Measurements and Experimentation

1. *What do you understand by the term order of magnitude of a quantity? What is the order of magnitude of 1,400,000,000,000,000 m?*

Ans. The exponential part of a particular measurement is called order of magnitude of a quanity.

$1{,}400{,}000{,}000{,}000{,}000 \text{ m} = 1.4 \times 10^{15}$

$\therefore$ Order of magnitude is $\mathbf{10^{15}\ m}$.

2. *Express the order of magnitude of the following :*

(a) *Diameter of Sun is 1,390,000,000 m.*

(b) *Diameter of an atom of hydrogen is 0.000000000106 m.*

(c) *The mass of a red blood cell is 0.0000000000001 kg.*

(d) *The diameter of proton is 0.000000000000001 m.*

(e) *The domain of farthest galaxy is 10,000,000,000,000,000,000,000,000 m.*

(f) *A human life span is 1,000,000,000 s.*

(g) *Time in which cracker explodes is 0.00001 s.*

Ans. (a) Diameter of Sun = $1{,}390{,}000{,}000 \text{ m} = 1.39 \times 10^{9}$ m

Order of magnitude of Sun = $\mathbf{10^{9}\ m.}$

(b) Diameter of an atom of hydrogen

$= 0.000000000106 \text{ m} = 1.06 \times 10^{-10}$ m

Order of magnitude of diameter of an atom of hydrogen

$= 10^{-10}$ m.

(c) The mass of a red blood cell = 0.0000000000001 kg

$= 1.0 \times 10^{-13}$ kg

Order of magnitude of a red blood cell = 10^{-13} kg.

(d) The diameter of proton = 0.00,000,000,000,0001 m

$= 1.0 \times 10^{-15}$ m

Order of magnitude of diameter of proton = $\mathbf{10^{-15}\ m}$.

(e) The domain of farthest galaxy = 10,000,000,000,000,000,000,000,000 m = 1.0×10^{25} m.
Order of magnitude of farthest galaxy = **10^{25} m**.

(f) A human life span = 1,000,000,000 s = 1.0×10^{9}s
Order of magnitude of human life span = **10^{9} s.**

(g) Time in which cracker explodes = 0.00001 s = 1.0×10^{-5}s
Order of magnitude oftime forthe explosion of cracker = **10^{-5} s**.

3. *What do you understand by the term degree of accuracy?*

Ans. The extent to which a quantity can be measured, without any error is called degree of accuracy.

4. *In an experiment, time can be calculated correct to one second and length correct to one millimetre. Which amongst the following speed is correct and why?*
(i) 2.957 ms^{-1} (ii) 2.95 ms^{-1} (iii) 2.9 ms^{-1}

Ans. 2·9 ms^{-1} is correct answer.
It is because the accuracy is determined by least accuracy to which various quantities are measured. As time can be measured correct to 1s only therefore the answer cannot be 2·957 ms^{-1} or 2·95 ms^{-1}.

5. *In the determination of density of a solid, the experimental value is 1.75 g cm^{-3}, whereas actual density of solid is 1.60 g cm^{-3}. Calculate the percentage error in result.*

Ans. Absolute error = (1·75 – 1.60) g cm^{-3} = 0·15 g cm^{-3}.

$$\text{Percentage error} = \frac{\text{Absolute error}}{\text{Actual value}} \times 100 = \frac{0.15}{1.60} \times 100 = 9.37\%$$

6. *A pupil determines velocity of sound as 300 ms^{-1}. If actual velocity of sound is 330 ms^{-1}, calculate the percentage error in result.*

Ans. Absolute error = (330 – 300) ms^{-1} = 30 ms^{-1}

$$\text{Percentage error} = \frac{\text{Absolute error}}{\text{Actual value}} \times 100 = \frac{30}{330} \times 100 = 9.09\%$$

7. *In the determination of acceleration due to gravity the experimental value is 944.8 cms^{-2}. If the actual value of acceleration due to gravity is 980 cms^{-2}, find the percentage error in result.*

Ans. Absolute error = $(980 - 944{\cdot}8)$ cms^{-2} = **35.2 cms^{-2}.**

$$\text{Percentage error} = \frac{\text{Absolute error}}{\text{Actual value}} \times 100 = \frac{35.2}{980} \times 100 = \mathbf{3.59\%}$$

8. *Add the following observations and state the most accurate answer : 15.287 cm; 5.05 cm; 180.0035 cm; 444.5 cm.*

Ans.

	15.287	cm
	5.05	cm
	180.0035	cm
	444.5	cm
Add	644.8405	cm

The correct answer is **644.8 cm.**

9. *Subtract the following observations and state the most accurate answer :*

(i) 87.0035 s − 12.23 s

(ii) 4.00085 kg − 0.012 kg

Ans. (i)

	87.0035	s
−	12.23	s
	74.7735	s

The correct answer is **74·77 s.**

(ii)

	4.00085	kg
−	0.012	kg
	3.98885	kg

The correct answer is **3·988 kg.**

10. *What do you understand by the term significant figures?*

Ans. The number of figures to which final result of an experiment is stated are called significant figures.

