حل تجميعة أسئلة نهائية وفق الهيكل الوزاري منهج انسباير

InspirePhysics

Grade 9 – Advanced. AY: 2024 – 2025 . . . T 1.

End of Term 1 Final Summative Assessment Preparation.

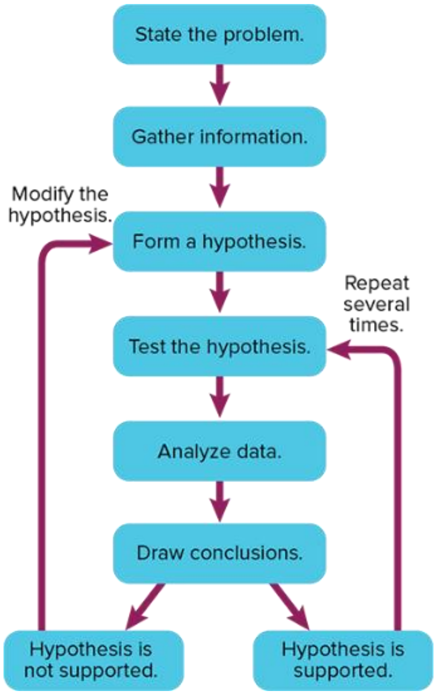
Contents.

[Unit – 1] Mechanics in One Dimension.	Lessons.
Module 1: Physics Toolkit.	Lesson – 1: Methods of Science. Lesson – 2: Mathematics and Physics. Lesson – 3: Measurement. Lesson – 4: Graphing Data.
Module 2: Representing Motion.	Lesson – 1: Picturing Motion. Lesson – 2: Where and when? Lesson – 3: Position – Time Graphs. Lesson – 4: How Fast?
Module 3: Accelerated Motion.	Lesson – 1: Acceleration. Lesson – 2: Motion with Constant Acceleration. Lesson – 3: Free Fall.

You may use the following equations			
$\Delta x = x_f - x_i$	$v_f = v_i + \bar{a}\Delta t$	$x_f = x_i + v_i t + \frac{1}{2}\bar{a}t_f^2$	$\bar{v} \equiv \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$
$x = \bar{v}t + x_i$	$v_f^2 = v_i^2 + 2\bar{a}(x_f - x_i)$	$g = 9.8\ \text{m/s}^2$	$\bar{a} \equiv \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$

PART ONE – MULTIPLE CHOICE QUESTIONS (MCQ). . . . . (LO): Learning Objective

LO – 1. Pages: 4 – 6. Questions 1 – 6 page 8.
(1) Define the term scientific method and list the common steps of scientific methods used in investigations.
(2) Define the term hypothesis and identify the ways in which a hypothesis can be tested.



Check Your Progress
1. Summarize the steps you might use to carry out an investigation using scientific methods.
1) Make observations and ask a question.
2) Research the problem and make a hypothesis.
3) Design and carry out an experiment.
4) Analyze to see if my hypothesis was supported.
5) Refine my question based on experimental results.

2. Define the term hypothesis. Identify three ways to test a hypothesis.
A hypothesis is an educated explanation. Hypotheses can be tested and evaluated.
A hypothesis is a possible explanation for a problem using what you know and what you observe. A hypothesis can be tested by making observations, by building a model, or by performing an experiment.

3. Describe why it is important for scientists to avoid bias.
Bias can affect the results or conclusion of an investigation, making them invalid.

4. Explain why scientists use models. Give an example of a scientific model not mentioned in this lesson and explain how it is useful.
Scientists use models to help explain or learn more about things that are too large, too small, or too far to visualize or observe easily. Examples may include the solar system, a cell, or the aerodynamics of an aircraft.

5. 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?

Testing opinions is not scientific. It is impossible to prove that an opinion is true for everyone. In addition, the survey was based on a small part of the population, and it only included students at one school. The results cannot be extended to the entire population.

6. Critical Thinking An accepted value for free-fall acceleration is $9.8\ \mathrm{m/s^2}$. In an experiment with pendulums, you calculate a value to be $9.4\ \mathrm{m/s^2}$. Should the accepted value be tossed out because of your finding? Explain.

No; the value of $9.8\ \mathrm{m/s^2}$ has been established by many other experiments, and to discard the finding you would have to explain why it is wrong. There are probably some factors affecting your calculation, such as friction or how precisely you measured the variables.

LO – 2: Pages: 9 – 10. Question 9 page 12.

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.

You need to memorize them.

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

Q (9). How many seconds are in a leap year?

$\text{Number of seconds in a leap year} = 366 \times 24 \times 3600 = 31{,}622{,}400\ \text{s}$

Question: Which is NOT an Sl base unit?

[A] meter

[B] kilogram

[C] second

[D] degree Celsius

LO – 3: Pages: 10 – 11. Questions 9 – 11 page 12.

Use dimensional analysis to validate equations and to choose the appropriate conversion factor when converting units.

Q (10) Rewrite $F = Bqv$ to find v in terms of $F, q,$ and B.

$F = Bqv$

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

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

Q (11). Using values given in a problem and the equation for distance, $distance = speed\ x\ time$, 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?

For most cars, the answer is unreasonable because 290 km/h is equivalent to 81 m/s or 180 mph. The speed might be reasonable for a race car.

LO – 4: Pages: 13 – 15. Q 12 – 17 Page 16.

Determine the sources of error and distinguish between precision and accuracy.

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?

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?

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.

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.

His height would be between 181.5 cm 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?

[a]

$$\text{Volume} = \text{Length} \times \text{Width} \times \text{Height}$$
$$\text{Volume} = 18.1\text{ cm} \times 19.2\text{ cm} \times 20.3\text{ cm}$$
$$\text{Volume} = 7054.656\text{ cm}^3$$
$$\text{Volume} = 7050\text{ cm}^3\ (3\text{ Significant Figures})$$
$$\text{Volume} = 7.05 \times 10^3\text{ cm}^3$$

[b] nearest tenth of a cm; nearest 10 cm^3

[c] Height of 12 boxes $= 12 \times 20.3 = 234.6$ cm

[d] 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.
You should not have much confidence in the precision of the report. A result can never be more precise than the least precise measurement. The calculated average lap time exceeds the precision possible with the clock.

LO – 5: Pages: 14 – 15. Q 12 – 17 Page 16.
Measure the base quantities and some derived quantities using suitable measurement tools and record those measurements taking into account significant figures and scientific notation.

LO – 6: Pages: 37 – 39. Questions: 10 – 14, Pages: 38 – 39.
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

For problems 10-12, refer to Figure 13.

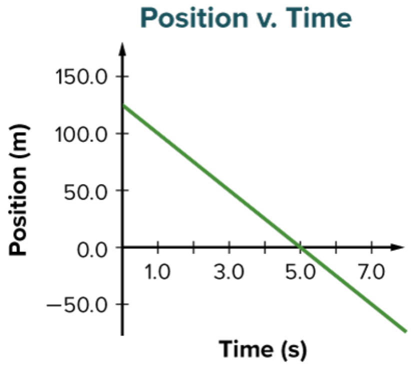
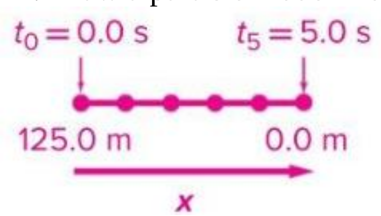


Figure 13

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

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?

		[a]	[b]
Average velocity	Equation of Motion	When is $x = 25$ m?	Where was the car at time $t = 1.0$ s?
$\bar{v} = \frac{x_f - x_i}{t_f - t_i}$ $\bar{v} = \frac{0 - 125}{5 - 0}$ $\bar{v} = -25$ m/s	$x = \bar{v}t + x_i$ $x = (-25)t + 125$	$25 = (-25)t + 125$ $t = 4.0$ s	$x = (-25)t + 125$ $x = (-25)(1.00) + 125$ $x = 100.0$ m east of origin

[c] The displacement of the car between times $t = 1.0$ s and $t = 3.0$ s?

$\Delta x = x_f - x_i$

$\Delta x = x_{at\ t=3} - x_{at\ t=1}$

$\Delta x = [(-25)(3) + 125] - [(-25)(1) + 125]$

$\Delta x = -50$ m

$\Delta x = 50.0$ m to the west

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.

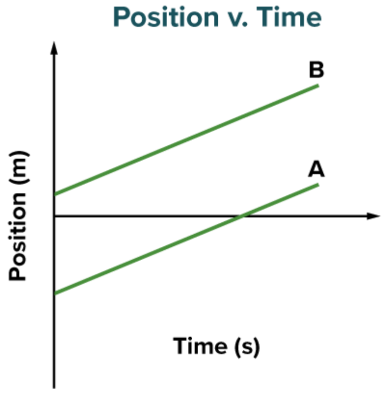


Figure 13

The pedestrians walk the same distance during each time interval, and they both walk east the entire time. Pedestrian A starts west of the origin, walks toward the origin, and continues walking east. Pedestrian B starts east of the origin and walks east.

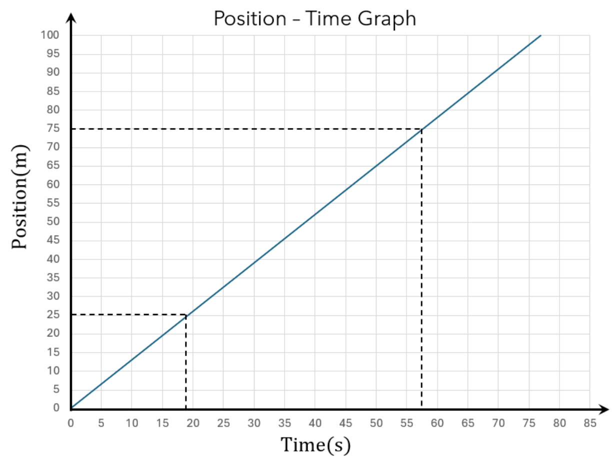
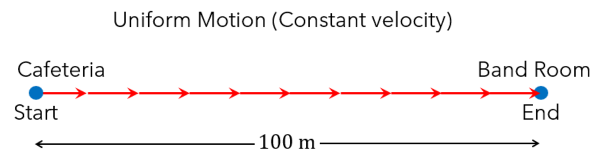
14. CHALLENGE Ari walked down the hall at school from the cafeteria to the band room, a distance of 100.0 m. A class of physics students recorded and graphed his position every 2.0 s, noting that he moved 2.6 m every 2.0 s. When was Ari at the following positions?

a. 25.0 m from the cafeteria

b. 25.0 m from the band room

c. Create a graph showing Ari's motion.

		[a]	[b]
Average velocity	Equation of Motion	When was Ari 25.0 m from the cafeteria?	When was Ari 25.0 m from the band room?
$\bar{v} = \frac{\Delta x}{\Delta t}$ $\bar{v} = \frac{2.6}{2.0}$ $\bar{v} = 1.3\ \text{m/s}$	$x = \bar{v}t + x_i$ $x = (1.3)t + 0.0$ $x = (1.3)t$	$x = (1.3)t$ $25 = (1.3)t$ $t = 19\ \text{s}$	$x = (1.3)t$ $75 = (1.3)t$ $t = 58\ \text{s}$

Position – time graph.	Motion diagram.
	

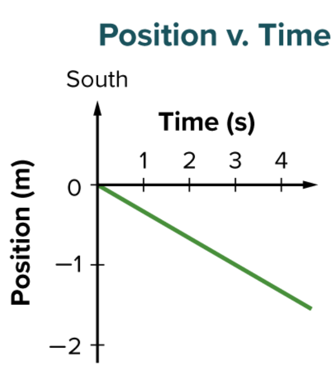
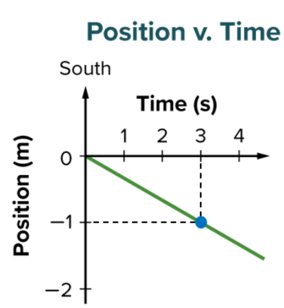
LO – 7: Pages: 43 – 44. Questions: 26 – 31, Pages: 45.

Explain the meaning of instantaneous position for an object in motion.

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?

Figure 22		Average velocity	Average speed
		$\bar{v} = \frac{x_f - x_i}{t_f - t_i}$ $\bar{v} = \frac{-1 - 0}{3 - 0}$ $\bar{v} = -0.3\ \text{m/s}$ $\bar{v} = 0.3\ \text{m/s north}$	$\overline{\text{speed}} = \lvert\bar{v}\rvert$ $\overline{\text{speed}} = \lvert -0.3\ \text{m/s}\rvert$ $\overline{\text{speed}} = 0.3\ \text{m/s}$

27. Describe, in words, the cruise ship's motion in the previous problem.
The ship is moving north at a speed of 0.3 m/s.

