

Class 9 Physics - 1st Unit Test Question Bank

PART – A (MCQ's)

Chapter 1: Measurements and Experimentation

1. Select the fundamental unit from the following:

- (a) pascal (b) newton (c) kilogram (d) joule

2. Which of the following is not a fundamental unit?

- (a) metre (b) litre (c) second (d) kilogram

3. The unit of time is:

- (a) light year (b) parsec (c) leap year (d) angstrom

4. 1 Å is equal to:

- (a) 0.1 nm (b) 10^{-10} cm (c) 10^{-8} m (d) $10^4 \mu$

5. Select the physical quantity which is used to measure time among the following units:

- (a) u (b) ly (c) ns (d) nm

6. Which of the following quantities has unit different from the remaining three?

- (a) Weight (b) Kinetic energy
(c) Energy (d) Product of force and displacement

7. Which of the following pairs of physical quantities has the same unit?

- (a) Momentum and energy (b) Force and pressure
(c) Work and power (d) Work and energy

8. Which of the following is not the unit of time?

- (a) Light year (b) Microsecond (c) Leap year
(d) Lunar months

9. Which of the following quantities has the same unit as that of Energy?

- (a) Momentum (b) Power (c) Work
(d) Force

10. The unit for impulse is same as the unit for:

- (a) Work
of momentum
- (b) Force
(d) Torque
- (c) Rate of change

11. What is the SI unit of acceleration due to gravity?

- (a) m s^{-2}
 cm s^{-2}
- (b) N g^{-1}
- (c) J kg^{-1}
- (d)

12. SI unit of energy is:

- (a) calorie
- (b) erg
- (c) joule
- (d) electron volt

13. Wavelength of ray of light is 5800 Å. It is equal to:

- (a) 580 nm
- (b) 58 nm
- (c) 0.58 nm
- (d) 5.8 nm

14. Light year is a unit of:

- (a) Speed
- (b) Mass
- (c) Time
- (d) Distance

15. Which of the following is not a unit of energy?

- (a) kg m s^{-2}
- (b) joule
- (c) Nm
- (d) kg m s^{-1}

16. Select the correct unit for measuring nuclear radii.

- (a) millimetre
- (b) Micron
- (c) Fermi
- (d) Angstrom

17. In a micrometer screw gauge, use of ratchet is:

(a) to correct the zero error
correct pressure

(b) to apply the

(c) to lock the spindle
scale

(d) to turn the circular

18. The dimensions of a pocketbook is measured as 33.2 mm, 54.6 mm, 13.8 mm. Select the measuring tool which could have been used to obtain these readings:

(a) Measuring Tape

(b) Vernier Caliper

(c) Micrometer Screw Gauge

(d) Metre Scale

19. You are given a ball point refill. The diameter of this refill can be measured by:

(a) A vernier calliper
gauge

(b) A micrometer screw

(c) A metre scale

(d) None of these

20. Which measuring tool should be used to measure the length of about half a metre long curved track accurately?

(a) Tape measure
gauge

(b) Micro-meter screw

(c) Metre scale

(d) Vernier caliper

21. You have to measure the diameter of a beaker in your school laboratory. You will use a:

(a) Metre scale

(b) Vernier calliper

(c) Measuring tape
gauge

(d) Micrometer screw

22. You are given a vernier calliper. On its main scale 1cm is divided in 10 parts and vernier scale is also divided in 10 parts. The least count of given vernier calliper will be:

(a) 1 cm

(b) 0.001 cm

(c) 0.1 cm

(d) 0.01 cm

23. A vernier calliper having 10 divisions on vernier scale with 10 divisions in 1 cm on main scale will have the least count:

(a) 0.1 mm

(b) 1.0 mm

(c) 0.001 mm

(d) 0.01 mm

24. If the length of a simple pendulum is made one-fourth, its time period will become:

(a) Four times

(b) One-fourth

(c) Half

(d) Double

25. The time period of a second's pendulum is:

(a) 1 s
min

(b) 2 s

(c) 2 min

(d) 1

26. The length of a second's pendulum is nearly:

(a) 0.5 m

(b) 9.8 m

(c) 1.0 m

(d)

2.0 m

Answers & Explanations:-

1. (c) 2. (b) 3. (c) 4. (a) [$10 \text{ \AA} = 1 \text{ nm} \Rightarrow 1 \text{ \AA} = 0.1 \text{ nm}$] 5. (c)
6. (a) 7. (d) 8. (a) 9. (c) 10. (c)
11. (a) 12. (c) 13. (a) 14. (d) 15. (d) 16. (c) 17. (b) 18. (b)
19. (b) 20. (a)
21. (b) 22. (d) 23. (a) 24. (c) 25. (b) 26. (c)

Chapter 2: Motion in One Dimension

1. Select a vector quantity from the following:

- (a) Potential energy (b) Pressure (c) Distance
(d) Velocity

2. Which of the following groups of physical quantities consists of scalars only?

- (a) acceleration, force, velocity
(b) force, time, velocity
(c) mass, speed, time
(d) acceleration, mass, speed

3. Select a scalar quantity from the following:

- (a) the thrust required to lift a rocket off the ground
- (b) the effort required to hammer a nail into wood
- (c) the braking force required to stop a truck
- (d) the heat required to boil one cup of water for preparing tea

4. Which of the following correctly lists one scalar and one vector quantity?

- (a) Scalar: Displacement, Vector: Work
- (b) Scalar: Energy, Vector: Force
- (c) Scalar: Force, Vector: Acceleration
- (d) Scalar: Velocity, Vector: Mass

5. Choose the S.I. unit of velocity.

- (a) km h^{-1}
- (b) km min^{-1}
- (c) m s^{-1}
- (d) m min^{-1}

6. The unit of retardation is:

- (a) m s^{-1}
- (b) m s^{-2}
- (c) $\text{m}^{-2} \text{s}^{-1}$
- (d) m s^2

7. An object is thrown vertically upward with an initial velocity u goes to a maximum height h in time t and then comes back at the point of projection. Choose the correct statement:

(a) Acceleration = zero

(b) Average velocity = $\frac{h}{t}$

(c) Final velocity on reaching the point of projection = $2u$

(d) Displacement = zero

8. 36 km h^{-1} is equal to:

(a) 10 m s^{-1} (b) 36 m s^{-1} (c) 18 m s^{-1}

(d) 1.0 m s^{-1}

9. A train starts from rest and moves with uniform acceleration. It attains a velocity of 72 km h^{-1} in 360 s . The acceleration of the train will be:

(a) $\frac{1}{21} \text{ m s}^{-2}$ (b) $\frac{1}{12} \text{ m s}^{-2}$ (c) $\frac{1}{18} \text{ m s}^{-2}$

(d) $\frac{1}{15} \text{ m s}^{-2}$

10. The velocity-time graph of a body in motion is a straight line inclined to the time axis. The correct statement is:

(a) Velocity is uniform

(b) Acceleration is uniform

(c) Both velocity and acceleration are uniform

(d) Neither velocity nor acceleration is uniform

11. For a uniformly retarded motion, the velocity-time (v-t) graph is:

- (a) a straight line inclined to the time axis with negative slope
- (b) a straight line parallel to the time axis
- (c) a straight line perpendicular to the time axis
- (d) a straight line inclined to the time axis with positive slope

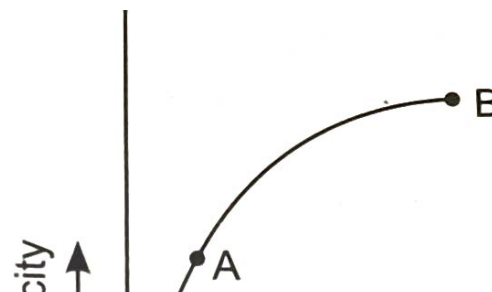
12. Which of the following comprises of one vector and one scalar quantity?

- (a) Force, Acceleration
- (b) Distance, Mass
- (c) Displacement, Speed
- (d) Momentum, Velocity

13. Choose the correct statement regarding motion:

- (a) The distance-time graph is a straight line parallel to the time axis
- (b) The speed-time graph is a straight line inclined to the time axis
- (c) The speed-time graph is a straight line parallel to the time axis
- (d) The acceleration-time graph is a straight line parallel to the time axis

14. The velocity-time (v-t) graph of an object moving in a straight line shown below. Choose the correct option:



- (a) In part OA acceleration is increasing
- (b) In part OA acceleration is decreasing
- (c) In part OA acceleration is constant and in part AB acceleration is decreasing
- (d) In part AB acceleration is increasing

15. Choose the correct equation of motion from the following options:

- (a) $S = ut + \frac{1}{2}at^2$
- (b) $v = u + 2aS$
- (c) $v = u + at$
- (d) $v = ut + a$

16. A car starting from rest and accelerates uniformly to acquire a speed of 20 km h^{-1} in half an hour. The distance travelled by car in this time interval will be:

- (a) 600 km
- (b) 6 km
- (c) 5 km
- (d) 10 km

17. Select the case of motion from the following in which the distance moved and the magnitude of displacement are equal:

- (a) If a four-wheeler is moving in circular path
- (b) The satellite is revolving around a planet
- (c) The pendulum is moving to and fro about its mean position
- (d) If a four-wheeler is moving on a straight road

18. In a velocity time (v-t) graph, slope of graph gives:

- (a) the speed
- (b) the distance
- (c) the displacement
- (d) the acceleration

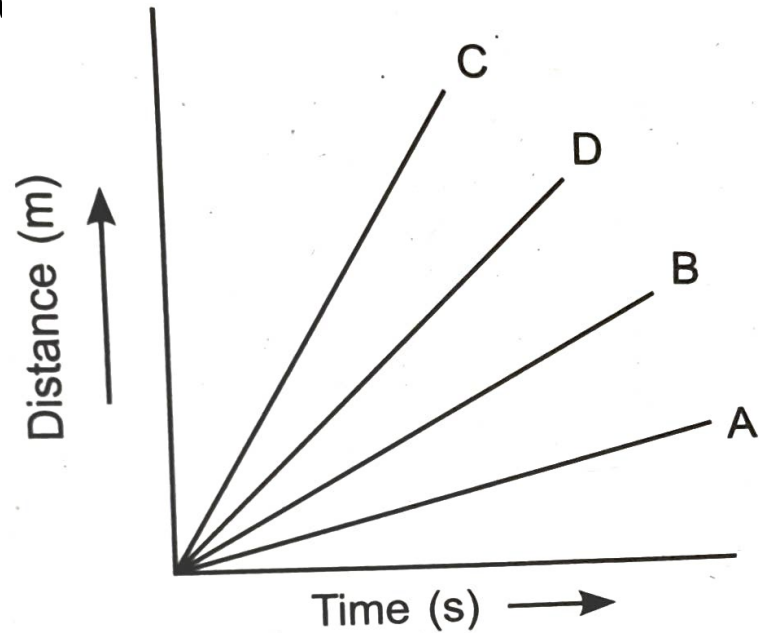
19. Suppose Sumita is enjoying a ride on a merry-go-round which is moving with a constant speed of 8 m s^{-1} . It implies that she is:

- (a) at rest
- (b) in accelerated motion
- (c) moving with uniform velocity with no acceleration
- (d) moving

20. Area under a velocity time (v-t) graph represents a physical quantity which has the unit:

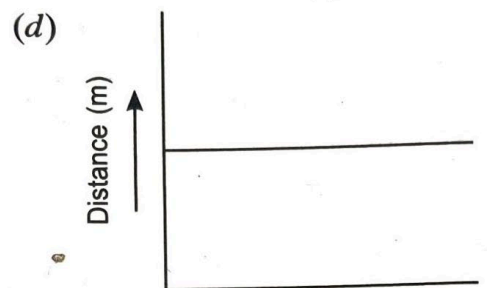
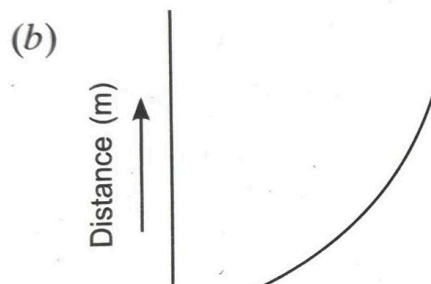
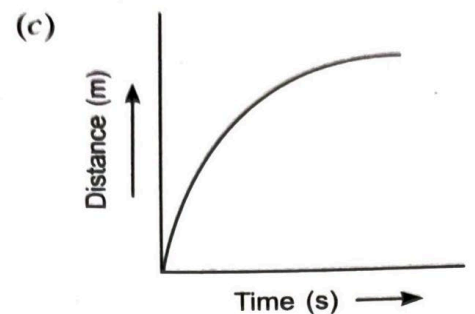
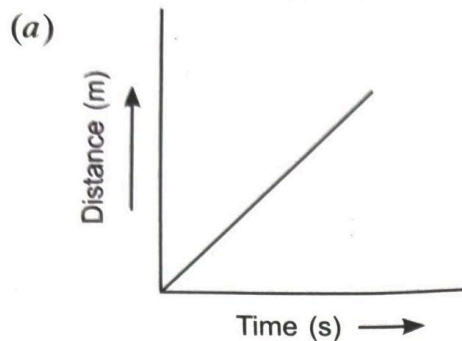
- (a) m s^{-1}
- (b) m^3
- (c) m
- (d) m^2

21. Four cars A, B, C and D are moving on a levelled road. Their distance vs time graphs are shown below. Identify the correct statement from the follow



- (a) Car B is the slowest.
- (b) Car A is faster than car D.
- (c) Car D is faster than car C.
- (d) Car C is the fastest .

22. Which of the following figures represent uniform motion of a moving object correctly?



23. An athlete is running in a circular track of radius r . The displacement after covering half of the track is:

- (a) Zero (b) πr (c) $2r$ (d) $2\pi r$

24. John moving on a circular track of radius 10 m completes three - fourth of the circular track. The distance travelled and displacement will be respectively:

- (a) 47.1 m and 14.1 m (b) 47.1 m and 10 m
(c) 31.4 m and 14.1 m (d) 31.4 m and 10 m

25. Reema throws a ball vertically upward with velocity u , the greatest height h to which the ball will rise is:

- (a) $\frac{u}{g}$ (b) $\frac{u}{g}$ (c) $\frac{u^2}{g}$
(d) $\frac{u^2}{2g}$

26. The numerical ratio of displacement to distance for a moving object is:

- (a) always less than 1 (b) always equal to 1

(c) equal to or less than 1
more than 1

(d) always

27. If the displacement of an object is proportional to square of time, then the object moves with:

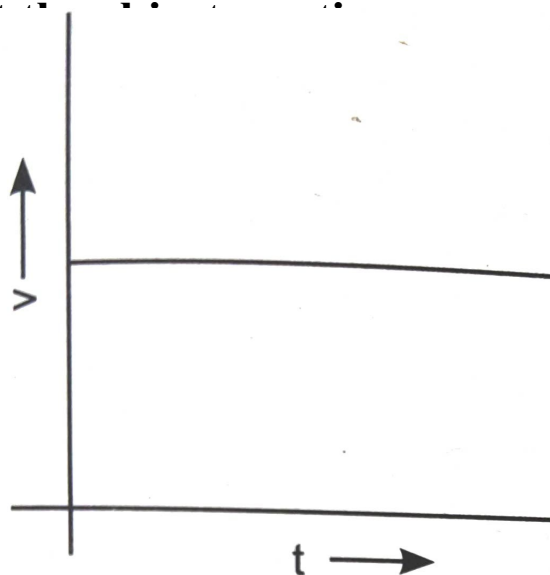
(a) uniform acceleration
velocity

(b) uniform

(c) increasing acceleration
decreasing acceleration

(d)

28. From the given velocity-time (v-t) graph, select the correct statement about



(a) in non-uniform motion

(b) at rest

(c) in uniform motion
with uniform acceleration

(d) moving

29. An object moving with an initial velocity of 10 km/h comes to rest after 15 min. Then the distance covered by the object is:

- (a) 2.5 km (b) 5 km (c) 1.25 km
 (d) 10 km

Answers & Explanations

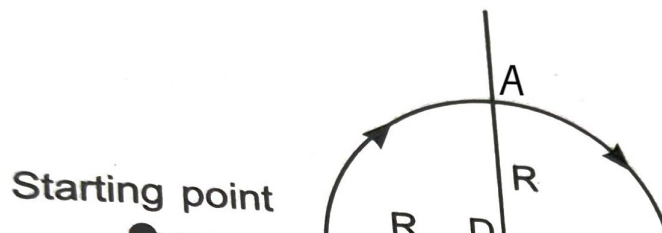
1. (d) 2. (c) 3. (d) 4. (b) 5. (c) 6. (b) 7. (d) 8. (a)
 9. (c) [$u=0$, $v=72 \text{ km/h} = 20 \text{ m/s}$, $t=360\text{s}$]

$$\text{As } v = u + at$$

$$\Rightarrow 20 = 0 + a \times 360$$

$$\Rightarrow a = \frac{1}{18} \text{ ms}^{-2}]$$

10. (b) [Uniform acceleration motion]
 11. (a) [Straight line inclined with negative slope – uniform retardation motion]
 12. (c) [Displacement, Speed]
 13. (c) [the speed-time graph is a straight line parallel to time axis, for a uniform motion as the slope is zero and hence the acceleration is zero and motion is uniform]
 14. (c) 15. (c) 16. (c) [Distance = 5 km]
 17. (d) 18. (d) 19. (b) 20. (c) 21. (a) 22. (d) 23. (c)
 24. (a)



$$\text{Distance} = \text{OA} + \text{AB} + \text{BC} = \text{OAB} + \text{BC}$$

$$= \pi R + \frac{2\pi R}{4}$$

$$= \frac{3}{2} \times \pi r$$

$$= 15\pi = 47.1\text{m}$$

$$\text{Displacement} = \text{OC}$$

By the Pythagoras theorem in $\triangle \text{ODC}$,

$$\text{OC}^2 = \text{OD}^2 + \text{DC}^2$$

$$\text{OC} = \sqrt{(\text{OD}^2 + \text{DC}^2)} = \sqrt{(R^2 + R^2)} =$$

14.1m

25. (d) 26. (c) 27. (a) 28. (c)

29. (c) [$u=10\text{km/h}$, $t=15\text{min} = \frac{1}{4}\text{h}$, $v= 0\text{km/h}$

$$\text{As } a = \frac{v-u}{t} \Rightarrow \frac{0-10}{1/4} = -40 \text{ kmh}^{-2}$$

$$\text{As } s = \frac{v^2 - u^2}{2a} \Rightarrow \frac{0 - 100}{2(-40)} = 1.25 \text{ km}]$$

PART – B

(SHORT ANSWER TYPE QUESTIONS)

Chapter 1: Measurements and Experimentation

Q1. What do you mean by measurement?

Ans.. Measurement is the process of comparison of the given physical quantity with the known standard quantity of the same nature

Q2. What do you mean by a unit?

Ans. Unit is the quantity of a constant magnitude which is used to measure the magnitude of other quantities of the same nature

Q3. How will you express the result of a measurement of a physical quantity?

Ans. The result of a measurement of a physical quantity is expressed by a number of numerical measure accompanied by a unit.

Thus,

measurement of a physical quantity (Q) = numerical measure (n) × unit (u).

Q4. What do you understand by a physical quantity?

Ans. A physical quantity in Physics is the quantity which can be measured directly or indirectly.

Or

any physical quantity is a magnitude of numerical value and its unit.

Q5. What do you mean by 'Le Systeme International d'Unites'?

Ans. At present 'Le Systeme International d'Unites' is an internationally accepted system of units for measurement whose Indian equivalent is International System of units abbreviated as SI.

In SI there are seven fundamental units of physical quantities: length, mass, time, temperature, electric current, luminous intensity and amount of substance, and two supplementary units of physical quantities: angle and solid angle.

Q6. Define 1 kilogram on an atomic scale.

Ans. On an atomic scale, 1 kilogram is equivalent to the mass of 5.0188×10^{25} atoms of carbon isotope C-12.

Q7. What do you mean by a mean solar day?

Ans. A mean solar day is the average time taken by the earth to revolve once on its own axis, i.e.

$$1 \text{ mean solar day} = 24 \text{ h} = (24 \times 60 \times 60) \text{ s} = 86400 \text{ s}$$

Q8. What do you mean by the following terms:

(i) least count of an instrument

(ii) vernier constant?

Ans.

(i) Least count of an instrument means the least measurement (e.g. distance) which can be measured by this instrument accurately.

(ii) Vernier constant is equal to the difference between the values of one main scale division and one vernier scale division.

Q9. What is the principle of vernier callipers?

Ans. If the length of one vernier scale division is V and main scale division is s . Then

Length of n vernier scale divisions = length of $(n - 1)$ divisions of main scale.

i.e. $nV = (n - 1)s = ns - s$

$$(s - V) = \frac{s}{n}$$

$$\text{Vernier constant} = \frac{\text{Length of one main scale division}}{\text{Total no.of divisions on vernier scale}}$$

Q10. What do you mean by zero correction?

Ans. Zero correction is the correction applied to a measured value on account of the zero error. It is negative of the zero error, i.e. it is negative for positive zero error and positive for negative zero error.