11. *In an experiment, for calculating acceleration due to gravity 'g', the length is measured correct to 0.1 cm and time correct to 0.5 s. A student expresses the answer as 981.437 cms^{-2}. What should be the correct value?*

Ans. Expressed value of 'g' = $981{\cdot}437$ cms^{-2} = $9{\cdot}81437 \times 102$ cms^{-2}.
As the length and time can be measured only correct to one decimal place, therefore,
Correct value of g = $9{\cdot}8 \times 10^2$ cms^{-2}.

12. *The result of an experiment is 2731000 kg. Express the answer in the order of magnitude, if accuracy of experiment is*
(a) 1 in 10 (b) 1 in 100 (c) 1 in 1000

Ans. 2731000 kg = 2.731000×10^6 kg
(a) When accuracy is 1 in 10, correct answer is $2{\cdot}7 \times 10^6$ kg.
(b) When accuracy is 1 in 100, correct answer is $2{\cdot}73 \times 10^6$ kg.
(c) When accuracy is 1 in 1000, correct answer is $2{\cdot}731 \times 10^6$ kg.

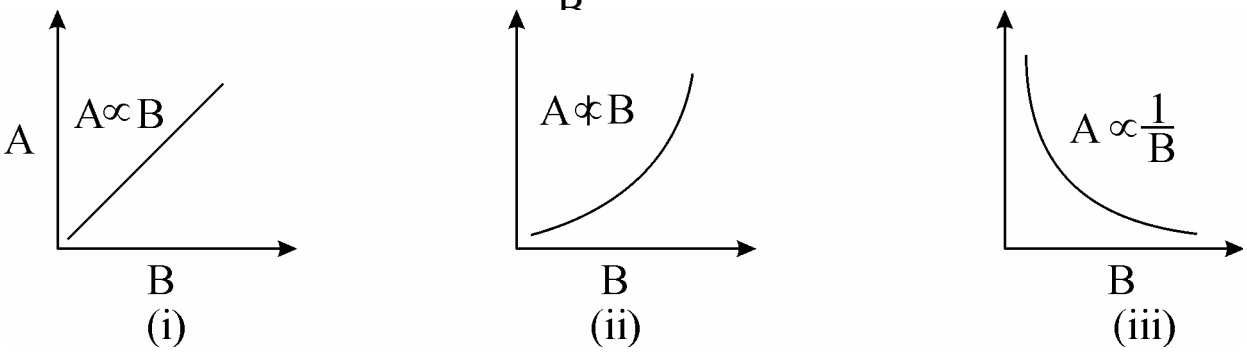
13. *What do you understand by the term graph?*

Ans. The pictorial representation of two physical variables recorded by an experimenter is called graph.

14. Draw a graph between two quantities A and B, if

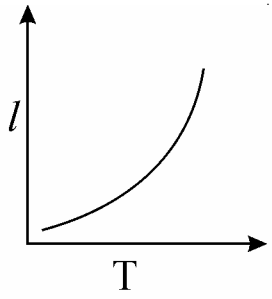
(i) $A \propto B$ (ii) $A \propto B$ (iii) $\propto \frac{1}{B}$

Ans.

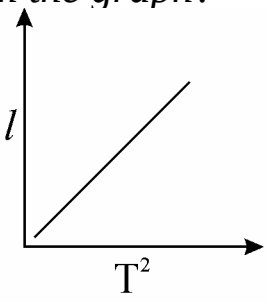


15. *Draw a graph between 'l' and 'T', and l and T 2 for a simple pendulum. What do you deduce from the graph?*

Ans.



Graph between *l* and T



Graph between *l* and T^2

The graph between *l* and T shows that *l* is not directly proportional to T.

The graph between *l* and T_2 shows that *l* is directly proportional to T_2.

16. *State three advantages of plotting graphs.*

Ans. Graph help in following ways :

(a) It helps in determining quantities, which are beyond the limit of observation, by extending graph.

(b) It helps in determination of average value of large number of observations.

(c) It helps to verify known physical laws.

17. *What do you understand by the term measurement ?*

Ans. The comparison of an unknown quantity with a standard quantity is called measurement.

18. *What do you understand by the terms (i) unit (ii) magnitude, as applied to a physical quantity?*

Ans. (i) The standard quantity used for comparison is called unit.

(ii) The number of times a standard quantity is present in a given physical quantity, is called the magnitude of a physical quantity.

19. *A body measures 25 m. State the unit and the magnitude of body.*

Ans. The unit is metre. Its magnitude is 25 times the standard metre.

20. *State four characteristics of a standard unit.*

Ans. (i) It should be of a convenient size.

