Topic-wise Solved Papers Physics

CHAPTER 1

Physical World, Units and Measurements

1. Identify the pair whose dimensions are equal **[2002]**
(a) torque and work
(b) stress and energy
(c) force and stress
(d) force and work

2. Dimensions of $\frac{1}{\mu_o \varepsilon_o}$, where symbols have their usual meaning, are **[2003]**
(a) $[L^{-1}T]$ (b) $[L^{-2}T^2]$
(c) $[L^2T^{-2}]$ (d) $[LT^{-1}]$

3. The physical quantities not having same dimensions are **[2003]**
(a) torque and work
(b) momentum and planck's constant
(c) stress and young's modulus
(d) speed and $(\mu_o \varepsilon_o)^{-1/2}$

4. Which one of the following represents the correct dimensions of the coefficient of viscosity? **[2004]**
(a) $\left[ML^{-1}T^{-1}\right]$ (b) $\left[MLT^{-1}\right]$
(c) $\left[ML^{-1}T^{-2}\right]$ (d) $\left[ML^{-2}T^{-2}\right]$

5. Out of the following pair , which one does NOT have identical dimensions ? **[2005]**
(a) Impulse and momentum
(b) Angular momentum and planck's constant
(c) Work and torque
(d) Moment of inertia and moment of a force

6. The dimensions of magnetic field in M, L, T and C (coulomb) is given as **[2008]**
(a) $[MLT^{-1}C^{-1}]$ (b) $[MT^2C^{-2}]$
(c) $[MT^{-1}C^{-1}]$ (d) $[MT^{-2}C^{-1}]$

7. A body of mass m = 3.513 kg is moving along the x-axis with a speed of 5.00 ms^{-1}. The magnitude of its momentum is recorded as **[2008]**
(a) 17.6 kg ms^{-1} (b) 17.565 kg ms^{-1}
(c) 17.56 kg ms^{-1} (d) 17.57 kg ms^{-1}

8. Two full turns of the circular scale of a screw gauge cover a distance of 1mm on its main scale. The total number of divisions on the circular scale is 50. Further, it is found that the screw gauge has a zero error of – 0.03 mm. While measuring the diameter of a thin wire, a student notes the main scale reading of 3 mm and the number of circular scale divisions in line with the main scale as 35. The diameter of the wire is **[2008]**
(a) 3.32 mm (b) 3.73 mm
(c) 3.67 mm (d) 3.38 mm

9. In an experiment the angles are required to be measured using an instrument, 29 divisions of the main scale exactly coincide with the 30 divisions of the vernier scale. If the smallest division of the main scale is half- a degree (= 0.5°), then the least count of the instrument is: **[2009]**
(a) half minute (b) one degree
(c) half degree (d) one minute

10. The respective number of significant figures for the numbers 23.023, 0.0003 and 2.1×10^{-3} are **[2010]**
(a) 5, 1, 2 (b) 5, 1, 5
(c) 5, 5, 2 (d) 4, 4, 2

11. A screw gauge gives the following reading when used to measure the diameter of a wire.
Main scale reading : 0 mm
Circular scale reading : 52 divisions
Given that 1mm on main scale corresponds to

100 divisions of the circular scale. The diameter of wire from the above data is **[2011]**

(a) 0.052 cm (b) 0.026 cm

(c) 0.005 cm (d) 0.52 cm

12. 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 **[2012]**

(a) 6% (b) zero

(c) 1% (d) 3%

13. A spectrometer gives the following reading when used to measure the angle of a prism.

Main scale reading : 58.5 degree

Vernier scale reading : 09 divisions

Given that 1 division on main scale corresponds to 0.5 degree. Total divisions on the Vernier scale is 30 and match with 29 divisions of the main scale. The angle of the prism from the above data is **[2012]**

(a) 58.59 degree (b) 58.77 degree

(c) 58.65 degree (d) 59 degree

14. Let $[\in_0]$ denote the dimensional formula of the permittivity of vacuum. If M = mass, L = length, T = time and A = electric current, then: **[2013]**

(a) $\in_0 = [M^{-1} L^{-3} T^2 A]$

(b) $\in_0 = [M^{-1} L^{-3} T^4 A^2]$

(c) $\in_0 = [M^1 L^2 T^1 A^2]$

(d) $\in_0 = [M^1 L^2 T^1 A]$

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

(a) 0.2 mA (b) 0.02 mA

(c) 0.5 mA (d) 0.05 mA

16. A student measured the length of a rod and wrote it as 3.50 cm. Which instrument did he use to measure it? **[2014]**

(a) A meter scale.