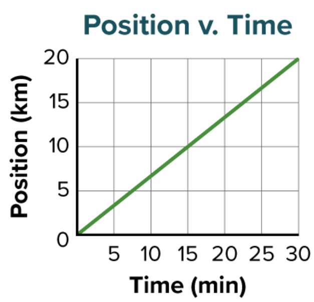
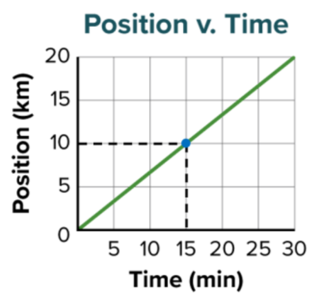
28. What is the average velocity of an object that moves from 6.5 cm to 3.7 cm relative to the origin in 2.3 s?

$$\bar{v} = \frac{x_f - x_i}{t_f - t_i}$$

$$\bar{v} = \frac{3.7 - 6.5}{2.3}$$

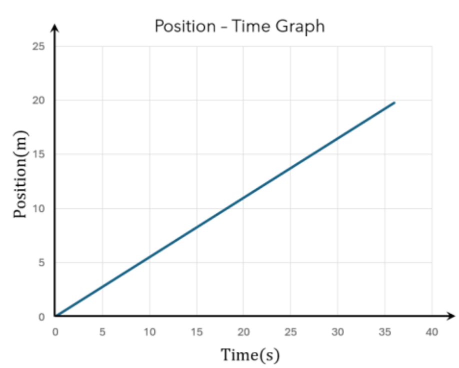
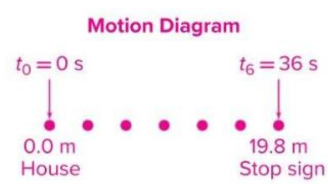
$$\bar{v} = -1.2 \text{ cm/s}$$

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?

Figure 23		Average velocity	Average speed
		$\bar{v} = \frac{x_f - x_i}{t_f - t_i}$ $\bar{v} = \frac{10 - 0}{15 - 0}$ $\bar{v} = 0.7 \text{ km/min } (+\text{ve})$	$\overline{\text{speed}} = \lvert \bar{v} \rvert$ $\overline{\text{speed}} = \lvert 0.7 \text{ km/min} \rvert$ $\overline{\text{speed}} = 0.7 \text{ km/min}$

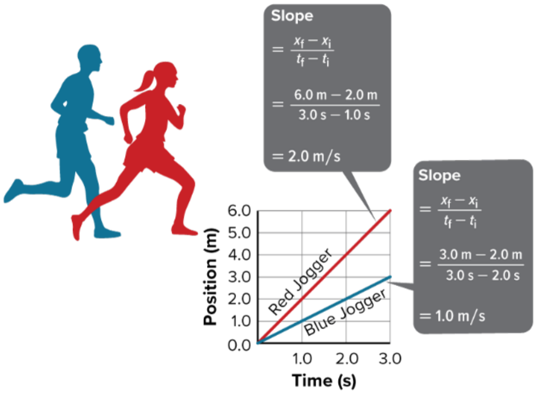
30. Describe, in words, the bicycle's motion in the previous problem.
The bicycle is moving in the positive direction at a speed of 0.7 km/min.

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.

Equation of Motion	Position – time Graph	Motion Diagram
$x = \bar{v}t + x_i$ $x = (0.55)t + 0.0$ $x = 0.55\,t$		

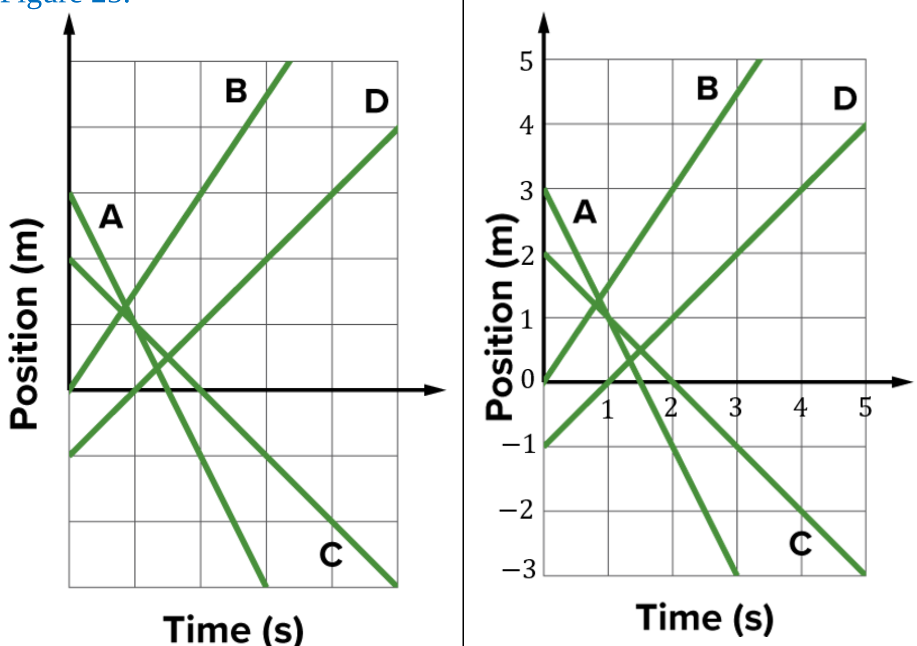
LO – 8: Pages: 42 – 44. Figure 19 & Questions: 37 – 39, Pages: 48.
Analyze a position-time graph to describe an object's motion.

Figure 19.



For problems 37-39, refer to Figure 25.

Figure 25.



$$\bar{v} = \frac{x_f - x_i}{t_f - t_i}$$

$$\bar{v}_A = \frac{-3-3}{3-0} = -2\ \text{m/s}$$

$$\bar{v}_B = \frac{3-0}{2-0} = 1.5\ \text{m/s}$$

$$\bar{v}_C = \frac{-3-2}{5-0} = -1\ \text{m/s}$$

$$\bar{v}_D = \frac{4-(-1)}{5-0} = 1\ \text{m/s}$$

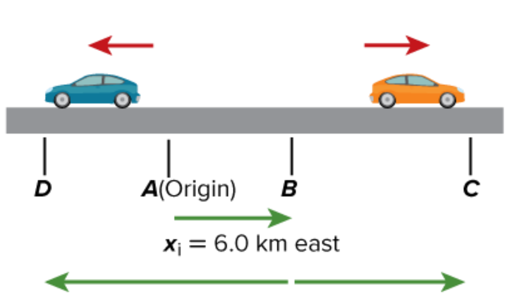
37. **Ranking Task** Rank the position-time graphs according to the average speed, from greatest average speed to least average speed. Specifically indicate any ties.
$A, B, C = D$

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.
The magnitude of the average velocity of A is greater than that of B, but the average velocity of A is negative, and the average velocity of B is positive. The magnitudes of the average velocities of C and D are equal, but the average velocity of D is positive, and the average velocity of C is negative.

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

40. **Average Speed and Average Velocity** Explain how average speed and average velocity are related to each other for an object in uniform motion.
Average speed is the absolute value of the average velocity if an object is in uniform motion.

41. **Position** Two cars are traveling along a straight road, as shown in Figure 26. They pass each other at point B and then continue in opposite directions. The orange car travels for 0.25 h from point B to point C at a constant velocity of 32 km/h east. The blue car travels for 0.25 h from point B to point D at a constant velocity of 48 km/h west. How far has each car traveled from point B?
What is the position of each car relative to the origin, point A?

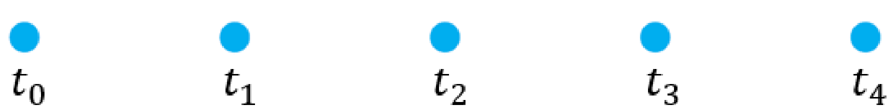
	The orange car has traveled 8 km east of point B. $\Delta x_{BC} = (32)(0.25)$ $\Delta x_{BC} = 8.0$ km	The blue car has traveled 12 km west of point B. $\Delta x_{BD} = (-48)(0.25)$ $\Delta x_{BD} = -12.0$ km

The orange car's position is 14 km east of the origin. The blue car's position is 6 km west of the origin.

LO – 9: Pages: 30 – 31. Questions: 1 – 5, Page: 31. Questions: 20 – 24, Page: 41
Conduct an investigation to show different kinds of motion using motion diagrams and particle models.

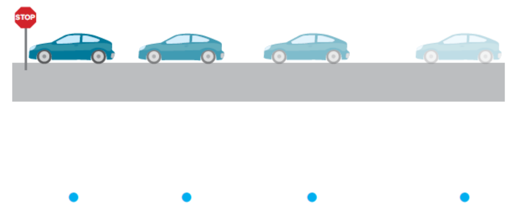
Q (1) How does a motion diagram represent an object's motion?
A motion diagram shows the positions of a moving object at equal time intervals.

Q (2) Describe the particle model motion diagram for a bike rider moving at a constant pace along a straight path.
A series of equally spaced dots along a straight line. Each dot represents the position of the bike rider at successive equal time intervals.



Q (3) 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



The point should be close to the center of the car. As the car slowed down as it moved to the left, the distance it traveled during each equal time interval became less and less.

Q (4) 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

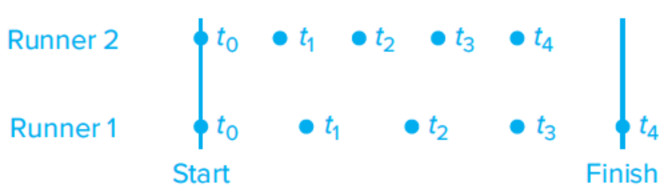
The point should be close to the center of the bird. The equal distances between the dots indicate that the bird was flying at a constant speed.

Figure 5

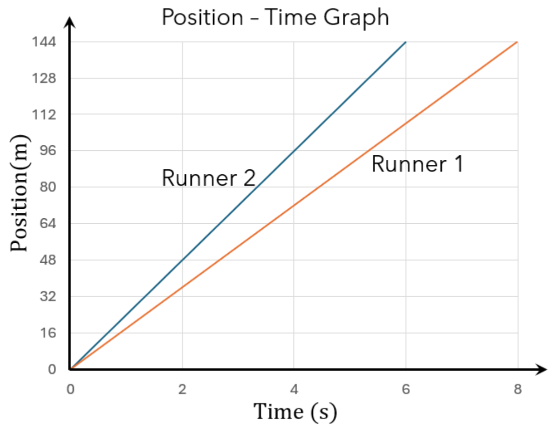
Q (5) Draw particle model motion diagrams for two runners during a race in which the first runner crosses the finish line as the other runner is three-fourths of the way to the finish line.

First Runner: Starts at the origin and moves steadily to the right, reaching the finish line (position $x = L$) at time $t = T$.

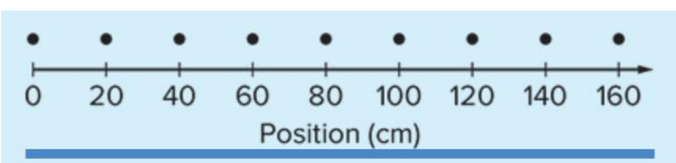
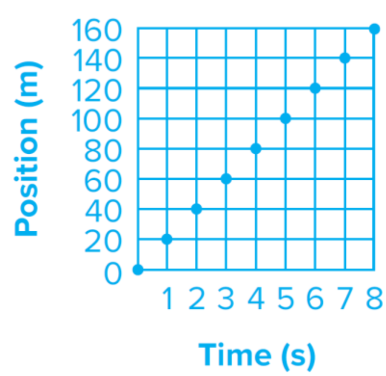
Second Runner: Starts at the origin and moves to the right, but at a slower pace, reaching only three-fourths of the distance to the finish line ($x = 0.75L$) at time $t = T$.



Numerically Example.
The path length is 144 m. Runner 2 speed is 24 m/s, and runner 1 speed is 18 m/s.

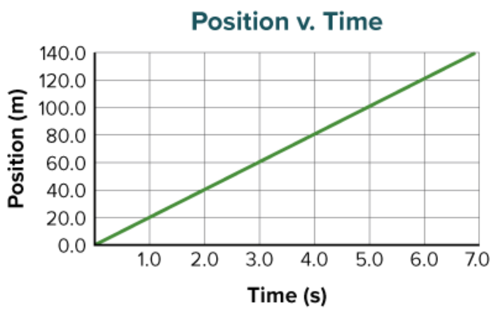
	$x_2 = 24\,t$ $x_1 = 18\,t$ Runner 2: $144 = 24\,t$ $t_2 = 6$ s Runner 1: $144 = 18\,t$ $t_1 = 8$ s	Runner 2 will pass the finish line in 6.0 seconds. While Runner 1 will be at: $x_1 = 18\,(6)$ $x_1 = 108$ m Form the finish line. Note that: $\frac{108}{144} = \frac{3}{4}$ Three-fourths of the way to the finish line.

Q (20) 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 baby's motion. The time interval between successive dots on the diagram is 1 s.

