mathbf{\frac{5}{3}}$ 4) 1

   Ans: 1

Sol : From the given problem

$\mathbf{h = E^a L^b G^c}$

Where a, b, c are constants

From the principle of homogeneity of dimensions

Dimensions of $\mathbf{h = [ML^2\ T^{-1}]}$

Dimensions of $\mathbf{E = [ML^2\ T^{-2}]}$

Dimensions of $\mathbf{L = [ML^2\ T^{-1}]}$

Dimensions of $\mathbf{G = [M^{-1}\ L^3\ T^{-2}]}$

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

$\mathbf{M^1 = M^{a+b-c}} \Rightarrow \mathbf{a + b - c = 0}$.................**1**

$\mathbf{L^2 = L^{2a+2b=3c}} \Rightarrow \mathbf{2a + 2b + 3c = 0}$...................**2**

$\mathbf{T^{-1} = T^{-2a-b-2c}} \Rightarrow \mathbf{-2a - b - 2c = 1}$...............**3**

Solving 1, 2 & 3 we get c = 0

3. Some physics constants are given in List – I and their dimensional formula are given in List – II. Match the following: **[EAMCET 2007 E]**

List – I	List – II
1) Planck's constant	i) $[ML^{-1}T^{-2}]$

2) Gravitational constant ii) $\left[ML^{-1}T^{-1}\right]$

3) Bulk modulus iii) $\left[ML^{2}T^{-1}\right]$

4) Coefficient of viscosity iv) $\left[M^{-1}L^{3}T^{-2}\right]$

The correct answer is

	1	**2**	**3**	**4**		**1**	**2**	**3**	**4**
1)	iv	iii	ii	i	2)	ii	i	iii	iv
3)	iii	ii	i	iv	4)	iii	iv	i	ii

Ans: 4

Sol : 1. Plancks constant $= \frac{\text{Energy}}{\text{Frequency}} = \frac{ML^2T^{-2}}{T^{-1}} = \left[ML^2\ T^{-1}\right]$

2. Gravitational constant $\left(G\right) = \frac{Fr^2}{m_1m_2} = \left[M^{-1}\ L^3\ T^{-2}\right]$

3. Bulk modulus $= \frac{\text{Bulk Stress}}{\text{Volume strain}} = \frac{F/A}{\frac{dv}{v}} = \left[ML^{-1}\ T^{-2}\right]$

4. Co-efficient of viscosity $= \frac{F}{A.\frac{dv}{dx}}\left(\text{from}\quad F = \eta a\frac{dv}{dx}\right)$

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

2006 :

4. If C, R, L and I denote capacity, resistance, inductance and electric current respectively, the quantitates having the same dimensions of time are **[EAMCET 2006 E]**

a) CR b) L/R c) $\sqrt{LC}$ d) LI^2

1) a and b only 2) a and c only 3) a and d only 4) a, b and c only

Ans: 4

Sol : Dimensional formula of capacity $= \left[\mathbf{M^{-1}\ L^{-2}\ T^4\ A^2}\right]$

Dimensional formula of Resistance $= \left[\mathbf{M\,L^2\ T^{-3}\ A^{-2}}\right]$

Dimensional formula of Inductance $= \left[\mathbf{M\,L^2\ T^{-2}\ A^{-2}}\right]$

Dimensional formula of Current $= \left[\mathbf{M^0\ L^0\ T^0\ A}\right]$

a. $\mathbf{CR = \left(M^{-1}\ L^{-2}\ T^4\ A^2\right)\left(ML^2\ T^{-3}\ A^{-2}\right) = M^0\ L^0\ TA^0 = Time}$

b. $\mathbf{\frac{L}{R} = \frac{ML^2\ T^{-2}\ A^{-2}}{ML^2\ T^{-3}\ A^{-2}} = T = Time}$

c. $\mathbf{\sqrt{LC} = \sqrt{\left(ML^2T^{-2}A^{-2}\right)\left(M^{-1}L^{-2}T^4A^2\right)} = T = Time}$

d. $\mathbf{LI^2 = ML^2T^{-2}A^{-2}\ x\ A^2 = ML^2T^{-2} = energy}$

5. Names of units some physical quantities are given in List – I and their dimensional formulae are given in List II. Match the correct pairs in the lists **[EAMCET 2005 E]**

