

**SECTION A: MULTIPLE CHOICE QUESTIONS (MCQ)****Q.1 The number of significant figures in 0.06900 is**

- (a) 5
- (b) 4
- (c) 2
- (d) 3

**Answer: (b)**

In 0.06900, the zeros on the right of decimal point and before the first non-zero digit are not significant. Hence, number of significant figures are four (6900).

**Q.2 The sum of the numbers 436.32, 227.2 and 0.301 in appropriate significant figures is**

- (a) 663.821
- (b) 664
- (c) 663.8
- (d) 663.82

**Answer: (b)**

The sum = 663.821 arithmetically. The number with least decimal places is 227.2 (correct to only one decimal place). The final result should be rounded off to one decimal place = 664.

**Q.3 The mass and volume of a body are 4.237 g and 2.5 cm<sup>3</sup>, respectively. The density of the material of the body in correct significant figures is**

- (a) 1.6048 g cm<sup>-3</sup>
- (b) 1.69 g cm<sup>-3</sup>
- (c) 1.7 g cm<sup>-3</sup>
- (d) 1.695 g cm<sup>-3</sup>

**Answer: (c)**

Density =  $4.237\text{g}/2.5\text{ cm}^3 = 1.6948\text{ g cm}^{-3}$  In multiplication/division, result should retain as many significant figures as in the original number with least significant figures (2.5 has 2 sig figs). Therefore, density =  $1.7\text{ g cm}^{-3}$

**Q.4 The numbers 2.745 and 2.735 on rounding off to 3 significant figures will give**

- (a) 2.75 and 2.74
- (b) 2.74 and 2.73
- (c) 2.75 and 2.73
- (d) 2.74 and 2.74

**Answer: (d)**

$2.745 \rightarrow 2.74$  and  $2.735 \rightarrow 2.74$  (when rounded to 3 significant figures)

**Q.5 The length and breadth of a rectangular sheet are 16.2 cm and 10.1 cm, respectively. The area of the sheet in appropriate significant figures and error is**

- (a)  $164 \pm 3\text{ cm}^2$
- (b)  $163.62 \pm 2.6\text{ cm}^2$
- (c)  $163.6 \pm 2.6\text{ cm}^2$
- (d)  $163.62 \pm 3\text{ cm}^2$

**Answer: (a)**

Given:  $l = (16.2 \pm 0.1)\text{ cm}$ ,  $b = (10.1 \pm 0.1)\text{ cm}$  Area  $A = l \times b = 16.2 \times 10.1 = 163.62\text{ cm}^2$   
Rounded to 3 significant digits:  $A = 164\text{ cm}^2$

Relative error:  $\Delta A/A = \Delta l/l + \Delta b/b = 0.1/16.2 + 0.1/10.1 = 2.63/163.62$   $\Delta A = 163.62 \times (2.63/163.62) = 2.63\text{ cm}^2$  Rounded to 1 significant figure:  $\Delta A = 3\text{ cm}^2$  Therefore,  $A = (164 \pm 3)\text{ cm}^2$

**Q.6 Which of the following pairs of physical quantities does not have same dimensional formula?**

- (a) Work and torque
- (b) Angular momentum and Planck's constant
- (c) Tension and surface tension

(d) Impulse and linear momentum

**Answer: (c)**

- Work = Force  $\times$  distance =  $[MLT^{-2}][L] = [ML^2T^{-2}]$
- Torque = Force  $\times$  distance =  $[ML^2T^{-2}]$
- Angular momentum =  $mvr = [ML^2T^{-1}]$
- Planck's constant =  $E/h = [ML^2T^{-2}]/[T^{-1}] = [ML^2T^{-1}]$
- Tension = Force =  $[MLT^{-2}]$
- Surface tension = Force/length =  $[MLT^{-2}]/[L] = [ML^0T^{-2}]$
- Impulse = Force  $\times$  time =  $[MLT^{-1}]$
- Momentum = mass  $\times$  velocity =  $[MLT^{-1}]$