Corrected reading = observed reading - zero error with proper sign

Q11. Mention the relation between frequency and time period of a simple pendulum.

Ans. Frequency of a simple pendulum (ν) is equal to reciprocal of its time period (T), i.e. $\nu \propto \frac{1}{T}$

Q12. State the factors on which the time period of a simple pendulum does not depend.

Ans. The period of oscillation does not depend on:

- (i) mass of the material and shape of the bob, and
- (ii) amplitude of oscillation.

Q13. Answer the following questions:

(i) A girl is swinging in a swing in a sitting position. How will the period of the swing be affected if she stands up?

(ii) The bob of an oscillating pendulum is made of ice. How will the time period change if the ice starts melting?

(iii) Will a pendulum gain or lose time, when taken to a mountain?

(iv) Why does a simple pendulum eventually stop?

Ans.

(i) The case of a swinging girl can be considered as a simple pendulum. As the girl stands up on the swing the centre of gravity of the swing is raised up, i.e. the length l of the

pendulum decreases. Hence, the time period $T (=2\pi \sqrt{\frac{l}{g}})$

decreases.

(ii) The time period will not be affected, as it is independent of the mass of the bob.

(iii) When a pendulum is taken to the top of a mountain, g will

decrease. Therefore, $T (=2\pi \sqrt{\frac{l}{g}})$ will increase, i.e. the pendulum

will take more time to complete one oscillation. In other words, it will lose time.

(iv) Due to frictional resistance between air and bob, the amplitude of oscillation of the pendulum gradually decreases and eventually the pendulum stops.

Q14. What do you understand by the statement 'the density of mercury is 13.6 g/cm³'?

Ans. The density of mercury is 13.6 g/cm³ means the mass of 1 cm³ of mercury is 13.6 g (or mass of 1 cubic metre of mercury is 13600 kg).

Q15. What is the need of measurement? Or Why is measurement necessary?

Ans. Physics is basically a science of measurements. To establish and verify physical laws, the experimental studies and measurements are necessary.

Q16. Mention the characteristics of a standard unit.

Ans. The standard unit must be:

- (i) well-defined
- (ii) invariable
- (iii) imperishable
- (iv) easily reproducible and
- (v) easily available.

Q17. Why is International System of units (SI) developed and recommended?

Ans. As from the MKS system, only the units of length, mass and time can be expressed. But the three fundamental units were not sufficient to express the units of all physical quantities, such as light, electricity, heat, etc. Therefore, the general conference on weights and measures in 1971 for international usage in scientific, technical and industrial/commercial work developed and recommended the International System of units abbreviated as SI.

Q18. Name the units which are used to measure very large astronomical distances.

Ans. (i) Astronomical unit (AU)

(ii) Light year (ly)

(iii) Parsec

Q19. How will you define unified atomic mass unit? What is its purpose?

Ans. Unified atomic mass unit (u) is defined as $\frac{1}{12}$ th of the mass of an atom of carbon-12 isotope.

$$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$$

It is used to deal with the mass of atoms or molecules.

Q20. What is backlash error? How is it avoided?

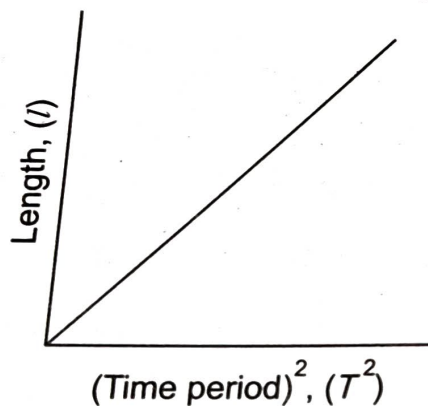
Ans. Backlash error is the error due to wear and tear of the threads of the screw due to which on reversing the direction of rotation of the thimble, the tip of the screw does not move in the opposite direction immediately but remains stationary for a part of rotation. To avoid backlash error, rotate the screw in one direction only while taking the measurement.

Q21. What do you mean by effective length of a simple pendulum? Draw a graph l versus T^2 and l versus T for a simple pendulum.

Ans. The effective length of a simple pendulum is the distance between the point of suspension and the centre of the bob.

(i) Graph l versus T^2 is a straight line.

(ii) Grap



Q22. When are two quantities said to be interdependent? How is the dependence of one quantity on the other be expressed?

Ans. Two quantities are said to be interdependent, if the variation of one of them leads to the variation of the other. There are different ways of expressing the dependence of one quantity on the other in a quantitative form:

- (i) in the form of mathematical relation.
- (ii) to write the values of physical quantities in the form of tables.
- (iii) by plotting a graph between two physical quantities.

Q23. What is the special advantage of presenting data in a graphical format?

Ans. A graphical format makes the dependence between the two quantities more visible, i.e. it clearly shows how one quantity varies with respect to other.

Q24. What does a straight line graph signify? What does the slope of such a graph give? How is slope calculated?

Ans. A straight line graph signifies that the changes in the values of the quantities represented on the graph are proportional to each other, e.g. in simple pendulum, the straight line graph

means $L \propto T^2$ or $\frac{L}{T^2}$ is constant.

The slope of the straight line gives the value of the constant of proportionality.

To calculate the slope, take two points on the line well apart.

Read the values on x-axis and y-axis respectively at these two points drawing the abscissa and ordinate clearly.

$$\text{Slope} = \frac{(\Delta Y)}{(\Delta X)}$$

Q25. How will you estimate the diameter of the thread if you are given a thread and a metre scale?

Ans. Wind a large number of turns (n) of the thread closely touching one another on a scale. Read the length (l) of the scale containing these turns. Then the diameter of the thread will be l/n .

Q26. A screw gauge has a pitch of 1.0 mm and 100 divisions on the circular scale. Is it possible to increase the accuracy of the gauge arbitrarily by changing the number of divisions on the circular scale?

Ans. If the least count of an instrument is smaller, then the accuracy of the instrument will be greater. The least count of screw gauge can be reduced by increasing the number of divisions on the circular scale only up to the extent the divisions will be clearly resolved by the eye.

Q27. Answer the following (in one word or in one sentence):

- (i) What will be the length of a second's pendulum?**
- (ii) State the name of the instrument used to measure mass.**
- (iii) Mention two characteristics of a base standard.**
- (iv) Define effective length of a simple pendulum.**
- (v) Define the term 'vernier constant'.**

Ans.

(i) ≈ 1 m

(ii) Beam balance

(iii) (1) accessible (2) invariable

(iv) The effective length of a simple pendulum is the length of the pendulum from the point of suspension to the centre of the bob.

(v) Vernier constant is equal to the difference between the value of one main scale division and one vernier scale division.

Q28. Name the SI units of force, mass and length.

Ans. The SI units of force, mass and length are newton, kilogram and metre respectively.

Q29. Define standard metre.

Ans. One metre is the length of the path travelled by light in vacuum during a time interval of $\frac{1}{299,792,458}$ of a second.

Q30. How is nanometre related to Angstrom?

Ans. $1 \text{ nm} = 10 \text{ \AA}$

Q31. How can the least count of a screw gauge be increased?

Ans. The least count of a screw gauge can be increased by increasing the total number of divisions on the circular scale or decreasing the pitch.

Q32. Two simple pendulums P and Q have equal length, but their bobs weigh 10 g and 20 g respectively. Will there be a difference in their time periods? Explain.

Ans. No, as the time period of a simple pendulum does not depend on the mass of the bob.

Q33. Two simple pendulums P and Q have lengths 5 m and 10 m respectively. Which pendulum will make more oscillations for the same time period? Explain.

Ans. Since the time period of a simple pendulum, i.e. $T \propto \sqrt{l}$, the time period of the simple pendulum of smaller length will be less in comparison to the pendulum of longer length. In a given time, the smaller length pendulum will make more oscillations.

Q34. The distance of a planet from the earth is 11 light minutes. What do you mean by this statement? Express the distance in km.

Ans. 11 light minutes mean the distance travelled by light in 11 minutes.

11 light minutes = speed of light \times 11 minutes = 3×10^8 m/s \times (11 \times 60) s

$$= 198 \times 10^9 \text{ m} = 1.98 \times 10^{11} \text{ m} = 1.98 \times 10^8 \text{ km}$$

Q35. Name three convenient units used to measure length ranging from very short to very long distances. How are they related to each other?

Ans. Millimetre, metre and kilometre

$1 \text{ mm} = 10^{-3} \text{ m}$; $1 \text{ m} = 10^{-3} \text{ km}$; $1 \text{ mm} = 10^{-6} \text{ km}$

Q36. Define the following:

(i) Fundamental quantities, (ii) Derived quantities, (iii) Fundamental unit (iv) Derived unit.

Ans.

(i) Fundamental quantities are those quantities which are independent of one another, e.g. length, mass, time, current, temperature, amount of substance, luminous intensity, plane angle and solid angle.

(ii) Derived quantities are those quantities which are derived from two or more fundamental quantities, e.g. speed, acceleration, work, pressure, etc.

(iii) Fundamental unit or base unit is an independent unit which can neither be derived from one another nor can be further resolved into simple unit of any other physical quantity, e.g. m, kg, s.

(iv) Derived unit can be obtained from the fundamental or base units, e.g. m/s, m/s², kg m/s, J, N.

Q37. Define the following terms related to simple pendulum:

(i) oscillation (ii) amplitude (iii) time period

(iv) frequency.

Ans.

- (i) When a bob moves from its mean position to the extreme right, from the extreme right to extreme left and finally back to the mean position, it completes one oscillation.
- (ii) Amplitude is the maximum displacement of the bob from its mean position on either side.
- (iii) The period of an oscillation (or the time period) is the time taken to complete one oscillation. It is denoted by T . Its SI unit is second.
- (iv) The frequency of an oscillation of a simple pendulum is the number of oscillations made in one second. It is denoted by ν or n or f . Its SI unit is per second or hertz (Hz).

Q38. What is a simple pendulum? State the factors on which time period of a simple pendulum depends.

Ans. A simple pendulum is a device which contains a heavy point mass called bob, suspended from a rigid support by an inextensible and massless string. Its effective length is taken from the point of suspension to the centre of the bob.

The period of oscillation (T) is:

- (i) directly proportional to the square root of its length (l), i.e. $T \propto \sqrt{l}$.
- (ii) inversely proportional to the square root of acceleration due

to gravity (g), i.e. $T \propto \frac{1}{\sqrt{g}}$.

$$\text{Thus, } T = 2\pi \frac{1}{\sqrt{g}}$$

Q39. Name the physical quantities which are expressed in the following units:

(i) metre (ii) second (iii) kilogram (iv) micron (v) nanometre, (vi) light year (vii) angstrom (viii) quintal (ix) month (x) tonne.

