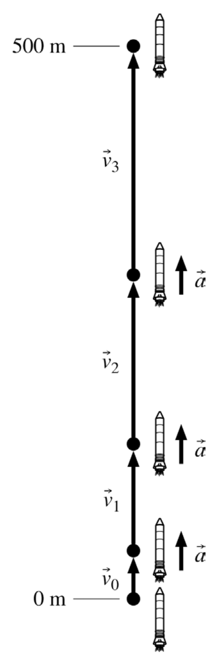
Physics 4A
Chapter 1/2 HW Solutions

Chapter 1
Conceptual Questions: 7
Problems: 2, 10, 17, 43, 51, 57

Chapter 2
Conceptual Questions: 5, 7, 14
Problems: 2, 8, 12, 37

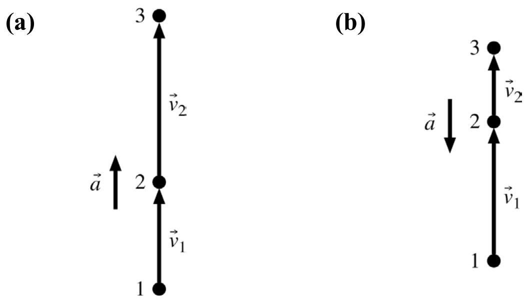
CQ 1.7. The particle position is below zero on the *y*-axis, so its position is negative. The particle is moving up, so its velocity is positive. The particle's speed is increasing as it moves in the positive direction, so its acceleration vector points in the same direction as its velocity vector (i.e., up). Thus, the acceleration is also positive.

1.2. Model: Model the rocket as a particle. We have no information about the acceleration of the rocket, so we will assume that it accelerates upward with a constant acceleration.
Solve:



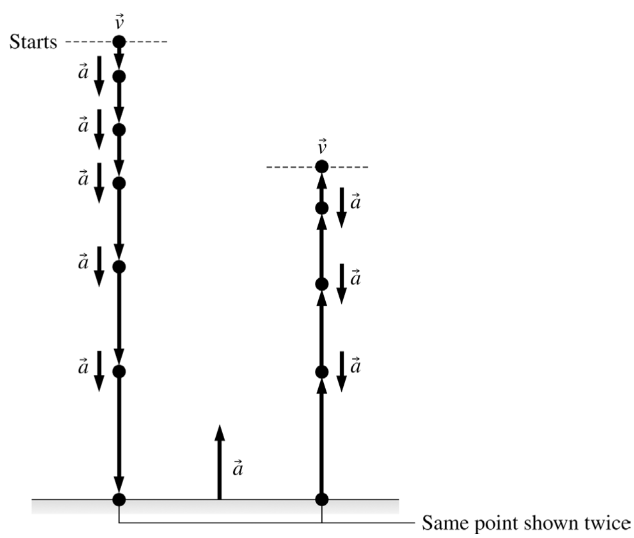
Assess: Notice that the length of the velocity vectors increases each step by the same amount.

1.10. Solve:



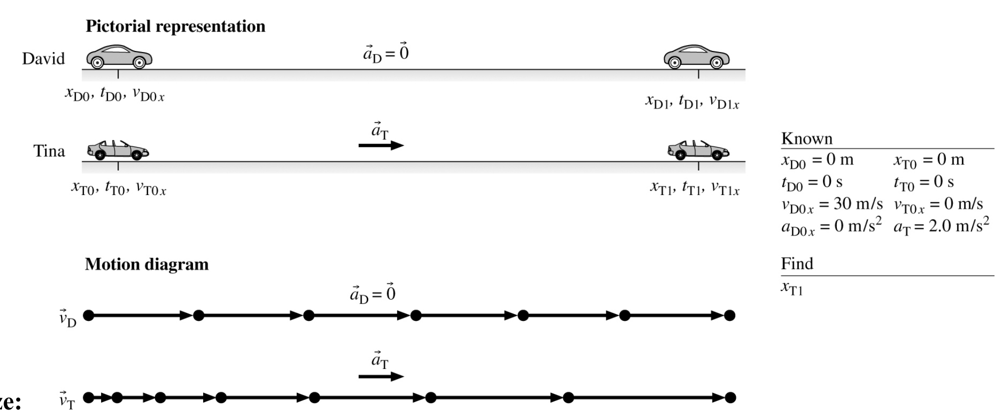
1.17. Model: Represent the tennis ball as a particle.

