Units, Dimensions and Measurement

SET Self Evaluation Test - 1

1. The surface tension of a liquid is $70\ dyne/cm$. In MKS system its value is

[CPMT 1973, 74; AFMC 1996; BHU 2002]

(a) $70\ N/m$ (b) $7 \times 10^{-2}\ N/m$

(c) $7 \times 10^{3}\ N/m$ (d) $7 \times 10^{2}\ N/m$

2. The SI unit of universal gas constant (R) is

[MP Board 1988; JIPMER 1993; AFMC 1996; MP PMT 1987, 94; CPMT 1984, 87; UPSEAT 1999]

(a) $Watt\ K^{-1} mol^{-1}$

(b) $Newton\ K^{-1} mol^{-1}$

(c) $Joule\ K^{-1}\ mol^{-1}$

(d) $Erg\ K^{-1}\ mol^{-1}$

3. The unit of permittivity of free space ε_0 is

[MP PET 1993; MP PMT 2003; CBSE PMT 2004]

(a) *Coulomb/Newton-metre*

(b) Newton-$metre^2/Coulomb^2$

(c) Coulomb$^2/(Newton\text{-}metre)^2$

(d) $Coulomb^2/Newton\text{-}metre^2$

4. The temperature of a body on Kelvin scale is found to be $X\ K$. When it is measured by a Fahrenheit thermometer, it is found to be $X^0 F$. Then X is

[UPSEAT 2000]

(a) 301.25

(b) 574.25

(c) 313

(d) 40

5. What are the units of $K = 1/4\pi\varepsilon_0$

[AFMC 2004]

(a) $C^2 N^{-1} m^{-2}$ (b) $Nm^2 C^{-2}$

(c) $Nm^2 C^2$ (d) Unitless

6. The SI unit of surface tension is **[DCE 2003]**

(a) *Dyne/cm* (b) *Newton/cm*

(c) *Newton/metre* (d) *Newton-metre*

7. E, m, l and G denote energy, mass, angular momentum and gravitational constant respectively, then the dimension of $\frac{El^2}{m^5 G^2}$ are **[AIIMS 1985]**

(a) Angle (b) Length

(c) Mass (d) Time

8. From the equation $\tan\theta = \frac{rg}{v^2}$, one can obtain the angle of banking θ for a cyclist taking a curve (the symbols have their usual meanings). Then say, it is

(a) Both dimensionally and numerically correct

(b) Neither numerically nor dimensionally correct

(c) Dimensionally correct only

(d) Numerically correct only

9. A dimensionally consistent relation for the volume V of a liquid of coefficient of viscosity η flowing per *second* through a tube of radius r and length l and having a pressure difference p across its end, is

(a) $V = \frac{\pi p r^4}{8\eta l}$ (b) $V = \frac{\pi\eta l}{8 p r^4}$

(c) $V = \frac{8 p \eta l}{\pi r^4}$ (d) $V = \frac{\pi p \eta}{8 l r^4}$

10. The velocity v (in $cm/\sec$) of a particle is given in terms of time t (in *sec*) by the relation $v = at + \frac{b}{t+c}$; the dimensions of a, b and c are **[CPMT 1990]**

(a) $a = L^2, b = T, c = LT^2$

(b) $a = LT^2, b = LT, c = L$

(c) $a = LT^{-2}, b = L, c = T$

(d) $a = L, b = LT, c = T^2$

11. From the dimensional consideration, which of the following equation is correct **[CPMT 1983]**

(a) $T = 2\pi\sqrt{\frac{R^3}{GM}}$ (b) $T = 2\pi\sqrt{\frac{GM}{R^3}}$

(c) $T = 2\pi\sqrt{\frac{GM}{R^2}}$ (d) $T = 2\pi\sqrt{\frac{R^2}{GM}}$

12. The position of a particle at time t is given by the relation $x(t) = \left(\frac{v_0}{\alpha}\right)(1 - c^{-\alpha t})$, where v_0 is a constant and $\alpha > 0$. The dimensions of v_0 and α are respectively

[CBSE PMT 1995]