Ans. (i) length (ii) time (iii) mass (iv) length (v) length (vi) distance (vii) length (viii) mass (ix) time (x) mass.

Q40. Fill in the blanks:

- (i) $1 \text{ \AA} = \dots\dots \text{ nm}$**
- (ii) $1 \text{ ly} = \dots\dots \text{ km}$**
- (iii) $1 \text{ quintal} = \dots\dots \text{ kg}$**
- (iv) $1 \text{ tonne} = \dots\dots \text{ quintal}$**
- (v) $1 \text{ leap year} = \dots\dots \text{ days}$**
- (vi) $1 \text{ day} = \dots\dots \text{ seconds}$**
- (vii) $1 \text{ u} = \dots\dots \text{ g}$**
- (viii) $1 \text{ parsec} = \dots\dots \text{ ly}$**
- (ix) $1 \text{ parsec} = \dots\dots \text{ km}$**

Ans.

- (i) 0.1

- (ii) 9.46×10^{12}
- (iii) 100
- (iv) 10
- (v) 366
- (vi) 86400
- (vii) 1.66×10^{-24}
- (viii) 3.26
- (ix) 3.08×10^{13}

Q41. Name two factors each on which time period of a simple pendulum depend and does not depend.

Ans. Time period of a simple pendulum depends upon the effective length as $T \propto \sqrt{l}$ and acceleration due to gravity, as $T \propto \frac{1}{\sqrt{g}}$.

Time period of a simple pendulum does not depend upon the mass of suspended bob and its amplitude.

Q42. What do you mean by zero error of a vernier calliper? What are the two types of zero error?

Ans. On bringing the movable jaw of contact with the fixed jaw, if the zero of the main scale coincides with the zero of the vernier scale, then the given vernier is free from zero error. But if zero of the vernier scale does not coincide with the zero of the main scale, the vernier is said to have zero error.

Zero error is defined as the distance between the zero of the main scale and the zero of the vernier scale when the two jaws are in contact.

Zero error is of two kinds, such as positive zero error and negative zero error.

The zero error is said to be positive if on bringing both the jaws together, the zero mark of the vernier is on the right hand side of the zero mark of the main scale.

The zero error is said to be negative, if on bringing both the jaws together, the zero mark of the vernier is on the left side of the zero of the main scale.

**Q43. What do you mean by zero error of a screw gauge?
What are the two types of zero error?**

Ans. On completely closing the gap between the spindle and the anvil by turning the thimble, if the zero mark on the main scale exactly coincides with the zero of the circular scale, the instrument is said to be free from the zero error. If it does not coincide, the instrument has zero error.

The zero error is said to be positive if the zero mark on the circular scale is below the base line of the main scale.

The zero error is said to be negative, if the zero mark on the circular scale is above the base line of the main scale.

Q44. Define the following:

(i) Light year (ii) Astronomical unit (iii) Parsec (iv) Micron (v) Angstrom (vi) Fermi.

Ans.

(i) Light year (ly) is the distance travelled by light in vacuum in one year

$$1 \text{ ly} = 3 \times 10^8 \text{ m/s} \times (365 \times 24 \times 60 \times 60) \text{ s} = 9.46 \times 10^{15} \text{ m}$$

(ii) Astronomical Unit (AU) is the mean distance between the sun and the earth

$$1 \text{ AU} = 1.496 \times 10^{11} \text{ m} \approx 1.5 \times 10^{11} \text{ m}$$

(iii) Parsec is the distance at which an arc of length of 1 AU subtends an angle of one second of the arc:

$$1 \text{ parsec} = 3.08 \times 10^{16} \text{ m} = 3.26 \text{ ly}$$

(iv) Micron is one millionth part of a metre: $1 \text{ micron } (\mu) = 10^{-6} \text{ m}$

(v) 1 Angstrom is 10^{-10} th part of a metre: $1 \text{ angstrom } (\text{\AA}) = 10^{-10} \text{ m}$

(vi) 1 Fermi is 10^{-15} th part of a metre: $1 \text{ fermi } (f) = 10^{-15} \text{ m} = 1 \text{ fm (femtometre)}$

Q45. What do you mean by a second's pendulum? A simple pendulum is set up in a laboratory at the sea-level. How would its time period change if it is shifted to (i) the moon (ii) a deep mine (iii) a place at Mount Everest (iv) an artificial satellite of the earth?

Ans. Second's pendulum is that pendulum whose time period is 2 s. Acceleration due to gravity is maximum on the earth's

surface.

(i) increases (as $T \propto \frac{1}{\sqrt{g}}$)

(ii) increases (as $T \propto \frac{1}{\sqrt{g}}$)

(iii) increases (as on mountain acceleration due to gravity decreases and $T \propto \frac{1}{\sqrt{g}}$)

(iv) infinite (as in an artificial satellite there is zero gravity condition exists and $T \propto \frac{1}{\sqrt{g}}$).

Chapter 2: Motion in one dimension

Q1. How do you represent a vector quantity?

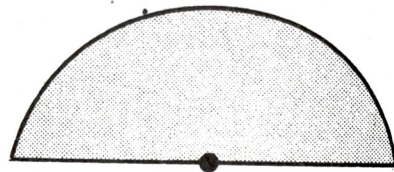
Ans. A vector quantity is represented by an arrow. The length of the arrow represents the magnitude and the arrow-head (tip) represents the direction.

The vector quantities are written by putting an arrow on a capital letter like \vec{A} or by an italicized letter like \mathbf{a} .

Q2. An insect is crawling on a cycle rim of radius r . What will be the distance and displacement of the insect (i) in half revolution, and (ii) in one complete revolution?

Ans.

(i) In a half revolution, the distance travelled by the insect will be equal to the circumference of the half circular rim, i.e., πr and displacement will be the shortest distance between initial and final positions, i.e., $2r$.



(ii) In a complete revolution, the distance travelled by the insect will be $2\pi r$ and displacement will be zero.

Q3. A girl leaves her home. She travels in a car and returns home after covering 20 km in half an hour. What is her average displacement?

Ans. Zero.

Q4. Can the distance travelled by an object be smaller than the magnitude of its displacement?

Ans. No.

Q5. In what condition is the distance covered equal to the magnitude of the displacement of a particle?

Ans. If an object moves along a straight line without changing its direction, the magnitude of its displacement is equal to the distance traversed.

Q6. Is it possible that the displacement is zero but not the distance?

Ans. Yes. If a particle moves in a closed path, its displacement will be zero but the distance will not be zero.

Q7. When do you say that a body is at rest and when do you say that it is in motion?

Ans. A body is said to be at rest if it does not change its position with respect to its surroundings. A body is said to be in motion if it changes its position with respect to its surroundings.

Q8. Explain with the help of two examples that motion is relative.

Ans. When you are sitting in a moving train, your distance from the wall, ceiling, and windows of the compartment remains the same. This shows that your position does not change with respect to the other parts of the compartment. So you are at rest with respect to the compartment. But your position is changing with respect to the ground/platform outside with the passage of time.

Similarly, if a person sitting in a boat is crossing a river, then the person with respect to the boat is in a state of rest as his position with respect to the boat is not changing, but with respect to the river bank, the person is in a state of motion.

Thus, we can infer that motion is relative.

Q9. If the displacement of an object is given, what information about the position of the object do you get?

Ans. Displacement tells us two things:

- (i) How far the final position is from the initial position, and
- (ii) In which direction the final position is when seen from the initial position.

Q10. How does the position of an object differ from its displacement?

Ans. The position of an object is expressed at a particular instant of time, while the displacement of an object is defined by the change in position of the object over a certain time interval.

Q11. What is the purpose of the distance-time graph?

Ans. The distance covered by a body in a certain time interval is represented visually through a distance-time graph. If a body is in motion, its nature and behavior can be easily studied from the distance-time graph.

Q12. What is the equation of motion of uniform velocity?

Ans. $s = vt$, where s is the displacement, v is the uniform velocity, and t is the time taken.

Q13. If velocity is uniform (constant), which physical quantity is always zero and why?

Ans. Acceleration, because acceleration is defined as the rate of change in velocity with time. In the case of uniform velocity, $\Delta v = 0$, which implies that the acceleration $a = 0$.

Q14. For a uniformly accelerated motion, what is uniform? What is changing regularly?

Ans. For a uniformly accelerated motion, the acceleration (rate of change of velocity) is uniform/constant. The change in velocity Δv per unit time is constant, so the velocity changes regularly and is directly proportional to time ($v \propto t$).

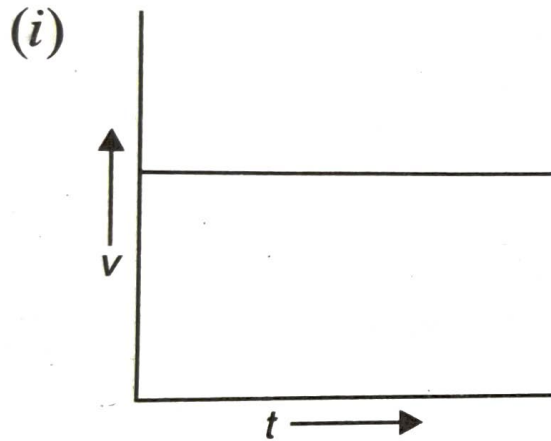
Q15. What does the area under a v-t graph represent?

Ans. The area under a velocity-time (v-t) graph represents the displacement of the object.

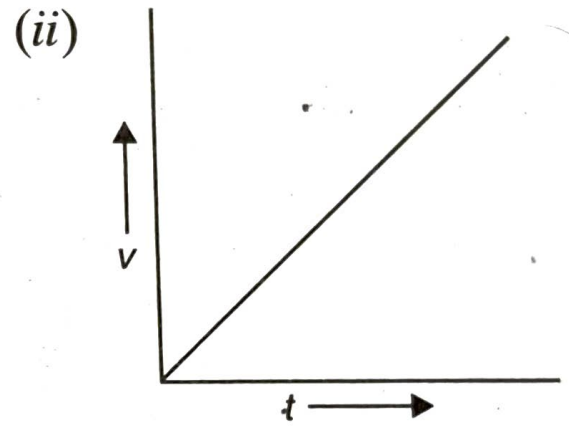
Q16. Draw the velocity-time graph for an object moving with

(i) uniform velocity, and (ii) uniform acceleration.

Ans.