 **Figure 16**	

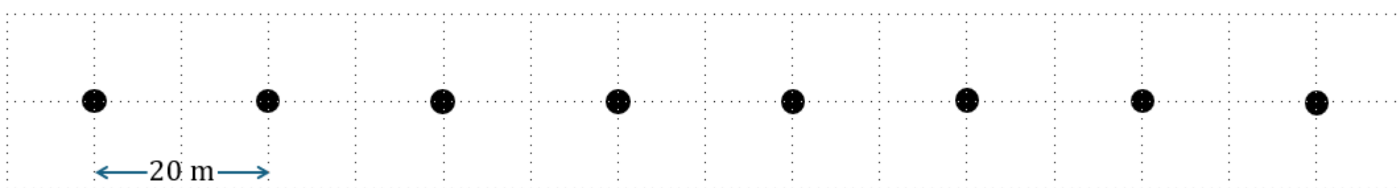
The straight line formed by the dots indicated the baby crawled at a constant speed.
The positive slope of the line of dots shows that the baby was crawling in the positive direction away from the origin.

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



Q (21) Create a particle model motion diagram from the position-time graph of a hockey puck gliding across the ice.
The diagram should show equally spaced dots. If the time interval between successive dots is one second, the dots should be spaced to represent 20 m apart.

Time (s)	0	1	2	3	4	5	6	7
Position (m)	0	20	40	60	80	100	120	140



Q (22) Use the hockey puck's position-time graph to determine the time when the puck was 10.0 m beyond the origin. 0.5 seconds.

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

$\Delta x = x_f - x_i$

$\Delta x = 100 - 0$

$\Delta x = 100 \text{ m}$

Q (24) Use the position-time graph for the hockey puck to determine how much time it took for the puck to go from 40 m beyond the origin to 80 m beyond the origin.

$\Delta t = t_f - t_i$

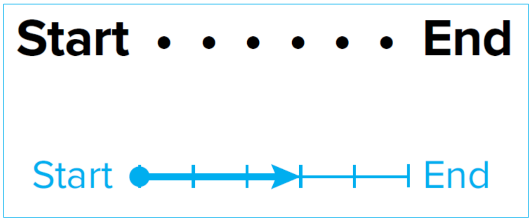
$\Delta t = 4 - 2$

$\Delta t = 2.0 \text{ s}$

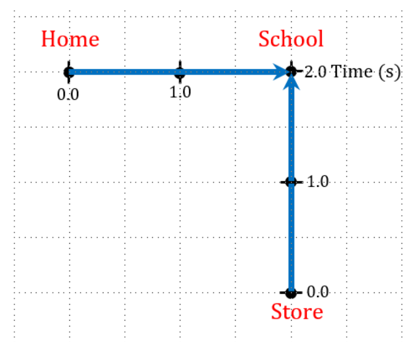
LO – 10: Page 33. Questions 7 – 9, Page 36.
Express the motion of an object along a straight line (uniform and non-uniform) using motion and vector diagrams and describe the motion in own words.

Q (7) 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.



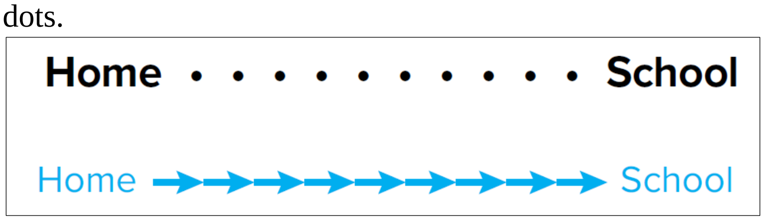
Q (8) Two students added a vector for a moving object's position at $t = 2$ s to a motion diagram. When they compared their diagrams, they found that their vectors did not point in the same direction. What is a possible explanation for this?

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.	

Q (9) The motion diagram for a boy walking to school is shown below.

Home • • • • • • • • • • School

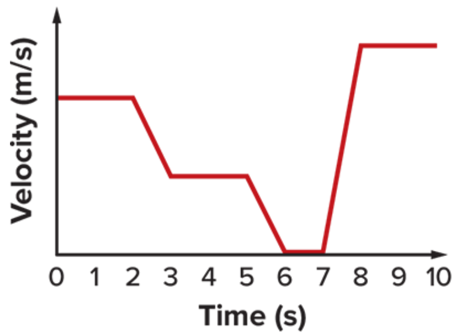
Make a copy of this motion diagram and draw vectors to represent the displacement between each pair of dots.

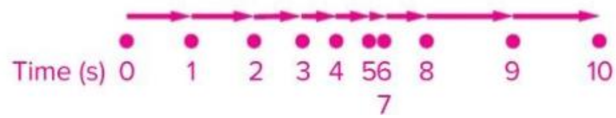


LO – 11: Pages 58 – 60. Questions 1 – 4, Page 60.
Calculate the instantaneous acceleration from a velocity-time graph.

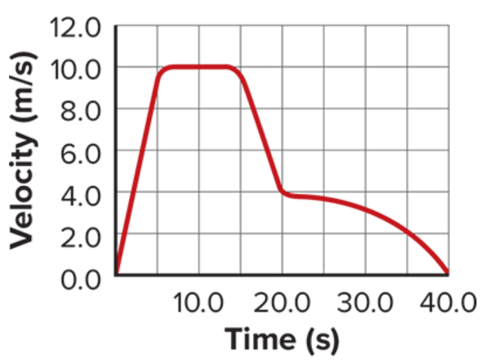
Q (1) The velocity-time graph in Figure 8 describes Steven's motion as he walks along the midway at the state fair. Sketch the corresponding motion diagram. Include velocity vectors in your diagram.

Figure 8





Q (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?



a. 5.0 to 15.0 s

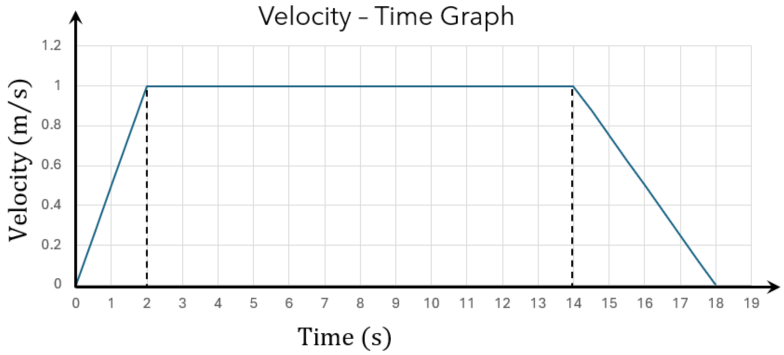
b. 0.0 to 5.0 s

c. 15.0 to 20.0 s

Q (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

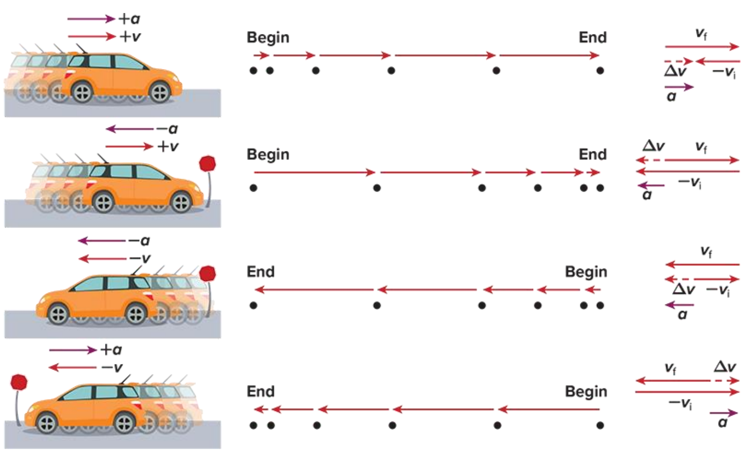
[a]	[b]	[c]
$\bar{a} = \frac{v_f - v_i}{t_f - t_i}$	$\bar{a} = \frac{v_f - v_i}{t_f - t_i}$	$\bar{a} = \frac{v_f - v_i}{t_f - t_i}$
$\bar{a} = \frac{10 - 0}{5 - 0}$	$\bar{a} = \frac{4 - 10}{20 - 15}$	$\bar{a} = \frac{0 - 0}{40 - 0}$
$\bar{a} = 2.0\ \mathrm{m/s^2}$	$\bar{a} = -1.2\ \mathrm{m/s^2}$	$\bar{a} = 0.0\ \mathrm{m/s^2}$

Q (4) 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 $0.5\ \mathrm{m/s^2}$, 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 $0.25\ \mathrm{m/s^2}$ for 4.0 s as it reaches the third floor.

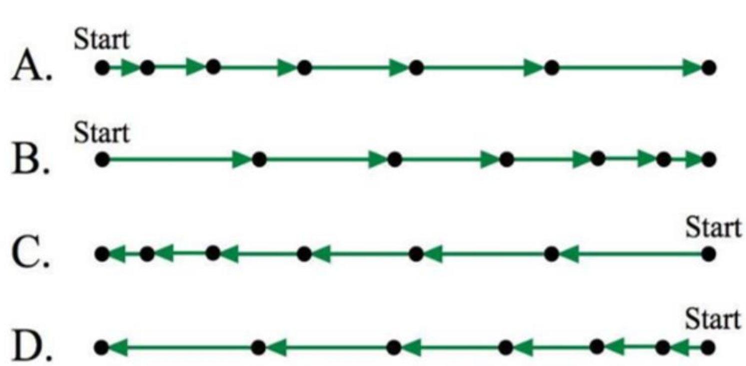


LO – 12: Pages 56. Figure 4.

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.

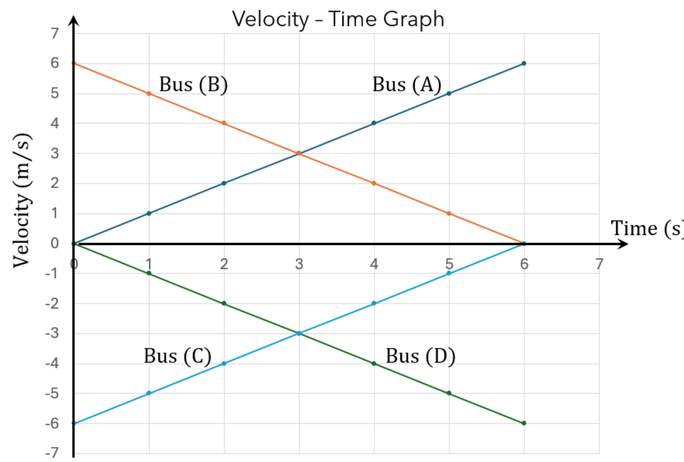


Question: The motion diagrams below show the motion of four busses moving along the x – axis. Which busses have positive acceleration?

	(a) A and C (b) B and D (c) A and D (d) B and C

Example:

<table>
<tr><td>
Assume the four buses have the same speed of 1.0 m/s.

	Velocity – time function.
Bus – A	$v = t$
Bus – B	$v = -t + 6$
Bus – C	$v = t - 6$
Bus – D	$v = -t$
</td><td>


</td></tr>
</table>

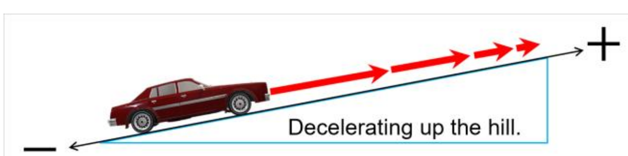
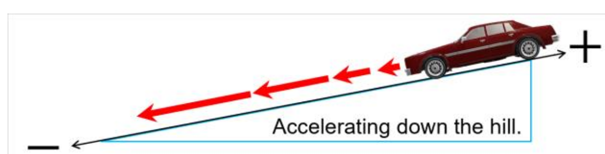
LO – 13: Page 57. Questions 1 – 4, Pages 60 – 61.

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.

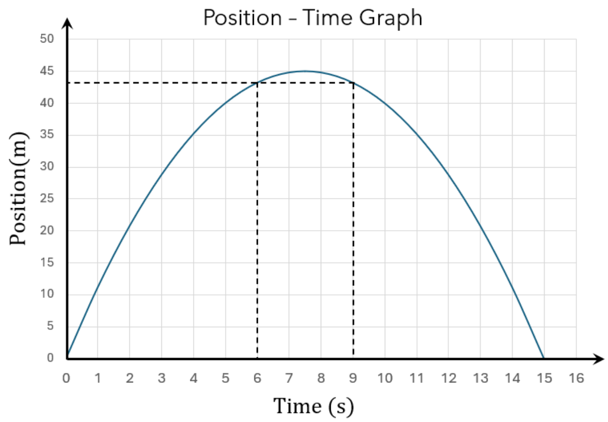
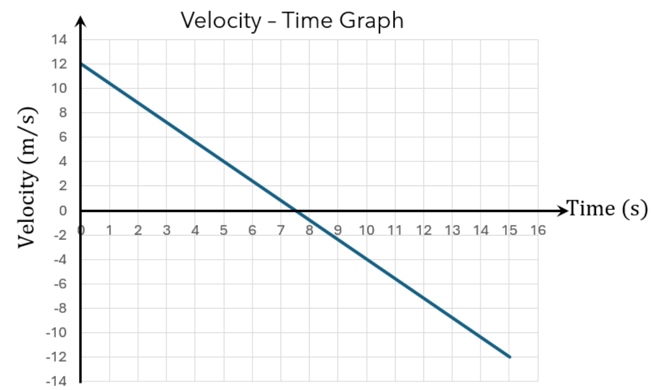
Q (1) A car moves forward up a hill at 12 m/s with a uniform backward acceleration of 1.6 $\mathrm{m/s^2}$.

a. What is its displacement after 6.0 s?	$\Delta x = v_i t + \frac{1}{2}\, a\, t^2$ $\Delta x = (12 \times 6.0) + \left(\frac{1}{2} \times (-1.6) \times 6.0^2\right)$ $\Delta x =$ 43 m up the hill
b. What is its displacement after 9.0 s?	$\Delta x = v_i t + \frac{1}{2}\, a\, t^2$ $\Delta x = (12 \times 9.0) + \left(\frac{1}{2} \times (-1.6) \times 9.0^2\right)$ $\Delta x =$ 43 m up the hill

Diagrams.

