

# Units and Measurement

1. 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 ( $= 0.5^\circ$ ), then the least count of the instrument is [AIEEE-2009]
- (1) Half minute      (2) One degree  
 (3) Half degree      (4) One minute
2. The respective number of significant figures for the numbers 23.023, 0.0003 and  $2.1 \times 10^{-3}$  are [AIEEE-2010]
- (1) 4, 4, 2      (2) 5, 1, 2  
 (3) 5, 1, 5      (4) 5, 5, 2
3. 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 [AIEEE-2012]
- (1) 58.77 degree      (2) 58.65 degree  
 (3) 59 degree      (4) 58.59 degree
4. 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 [AIEEE-2012]
- (1) Zero      (2) 1%  
 (3) 3%      (4) 6%
5. Let  $[\epsilon_0]$  denote the dimensional formula of the permittivity of vacuum. If M = mass, L = length, T = time and A = electric current, then [JEE (Main)-2013]
- (1)  $[\epsilon_0] = M^{-1} L^{-3} T^2 A]$   
 (2)  $[\epsilon_0] = M^{-1} L^{-3} T^4 A^2]$   
 (3)  $[\epsilon_0] = M^{-1} L^2 T^{-1} A^{-2}]$   
 (4)  $[\epsilon_0] = M^{-1} L^2 T^{-1} A]$
6. The current voltage relation of diode is given by  $I = (e^{1000V/T} - 1)$  mA, where the applied V is in volts and the temperature T is in degree kelvin. If a student makes an error measuring  $\pm 0.01$  V while measuring the current of 5 mA at 300 K, what will be the error in the value of current in mA? [JEE (Main)-2014]
- (1) 0.2 mA      (2) 0.02 mA  
 (3) 0.5 mA      (4) 0.05 mA
7. A student measured the length of a rod and wrote it as 3.50 cm. Which instrument did he use to measure it? [JEE (Main)-2014]
- (1) A meter scale  
 (2) 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  
 (3) A screw gauge having 100 divisions in the circular scale and pitch as 1 mm  
 (4) A screw gauge having 50 divisions in the circular scale and pitch as 1 mm
8. 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 1 s resolution. The accuracy in the determination of g is [JEE (Main)-2015]
- (1) 2%      (2) 3%  
 (3) 1%      (4) 5%
9. 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: [JEE (Main)-2016]
- (1)  $92 \pm 5.0$  s      (2)  $92 \pm 1.8$  s  
 (3)  $92 \pm 3$  s      (4)  $92 \pm 2$  s

10. 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 when the two jaws of the screw gauge are brought in contact, the 45<sup>th</sup> division coincides with the main scale line and that 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 25<sup>th</sup> division coincides with the main scale line?

[JEE (Main)-2016]

- (1) 0.80 mm      (2) 0.70 mm  
 (3) 0.50 mm      (4) 0.75 mm
11. The following observations were taken for determining surface tension  $T$  of water by capillary method:

diameter of capillary,  $D = 1.25 \times 10^{-2}$  m

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

Using  $g = 9.80 \text{ m/s}^2$  and the simplified relation

$$T = \frac{rgh}{2} \times 10^3 \text{ N/m}, \text{ the possible error in surface tension is closest to}$$

[JEE (Main)-2017]

- (1) 0.15%      (2) 1.5%  
 (3) 2.4%      (4) 10%
12. The density of a material in the shape of a cube is determined by measuring three sides of the cube and its mass. If the relative errors in measuring the mass and length are respectively 1.5% and 1%, the maximum error in determining the density is

[JEE (Main)-2018]

- (1) 2.5%      (2) 3.5%  
 (3) 4.5%      (4) 6%

13. The pitch and the number of divisions, on the circular scale, for a given screw gauge are 0.5 mm and 100 respectively. When the screw gauge is fully tightened without any object, the zero of its circular scale lies 3 divisions below the mean line.