(ii) It should not change with respect to space or time.

(iii) It should be possible to define, without any doubt or ambiguity.

(iv) It should be easily reproduced.

21. (a) *Define the term fundamental unit.*

(b) *State the fundamental units of the following physical quantities in S.I. system.*

(i) *Mass* ***(ii)*** *Length* ***(iii)*** *Time* ***(iv)*** *Temperature* ***(v)*** *Current.*

Ans. (a) A unit which is independent of any other unit and which cannot be related to any other unit is called a fundamental unit.

(b)

Physical Quantity	**Unit**
Mass	Kilogram
Length	Metre
Time	Second
Temperature	Kelvin
Current	Ampere

22. **(a)** *What do you understand by the term derived unit ?*
(b) *Give three examples of derived units.*

Ans. **(a)** A unit which can be obtained by the combination of one or more fundamental units is called derived unit.
(b) (i) Density (kgm^{-3}), (ii) Volume (m^3), (iii) Acceleration (ms^{-2}).

23. **(a)** *Define metre according to the old definition.*
(b) *Define metre in terms of wavelength of light.*
(c) *Why metre length in terms of wavelength of light is considered more accurate ?*

Ans. **(a)** One-millionth part of the distance between the pole and the equator is called metre.
(b) One metre is 1,650,763.73 times the wavelength of specified orange red spectral line of emission spectra of krypton–86.
(c) It is because the wavelength of light does not change with respect to space or time and is possible to define without any ambiguity.

24. *Name a convenient unit of length you will use to measure :*
(i) Length of a hall. (ii) Width of a book.
(iii) Diameter of a hair. (iv) Distance between two cities.

Ans. (i) Metres (ii) Centimetres (iii) Microns (iv) Kilometres.

25. *Name two units of length which are bigger than metre. How the units named by you are related to metre ?*

Ans. (1) Hectometre = 102 m. (2) Kilometre = 103 m.

26. *Name two units of length which are smaller than metre. How the units named by you are related to metre ?*

Ans. (1) Centimetre = 10^{-2} m. (2) Millimetre = 10^{-3} m.

27. *Amongst the following units, which is the unit of time and which is the unit of length?*

(i) Light year (ii) Leap year (iii) Parsec (iv) Angstrom.

Ans. Leap year is the unit of time.

Light year, parsec and angstrom are the units of length.

28. *Fill in the blank spaces :*

(i) *1 metre = ... Å (angstrom).*

(ii) *1 metre = ... μ (micron).*

(iii) *1 metre = ... kilometre.*

(iv) *1 micron = ... Å.*

(v) *1 light year = ... m.*

(vi) *1 parsec = ... m.*

Ans. (i) 1 metre = 10^{10} Å

(ii) 1 metre = 10^{6} μ

(iii) 1 metre = 10^{-3} km

(iv) 1 micron = 10^{4} Å

(v) 1 light year = 9.46×10^{15} m

(vi) 1 parsec = 3.08×10^{16} m.

29. (a) *Define mass.*

(b) *Name the (i) C.G.S and (ii) S.I. units of mass.*

(c) *Name the most convenient unit of mass to measure:*

(i) Small amount of medicine (ii) Grain output of a state

(iii) Bag of sugar (iv) Mass of a cricket ball.

Ans. (a) The amount of matter contained in a body is called its mass.

(b) (i) In C.G.S. system the unit of mass is gram.

(ii) In S.I. system the unit of mass is kilogram.

(c) (i) Small amount of medicine is measured in milligrams.

(ii) Grain output of a state is measured in tonnes.

(iii) Bag of sugar is measured in kilograms.

(iv) Mass of a cricket ball is measured in grams.

30. **(a)** *Define time.*
(b) *State or define the following terms:*
(i) *Solar day* ***(ii)*** *Mean solar day* ***(iii)*** *An hour*
(iv) *Minute* ***(v)*** *Second* ***(vi)*** *Year.*

Ans. **(a)** **Time :** The interval between two events is called time.

(b) **(i)** **Solar day :** The time taken by earth, to complete one rotation about its own axis is called solar day.

(ii) **Mean solar day :** The average of varying solar days, when earth completes one revolution around the sun is called mean solar day

(iii) **Hour :** $\frac{1}{24}$th part of mean solar day is called an hour.

(iv) **Minute :** $\frac{1}{1440}$th part of mean solar day is called minute.

(v) **Second :** $\frac{1}{86400}$th part mean solar day is called a second.

(vi) **Year :** The time in which earth completes one revolution round the sun is called a year. It is equal to 365 solar days.

31. *State or define the following terms :*
(i) *Leap year* ***(ii)*** *Decade* ***(iii)*** *Century*
(iv) *Millennium* ***(v)*** *Lunar Month*

Ans. **(i)** **Leap Year :** A year consisting of 366 solar days is called large year.

(ii) **Decade :** A time span of 10 year is called a decade.