During the first 7.5 seconds.	During the second 7.5 seconds.
	

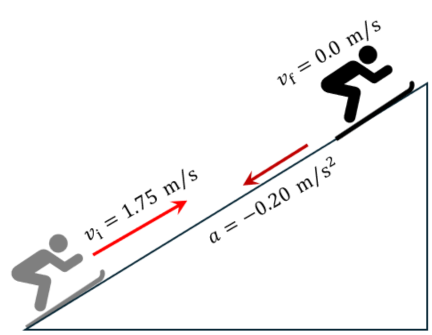
Graphs.

<table>
<tr><th>Position – Time Graph. $x = 12\,t - 0.8\,t^2$</th><th>Velocity – Time Graph. $v = 12 - 1.6\,t$</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

LO – 14: Pages 67 – 69. Questions 23 – 27, Pages 68 – 69.

Apply the equation of motion relating the final position of an object to its initial position, initial velocity, uniform acceleration, and time $x_f = x_i + v_i t + \frac{1}{2}\bar{a}t_f^2$

Q (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 $-0.20\ \text{m/s}^2$. How much time passes from when she begins to slow down until she begins to move back down the incline?

<table>
<tr><td>$v_f = v_i + \bar{a}\Delta t$
$0 = 1.75 + (-0.20)(\Delta t)$
$\Delta t = 8.75\ \text{s}$
$\Delta t = 8.8\ \text{s}$</td><td>
</td></tr>
</table>

Q (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?

$\bar{a} = \frac{v_f - v_i}{t_f - t_i}$ $\bar{a} = \frac{22 - 44}{11}$ $\bar{a} = -2\ \text{m/s}^2$	$x_f = x_i + v_i t + \frac{1}{2}\bar{a}t_f^2$ $x_f = 0 + (44 \times 11) + \frac{1}{2}(-2)(11)^2$ $x_f = 363\ \text{m}$ $x_f = 360\ \text{m}$ (2 Significant Figures)

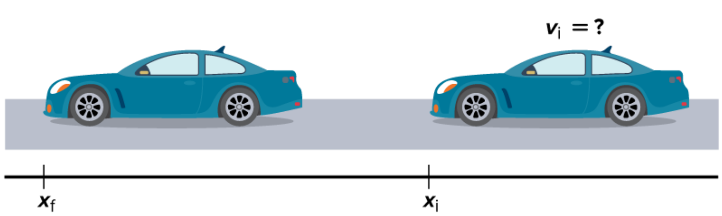
Q (25) A car accelerates at a constant rate from 15 m/s to 25 m/s while it travels a distance of 125 m. How long does it take to achieve the final speed?

$v_f^2 = v_i^2 + 2\bar{a}(x_f - x_i)$ $25^2 = 15^2 + 2\bar{a}(125 - 0)$ $\bar{a} = 1.6\ \text{m/s}^2$	$v_f = v_i + \bar{a}\Delta t$ $25 = 15 + (1.6)(\Delta t)$ $\Delta t = 6.25\ \text{s}$ $\Delta t = 6.3\ \text{s}$ (2 Significant Figures)

Q (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?

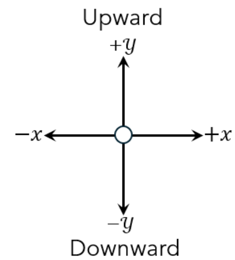
$v_f = v_i + \bar{a}\Delta t$ $7.5 = v_i + \bar{a}(4.5)$ $\bar{a} = \frac{7.5 - v_i}{4.5}$	$v_f^2 = v_i^2 + 2\bar{a}(x_f - x_i)$ $7.5^2 = v_i^2 + 2\left(\frac{7.5 - v_i}{4.5}\right)(19)$ $v_i = 0.94\ \text{m/s north}$	Alternative Solution: $\Delta x = \left(\frac{v_i + v_f}{2}\right) t$ $19 = \left(\frac{v_i + 7.5}{2}\right)(4.5)$ $v_i = 0.94\ \text{m/s north}$

Q (27) The car in the diagram travels west with a forward acceleration of $0.22\ \text{m/s}^2$. What was the car's velocity (v_i) at point x_i if it travels a distance of 350 m in 18.4 s?

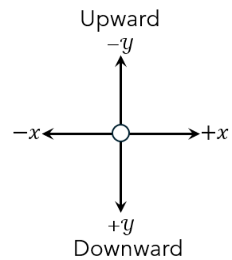
	$\Delta x = v_i t + \frac{1}{2} a t^2$ $350 = (v_i \times 18.4) + \left(\frac{1}{2} \times 0.22 \times 18.4^2\right)$ $v_i = 17\ \text{m/s west}$

LO – 15: Pages 71 – 75. Questions 40 – 51 Pages 75 – 76.
Analyze the position-time, velocity-time, and acceleration-time graphs for an object under free fall.

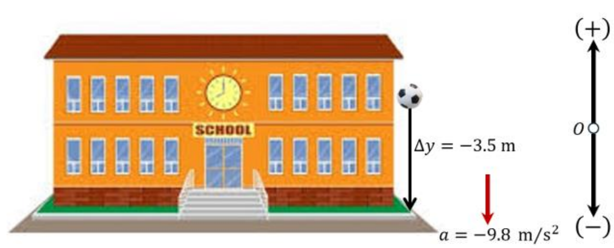
Q (40) A construction worker accidentally drops a brick from a high scaffold.
a. What is the velocity of the brick after 4.0 s?
b. How far does the brick fall during this time?

[a]	[b]	Directions.
$v_f = v_i - g\Delta t$ $v_f = 0 - (9.8)(4.0)$ $v_f = -39.2\ \text{m/s}$ $v_f = 39\ \text{m/s}$ downward	$\Delta y = v_i t - \frac{1}{2} g t^2$ $\Delta y = 0 - \frac{1}{2}(9.8)(4.0)^2$ $\Delta y = -78.4\ \text{m}$ $\lvert\Delta y\rvert = 78\ \text{m}$	

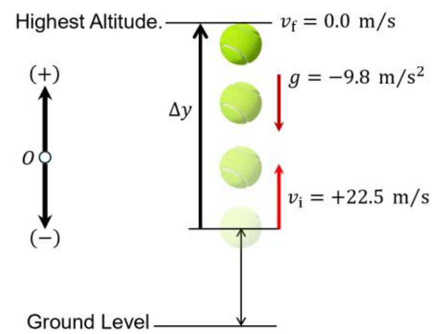
Q (41) Suppose for the previous problem you choose your coordinate system so that the opposite direction is positive.
a. What is the brick's velocity after 4.0 s?
b. How far does the brick fall during this time?

[a]	[b]	Directions.
$v_f = v_i + g\Delta t$ $v_f = 0 + (9.8)(4.0)$ $v_f = +39.2\ \text{m/s}$ $v_f = 39\ \text{m/s}$ downward	$\Delta y = v_i t + \frac{1}{2} g t^2$ $\Delta y = 0 + \frac{1}{2}(9.8)(4.0)^2$ $\Delta y = +78.4\ \text{m}$ $\lvert\Delta y\rvert = 78\ \text{m}$	

Q (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?

$v_f^2 - v_i^2 = 2\,a\,(\Delta y)$ $v_f^2 - 0.0^2 = 2\,(-9.8)\,(-3.5)$ $v_f = 8.3\ \text{m/s}$ downward	

Q (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?

Vertical Displacement.	Time of Flight.	Diagram.
$v_f^2 - v_i^2 = 2\,a\,(\Delta y)$ $0.0^2 - (22.0)^2 = 2\,(-9.8)(\Delta y)$ $\Delta y = 25.8\text{ m}$ $\Delta y = 26\text{ m}$ (2 Significant Figures)	$v_f = v_i + at$ $0.0 = 22.5 + (-9.8 \times t)$ $t_{max} = 2.29\text{ s}$ $t_{total} = 2 \times t_{max}$ $t_{total} = 2 \times 2.30$ $t_{total} = 4.6\text{ s}$	

Q (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?
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?

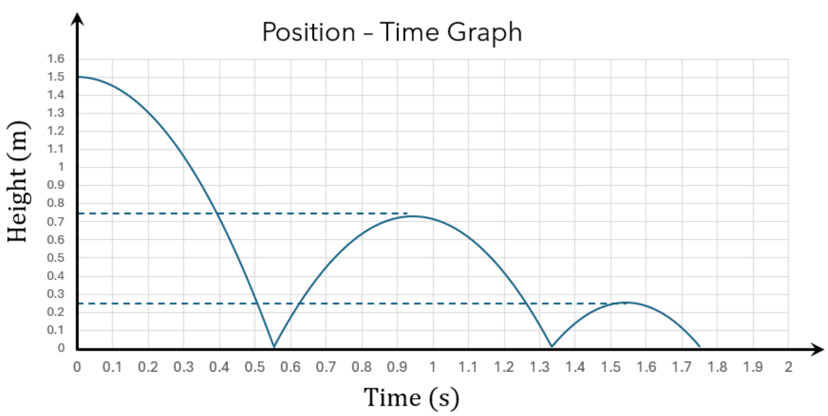
[a]	[b]	[c]
$v = 0.0\text{ m/s}$ $a = 9.8\text{ m/s}^2$ downward	$v_f^2 - v_i^2 = 2\,a\,(\Delta y)$ $0.0^2 - v_i^2 = 2\,(-9.8)(0.25)$ $v_i^2 = 4.9$ $v_i = 2.2\text{ m/s}$	$v_f = v_i + at$ $0.0 = 2.2 + (-9.8 \times t)$ $t_{max} = 0.23\text{ s}$ $t_{total} = 2 \times t_{max}$ $t_{total} = 2 \times 0.23$ $t_{total} = 0.46\text{ s}$

Q (45) 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.

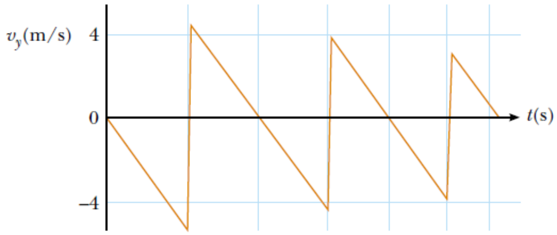
a. Suppose downward is the positive direction. What would the shape of a velocity-time graph look like for the first two bounces?
b. What would be the shape of a position-time graph for the first two bounces?

a. The velocity-time graph would be straight line segments that start at the origin and then rise, fall, and rise again.
b. The graph would start at the origin and have an inverted parabolic shape.

The first fall	After the first bounce.	After the second bounce.
$v_f = v_i - g\Delta t$ $v_f = 0 - (9.8)(t)$ $v_f = -9.8\,t$ $y = y_0 + v_i t - \frac{1}{2}\,g\,t^2$ $y = 1.5 - 4.9\,t^2$	$v_f = v_i - g\Delta t$ $0 = v_i - (9.8)(t_{max})$ $t_{max} = \frac{v_i}{g}$ $y = y_0 + v_i t - \frac{1}{2}\,g\,t^2$ $0.75 = 0 + v_i\left(\frac{v_i}{g}\right) - \left(\frac{g}{2}\right)\left(\frac{v_i}{g}\right)^2$ $0.75 = \frac{v_i^2}{2g}$ $v_i = \sqrt{1.5\,g}$ $y = \sqrt{1.5\,g}\,t - 4.9\,t^2$ $y = \sqrt{14.7}\,t - 4.9\,t^2$	$v_f = v_i - g\Delta t$ $0 = v_i - (9.8)(t_{max})$ $t_{max} = \frac{v_i}{g}$ $y = y_0 + v_i t - \frac{1}{2}\,g\,t^2$ $0.25 = 0 + v_i\left(\frac{v_i}{g}\right) - \left(\frac{g}{2}\right)\left(\frac{v_i}{g}\right)^2$ $0.25 = \frac{v_i^2}{2g}$ $v_i = \sqrt{0.5\,g}$ $y = \sqrt{0.5\,g}\,t - 4.9\,t^2$ $y = \sqrt{4.9}\,t - 4.9\,t^2$



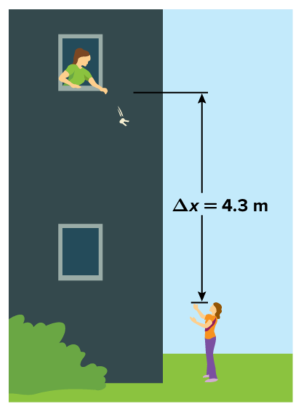
The first fall	After the first bounce.	After the second bounce.
$v_f = -9.8\,t$ $y = y_0 + v_i t - \frac{1}{2}\,g\,t^2$ $0 = 1.5 - 4.9\,t^2$ $t = \sqrt{\frac{3}{g}} = 0.55$ s	$v_f = v_i - g\,t$ $v_f = \sqrt{14.7} - 9.8\,t$ Time of flight: $t_{hang} = 2 \times \frac{\sqrt{14.7}}{9.8}$ $t_{hang} = 0.78$ s	$v_f = v_i - g\,t$ $v_f = \sqrt{4.9} - 9.8\,t$ Time of flight: $t_{hang} = 2 \times \frac{\sqrt{4.9}}{9.8}$ $t_{hang} = 0.45$ s



Q (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.

