حلول مسائل الوحدة الثانية: الحركة – Inspire

تم تحميل هذا الملف من موقع المناهج الإماراتية	
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المزيد من الملفات بحسب ملفات والمادة فيزياء في الفصل الأول	
1	حلول مسائل الوحدة الثانية: الحركة – Inspire

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Module 2 Physics Problems

Lesson 1 Picturing Motion

Mastering Concepts

1. What is the purpose of drawing a motion diagram?

A motion diagram gives you a picture of motion that helps you visualize displacement and velocity.

2. Under what circumstances is it legitimate to treat an object as a particle when solving motion problems?

An object can be treated as a point particle if internal motions are not important and if the object is small in comparison to the distance it moves.

Lesson 2 Where and When?

Mastering Concepts

3. The following quantities describe location or its change: position, distance, and displacement. Briefly describe the differences among them.

Position and displacement are different from distance because position and displacement both contain information about the direction in which an object has moved, while distance does not. Distance and displacement are different from position because they describe how an object's location has changed during a time interval, where position tells exactly where an object is located at a precise time.

4. How can you use a clock to find a time interval?

Read the clock at the beginning and end of the interval and subtract the beginning time from the ending time.

Lesson 3 Position-Time Graphs

Mastering Concepts

5. **In-line Skating** How can you use the position-time graphs for two in-line skaters to determine if and when one in-line skater will pass the other one?

Draw the two graphs on the same set of axes. One in-line skater will pass the other if the lines representing each of their motions intersect. The time coordinate of the point where the lines intersect is the time at which the passing occurs.

Lesson 4 How Fast?

Mastering Concepts

6. Which equation describes how the average velocity of a moving object relates to its displacement?

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

7. **Walking Versus Running** A walker and a runner leave your front door at the same time. They move in the same direction at different constant velocities. Describe the position-time graphs of each.

Both are straight lines that start at the same position, but the slope of the runner's line is steeper.

8. What does the slope of a position-time graph measure?

velocity

9. If you know the time it took an object to travel between two points and the positions of the object at the points, can you determine the object's instantaneous velocity? Its average velocity? Explain.

It is possible to calculate the average velocity from the information given, but it is not possible to find the instantaneous velocity.

Mastering Problems

10. You ride a bike at a constant speed of 4.0 m/s for 5.0 s. How far do you travel? (Level 1)

$x = vt$
$= (4.0 \text{ m/s})(5 \text{ s})$
$= 2.0 \times 10^1 \text{ m}$

11. **Astronomy** Light from the Sun reaches Earth in about 8.3 min. The speed of light is 3.00×10^8 m/s. What is the distance from the Sun to Earth? (Level 1)

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$$x = vt$$

$$= (3.00\times10^{8}\ \text{m/s})(8.3\ \text{min})\left(\frac{60\ \text{s}}{1\ \text{min}}\right)$$

$$= 1.5\times10^{11}\ \text{m}$$

12. **Problem Posing** Complete this problem so that someone must solve it using the concept of average speed: "A butterfly travels 15 m from one flower to another...." (Level 2)

Answers will vary. A possible form of the correct answer is, "... If it takes the butterfly 7 seconds, what is its average speed?"

13. Nora jogs several times a week and always keeps track of how much time she runs each time she goes out. One day she forgets to take her stopwatch with her and wonders if there is a way she can still have some idea of her time. As she passes a particular bank building, she remembers that it is 4.3 km from her house. She knows from her previous training that she has a consistent pace of 4.0 m/s. How long has Nora been jogging when she reaches the bank? (Level 2)

$$x = vt$$

$$t = \frac{x}{v} = \frac{(4.3\ \text{km})\left(\frac{1000\ \text{m}}{1\ \text{km}}\right)}{4.0\ \text{m/s}}$$

$$= 1075\ \text{s}$$

$$= (1075\ \text{s})\left(\frac{1\ \text{min}}{60\ \text{s}}\right)$$

$$= 18\ \text{min}$$

14. **Driving** You and a friend each drive 50.0 km. You travel at 90.0 km/h; your friend travels at 95.0 km/h. How much sooner will your friend finish the trip? (Level 3)

