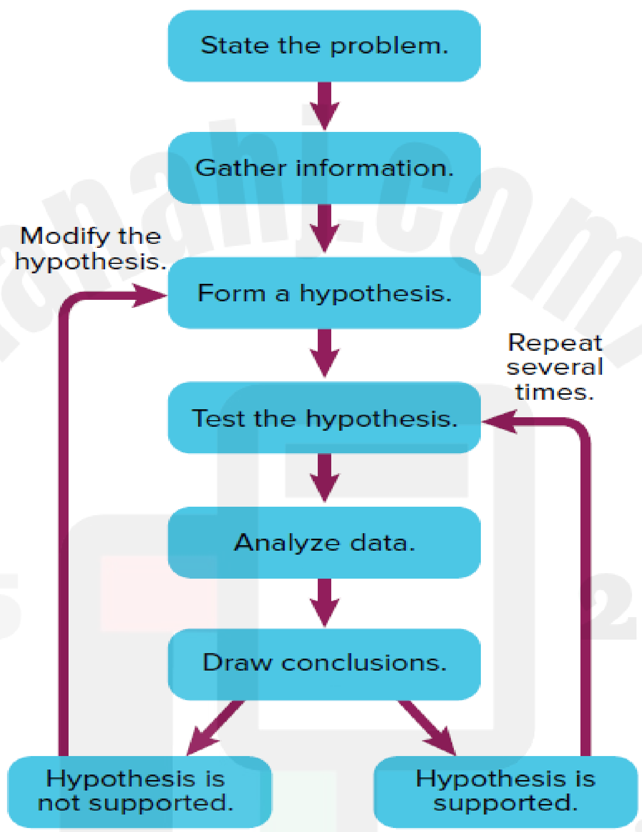
UMKULTHOOM SCHOOL

PHYSICS EOT COVERAGE

GRADE 9 ADV

TEACHER-SHIKHA AWASTHI

1. **Define the term scientific method and list the common steps of scientific methods used in investigations. P. (4 - 6)**
   Although physicists do not always follow a rigid set of steps, investigations often follow similar patterns called scientific methods.



2. **2. Define the term hypothesis and identify the ways in which a hypothesis can be tested. Q.(1 - 6) . P.(8)**
   A hypothesis is a possible explanation for a problem using what you know and have observed.
   A scientific theory is an explanation of things or events based on knowledge gained from many observations and investigations.
   A scientific law is a statement about what happens in nature and seems to be true all the time.

Q1. **Summarize** the steps you might use to carry out an investigation using scientific

methods.

Q2. Define the term *hypothesis*. Identify three ways to test a hypothesis.

Ans- A hypothesis is a possible explanation for a problem using what you know and have observed.

1.A scientific hypothesis can be tested through experimentation and observation

2.Some hypotheses can be tested by making observations.

3.Others can be tested by building a model and relating it to real-life situations.

4.To collect and analyze valuable data to help us learn more about events occurring **there.**

Q3. Describe why it is important for scientists to avoid bias.

Ans- Avoiding bias ensures scientific accuracy, credibility, and ethical integrity, leading to reliable, reproducible findings that guide informed decision-making and benefit diverse communities by representing objective truths rather than subjective views.

Q4. Explain why scientists use models. Give an example of a scientific model not mentioned in this lesson, and explain how it is useful.

Ans- Scientists use models to simplify complex systems, predict outcomes, and test hypotheses. For example, climate models simulate Earth's atmosphere and oceans, helping predict climate change effects and inform environmental policies.

Q5. Analyze Your friend finds that 90 percent of students surveyed in the cafeteria like pizza. She says this scientifically proves that everyone likes pizza. How would you respond?

Ans- I'd explain that surveying only cafeteria students may not represent everyone, and a single survey doesn't scientifically prove a universal preference. Broader, randomized surveys are needed for reliable conclusions.

Q6. Critical Thinking An accepted value for freefall acceleration is 9.8 m/s2. In an experiment with pendulums, you calculate a value to be 9.4 m/s2. Should the accepted value be tossed out because of your finding? Explain.

No. The value 9.801 m/s^2 has been established by many other experiments, and to discard the finding you would have to explain why they were wrong. There are probably some factors affecting your calculation, such as friction and how precisely you can measure the different variables.

2.Recognize physical quantities like time, mass, temperature, volume, density, and classify them into base and derived quantities and specify the dimension of each quantity in the SI - system of units. P.(9 – 10) Q.9 P-12

the Système International d'Unités, or SI, uses seven base quantities.

Other units, called derived units,

Table 1 SI Base Units

Base Quantity	Base Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Amount of a substance	mole	mol
Electric current	ampere	A
Luminous intensity	candela	cd

Q9 . How many seconds are in a leap year?

$$366 \text{ days}\left(\frac{24 \text{ h}}{1 \text{ day}}\right)\left(\frac{60 \text{ min}}{1 \text{ h}}\right)\left(\frac{60 \text{ s}}{1 \text{ min}}\right) =$$

31,622,400 s

3.Use dimensional analysis to validate equations and to choose the appropriate conversion factor when converting units. P.(10 - 11) Q.(9 - 11) P-12

10. Solving Problems Rewrite F = Bqv to find v in terms of F, q, and B.

$$V = \frac{F}{Bq}$$

11. Critical Thinking Using values given in a problem and the equation for distance, distance = speed × time, you calculate a car's speed to be 290 km/h. Is this answer reasonable? Explain. Under what circumstances might this be a reasonable answer?

Ans- A speed of 290 km/h is generally unreasonable for most standard cars on regular roads, as typical highway speeds are around 100-130 km/h. However, this speed could be reasonable under specific circumstances, such as for high-performance or racing cars on closed tracks, where speeds commonly exceed 250 km/h.

4. **Determine the sources of error and distinguish between precision and accuracy. P.(13 – 15) Q.(12 – 17) .P-16**
5. **Measure the base quantities and some derived quantities using suitable measurement tools and record those measurements taking into account significant figures and scientific notation. P.(14 – 15) Q.(12 – 17) .P-16**

12. Precision and Accuracy You find a micrometer (a tool used to measure objects to the nearest 0.001 mm) that has been bent. How does it compare to a new, high-quality meter-stick in its precision and accuracy?

ANS-

It would be more precise but less accurate.

13. Accuracy Some wooden rulers do not start with 0 at the edge, but have it set in a few millimeters. How could this improve the accuracy of the ruler?

ANS-

As the edge of the ruler gets worn away over time, the first millimeter or two of the scale would also be worn away if the scale started at the edge.

14. Parallax Does parallax affect the precision of a measurement that you make? Explain.

ANS-

No, it doesn't change the fineness of the divisions on its scale.

15. Uncertainty Your friend tells you that his height is 182 cm. In your own words, explain the range of heights implied by this statement.

ANS-

His height would be between 181.5 and 182.5 cm. Precision of a measurement is one-half the smallest division on the instrument. The height 182 cm would range ± 0.5 cm.

16. Precision A box has a length of 18.1 cm, a width of 19.2 cm, and is 20.3 cm tall.

a. What is its volume?

b. How precise is the measurement of length? Of volume?

c. How tall is a stack of 12 of these boxes?

d. How precise is the measurement of the height of one box? Of 12 boxes?

Precision A box has a length of 18.1 cm and a width of 19.2 cm, and it is 20.3 cm tall.

a. What is its volume?

7.05×10^3 cm^3

b. How precise is the measure of length? Of volume?

nearest tenth of a cm; nearest 10 cm^3

c. How tall is a stack of 12 of these boxes?

243.6 cm

d. How precise is the measure of the height of one box? Of 12 boxes?

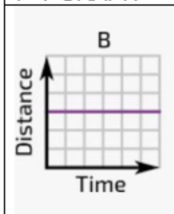
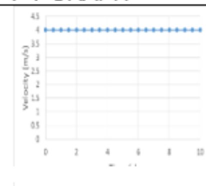
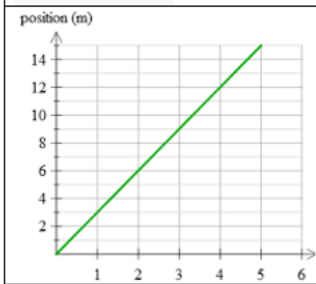
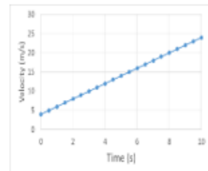
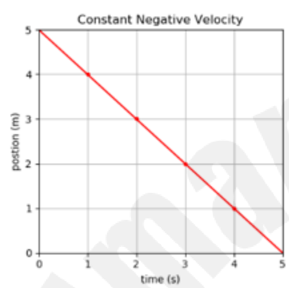
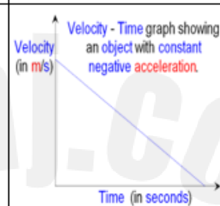
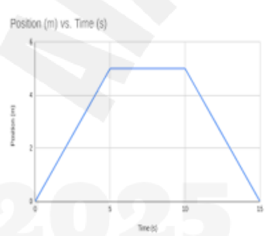
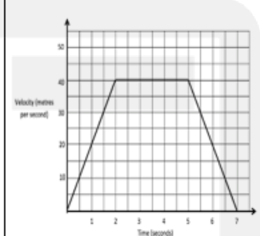
nearest tenth of a cm; nearest tenth of a cm

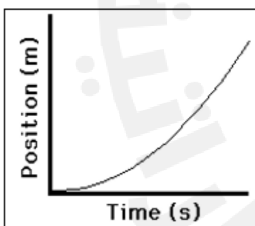
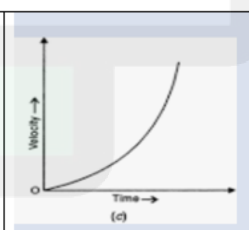
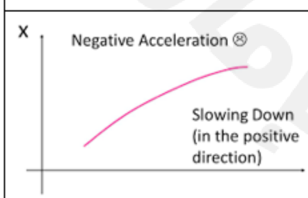
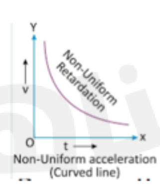
17. Critical Thinking Your friend states in a report that the average time required for a car to circle a 2.4-km track was 65.414 s. This was measured by timing 7 laps using a clock with a precision of 0.1 s. How much confidence do you have in the results of the report? Explain.