Free fall is the motion of an object when gravity is the only significant force on it. Air significantly affects the paper but not the book.

Q (47) Your sister drops your house keys down to you from the second-floor window, as shown in the image. What is the velocity of the keys when you catch them?

$v_f^2 - v_i^2 = 2\,a\,(\Delta x)$ $v_f^2 - 0.0^2 = 2\,(-9.8)\,(-4.3)$ $v_f = 9.2\ \text{m/s downward}$	(+) ↕ (−)	

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

Velocity	Displacement.
$v_f = v_i + at$ $v_f = 0.0 + (-9.8 \times 2.3)$ $v_f = -22.54\ \text{m/s}$ $v_f \approx 23\ \text{m/s downward}$	$\Delta y = v_i t + \frac{1}{2}\,a\,t^2$ $\Delta y = (0.0 \times t) + \frac{1}{2}\,(-9.8)\,(2.3)^2$ $\Delta y = -25.921\ \text{m}$ $\Delta y \approx -26\ \text{m}$ $\lvert\Delta y\rvert = 26\ \text{m}$

Q (49) 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?

Maximum height.		Flight time	
Earth	Mars	Earth	Mars
$g = 9.8\ \text{m/s}^2$ $v_f^2 - v_i^2 = -2\,g\,(y - y_0)$ $0 - v_i^2 = -2\,g\,(y_{max} - 0)$ $v_i^2 = 2\,g\,y_{max}$ $y_{max} = \frac{v_i^2}{2g}$	$g_{Mars} = \frac{1}{3} \times g$ $v_f^2 - v_i^2 = -2\,g_{Mars}\,(y - y_0)$ $0 - v_i^2 = -2\left(\frac{g}{3}\right)(y_{max} - 0)$ $v_i^2 = \frac{2\,g\,y_{max}}{3}$ $y_{max} = 3 \times \frac{v_i^2}{2g}$	$v_f = v_i - gt$ $0 = v_i - gt_{max}$ $t_{max} = \frac{v_i}{g}$ Mars.	$v_f = v_i - g_{Mars}t$ $0 = v_i - \frac{g}{3}t_{max}$ $t_{max} = 3 \times \frac{v_i}{g}$

a. The maximum height would be three times higher on Mars.
b. Flight time is three times longer on Mars.

Q (50) 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.
Velocity decreases at a constant rate as the ball travels upward. At the ball's highest point, velocity is zero. As the ball begins to drop, the velocity begins to increase in the negative direction until it reaches the height from which it was initially released. At that point, the ball has the same speed it had upon release. The acceleration is constant throughout the ball's flight.

Q (51) 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 multi-flash photo to measure its position. From photos, calculate the ball's velocity.

PART TWO – FREE RESPONSE QUESTIONS (FRQ)

QUESTION – 1:

Part A:

Define the terms scientific methods, hypothesis, model, scientific theory, and scientific law.
Pages 3 – 8, and Pages 17 – 22.

Scientific methods: The patterns of investigation procedures.

Hypothesis: A possible explanation for a problem using what you know and what you observe.

Model: A representation of an idea, event, structure, or object to help people better understand it.

Scientific theory: an explanation based on many observations during repeated experiments; valid only if consistent with observations, can be used to make testable predictions, and is the simplest explanation; can be changed or modified with the discovery of new data.

Scientific law: 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.
Page 8, and Page 22. Questions 1 – 6, and Questions 19 – 23.

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.

Q (1) Summarize the steps you might use to carry out an investigation using scientific methods.
1) Make observations and ask a question.
2) Research the problem and make a hypothesis.
3) Design and carry out an experiment.
4) Analyze to see if my hypothesis was supported.
5) Refine my question based on experimental results.

Mnemonic: MR. DAR

Q (2) Define the term hypothesis. Identify three ways to test a hypothesis.
A hypothesis is an educated explanation. Hypotheses can be tested and evaluated.

Q (3) Describe why it is important for scientists to avoid bias.
Bias can affect the results or conclusion of an investigation, making them invalid.

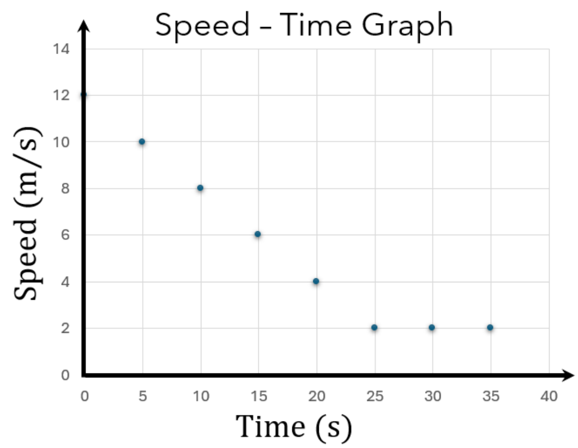
Q (4) Explain why scientists use models. Give an example of a scientific model not mentioned in this lesson and explain how it is useful.
Scientists use models to help explain or learn more about things that are too large, too small, or too far to visualize or observe easily. Examples may include the solar system, a cell, or the aerodynamics of an aircraft.

Q (5) 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?
Testing opinions is not scientific. It is impossible to prove that an opinion is true for everyone. In addition, the survey was based on a small part of the population, and it only included students at one school. The results cannot be extended to the entire population.

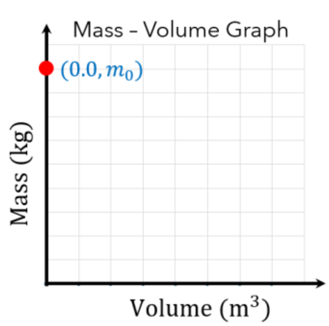
Q (6) An accepted value for free-fall acceleration is 9.8 m/s^2. In an experiment with pendulums, you calculate a value to be 9.8 m/s^2. Should the accepted value be tossed out because of your finding? Explain.
No; the value of 9.8 m/s^2 has been established by many other experiments, and to discard the finding you would have to explain why it is wrong. There are probably some factors affecting your calculation, such as friction or how precisely you measured the variables.

Q (19) Graph the following data. Time is an independent variable.

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



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



$$\text{Mass} = \text{Density} \times \text{Volume}$$

$$m = \rho V$$

In graph representations, it is standard practice to position the dependent variable along the vertical axis (y-axis) and the independent variable along the horizontal axis (x-axis).

This convention ensures clarity in data interpretation, as the dependent variable is understood to change in response to variations in the independent variable.

Consequently, when naming graphs, we refer to the dependent variable "versus" the independent variable—for instance, "mass versus volume," "position versus time," or "velocity versus time." This approach facilitates accurate communication of data relationships and trends.

Q (21) Use the relationship illustrated in Figure 16 to determine the mass required to stretch the spring 15 cm.

Mathematically: intercept

$y = \text{Slope}(x) + \text{Intercept}$

$\text{Slope} = \dfrac{\text{rise}}{\text{run}}$

$\text{Slope} = \dfrac{16 - 13.7}{30 - 0}$

$\text{Slope} = 0.0766\ \text{cm/g}$

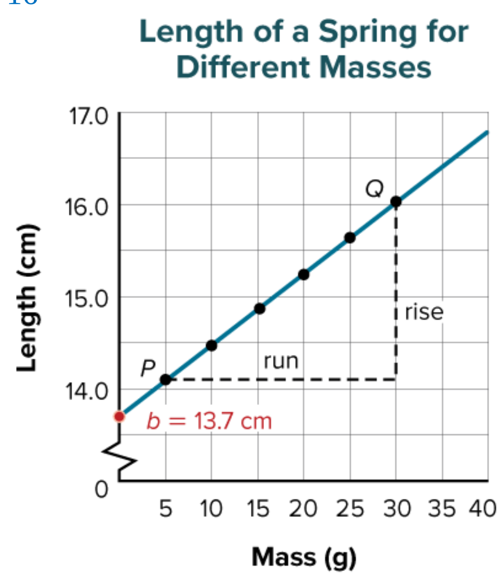
$\ell = \text{Slope}(m) + \text{Intercept}$

$\ell = 0.0766\, m + 13.7$

$15 = 0.0766\, m + 13.7$

$m = 17\ \text{g}$

Figure 16



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

The graph represents an inverse relationship between time and speed.

$y = \dfrac{a}{x} \implies \quad t = \dfrac{a}{s}$

Choose point to find (a) $\implies$ (60,5)

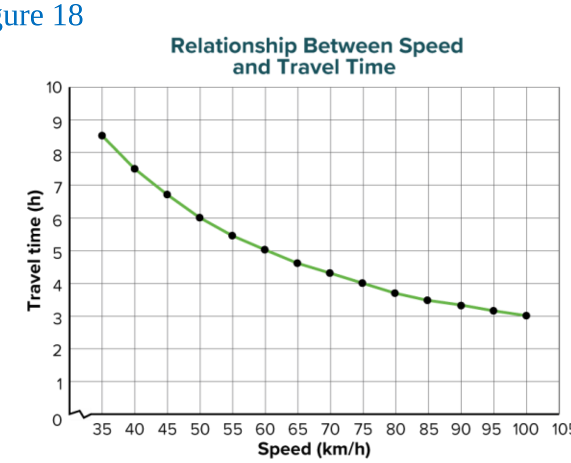
$5 = \dfrac{a}{60}$

$a = 300$

$t = \dfrac{300}{s}$

Calculate: $t = \dfrac{300}{110} = 2.7$ hours

Figure 18

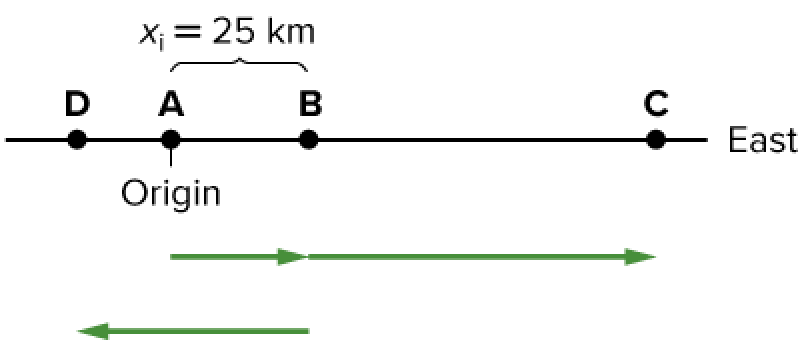


Q (23) Look again at the graph in Figure 16. In your own words, explain how the spring would be different if the line in the graph were shallower or had a smaller slope.
The spring whose line has a smaller slope is stiffer and, therefore, requires more mass to stretch it 1 cm.

QUESTIONS – 2:
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
Pages: 33 and 46 – 48. Questions 32 – 35. Questions: 36 – 42.

Part B:
Differentiate between scalar and vector quantities with examples.

*For problems 32 - 35, refer to **Figure 24**.*



32. The diagram at the right shows the path of a ship that sails at a constant velocity of 42 km/h east. What is the ship's position when it reaches point C, relative to the starting point A. if it sails from point B to point C in exactly 1.5 h?

$x = \bar{v}t + x_i$

$x = (42 \times 1.5) + 25$

$x = 88$ km east

33. Another ship starts at the same time from point B, but its average velocity is 58 km/h east. What is its position, relative to A, after 1.5 h?

$x = \bar{v}t + x_i$

$x = (58 \times 1.5) + 25$

$x = 112$ km east

34. What would a ship's position be if that ship started at point B and traveled at an average velocity of 35 km/h west to point D in a time period of 1.2 h?

$x = \bar{v}t + x_i$

$x = (35 \times 1.2) - 25$

$x = 17$ km west

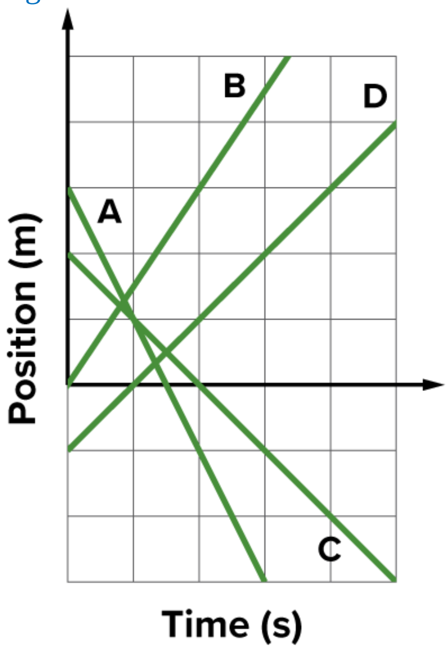
35. Suppose two ships start from point B and travel west. One ship travel at an average velocity of 35 km/h for 2.2 h. Another ship travels at an average velocity of 26 km/h for 2.5 h. What is the final position of each ship?

