Exercise-1

PART - I : SUBJECTIVE QUESTIONS

1. Using screw gauge, the observation of the diameter of a wire are 1.324, 1.326, 1.334, 1.336 cm respectively. Find the average diameter, the mean error, the relative error and % error.

2. Find significant figures in the following observations -
(i) 0.007 gm   (ii) 2.64×10^{24} kg   (iii) 0.2370 gm/cm^3 (iv) 6.320 J/K
(v) 6.032 N/m^2 (vi) 0.0006032 K^{-1}

3. Round off the following numbers within three significant figures -
(i) 0.03927 kg   (ii) 4.085×10^8 sec   (iii) 5.2354 m   (iv) 4.735×10^{-6} kg

4. If a tuning fork of frequency (f_0) 340 Hz and tolerance $\pm$ 1% is used in resonance column method [$v = 2f_0$ ($\ell_2 - \ell_1$)], the first and the second resonance are measured at ℓ_1 = 24.0 cm and ℓ_2 = 74.0 cm. Find max. permissible error in speed of sound.

PART - II : ONLY ONE OPTION CORRECT TYPE

1. The length of a rectangular plate is measured by a meter scale and is found to be 10.0 cm. Its width is measured by vernier callipers as 1.00 cm. The least count of the meter scale and vernier callipers are 0.1 cm and 0.01 cm respectively (Obviously). Maximum permissible error in area measurement is -
(1) $\pm$ 0.2 cm^2 (2) $\pm$ 0.1 cm^2 (3) $\pm$ 0.3 cm^2 (4) Zero

2. In the previous question, minimum possible error in area measurement can be -
(1) $\pm$ 0.02 cm^2 (2) $\pm$ 0.01 cm^2 (3) $\pm$ 0.03 cm^2 (4) Zero

3. For a cubical block, error in measurement of sides is $\pm$ 1% and error in measurement of mass is $\pm$ 2%, then maximum possible error in density is -
(1) 1%   (2) 5%   (3) 3%   (4) 7%

4. To estimate 'g' (from g = $4\pi^2 \dfrac{L}{T^2}$), error in measurement of L is $\pm$ 2% and error in measurement of T is $\pm$ 3%. The error in estimated 'g' will be -
(1) $\pm$ 8%   (2) $\pm$ 6%   (3) $\pm$ 3%   (4) $\pm$ 5%

5. The least count of a stop watch is 0.2 second. The time of 20 oscillations of a pendulum is measured to be 25 seconds. The percentage error in the time period is
(1) 16%   (2) 0.8 %   (3) 1.8 %   (4) 8 %

6. The dimensions of a rectangular block measured with a vernier callipers having least count of 0.1 mm is 5 mm × 10 mm × 5 mm. The maximum percentage error in measurement of volume of the block is
(1) 5 %   (2) 10 %   (3) 15 %   (4) 20 %

7. An experiment measures quantities x, y, z and then t is calculated from the data as t = $\dfrac{xy^2}{z^3}$. If percentage errors in x, y and z are respectively 1%, 3%, 2%, then percentage error in t is :
(1) 10 %   (2) 4 %   (3) 7 %   (4) 13 %

8. The external and internal diameters of a hollow cylinder are measured to be (4.23 ± 0.01) cm and (3.89 ± 0.01) cm. The thickness of the wall of the cylinder is
(1) (0.34 ± 0.02) cm   (2) (0.17 ± 0.02) cm   (3) (0.17 ± 0.01) cm   (4) (0.34 ± 0.01) cm

9. The mass of a ball is 1.76 kg. The mass of 25 such balls is
(1) 0.44×10^3 kg   (2) 44.0 kg   (3) 44 kg   (4) 44.00 kg

10. Two resistors R_1 (24 ± 0.5) Ω and R_2 (8 ± 0.3) Ω are joined in series. The equivalent resistance is
(1) 32 ± 0.33 Ω (2) 32 ± 0.8 Ω (3) 32 ± 0.2 Ω (4) 32 ± 0.5 Ω

11. The pitch of a screw gauge is 0.5 mm and there are 100 divisions on it circular scale. The instrument reads +2 divisions when nothing is put in-between its jaws. In measuring the diameter of a wire, there are 8 divisions on the main scale and 83rd division coincides with the reference line. Then the diameter of the wire is