The readings of the main scale and the circular scale, for a thin sheet, are 5.5 mm and 48 respectively, the thickness of this sheet is

[JEE (Main)-2019]

- (1) 5.725 mm      (2) 5.740 mm  
 (3) 5.755 mm      (4) 5.950 mm
14. Expression for time in terms of  $G$  (universal gravitational constant),  $h$  (Planck constant) and  $c$  (speed of light) is proportional to

[JEE (Main)-2019]

$$(1) \sqrt{\frac{Gh}{c^5}} \quad (2) \sqrt{\frac{c^3}{Gh}}$$

$$(3) \sqrt{\frac{Gh}{c^3}} \quad (4) \sqrt{\frac{hc^5}{G}}$$

15. The density of a material is SI units is  $128 \text{ kg m}^{-3}$ . In certain units in which the unit of length is 25 cm and the unit of mass is 50 g, the numerical value of density of the material is

[JEE (Main)-2019]

- (1) 640      (2) 410  
 (3) 40      (4) 16

16. The diameter and height of a cylinder are measured by a meter scale to be  $12.6 \pm 0.1$  cm and  $34.2 \pm 0.1$  cm, respectively. What will be the value of its volume in appropriate significant figures?

[JEE (Main)-2019]

- (1)  $4264 \pm 81 \text{ cm}^3$       (2)  $4300 \pm 80 \text{ cm}^3$   
 (3)  $4260 \pm 80 \text{ cm}^3$       (4)  $4264.4 \pm 81.0 \text{ cm}^3$

17. The force of interaction between two atoms is given

$$\text{by } F = \alpha\beta \exp\left(-\frac{x^2}{\alpha kT}\right); \text{ where } x \text{ is the distance, } k$$

is the Boltzmann constant and  $T$  is temperature and  $\alpha$  and  $\beta$  are two constants. The dimension of  $\beta$  is

[JEE (Main)-2019]

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

18. If speed ( $V$ ), acceleration ( $A$ ) and force ( $F$ ) are considered as fundamental units, the dimension of Young's modulus will be

[JEE (Main)-2019]

- (1)  $V^{-2} A^2 F^{-2}$       (2)  $V^{-2} A^2 F^2$   
 (3)  $V^{-4} A^2 F$       (4)  $V^{-4} A^{-2} F$

19. The least count of the main scale of a screw gauge is 1 mm. The minimum number of divisions on its circular scale required to measure 5  $\mu\text{m}$  diameter of a wire is

[JEE (Main)-2019]

- (1) 200      (2) 50  
 (3) 100      (4) 500

20. If Surface tension ( $S$ ), Moment of Inertia ( $I$ ) and Planck's constant ( $h$ ), were to be taken as the fundamental units, the dimensional formula for linear momentum would be:

[JEE (Main)-2019]

- (1)  $S^{1/2} I^{3/2} h^{-1}$       (2)  $S^{3/2} I^{1/2} h^0$   
 (3)  $S^{1/2} I^{1/2} h^{-1}$       (4)  $S^{1/2} I^{1/2} h^0$

21. In a simple pendulum experiment for determination of acceleration due to gravity ( $g$ ), time taken for 20 oscillations is measured by using a watch of 1 second least count. The mean value of time taken comes out to be 30 s. The length of pendulum is measured by using a meter scale of least count 1 mm and the value obtained is 55.0 cm. The percentage error in the determination of  $g$  is close to:

[JEE (Main)-2019]

- (1) 6.8%
- (2) 0.2%
- (3) 3.5%
- (4) 0.7%

22. In the density measurement of a cube, the mass and edge length are measured as  $(10.00 \pm 0.10)$  kg and  $(0.10 \pm 0.01)$  m, respectively. The error in the measurement of density is

[JEE (Main)-2019]

- (1)  $0.31 \text{ kg/m}^3$
- (2)  $1000 \text{ kg/m}^3$
- (3)  $0.10 \text{ kg/m}^3$
- (4)  $3100 \text{ kg/m}^3$

23. The area of a square is  $5.29 \text{ cm}^2$ . The area of 7 such squares taking into account the significant figures is

[JEE (Main)-2019]

- (1)  $37.03 \text{ cm}^2$
- (2)  $37.0 \text{ cm}^2$
- (3)  $37.030 \text{ cm}^2$
- (4)  $37 \text{ cm}^2$

24. In the formula  $X = 5YZ^2$ ,  $X$  and  $Z$  have dimensions of capacitance and magnetic field, respectively. What are the dimensions of  $Y$  in SI units ?