A result can never be more precise than the least precise measurement. The calculated average lap time exceeds the precision possible with the clock.

6. **Analyze curves of position versus time graphs and velocity versus time graphs for an object moving along a straight line in uniform or non-uniform motion with constant or variable acceleration, and use the equations of motion to solve relevant problems .P(37 - 39)Physics Challenge, Q.(10 – 14)**

Ans-

P-T GRAPH		V-T GRAPH	
	Object is at rest Velocity is zero.		Object is moving with constant velocity or with zero acceleration.
	Object is moving with constant velocity Slope=velocity $V=\frac{\Delta x}{\Delta t}$		Object is moving with constant acceleration. Slope=acceleration $A=\frac{\Delta v}{\Delta t}$
	Object is moving with constant negative velocity.		Object is moving with constant negative acceleration
	Non uniform motion		From t=0s to 2s ,object is speeding up in positive direction. 2s to 5s, object is moving with constant velocity. From t=5s to 7s, object is slowing down.

	Object is moving with positive constant acceleration		Object is moving with positive non-uniform acceleration
	Object is moving with negative acceleration		Object is moving with non-uniform negative acceleration

For problems 10–12, refer to ***Figure 13.***

10. The graph in **Figure 13** represents the motion of a car moving along a straight highway. Describe in words the car's motion.

11. Draw a particle model motion diagram that corresponds to the graph.

12. Answer the following questions about the car's motion. Assume that the positive *x*-direction is east of the origin and the negative *x*-direction is west of the origin.

a. At what time was the car's position 25.0 m east of the origin?

b. Where was the car at time $t = 1.0$ s?

c. What was the displacement of the car between times $t = 1.0$ s and $t = 3.0$ s?

13. The graph in **Figure 14** represents the motion of two pedestrians who are walking along a straight sidewalk in a city. Describe in words the motion of the pedestrians. Assume that the positive direction is east of the origin.

14. CHALLENGE Ari walked down the hall at school from the cafeteria to the band room, a distance of 100.0 m. A class of physics students recorded and graphed his position every 2.0 s, noting that he moved 2.6 m every 2.0 s. When was Ari at the following positions?

a. 25.0 m from the cafeteria

b. 25.0 m from the band room

c. Create a graph showing Ari's motion.

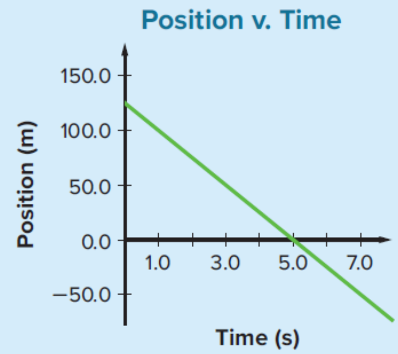


Figure 13

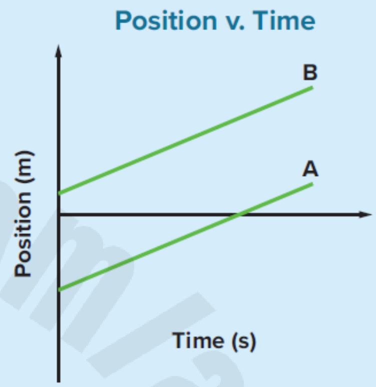
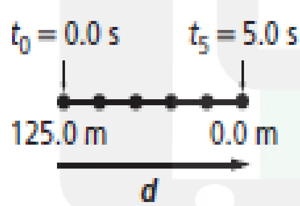


Figure 14

Ans-10 The car begins at a position of 125.0 m and moves toward the origin, arriving at the origin 5.0 s after it begins moving. The car continues beyond the origin.

Ans-11



Ans-12 a. At 4.0 s

b. 100.0 m

C. Displacement= 50-125=-75m

ANS-13 Pedestrian A starts west of High Street and walks east (the positive direction). Pedestrian B begins east of High Street and walks Iin the east direction).Pedistrian A & B are moving in East direction with same velocity as they start will different positions and the lines are parallel , so they will never cross each other.

ANS-14

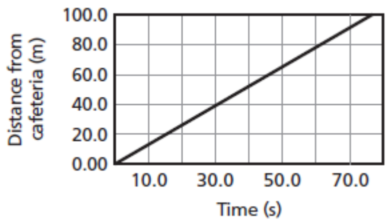
a. 25.0 m from the cafeteria

19 s

b. 25.0 m from the band room

58 s

c. Create a graph showing Odina's motion.



7. **Explain the meaning of instantaneous position for an object in motion. P.(43 - 44) Q.(26 - 31) P.45**

Ans-instantaneous position is the position at a particular instant.
Instantaneous position is usually simply called position.

26. The graph in **Figure 22** describes the motion of a cruise ship drifting slowly through calm waters. The positive *x*-direction (along the vertical axis) is defined to be south.

a. What is the ship's average speed?

b. What is its average velocity?

27. Describe, in words, the cruise ship's motion in the previous problem.

28. What is the average velocity of an object that moves from 6.5 cm to 3.7 cm relative to the origin in 2.3 s?

29. The graph in **Figure 23** represents the motion of a bicycle.

a. What is the bicycle's average speed?

b. What is its average velocity?

30. Describe, in words, the bicycle's motion in the previous problem.

31. **CHALLENGE** When Marshall takes his pet dog for a walk, the dog walks at a very consistent pace of 0.55 m/s. Draw a motion diagram and a position-time graph to represent Marshall's dog walking the 19.8-m distance from in front of his house to the nearest stop sign.

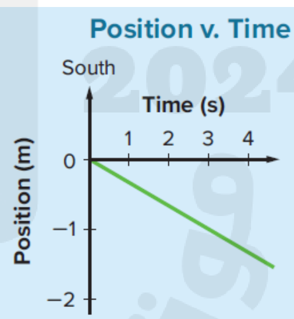


Figure 22

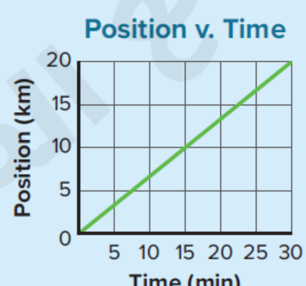
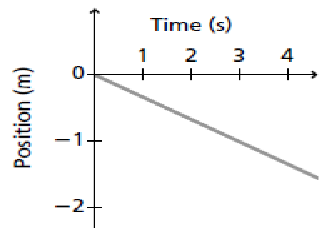


Figure 23

ans-26



■ Figure 2-22

a. What is the ship's average speed?

Using the points (0.0 s, 0.0 m) and (3.0 s, −1.0 m)

$$\bar{v} = \left|\frac{\Delta d}{\Delta t}\right| = \left|\frac{d_2 - d_1}{t_2 - t_1}\right| = \left|\frac{-1.0\text{ m} - 0.0\text{ m}}{3.0\text{ s} - 0.0\text{ s}}\right| = |-0.33\text{ m/s}| = 0.33\text{ m/s}$$

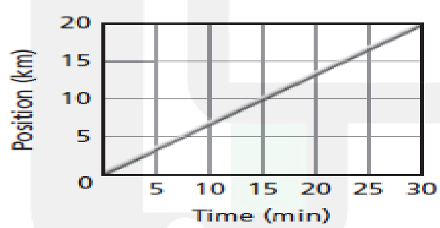
b. What is its average velocity?

The average velocity is the slope of the line, including the sign, so it is −0.33 m/s or 0.33 m/s north.

Ans-27 The ship is moving to the north at a speed of 0.33 m/s.

Ans-28 Average velocity=(3.7-6.50/2.3=-1.21cm/s= - 0.012m/s

Ans-29



■ Figure 2-23

Because the bicycle is moving in the positive direction, the average speed and average velocity are the same. Using the points (0.0 min, 0.0 km) and (15.0 min, 10.0 km),

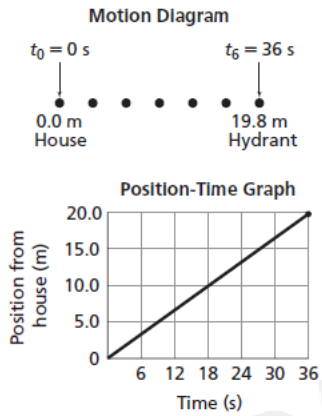
$$\bar{v} = \left|\frac{\Delta d}{\Delta t}\right| = \left|\frac{d_2 - d_1}{t_2 - t_1}\right| = \left|\frac{10.0\text{ km} - 0.0\text{ km}}{15.0\text{ min} - 0.0\text{ min}}\right| = 0.67\text{ km/min}$$

$\bar{v}$ = 0.67 km/min in the positive direction

The bicycle is moving in the positive direction at a speed of 0.67 km/min.

Ans-30 The bicycle is moving in the positive direction at a speed of 0.67km/min.