List –I	List – II
a) Pa s	(e) $\left[L^2T^{-2}K^{-1}\right]$
b) $Nm\,K^{-1}$	(f) $\left[MLT^{-3}K^{-1}\right]$
c) $J\,kg^{-1}K^{-1}$	(g) $\left[ML^{-1}T^{-1}\right]$
d) $Wm^{-1}K^{-1}$	(h) $\left[ML^2T^{-2}K^{-1}\right]$

	a	b	c	d		a	b	c	d
1)	h	g	e	f	2)	g	f	h	e
3)	g	e	h	f	4)	g	h	e	f

Ans: 4

Sol :

a. Dimensional formula of Pa – s $= \left[ML^{-1}T^{-2}\right]\left[T\right]$

$= \left[ML^{-1}\,T^{-1}\right]$

b. Dimensional formula of $\mathbf{Nm\text{-}k^{-1}} = \left[MLT^{-2}\right]\left[L\right]\left[K^{-1}\right]$

$= \left[ML^2\;T^{-2}\;K^{-1}\right]$

c. Dimensional formula of $\mathbf{J\,kg^{-1}k^{-1}} = \left[ML^2\,T^{-2}\right]\left[M^{-1}\right]\left[K^{-1}\right]$

$= \left[L^2\,T^{-2}\,K^{-1}\right]$

d. Dimensional formula of $\mathbf{Wm^{-1}\,k^{-1}} = \left[ML^2\,T^{-3}\right]\left[L^{-1}\right]\left[K^{-1}\right]$

$= \left[MLT^{-3}\,K^{-1}\right]$

6. The position of a particle at time 't' is given by the equation x(t) = $\frac{V_0}{A}\left(1-e^{At}\right)$ V_0 = constant and A > 0. Dimension of V_0 and A respectively are **[EAMCET 2004 E]**

1) $M^\circ LT^\circ$ and T^{-1} 2) $M^\circ LT^{-1}$ and LT^{-2} 3) $M^\circ LT^{-1}$ and T 4) $M^\circ LT^{-1}$ and T^{-1}

Ans: 4

Sol : Since exponential functions has no dimensions

$\therefore\ \mathbf{AT = M^0L^0T^0 \Rightarrow A = \left[T^{-1}\right]}$

According to the principle of homogeneity of dimensions

$\mathbf{x = \frac{V_0}{A} \Rightarrow V_0 = xA = \left[LT^{-1}\right]}$

7. In planetary motion the areal velocity of position vector of a planet depends on angular velocity (ω) and the distance of the planet from sun (r). If so the correct relation for areal velocity is **[EAMCET 2003 E]**

1) $\frac{dA}{dt} \propto \omega r$ 2) $\frac{dA}{dt} \propto \omega^2 r$ 3) $\frac{dA}{dt} \propto \omega r^2$ 4) $\frac{dA}{dt} \propto \sqrt{\omega r}$

Ans : 3

Sol : In the problem it is given that Areal velocity $\mathbf{\frac{dA}{dt}}$ depends on angular frequency (ω) and distance of the planet from the sun (r)

$$\therefore \mathbf{\frac{dA}{dt} \alpha\, \omega^a r^b}$$

Where a and b are dimensions of ω and r .

$$\Rightarrow \mathbf{\frac{d\,A}{d\,t} = K\ \omega^a\ r^b}$$

K is proportionality constant writing dimensional formulas on both sides $\mathbf{\left[L^2\ T^{-1}\right] = \left[T^{-1}\right]^a \left[L\right]^b}$