(iii) **Century :** A time span of 100 year is called a century.

(iv) **Millennium :** A time span of 1000 years is called a millennium.

(v) **Lunar month :** A time span from new moon to new moon or full moon is called lunar month. Its exact value is 29 days, 12 hours, 44 minutes and 3 second which is approximately equal to $29\frac{1}{2}$ hours.

32. **(a)** *Who invented vernier callipers ?*
(b) *What is the need for measuring length with vernier callipers ?*
(c) *Upto how many decimal places a common vernier callipers can measure length in centimetres?*

Ans. **(a)** Pierre vernier invented vernier callipers.
(b) The distance less than a millimetre could be only approximated as the ordinary scales cannot be marked in sub parts of millimetre. Thus, in order to measure this small distance accurately for precision machinery, vernier callipers was invented.
(c) It can measure accurately upto 0.01 cm.

33. *Define the following terms as applied to vernier callipers :*
(i) *Pitch* ***(ii)*** *Least count.*

Ans. **(i)** The smallest value of length or any other unit, which can be read directly from the main scale is called pitch of vernier callipers.
(ii) The different between one main scale and one vernier scale division is called least count of vernier callipers.

34. *State the formula for vernier callipers for the determination of its :*
(i) *Pitch* ***(ii)*** *Least count.*

Ans. **(i)** pitch of vernier calipers = $\frac{\text{Unit length on the main scale}}{\text{Number of divisions in a unit on the main scale}}$

(ii) Least count of vernier calipers = $\frac{\text{Pitch}}{\text{Number of vernier scale divisions}}$

35. *State the formula for calculating observed length in the following cases :*
(a) *Number of vernier scale divisions coinciding with main scale and the number of divisions of main scale on the left hand side of zero of vernier are known.*
(b) *The reading of main scale and the number of vernier scale divisions conciding with main scale are known.*

Ans. (a) Observed length = Pitch × Main scale divisions + Least count × Vernier scale reading.

(b) Observed length = Main scale reading + Least count × Vernier scale reading.

36. (a) *What do you understand by the term zero error ?*

(b) *When does a vernier callipers have (i) positive zero error (ii) negative zero error ?*

(c) *State the correction if (i) positive error is 7 div. (ii) negative error is 7 div. Least count is 0.01 cm.*

Ans. (a) If the zero of vernier scale and zero of the main scale do not coincide, when the external jaws of vernier are closed, then the vernier is said to have zero error.

(b) (i) If the zero of vernier scale is on the right hand side of the zero of main scale, the error is said to be positive error.

(ii) If the zero of vernier scale is on the left hand side of the zero of main scale, the error is said to be negative error.

(c) (i) Correction = – (7 × 0.01 cm) = – 0.07 cm.

(ii) Correction = + (7 × 0.01 cm) = + 0.07 cm.

37. *Which part amongst external jaws, internal jaws and tail is used to measure :*

(i) *internal length of hollow cylinder? (ii) internal diameter of hollow cylinder?*

(iii) *diameter of solid sphere?*

Ans. (i) Tail is used for measuring internal length.

(ii) Internal jaws are used for measuring internal diameter.

(iii) External jaws are used for measuring the diameter of sphere.

38. *For what range of measurement, micrometre screw gauge is used ?*

Ans. It can measure upto one micron, i.e., 10^{-6}m.

39. *What do you understand by the following terms as applied to micrometre screw gauge ?*

(i) *Sleeve cylinder* ***(ii)*** *Sleeve scale* ***(iii)*** *Thimble*

(iv) *Thimble scale* ***(v)*** *Base line.*

Ans. (i) Sleeve cylinder : The hollow cylinder attached to nut is called sleeve cylinder. The spindle of the screw passes through this cylinder.

(ii) Sleeve scale : The main scale (marked in mm) on the sleeve cylinder is called sleeve scale.

(iii) Thimble : The hollow cylinder connected to screw which revolves along with the screw is called thimble.

(iv) Thimble scale : The circular scale marked on the thimble is called thimble scale.

(v) Base line : A straight line drawn parallel to the axis of sleeve cylinder and graduated in mm is called base line.

40. *What do you understand by the following terms as applied to screw gauge :*

(a) *Pitch of screw* **(b)** *Least count of screw.*

Ans. (a) The distance traveled by the tip of screw, when its head is given one complete turn is called pitch of serew gauge.

(b) The smallest distance moved by the tip of a screw gauge, when the circular scale of it moves by one division is called least count of serew gauge.