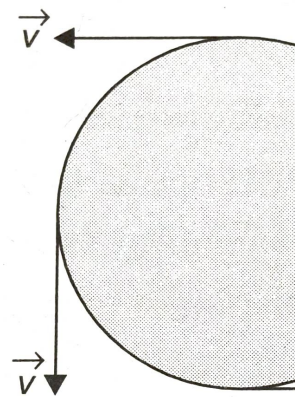
Object moving with uniform velocity



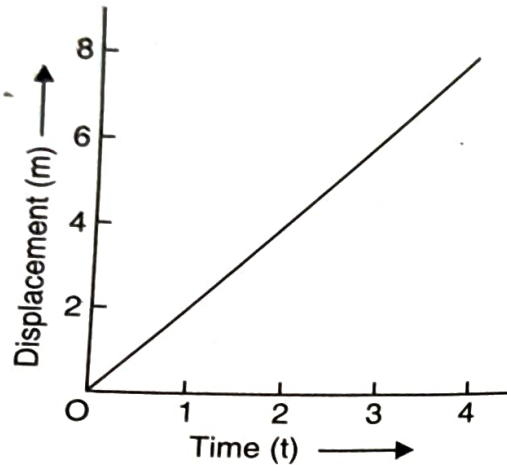
Object moving with uniform acceleration

Q17. Give an example for the motion of an object moving with constant speed but variable velocity.

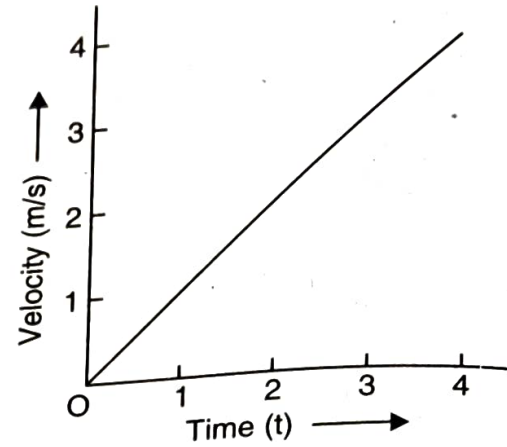
Ans. An object moving with a constant speed on a circular path is an example of motion with variable velocity, because its direction changes continuously at every point of the path.



Q18. Corresponding to the Fig. (a) and (b) draw v-t and x-t graphs respectively.

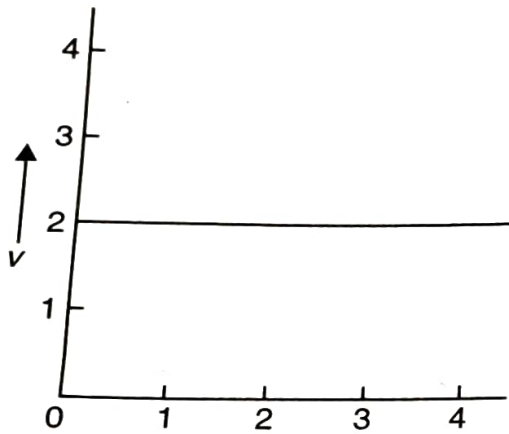


(a)



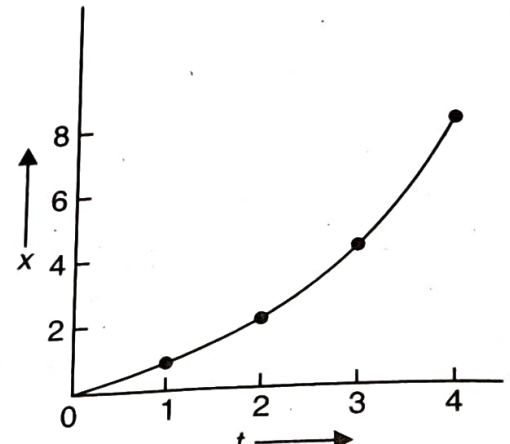
(b)

Ans.



$v-t$ graph

(a)



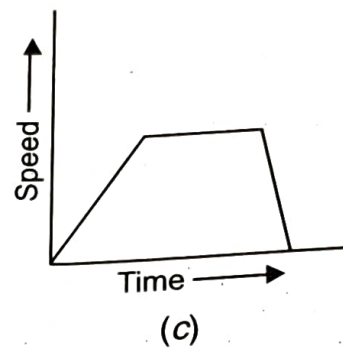
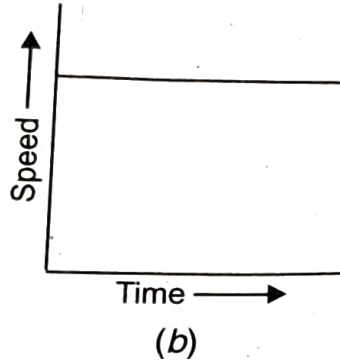
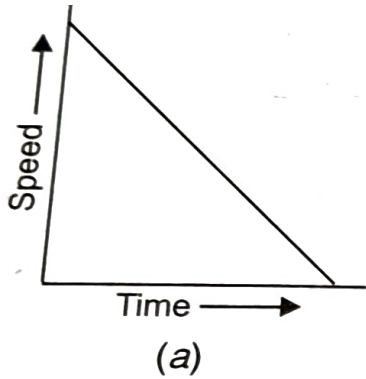
$x-t$ graph

(b)

Q19. The following figures show speed-time graphs for four cases.

1. In which case the speed is (i) constant, (ii) shown increasing, and (iii) decreasing?

2. In which case the functions of parts (i), (ii) and (iii) are shown?



Ans.

1. (i) Constant: Fig. (b)
(ii) Increasing: Fig. (d)
(iii) Decreasing: Fig. (a)
2. Fig. (c)

Q20. Define a scalar and a vector quantity. Give two examples of each.

Ans.

Scalar quantities: Those physical quantities which are completely described by their magnitude only. Examples: length, mass, time, distance, speed, temperature, energy, pressure, work, etc.

Vector quantities: Those physical quantities which are completely described by both magnitude and direction, and which follow the laws of vector addition. Examples:

displacement, velocity, acceleration, force, momentum, torque, etc.

Q21. Define distance and displacement. Mention their SI units.

Ans.

Distance: The total length of the actual path covered by a body during its motion in a given time interval. It is a scalar quantity. Its SI unit is metre (m).

Displacement: The shortest straight-line distance between the final and initial positions of a moving body, directed from the initial to the final position. It is a vector quantity. Its SI unit is metre (m).

Q22. Define speed and mention its SI unit.

Ans. Speed is defined as the distance travelled by an object per unit time interval.

Formula: $\text{Speed (v)} = \frac{\text{Distance}}{\text{(Time interval)}}$

It is a scalar quantity. Its SI unit is metre/second (m/s).

Q23. Which physical quantity is obtained from the slope of (i) x-t graph and (ii) v-t graph? If these graphs are straight lines parallel to the time axis, what do you infer in each case?

Ans.

(i) The slope of an x-t (position-time) graph gives the Speed/Velocity.

(ii) The slope of a v-t (velocity-time) graph gives the

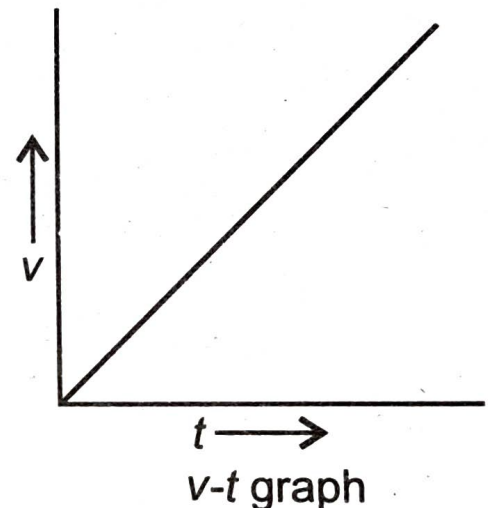
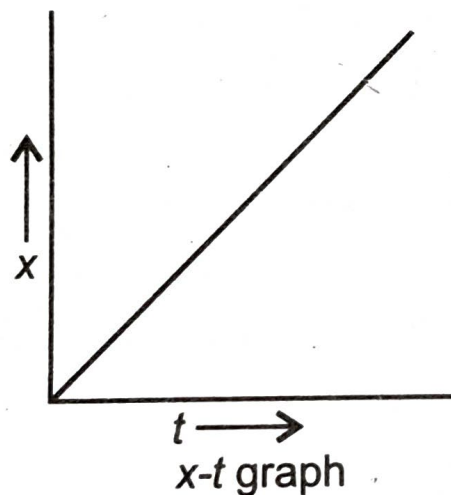
Acceleration.

Inferences when parallel to the time axis:

- An x-t graph parallel to the time axis implies the slope is zero, meaning the object is at rest.
- A v-t graph parallel to the time axis implies the slope is zero, meaning the object is moving with constant velocity (zero acceleration).

Q24. Draw an x-t graph and a v-t graph for an object in uniform motion. What do the slopes represent in each case?

Ans.



- In an x-t graph for uniform motion, the graph is a straight line sloping upwards. Its slope represents constant speed/velocity.
- In a v-t graph for uniform motion, the graph is a straight horizontal line parallel to the time axis. Its slope is zero, representing zero acceleration.

Q25. Differentiate between the scalar and vector quantities, giving two examples of each.

Scalar quantity	Vector quantity
It is a physical quantity that is expressed only by its magnitude.	It is a physical quantity that requires the magnitude as well as the direction to express it, only after which its meaning is complete.
It is a pure number and has no specific directional component. Scalars can be added, subtracted, multiplied and divided by simple arithmetic methods.	The numerical value of a vector quantity along with its unit gives us the magnitude of that quantity. Vectors have a different algebra to perform basic addition, subtraction, multiplication and division.
Example: mass of a body is 5 kg, distance is 5 km.	Example: velocity, displacement, force.

Q26. State whether the following quantity is a scalar or vector?

(a) Pressure (b) Force (c) Momentum (d) Energy (e) Weight (f) Speed

Scalar quantity	Vector quantity
Pressure	Force
Energy	Momentum
Speed	Weight

Q27. Distinguish between speed and velocity.

Ans.

Speed	Velocity
--------------	-----------------

It is the distance travelled by a moving body per unit time.	It is the displacement of a moving body per unit time.
It is a scalar quantity.	It is a vector quantity.
It is always positive, since direction is not taken into account.	It can be positive or negative depending upon the direction of motion.
After one round in a circular track, the average speed is not zero.	After one round in a circular track, the average velocity is zero.

Q28. Distinguish between distance and displacement.

Ans.

Distance	Displacement
It is a scalar quantity.	It is a vector quantity.
It is always positive.	It can be negative, zero or positive.
It is the length of the actual path covered by the body during its motion in a given interval of time.	It is the shortest distance between the initial and final positions.
It cannot decrease with time and is	It can never be greater than

never zero for a moving body.	distance. In uniform motion, displacement is equal to distance.
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Q29. Differentiate between uniform acceleration and variable acceleration.