(a) $M^0 L^1 T^{-1}$ and T^{-1}

(b) $M^0 L^1 T^0$ and T^{-1}

(c) $M^0 L^1 T^{-1}$ and LT^{-2}

(d) $M^0 L^1 T^{-1}$ and T

13. The equation of state of some gases can be expressed as $\left(P+\frac{a}{V^2}\right)=\frac{R\theta}{V}$ Where P is the pressure, V the volume, θ the absolute temperature and a and b are constants. The dimensional formula of a is

[UPSEAT 2002; Orissa PMT 2004]

(a) $[ML^5T^{-2}]$ (b) $[M^{-1}L^5T^{-2}]$

(c) $[ML^{-1}T^{-2}]$ (d) $[ML^{-5}T^{-2}]$

14. The dimensions of $\frac{a}{b}$ in the equation $P=\frac{a-t^2}{bx}$, where P is pressure, x is distance and t is time, are

[KCET 2003]

(a) MT^{-2} (b) M^2LT^{-3}

(c) ML^3T^{-1} (d) LT^{-3}

15. Dimensions of $\frac{1}{\mu_0\varepsilon_0}$, where symbols have their usual meaning, are **[AIEEE 2003]**

(a) $[LT^{-1}]$ (b) $[L^{-1}T]$

(c) $[L^{-2}T^2]$ (d) $[L^2T^{-2}]$

16. The dimensions of $e^2/4\pi\varepsilon_0 hc$, where e, ε_0, h and c are electronic charge, electric permittivity, Planck's constant and velocity of light in vacuum respectively**[UPSEAT 2004]**

(a) $[M^0L^0T^0]$ (b) $[M^1L^0T^0]$

(c) $[M^0L^1T^0]$ (d) $[M^0L^0T^1]$

17. If radius of the sphere is $(5.3\pm0.1)\,cm$. Then percentage error in its volume will be **[Pb. PET 2000]**

(a) $3+6.01\times\frac{100}{5.3}$ (b) $\frac{1}{3}\times0.01\times\frac{100}{5.3}$

(c) $\left(\frac{3\times0.1}{5.3}\right)\times100$ (d) $\frac{0.1}{5.3}\times100$

18. The pressure on a square plate is measured by measuring the force on the plate and the length of the sides of the plate. If the maximum error in the measurement of force and length are respectively 4% and 2%, The maximum error in the measurement of pressure is

[CPMT 1993]

(a) 1% (b) 2%

(c) 6% (d) 8%

19. While measuring the acceleration due to gravity by a simple pendulum, a student makes a positive error of 1% in the length of the pendulum and a negative error of 3% in the value of time period. His percentage error in the measurement of g by the relation $g=4\pi^2(l/T^2)$ will be

(a) 2% (b) 4%

(c) 7% (d) 10%

20. The length, breadth and thickness of a block are given by $l=12\,cm, b=6\,cm$ and $t=2.45\,cm$

The volume of the block according to the idea of significant figures should be **[CPMT 2004]**

(a) $1\times10^2\,cm^3$ (b) $2\times10^2\,cm^3$

(c) $1.763\times10^2\,cm^3$ (d) None of these

Answers and Solutions

(SET -1)

1. (b) 1 $dyne = 10^{-5}$ $Newton$, $1\,cm = 10^{-2}\,m$

$$70\frac{dyne}{cm} = \frac{70\times 10^{-5}}{10^{-2}}\frac{N}{m}$$

$= 7\times 10^{-2}\,N/m$.