(b) A vernier calliper where the 10 divisions in vernier scale matches with 9 division in main scale and main scale has 10 divisions in 1 cm.

(c) A screw gauge having 100 divisions in the circular scale and pitch as 1 mm.

(d) A screw gauge having 50 divisions in the circular scale and pitch as 1 mm.

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

(a) 1% (b) 5%

(c) 2% (d) 3%

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

(a) 92 ± 1.8 s (b) 92 ± 3s

(c) 92 ± 1.5 s (d) 92 ± 5.0 s

19. A screw gauge with a pitch of 0.5 mm and a circular scale with 50 divisions is used to measure the thickness of a thin sheet of Aluminium. Before starting the measurement, it is found that wen the two jaws of the screw gauge are brought in contact, the 45th division coincides with the main scale line and the zero of the main scale is barely visible. What is the thickness of the sheet if the main scale reading is 0.5 mm and the 25th division coincides with the main scale line? **[2016]**

(a) 0.70 mm (b) 0.50 mm

(c) 0.75 mm (d) 0.80 mm

20. The following observations were taken for determining surface tensiton T of water by capillary method :

Diameter of capilary, $D = 1.25 \times 10^{-2}$ m

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

Using $g = 9.80$ m/s^2 and the simplified relation $T = \frac{rhg}{2} \times 10^3$ N/m, the possible error in surface tension is closest to : **[2017]**

(a) 2.4 % (b) 10 %

(c) 0.15% (d) 1.5%

Answer Key														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
(a)	(c)	(b)	(a)	(d)	(c)	(a)	(d)	(d)	(a)	(a)	(a)	(c)	(b)	(a)
16	17	18	19	20										
(b)	(d)	(c)	(d)	(d)										

SOLUTIONS

1. **(a)** $W = \vec{F} \cdot \vec{s} = Fs\cos\theta$

$= [MLT^{-2}][L] = [ML^2T^{-2}]$;

$\vec{\tau} = \vec{r} \times \vec{F} \Rightarrow \tau = rF\sin\theta$

$= [L][MLT^{-2}] = [ML^2T^{-2}]$

2. **(c)** We know that the velocity of light in vacuum is given by

$$c = \frac{1}{\sqrt{\mu_o \varepsilon_o}}$$

$$\therefore \frac{1}{\mu_o \varepsilon_o} = c^{21} = L^2T^{-2}$$

3. **(b)** Momentum $= mv = [MLT^{-1}]$

Planck's constant,

$$h = \frac{E}{v} = \frac{[ML^2T^{-2}]}{[T^{-1}]} = [ML^2T^{-1}]$$

4. **(a)** From Stokes law,

$$F = 6\pi\eta r v \Rightarrow \eta = \frac{F}{6\pi r v}$$

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

5. **(d)** Moment of Inertia, $I = Mr^2$

$[I] = [ML^2]$

Moment of force, $\vec{\tau} = \vec{r} \times \vec{F}$

$$\left[\vec{\tau}\right] = [L][MLT^{-2}] = [ML^2T^{-2}]$$

6. **(c)** We know that $F = q\,v\,B$

$$\therefore \quad B = \frac{F}{qv} = \frac{MLT^{-2}}{C \times LT^{-1}} = [MT^{-1}C^{-1}]$$

7. **(a)** Momentum, $p = m \times v$

$= (3.513) \times (5.00) = 17.565$ kg m/s

$= 17.6$ (Rounding off to get three significant figures)

8. **(d)** Least count of screw gauge

$$= \frac{0.5}{50}\text{mm} = 0.01\text{mm}$$

$\therefore$ Reading = [Main scale reading + circular scale reading × L.C] − (zero error)

$= [3 + 35 \times 0.01] - (-0.03) = 3.38$ mm

9. **(d)** 30 Divisions of vernier scale coincide with 29 divisions of main scales

Therefore 1 V.S.D $= \frac{29}{30}$ MSD

Least count = 1 MSD − 1VSD

$$= 1\text{ MSD} - \frac{29}{30}\text{ MSD}$$

$$= \frac{1}{30}\text{MSD}$$

$$= \frac{1}{30} \times 0.5° = 1\text{ minute.}$$

10. **(a)** Number of significant figures in $23.023 = 5$

Number of significant figures in $0.0003 = 1$

Number of significant figures in $2.1 \times 10^{-3} = 2$

So, the radiation belongs to X-rays part of the spectrum.