Ans.

Uniform acceleration	Variable acceleration
<p>If an equal change in velocity takes place in equal intervals of time, the acceleration is said to be uniform or constant, however small these intervals may be, e.g. the motion of a body under gravity like the free fall of a body.</p> <p>In uniform acceleration, the velocity changes with a uniform rate.</p>	<p>If the change in velocity is not same in equal intervals of time or same in unequal intervals of time, the acceleration is said to be variable, e.g. the motion of a car on a crowded road.</p>

Q30. Distinguish between uniform velocity and variable velocity.

Uniform velocity	Variable velocity
<p>If a body travels equal distances in a particular direction, in equal intervals of time, the body is said to</p>	<p>If a body moves unequal distances in a particular direction in equal intervals of time, or it moves equal distances in equal intervals</p>

be moving with a uniform velocity.	of time, but its direction of motion does not remain the same, then the velocity of the body is said to be variable.
Example: Motion of a body under gravity (free fall of a body).	Example: Motion of a vehicle on a hilly road / circular path.

Q31. Distinguish between average speed and average velocity.

Average speed	Average velocity
It is the ratio of the total distance covered by the body to the total time of journey.	It is the ratio of displacement to the total time taken.
Average speed can never be zero.	It can be zero, even if average speed is a non-zero value.

Q32. Distinguish between acceleration and retardation.

Acceleration	Retardation
It is the increase in velocity per second.	It is the decrease in the velocity per second.
If the final velocity is greater than initial velocity, acceleration is positive.	If the final velocity is lesser than initial velocity, acceleration becomes negative, hence it is the retardation.

Q33. Differentiate between uniform acceleration and variable acceleration.

Uniform Acceleration	Variable acceleration
Here, equal changes in velocity occur in equal intervals of time.	If change in velocity is not the same in the same intervals of time, then it is variable acceleration.

Q34. Which of the quantity, velocity or acceleration determines the direction of motion?

Solution:

Velocity determines the direction of motion. The acceleration of the body does not determine its direction of motion while velocity determines its direction of motion. Positive or negative sign of acceleration indicates if the velocity is increasing or decreasing whereas positive or negative sign of velocity indicates the direction of motion.

Q35. Give one example of each type of the following motion:

- (a) Uniform velocity**
- (b) Variable velocity**
- (c) Variable acceleration**
- (d) Uniform retardation**

Solution:

- (a) Uniform velocity - Rain drops reach the earth's surface falling with uniform velocity
- (b) Variable velocity - Motion of a body in a circular path
- (c) Variable acceleration - Motion of a vehicle on a crowded road
- (d) Uniform retardation - A train reaching a station

Q36. 'The value of g remains same at all places on the earth surface'. Is this statement true? Give reason for your answer.

Solution:

No, the value of ' g ' is not the same at all places. The average value of ' g ' is 9.8 m/s^2 and varies from place to place. The value of ' g ' is minimum at the equator on the surface of the earth and the maximum at the poles.

Q37. If a stone and a pencil are dropped simultaneously in vacuum from the top of a tower, which of the two will reach the ground first? Give reason.

Solution:

In vacuum, there is no resistance from the viscous force of air hence both the objects i.e., the pencil and the stone will reach the ground at the same time from the top of the tower as the value of acceleration due to gravity ' g ', is the same on both the objects.

Q33. What do you understand by the term acceleration due to gravity? How does the acceleration due to gravity change (i) from equator to poles (ii) above the surface of the earth and (iii) below the surface of the earth?

Ans. When a body falls freely, its velocity increases constantly with time. Thus, the acceleration due to gravity is the acceleration of a freely falling object under the action of gravity of earth. It is represented by g . Its SI unit is m/s^2 . Its value changes from place to place.

- (i) From equator to poles:** Its value increases.
- (ii) Above the surface of the earth:** Its value decreases.
- (iii) Below the surface of the earth:** Its value decreases.

Q34. Obtain the equations of motion of a body moving with uniform acceleration.

Ans. Consider an object starting with initial velocity u and moving with a uniform acceleration a such that after time t it attains a velocity v and during time t its displacement is s .

1. To obtain $v = u + at$:

We know that:

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

$$a = \frac{(v - u)}{t}$$

$$a \times t = v - u$$

$$v = u + at$$

2. To obtain $s = ut + \frac{1}{2}at^2$:

We know that average velocity $= \frac{(u+v)}{2}$

$$s = \text{average velocity} * \text{time} = \left[\frac{(u+v)}{2} \right] \times t$$

Substituting $v = u + at$:

$$s = \left[\frac{(u+u+at)}{2} \right] \times t$$

$$s = \left[\frac{(2u+at)}{2} \right] \times t$$

$$s = \left(u + \frac{1}{2}at\right) \times t$$

$$s = ut + \frac{1}{2}at^2$$

3. To obtain $v^2 = u^2 + 2as$:

We know that $v = u + at$

Squaring both sides:

$$(v)^2 = (u + at)^2$$

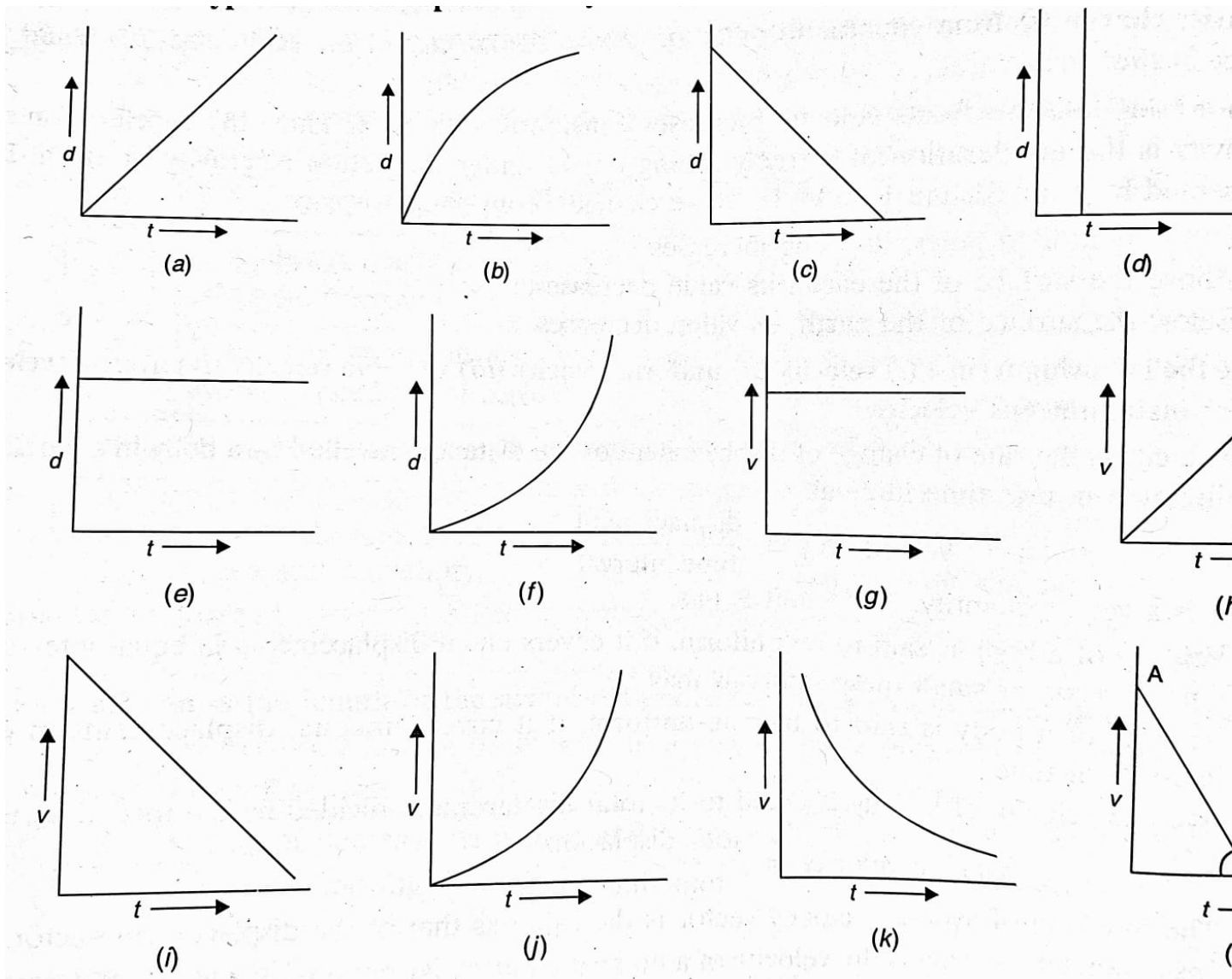
$$v^2 = u^2 + 2uat + a^2t^2$$

$$v^2 = u^2 + 2a\left(ut + \frac{1}{2}at^2\right)$$

Since $s = ut + \frac{1}{2}at^2$:

$$v^2 = u^2 + 2as$$

Q36. State the type of motion represented by the following sketches:



(a) d-t graph: Object is in motion with uniform velocity.

(b) d-t graph: Object is in motion with decreasing velocity.

(c) d-t graph: Object is in motion with negative velocity (i.e. the object is moving in opposite direction or towards initial position).

- (d) d-t graph: The displacement of the object is increasing in a certain direction without any increase in time, i.e. velocity is infinite.
- (e) d-t graph: Object is at rest.
- (f) d-t graph: Uniformly accelerated motion.
- (g) v-t graph for a uniform motion or motion with a constant but non-zero velocity.
- (h) v-t graph for an object moving with uniform acceleration with zero initial velocity.
- (i) v-t graph for an object moving with uniform retardation.
- (j) v-t graph for an object moving with a changing or non-uniform acceleration.
- (k) v-t graph for an object moving with a changing or non-uniform retardation.
- (l) The part AO represents that object is in motion with uniform retardation and the part OB represents motion of the object with uniform acceleration.

PART – C (NUMERICALS)

Chapter 1: Measurements and Experimentation

Q1. Calculate the length of a second's pendulum at a place where acceleration due to gravity is 9.8 m/s^2 .

Sol. Given: $T = 2 \text{ s}$, $g = 9.8 \text{ m/s}^2$, $l = ?$

We know that:

$$l = \frac{gT^2}{4\pi^2} = \frac{9.8 \text{ m/s}^2 \times (2\text{s})^2}{(4 \times (22/7)^2)} = 0.992 \text{ m}$$

Q2. Compare the time periods of two pendulums of length 9 m and 1 m.