(1) 4.05 mm (2) 4.405 mm (3) 3.05 mm (4) 1.25 mm

12. The pitch of a screw gauge having 50 divisions on its circular scale is 1 mm. When the two jaws of the screw gauge are in contact with each other, the zero of the circular scale lies 6 division below the line of graduation. When a wire is placed between the jaws, 3 linear scale divisions are clearly visible while 31st division on the circular scale coincide with the reference line. The diameter of the wire is :

(1) 3.62 mm (2) 3.50 mm (3) 3.5 mm (4) 3.74 mm

13. The smallest division on the main scale of a vernier callipers is 1 mm, and 10 vernier divisions coincide with 9 main scale divisions. While measuring the diameter of a sphere, the zero mark of the vernier scale lies between 2.0 and 2.1 cm and the fifth division of the vernier scale coincide with a scale division. Then diameter of the sphere is

(1) 2.05 cm (2) 3.05 cm (3) 2.50 cm (4) None of these

14. You are given two unknown resistors X and Y. These resistances are to be determined, using an ammeter of $R_A = 0.5$ Ω and a voltmeter of $R_v = 20$ kΩ. It is known that X is in range of a few ohms and Y is in the range of several kilo ohm's. Which circuit is preferable to measure X and Y :

     Resistor   Circuit
     x   (a)
     y   (b)

(1) x → (a), y → (b)   (2) x → (b), y → (a)
(3) x → (a), y → (a)   (4) x → (b), y → (b)

15. The main scale of a vernier callipers reads 10 mm in 10 divisions. 10 divisions of Vernier scale coincide with 9 divisions of the main scale. When a cylinder is tightly placed between the two jaws, the zero of vernier scale lies slightly behind 3.2 cm and the fourth vernier division coincides with a main scale division. The diameter of the cylinder is :

(1) 3.09 cm (2) 3.14 cm (3) 3.04 cm (4) 3.03 cm

16. Two resistances are measured in Ohm.

$R_1 = 3 \wedge \pm 1\%$

$R_2 = 6 \wedge \pm 2\%$

When they are connected in parallel, maximum percentage error in equivalent resistance is α. Find 3α.

(1) 4   (2) 5   (3) 7

 (4) 9

17. The edge of a cube is $a = 1.2 \times 10^{-2}$ m. Then its volume will be recorded as: **[JEE 2003 (Scr.), 3/84,–1]**

(1) 1.72×10^{-6} m³ (2) 1.728×10^{-6} m³ (3) 1.7×10^{-6} m³ (4) 1.73×10^{-6} m³

18. In the shown arrangement of the experiment of the meter bridge if the length AC corresponding to null deflection of galvanometer is x, what would be its value if the radius of the wire AB is doubled?

[JEE 2003 (Scr.), 3/84,–1]
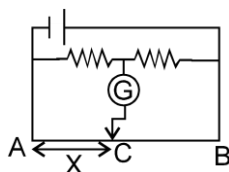
(1) x (2) x/4 (3) 4x (4) 2x

19. In the post office arrangement to determine the value of unknown resistance, the unknown resistance should be connected between: **[JEE 2004 (Scr.), 3/84,–1]**
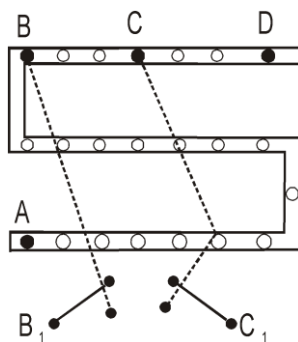
(1) B and C   (2) C and D   (3) A and D   (4) B_1 and C_1

20. A wire has a mass (0.3 ± 0.003)g, radius (0.5 ± 0.005)mm and length (6 ± 0.06)cm. The maximum percentage error in the measurement of its density is :   **[JEE 2004 (Scr.), 3/84,–1]**
(1) 1   (2) 2   (3) 3   (4) 4