Ans-31



8. Analyze a position-time graph to describe an object's motion. P.(42 - 43) Figure 19, Q.(37 - 39) P.48

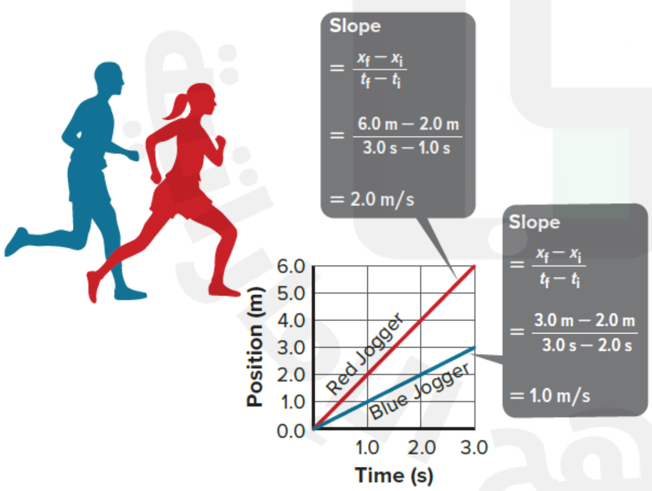


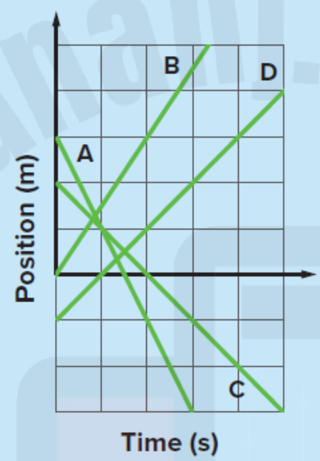
Figure 19 A greater slope shows that the red jogger traveled faster.

Analyze *How much farther did the red jogger travel than the blue jogger in the 3 s interval described by the graph?*

37. **Ranking Task** Rank the position-time graphs according to the average speed, from greatest average speed to least average speed. Specifically indicate any ties.

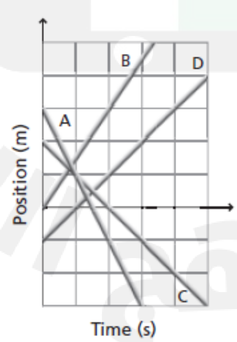
38. **Contrast Average Velocities** Describe differences in the average velocities shown on the graph for objects A and B. Describe differences in the average velocities shown on the graph for objects C and D.

39. **Ranking Task** Rank the graphs in **Figure 25** according to each object's initial position, from most positive position to most negative position. Specifically indicate any ties. Would your ranking be different if you ranked according to initial distance from the origin?



ANS-37-

Average Speed Rank the position-time graphs according to the average speed of the object, from greatest average speed to least average speed. Specifically indicate any ties.



■ **Figure 2-25**

$$\text{Slope}_A = -2$$
$$\text{Slope}_B = \frac{3}{2}$$
$$\text{Slope}_C = -1$$
$$\text{Slope}_D = 1$$

For speed use the absolute value, therefore A, B, C = D

ANS-38

Average Velocity Rank the graphs according to average velocity, from greatest average velocity to least average velocity. Specifically indicate any ties.

B, D, C, A

$\text{Slope}_A = -2$

$\text{Slope}_B = \frac{3}{2}$

$\text{Slope}_C = -1$

$\text{Slope}_D = 1$

ANS-39

A, C, B, D. Yes, the ranking from greatest to least distance would be A, C, D, B.

9. Conduct an investigation to show different kinds of motion using motion diagrams and particle models. P. (30 - 31) Q. (1 - 5); Q.(20 - 24) P.31; P.41

1. **Representing Motion** How does a motion diagram represent an object's motion?
2. **Bike Motion Diagram** Draw a particle model motion diagram for a bike rider moving at a constant pace along a straight path.
3. **Car Motion Diagram** Draw a particle motion diagram corresponding to the motion in **Figure 4** for a car coming to a stop at a stop sign. What point on the car did you use to represent the car?

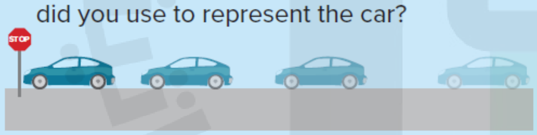


Figure 4

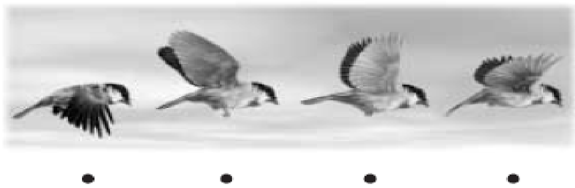
4. **Bird Motion Diagram** Draw a particle model motion diagram corresponding to the motion diagram in **Figure 5.** What point on the bird did you choose to represent the bird?

Figure 5

5. **Critical Thinking** Draw particle model motion diagrams for two runners during a race in which the first runner crosses the finish line as the other runner is three-fourths of the way to the finish line.

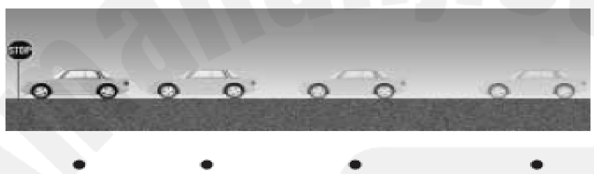
1. **Motion Diagram of a Runner** Use the particle model to draw a motion diagram for a bike rider riding at a constant pace.

2. **Motion Diagram of a Bird** Use the particle model to draw a simplified motion diagram corresponding to the motion diagram in **Figure 2-4** for a flying bird. What point on the bird did you choose to represent it?



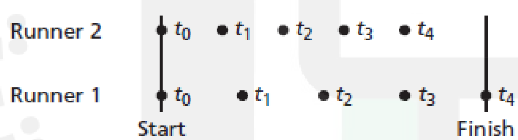
■ **Figure 2-4**

3. **Motion Diagram of a Car** Use the particle model to draw a simplified motion diagram corresponding to the motion diagram in **Figure 2-5** for a car coming to a stop at a stop sign. What point on the car did you use to represent it?



■ **Figure 2-5**

4. **Critical Thinking** Use the particle model to draw motion diagrams for two runners in a race, when the first runner crosses the finish line as the other runner is three-fourths of the way to the finish line.



20. **Particle Diagram** Using the particle model motion diagram in **Figure 16** of a baby crawling across a kitchen floor, plot a position-time graph to represent the motion. The time interval between dots on the diagram is 1 s.

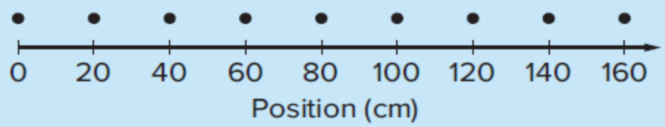


Figure 16

*For problems 21–24, refer to **Figure 17**.*

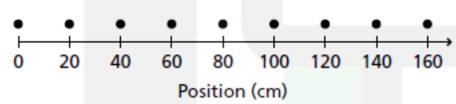
21. **Particle Model** Create a particle model motion diagram from the position-time graph of a hockey puck gliding across the ice.

22. **Time** Use the hockey puck's position-time graph to determine the time when the puck was 10.0 m beyond the origin.

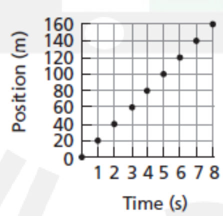
23. **Distance** Use the position-time graph to determine how far the hockey puck moved between 0.0 s and 5.0 s.

24. **Time Interval** Use the position-time graph for the hockey puck to determine the time it took for the puck to go from 40.0 m beyond the origin to 80.0 m beyond the origin.

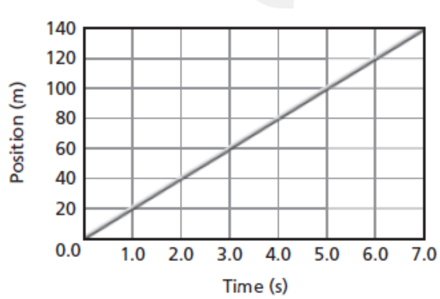
ANS-20



■ Figure 2-17



ANS-21



ANS-22 0.5 s

ANS-23 100m

ANS-24 2.0s

10. Express the motion of an object along a straight line (uniform and non-uniform) using motion and vector diagrams and describe the motion in own words. P.33 Q. (7 - 9) P.36

Q7. The motion diagram for a car traveling on an interstate highway is shown below. The starting and ending points are indicated.

Start • • • • • • End

Make a copy of the diagram. Draw a vector to represent the car's displacement from the starting time to the end of the third time interval.

ANS-

8. Position Two students added a vector for a moving object's position at t = 2 s to a motion diagram. When they compared their diagrams, they found that their vectors did not point in the same direction. Explain.

ANS- A position vector goes from the origin to the object. When the origins are different, the position vectors are different.

On the other hand, a displacement vector has nothing to do with the origin.

9. Displacement The motion diagram for a boy walking to school is shown below.

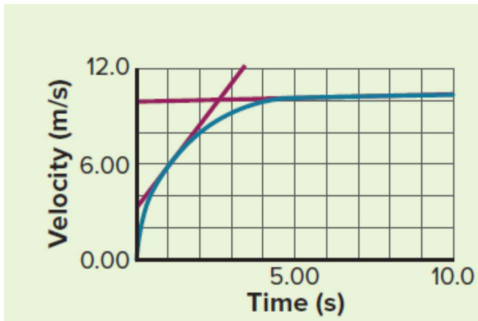
Home • • • • • • • • • • • School

Make a copy of this motion diagram, and draw vectors to represent the displacement between each pair of dots.