Sol. Given: $l_1 = 9 \text{ m}$, $l_2 = 1 \text{ m}$

We know that $T \propto \sqrt{l}$

$$\frac{T_1}{T_2} = \sqrt{\frac{l_1}{l_2}} = \sqrt{\frac{9\text{m}}{1\text{m}}} = \frac{3}{1}$$

$$T_1 : T_2 = 3 : 1$$

Q3. How many protons would make 1 g if the mass of a proton is $1.67 \times 10^{-27} \text{ kg}$?

Sol. Number of protons in 1 g = total mass / mass of one proton

$$= \frac{(1 \text{ g})}{(1.67 \times 10^{-27} \text{ kg})} = \frac{(1 \text{ g})}{(1.67 \times 10^{-27} \times 10^3 \text{ g})} = 5.99 \times 10^{23}$$

Q4. Express 0.01 mm in fermi.

Sol. We know that $1 \text{ f} = 10^{-15} \text{ m}$ or $1 \text{ m} = 10^{15} \text{ f}$
 $0.01 \text{ mm} = 0.01 \times 10^{-3} \text{ m} = 1 \times 10^{-5} \text{ m} = 10^{10} \text{ f}$

Q5. How many electrons would make 1 kg if the mass of an electron is $9.1 \times 10^{-31} \text{ kg}$?

Sol. The number of electrons in 1 kg = $\frac{\text{total mass}}{\text{mass of one electron}} =$
 $\frac{1 \text{ kg}}{(9.1 \times 10^{-31} \text{ kg})} = 1.1 \times 10^{30}$

Q6. How much longer is a millimetre (mm) than a nanometre (nm)?

Sol. $1 \text{ mm} = 10^{-3} \text{ m}$, $1 \text{ nm} = 10^{-9} \text{ m}$
Ratio of 1 mm to 1 nm = $10^{-3} \text{ m} / 10^{-9} \text{ m} = 10^6$

Q7. Calculate the quintals in a gigagram.

Sol. $1 \text{ q} = 100 \text{ kg}$; $1 \text{ Gg} = 10^9 \text{ g} = 10^6 \text{ kg}$
Quintals in a gigagram = $1 \text{ Gg} / 1 \text{ q} = 10^6 \text{ kg} / 10^2 \text{ kg} = 10^4$

Q8. Calculate the number of seconds in 365 days.

Sol. Number of seconds in 365 days = $365 \times 86400 \text{ s} = 31536000 \text{ s} = 3.15 \times 10^7 \text{ s}$

[since 1 day = 86400 s]

Q9. Find the time period of a simple pendulum of length 90 cm at a place where $g = 10 \text{ m/s}^2$. Take $\pi = 3.142$.

Sol. Given: $l = 90 \text{ cm} = 0.9 \text{ m}$, $g = 10 \text{ m/s}^2$, $T = ?$

We know that $T = 2\pi \sqrt{\frac{l}{g}} = 2 \times 3.142 \times \sqrt{\frac{0.9\text{m}}{10\text{m/s}^2}} = 1.8852 \text{ s} \Rightarrow T \approx 1.9 \text{ s}$

Q10. A second's pendulum is taken to a planet where the acceleration due to gravity is 4 times that on the earth. What would be the time period of the pendulum on the planet?

Sol. Given: $g_1 = g$, $g_2 = 4g$, $T_1 = 2 \text{ s}$, $T_2 = ?$

We know that $T \propto \sqrt{\frac{1}{g}}$ (since $T = 2\pi \sqrt{\frac{l}{g}}$)

$$\frac{T_2}{T_1} = \sqrt{\frac{g_1}{g_2}} \Rightarrow \frac{T_2}{2} = \sqrt{\frac{g}{4g}} = 1/2$$

$$T_2 = 2 \times 1/2 = 1 \text{ s}$$

Q11. Find the length of a simple pendulum whose time period of oscillation is 1.8 s at a place where $g = 9.8 \text{ m/s}^2$.

Sol. Given: $T = 1.8 \text{ s}$, $g = 9.8 \text{ m/s}^2$, $l = ?$

We know that $T = 2\pi \sqrt{\frac{l}{g}}$

$$l = \frac{gT^2}{4\pi^2} = \frac{9.8 \text{ m/s}^2 \times (1.8\text{s})^2}{(4 \times (3.14))^2} = 0.8 \text{ m}$$

Q12. Find the length of a simple pendulum which completes 6 oscillations in 15 s. Take $g = 9.8 \text{ m/s}^2$ and $\pi = 3.14$.

Sol. Given: $g = 9.8 \text{ m/s}^2$, $T = 15 \text{ s} / 6 = 2.5 \text{ s}$, $l = ?$

$$l = \frac{gT^2}{4\pi^2} = \frac{9.8 \text{ m/s}^2 \times (2.5\text{s})^2}{(4 \times (3.14))^2} = 1.55 \text{ m}$$

Q13. The mass of the earth is $5.98 \times 10^{24} \text{ kg}$. Calculate the number of atoms in the earth, if average mass of the atoms of earth is 40 u.

Sol. Given: mass of earth = $5.98 \times 10^{24} \text{ kg}$

Average mass of the atom of earth = $40 \text{ u} = 40 \times 1.66 \times 10^{-27} \text{ kg}$
 $= 66.4 \times 10^{-27} \text{ kg}$

Number of atoms in the earth

$$= \frac{\text{mass of the earth}}{\text{average mass of the atom of the earth}} = \frac{(5.98 \times 10^{24} \text{ kg})}{(66.4 \times 10^{-27} \text{ kg})} = 9.0 \times 10^{49}$$

Q14. A second's pendulum was designed on a day when the room temperature was 22°C. On a hot summer day when the temperature rose to 50°C, the length of the pendulum increased by a fraction (1/10). What would be the period of the second's pendulum on that day? What will be the effect on the time of a clock having that pendulum on that day?

Sol. Given: $l_1 = 100 \text{ cm}$, $l_2 = 100 + 1/10 = 100.1 \text{ cm}$, $T_1 = 2 \text{ s}$, $T_2 = ?$

We know that $T \propto \sqrt{l}$

$$\frac{T_1}{T_2} = \frac{\sqrt{l_1}}{\sqrt{l_2}} = \frac{\sqrt{9m}}{\sqrt{1m}} = \frac{3}{1}$$

$$\Rightarrow T_2 = T_1 \times \sqrt{\frac{l_2}{l_1}} = 2\text{s} \times \sqrt{\frac{100.1\text{cm}}{100\text{cm}}} = 2.001 \text{ s}$$

The clock having such a pendulum will lose time as it is taking longer time to complete one oscillation.

Q15. The length of a pendulum is decreased by 10%. What effect does it have on the oscillation frequency of the pendulum?

Sol. Given: $l_1 = 1$, $l_2 = 1 - 10\% \text{ of } 1 = 0.9l$, $v_1 = v$, $v_2 = ?$

From frequency relation: $v = \frac{1}{2\pi} \times \sqrt{\frac{g}{l}} \Rightarrow v \propto \frac{1}{\sqrt{l}}$

$$\frac{v_1}{v_2} = \frac{\sqrt{l_2}}{\sqrt{l_1}} = \sqrt{\frac{0.9l}{1}} \Rightarrow v_2 = v / \sqrt{0.9} = 1.054v$$

Change in frequency $v_2 - v_1 = 1.054v - v = 0.054v$

$$\text{Percentage change in frequency} = \frac{v_2 - v_1}{v_1} \times 100 = \frac{0.054v}{v} \times 100 = 5.4\%$$

Chapter 2: Motion in one dimension

Q1. Calculate the acceleration of the car starting from rest which attains a velocity of 30 m/s in 0.05 h.

Sol. Given:

Initial velocity (u) = 0

Final velocity (v) = 30 m/s

Time (t) = 0.05 h = 0.05×3600 s = 180 s

Acceleration (a) = ?

Using the first equation of motion:

$$v = u + at$$

$$30 = 0 + a \times 180$$

$$a = \frac{30}{180} = 1/6 \text{ m/s}^2 \approx 0.167 \text{ m/s}^2$$

Q2. Everyone blinks. The lids move to close the eyes for a moment and move back to open them. If the radius of the eyeball is about 1 cm and the lids move about double the

radius of the eyeball, estimate the speed with which we blink our eyes, if the time for 50 blinks is $16\frac{2}{3}$ s.

Sol. Given:

Distance covered by lids in one blink (s) = $2 \times \text{radius} = 2 \times 1 \text{ cm}$
= 2 cm

Total time for 50 blinks = $16\frac{2}{3} \text{ s} = \frac{50}{3} \text{ s}$

Time for one blink (t) = $\frac{50}{3} \div 50 = \frac{1}{3} \text{ s}$

Speed (v) = $\frac{s}{t} = \frac{2\text{cm}}{1/3\text{s}} = 6 \text{ cm/s}$

Q3. A train takes 3 h to travel from Mathura to Delhi with a uniform speed of 70 km/h. Find the distance between the two cities.

Sol. Given:

Speed (v) = 70 km/h

Time (t) = 3 h

Distance (s) = ?

Formula: $s = v \times t = 70 \text{ km/h} \times 3 \text{ h} = 210 \text{ km}$

Q4. A car moving on a straight path covers a distance of 2 km due east in 100 s. What is the speed of the car? What is its velocity?

Sol. Given:

Distance or Displacement (s) = 2 km = 2000 m

Time (t) = 100 s

$$\text{Speed} = \frac{\text{distance}}{\text{time}} = \frac{2000\text{m}}{100\text{s}} = 20 \text{ m/s}$$

Velocity = 20 m/s due east (since direction is specified).

Q5. In a hare-tortoise race, the hare ran for 2 min at a speed of 7.5 km/h, slept for 56 min and again ran for 2 min at a speed of 7.5 km/h. Find the average speed of the hare in the race.

Sol. Given:

$$\text{Phase 1: run time} = 2 \text{ min} = \frac{2}{60}\text{h}, \text{ speed} = 7.5 \text{ km/h} \rightarrow \text{distance} = 7.5 \times \frac{2}{60} = 0.25 \text{ km}$$

$$\text{Phase 2: sleep time} = 56 \text{ min}, \text{ speed} = 0 \rightarrow \text{distance} = 0 \text{ km}$$

$$\text{Phase 3: run time} = 2 \text{ min} = \frac{2}{60} \text{ h}, \text{ speed} = 7.5 \text{ km/h} \rightarrow \text{distance} = 7.5 \times \frac{2}{60} = 0.25 \text{ km}$$

$$\text{Total distance covered} = 0.25 \text{ km} + 0 + 0.25 \text{ km} = 0.5 \text{ km}$$

$$\text{Total time taken} = 2 \text{ min} + 56 \text{ min} + 2 \text{ min} = 60 \text{ min} = 1 \text{ h}$$

$$\text{Average speed} = \frac{\text{total distance covered}}{\text{total time taken}} = \frac{0.5\text{km}}{1\text{h}} = 0.5 \text{ km/h}$$

Q6. A train passed the 100 km, 160 km and 220 km marks at 8:30 am, 9:30 am and 11:30 am. Find the average speed of the bus/train during:

(i) 8:30 am to 9:30 am, (ii) 9:30 am to 11:30 am, and (iii) 8:30 am to 11:30 am.