From the principle of homogeneity of dimensions

$\mathbf{L^2 = L^b} \quad \Rightarrow \quad \mathbf{b = 2}$

$\mathbf{T^{-1} = T^{-a}} \quad \Rightarrow \quad a = \mathbf{1}$

8. The Vander Waal's equation for a gas is $\left(P + \frac{a}{V^2}\right)\left(V - b\right) = nRT$ where P, V, R, T and n represent the pressure volume, universal gas constant, absolute temperature and number of moles of a gas respectively, 'a' and 'b' are constant. The ratio b/a will have the following dimensional formula : **[EAMCET 2002 E]**

1) $M^{-1}L^{-2}T^2$ 2) $M^{-1}L^{-1}T^{-1}$ 3) ML^2T^2 4) MLT^{-2}

Ans: 1

Sol : According to the principle of homogeneity of dimensions physical quantities having same dimensional formula can be added or subtracted.

$$\therefore\ \mathbf{P = \frac{a}{v^2} \Rightarrow a = Pv^2 = \left[ML^{-1}\ T^{-2}\right]\left[L^3\right]^2 = \left[ML^5\ T^{-2}\right]}$$

$$\mathbf{v = b = L^3} \qquad \Rightarrow \qquad \mathbf{\frac{b}{a} = \frac{L^3}{ML^5\,T^{-2}} = \left[M^{-1}\,L^{-2}\,T^{+2}\right]}$$

9. In C.G.S system the magnitude of the force is 100 dynes. In another system where the fundamental physical quantities are kilogram, meter and minute, the magnitude of the force is **[EAMCET 2001 E]**

1) 0.0.36 2) 0.36 3) 3.6 4) 36

Ans: 4

Sol : From $n_1 u_1 = n_2 u_2$

$$n_1\left[M_1 L_1 T_1^{-2}\right] = n_1\left[M_2 L_2 T_2^{-2}\right]$$

$$n_2 = n_1\left[\frac{M_1}{M_2}\right]\left[\frac{L_1}{L_2}\right]\left[\frac{T_1}{T_2}\right]^{-2}$$

$$n_2 = 100\left[\frac{g}{kg}\right]\left[\frac{cm}{m}\right]\left[\frac{s}{min}\right]^{-2}$$

$$= 100\left[\frac{g}{1000g}\right]\left[\frac{cm}{100cm}\right]\left[\frac{s}{60s}\right]^{-2}$$

$$n_2 = 3.6$$

10. The fundamental , physical quantities that have same dimensions in the formulae of torque and angular momentum are **[EAMCET 2000 E]**

 1) mass, time 2) time, length 3) mass, length 4) time, mole

 Ans: 3

Sol : Dimensional formula of Torque $= \left[\mathbf{ML^2\,T^{-2}}\right]$

Dimensional formula of angular momentum = mvr $= \left[\mathbf{ML^2\,T^{-1}}\right]$

$\therefore$ Mass and length have same dimensions

11. If pressure P, velocity V and time T are taken as fundamental physical quantities, the dimensional formula of the force is **[EAMCET 2000 E]**

 1) PV^2T^2 2) $P^{-1}V^2T^{-2}$ 3) PVT^2 4) $P^{-1}VT^2$

 Ans: 1

Sol : From the given problem $\mathbf{F \,\alpha\, P^a\, v^b\, T^c}$

Where a, b, c are dimensions

$\mathbf{F = K\, P^a\, v^b\, T^c}$

K is dimensionless proportionality constant

Dimensional formula of Force $= \left[\mathbf{MLT^{-2}}\right]$

Dimensional formula of Pressure $= \left[\mathbf{ML^{-1}\,T^{-2}}\right]$

Dimensional formula of Velocity $= \left[\mathbf{LT^{-1}}\right]$

Dimensional formula of Time $= \left[\mathbf{T}\right]$

$\therefore \left[\mathbf{MLT^{-2}}\right] = \left[\mathbf{ML^{-1}\,T^{-2}}\right]^a \left[\mathbf{LT^{-1}}\right]^b \left[\mathbf{T}\right]^c$