$$x = vt$$

$$t_1 = \frac{x}{v} = \frac{50.0\ \text{km}}{90.0\ \text{km/h}}$$

$$= 0.556\ \text{h}$$

$$t_2 = \frac{x}{v} = \frac{50.0\ \text{km}}{95.0\ \text{km/h}}$$

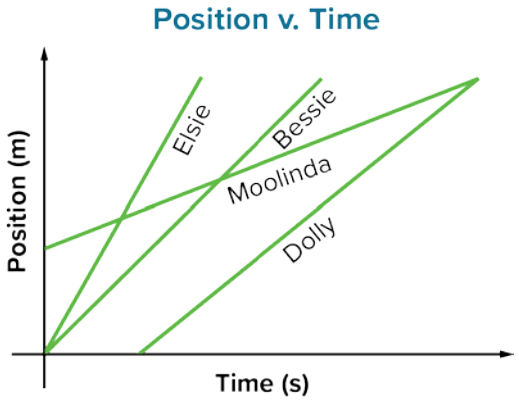
$$= 0.526\ \text{h}$$

$$t_1 = t_2 = (0.556\ \text{h} + 0.526\ \text{h})\left(\frac{60\ \text{min}}{1\ \text{h}}\right)$$

$$= 1.8\ \text{min}$$

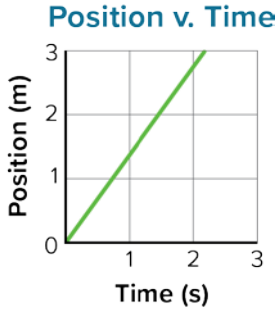
Applying Concepts

15. **Ranking Task** The position-time graph represents the motion of four cows walking from the pasture back to the barn. Rank the cows according to their average velocity, from slowest to fastest.



Moolinda, Dolly, Bessie, Elsie

16. The position-time graph represents a rabbit running away from a dog. How would the graph differ if the rabbit ran twice as fast? How would it differ if the rabbit ran in the opposite direction?



If the rabbit ran twice as fast, the slope of the graph would be twice as steep. If the rabbit ran in the opposite direction, the magnitude of the slope would be the same, but it would be negative.

17. Test the following combinations and explain why each does not have the properties needed to describe the concept of velocity: $\Delta x + \Delta t$, $\Delta x - \Delta t$, $\Delta x \times \Delta t$, $\Delta t/\Delta x$.

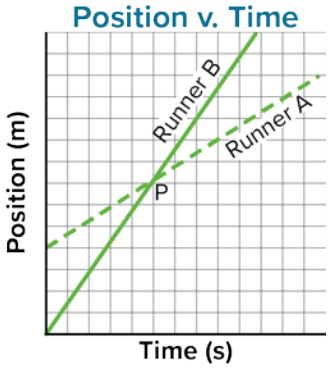
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None of the combinations has the correct units, meters per second. In addition, $\Delta x + \Delta t$ increases when either term increases. The sign of $\Delta x - \Delta t$ depends upon the relative sizes of Δx and Δt. $\Delta x \times \Delta t$ increases when either increases. $\Delta t/\Delta x$ decreases with increasing displacement and increases with increasing time interval, which is backward from velocity.

18. **Football** When solving physics problems, what must be true about the motion of a football in order for you to treat the football as if it were a particle?

The football can be treated as a particle if its rotations are not important and if the distance it moves is much larger than the football.

19. This graph represents two people running.



a. Describe the position of runner A relative to runner B at the *y*-intercept.

Runner A has a head start by four units.

b. Which runner is faster?

Runner B is faster, as shown by the steeper slope.

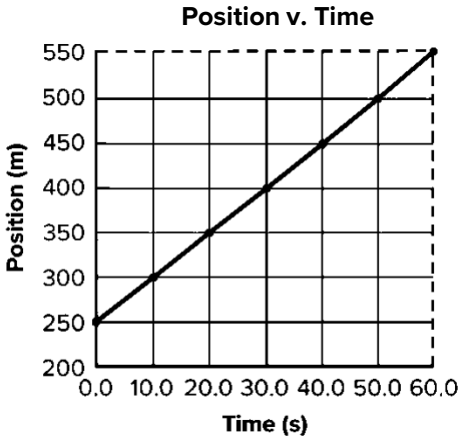
c. What occurs at point P and beyond?

Runner B passes runner A at point P and is ahead of runner A beyond that point.

Mixed Review

20. **Cycling** A cyclist traveling along a straight path maintains a constant velocity of 5.0 m/s west. At time $t = 0.0$ s, the cyclist is 250 m west of point A. (Level 1)

a. Plot a position-time graph of the cyclist's location from point A at 10.0-s intervals for a total time of 60.0 s.



b. What is the cyclist's position from point A at 60.0 s?