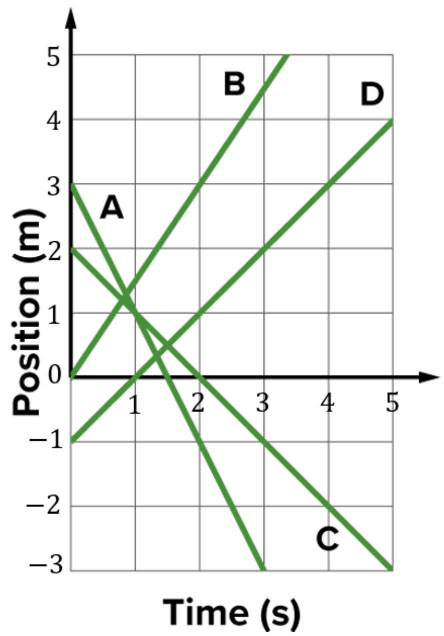
First Ship	Second Ship
$x = \bar{v}t + x_i$	$x = \bar{v}t + x_i$
$x = (35 \times 2.2) - 25$	$x = (26 \times 2.5) - 25$
$x = 52$ km west	$x = 40$ km west

Q (36) Velocity and Position How is an object's velocity related to its position?
An object's velocity is the rate of change in its position.

For problems 37-39, refer to Figure 25.

Figure 25.





$$\bar{v} = \frac{x_f - x_i}{t_f - t_i}$$

$$\bar{v}_A = \frac{-3 - 3}{3 - 0} = -2 \text{ m/s}$$

$$\bar{v}_B = \frac{3 - 0}{2 - 0} = 1.5 \text{ m/s}$$

$$\bar{v}_C = \frac{-3 - 2}{5 - 0} = -1 \text{ m/s}$$

$$\bar{v}_D = \frac{4 - (-1)}{5 - 0} = 1 \text{ m/s}$$

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.
A, B, C = D

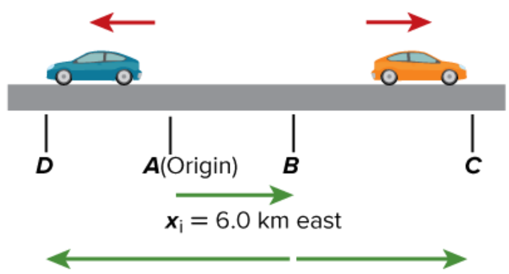
38. **Contrast Average Velocities** Describe differences in the average velocities shown on the graph for objects A and B. Describe differences in the average velocities shown on the graph for objects C and D.
The magnitude of the average velocity of A is greater than that of B, but the average velocity of A is negative, and the average velocity of B is positive. The magnitudes of the average velocities of C and D are equal, but the average velocity of D is positive, and the average velocity of C is negative.

39**.** 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?

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

40. Explain how average speed and average velocity are related to each other for an object in uniform motion.
Average speed is the absolute value of the average velocity if an object is in uniform motion.

41. Two cars are traveling along a straight road, as shown in Figure 26. They pass each other at point B and then continue in opposite directions. The orange car travels for 0.25 h from point B to point C at a constant velocity of 32 km/h east. The blue car travels for 0.25 h from point B to point D at a constant velocity of 48 km/h west. How far has each car traveled from point B?
What is the position of each car relative to the origin, point A?

<table>
<tr>
<td>
</td>
<td>The orange car has traveled 8 km east of point B.

$\Delta x_{\mathrm{BC}} = (32)(0.25)$
$\Delta x_{\mathrm{BC}} = 8.0\ \mathrm{km}$</td>
<td>The blue car has traveled 12 km west of point B.

$\Delta x_{\mathrm{BD}} = (-48)(0.25)$
$\Delta x_{\mathrm{BD}} = -12.0\ \mathrm{km}$</td>
</tr>
</table>

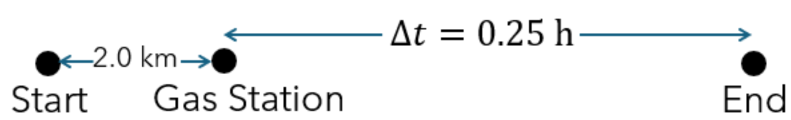
The orange car's position is 14 km east of the origin. The blue car's position is 6 km west of the origin.

42. A car travels north along a straight highway at an average speed of 85 km/h. After driving 2.0 km, the car passes a gas station and continues along the highway. What is the car's position relative to the start of its trip 0.25 h after it passes the gas station?

<table>
<tr>
<td>$x = \bar{v}t + x_{\mathrm{i}}$

$x = (85 \times 0.25) + 2.0$

$x = 23.25\ \mathrm{km}$

$x = 23\ \mathrm{km}$</td>
<td>
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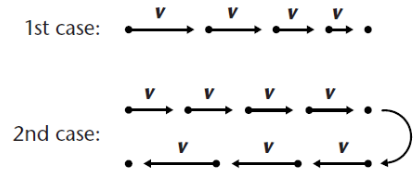
QUESTION – 3:
Solve problems using the combination of equations of motion for constant acceleration.
Pages: 63 – 70. Questions: 16 – 39.

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 $\mathrm{m/s^2}$, 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]	[b]	[c]
$v_f = v_i + \bar{a}\Delta t$ $v_f = 2.0 + (-0.5)(2.0)$ $v_f = 1.0\ \text{m/s}$	$v_f = v_i + \bar{a}\Delta t$ $v_f = 2.0 + (-0.5)(6.0)$ $v_f = -1.0\ \text{m/s}$	The ball's velocity decreased in the first case. In the second, 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/s^2. What is its velocity 6.8 s later?

$30\ \frac{\text{km}}{\text{h}} = 30 \times \frac{1000\ \text{m}}{3600\ \text{h}} = 8.3\ \text{m/s}$

$v_f = v_i + \bar{a}\Delta t$

$v_f = 8.3 + (1.5)(6.8)$

$v_f = 18.5\ \text{m/s}$

$v_f = 66.72\ \text{km/h east}$

18. If a car accelerates from rest at a constant rate of 5.5 m/s^2 north, how long will it take for the car to reach a velocity of 28 m/s north?

$v_f = v_i + \bar{a}\Delta t$

$28 = 0.0 + (5.5)(t)$

$t = 5.1\ \text{s}$

19. A car slows from 22 m/s to 3.0 m/s at a constant rate of 2.1 m/s^2. How many seconds are required before the car is traveling at a forward velocity of 3.0 m/s?

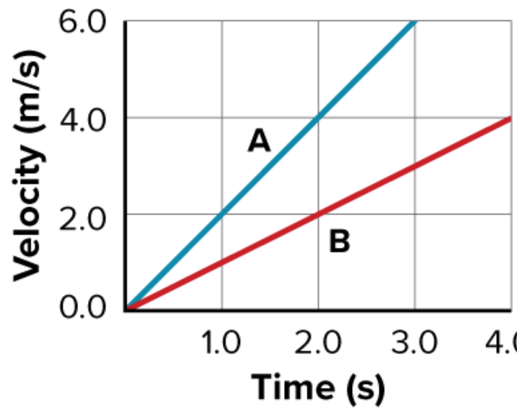
$v_f = v_i + \bar{a}\Delta t$

$3.0 = 22 + (-2.1)(t)$

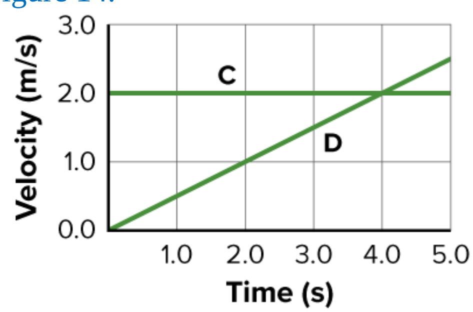
$t = 9.0\ \text{s}$

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 constant acceleration. What was the total displacement of each bicyclist during the time shown for each?

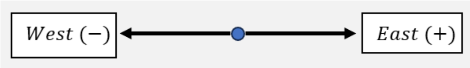
Hint: Use the area of a triangle: $area = \left(\frac{1}{2}\right)(base)(height)$

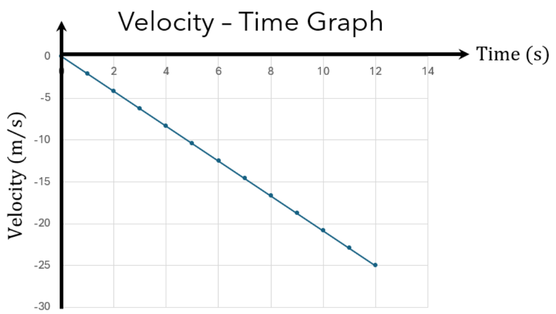
Cyclist A	Cyclist A	Figure 18.
$\Delta x = \frac{1}{2} \times base \times height$ $\Delta x = \frac{1}{2} \times 3.0 \times 6.0$ $\Delta x = 9.0\text{ m north}$	$\Delta x = \frac{1}{2} \times base \times height$ $\Delta x = \frac{1}{2} \times 4.0 \times 4.0$ $\Delta x = 8.0\text{ m north}$	

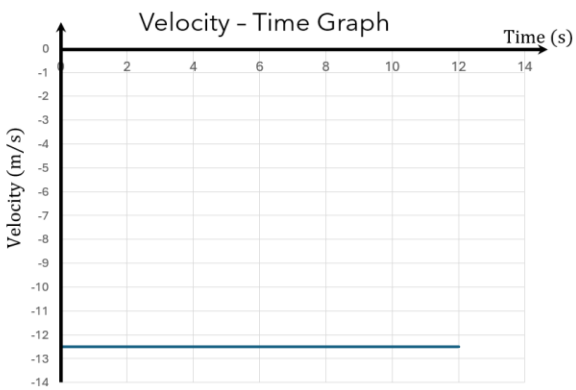
21. The motion of two people, Carlos and Diana, moving south along a straight path is described by the graph in Figure 14. What is the total displacement of each person during the first 4.0-s interval shown on the graph?

Person C	Person D	Figure 14.
$\Delta x = \text{length} \times \text{width}$ $\Delta x = 4.0 \times 2.0$ $\Delta x = 8.0\text{ m south}$	$\Delta x = \frac{1}{2} \times \text{base} \times \text{height}$ $\Delta x = \frac{1}{2} \times 4.0 \times 2.0$ $\Delta x = 4.0\text{ m south}$	

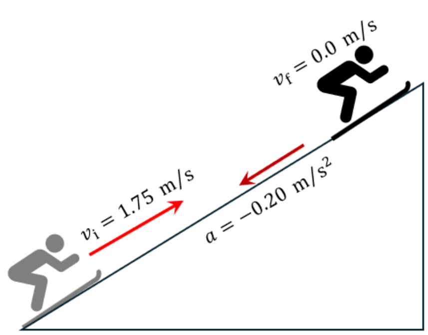
22. A car, just pulling onto a straight stretch of highway, has a constant acceleration from 0 m/s to 25 m/s west in 12 s.
a. Draw a $v - t$ graph of the car's motion.
b. Use the graph to determine the car's displacement during the 12.0-s time interval.
c. Another car is traveling along the same stretch 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.
d. Explain how you knew this car's velocity.



[a]	[b]
	Displacement (Δx) = Bounded Area $\Delta x = \frac{1}{2} \times \text{base } \times \text{height}$ $\Delta x = \frac{1}{2} \times 12 \times (-25)$ $\Delta x = -150 \text{ m} = 150 \text{ m west}$

[c]	[d]
	The displacement was the same for both cars. For the second car, then, $\bar{v} = \frac{\Delta x}{\Delta t}$ $\bar{v} = \frac{-150}{12}$ $\bar{v} = -12.5 \text{ m/s}$ $\bar{v} = 12.5 \text{ m/s West}$

Q (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/s^2. How much time passes from when she begins to slow down until she begins to move back down the incline?

$v_f = v_i + \bar{a}\Delta t$ $0 = 1.75 + (-0.20)(\Delta t)$ $\Delta t = 8.75 \text{ s}$ $\Delta t = 8.8 \text{ s}$	

Q (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?