**Q.7 Measure of two quantities along with the precision of respective measuring instrument is  $A = 2.5 \text{ ms}^{-1} \pm 0.5 \text{ ms}^{-1}$ ,  $B = 0.10 \text{ s} \pm 0.01 \text{ s}$ . The value of  $AB$  will be**

(a)  $(0.25 \pm 0.08) \text{ m}$

(b)  $(0.25 \pm 0.5) \text{ m}$

(c)  $(0.25 \pm 0.05) \text{ m}$

(d)  $(0.25 \pm 0.135) \text{ m}$

**Answer: (a)**

$x = AB = (2.5)(0.10) = 0.25 \text{ m}$   $\Delta x/x = \Delta A/A + \Delta B/B = 0.5/2.5 + 0.01/0.10 = 0.075/0.25$   $\Delta x = 0.075 = 0.08 \text{ m}$  (rounded to two significant figures)  $AB = (0.25 \pm 0.08) \text{ m}$

**Q.8 You measure two quantities as  $A = 1.0 \text{ m} \pm 0.2 \text{ m}$ ,  $B = 2.0 \text{ m} \pm 0.2 \text{ m}$ . We should report correct value for  $\sqrt{AB}$  as**

(a)  $1.4 \text{ m} \pm 0.4 \text{ m}$

(b)  $1.41 \text{ m} \pm 0.15 \text{ m}$

(c)  $1.4 \text{ m} \pm 0.3 \text{ m}$

(d)  $1.4 \text{ m} \pm 0.2 \text{ m}$

**Answer: (d)**

$Y = \sqrt{AB} = \sqrt{(1.0 \times 2.0)} = 1.414 \text{ m} \approx 1.4 \text{ m}$   $\Delta Y/Y = (1/2)[\Delta A/A + \Delta B/B] = (1/2)[0.2/1.0 + 0.2/2.0] = 0.6/(2 \times 2.0)$   $\Delta Y = (0.6 \times 1.4)/(2 \times 2.0) = 0.212 \approx 0.2 \text{ m}$  Therefore,  $\sqrt{AB} = 1.4 \pm 0.2 \text{ m}$

**Q.9 Which of the following measurement is most precise?**

- (a) 5.00 mm
- (b) 5.00 cm
- (c) 5.00 m
- (d) 5.00 km

**Answer: (a)**

All measurements are correct to two decimal places. 5.00 mm has the smallest unit and least error (0.01 mm), hence most precise.

**Q.10 The mean length of an object is 5 cm. Which of the following measurements is most accurate?**

- (a) 4.9 cm
- (b) 4.805 cm
- (c) 5.25 cm
- (d) 5.4 cm

**Answer: (a)**

Errors:  $|5 - 4.9| = 0.1$  cm,  $|5 - 4.805| = 0.195$  cm,  $|5 - 5.25| = 0.25$  cm,  $|5 - 5.4| = 0.4$  cm  
Smallest error is 0.1 cm, hence 4.9 cm is most accurate.

**Q.11 Young's modulus of steel is  $1.9 \times 10^{11}$  N/m<sup>2</sup>. When expressed in CGS units of dyne/cm<sup>2</sup>, it will be equal to (1N = 10<sup>5</sup> dyne, 1 m<sup>2</sup> = 10<sup>4</sup> cm<sup>2</sup>)**

- (a)  $1.9 \times 10^{10}$
- (b)  $1.9 \times 10^{11}$
- (c)  $1.9 \times 10^{12}$
- (d)  $1.9 \times 10^{13}$

**Answer: (c)**

$Y = 1.9 \times 10^{11}$  N/m<sup>2</sup> =  $1.9 \times 10^{11} \times 10^5$  dyne/m<sup>2</sup> =  $1.9 \times 10^{16}$  dyne/(100 cm)<sup>2</sup> =  $1.9 \times 10^{16-4}$  dyne/cm<sup>2</sup> =  $1.9 \times 10^{12}$  dyne/cm<sup>2</sup>