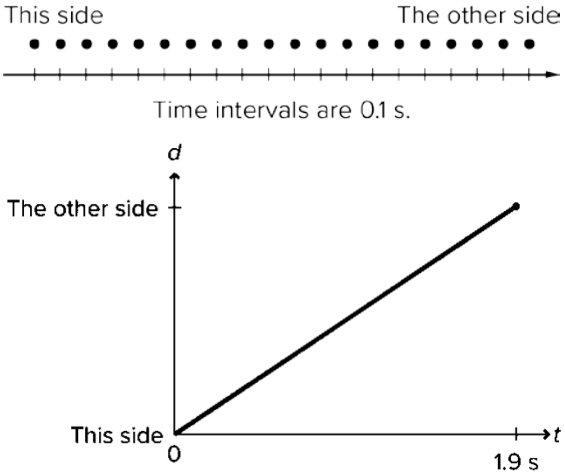
Let west be positive.

$$x = \bar{v}t + x_i$$
$$= (5.0 \text{ m/s})(60.0 \text{ s}) + 250 \text{ m}$$
$$= 550 \text{ m}$$
$$x = 550 \text{ m west}$$

c. What is the displacement from the starting position at 60.0 s?

$550 \text{ m} - 250 \text{ m} = 3.0 \times 10^2 \text{ m}$

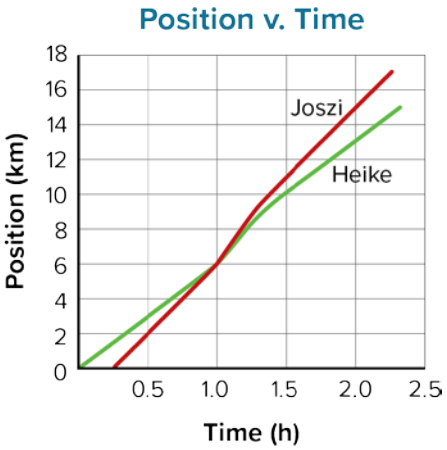
21. The particle model diagram represents a chicken casually walking across a road. Time intervals in the model are every 0.1 s. Draw the corresponding position-time graph, and write an equation to describe the chicken's motion. (Level 1)



The equation is $\Delta x = \bar{v}\,\Delta t$.

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22. The position-time graph represents Joszi and Heike paddling canoes in a local river. (Level 1)



a. At what time(s) are Joszi and Heike in the same place?

1.0 h

b. How long is Joszi paddling before passing Heike?

45 min

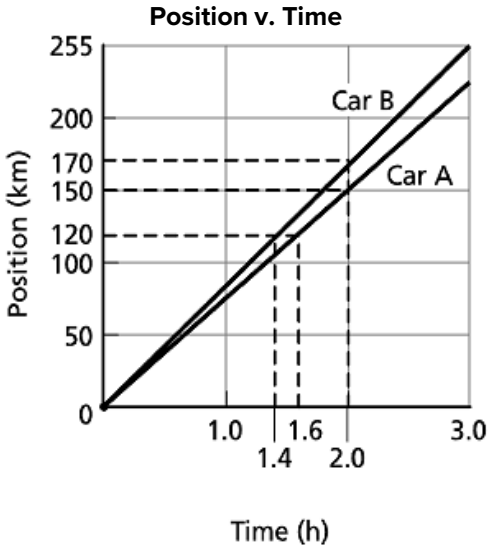
c. Where on the river does it appear that there might be a swift current?

from 6.0 to 9.0 km from the origin

23. **Driving** Both car A and car B leave school when a stopwatch reads zero. Car A travels at a constant 75 km/h, and car B travels at a constant 85 km/h. (Level 2)

a. Draw a position-time graph showing the motion of both cars over 3 hours. How far are the two cars from school when the stopwatch reads 2.0 h? Calculate the distances and show them on your graph.

$x_A = v_A t$ = (75 km/h)(2.0 h) = 150 km
$x_B = v_B t$ = (85 km/h)(2.0 h) = 170 km

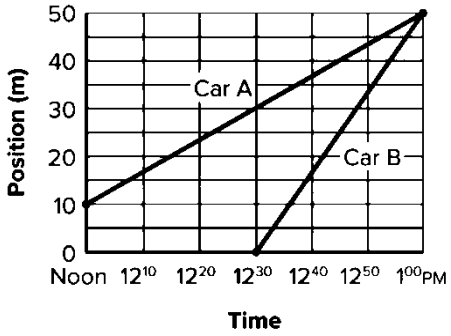


b. Both cars passed a gas station 120 km from the school. When did each car pass the gas station? Calculate the times and show them on your graph.