41. *State the formula for calculating (a) pitch (b) least count of screw gauge?*

Ans. (a) Pitch of screw gauge $= \dfrac{\text{Unit length on the main scale}}{\text{Number of divisions in a unit length}}$

or

$$\frac{\text{Distance moved by the screw on main scale}}{\text{Number of revolution of the screw}}$$

(b) Least count of screw gauge $= \dfrac{\text{Pitch}}{\text{Number of divisions on the circular scale}}$

42. *What do you understand by the following terms as applied to screw gauge?*

(a) *Zero error* **(b)** *Positive zero error* **(c)** *Negative zero error*

Ans. (a) If the reference line on main scale does not cointcide with the zero mark on circular scale, when the tip of screw is touching a dead end, it is said to have zero error of screw gauge.

(b) If the zero mark on circular scale is below the reference line on main scale, then there is positive zero error of screw gauge.

(c) If the zero mark on circular scale is above the refence line on main scale, then there is negative zero error of screw gauge.

43. *How do you account for the following for calculating the correct diameter of a wire?*

(a) *Positive zero error* **(b)** *Negative zero error.*

Ans. (a) When there is positive zero error, correction is – [L.C. × positive error.]

(b) When there is negative zero error, correction is + [L.C. × negative error.]

44. *The main scale of vernier callipers has 10 divisions to a centimetre and 10 vernier scale divisions coincide with 9 main scale divisions. Calculate (i) pitch (ii) least count of vernier callipers.*

Ans. (i) $\text{Pitch} = \dfrac{1\text{ cm}}{\text{No. of divisions in one cm}} = \dfrac{1\text{ cm}}{10} = 0.1\text{ cm.}$

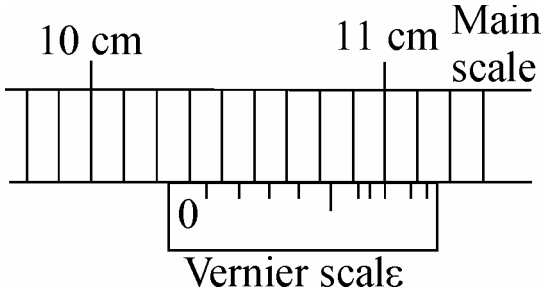
(ii) $\text{L.C.} = \dfrac{\text{Pitch}}{\text{V.S.D}} = \dfrac{0.1\text{ cm}}{10} = 0.01\text{ cm.}$

45. *In a vernier callipers, 24 main scale divisions coincide with 25 vernier scale divisions. If the main scale has 20 divisions to a centimetre, calculate (i) pitch (ii) least count of vernier callipers.*

Ans. (i) $\text{Pitch} = \dfrac{1\text{ cm}}{\text{No. of divisions in one cm}} = \dfrac{1\text{ cm}}{20} =$ **0.05 cm.**

(ii) $\text{L.C.} = \dfrac{\text{Pitch}}{\text{V.S.D}} = \dfrac{0.05}{25} =$ **0.002 cm.**

46. *The figure alongside shows the position of vernier scale, while measuring external length of wooden cylinder.*



(i) *What is the length recorded on main scale?*

(ii) *Which reading of vernier scale coincides with main scale?*

(iii) *Calculate the length.*

Ans. (i) Length recorded on main scale = 10.2 cm.

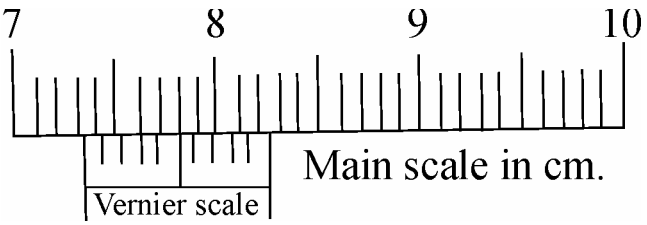
(ii) 7th reading of vernier scale coincides with main scale.

(iii) Length = Main scale reading + L.C. × V.S.D.

= 10.2 cm + 0.01 cm × 7

= **10.27 cm.**

47. *The figure alongside shows the position of vernier on main scale. Calculate the length.*



Ans. Reading on main scale = 7.3 cm

$$\text{Pitch of main scale} = \frac{1 \text{ cm}}{10} = 0.1 \text{ cm}$$

$$\text{L.C. of vernier} = \frac{0.1}{10} = 0.01 \text{ cm.}$$

Vernier scale reading = 5

$\therefore$ Length = Main scale reading + L.C. × V.S.D.

= 7.3 cm + 0.01 cm × 5 = **7.35 cm**.