**Q.12** 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)  $[p^2AT]$
- (c)  $[pA^{-1/2}T]$
- (d)  $[pA^{1/2}T^{-1}]$

**Answer: (d)**

Let  $E \propto p^a A^b T^c$ , so  $E = kp^a A^b T^c$   $[ML^2T^{-2}] = [MLT^{-1}]^a [L^2]^b [T]^c$  Comparing dimensions:  $a = 1$ ,  $2b + a = 2 \Rightarrow b = 1/2$ ,  $-a + c = -2 \Rightarrow c = -1$  Therefore,  $E \propto pA^{1/2}T^{-1}$

**Multiple Choice Questions (More Than One Options)**

**Q.13** On the basis of dimensions, decide which of the following relations for the displacement of a particle undergoing simple harmonic motion is not correct?

- (a)  $y = a \sin 2\pi t/T$
- (b)  $y = a \sin vt$
- (c)  $y = (a/T) \sin(t/a)$
- (d)  $y = a\sqrt{2}[\sin(2\pi t/T) - \cos(2\pi t/T)]$

**Answer: (b, c)**

For option (c):  $[RHS] = L/T \times LT^{-1} = LT^{-1} \neq L = [LHS]$  For option (b): Dimension of angle  $[vt] = LT^{-1} \times T = L \neq$  dimensionless

**Q.14** If  $P$ ,  $Q$ ,  $R$  are physical quantities, having different dimensions, which of the following combinations can never be a meaningful quantity?

- (a)  $(P-Q)/R$
- (b)  $PQ-R$
- (c)  $PQ/R$
- (d)  $(PR-Q^2)/R$
- (e)  $(R-Q)/P$

**Answer: (a, e)**

Physical quantities with different dimensions cannot be added or subtracted. Options (a) and (e) involve subtraction of quantities with different dimensions.

**Q.15 Photon is quantum of radiation with energy  $E = h\nu$ , where  $\nu$  is frequency and  $h$  is Planck's constant. The dimensions of  $h$  are the same as that of**

- (a) linear impulse
- (b) angular impulse
- (c) linear momentum
- (d) angular momentum

**Answer: (b, d)**

$$[h] = [E]/[\nu] = [ML^2T^{-2}]/[T^{-1}] = [ML^2T^{-1}]$$

- Linear impulse =  $[MLT^{-1}]$
- Angular impulse = Change in angular momentum =  $[ML^2T^{-1}]$
- Linear momentum =  $[MLT^{-1}]$
- Angular momentum =  $[ML^2T^{-1}]$

**Q.16 If Planck's constant ( $h$ ) and speed of light in vacuum ( $c$ ) are taken as two fundamental quantities, which one of the following can, in addition, be taken to express length, mass and time in terms of the three chosen fundamental quantities?**

- (a) Mass of electron ( $m_e$ )
- (b) Universal gravitational constant
- (G) (c) Charge of electron ( $e$ )
- (d) Mass of proton ( $m_p$ )

**Answer: (a, b, d)**

$[h] = [ML^2T^{-1}]$ ,  $[c] = [LT^{-1}]$  For fundamental system, we need three independent quantities.

- $[m_e] = [M]$ ,  $[G] = [M^{-1}L^3T^{-2}]$ ,  $[m_p] = [M]$  can work
- $[e] = [AT]$  involves electric current dimension

**Q.17 Which of the following ratios express pressure?**

- (a) Force/Area
- (b) Energy/Volume
- (c) Energy/Area
- (d) Force/Volume

**Answer: (a, b)**

Pressure = Force/Area = (Force × Distance)/(Area × Distance) = Work/Volume = Energy/Volume

**Q.18 Which of the following are not a unit of time?**

- (a) Second
- (b) Parsec
- (c) Year
- (d) Light year

**Answer: (b, d)**

- 1 light year =  $9.46 \times 10^{15}$  m (distance)
- 1 parsec =  $3.08 \times 10^{16}$  m (distance)
- Second and year are units of time