21. A student performs an experiment for determination of $g\left(=\dfrac{4\pi^2\ell}{T^2}\right)$, $\ell \approx 1$m, and he commits an error of $\Delta\ell$. For T he takes the time of n oscillations with the stop watch of least count ΔT and he commits a human error of 0.1 sec. For which of the following data, the measurement of g will be most accurate ?   **[JEE 2006; 3/181, -1]**
(1) $\Delta L = 0.5$, $\Delta T = 0.1$, n = 20   (2) $\Delta L = 0.5$, $\Delta T = 0.1$, n = 50
(3) $\Delta L = 0.5$, $\Delta T = 0.01$, n = 20   (4) $\Delta L = 0.1$, $\Delta T = 0.05$, n = 50

22. A resistance of 2 Ω is connected across one gap of a metre-bridge (the length of the wire is 100 cm) and an unknown resistance, greater than 2 Ω, is connected across the other gap. When these resistances are interchanged, the balance point shifts by 20 cm. Neglecting any corrections, the unknown resistance is   **[JEE 2007, 3/184, –1]**
(1) 3 Ω   (2) 4 Ω   (3) 5 Ω   (4) 6 Ω

23. A vernier calipers has 1 mm marks on the main scale. It has 20 equal division on the Vernier scale which match with 16 main scale divisions. For this Vernier calipers, the least count is :   **[JEE 2010, 5/163,–2]**
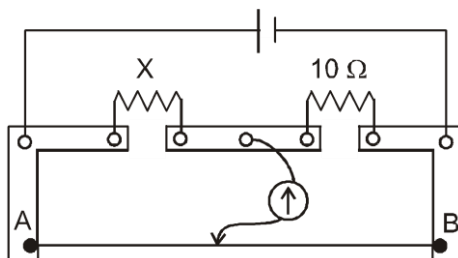(1) 0.02 mm   (2) 0.05 mm   (3) 0.1 mm   (4) 0.2 mm

24. A meter bridge is set-up as shown, to determine an unknown resistance 'X' using a standard 10 ohm resistor. The galvanometer shows null point when tapping-key is at 52 cm mark. The end-corrections are 1 cm and 2 cm respectively for the ends A and B. The determined value of 'X' is :   **[JEE 2011, 3/160,–1]**

(1) 10.2 ohm   (2) 10.6 ohm   (3) 10.8 ohm   (4) 11.1 ohm

25. Unit of diploe moment is :   **[RPMT-2001]**
(1) -amp-m   (2) coulomb-m   (3) amp-m_2 (4) coulomb-m_2

26. The length, breadth and thickness of a block are given by l = 12cm, b = 6 cm and t = 2.45 cm. The volume of the block according to the idea of significant figures should be :   **[RPMT-2006]**
(1) $1 \times 10_2$ cm_3 (2) $2 \times 10_2$ cm_3 (3) $1.763 \times 10_2$ cm_3 (4) none of these

27. An ice-cube of density 900 kg/m_3 is floating in water of density 1000 kg/m_3. The percentage of volume of ice-cube outside the water is :   **[RPMT-2006]**
(1) 20%   (2) 35%   (3) 10%   (4) None of these

28. In an experiment four quantities a, b, c and d are measured with percentage error 1%, 2%, 3% and 4% respectively. Quantity P is calculated as follows :   **[NEET-2013]**

$$P = \frac{a^3 b^2}{cd}$$ % error in P is :

(1) 10%   (2) 7%   (3) 4%   (4) 14%

29. An experiment measures quantities a, b, c and x is calculated from $x = \dfrac{ab^2}{c^3}$. If the percentage errors in a, b, c are ± 1%, ± 3% and ± 2% respectively.