48. *The circular scale of a screw gauge has 50 divisions. Its spindle moves by 2 mm on sleeve scale, when given four complete revolutions. Calculate (i) pitch (ii) least count.*

Ans. (i) $\text{Pitch} = \frac{\text{Distance moved by spindle}}{\text{No. of complete revolutions}} = \frac{2 \text{ mm}}{4} = 0.5 \text{ mm} = 0.05 \text{ cm.}$

(ii) $\text{L.C.} = \frac{\text{Pitch}}{\text{C.S. Divisions}} = \frac{0.05 \text{ cm}}{50} = 0.001 \text{ cm.}$

49. *The circular scale of a screw gauge has 100 divisions. Its spindle moves by 2.5 mm when given five complete turns. Calculate (i) pitch (ii) least count of screw gauge.*

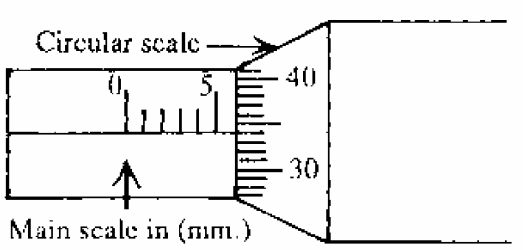
Ans. (i) Pitch $= \dfrac{\text{Distance moved by spindle}}{\text{No. of complete revolutions}} = \dfrac{2.5 \text{ mm}}{5} = 0.5 \text{ mm} = 0.05 \text{ cm}.$

(ii) L.C. $= \dfrac{\text{Pitch}}{\text{C.S. Divisions}} = \dfrac{0.05 \text{ cm}}{100} =$ **0.0005 cm.**

50. *Diagram alongside shows a screw gauge in which circular scale has 200 divisions, calculate :*

(i) *Least count*

(ii) *Radius of wire.*



Ans. (i) L.C. $= \dfrac{\text{Pitch}}{\text{C.S. Divisions}} = \dfrac{1 \text{ mm}}{200} = 0.005 \text{ mm} =$ **0.0005 cm.**

(ii) Diameter = Main scale reading + C.S.D × L.C.

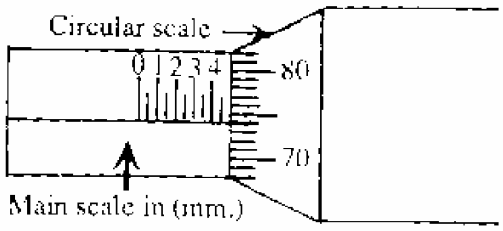
$= 5 \text{ mm} + 34 \times 0.0005 \text{ cm}$

$= 0.5 \text{ cm} + 0.017 \text{ cm}$

$= 0.517 \text{ cm}.$

$\therefore$ Radius $= \dfrac{0.517}{2} =$ **0.2585 cm**.

51. *The diagram alongside shows a screw guage in which circular scale has 100 divisions. Calculate the least count and radius of wire.*



Ans. (i) Least count $= \dfrac{\text{Pitch}}{\text{C.S. Divisions}} = \dfrac{0.5 \text{ mm}}{100} = 0.005 \text{ mm} =$ **0.0005 cm.**

(ii) Diameter of wire = Main scale reading + L.C. × C.S.D

$= 4.5 \text{ mm} + 0.0005 \text{ cm} \times 74 = 4.5 \text{ mm} + 0.0370 \text{ cm}$

$= 0.45 \text{ cm} + 0.0370 \text{ cm} = 0.4870 \text{ cm}$

$\therefore$ Radius $= \dfrac{0.4870 \text{ cm}}{2} =$ **0.2435 cm.**

52. **(a)** *Define simple pendulum.*

(b) *State two factors which determine the time period of a pendulum.*

(c) *Write an expression for the time period of a pendulum, stating clearly the meaning of symbols used.*

Ans. **(a)** **Simple pendulum :** A heavy particle, suspended by a weightless extensible string and oscillating freely without friction about a point, to which the upper end of string is fixed, constitutes a simple pendulum.

(b) **Factors which determine time period :**

(a) Time period is directly proportional to the square root of the effective length.

(b) Time period is inversely proportional to square root of the acceleration due to gravity.

(c) $T = 2\pi\sqrt{\frac{l}{g}}$, where T is the time period, '*l*', the effective length and 'g', the acceleration due to gravity.

53. *Define the following in relation to simple pendulum:*

(a) *Effective length*

(b) *Time period*

(c) *Frequency of oscillation*

(d) *Amplitude*

Ans. **(a)** **Effective length of pendulum :** The distance between point of suspension and centre of gravity of the bob is called length of pendulum.

(b) **Time period :** The time taken by pendulum to complete one oscillation.

(c) **Frequency of oscillation :** The number of oscillations made by a pendulum in one second is called frequency of oscillation.

(d) **Amplitude :** The maximum displacement of pendulum from its mean position.

54. **(a)** *What is a second's pendulum ? What is its approximate effective length ?*

(b) *A second's pendulum is set up on the surface of moon, where acceleration due to gravity is* $\frac{1}{6}$ *of that of earth. How is the time period of a pendulum affected ? Give a reason in support of your answer.*

Ans. **(a)** A pendulum which has a time period of 2 s is called second's pendulum. Its effective length is 1 m.

(b) The time period increases on the surface of moon.

It is because $T \propto \sqrt{\frac{1}{g}}$. Thus, as 'g' on moon decreases, time period increases.