ANS-9

11. **Calculate the instantaneous acceleration from a velocity-time graph. P.(58-60) Q.(1 - 4)P-60**

ANS- The change in an object's velocity at an instant of time is called instantaneous acceleration.



1. The velocity-time graph in **Figure 8** describes Steven's motion as he walks along the midway at the state fair. Sketch the corresponding motion diagram. Include velocity vectors in your diagram.
2. Use the *v-t* graph of the toy train in **Figure 9** to answer these questions.
   - **a.** When is the train's speed constant?
   - **b.** During which time interval is the train's acceleration positive?
   - **c.** When is the train's acceleration most negative?
3. Refer to **Figure 9** to find the average acceleration of the train during the following time intervals.
   a. 0.0 s to 5.0 s **b.** 15.0 s to 20.0 s **c.** 0.0 s to 40.0 s
4. **CHALLENGE** Plot a *v-t* graph representing the following motion: An elevator starts at rest from the ground floor of a three-story shopping mall. It accelerates upward for 2.0 s at a rate of 0.5 m/s^2, continues up at a constant velocity of 1.0 m/s for 12.0 s, and then slows down with a constant downward acceleration of 0.25 m/s^2 for 4.0 s as it reaches the third floor.

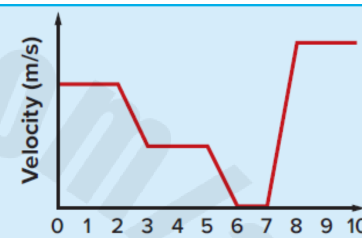


Figure 8

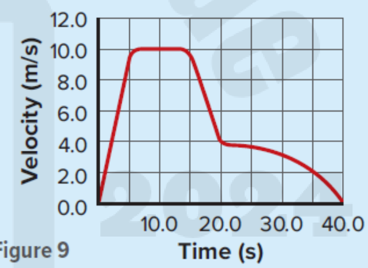
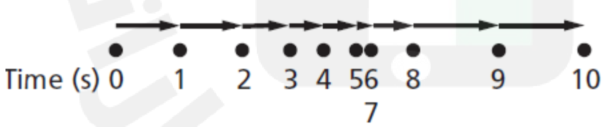


Figure 9

ANS1



ANS2- When is the train's speed constant?

5.0 to 15.0 s

b. During which time interval is the train's acceleration positive?

0.0 to 5.0 s

c. When is the train's acceleration most negative?

15.0 to 20.0 s

ANS3-

a. 0.0 s to 5.0 s

$$\bar{a} = \frac{v_2 - v_1}{t_2 - t_1}$$

$$= \frac{10.0\ \text{m/s} - 0.0\ \text{m/s}}{5.0\ \text{s} - 0.0\ \text{s}}$$

$$= 2.0\ \text{m/s}^2$$

b. 15.0 s to 20.0 s

$$\bar{a} = \frac{v_2 - v_1}{t_2 - t_1}$$

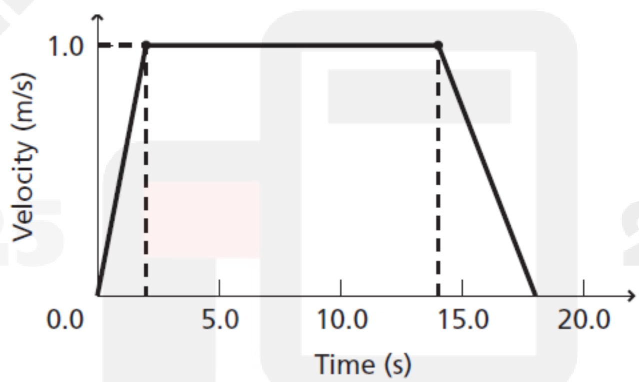
$$= \frac{4.0\ \text{m/s} - 10.0\ \text{m/s}}{20.0\ \text{s} - 15.0\ \text{s}}$$

$$= -1.2\ \text{m/s}^2$$

c. 0.0 s to 40.0 s

$$\bar{a} = \frac{v_2 - v_1}{t_2 - t_1}$$

ANS-4



Q12. Describe the motion of an object if its velocity and acceleration are either in the same directions or opposite directions, hence state if an object is slowing down or speeding up. P.56, Figure 4

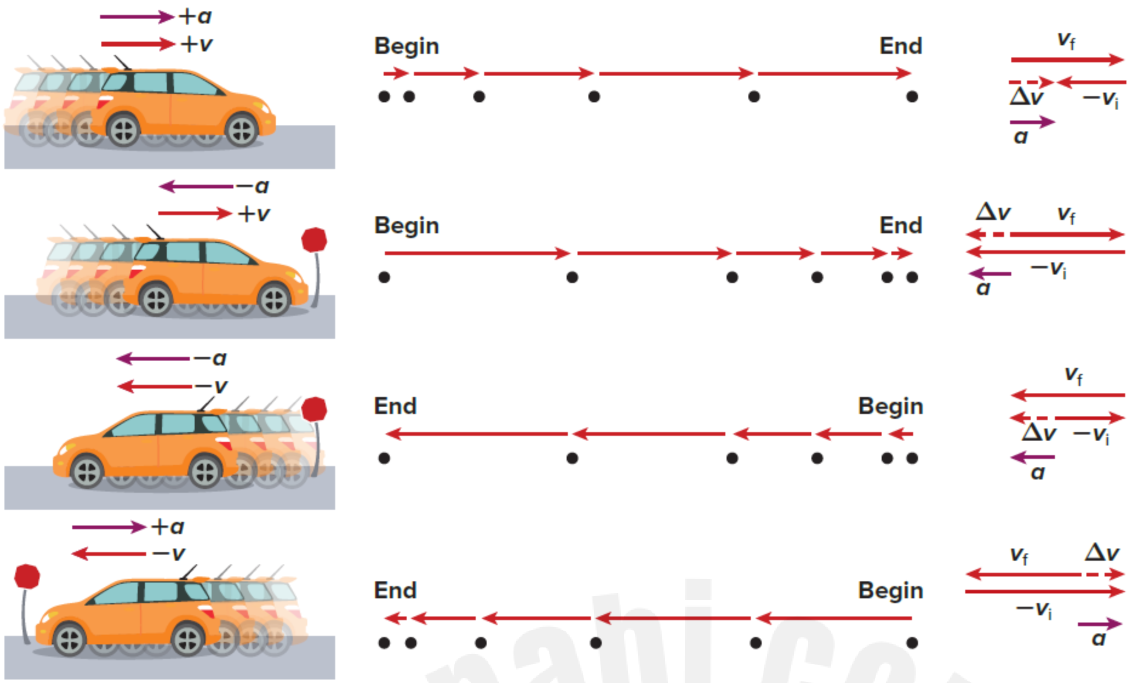


Figure 4 You need to know the direction of both the velocity and acceleration vectors in order to determine whether an object is speeding up or slowing down.

13.Analyze curves of position versus time graphs and velocity versus time graphs for an object moving along a straight line in uniform or non-uniform motion with constant or variable acceleration, and use the equations of motion to solve relevant problems. P.57 Q.(1 - 4) P.(60 – 61)

SAME AS Q12.

14. Apply the equation of motion relating the final position of an object to its initial position, initial velocity, uniform acceleration, and time $xf=xi+uit+2at2$. P.(67-68)

Q.(23 - 27) P.(68 – 69)

23. A skateboarder is moving at a constant speed of 1.75 m/s when she starts up an incline that causes her to slow down with a constant acceleration of –0.20 m/s². How much time passes from when she begins to slow down until she begins to move back down the incline?

24. A race car travels on a straight racetrack with a forward velocity of 44 m/s and slows at a constant rate to a velocity of 22 m/s over 11 s. How far does it move during this time?

25. A car accelerates at a constant rate from 15 m/s to 25 m/s while it travels a distance of 125 m. How long does it take to achieve the final speed?

26. A bike rider pedals with constant acceleration to reach a velocity of 7.5 m/s north over a time of 4.5 s. During the period of acceleration, the bike's displacement is 19 m north. What was the initial velocity of the bike?

27. CHALLENGE The car in **Figure 16** travels west with a forward acceleration of 0.22 m/s². What was the car's velocity (v_i) at point x_i if it travels a distance of 350 m in 18.4 s?

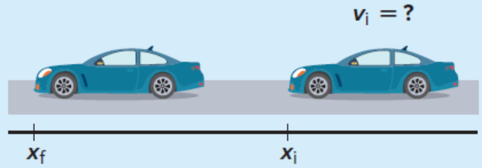


Figure 16

ANS-23

$$v_f = v_i + at$$

$$t = \frac{v_f - v_i}{a} = \frac{0.0\ \text{m/s} - 1.75\ \text{m/s}}{-0.20\ \text{m/s}^2} = 8.8\ \text{s}$$