[JEE (Main)-2019]

- (1)  $[\text{M}^{-2}\text{L}^{-2}\text{T}^6\text{A}^3]$
- (2)  $[\text{M}^{-1}\text{L}^{-2}\text{T}^4\text{A}^2]$
- (3)  $[\text{M}^{-2}\text{L}^0\text{T}^{-4}\text{A}^{-2}]$
- (4)  $[\text{M}^{-3}\text{L}^{-2}\text{T}^8\text{A}^4]$

25. A simple pendulum is being used to determine the value of gravitational acceleration  $g$  at a certain place. The length of the pendulum is 25.0 cm and a stopwatch with 1 s resolution measures the time taken for 40 oscillation to be 50 s. The accuracy in  $g$  is

[JEE (Main)-2020]

- (1) 3.40%
- (2) 2.40%
- (3) 5.40%
- (4) 4.40%

26. If the screw on a screw-gauge is given six rotations, it moves by 3 mm on the main scale. If there are 50 divisions on the circular scale the least count of the screw gauge is

[JEE (Main)-2020]

- (1) 0.01 cm
- (2) 0.001 mm
- (3) 0.001 cm
- (4) 0.02 mm

27. A quantity  $f$  is given by  $f = \sqrt{\frac{hc^5}{G}}$  where  $c$  is speed of light,  $G$  universal gravitational constant and  $h$  is the Planck's constant. Dimension of  $f$  is that of

[JEE (Main)-2020]

- (1) Energy
- (2) Area
- (3) Volume
- (4) Momentum

28. For the four sets of three measured physical quantities as given below. Which of the following options is correct?

[JEE (Main)-2020]

- (i)  $A_1 = 24.36, B_1 = 0.0724, C_1 = 256.2$
  - (ii)  $A_2 = 24.44, B_2 = 16.082, C_2 = 240.2$
  - (iii)  $A_3 = 25.2, B_3 = 19.2812, C_3 = 236.183$
  - (iv)  $A_4 = 25, B_4 = 236.191, C_4 = 19.5$
- (1)  $A_1 + B_1 + C_1 = A_2 + B_2 + C_2 = A_3 + B_3 + C_3 = A_4 + B_4 + C_4$
  - (2)  $A_1 + B_1 + C_1 < A_3 + B_3 + C_3 < A_2 + B_2 + C_2 < A_4 + B_4 + C_4$
  - (3)  $A_4 + B_4 + C_4 < A_1 + B_1 + C_1 = A_2 + B_2 + C_2 = A_3 + B_3 + C_3$
  - (4)  $A_4 + B_4 + C_4 < A_1 + B_1 + C_1 < A_3 + B_3 + C_3 < A_2 + B_2 + C_2$

29. The least count of the main scale of a vernier callipers is 1 mm. Its vernier scale is divided into 10 divisions and coincide with 9 divisions of the main scale. When jaws are touching each other, the 7<sup>th</sup> division of vernier scale coincides with a division of main scale and the zero of vernier scale is lying right side of the zero of main scale. When this vernier is used to measure length of a cylinder the zero of the vernier scale between 3.1 cm and 3.2 cm and 4<sup>th</sup> VSD coincides with a main scale division. The length of the cylinder is (VSD is vernier scale division)

[JEE (Main)-2020]