11. **(a)** L.C. $= \frac{1}{100}$ mm

Diameter of wire $= MSR + CSR \times L.C.$

$$= 0 + \frac{1}{100} \times 52 = 0.52\text{ mm} = 0.052\text{ cm}$$

12. **(a)** $R = \frac{V}{I} \Rightarrow R \pm \Delta R = \frac{V \pm \Delta V}{I \pm \Delta I}$

$$R\left(1 \pm \frac{\Delta R}{R}\right) = \frac{V}{I}\left(\frac{1 \pm \Delta V/V}{1 \pm \frac{\Delta I}{I}}\right)$$

$$\left(\frac{\Delta R}{R}\right) = \left(\frac{\Delta V}{V}\right) + \left(\frac{\Delta I}{I}\right) = (3+3)\% = 6\%$$

13. **(c)** ∵ Reading of Vernier = Main scale reading + Vernier scale reading × least count.
Main scale reading = 58.5
Vernier scale reading = 09 division
least count of Vernier = 0.5°/30

Thus, $R = 58.5° + 9 \times \frac{0.5°}{30}$

$R = 58.65°$

14. **(b)** As we know,

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

Hence, $\varepsilon_0 = \frac{C^2}{N.m^2} = \frac{[AT]^2}{MLT^{-2}.L^2}$

$= [M^{-1} L^{-3} T4 A^2]$

15. **(a)** The current voltage relation of diode is

$$I = (e^{1000\,V/T} - 1)\ \text{mA (given)}$$

When, $I = 5mA, e^{1000\ V/T} = 6mA$

Also, $dI = (e^{1000\ V/T}) \times \frac{1000}{T}$

(By exponential function)

$= (6\,mA) \times \frac{1000}{300} \times (0.01) = 0.2\,\text{mA}$

16. **(b)** Measured length of rod = 3.50 cm
For vernier scale with 1 Main Scale Division = 1 mm
9 Main Scale Division = 10 Vernier Scale Division,
Least count = 1 MSD – 1 VSD = 0.1 mm

17. **(d)** As, $g = 4\pi^2 \frac{L}{T^2}$

So, $\frac{\Delta g}{g} \times 100 = \frac{\Delta L}{L} \times 100 + 2\frac{\Delta T}{T} \times 100$

$= \frac{0.1}{20} \times 100 + 2 \times \frac{1}{90} \times 100 = 2.72 \simeq 3\%$

18. **(c)** $\Delta T = \frac{|\Delta T_1| + |\Delta T_2| + |\Delta T_3| + |\Delta T_4|}{4}$

$= \frac{2+1+3+0}{4} = 1.5$

As the resolution of measuring clock is 1.5 therefore the mean time should be 92 ± 1.5

19. **(d)** L.C. $= \frac{0.5}{50} = 0.01$ mm
Zero error = 5 × 0.01 = 0.05 mm (Negative)
Reading = (0.5 + 25 × 0.01) + 0.05 = 0.80 mm

20. **(d)** Surface tension, $T = \frac{rhg}{2} \times 10^3$

Relative error in surface tension,

$$\frac{\Delta T}{T} = \frac{\Delta r}{r} + \frac{\Delta h}{h} + 0$$

(∵ g, 2 and 10^3 are constant)

Percentage error

$$100 \times \frac{\Delta T}{T} = \left(\frac{10^{-2} \times 0.01}{1.25 \times 10^{-2}} + \frac{10^{-2} \times 0.01}{1.45 \times 10^{-2}}\right) 100$$

$= (0.8 + 0.689)$

$= (1.489) = 1.489\% \cong 1.5\%$