ANS-24

$$\bar{v} = \frac{\Delta v}{2} = \frac{(v_f - v_i)}{2}$$

$$\Delta d = \bar{v}\Delta t$$

$$= \frac{(v_f - v_i)\Delta t}{2}$$

$$= \frac{(22\ \text{m/s} - 44\ \text{m/s})(11\ \text{s})}{2}$$

$$= -1.2\times10^2\ \text{m}$$

ANS-25

$$\bar{v} = \frac{\Delta v}{2} = \frac{(v_f - v_i)}{2}$$

$$\Delta d = \bar{v}\Delta t$$

$$= \frac{(v_f - v_i)\Delta t}{2}$$

$$\Delta t = \frac{2\Delta d}{(v_f - v_i)}$$

$$= \frac{(2)(125\ \text{m})}{25\ \text{m/s} - 15\ \text{m/s}}$$

$$= 25\ \text{s}$$

ANS-26

$$\bar{v} = \frac{\Delta v}{2} = \frac{(v_f - v_i)}{2}$$

$$\Delta d = \bar{v}\Delta t = \frac{(v_f - v_i)\Delta t}{2}$$

$$\text{so } v_i = \frac{2\Delta d}{\Delta t} - v_f$$

$$= \frac{(2)(19 \text{ m})}{4.5 \text{ s} - 7.5 \text{ m/s}}$$

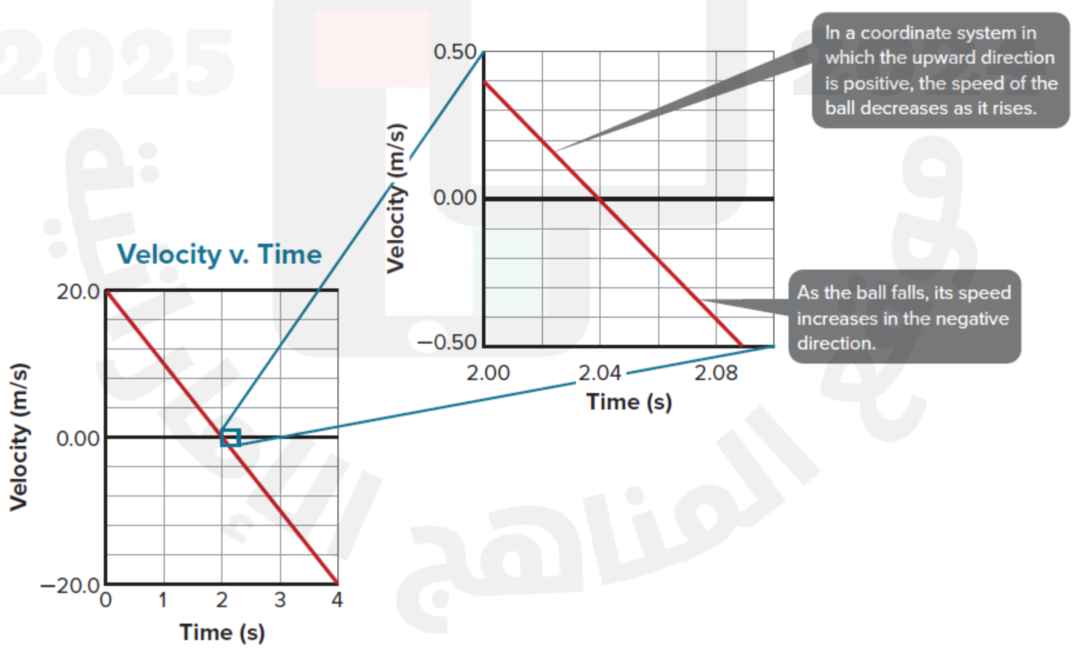
$$= 0.94 \text{ m/s}$$

ANS25- $\Delta X = v_i \Delta t + \frac{1}{2} a \Delta t^2$

350=v_i**(18.4) +**$\frac{1}{2}(0.22)(18.4)2$

v_i**=**

15. Analyze the position-time, velocity-time, and acceleration-time graphs for an object under free fall. P.(71 - 75) Q.(40 - 51) P.(75 – 76)



Velocity-time graph The v-t graph for the ball as it goes up and down is shown in Figure 21.

The straight line sloping downward does not mean that the speed is always decreasing. The speed decreases as the ball rises and increases as it falls. At around 2 s, the velocity changes smoothly from positive to negative. As the ball falls, its speed increases in the negative direction. The figure also shows a closer view of the v-t graph. At an instant of time, near 2.04 s, the velocity is zero.

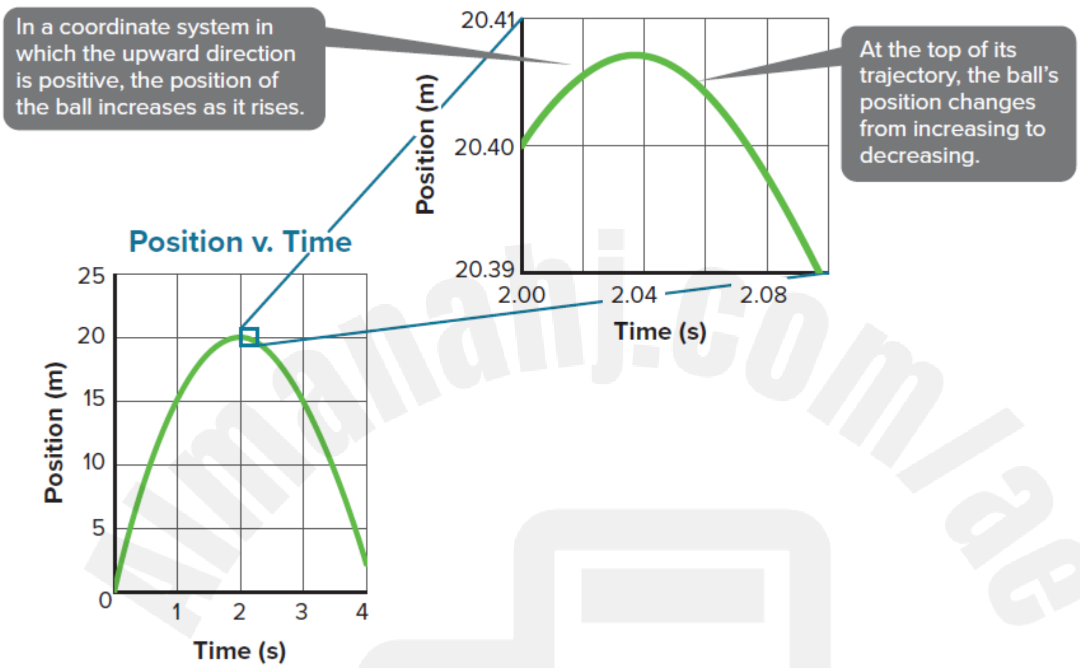


Figure 22 A position-time graph shows how the ball's position changes as it rises and falls. The graph at the right shows a close-up view of how the position changes at the top of the ball's trajectory.

Position-time graph Look at the position-time graphs in Figure 22 on the next page. These graphs show how the ball's height changes as it rises and falls. If an object is moving with constant acceleration, its position-time graph forms a parabola. Because the ball is rising and falling, its graph is an inverted parabola. The shape of the graph shows the progression of time. It does not mean that the ball's path was in the shape of a parabola. The close-up graph on the right shows that at about 2.04 s, the ball reaches its maximum height.

40. A construction worker accidentally drops a brick from a high scaffold.

a. What is the velocity of the brick after 4.0 s?

b. How far does the brick fall during this time?

a. What is the velocity of the brick after 4.0 s?

Say upward is the positive direction.

$v_f = v_i + at$, $a = -g = -9.80\ \text{m/s}^2$

$v_f = 0.0\ \text{m/s} + (-9.80\ \text{m/s}^2)(4.0\ \text{s})$

$= -39\ \text{m/s}$ **when the upward direction is positive**

b. How far does the brick fall during this time?

$d = v_i t + \frac{1}{2}at^2$

$= 0 + \left(\frac{1}{2}\right)(-9.80\ \text{m/s}^2)(4.0\ \text{s})^2$

$= -78\ \text{m}$

The brick falls 78 m.

41. Suppose for the previous problem you choose your coordinate system so that the opposite direction is positive.

a. What is the brick's velocity after 4.0 s?

b. How far does the brick fall during this time?

a. What is the brick's velocity after 4.0 s?

Now the positive direction is downward.

$v_f = v_i + at$, $a = g = 9.80\ \text{m/s}^2$

$v_f = 0.0\ \text{m/s} + (9.80\ \text{m/s}^2)(4.0\ \text{s})$

$= +39\ \text{m/s}$ **when the downward direction is positive**

b. How far does the brick fall during this time?

$d = v_i t + \frac{1}{2}at^2$, $a = g = 9.80\ \text{m/s}^2$

$= (0.0\ \text{m/s})(4.0\ \text{s}) + \left(\frac{1}{2}\right)(9.80\ \text{m/s}^2)(4.0\ \text{s})^2$

$= +78\ \text{m}$

The brick still falls 78 m.

42. A student drops a ball from a window 3.5 m above the sidewalk. How fast is it moving when it hits the sidewalk?

$v_f^2 = v_i^2 + 2ad$, $a = g$ and $v_i = 0$

so $v_f = \sqrt{2gd}$

$= \sqrt{(2)(9.80 \text{ m/s}^2)(3.5 \text{ m})}$

$= 8.3$ m/s

43. A tennis ball is thrown straight up with an initial speed of 22.5 m/s. It is caught at the same distance above the ground.

a. How high does the ball rise?

b. How long does the ball remain in the air?

Hint: The time it takes the ball to rise equals the time it takes to fall.

a. How high does the ball rise?

$a = -g$, and at the maximum height, $v_f = 0$

$v_f^2 = v_i^2 + 2ad$ becomes

$v_i^2 = 2gd$

$$d = \frac{v_i^2}{2g} = \frac{(22.5 \text{ m/s})^2}{(2)(9.80 \text{ m/s}^2)} = 25.8 \text{ m}$$

b. How long does the ball remain in the air? *Hint: The time it takes the ball to rise equals the time it takes to fall.*

Calculate time to rise using $v_f = v_i + at$, with $a = -g$ and $v_f = 0$

$$t = \frac{v_i}{g} = \frac{22.5 \text{ m/s}}{9.80 \text{ m/s}^2} = 2.30 \text{ s}$$

The time to fall equals the time to rise, so the time to remain in the air is

$t_{air} = 2t_{rise} = (2)(2.30 \text{ s}) = 4.60$ s

44. You decide to flip a coin to determine whether to do your physics or English homework first. The coin is flipped straight up.

a. What are the velocity and acceleration of the coin at the top of its trajectory?