Visualize: The ball falls freely for three stories. Upon impact, it quickly decelerates to zero velocity while comp-ressing, then accelerates rapidly while re-expanding. As vectors, both the deceleration and acceleration are an upward vector. The downward and upward motions of the ball are shown separately in the figure. The increasing length between the dots during downward motion indicates an increasing average velocity or downward acceleration. On the other hand, the decreasing length between the dots during upward motion indicates acceleration in a direction opposite to the motion, so the average velocity decreases.



Assess: For free-fall motion, acceleration due to gravity is always vertically downward. Notice that the acceleration due to the ground is quite large (although not to scale—that would take too much space) because in a time interval much shorter than the time interval between the points, the velocity of the ball is essentially completely reversed.

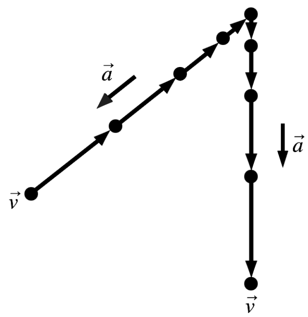
1.43. Model: Represent the cars of David and Tina and as particles for the motion diagram.



Visualize:

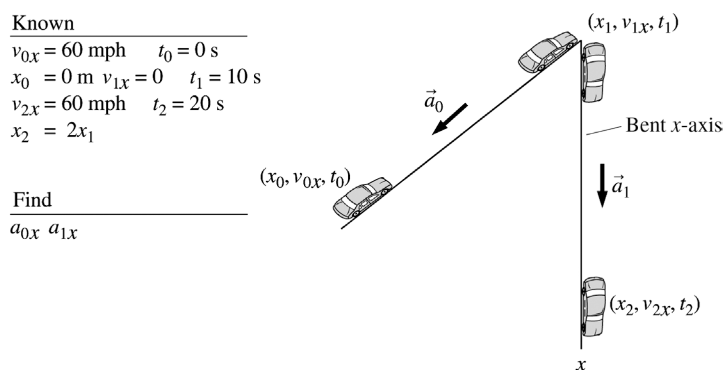
1.51. Solve:

(a)



(b) Jeremy has perfected the art of steady acceleration and deceleration. From a speed of 60 mph he brakes his car to rest in 10 s with a constant deceleration. Then he turns into an adjoining street. Starting from rest, Jeremy accelerates with exactly the same magnitude as his earlier deceleration and reaches the same speed of 60 mph over the same distance in exactly the same time. Find the car's acceleration or deceleration.

(c)



1.57. Visualize: Use the letter ρ for density.

Solve: (a) $\rho = \left(\dfrac{0.0179\text{ kg}}{215\text{ cm}^3}\right)\left(\dfrac{100\text{ cm}}{1\text{ m}}\right)^3 = 83.3\text{ kg/m}^3$

(b) $\rho = \left(\dfrac{77\text{ g}}{95\text{ cm}^3}\right)\left(\dfrac{1\text{ kg}}{1000\text{ g}}\right)\left(\dfrac{100\text{ cm}}{1\text{ m}}\right)^3 = 810\text{ kg/m}^3$

CQ 2.5. (a) A's speed is greater at $t = 1$ s. The slope of the tangent to B's curve at $t = 1$ s is smaller than the slope of A's line.
(b) A and B have the same speed at just about $t = 3$ s. At that time, the slope of the tangent to the curve representing B's motion is equal to the slope of the line representing A.

CQ 2.7. (a) The slope of the position-versus-time graph is greatest at C, so the object is moving fastest at this point.
(b) The slope is negative at point F, meaning the object is moving to the left there.
(c) At point F the slope is increasing in magnitude (getting more negative), meaning that the object is speeding up to the left.
(d) At point E the object is not moving since the slope is zero. Before point E, the slope is positive, while after E it is negative, so the object is turning around at E.

CQ 2.14. **(a)** The vertical axis of the graph is velocity, not position. The object is speeding up where the velocity is increasing; this is the case at point C.
(b) The object is slowing down at point A because the velocity in the *x* direction is getting smaller.
(c) The graph of velocity is always above the *t* axis, so the velocity is always positive, or in the direction to the right. At none of the points A, B, or C is it moving to the left.
(d) The object is moving to the right at all three points because the velocity is positive at all three points.