55. *Which of the following do not affect time period of a pendulum?*

(i) *Mass of the bob* ***(ii)*** *Size of the bob*

(iii) *Effective length of pendulum* ***(iv)*** *Amplitude*

(v) *Acceleration due to gravity.*

Ans. Mass of the bob, size of the bob and amplitude do not affect the time period of simple pendulum.

56. *How the time period of a pendulum is affected in the following cases ? If time period is not affected, write "no change".*

(a) *Mass of the bob is doubled*

(b) *Amplitude of swing is doubled.*

(c) *Acceleration due to gravity increases*

(d) *The length of pendulum is halved*

(e) *Pendulum is set up deep in a mine*

(f) *Pendulum is set up at a height 10 km above the sea level.*

Ans. **(a)** No change.

(b) No change.

(c) The time period decreases with the increase in acceleration due to gravity.

(d) The time period decreases with the decrease in length.

(e) The time period increases, because deep inside the mine acceleration due to gravity decreases.

(f) The time period increases, because 10 km up, the acceleration due to gravity decreases.

57. *A person standing on an oscillating swing, sits down. How does the time period of a swing get affected ? What happens to its frequency of oscillation ?*

Ans. The time period increases. It is because the centre of gravity is lowered in sitting position. This in turn increases effective length and hence the time period.

The frequency of oscillation decreases because $T \propto \frac{1}{f}$

58. *A simple pendulum has a hollow bob, such that its time period is T. How the time period of pendulum is affected, if :*

(a) *¼ of the bob is filled with mercury?*

(b) *¾ of the bob is filled with mercury?*

(c) *The bob is completely filled with mercury?*

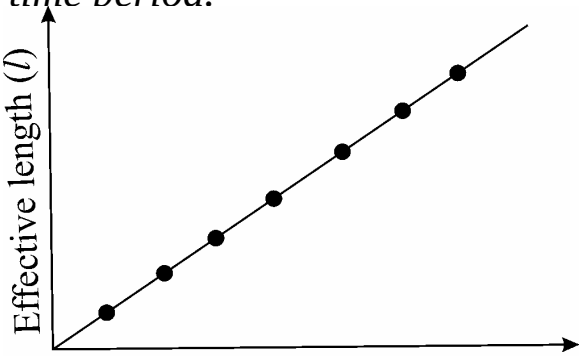
Ans. (a) The time period increases because the ¼ filling mercury lowers centre of gravity. This in turn increases effective length and hence time period.

(b) The time period will be more than what it was initially, because when bob is ¾ filled with mercury, the C.G. will be lower than its initial value and hence the effective length is more.

(c) The time period will not change, because C.G. and hence effective length does not change.

59. *Draw a graph of 'l' the length of simple pendulum, against T^2, the square of its time period.*

Ans.



Graph between l and T^2

60. *State the numerical value of frequency of oscillation of second's pendulum? Does it depend upon amplitude of oscillation ?*

Ans. Numerical value of frequency of oscillation $\frac{1}{2s} = \mathbf{0.5\ s^{-1}}$

It does not depend upon amplitude.

61. *Two simple pendulums A and B have equal lengths, but their bobs weigh 50 gf and 100 gf respectively. What would be the ratio of their time periods? State a reason for your answer.*

Ans. The ratio of time periods of A : B = 1 : 1.

Reason : It is because time period is independent of the mass of bob.

62. *Two pendulums A and B have length 2 m and 0.5 m. Which pendulum will make more oscillations in one minute and why ?*

Ans. The pendulum B of length 0.5 m will make more oscillations per minute as compared to pendulum A of length 2 m.

It is because $T \propto \sqrt{l}$. As time period for B < A, therefore, B makes more oscillations than A.

63. *Calculate the time period of a simple pendulum of length 0.84 m, when $g = 9.8\ ms^{-2}$.*

Ans. length (l) = 0.84 m; $g = 9.8\ ms^{-2}$; $T = ?$

$$T = 2\pi\sqrt{\frac{l}{g}} = \frac{2 \times 22}{7}\sqrt{\frac{0.84}{9.8}} = \frac{2 \times 22 \times 0.2927}{7} = \mathbf{1.84\ s}.$$

64. *Calculate the time period of a simple pendulum of length 1.44 m, on the surface of moon. The acceleration due to gravity on the surface of moon is* $\frac{1}{6}$ *of the acceleration due to gravity on earth [g = 9.8 ms^{-2}].*

Ans. Length (l) = 1.44 m; $g = \frac{9.8}{6}$ ms^{-2}; T = ?

$$T = 2\pi\sqrt{\frac{l}{g}} = \frac{2 \times 22}{7}\sqrt{\frac{1.44 \times 6}{9.8}} = \frac{2 \times 22 \times 0.8816}{7} = \mathbf{5.54\ s}.$$

65. *Length of a second's pendulum is 100 cm. Find the length of another pendulum whose time period is 2.4 s.*