(1) The percentage error in x can be ± 13%   (2) The percentage error in x can be ± 30%
(3) The percentage error in x can be ± 20%   (4) The percentage error in x can be ± 26%

30. If the error in the measurement of radius of a sphere is 2%, then the error in the determination of volume of the sphere will be **[AIPMT-2008]**

(1) 4%   (2) 6%   (3) 8%   (4) 2%

Exercise-2

ONLY ONE OPTION CORRECT TYPE

1. The number of circular divisions on the shown screw gauge is 50. It moves 0.5 mm on main scale for one complete rotation. Main scale reading is 2. The diameter of the ball is : **[JEE 2006; 3/181, -1]**
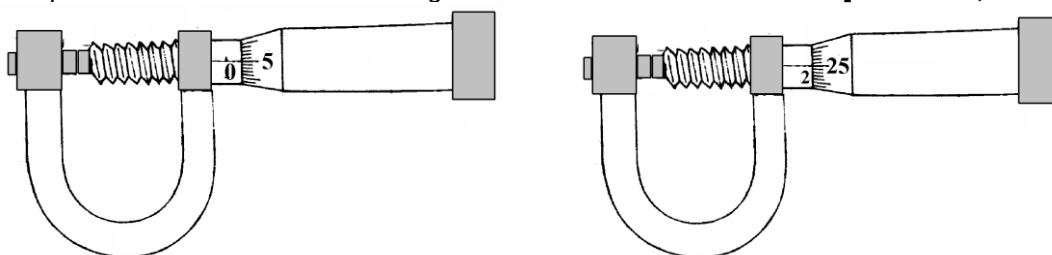
(1) 2.25 mm   (2) 2.20 mm   (3) 1.20 mm   (4) 1.25 mm

2. A student performs an experiment to determine the Young's modulus of a wire, exactly 2 m long, by Searle's method. In a particular reading, the student measures the extension in the length of the wire to be 0.8 mm with an uncertainty of ±0.05 mm at a load of exactly 1.0 kg. The student also measures the diameter of the wire to be 0.4 mm with an uncertainty of ±0.01 mm. Take g = 9.8 m/s^2 (exact). The Young's modulus obtained from the reading is **[JEE 2007, 3/184, –1]**

(1) $(2.0 \pm 0.3) \times 10^{11}$ N/m^2 (2) $(2.0 \pm 0.2) \times 10^{11}$ N/m^2
(3) $(2.0 \pm 0.1) \times 10^{11}$ N/m^2 (4) $(2.0 \pm 0.05) \times 10^{11}$ N/m^2

3. Student I, II and III perform an experiment for measuring the acceleration due to gravity (g) using a simple pendulum. They use different lengths of the pendulum and /or record time for different number of oscillations. The observations are shown in the table.

Least count for length = 0.1 cm
Least count for time = 0.1 s

Student	Length of the pendulum (cm)	Number of oscillations (n)	Total time for (n) oscillations (s)	Time period (s)
I	64.0	8	128.0	16.0
II	64.0	4	64.0	16.0
III	20.0	4	36.0	9.0

If E_I, E_{II} and E_{III} are the percentage errors in g, i.e., $\left(\dfrac{\Delta g}{g} \times 100 \right)$ for students I, II and III, respectively,

[JEE 2008, 3/163, –1]

(1) $E_I = 0$ (2) E_I is minimum   (3) $E_I = E_{II}$ (4) E_{II} is maximum

4. The density of a solid ball is to be determined in an experiment. The diameter of the ball is measured with a screw gauge, whose pitch is 0.5 mm and there are 50 divisions on the circular scale. The reading on the main scale is 2.5 mm and that on the circular scale is 20 divisions. If the measured mass of the ball has a relative error of 2%, the relative percentage error in the density is **[JEE 2011, 3/160,–1]**

(1) 0.9%   (2) 2.4%   (3) 3.1%   (4) 4.2%

5. Consider a vernier callipers in which each 1 cm on the main scale is divided into 8 equal divisions and a screw gauge with 100 divisions on its circular scale. In the vernier callipers, 5 divisions of the vernier

scale coincide with 4 division on the main scale and in the screw gauge, one complete rotation of the circular scale moves it by two divisions on the linear scale. Then, **[JEE(Advanced) 2015 ; 4/88, –2]**
(1) If the pitch of the screw gauge is twice the least count of the Vernier callipers, the least count of the screw gauge is 0.01mm.
(2) If the pitch of the screw gauge is twice the least count of the Vernier callipers, the least count of the screw gauge is 0.005mm.
(3) If the least count of the linear scale of the screw gauge is twice the least count of the vernier callipers, the least count of the screw gauge is 0.005 mm.
(4) None of these

