Unit 2: Kinematics

Textbook Exercise Questions

2.1 Encircle the correct answer from the given choices.

i. A body has translatory motion if it moves along a:

(a) Straight line **(b)** circle

(c) line without rotation ✓ **(d)** Curved path

ii. The motion of a body around an axis is called _____ motion. (LHR 2015)

(a) Circular **(b) Rotatory ✓**

(c) Vibratory **(d)** Random

iii. Which of the following is a vector quantity?

(a) Speed **(b)** distance

(c) Displacement ✓ **(d)** power

iv. If an object is moving with constant speed then its distance-time graph will be a straight line.

(a) Along time-axis **(b)** Along distance-axis

(c) Parallel to time-axis **(d) Inclined to time-axis ✓**

v. A straight line parallel to time-axis on a distance-time graph tells that the object is:

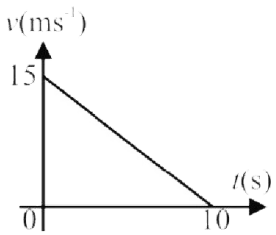
(a) Moving with constant speed **(b) At rest ✓**

(c) Moving with variable speed **(d)** In motion

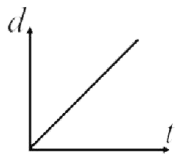
vi. The speed-time graph of a car is shown in the figure, which of the following statement is true?

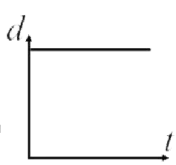
(a) Car has an acceleration of 1.5 ms^{-2} **(b)** Car has constant speed of 7.5ms^{-1}

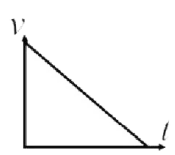
(c) Distance travelled by the car is 75 m✓ **(d)** Average speed of the car is 15 ms^{-1}



vii. Which of the following graphs is representing uniform acceleration? (LHR 2015)

(a)  **✓**

(b) 

(c) 

(d) 

viii. By dividing displacement of a moving body with time, we obtain:

(a) Speed **(b)** Acceleration

(c) Velocity ✓ **(d)** Deceleration

ix. A ball is thrown vertically upward. It velocity at the highest point is:

(a) -10 ms^{-2} **(b) Zero✓**

(c) 10 ms^{-2} **(d)** None of these

x. A change in position is called: (GRW 2015)

(a) Speed **(b)** Velocity

(c) Displacement✓ **(d)** Distance

xi. A train is moving at a speed of 36kmh^{-1}. Its speed expressed in ms^{-1} is: (GRW 2015)

(a) 10 ms^{-1}✓ **(b)** 20 ms^{-1}

(c) 25 ms^{-1} **(d)** 30 ms^{-1}

xii. A car starts from rest. It acquires a speed of 25 ms^{-1} after 20 s. the distance moved by the car during this time is:

(a) 31. 25 m **(b) 250 m✓**

(c) 500 m **(d)** 5000 m

2.2 Explain translatory motion and give examples of various types of translatory motion.

Ans: Such type of motion in which a body moves along a line without any rotation. The line may be straight or curved.

(i) Linear motion

- The motion of freely falling bodies
- A car moving along the straight line

(ii) Circular motion

- A stone attached with thread, when whirled, it will move along a circular path.
- A toy train moving on a circular track.

(iii) Random motion

- The flight of an insect and birds
- Motion of dust or smoke particles in air

2.3 Differentiate between the following:

(i) Rest and motion

(ii) Circular motion and rotatory motion

(iii) Distance and displacement (GRW 2014)

(iv) Speed and velocity (LHR 2013, 2015)

(v) Scalars and vectors (GRW 2013, LHR 2014, 2015)

(i) Difference between Rest and Motion

REST	MOTION
If a body does not change its position with respect to surroundings then it is said to be in a state of rest.	If a body continuously changes its position with respect to surroundings then it is said to be in a state of motion.

(ii) Circular motion and rotatory motion.

CIRCULAR MOTION	ROTATORY MOTION
The motion of an object in a circular path is known as circular motion. **Examples:** • The motion of earth around the sun. • The motion of electron around nucleus.	The spinning motion of a body about its axis is called rotatory motion. **Examples:** • The motion of wheel about its axis. • Motion of ceiling fan.

(iii) Difference between Distance and Displacement.

DISTANCE	DISPLACEMENT
• Actual (total) length between two points is known as distance. • It is a scalar quantity. • It is represented by "S".	• The shortest distance between two points is known as displacement. • It is a vector quantity. • It is represented by "$\vec{d}$".

(iv) Difference between Speed and Velocity

SPEED	VELOCITY
• The distance covered in unit time is known as speed. • Mathematically speed is given by Speed = distance/time $v = \frac{S}{t}$ • It is a scalar quantity.	• The rate of displacement of a body is called velocity. • Mathematically velocity is given by Velocity = displacement/time $\vec{v} = \frac{\vec{d}}{t}$ • It is a vector quantity.