$\left[\mathbf{MLT^{-2}}\right] = \left[\mathbf{M^a}\right]\left[\mathbf{L}\right]^{-a+b}\left[\mathbf{T}\right]^{-2a-b+c}$

From the principle of homogeneity of dimensions

$\Rightarrow \mathbf{M^1 = M^a} \quad \mathbf{a = 1}$

$\Rightarrow \mathbf{L^1 = L^{-a+b}} \quad \therefore \mathbf{-a + b = 1}$

$\Rightarrow \mathbf{T^{-2} = T^{-2a-b+c}} \quad \therefore \mathbf{-2a - b + c = -2}$

Solving a = 1, b = 2, c = 2.

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12. If energy E , velocity V and time T are taken as fundamental quantitates, the dimensional formula for surface tension is **[EAMCET 2009 M]**

1) $E^1V^2T^{-2}$ 2) $E^2V^1T^{-2}$ 3) $E^2V^{-2}T^{-1}$ 4) $E^{-2}V^{-2}T^{-1}$

Ans 1

Sol. From the problem surface tension (s) $\propto E^aV^bT^c$

$$S = KE^aV^bT^c$$

where a, b, c are dimensions, K is a proportionality constant

$\therefore\ ML^0T^{-2} = \left(ML^2T^{-2}\right)^a \left(LT^{-1}\right)^b \left(T\right)^c$

equating the powers

$\therefore$ a = 1, b = - 2 and c = – 2

$\therefore\ s \propto E^1V^{-2}T^{-2}$

13. If power (p)surface tension (T) and plancks constant (h) are arranged so that the dimensions of time in their dimension formulae are in ascending order, then which of the following is correct **[EAMCET 2008 M]**

1) P, T, h 2) P, h, T 3) T, P, h 4) T, h, P

Ans : 1

Sol : Dimensional formula of power $= \dfrac{\textbf{Work}}{\textbf{time}} = \left[\mathbf{ML^2\,T^{-3}}\right]$

Dimensional formula of surface tension $= \dfrac{\textbf{Force}}{\textbf{Length}} = \left[\mathbf{MT^{-2}}\right]$

Dimensional formula of plancks constant $= \dfrac{\textbf{Energy}}{\textbf{frequency}} = \left[\mathbf{ML^2\,T^{-1}}\right]$

Ascending order of time is -3, -2, -1

14. If force (F), work (W) and velocity (V) are taken as fundamental quantities then the dimensional formula of time (T) is **[EAMCET 2007 M]**

1) $\mathbf{W^1\,F^1\,v^1}$ 2) $\mathbf{W^1\,F^1\,v^{-1}}$ 3) $\mathbf{W^{-1}\,F^{-1}\,v^{-1}}$ 4) $\mathbf{W^1\,F^{-1}\,v^{-1}}$

Ans : 4

Sol : From the given problem $\mathbf{T\,\alpha\,F^a\,w^b\,v^c}$

Where a, b, c are dimensions

$\therefore \mathbf{T = K\,F^a\,w^b\,v^c}$

K is a dimensionless constant

$\mathbf{T = \left[MLT^{-2}\right]^a \left[ML^2\,T^{-2}\right]^b \left[LT^{-1}\right]^c}$

$\mathbf{T = \left[M\right]^{a+b} \left[L\right]^{a+2b+c} \left[T\right]^{-2a-2b-c}}$

Comparing the powers we get

a + b = 0 ………..……………..…..1

a + 2b+c = 0 ….…………………. 2

-2a -2b - c = 1……………………. 3

Solving equations 1, 2 & 3 we get

a = -1, b = 1, c = -1 $\therefore$ $\mathbf{T = F^{-1}\,w^1\,v^{-1}}$

15. Some physics constants are given in List – I and their dimensional formula are given in List – II. Match the following: **[EAMCET 2006 M]**