6. The energy of a system as a function of time t is given as $E(t) = A_2 \exp(-at)$, where $a = 0.2s_{-1}$. The measurement of A has an error of 1.25%. If the error in the measurement of time is 1.50%, the percentage error in the value of $E(t)$ at t = 5 s is **[JEE(Advanced) 2015 ; 4/88]**
(1) 1   (2) 2   (3) 3   (4) 4

7. A body of uniform cross-sectional area floats in a liquid of density thrice its value. The fraction of exposed height will be : **[RPMT-2005]**
(1) $\dfrac{2}{3}$ (2) $\dfrac{5}{6}$ (3) $\dfrac{1}{6}$ (4) $\dfrac{1}{3}$

8. Meter bridge is used to find resistance of a wire using a standard resistance 20Ω with 0.5% tolerance. The unknown resistance is placed in left gap of the meter bridge. The null point is obtained at 60.0 cm from left end. The maximum permissible error in this measurement is 0.1 cm. Find the maximum error in measurement of the resistance.
(1) 0.37Ω   (2) 0.35Ω   (3) 0.20Ω   (4) 0.27Ω

9. 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 : **[AIEEE-2008, 3/105]**
(1) 3.32 mm   (2) 3.73 mm   (3) 3.67 mm   (4) 3.38 mm

10. An experiment is performed to find the refractive index of glass using a travelling microscope. In this experiment distance is measured by **[AIEEE-2008, 3/105]**
(1) a vernier scale provided on the microscope   (2) a standard laboratory scale
(3) a metal scale provided on the microscope   (4) a screw gauge provided on the microscope

Exercise-3

PART - I : NEET / AIPMT QUESTION (PREVIOUS YEARS)

1. A student measures the distance traversed in free fall of a body, initially at rest, in a given time. He uses this data to estimate g, the acceleration due to gravity. If the maximum percentage errors in measurement of the distance and the time are e_1 and e_2 respectively, the percentage error in the estimation of g is **[AIPMT-2009]**
(1) $e_2 - e_1$ (2) $e_1 + 2e_2$ (3) $e_1 + e_2$ (4) $e_1 - 2e_2$

2. In an experiment, the percentage of error occurred in the in the measurement of physical quantities A, B, C and D are 1%, 2%, 3% and 4% respectively. Then the maximum percentage of error in the measurement X, where $X = \dfrac{A^2 B^{1/2}}{C^{1/3} D^3}$, will be **[NEET_2019-I]**
(1) 10 %   (2) $\left(\dfrac{3}{13}\right)\%$ (3) 16%   (4) – 10%

3. The main scale of a vermier calipers has n divisions/cm. n division of the vermier scale coincide with (n – 1) divisions of main scale. The least count of the vernier calipers is : **[NEET_2019- II]**

(1) $\dfrac{1}{(n+1)(n-1)}$cm   (2) $\dfrac{1}{n}$cm   (3) $\dfrac{1}{n^2}$cm   (4) $\dfrac{1}{n(n+1)}$cm

PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

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°), then the least count of the instrument is: **[AIEEE-2009, 4/144]**
    (1) half minute   (2) one degree   (3) half degree   (4) one minute

2. In an optics experiment, with the position of the object fixed, a student varies the position of the convex lens and for each position, the screen is adjusted to get a clear image of the object. A graph between the object distance u and the image distance v, from the lens, is plotted using the same scale for the two axes. A straight line passing through the origin and making an angle of 45° with the x-axis meets the experimental curve at P. The coordinates of P will be: **[AIEEE-2009, 4/144]**
    (1) $\left(\dfrac{f}{2}, \dfrac{f}{2}\right)$ (2) (f, f)   (3) (4f, 4f)   (4) (2f, 2f)

3. The respective number of significant figures for the numbers 23.023, 0.0003 and 2.1 × 10$_{-3}$ are
    [AIEEE-2010, 4/144, −1]
    (1) 5, 1, 2   (2) 5, 1, 5   (3) 5, 5, 2   (4) 4, 4, 2

4. 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 division
    Given that 1 mm on main scale corresponds to 100 divisions of the circular scale.
    The diameter of wire from the above data is : **[AIEEE - 2011, 4/120, −1]**
    (1) 0.52 cm   (2) 0.052 cm   (3) 0.026 cm   (4) 0.005 cm