$$t_A = \frac{x}{v_A} = \frac{120\ \text{km}}{75\ \text{km/h}} = 1.6\ \text{h}$$

$$t_B = \frac{x}{v_B} = \frac{120\ \text{km}}{85\ \text{km/h}} = 1.4\ \text{h}$$

24. Draw a position-time graph for two cars traveling to a beach that is 50 km from school. At noon, Car A leaves a store that is 10 km closer to the beach than the school is and moves at 40 km/h. Car B starts from school at 12:30 p.m. and moves at 100 km/h. When does each car get to the beach? (Level 2)

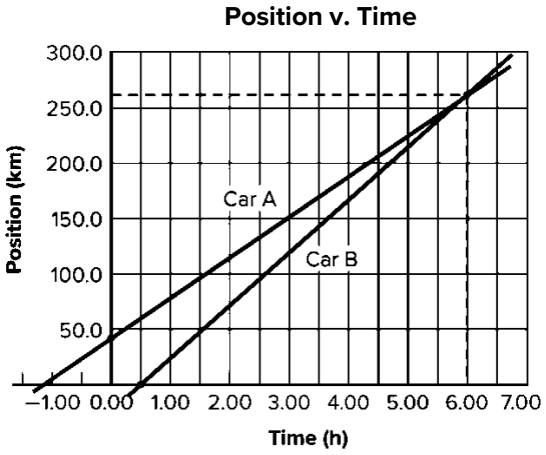


Both cars arrive at the beach at 1:00 P.M.

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25. Two cars travel along a straight road. When a stopwatch reads $t = 0.00$ h, car A is at $x_A = 48.0$ km moving at a constant speed of 36.0 km/h. Later, when the watch reads $t = 0.50$ h, car B is at $x_B = 0.00$ km moving at 48.0 km/h. Answer the following questions, first graphically by creating a position-time graph, and then algebraically by writing equations for the positions x_A and x_B as a function of the stopwatch time, t. (Level 3)

a. What will the watch read when car B passes car A?



Cars pass when the distances are equal, $x_A = x_B$

$x_A = 48.0$ km + (36.0 km/h)t and

$x_B = 0 + (48.0 \text{ km/h})(t - 0.50 \text{ h})$

so 48.0 km + (36.0 km/h)t

$= (48.0 \text{ km/h})(t - 0.50 \text{ h})$

and (48.0 km) + (36.0 km/h)t

$= (48.0 \text{ km/h})t - 24 \text{ km}$

72 km = (12.0 km/h)t

$t = 6.0$ h

b. At what position will car B pass car A?

$x_A = 48.0 \text{ km} + (36.0 \text{ km/h})(6.0 \text{ h})$

$= 2.6 \times 10^2$ km

c. When the cars pass, how long will it have been since car A was at the reference point?

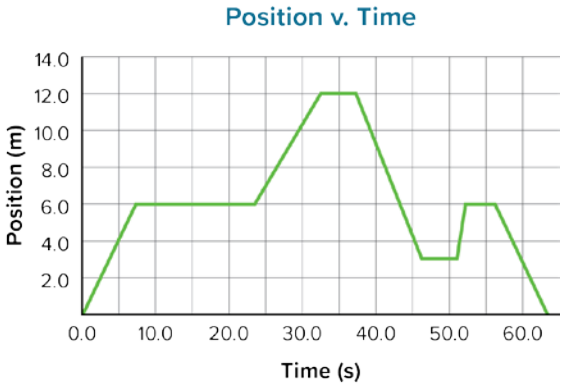
$x = vt$

so $t = \dfrac{x}{v} = \dfrac{-48.0 \text{ km}}{36.0 \text{ km/h}} = -1.33$ h

Car A started 1.33 h before the clock started.

$t = 6.0 \text{ h} + 1.33 \text{ h} = 7.3$ h

26. The graph represents Jim's movement along a straight path. The origin is at one end of the path. (Level 3)



a. Reverse Problem Write a story describing Jim's movements along the path that would correspond to the motion represented by the graph.

Answers will vary, but a correct form of the answer is Jim walks 6 m in 7 s. He stops for 16 s. He walks 6 m in 9 s and stops for 5 s. He turns around and walks back toward the origin. He walks 9 m in 9 s and stops for 5 s. He walks away from the origin again for 3 m in 1 s. He stops again for 5 s, and he turns around and walks 6 m back toward the origin in 6 s.

b. When is Jim 6.0 m from the origin?

from 7.0 to 23.0 s, momentarily at 43.0 s, and from 52.0 s to 57.0 s

c. How much time passes between when Jim starts moving and when he is 12.0 m from the origin?

$\Delta t = 32.0 \text{ s} - 0.0 \text{ s} = 32.0$ s

d. What is Jim's average velocity between 37.0 s and 46.0 s?