Ans- at the top velocity=0 and a=-g=-9.8m/s^2

b. If the coin reaches a high point of 0.25 m above where you released it, what was its initial speed?

c. If you catch it at the same height as you released it, how much time was it in the air?

$$v_f^2 = v_i^2 + 2a\Delta d$$

$v_i = \sqrt{v_f^2 + 2g\Delta d}$ where $a = -g$

and $v_f = 0$ at the height of the toss, so

$$v_i = \sqrt{(0.0 \text{ m/s})^2 + (2)(9.80 \text{ m/s}^2)(0.25 \text{ m})}$$

$$= 2.2 \text{ m/s}$$

b. If you catch it at the same height as you released it, how much time did it spend in the air?

$v_f = v_i + at$ where $a = -g$

$v_i = 2.2$ m/s and

$v_f = -2.2$ m/s

$$t = \frac{v_f - v_i}{-g}$$

$$= \frac{-2.2 \text{ m/s} - 2.2 \text{ m/s}}{-9.80 \text{ m/s}^2}$$

$$= 0.45 \text{ s}$$

45. CHALLENGE A basketball player is holding a ball in her hands at a height of 1.5 m above the ground. She drops the ball, and it bounces several times. After the first bounce, the ball only returns to a height of 0.75 m. After the second bounce, the ball only returns to a height of 0.25 m.

a. Suppose downward is the positive direction. What would the shape of a velocity-time graph look like for the first two bounces?

b. What would be the shape of a position-time graph for the first two bounces?

Ans- The velocity-time graph shows sharp V-shaped changes at each bounce.

The position-time graph shows a series of diminishing parabolas representing each bounce.

46. Free Fall Suppose you hold a book in one hand and a flat sheet of paper in your other hand. You drop them both, and they fall to the ground. Explain why the falling book is a good example of free fall, but the paper is not.

Ans-the falling book is a good example of free fall because it has a compact shape and enough mass to minimize the effect of air resistance. This allows it to accelerate downward primarily due to gravity, following the principles of free fall.

In contrast, the flat sheet of paper experiences significant air resistance relative to its mass. This resistance slows its descent, preventing it from accelerating solely due to

gravity. Therefore, the paper does not follow a free-fall path, as its motion is significantly influenced by the air.

47. Final Velocity Your sister drops your house keys down to you from the second-floor window, as shown in Figure 25. What is the velocity of the keys when you catch them?

$$v^2 = v_i^2 + 2a\Delta d \text{ where } a = -g$$

$$v = \sqrt{v_i^2 - 2g\Delta d}$$

$$= \sqrt{(0.0 \text{ m/s})^2 - (2)(9.80 \text{ m/s}^2)(-4.3 \text{ m})}$$

$$= 9.2 \text{ m/s}$$

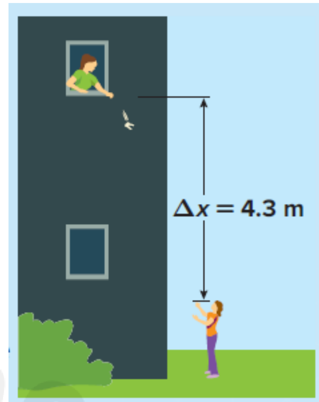


Figure 25

48. Free-Fall Ride Suppose a free-fall ride at an amusement park starts at rest and is in free fall. What is the velocity of the ride after 2.3 s? How far do people on the ride fall during the 2.3-s time period?

Ans- v=g.t

Velocity after 2.3 seconds: 22.54 m/s downward

Distance fallen after 2.3 seconds: $d = \frac{1}{2}gt^2 = 25.9$ **meters**

49. Maximum Height and Flight Time The free-fall acceleration on Mars is about one-third that on Earth. Suppose you throw a ball upward with the same velocity on Mars as on Earth.

a. How would the ball's maximum height compare to that on Earth?

b. How would its flight time compare?

a. How would the ball's maximum height compare to that on Earth?

At maximum height, $v_f = 0$,

so $d_f = \frac{v_i^2}{2g}$, **or three times higher.**

b. How would its flight time compare?

Time is found from $d_f = \frac{1}{2}gt_f^2$, **or**

$t_f = \sqrt{\frac{2d_f}{g}}$. **Distance is multiplied by 3 and** g **is divided by 3,**

so the flight time would be three times as long.

50. Velocity and Acceleration Suppose you throw a ball straight up into the air. Describe the changes in the velocity of the ball. Describe the changes in the acceleration of the ball.

51. Critical Thinking A ball thrown vertically upward continues upward until it reaches a certain position, and then falls downward. The ball's velocity is instantaneously zero at that highest point. Is the ball accelerating at that point? Devise an experiment to prove or disprove your answer.

The ball is accelerating; its velocity is changing. Take a strobe photo to

measure its position. From photos, calculate the ball's velocity.

Q1. Part-A Define the terms scientific methods, hypothesis, model, scientific theory, and scientific law. P.(3 – 8)P.(17-22)

Scientific Methods: A systematic, step-by-step approach used by scientists to investigate questions, gather data, form hypotheses, conduct experiments, and analyze results to draw conclusions about natural phenomena.

Hypothesis: A testable, educated guess or prediction about the relationship between variables or the outcome of an experiment, which can be investigated through scientific methods.

Model: A model is a representation of an idea, event, structure, or object that helps people better understand it.

Scientific Theory is an explanation of things or events based on knowledge gained from many observations and investigations**.**

Scientific Law is a statement about what happens in nature and seems to be true all the time.

Part B:1. Identify variables in tabulated data and represent them in a suitable graph to determine the relationship between the variables, and obtain the mathematical equation describing that relationship to determine the value of the dependent variable for a specific value of the independent variable and vice versa. Q(1-6) P.8

Ans- Already discussed in Q2.

2.Identify the relationship between the average change of a function between two points and the slope of the secant joining these points, and relate the slope of the tangent to the curve at a point to the rate of change of the function at that point. Physics Challenge, Practice problems, Q.(19 – 23) P. 22

19. **Make a Graph** Graph the following data. Time is the independent variable.

Time (s)	0	5	10	15	20	25	30	35
Speed (m/s)	12	10	8	6	4	2	2	2

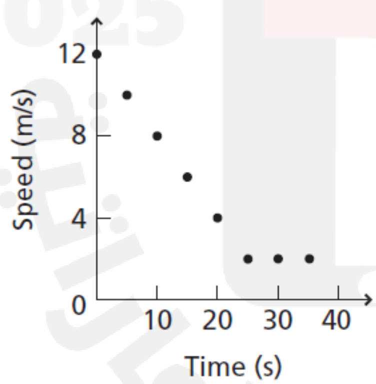
20. **Interpret a Graph** What would be the meaning of a nonzero *y*-intercept in a graph of total mass versus volume?

21. **Predict** Use the relationship illustrated in **Figure 16** to determine the mass required to stretch the spring 15 cm.

22. **Predict** Use the relationship shown in **Figure 18** to predict the travel time when speed is 110 km/h.

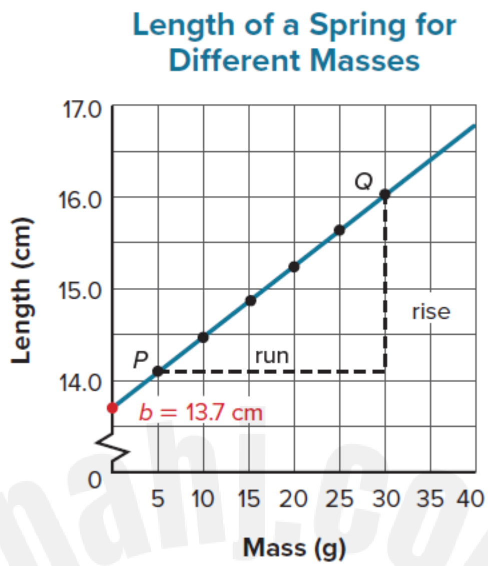
23. **Critical Thinking** Look again at the graph in **Figure 16.** In your own words, explain how the spring would be different if the line in the graph were shallower or had a smaller slope.

ANS-19

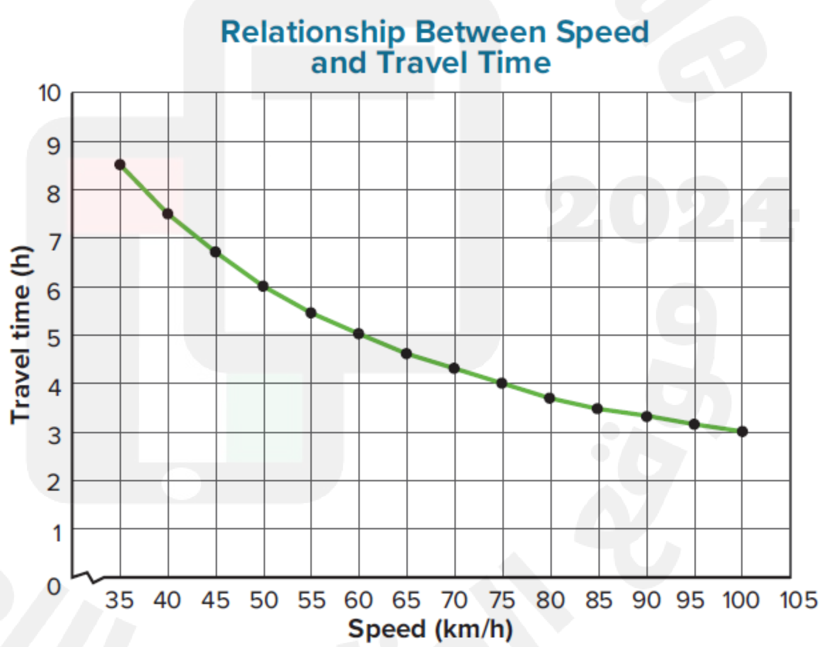


ANS-20 There is a nonzero total mass when the volume of the material is zero. This could happen if the mass value includes the material's container.