Ans. $l_1 = 100$ cm; $T_1 = 2$ s; $l_2 = ?$; $T_2 = 2.4$ s.

$$\Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{l_1}{l_2}} \quad \Rightarrow \frac{2\text{ s}}{2.4\text{ s}} = \sqrt{\frac{100}{l_2}}$$

$$\Rightarrow \frac{4}{5.76} = \frac{100}{l_2} \quad \text{(squaring both sides)}$$

$$\therefore \quad l_2 = \frac{100 \times 5.76}{4} = \mathbf{144\ cm.}$$

66. *A pendulum whose length is 36 cm has time period 1.2 s. Find the time period of another pendulum whose length is 81 cm.*

Ans. $l_1 = 36$ cm; $T_1 = 1.2$ s; $l_2 = 81$ cm; $T_2 = ?$

$$\frac{T_1}{T_2} = \sqrt{\frac{l_1}{l_2}}$$

$$\Rightarrow \frac{1.2\text{ s}}{T_2} = \sqrt{\frac{36\text{ cm}}{81\text{ cm}}}$$

$$\Rightarrow \frac{1.2\text{ s}}{T_2} = \frac{6}{9}$$

$$\therefore \quad T_2 = \frac{1.2 \times 9}{6} = \mathbf{1{\cdot}8\ s.}$$

67. *Calculate the length of second's pendulum on the surface of moon, when acceleration due to gravity on moon is 1.63 ms^{-2}*

Ans. T = 2 s; l = ?; g = 1.63 ms^{-2}

$$T = 2\pi\sqrt{\frac{l}{g}}.$$

$$\therefore \quad 2 = \frac{2 \times 22}{7} \times \sqrt{\frac{l}{1.63}}$$

$$\Rightarrow \quad 4 = \frac{4 \times 484}{49} \times \frac{l}{1.63} \qquad \text{(squaring both sides)}$$

$$\therefore \quad l = \frac{4 \times 49\ 1.63}{4 \times 484} = \mathbf{0.165\ m.}$$

68. *Calculate the length of a second's pendulum at a place where g = 9.83 ms^{-2}.*

Ans. T = 2 s; l = ?; g = 9.83 ms^{-2}

$$T = 2\pi\sqrt{\frac{l}{g}}.$$

$$\therefore \quad T^2 = \frac{4\pi^2 l}{g} \qquad \text{(squaring both sides)}$$

$$\therefore \quad l = \frac{T^2 \times g}{4\pi^2} = \frac{(2)^2 \times 9.83 \times 49}{4 \times 484} = \mathbf{0.995\ m.}$$

69. *The length of two pendulums is 110 cm and 27.5 cm. Calculate the ratio of their time periods.*

Ans. l_1 = 110 cm; l_2 = 27.5 cm; $T_1 : T_2$ = ?

$$\frac{T_1}{T_2} = \sqrt{\frac{l_1}{l_2}} \quad \frac{T_1}{T_2} = \sqrt{\frac{110}{27.5}} = \sqrt{\frac{4}{1}} = \frac{2}{1}$$

$$\therefore \quad \mathbf{T_1 : T_2 = 2 : 1.}$$

70. *A pendulum of length 100 cm and another pendulum of length 40 cm are oscillating at the same time. Calculate the ratio of their time periods.*

Ans. $l_1 = 100$ cm; $l_2 = 40$ cm; $T_1 : T_2 = ?$

$$\frac{T_1}{T_2} = \sqrt{\frac{l_1}{l_2}} = \sqrt{\frac{100}{40}} = \sqrt{\frac{2.5}{1}} = \frac{1.58}{1}$$

$\therefore$ **$T_1 : T_2 = 1.58 : 1$.**

71. *The time periods of two pendulums is 1.44 s and 0.36 s respectively. Calculate the ratio of their lengths.*

Ans. $T_1 = 1.44$ s; $T_2 = 0.36$ s; $l_1 : l_2 = ?$

$$\frac{l_1}{l_2} = \frac{T_1^2}{T_2^2} = \left(\frac{1.44\text{ s}}{0.36\text{ s}}\right)^2 = \left(\frac{4}{1}\right)^2 = \frac{16}{1}$$

$\therefore$ **$l_1 : l_2 = 16 : 1$.**

72. *The time periods of two pendulums is 2 s and 1.2 s respectively. Find the ratio of their lengths.*

Ans. $T_1 = 2$ s; $T_2 = 1.2$ s; $l_1 : l_2 = ?$

$$\therefore \quad \frac{l_1}{l_2} = \frac{T_1^2}{T_2^2} \quad \text{or} \quad \frac{l_1}{l_2} = \left(\frac{2\text{ s}}{1.2\text{ s}}\right)^2 = \frac{4}{1.44} = \frac{2.77}{1}$$

$\therefore$ **$l_1 : l_2 = 2.77 : 1$.**