Using the points (37.0 s, 12.0 m) and (46.0 s, 3.00 m)

$$\bar{v} = \frac{x_f - x_i}{t_f - t_i} = \frac{3.00 \text{ m} - 12.0 \text{ m}}{46.0 \text{ s} - 37.0 \text{ s}}$$

$$= -1.00 \text{ m/s}$$

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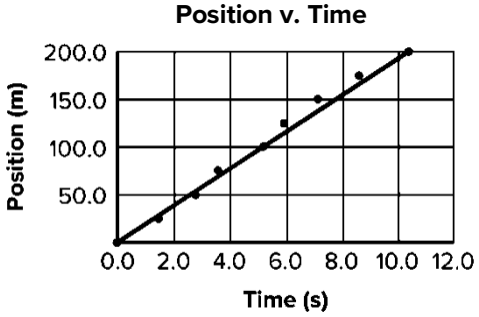
Thinking Critically

27. **Apply Calculators** Members of a physics class stood 25 m apart and used stopwatches to measure the time at which a car traveling on the highway passed each person. **Table 2** shows their data.

Table 2 Position v. Time

Time (s)	Position (m)
0.0	0.0
1.3	25.0
2.7	50.0
3.6	75.0
5.1	100.0
5.9	125.0
7.0	150.0
8.6	175.0
10.3	200.0

Use a graphing calculator to fit a line to a position-time graph of the data and to plot this line. Be sure to set the display range of the graph so that all the data fit on it. Find the line's slope. What was the car's speed?



The slope of the line and the speed of the car are about 19.7 m/s.

28. **Apply Concepts** You want to average 90 km/h on a car trip. You cover the first half of the distance at an average speed of 48 km/h. What average speed must you have for the second half of the trip to meet your goal? Is this reasonable? Note that the velocities are based on half the distance, not half the time.

720 km/h; no
Explanation:
Assume you want to travel 90 km in 1 h. If you cover the first half of the distance at 48 km/h, then you've gone 45 km in 0.9375 h (because $t = \frac{x}{v}$). This means you have used 93.75% of your time for the first half of the distance leaving 6.25% of the time to go the remaining 45 km.

$$v = \frac{45\ \text{km}}{0.0625\ \text{h}}$$
$$= 720\ \text{km/h}$$

29. **Design an Experiment** Every time someone drives a particular red motorcycle past your friend's home, his father becomes angry. He thinks the motorcycle is going too fast for the posted 25 mph (40 km/h) speed limit. Describe a simple experiment you could do to determine whether the motorcycle is speeding the next time it passes your friend's house.

Possible answers: 1) Get several people together and give everyone a watch. Synchronize the watches and stand along the street separated by a consistent distance, maybe 10 m or so. When the motorcycle passes, have each person record the time (at least to an accuracy of seconds) that the motorcycle crossed in front of them. Plot a position time graph, and compute the slope of the best-fit line. If the slope is greater than 25 mph, the motorcycle is speeding. 2) Get someone with a driver's license to drive a car along the street at 25 mph in the same direction as you expect the motorcycle to go. If the distance between the motorcycle and the car decreases, the motorcycle is speeding. If the distance between them stays the same, the motorcycle is driving at the speed limit. If the distance increases, the motorcycle is driving less than the speed limit.

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Module 2 continued

30. **Interpret Graphs** Is it possible for an object's position-time graph to be a horizontal line? A vertical line? If you answer yes to either situation, describe the associated motion in words.

It is possible to have a horizontal line as a position-time graph. This would indicate that the object's position is not changing, or in other words, that it is not moving. It is not possible to have a position-time graph that is a vertical line, because this would mean the object is moving at an infinite speed.

Writing in Physics

31. Physicists have determined that the speed of light is 3.00×10^8 m/s. How did they arrive at this number? Read about some of the series of experiments that scientists have performed to determine light's speed. Describe how the experimental techniques improved to make the experiments' results more accurate.

Answers will vary. Galileo attempted to determine the speed of light but was unsuccessful. Danish astronomer Ole Roemer successfully measured the speed of light in 1676 by observing the moonrise of one of Jupiter's moons. His estimate was 140,000 miles/second (225,308 km/s). Many others since have tried to measure it more accurately using rotating toothed wheels, rotating mirrors, and the Kerr cell shutter.

32. Some species of animals have good endurance, while others have the ability to move very quickly, but for only a short amount of time. Use reference sources to find two examples of each quality, and describe how it is helpful to that animal.

Answers will vary. Examples of animals that have high endurance to outlast predators or prey include mules, bears, and coyotes. Animals that have the speed to quickly escape predators or capture prey include cheetahs, antelopes, and deer.

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