ANS-21 MASS= 16 g



ANS22- Time=2.8h



Ans-23 The spring whose line has a smaller slope is stiffer, and therefore requires more mass to stretch it one centimeter.

Q2. Part A-Analyze curves of position versus time graphs and velocity versus time graphs for an object moving along a straight line in uniform or non-uniform motion with constant or variable acceleration, and use the equations of motion to solve relevant problems P.(46-47) P.33

Already discussed.

Part B:Differentiate between scalar and vector quantities with examples. Q.(32-35); Q.(36 – 43) P.47; P.48

Scalar Quantities Defined by magnitude alone.

Examples:Speed (e.g., 60 km/h),Distance (e.g., 5 meters) ,Mass (e.g., 10 kg)

Temperature (e.g., 25°C)

Vector Quantities:Defined by both magnitude and direction.

Examples:Velocity (e.g., 60 km/h east),Displacement (e.g., 5 meters north),Force (e.g., 10 newtons downward), Acceleration (e.g., 9.8 m/s² downward)

Q3. Solve problems using the combination of equations of motion for constant acceleration. P.(63-70) Q.(16-39)P.65 & P.66 & P.68 & P.70

16. A golf ball rolls up a hill toward a miniature-golf hole. Assume the direction toward the hole is positive.

a. If the golf ball starts with a speed of 2.0 m/s and slows at a constant rate of 0.50 m/s2, what is its velocity after 2.0 s?

b. What is the golf ball's velocity if the constant acceleration continues for 6.0 s?

c. Describe the motion of the golf ball in words and with a motion diagram.

a. If the golf ball starts with a speed of 2.0 m/s and slows at a constant rate of 0.50 m/s², what is its velocity after 2.0 s?

$v_f = v_i + at$

$= 2.0\ m/s + (-0.50\ m/s^2)(2.0\ s)$

$= 1.0\ m/s$

b. What is the golf ball's velocity if the constant acceleration continues for 6.0 s?

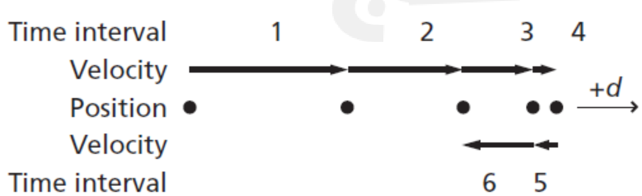
$v_f = v_i + at$

$= 2.0\ m/s + (-0.50\ m/s^2)(6.0\ s)$

$= -1.0\ m/s$

c. Describe the motion of the golf ball in words and with a motion diagram.

The ball's velocity simply decreased in the first case. In the second case, the ball slowed to a stop and then began rolling back down the hill.



17. A bus traveling 30.0 km/h east has a constant increase in speed of 1.5 m/s2. What is its velocity 6.8 s later?

$$v_f = v_i + at$$
$$= 30.0\ \text{km/h} + (3.5\ \text{m/s}^2)(6.8\ \text{s})\left(\frac{1\ \text{km}}{1000\ \text{m}}\right)\left(\frac{3600\ \text{s}}{1\ \text{h}}\right)$$
$$= 120\ \text{km/h}$$

18. If a car accelerates from rest at a constant rate of 5.5 m/s2 north, how long will it take for the car to reach a velocity of 28 m/s north?

$$v_f = v_i + at$$
$$\text{so } t = \frac{v_f - v_i}{a}$$
$$= \frac{28\ \text{m/s} - 0.0\ \text{m/s}}{5.5\ \text{m/s}^2}$$
$$= 5.1\ \text{s}$$

19. CHALLENGE A car slows from 22 m/s to 3.0 m/s at a constant rate of 2.1 m/s2. How many seconds are required before the car is traveling at a forward velocity of 3.0 m/s?

$$v_f = v_i + at$$
$$\text{so } t = \frac{v_f - v_i}{a}$$
$$= \frac{3.0\ \text{m/s} - 22\ \text{m/s}}{-2.1\ \text{m/s}^2}$$
$$= 9.0\ \text{s}$$

20. The graph in Figure 13 describes the motion of two bicyclists, Akiko and Brian, who start from rest and travel north, increasing their speed with a constant acceleration. What was the total displacement of each bicyclist during the time shown for each?

Hint: Use the area of a triangle: area = (0.5)(base)(height).

A=9m

B=8m

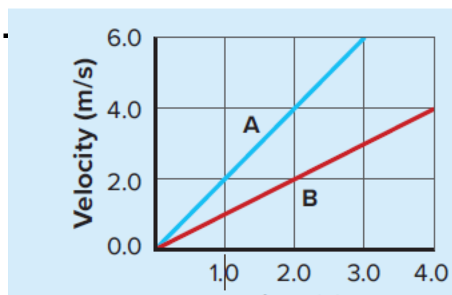


Figure 13

21. The motion of two people, Carlos and Diana, moving south along a straight path is described by the graph in Figure 14. What is the total displacement of each person during the first 4.0-s interval shown on the graph?

Ans- c=8m

D=4m

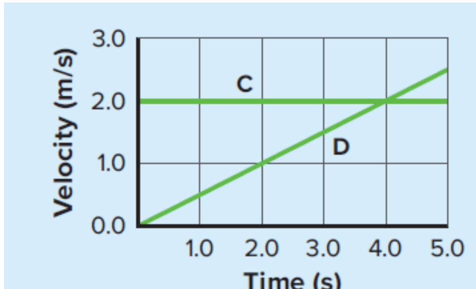
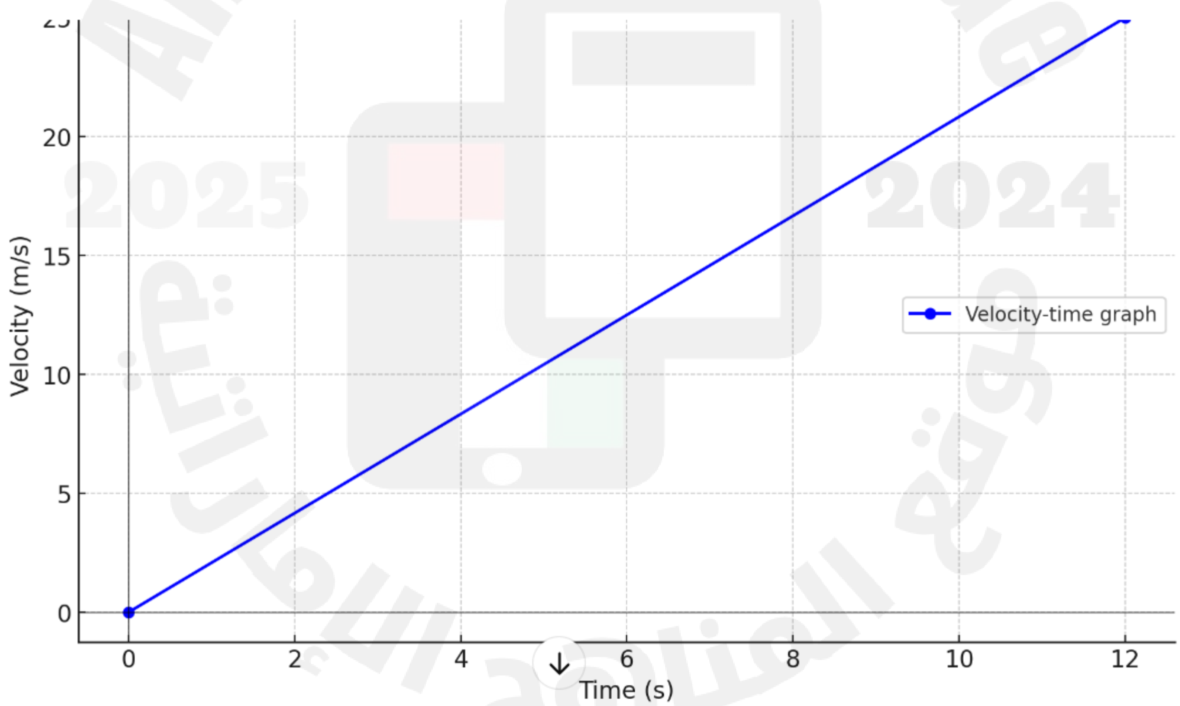


Figure 14

22. CHALLENGE A car, just pulling onto a straight stretch of highway, has

a constant acceleration from 0 m/s to 25 m/s west in 12 s.

a. Draw a v-t graph of the car's motion.

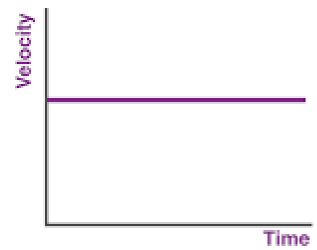


b. Use the graph to determine the car's displacement during the 12.0-s time interval.

As- displacement= (12x25)/2

=150m

c. Another car is traveling along the same stretch of highway. It travels the same distance in the same time as the first car, but its velocity is constant. Draw a v-t graph for this car's motion.



Velocity-time graphs with constant velocity (zero acceleration)

d. Explain how you knew this car's velocity.
Ans- velocity= displacement/time

Q23-Q27 – we solved already.