2. (c) $PV = nRT \Rightarrow R = \frac{PV}{nT} = \frac{Joule}{mole \times Kelvin} = JK^{-1}mol^{-1}$

3. (d) $F = \frac{1}{4\pi\varepsilon_0}.\frac{Q_1 Q_2}{r^2}$

$\Rightarrow \varepsilon_0 \propto \frac{Q^2}{F\times r^2}$

So ε_0 has units of $Coulomb^2/Newton\text{-}m^2$

4. (b) $\frac{F-32}{9} = \frac{K-273}{5} \Rightarrow \frac{x-32}{9} = \frac{x-273}{5} \Rightarrow x = 574.25$

5. (b) Unit of $\varepsilon_0 = C^2/N\text{-}m^2$ $\therefore$ Unit of $K = Nm^2C^{-2}$

6. (c)

7. (a) $[E] = [ML^2T^{-2}], [m] = [M], [l] = [ML^2T^{-1}]$ and $[G] = [M^{-1}L^3T^{-2}]$ Substituting the dimension of above quantities in the given formula :

$$\frac{El^2}{m^5G^2}\ \frac{[ML^2T^{-2}][ML^2T^{-1}]^2}{[M^5][M^{-1}L^3T^{-2}]^2} = \frac{M^3L^6T^{-4}}{M^3L^6T^{-4}} = [M^0L^0T^0]$$

8. (c) Given equation is dimensionally correct because both sides are dimensionless but numerically wrong because the correct equation is $\tan\theta = \frac{v^2}{rg}$.

9. (a) Formula for viscosity $\eta = \frac{\pi pr^4}{8Vl} \Rightarrow V = \frac{\pi pr^4}{8\eta l}$

10. (c) From the principle of dimensional homogenity $[v] = [at] \Rightarrow [a] = [LT^{-2}]$. Similarly $[b] = [L]$ and $[c] = [T]$

11. (a) By substituting the dimensions in $T = 2\pi\sqrt{\frac{R^3}{GM}}$

we get $\sqrt{\frac{L^3}{M^{-1}L^3T^{-2}\times M}} = T$

12. (a) Dimension of $\alpha t = [M^0L^0T^0]$ $\therefore$ $[\alpha] = [T^{-1}]$

Again $\left[\frac{v_0}{\alpha}\right] = [L]$ so $[v_0] = [LT^{-1}]$

13. (a) By the principle of dimensional homogenity

$[P] = \left[\frac{a}{V^2}\right] \Rightarrow [a] = [P]\times[V^2] = [ML^{-1}T^{-2}][L^6]$

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

14. (a) $[a] = [T^2]$ and $[b] = \frac{[a-t^2]}{[P][x]} = \frac{T^2}{[ML^{-1}T^{-2}][L]}$

$\Rightarrow [b] = [M^{-1}T^4]$

So $\left[\frac{a}{b}\right] = \frac{[T^2]}{[M^{-1}T^4]} = [MT^{-2}]$

15. (d) $C = \frac{1}{\sqrt{\mu_0\varepsilon_0}} \Rightarrow \frac{1}{\mu_0\varepsilon_0} = c^2 = [L^2T^{-2}]$

16. (a) $[e] = [AT]$, $\in_0 = [M^{-1}L^{-3}T^4A^2]$, $[h] = [ML^2T^{-1}]$

and $[c] = [LT^{-1}]$

$\therefore \left[\frac{e^2}{4\pi\in_0 hc}\right] = \left[\frac{A^2T^2}{M^{-1}L^{-3}T^4A^2\times ML^2T^{-1}\times LT^{-1}}\right]$

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

17. (c) Volume of sphere $(V) = \frac{4}{3}\pi r^3$

% error in volume $= 3\times\frac{\Delta r}{r}\times 100 = \left(3\times\frac{0.1}{5.3}\right)\times 100$

18. (d) $P = \frac{F}{A} = \frac{F}{l^2}$, so maximum error in pressure (P)

$\left(\frac{\Delta P}{P}\times 100\right)_{\max} = \frac{\Delta F}{F}\times 100 + 2\frac{\Delta l}{l}\times 100$

=4%+2×2%=8%

19. (c) Percentage error in g = (%error in l) + 2(% error in T) = 1% + 2(3%) = 7%

20. (b) Volume $V = l\times b\times t$

$= 12\times 6\times 2.45 = 176.4\ cm^3$

$V = 1.764\times 10^2\ cm^3$

since, the minimum number of significant figure is one in breadth, hence volume will also contain only one significant figure. Hence, $V = 2\times 10^2\ cm^3$.

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