$\bar{a} = \frac{v_f - v_i}{t_f - t_i}$ $\bar{a} = \frac{22 - 44}{11}$ $\bar{a} = -2\ \text{m/s}^2$	$x_f = x_i + v_i t + \frac{1}{2}\bar{a}t_f^2$ $x_f = 0 + (44 \times 11) + \frac{1}{2}(-2)(11)^2$ $x_f = 363\ \text{m}$ $x_f = 360\ \text{m}$ (2 Significant Figures)

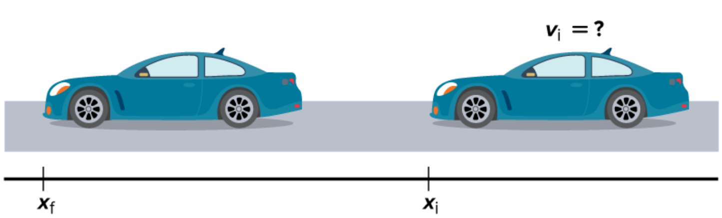
Q (25) A car accelerates at a constant rate from 15 m/s to 25 m/s while it travels a distance of 125 m. How long does it take to achieve the final speed?

$v_f^2 = v_i^2 + 2\bar{a}(x_f - x_i)$ $25^2 = 15^2 + 2\bar{a}(125 - 0)$ $\bar{a} = 1.6\ \text{m/s}^2$	$v_f = v_i + \bar{a}\Delta t$ $25 = 15 + (1.6)(\Delta t)$ $\Delta t = 6.25\ \text{s}$ $\Delta t = 6.3\ \text{s}$ (2 Significant Figures)

Q (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?

$v_f = v_i + \bar{a}\Delta t$ $7.5 = v_i + \bar{a}(4.5)$ $\bar{a} = \frac{7.5 - v_i}{4.5}$	$v_f^2 = v_i^2 + 2\bar{a}(x_f - x_i)$ $7.5^2 = v_i^2 + 2\left(\frac{7.5 - v_i}{4.5}\right)(19)$ $v_i = 0.94\ \text{m/s north}$	Alternative Solution: $\Delta x = \left(\frac{v_i + v_f}{2}\right) t$ $19 = \left(\frac{v_i + 7.5}{2}\right)(4.5)$ $v_i = 0.94\ \text{m/s north}$

Q (27) The car in the diagram travels west with a forward acceleration of $0.22\ \text{m/s}^2$. What was the car's velocity (v_i) at point x_i if it travels a distance of 350 m in 18.4 s?

	$\Delta x = v_i t + \frac{1}{2}\, a\, t^2$ $350 = (v_i \times 18.4) + \left(\frac{1}{2} \times 0.22 \times 18.4^2\right)$ $v_i = 17\ \text{m/s west}$

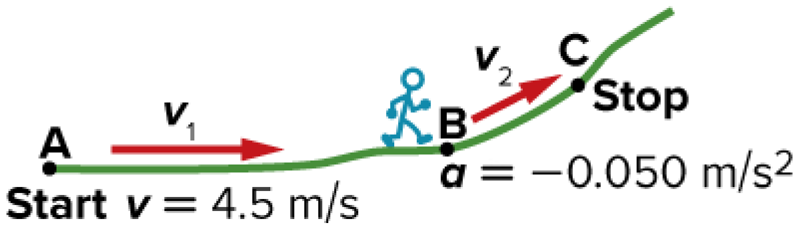
28. A car with an initial velocity of 24.5 m/s east has an acceleration of $4.2\ \mathrm{m/s^2}$ west. What is its displacement at the moment that its velocity is 18.3 m/s east?

$v_f^2 = v_i^2 + 2\bar{a}(x_f - x_i)$

$18.3^2 = 24.5^2 + 2(-4.2)(x_f - 0)$

$x_f = 32$ m east

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 $0.050\ \mathrm{m/s^2}$ for 90.0 s and comes to a stop at point C. What was the total distance the man ran?



$(\Delta x)_{total} = (\Delta x)_{AB} + (\Delta x)_{BC}$

$(\Delta x)_{total} = (v_1 t_1) + \left(v_1 t_2 + \frac{1}{2} a t_2^2\right)$

$(\Delta x)_{total} = (4.5 \times 15 \times 60) + \left(4.5 \times 90 + \frac{1}{2}(-0.05)(90)^2\right)$

$(\Delta x)_{total} = 4252.5$ m

$(\Delta x)_{total} = 4.2525$ km

$(\Delta x)_{total} = 4.3$ km

30. You start your bicycle ride at the top of a hill. You coast down the hill at a constant acceleration of $2.00\ \mathrm{m/s^2}$. 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?

The nonuniform motion period	The uniform motion period	
$v_f^2 = v_i^2 + 2\bar{a}(x_f - x_i)$ $18.0^2 = 0.0^2 + 2(2.0)(\Delta x)$ $\Delta x = 81$ m	$\Delta x = v\,t$ $\Delta x = (18.0)(1.00 \times 60)$ $\Delta x = 1080$ m	$(\Delta x)_{total} = 81 + 1080$ $(\Delta x)_{total} = 1161$ m $(\Delta x)_{total} = 1.161$ km

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? Nonuniform

$$(\Delta x)_{\text{total}} = (\Delta x)_{\text{Uniform}} + (\Delta x)_{\text{Nonuniform}}$$

$$(\Delta x)_{\text{total}} = (v_1 t_1) + \left(v_1 t_2 + \frac{1}{2} a t_2^2\right)$$

$$5.0 \times 1000 = (4.3 \times 19 \times 60) + \left(4.3 \times 19.4 + \frac{1}{2}(a)(19.4)^2\right)$$

$$5000 = (4902) + (83.42 + 188.18\, a)$$

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

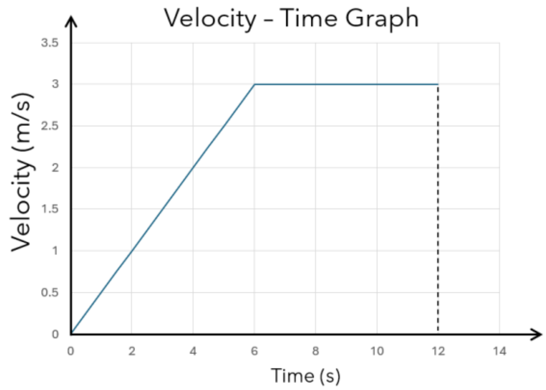
32. Sekazi is learning to ride a bike without training wheels. His father pushes him with a constant acceleration of 0.50 m/s^2 east for 6.0 s. Sekazi then travels at 3.0 m/s east for another 6.0 s before falling. What is Sekazi's displacement? Solve this problem by constructing a velocity-time graph for Sekazi's motion and computing the area underneath the graphed line.

Displacement = Bounded Area.

$$\Delta x = \left(\frac{1}{2} \times \text{base } \times \text{height}\right) + (\text{length} \times \text{width})$$

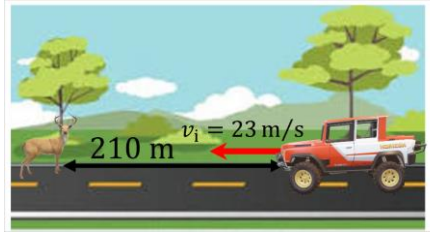
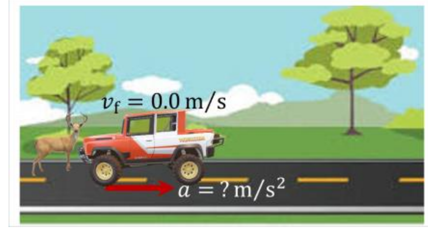
$$\Delta x = \left(\frac{1}{2} \times 6.0 \ \times 3.0\right) + (6.0 \times 3.0)$$

$$\Delta x = 27 \text{ m east}$$

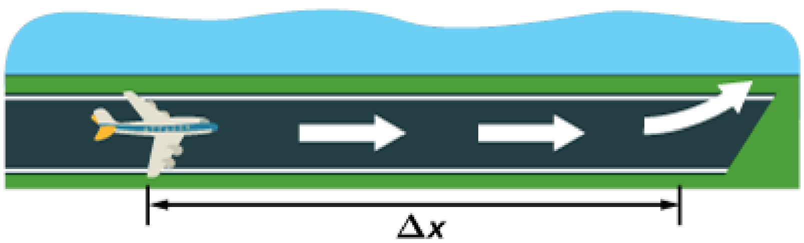


33. Given initial and final velocities and the constant acceleration of an object, what mathematical relationship would you use to find the displacement?
The time independent equation of motion: $v_f^2 - v_i^2 = 2\, a\, (\Delta x)$

34. 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?

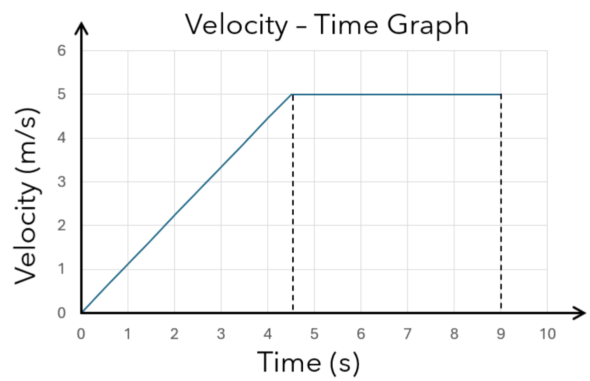
	At the moment of applying the brakes.	A complete stop before hitting the deer.
$v_f^2 - v_i^2 = 2\,a\,(\Delta x)$ $0.0^2 - 23^2 = 2\,(a)\,(210)$ $a = -1.3\ \text{m/s}^2$ $a = 1.3\ \text{m/s}^2$ east		

35. The airplane in Figure 18 starts from rest and accelerates east at a constant $3.00\ \text{m/s}^2$ for 30.0 s before leaving the ground.
a. What was the plane's displacement (Δx)?
b. How fast was the airplane going when it took off?



The displacement.	The velocity after 30.0 s.
$\Delta x = v_i t + \frac{1}{2}\,a\,t^2$ $\Delta x = (0.0 \times 30.0) + \left(\frac{1}{2} \times 3.00 \times 30.0^2\right)$ $\Delta x = 1350\ \text{m}$	$v_f = v_i + at$ $v_f = 0.0 + (3.0 \times 30.0)$ $v_f = 90.0\ \text{m/s}$

36. 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?

$(\Delta x)_{\text{total}} = (\Delta x)_{\text{Nonuniform}} + (\Delta x)_{\text{Uniform}}$ $(\Delta x)_{\text{total}} = \left(v_1 t_2 + \frac{1}{2} a t_2^2\right) + (v_1 t_1)$ $(\Delta x)_{\text{total}} = \left(0.0 \times 4.5 + \frac{1}{2}\left(\frac{5.0}{4.5}\right)(4.5)^2\right) + (5.0 \times 4.5)$ $(\Delta x)_{\text{total}} = 11.25 + 22.5$ $(\Delta x)_{\text{total}} = 34\ \text{m}$	

37. A plane travels 5.0×10^2 m north while accelerating uniformly from rest at $5.0\ \text{m/s}^2$. What final velocity does it attain?

$v_f^2 = v_i^2 + 2\,a\,(\Delta x)$

$v_f^2 = 0.0^2 + 2\,(5)\,(500)$

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

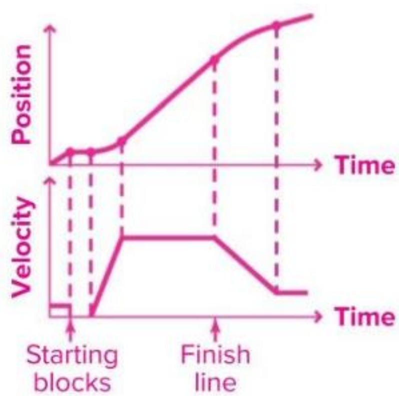
38. An airplane accelerated uniformly from rest at the rate of $5.0\ \text{m/s}^2$ south for 14 s. What final velocity did it attain?

$v_f = v_i + at$

$v_f = 0.0 + (5.0 \times 14)$

$v_f = 70.0\ \text{m/s south}$

39. 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.



QUESTION – 4:

Pages: 9 – 10, 33 – 36, 71 – 74.

Questions: 9 – 11 Page 12, 7 – 9 Page 36, 40 – 51 Page 75.

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.

Part B:

Differentiate between distance travelled and displacement and calculate them.

Part C:

1. Describe the motion of an object under free fall during its rising and falling motion.
2. Perform an investigation to study the acceleration due to gravity for a system in free fall.

QUESTIONS: 9 – 11 PAGE 12.
Q (9). How many seconds are in a leap year?
Number of seconds in a leap year $= 366 \times 24 \times 3600 = 31{,}622{,}400$ s

Q (10) Rewrite $F = Bqv$ to find v in terms of $F, q,$ and B.

$$F = Bqv$$

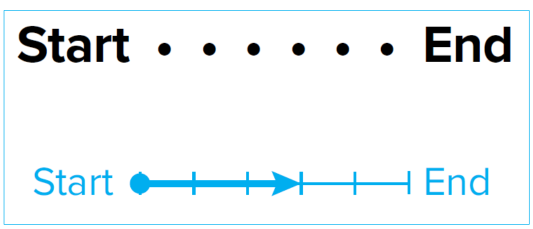
$$\frac{F}{Bq} = \frac{Bqv}{Bq}$$

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

Q (11). Using values given in a problem and the equation for distance, $distance = speed \ x \ time$, 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?
For most cars, the answer is unreasonable because 290 km/h is equivalent to 81 m/s or 180 mph. The speed might be reasonable for a race car.