28. A car with an initial velocity of 24.5 m/s east has an acceleration of 4.2 m/s2 west.

What is its displacement at the moment that its velocity is 18.3 m/s east?

$$\frac{v_f^2 - v_i^2}{2a} = \Delta x$$

$$\frac{334.89 - 600.25}{2(-4.2)} = 31.59 m$$

29. A man runs along the path shown in Figure 17. From point A to point B, he runs at a forward velocity of 4.5 m/s for 15.0 min. From point B to point C, he runs up a hill. He slows down at a constant rate of 0.050 m/s2 for 90.0 s and comes to a stop at point C. What was the total distance the man ran?

$$d = v_1 t_1 + \frac{1}{2}(v_{2f} + v_{2i})t_2$$

$$= (4.5 \text{ m/s})(15.0 \text{ min})(60 \text{ s/min}) + \frac{1}{2}(0.0 \text{ m/s} + 4.5 \text{ m/s})(90.0 \text{ s})$$

$$= 4.3 \times 10^3 \text{ m}$$

30. You start your bicycle ride at the top of a hill. You coast down the hill at a constant acceleration of 2.00 m/s2. When you get to the bottom of the hill, you are moving at 18.0 m/s, and you pedal to maintain that speed. If you continue at this speed for 1.00 min, how far will you have gone from the time you left the hilltop?

Part 1: Constant acceleration:

$v_f^2 = v_i^2 + 2a(d_f - d_i)$ and $d_i = 0.00$ m

so $d_f = \frac{v_f^2 - v_i^2}{2a}$

since $v_i = 0.00$ m/s

$$d_f = \frac{v_f^2}{2a}$$

$$= \frac{(18.0 \text{ m/s})^2}{(2)(2.00 \text{ m/s}^2)}$$

$$= 81.0 \text{ m}$$

31. Sunee is training for a 5.0-km race. She starts out her training run by moving at a constant pace of 4.3 m/s for 19 min. Then she accelerates at a constant rate until she crosses the finish line 19.4 s later. What is her acceleration during the last portion of the training run?

Part 1: Constant velocity:

$d = vt$

$= (4.3 \text{ m/s})(19 \text{ min})(60 \text{ s/min})$

$= 4902$ m

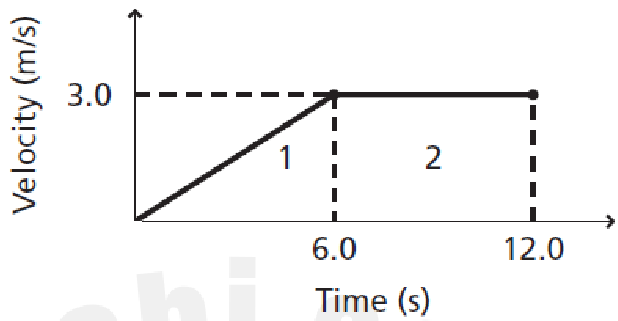
Part 2: Constant acceleration:

$$d_f = d_i + v_i t + \frac{1}{2}at^2$$

$$a = \frac{2(d_f - d_i - v_i t)}{t^2} = \frac{(2)(5.0\times10^3 \text{ m} - 4902 \text{ m} - (4.3 \text{ m/s})(19.4 \text{ s}))}{(19.4 \text{ s})^2}$$

$$= 0.077 \text{ m/s}^2$$

32. CHALLENGE Sekazi is learning to ride a bike without training wheels. His father pushes him with a constant acceleration of 0.50 m/s2 east for 6.0 s. Sekazi then travels at 3.0 m/s east for another 6.0 s before falling. What is Sekazi's displacement? Solve this problem by constructing a velocity-time graph for Sekazi's motion and computing the area underneath the graphed line.



Part 1: Constant acceleration:

$d_1 = \frac{1}{2}(3.0 \text{ m/s})(6.0 \text{ s})$

$= 9.0 \text{ m}$

Part 2: Constant velocity:

$d_2 = (3.0 \text{ m/s})(12.0 \text{ s} - 6.0 \text{ s})$

$= 18 \text{ m}$

Thus $d = d_1 + d_2 = 9.0 \text{ m} + 18 \text{ m} = 27 \text{ m}$

33. Displacement Given initial and final velocities and the constant acceleration of an object, what mathematical relationship would you use to find the displacement?

$v_f^2 = v_i^2 + 2ad_f$

34. Acceleration A woman driving west along a straight road at a speed of 23 m/s sees a deer on the road ahead. She applies the brakes when she is 210 m from the deer. If the deer does not move and the car stops right before it hits the deer, what is the acceleration provided by the car's brakes?

$$v_f^2 = v_i^2 + 2a(d_f - d_i)$$

$$a = \frac{v_f^2 - v_i^2}{2(d_f - d_i)}$$

$$= \frac{0.0 \text{ m/s} - (23 \text{ m/s})^2}{(2)(210 \text{ m})}$$

$$= -1.3 \text{ m/s}^2$$

35. Distance The airplane in Figure 18 starts from rest and accelerates east at a constant 3.00 m/s2 for 30.0 s before leaving the ground.

a. What was the plane's displacement (Δ*x*)?

b. How fast was the airplane going when it took off?

a. How far did it move?

$$d_f = v_i t_f + \frac{1}{2} a t_f^2$$

$$= (0.0 \text{ m/s})(30.0 \text{ s})^2 + \left(\frac{1}{2}\right)(3.00 \text{ m/s}^2)(30.0 \text{ s})^2$$

$$= 1.35\times10^3 \text{ m}$$

b. How fast was the airplane going when it took off?

$$v_f = v_i + a t_f$$

$$= 0.0 \text{ m/s} + (3.00 \text{ m/s}^2)(30.0 \text{ s})$$

$$= 90.0 \text{ m/s}$$

36. Distance An in-line skater accelerates from 0.0 m/s to 5.0 m/s in 4.5 s, then continues at this constant speed for another 4.5 s. What is the total distance traveled by the in-line skater?

Accelerating

$$d_f = \bar{v}t_f = \frac{v_i + v_f}{2}(t_f)$$

$$= \left(\frac{0.0\ \text{m/s} + 5.0\ \text{m/s}}{2}\right)(4.5\ \text{s})$$

$$= 11.25\ \text{m}$$

Constant speed

$$d_f = v_f t_f$$

$$= (5.0\ \text{m/s})(4.5\ \text{s})$$

$$= 22.5\ \text{m}$$

$$\text{total distance} = 11.25\ \text{m} + 22.5\ \text{m}$$

$$= 34\ \text{m}$$

37. Final Velocity A plane travels 5.0×10^2 m north while accelerating uniformly from rest at 5.0 m/s^2. What final velocity does it attain?

$$v_f^2 = v_f^2 + 2a(d_f - d_i) \text{ and } d_i = 0, \text{ so}$$

$$v_f^2 = v_f^2 + 2ad_f$$

$$v_f = \sqrt{(0.0\ \text{m/s})^2 + 2(5.0\ \text{m/s}^2)(5.0\times10^2\ \text{m})}$$

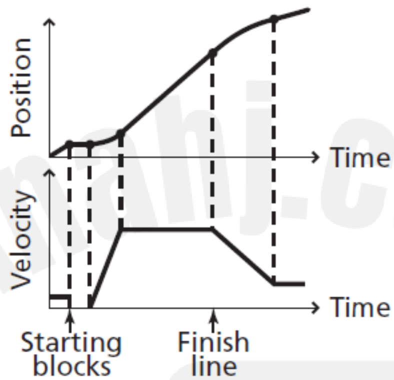
$$= 71\ \text{m/s}$$

38. Final Velocity An airplane accelerated uniformly from rest at the rate of 5.0 m/s2 south for 14 s. What final velocity did it attain?

$$v_f = v_i + at_f$$

$$= 0 + (5.0\ \text{m/s}^2)(14\ \text{s}) = 7.0\times10^1\ \text{m/s}$$

39. Graphs A sprinter walks to the starting blocks at a constant speed, then waits. When the starting pistol sounds, she accelerates rapidly until she attains a constant velocity. She maintains this velocity until she crosses the finish line, and then she slows to a walk, taking more time to slow down than she did to speed up at the beginning of the race. Sketch a velocity time and a position-time graph to represent her motion. Draw them one above the other using the same time scale. Indicate on your position time graph where the starting blocks and finish line are.



Q4.Part A:Recognize physical quantities like time, mass, temperature, volume, density, and classify them into base and derived quantities and specify the dimension of each quantity in the SI - system of units. P. (9 - 10)P.(33-36)P. (71-74)

ANS- ALREADY SOLVED

Part B:Differentiate between distance travelled and displacement and calculate them.P.12 Q(9-11)-ALREADY SOLVED

No.	Distance covered	No.	Displacement
1.	It is the change in position of a particle without the mention of a direction.	1.	It is change in position of a particle in a specified direction.
2.	It is the actual length of the path covered by the particle.	2.	It is the shortest distance between the initial and the final point described by the particle.
3.	It is not zero at the end of the motion of the particle even if it returns to the point of start.	3.	It is zero, if the particle returns back to the point of start.
4.	It is a scalar physical quantity.	4.	It is a vector physical quantity.

Part C:1. Describe the motion of an object under free fall during its rising and falling motion.Q.(7-9)P.36 -ALREADY SOLVED

ANS- An object that is moving under only the influence of gravity is in free fall. In order for an object to be in free fall, wind and air resistance must be ignored. On Earth, all objects in free fall accelerate downward at the rate of gravity or 9.81 m/s 2

2.Perform an investigation to study the acceleration due to gravity for a system in free fall. Q.(40-51) P.75

ANS- ALREADY SOLVED