HOMEWORK #2 (1313)

CONCEPTUAL QUESTIONS

8. ***REASONING AND SOLUTION*** It *is* possible for the instantaneous velocity at any point during a trip to have a negative value, even though the average velocity for the entire trip has a positive value. The average velocity for the trip is the displacement for the trip divided by the elapsed time. It depends only on the initial and final positions, and the time required for the trip. The average velocity contains no information concerning the actual path taken by the object. Let us assume that the object is constrained to move in a straight line with directions designated as positive or negative. The direction of the average velocity is the same as the direction of the displacement, while the direction of the instantaneous velocity is the same as the instantaneous direction of motion. The average velocity will be positive if the displacement vector points in the positive direction. At any point in the trip, the object could temporarily reverse direction and move in the negative direction. While the object is moving in the negative direction, its instantaneous velocity is negative. As long as the overall displacement is positive, the average velocity for the trip is positive.

PROBLEMS

14. ***REASONING*** The average acceleration is defined by Equation 2.4 as the change in velocity divided by the elapsed time. We can find the elapsed time from this relation because the acceleration and the change in velocity are given. Since the acceleration of the spacecraft is constant, it is equal to the average acceleration.

SOLUTION

a. The time Δt that it takes for the spacecraft to change its velocity by an amount $\Delta v = +\ 2700$ m/s is

$$\Delta t = \frac{\Delta v}{a} = \frac{+2700\ \text{m/s}}{+9.0\ \dfrac{\text{m/s}}{\text{day}}} = \boxed{3.0\times10^2\ \text{days}}$$

b. Since 24 hr = 1 day and 3600 s = 1 hr, the acceleration of the spacecraft (in m/s^2) is

$$a = \frac{\Delta v}{t} = \frac{+9.0 m/s}{\dfrac{24hr}{day}\cdot\dfrac{3600s}{hr}} = 1.04\times10^{-4} m/s^2$$

32. ***REASONING AND SOLUTION*** The distance covered by the cab driver during the two phases of the trip must satisfy the relation

$$x_1 + x_2 = 2.00\ \text{km} \qquad (1)$$

where x_1 and x_2 are the displacements of the acceleration and deceleration phases of the trip, respectively. The quantities x_1 and x_2 can be determined from Equation 2.9 $\left(v^2 = v_0^2 + 2ax\right)$:

$$x_1 = \frac{v_1^2 - (0\ \text{m/s})^2}{2a_1} = \frac{v_1^2}{2a_1} \quad \text{and} \quad x_2 = \frac{(0\ \text{m/s})^2 - v_{02}^2}{2a_2} = -\frac{v_{02}^2}{2a_2}$$

with $v_{02} = v_1$ and $a_2 = -3a_1$. Thus,

$$\frac{x_1}{x_2} = \frac{v_1^2/(2a_1)}{-v_1^2/(-6a_1)} = 3$$

so that

$$x_1 = 3x_2 \qquad (2)$$

Combining (1) and (2), we have,

$$3x_2 + x_2 = 2.00 \text{ km}$$

Therefore, $x_2 = 0.50$ km, and from Equation (1), $x_1 = 1.50$ km. Thus, the length of the acceleration phase of the trip is $x_1 = \boxed{1.50 \text{ km}}$, while the length of the deceleration phase is $x_2 = \boxed{0.50 \text{ km}}$.

40. ***REASONING AND SOLUTION*** In a time t the card will undergo a vertical displacement y given by

$$y = \frac{1}{2}at^2$$

where a = –9.80 m/s^2. When t = 60.0 ms = 6.0×10^{-2} s, the displacement of the card is 0.018 m, and the distance is the magnitude of this value or $\boxed{d_1 = 0.018 \text{ m}}$.

Similarly, when t = 120 ms, $\boxed{d_2 = 0.071 \text{ m}}$, and when t = 180 ms, $\boxed{d_3 = 0.16 \text{ m}}$.

44. ***REASONING AND SOLUTION***

a.

$$v^2 = v_0^2 + 2ay$$

$$v = \pm\sqrt{(1.8 \text{ m/s})^2 + 2\left(-9.80 \text{ m/s}^2\right)(-3.0 \text{ m})} = \pm 7.9 \text{ m/s}$$

The minus is chosen, since the diver is now moving down. Hence, $\boxed{v = -7.9 \text{ m/s}}$.

b. The diver's velocity is zero at his highest point. The position of the diver relative to the board is

$$y = -\frac{v_0^2}{2a} = -\frac{(1.8 \text{ m/s})^2}{2\left(-9.80 \text{ m/s}^2\right)} = 0.17 \text{ m}$$

The position above the water is 3.0 m + 0.17 m = $\boxed{3.2 \text{ m}}$.

58. ***REASONING*** The average velocity for each segment is the slope of the line for that segment.

SOLUTION Taking the direction of motion as positive, we have from the graph for segments *A*, *B*, and *C*,

$$v_A = \frac{10.0\text{ km} - 40.0\text{ km}}{1.5\text{ h} - 0.0\text{ h}} = \boxed{-2.0 \times 10^1\text{ km/h}}$$

$$v_B = \frac{20.0\text{ km} - 10.0\text{ km}}{2.5\text{ h} - 1.5\text{ h}} = \boxed{1.0 \times 10^1\text{ km/h}}$$

$$v_C = \frac{40.0\text{ km} - 20.0\text{ km}}{3.0\text{ h} - 2.5\text{ h}} = \boxed{40\text{ km/h}}$$