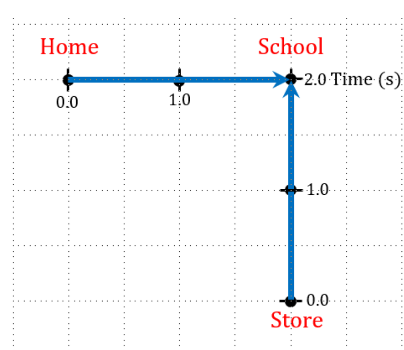
QUESTIONS: 7 – 9 PAGE 36.
Q (7) The motion diagram for a car traveling on an interstate highway is shown below. The starting and ending points are indicated.
Start • • • • • • End

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.



Q (8) 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. What is a possible explanation for this?

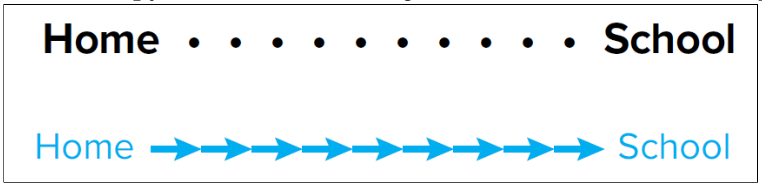
A position vector goes from the origin to the object. When the origins are different, the position vectors are different. On the other hand, a displacement vector has nothing to do with the origin.



Q (9) The motion diagram for a boy walking to school is shown below.

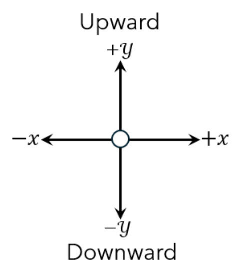
Home • • • • • • • • • • School

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

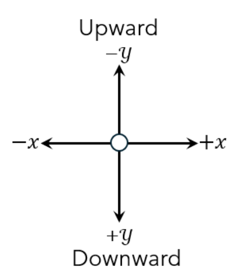


QUESTIONS: 40 – 51 PAGE 75.

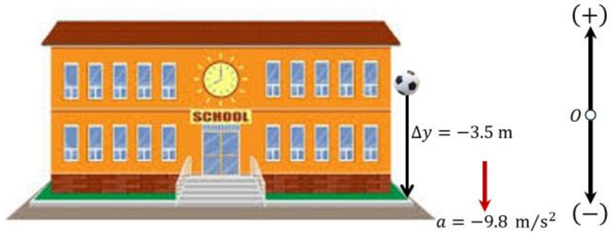
Q (40) A construction worker accidentally drops a brick from a high scaffold.
a. What is the velocity of the brick after 4.0 s?
b. How far does the brick fall during this time?

[a]	[b]	Directions.
$v_f = v_i - g\Delta t$ $v_f = 0 - (9.8)(4.0)$ $v_f = -39.2\ \text{m/s}$ $v_f = 39\ \text{m/s downward}$	$\Delta y = v_i t - \frac{1}{2} g t^2$ $\Delta y = 0 - \frac{1}{2}(9.8)(4.0)^2$ $\Delta y = -78.4\ \text{m}$ $\lvert\Delta y\rvert = 78\ \text{m}$	

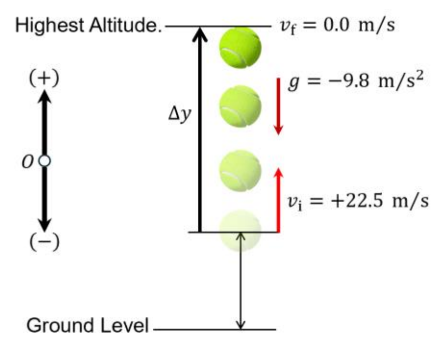
Q (41) Suppose for the previous problem you choose your coordinate system so that the opposite direction is positive.
a. What is the brick's velocity after 4.0 s?
b. How far does the brick fall during this time?

[a]	[b]	Directions.
$v_f = v_i + g\Delta t$ $v_f = 0 + (9.8)(4.0)$ $v_f = +39.2\ \text{m/s}$ $v_f = 39\ \text{m/s downward}$	$\Delta y = v_i t + \frac{1}{2} g t^2$ $\Delta y = 0 + \frac{1}{2}(9.8)(4.0)^2$ $\Delta y = +78.4\ \text{m}$ $\lvert\Delta y\rvert = 78\ \text{m}$	

Q (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?

$v_f^2 - v_i^2 = 2\,a\,(\Delta y)$ $v_f^2 - 0.0^2 = 2\,(-9.8)\,(-3.5)$ $v_f = 8.3\ \text{m/s}$ downward	

Q (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?

Vertical Displacement.	Time of Flight.	Diagram.
$v_f^2 - v_i^2 = 2\,a\,(\Delta y)$ $0.0^2 - (22.0)^2 = 2\,(-9.8)(\Delta y)$ $\Delta y = 25.8\ \text{m}$ $\Delta y = 26\ \text{m}$ (2 Significant Figures)	$v_f = v_i + at$ $0.0 = 22.5 + (-9.8 \times t)$ $t_{max} = 2.29\ \text{s}$ $t_{total} = 2 \times t_{max}$ $t_{total} = 2 \times 2.30$ $t_{total} = 4.6\ \text{s}$	

Q (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?
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?

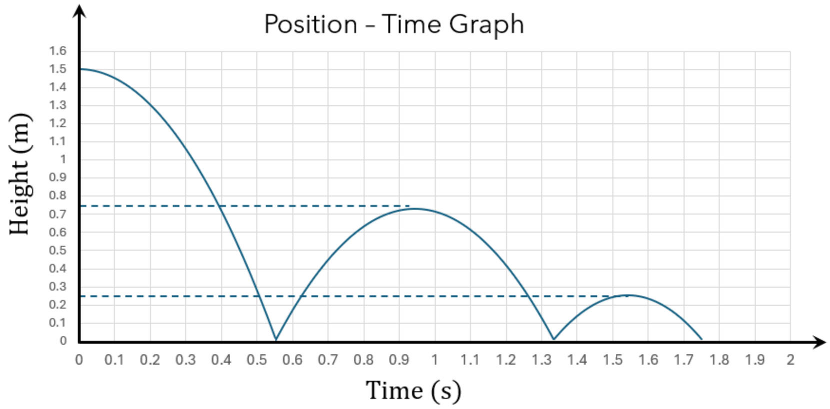
[a]	[b]	[c]
$v = 0.0\ \text{m/s}$ $a = 9.8\ \text{m/s}^2$ downward	$v_f^2 - v_i^2 = 2\,a\,(\Delta y)$ $0.0^2 - v_i^2 = 2\,(-9.8)(0.25)$ $v_i^2 = 4.9$ $v_i = 2.2\ \text{m/s}$	$v_f = v_i + at$ $0.0 = 2.2 + (-9.8 \times t)$ $t_{max} = 0.23\ \text{s}$ $t_{total} = 2 \times t_{max}$ $t_{total} = 2 \times 0.23$ $t_{total} = 0.46\ \text{s}$

Q (45) 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.

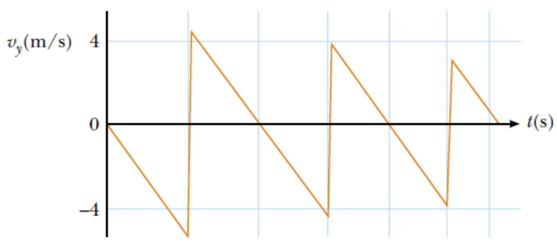
a. Suppose downward is the positive direction. What would the shape of a velocity-time graph look like for the first two bounces?
b. What would be the shape of a position-time graph for the first two bounces?

a. The velocity-time graph would be straight line segments that start at the origin and then rise, fall, and rise again.
b. The graph would start at the origin and have an inverted parabolic shape.

The first fall	After the first bounce.	After the second bounce.
$v_f = v_i - g\Delta t$	$v_f = v_i - g\Delta t$	$v_f = v_i - g\Delta t$
$v_f = 0 - (9.8)(t)$	$0 = v_i - (9.8)(t_{max})$	$0 = v_i - (9.8)(t_{max})$
$v_f = -9.8\,t$	$t_{max} = \frac{v_i}{g}$	$t_{max} = \frac{v_i}{g}$
$y = y_0 + v_i t - \frac{1}{2}g\,t^2$	$y = y_0 + v_i t - \frac{1}{2}g\,t^2$	$y = y_0 + v_i t - \frac{1}{2}g\,t^2$
$y = 1.5 - 4.9\,t^2$	$0.75 = 0 + v_i\left(\frac{v_i}{g}\right) - \left(\frac{g}{2}\right)\left(\frac{v_i}{g}\right)^2$	$0.25 = 0 + v_i\left(\frac{v_i}{g}\right) - \left(\frac{g}{2}\right)\left(\frac{v_i}{g}\right)^2$
	$0.75 = \frac{v_i^2}{2g}$	$0.25 = \frac{v_i^2}{2g}$
	$v_i = \sqrt{1.5\,g}$	$v_i = \sqrt{0.5\,g}$
	$y = \sqrt{1.5\,g}\,t - 4.9\,t^2$	$y = \sqrt{0.5\,g}\,t - 4.9\,t^2$
	$y = \sqrt{14.7}\,t - 4.9\,t^2$	$y = \sqrt{4.9}\,t - 4.9\,t^2$



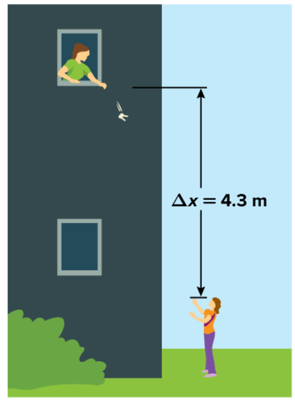
The first fall	After the first bounce.	After the second bounce.
$v_f = -9.8\,t$ $y = y_0 + v_i t - \frac{1}{2}\,g\,t^2$ $0 = 1.5 - 4.9\,t^2$ $t = \sqrt{\frac{3}{g}} = 0.55$ s	$v_f = v_i - g\,t$ $v_f = \sqrt{14.7} - 9.8\,t$ Time of flight: $t_{hang} = 2 \times \frac{\sqrt{14.7}}{9.8}$ $t_{hang} = 0.78$ s	$v_f = v_i - g\,t$ $v_f = \sqrt{4.9} - 9.8\,t$ Time of flight: $t_{hang} = 2 \times \frac{\sqrt{4.9}}{9.8}$ $t_{hang} = 0.45$ s



Q (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.

Free fall is the motion of an object when gravity is the only significant force on it. Air significantly affects the paper but not the book.

Q (47) Your sister drops your house keys down to you from the second-floor window, as shown in the image. What is the velocity of the keys when you catch them?

$v_f^2 - v_i^2 = 2\,a\,(\Delta x)$ $v_f^2 - 0.0^2 = 2\,(-9.8)\,(-4.3)$ $v_f = 9.2$ m/s downward	(+) ↑ ↓ (−)	

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

Velocity	Displacement.
$v_f = v_i + at$ $v_f = 0.0 + (-9.8 \times 2.3)$ $v_f = -22.54$ m/s $v_f \approx 23$ m/s downward	$\Delta y = v_i t + \frac{1}{2}\,a\,t^2$ $\Delta y = (0.0 \times t) + \frac{1}{2}\,(-9.8)\,(2.3)^2$ $\Delta y = -25.921$ m $\Delta y \approx -26$ m $\lvert\Delta y\rvert = 26$ m

Q (49) 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?

Maximum height.		Flight time	
Earth	Mars	Earth	Mars
$g = 9.8$ m/s^2 $v_f^2 - v_i^2 = -2\,g\,(y - y_0)$ $0 - v_i^2 = -2\,g\,(y_{max} - 0)$ $v_i^2 = 2\,g\,y_{max}$ $y_{max} = \frac{v_i^2}{2g}$	$g_{Mars} = \frac{1}{3} \times g$ $v_f^2 - v_i^2 = -2\,g_{Mars}\,(y - y_0)$ $0 - v_i^2 = -2\left(\frac{g}{3}\right)(y_{max} - 0)$ $v_i^2 = \frac{2\,g\,y_{max}}{3}$ $y_{max} = 3 \times \frac{v_i^2}{2g}$	$v_f = v_i - gt$ $0 = v_i - g t_{max}$ $t_{max} = \frac{v_i}{g}$ Mars.	$v_f = v_i - g_{Mars} t$ $0 = v_i - \frac{g}{3} t_{max}$ $t_{max} = 3 \times \frac{v_i}{g}$

a. The maximum height would be three times higher on Mars.
b. Flight time is three times longer on Mars.

Q (50) 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.
Velocity decreases at a constant rate as the ball travels upward. At the ball's highest point, velocity is zero. As the ball begins to drop, the velocity begins to increase in the negative direction until it reaches the height from which it was initially released. At that point, the ball has the same speed it had upon release. The acceleration is constant throughout the ball's flight.

Q (51) 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 multi-flash photo to measure its position. From photos, calculate the ball's velocity.

the end