5. If 400 Ω of resistance is made by adding four 100 Ω resistances of tolerance 5%, then the tolerance of the combination is : **[AIEEE 2011, 11 May; 4, −1]**
    (1) 5%   (2) 10 %   (3) 15 %   (4) 20 %

6. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\dfrac{L}{g}}$. 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 90s using a wrist watch of 1s resolution. The accuracy in the determination of g is : **[JEE(Main)-2015; 4/120, −1]**
    (1) 2%   (2) 3%   (3) 1%   (4) 5%

7. 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; 4/120, −1]**
    (1) 4.5%   (2) 6%   (3) 2.5%   (4) 3.5 %

8. 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) 5.740 mm   (2) 5.950 mm   (3) 5.725 mm   (4) 5.755 mm

9. 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) $\sqrt{\dfrac{hc^5}{G}}$ (2) $\sqrt{\dfrac{Gh}{c^3}}$ (3) $\sqrt{\dfrac{c^3}{Gh}}$ (4) $\sqrt{\dfrac{Gh}{c^5}}$

10. The diameter and height of a cylinder are measured by a meter scale to be 12.6 ± 0.1 cm and 34.2 ± 0.1 cm, respectively. What will be the value of its volume in appropriate significant figure.

(1) 4264 ± 81 cm^3 (2) 4300 ± 80 cm^3 (3) 4260 ± 80 cm^3 (4) 4264.4 ± 81.0 cm^3

11. 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 µm diameter of a wire is: **[JEE(Main)-2019]**

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

12. 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) 0.2%   (2) 0.7%   (3) 6.8 %   (4) 3.5 %

13. In the density measurement of a cube, the mass and edge length are measured as (10.00 ± 0.10) kg and (0.10 ± 0.01) m, respectively. The error in the measurement of density is : **[JEE(Main)-2019]**

(1) 0.07 kg/m^3 (2) 0.10 kg/m^3 (3) 0.01 kg/m^3 (4) 0.31 kg/m^3

14. The area of a square is 5.29 cm^2. The area of 7 such squares taking into account the significant figures is : **[JEE(Main)-2019]**

(1) 37.0 cm^2 (2) 37 cm^2 (3) 37.03 cm^2 (4) 37.030 cm^2

Answers

EXERCISE # 1

PART - I

1. $\bar{D} = 1.330\,\text{cm}$, $\overline{\Delta D} = 0.005\,\text{cm}$, Relative error $= \pm 0.004$ %, error = 0.4%
2. (i) 1 (ii) 3 (iii) 4 (iv) 4 (v) 4 (vi) 4
3. (i) 0.0393 kg (ii) $4.08 \times 10_8$ sec (iii) 5.24 m (iv) $4.74 \times 10_{-6}$ kg
4. 1.4%

PART - II

1.	(1)	**2.**	(4)	**3.**	(2)	**4.**	(1)	**5.**	(1)	**6.**	(1)	**7.**	(4)
8.	(3)	**9.**	(2)	**10.**	(2)	**11.**	(2)	**12.**	(4)	**13.**	(1)	**14.**	(2)
15.	(2)	**16.**	(1)	**17.**	(3)	**18.**	(1)	**19.**	(3)	**20.**	(4)	**21.**	(4)
22.	(1)	**23.**	(4)	**24.**	(2)	**25.**	(2)	**26.**	(2)	**27.**	(3)	**28.**	(4)

29.	(1)	**30.**	(2)

EXERCISE # 2

1.	(3)	**2.**	(2)	**3.**	(2)	**4.**	(3)	**5.**	(2)	**6.**	(4)	**7.**	(1)
8.	(4)	**9.**	(4)	**10.**	(1)								

EXERCISE # 3

PART - I

1.	(2)	**2.**	(3)	**3.**	(3)

PART - II

1.	(4)	**2.**	(4)	**3.**	(1)	**4.**	(2)	**5.**	(1)	**6.**	(2)	**7.**	(1)
8.	(4)	**9.**	(4)	**10.**	(3)	**11.**	(1)	**12.**	(3)	**13.**	(4)	**14.**	(3)