List – I	**List – II**
1) Planck's constant	i) $\left[ML^{-1}T^{-2}\right]$
2) Gravitational constant	ii) $\left[ML^{-1}T^{-1}\right]$
3) Bulk modulus	iii) $\left[ML^{2}T^{-1}\right]$
4) Coefficient of viscosity	iv) $\left[M^{-1}L^{3}T^{-2}\right]$

The correct answer is

	1	**2**	**3**	**4**		**1**	**2**	**3**	**4**
1)	iv	iii	ii	i	2)	ii	i	iii	iv
3)	iii	ii	i	iv	4)	iii	iv	i	ii

Ans: 4

Sol : 1. Plancks constant $= \dfrac{\text{Energy}}{\text{Frequency}} = \dfrac{ML^{2}T^{-2}}{T^{-1}} = \left[ML^{2}\ T^{-1}\right]$

2. Gravitational constant $(G) = \dfrac{Fr^{2}}{m_1 m_2} = \left[M^{-1}\ L^{3}\ T^{-2}\right]$

3. Bulk modulus $= \dfrac{\text{Bulk Stress}}{\text{Volume strain}} = \dfrac{F/A}{\frac{dv}{v}} = \left[ML^{-1}\ T^{-2}\right]$

4. Co-efficient of viscosity $= \dfrac{F}{A.\frac{dv}{dx}} \left(\text{from}\quad F = \eta a \dfrac{dv}{dx}\right)$

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

16. According to Bermoulli's theorem $\dfrac{P}{d} + \dfrac{V^{2}}{2} + gh = \text{constant}$. The dimensional formula of the constant is (P = Pressure, d= density, h= height, V = velocity, g = acceleration due to gravity) **[EAMCET 2005 M]**

1) $\left[M^{0}L^{0}T^{0}\right]$ 2) $\left[M^{0}LT^{0}\right]$ 3 $\left[M^{0}L^{2}T^{-2}\right]$ 4) $\left[M^{0}L^{2}T^{-4}\right]$

Ans: 3

Sol : According to Bernoulli's theorem $\mathbf{\dfrac{p}{d} + \dfrac{v^{2}}{2} + gh = constant}$

According to the principle of homogeneity of dimensions only same quantities can be added or subtracted.

$\therefore$ Dimensional formula of $\mathbf{\dfrac{p}{d}} =$ Dimensional formula of $\mathbf{\dfrac{v^{2}}{2}}$

= Dimensional formula of gh

= Dimensional formula of constant

$= \mathbf{M^0 L^2 T^{-2}}$

17. The correct order in which the dimension of ‘ Length ‘ increases in the following physical quantities is **[EAMCET 2004 M]**

a) permittivity b) resistance c) magnetic permeability d) stress

1) a, b, c, d 2) d, c,b, a 3) a, d, c, b 4) c, b, d, a

Ans: 3

Sol : a) From coulombs law $\mathbf{F = \frac{1}{4\pi\varepsilon_0} . \frac{Q_1 Q_2}{r^2}}$

$$\Rightarrow \varepsilon_0 = \frac{Q_1 Q_2}{F 4\pi r^2} = \frac{(IT) x (IT)}{MLT^{-2} x L^2} = \left[M^{-1} L^{-3} T^4 I^2\right]$$

b) From ohms law $\mathbf{v = iR \Rightarrow R} = \frac{\mathbf{v}}{\mathbf{i}} = \frac{\mathbf{w}}{\mathbf{Q\,i}} = \frac{\mathbf{w}}{\mathbf{it.i}}$

$$= \frac{ML^2 T^{-2}}{I^2 T}$$

$$= \left[ML^2 T^{-3} I^{-2}\right]$$

c) From coulombs inverse square law

$$F = \frac{\mu_0}{4\pi} \frac{m_1 m_2}{d^2} \quad \Rightarrow \quad \mu_0 = \frac{Fd^2 4\pi}{m_1 m_2}$$