Sol. Formula: Average speed = $\frac{\text{total distance covered}}{\text{total time taken}}$

(i) From 8:30 am to 9:30 am:

Distance = 160 km - 100 km = 60 km; Time = 1 h

$$\text{Average speed} = \frac{60\text{km}}{1\text{h}} = 60 \text{ km/h}$$

(ii) From 9:30 am to 11:30 am:

Distance = 220 km - 160 km = 60 km; Time = 2 h

$$\text{Average speed} = \frac{60\text{km}}{2\text{h}} = 30 \text{ km/h}$$

(iii) From 8:30 am to 11:30 am:

Distance = 220 km - 100 km = 120 km; Time = 3 h

$$\text{Average speed} = \frac{120\text{km}}{3\text{h}} = 40 \text{ km/h}$$

Q7. A body is dropped from the top of a tower. It acquires a velocity of 20 m/s on reaching the ground. Calculate the height of the tower. (Take $g = 10 \text{ m/s}^2$)

Sol. According to the cartesian sign convention:

Initial velocity (u) = 0

Final velocity (v) = -20 m/s (downward)

Acceleration due to gravity (g) = -10 m/s^2 (downward)

Using the third equation of motion:

$$v^2 = u^2 + 2gh$$

$$(-20)^2 = 0^2 + 2(-10)h$$

$$400 = -20h$$

$$h = -20 \text{ m}$$

The negative sign indicates downward displacement. Therefore, the physical height of the tower is 20 m.

Q8. A steel sphere is held by an electromagnet and when the current is switched off, it sets 'on' a stroboscopic photography timing set up. It is found that the steel sphere starting from rest, takes 450 ms to fall through 1 m. What value does this give for the acceleration due to gravity? How far does the sphere fall in the first 200 ms?

Sol. Part 1: Finding acceleration due to gravity (g)

Given:

$$\text{Initial velocity (u)} = 0$$

$$\text{Displacement (h)} = -1 \text{ m}$$

$$\text{Time (t)} = 450 \text{ ms} = 0.450 \text{ s}$$

Using $h = ut + \frac{1}{2}gt^2$:

$$-1 = 0 \times 0.450 + \frac{1}{2} \times g \times (0.450)^2$$

$$-1 = \frac{1}{2} \times g \times 0.2025$$

$$g = -2 / 0.2025 = -9.876 \text{ m/s}^2$$

Therefore, the value of acceleration due to gravity is 9.876 m/s^2 .

Part 2: Distance fallen in the first 200 ms

Given:

$$u = 0, t = 200 \text{ ms} = 0.200 \text{ s}, g = -9.876 \text{ m/s}^2$$

Using $h = ut + \frac{1}{2}gt^2$:

$$h = 0 \times 0.200 + \frac{1}{2} \times (-9.876) \times (0.200)^2$$

$$h = \frac{1}{2} \times (-9.876) \times 0.040$$

$$h = -0.1975 \text{ m}$$

Thus, the distance fallen by the sphere in the first 200 ms is 0.1975 m (or 19.75 cm).

Q9. A train takes 2h to reach station B from station A, and then 3 h to return from station B to station A. The distance between the two stations is 200km. Find:

(i) The average speed

(ii) The average velocity of the train

Solution:

Given: Distance = 200 km

Time taken to travel from A to B (t_1) = 2 h

Time taken to travel back from B to A (t_2) = 3 h

Total time = $t_1 + t_2 = 2 + 3 = 5$ h

Total distance travelled = 200 km + 200 km = 400 km

$$(i) \text{ Average speed} = \frac{\text{total distance covered}}{\text{total time taken}} = \frac{400\text{km}}{5\text{h}} = 80 \text{ km/h}$$

(ii) As the train travels from Station A to station B and back to A, the net displacement is zero. Hence, the average velocity is also zero.

Q10. A car moving on a straight path covers a distance of 1km due east in 100s. What is (i) the speed and (ii) the velocity of car?

Solution:

Given: distance (d) = 1 km = 1000 m, time (t) = 100 s

$$(i) \text{ Speed} = \frac{\text{distance}}{\text{time}} = \frac{1000\text{m}}{100\text{s}} = 10 \text{ m/s}$$

(ii) The velocity of the car has the same magnitude as speed but includes direction, hence velocity = 10 m/s due east.

Q11. A body starts from rest and acquires a velocity 10 m/s in 2s. Find its acceleration.

Solution:

Given: Initial velocity (u) = 0 m/s, Final velocity (v) = 10 m/s, time (t) = 2 s

$$\text{Acceleration} = \frac{(v - u)}{t} = \frac{10}{2} = 5 \text{ m/s}^2$$

Q12. A car starting from rest acquires a velocity 180 m/s in 0.05h. Find the acceleration.

Solution:

Given: Initial velocity (u) = 0 m/s, Final velocity (v) = 180 m/s
time (t) = 0.05 h = 0.05 x 60 x 60 = 180 s

$$\text{Acceleration} = \frac{(v - u)}{t} = \frac{180}{180} = 1 \text{ m/s}^2$$

Q13. A body is moving vertically upwards. Its velocity changes at a constant rate from 50 m/s to 20 m/s in 3s. What is its acceleration?

Solution:

Given: $u = 50 \text{ m/s}$, $v = 20 \text{ m/s}$, $t = 3 \text{ s}$

$$\text{Acceleration} = \frac{(v - u)}{t} = \frac{20 - 50}{3} = \frac{-30}{3} = -10 \text{ m/s}^2$$

The negative sign indicates velocity decreases with time, hence retardation is 10 m/s^2 .

Q14. A toy car initially moving with a uniform velocity of 18 km/h comes to a stop in 2s. Find the retardation of the car in S.I units.

Solution:

Given: $u = 18 \text{ km/h} = 18 \times \frac{1000}{3600} = 5 \text{ m/s}$, $v = 0$, $t = 2 \text{ s}$

$$\text{Acceleration} = \frac{(v - u)}{t} = \frac{0 - 5}{2} = -2.5 \text{ m/s}^2$$

Hence, retardation is 2.5 m/s^2 .

Q15. A car accelerates at a rate of 5 m/s². Find the increase in its velocity in 2s.

Solution:

Given: $a = 5 \text{ m/s}^2$, $t = 2 \text{ s}$

Increase in velocity = acceleration x time = $5 \times 2 = 10 \text{ m/s}$.

Q16. A car is moving with a velocity 20 m/s. The brakes are applied to retard it at a rate of 2 m/s². What will be the velocity after 5s of applying the brakes?

Solution:

Given: $u = 20 \text{ m/s}$, retardation = $2 \text{ m/s}^2 \Rightarrow a = -2 \text{ m/s}^2$, $t = 5 \text{ s}$

Using $v = u + at$:

$$v = 20 + (-2) \times 5 = 20 - 10 = 10 \text{ m/s}.$$

Q17. A bicycle initially moving with a velocity 5 m/s accelerates for 5s at a rate of 2 m/s². What will be its final velocity?

Solution:

Given: $u = 5 \text{ m/s}$, $t = 5 \text{ s}$, $a = 2 \text{ m/s}^2$

Using $v = u + at$:

$$v = 5 + 2 \times 5 = 5 + 10 = 15 \text{ m/s.}$$

Q18. A car is moving in a straight line with speed 18 km/h. It is stopped in 5s by applying the brakes. Find: (i) the speed of car in m/s, (ii) the retardation and (iii) the speed of car after 2s of applying the brakes.

Solution:

Given: $u = 18 \text{ km/h} = 5 \text{ m/s}$, $t = 5 \text{ s}$, $v = 0$

(i) Speed in m/s = 5 m/s

(ii) Acceleration = $\frac{(v - u)}{t} = \frac{0 - 5}{5} = -1 \text{ m/s}^2 \Rightarrow$ Retardation = 1 m/s²

(iii) Speed after $t = 2 \text{ s}$:

$$v = u + at = 5 + (-1) \times 2 = 3 \text{ m/s.}$$

Q19. A body starts from rest with a uniform acceleration of 2 m/s². Find the distance covered by the body in 2s.

Solution:

Given: $u = 0$, $a = 2 \text{ m/s}^2$, $t = 2 \text{ s}$

$$v = u + at = 0 + 2 \times 2 = 4 \text{ m/s}$$

$$\text{Distance (s)} = ut + 0.5 \times a \times t^2 = 0 + 0.5 \times 2 \times (2)^2 = 4 \text{ m.}$$

Q20. A body starts with an initial velocity of 10 m/s and acceleration 5 m/s². Find the distance covered by it in 5s.

Solution:

Given: $u = 10 \text{ m/s}$, $a = 5 \text{ m/s}^2$, $t = 5 \text{ s}$

$$s = ut + 0.5 \times a \times t^2 = 10 \times 5 + 0.5 \times 5 \times (5)^2 = 50 + 62.5 = 112.5 \text{ m.}$$

Q21. A vehicle is accelerating on a straight road. Its velocity at any instant is 30 km/h, after 2s, it is 33.6 km/h and after further 2s, it is 37.2 km/h. Find the acceleration of vehicle in m/s². Is the acceleration uniform?

Solution:

Case 1: Change in velocity in first 2s = $33.6 - 30 = 3.6 \text{ km/h}$

$$\text{Acceleration} = \frac{3.6 \text{ km/h}}{2 \text{ s}} = 1.8 \text{ km/h}^2 = \frac{1.8 \times 1000}{3600 \times 3600} \Rightarrow \text{Let's}$$

convert km/h to m/s first:

$$3.6 \text{ km/h} = 3.6 \times \frac{5}{18} = 1 \text{ m/s.}$$

$$\text{Acceleration} = \frac{1 \text{ m/s}}{2 \text{ s}} = 0.5 \text{ m/s}^2.$$

Case 2: Change in velocity in next 2s = $37.2 - 33.6 = 3.6 \text{ km/h} = 1 \text{ m/s}$.

$$\text{Acceleration} = \frac{1 \text{ m/s}}{2 \text{ s}} = 0.5 \text{ m/s}^2.$$

Since the acceleration is identical in both cases, the acceleration is uniform at 0.5 m/s^2 .