(v) Difference between scalar and vector.

SCALAR	VECTOR
Physical quantities which are completely described by their magnitude only are known as scalars. **Example** Speed, distance, time etc.	Physical quantities which are completely described by their magnitude and direction as well are known as vectors. **Example** Force, displacement, velocity etc.

2.4 Define the terms speed, velocity, and acceleration. (GRW 2013, LHR 2015)

Ans: **Speed**

The distance covered by an object in unit time is called its speed.

Mathematical Formula

$$\text{Speed} = \frac{\text{Distance covered}}{\text{Total time}}$$

$$v = \frac{S}{t}$$

Distance = speed x time

Or $S = v \times t$

Velocity

The rate of displacement of a body is called velocity.

Mathematical form

$$\text{velocity} = \frac{\text{displacement}}{\text{time taken}}$$

$$\vec{v} = \frac{\vec{d}}{t}$$

Here $\vec{d}$ is the displacement of the body moving with velocity $\vec{v}$ in time t.

Acceleration

The rate of change of velocity of a body is known as acceleration.

Mathematical form

If a body is moving with initial velocity '$\mathbf{v_i}$' and after some time 't' its velocity becomes '$\mathbf{v_f}$' then change in velocity will occur in time t.

$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{total time}}$$

$$\text{Acceleration} = \frac{\text{final velocity} - \text{initial velocity}}{\text{total time}}$$

So $$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{t}$$

2.5 Can a body moving at a constant speed have acceleration? (LHR 2014)

Ans: A body moving with constant speed can have acceleration if its direction of motion changes continuously. For example a body moving with constant speed in a circular path has an acceleration.

2.6 How do riders in a Ferris wheel possess translatory motion but not circular motion?

Ans: Riders in a Ferris wheel move in a circle without rotation therefore motion of rider in Ferris wheel is translatory not rotatory.

2.7 Sketch a distance – time graph for a body starting from rest. How will you determine the speed of a body from this graph?

Ans: The distance-time graph is shown below

The slope of the graph gives speed with the help of the formula

Speed (v) of the object = slope of line AB

$$= \frac{\text{distance EF}}{\text{time CD}}$$

$$= \frac{20\text{m}}{10\text{s}}$$

$$= 2\ \text{ms}^{-1}$$

The speed found from the graph is 2 ms^{-1}

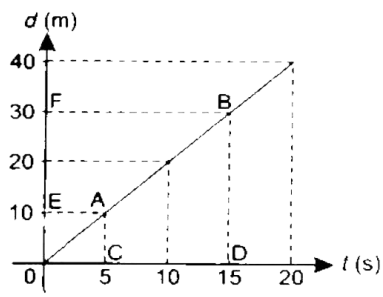


Figure 2.19: Distance-time graph showing constant speed.

2.8 What would be the shape of speed – time graph of a body moving with variable speed? (LHR 2013, 2014, 2015)

Ans: Lines OA and OB shows that body is moving with variable speed. Line OA shows that speed of body changes equally in equal intervals of time. Line OB shows that speed of body changes unequally in a equal intervals of time.

2.9 Which of the following can be obtained from speed – time graph of a body?

Ans: All the given quantities can be obtained form speed-time graph.

2.10 How can vector quantities be represented graphically? (LHR 2014, GRW 2014)

Ans: To represent a vector quantity graphically we draw a line known as represented line. The length of the line drawn is according to some selected scale give the magnitude of vector and an arrow on one end of this line shows the direction of vector.

2.11 Why vector quantities cannot be added and subtracted like scalar quantities?

Ans: Scalar quantities can be described completely by magnitude only and can be added or subtracted by simple arithmetic rules. Vector quantities in addition to magnitude also need direction for their description. So vectors cannot be added or subtracted by arithmetic rules due to direction.

2.12 How are vector quantities important to us in our daily life?

Ans: In order to locate a place from a reference point, we will have to describe the distance and direction of that place from reference point. Description of distance along with direction will make up a vector quantity. Hence by using vector quantities we can describe the position (or location) of bodies.

2.13 Derive equations of motion for uniformly accelerated rectilinear motion.

Ans: See Q.no.4 Long Question

2.14 Sketch a velocity – time graph for the motion of the body. From the graph explaining each step, calculate total distance covered by the body.

Ans: Total distance travelled

= area under the graph (trapezium OABC)

$= \frac{1}{2}$ (sum of parallel sides) x height

$= \frac{1}{2}$ (18s + 30 s) x (16 ms^{-1})

= 384 m

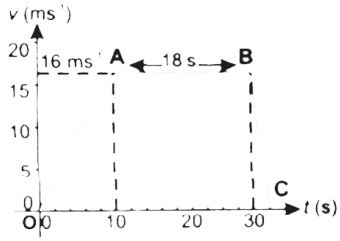


Figure 2.25: Speed-time graph of a car during 30 seconds.