Where $\mathbf{m_1, m_2 =}$ pole strength = $[\mathbf{I\,L}]$

$$\mu_0 = \frac{MLT^{-2} x L^2}{I^2 L^2} = \left[MLT^{-2}\ I^{-2}\right]$$

d) Stress $= \frac{\mathbf{Force}}{\mathbf{area}} = \frac{\mathbf{MLT^{-2}}}{\mathbf{L^2}} = \left[\mathbf{ML^{-1} T^{-2}}\right]$

$\therefore$ As $\mathbf{< 3 < -1 < 1 < 2}$ $\therefore$ A, D, C, B

18. The dimensional equation for magnetic flux is **[EAMCET 2003 M]**

1) $ML^2T^{-2}I^{-1}$ 2) $ML^2T^{-2}I^{-2}$ 3) $ML^{-2}T^{-2}I^{-1}$ 4) $ML^{-2}T^{-2}I^{-2}$

Ans: 1

Sol : Magnetic flux $\phi = \mathbf{BA}$ but F = mB or $\mathbf{B = \frac{F}{m}}$

$$\therefore \phi = \frac{FA}{m} = \frac{Force\,x\,Area}{Pole\,Strength} = \frac{MLT^{-2}\ x\ L^2}{I\,L}$$

$$= \left[ML^2 T^{-2} I^{-1}\right]$$

19. The dimensional formula of coefficient of kinematic viscosity is **[EAMCET 2002 M]**

1) $M^0L^{-1}T^{-1}$ 2) $M^0L^2T^{-1}$ 3) ML^2T^{-1} 4) $ML^{-1}T^{-1}$

Ans: 2

Sol : Coefficient of kinematic viscosity = $M^0L^2T^{-1}$

20. The dimensional formula of the product of two physical quantities P and Q is ML^2T^{-2}. The dimensional formula of P/Q is MT^{-2}. P and Q respectively are **[EAMCET 2001 M]**

1) Force, Velocity 2) Momentum , Displacement
3) Force , Displacement 4)Work, Velocity

Ans: 3

Sol : Check all the options which satisfies $\mathbf{PQ = ML^2\ T^{-2}}$ and $\mathbf{P/Q = ML^{-2}}$

1. Let force = P Velocity = Q

$\therefore \mathbf{PQ = MLT^{-2}\ x\ LT^{-1} = ML^2T^{-3}}$

2. $\mathbf{PQ =}$ Momentum x displacement

$\mathbf{= MLT^{-1}\ x\ L = \left[ML^2\ T^{-1}\right]}$

3. $\mathbf{PQ =}$ force x displacement = $\mathbf{MLT^{-2}\ x\ L = \left[ML^2\ T^{-2}\right]}$

$$\mathbf{\frac{P}{Q} = \frac{MLT^{-2}}{L} = \left[M\,T^{-2}\right]}$$

$\therefore$ As both the conditions are satisfied

P = Force Q = displacement

21. The physical quantity which has dimensional formula as that of $\frac{\text{Energy}}{\text{mass}\times\text{length}}$ is **[EAMCET 2000M]**

1) Force 2) Power 3) Pressure 4) Acceleration

Ans: 4

Sol :

$$\mathbf{\frac{Energy}{mass\ x\ length} = \frac{ML^2\ T^{-2}}{M\ x\ L} = L\,T^{-2}} = \text{acceleration}$$

22. The dimensional formula of magnetic induction is **[EAMCET 2000 M]**

1) $MT^{-1}A^{-1}$ 2) $MT^{-2}A^{-1}$ 3) MLA^{-1} 4) MT^2A

Ans: 2

Sol : From $\mathbf{F = mB}$ $\Rightarrow$ $\mathbf{B = \frac{F}{m} = \frac{Force}{pole\ strength} = \frac{MLT^{-2}}{AL} = MT^{-2}A^{-1}}$

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