- (1) 3.21 cm
- (2) 2.99 cm
- (3) 3.07 cm
- (4) 3.2 cm

30. If speed  $V$ , area  $A$  and force  $F$  are chosen as fundamental units, then the dimension of Young's modulus will be  
**[JEE (Main)-2020]**

- (1)  $FA^{-1}V^0$       (2)  $FA^2V^{-1}$   
 (3)  $FA^2V^{-2}$       (4)  $FA^2V^{-3}$

31. If momentum ( $P$ ), area ( $A$ ) and time ( $T$ ) are taken to be the fundamental quantities then the dimensional formula for energy is

**[JEE (Main)-2020]**

- (1)  $\left[ P^{\frac{1}{2}}AT^{-1} \right]$       (2)  $[P^2AT^{-2}]$   
 (3)  $\left[ PA^{\frac{1}{2}}T^{-1} \right]$       (4)  $[PA^{-1}T^{-2}]$

32. Using screw gauge of pitch 0.1 cm and 50 divisions on its circular scale, the thickness of an object is measured. It should correctly be recorded as  
**[JEE (Main)-2020]**

- (1) 2.124 cm      (2) 2.123 cm  
 (3) 2.125 cm      (4) 2.121 cm

33. Dimensional formula for thermal conductivity is (here  $K$  denotes the temperature)

**[JEE (Main)-2020]**

- (1)  $MLT^{-2}K^{-2}$       (2)  $MLT^{-3}K^{-1}$   
 (3)  $MLT^{-3}K$       (4)  $MLT^{-2}K$

34. A quantity  $x$  is given by  $(IFv^2/WL^4)$  in terms of moment of inertia  $I$ , force  $F$ , velocity  $v$ , work  $W$  and length  $L$ . The dimensional formula for  $x$  is same as that of  
**[JEE (Main)-2020]**

- (1) Coefficient of viscosity  
 (2) Force constant  
 (3) Energy density  
 (4) Planck's constant

35. A physical quantity  $z$  depends on four observables

$$a, b, c \text{ and } d, \text{ as } z = \frac{a^2b^{\frac{2}{3}}}{\sqrt{cd^3}}.$$

The percentages of error in the measurement of  $a, b, c$  and  $d$  are 2%, 1.5%, 4% and 2.5% respectively. The percentage of error in  $z$  is  
**[JEE (Main)-2020]**

- (1) 13.5%      (2) 14.5%  
 (3) 16.5%      (4) 12.25%

36. A screw gauge has 50 divisions on its circular scale. The circular scale is 4 units ahead of the pitch scale marking, prior to use. Upon one complete rotation of the circular scale, a displacement of 0.5 mm is noticed on the pitch scale. The nature of zero error involved, and the least count of the screw gauge, are respectively.

**[JEE (Main)-2020]**

- (1) Positive, 0.1 mm      (2) Positive,  $10 \mu\text{m}$   
 (3) Negative,  $2 \mu\text{m}$       (4) Positive,  $0.1 \mu\text{m}$

37. A student measuring the diameter of a pencil of circular cross-section with the help of a vernier scale records the following four readings 5.50 mm, 5.55 mm, 5.45 mm; 5.65 mm. The average of these four readings is 5.5375 mm and the standard deviation of the data is 0.07395 mm. The average diameter of the pencil should therefore be recorded as  
**[JEE (Main)-2020]**

- (1)  $(5.5375 \pm 0.0739) \text{ mm}$   
 (2)  $(5.54 \pm 0.07) \text{ mm}$   
 (3)  $(5.538 \pm 0.074) \text{ mm}$   
 (4)  $(5.5375 \pm 0.0740) \text{ mm}$

38. The density of a solid metal sphere is determined by measuring its mass and its diameter. The maximum error in the density of the sphere is

$\left( \frac{x}{100} \right)\%$ . If the relative errors in measuring the mass and the diameter are 6.0% and 1.5% respectively, the value of  $x$  is \_\_\_\_\_.

**[JEE (Main)-2020]**