2.2. Solve: (a) The time for each segment is $\Delta t_1 = 50\text{ mi}/40\text{ mph} = 5/4\text{ hr}$ and $\Delta t_2 = 50\text{ mi}/60\text{ mph} = 5/6\text{hr}$. The average speed to the house is

$$\frac{100\text{ mi}}{5/6\text{ h} + 5/4\text{ h}} = 48\text{ mph}$$

(b) Julie drives the distance Δx_1 in time Δt_1 at 40 mph. She then drives the distance Δx_2 in time Δt_2 at 60 mph. She spends the same amount of time at each speed, thus

$$\Delta t_1 = \Delta t_2 \Rightarrow \Delta x_1/40\text{ mph} = \Delta x_2/60\text{ mph} \Rightarrow \Delta x_1 = (2/3)\Delta x_2$$

But $\Delta x_1 + \Delta x_2 = 100$ miles, so $(2/3)\Delta x_2 + \Delta x_2 = 100$ miles. This means $\Delta x_2 = 60$ miles and $\Delta x_1 = 40$ miles. Thus, the times spent at each speed are $\Delta t_1 = 40\text{ mi}/40\text{ mph} = 1.00\text{ h}$ and $\Delta t_2 = 60\text{ mi}/60\text{ mph} = 1.00\text{ h}$. The total time for her return trip is $\Delta t_1 + \Delta t_2 = 2.00\text{ h}$. So, her average speed is $100\text{ mi}/2\text{ h} = 50\text{ mph}$.

2.8. Solve: We can calculate the position of the particle at every instant with the equation

$$x_f = x_i + \text{area under the velocity-versus-time graph between } t_i \text{ and } t_f$$

The particle starts from the origin at $t = 0$ s, so $x_i = 0$ m. Notice that the each square of the grid in Figure EX2.8 has "area" $(5\text{ m/s}) \times (2\text{ s}) = 10$ m. We can find the area under the curve, and thus determine *x*, by counting squares. You can see that *x* = 35 m at 6 because there are 3.5 squares under the curve. In addition, $x = 35$ m at *t* = 10 s because the 5 m represented by the half square between 6 s and 8 s is canceled by the –5 m represented by the half square between 8 s and 10 s. Areas beneath the axis are negative areas. The particle passes through $x = 35$ m at $t = 6$ s and again at $t = 10$ s.

2.12. Solve: (a) Using the equation

$$x_f = x_i + \text{area under the velocity-versus-time graph between } t_i \text{ and } t_f$$

we have

$$x(\text{at } t = 1\text{ s}) = x(\text{at } t = 0\text{ s}) + \text{area between } t = 0\text{ s and } t = 1\text{ s}$$
$$= 2.0\text{ m} + (4\text{ m/s})(1\text{ s}) = 6\text{ m}$$

Reading from the velocity-versus-time graph, $v_x(\text{at } t = 1\text{ s}) = 4$ m/s. Also, $a_x = \text{slope} = \Delta v/\Delta t = 0\text{ m/s}^2$.
(b) $x(\text{at } t = 3.0\text{ s}) = x(\text{at } t = 0\text{ s}) +$ area between $t = 0$ s and $t = 3$ s

$$= 2.0\text{ m} + 4\text{ m/s} \times 2\text{ s} + 2\text{ m/s} \times 1\text{ s} + (1/2) \times 2\text{ m/s} \times 1\text{ s} = 13.0\text{ m}$$

Reading from the graph, $v_x(t = 3\text{ s}) = 2$ m/s. The acceleration is

$$a_x(t = 3\text{ s}) = \text{slope} = \frac{v_x(\text{at } t = 4\text{ s}) - v_x(\text{at } t = 2\text{ s})}{2\text{ s}} = -2\text{ m/s}^2$$

2.37. Solve: The graph for particle A is a straight line from $t = 2$ s to $t = 8$ s. The slope of this line is -10 m/s, which is the velocity at $t = 7.0$ s. The negative sign indicates motion toward lower values on the *x*-axis. The velocity of particle B at $t = 7.0$ s can be read directly from its graph. It is -20 m/s. The velocity of particle C can be obtained from the equation

$$v_f = v_i + \text{area under the acceleration curve between } t_i \text{ and } t_f$$

This area can be calculated by adding up three sections. The area between $t = 0$ s and $t = 2$ s is 40 m/s, the area between $t = 2$ s and $t = 5$ s is 45 m/s, and the area between $t = 5$ s and $t = 7$ s is -20 m/s. We get $(10 \text{ m/s}) + (60 \text{ m/s}) + (45 \text{ m/s}) - (20 \text{ m/s}) = 95 \text{ m/s}$.