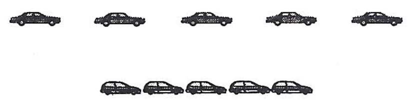
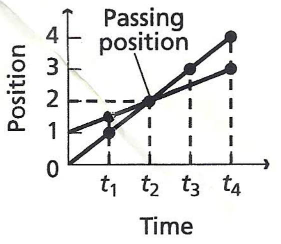
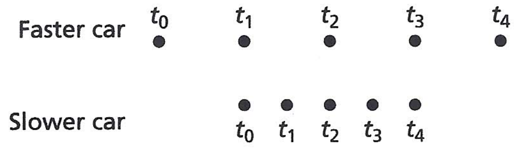
Sketch



Position-Time Graph



Motion diagram



Practice Problems

3.2 Motion with Constant Acceleration pages 65–71

page 65

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

a. If the golf ball starts with a speed of 2.0 m/s and slows at a constant rate of 0.50 m/s^2, what is its velocity after 2.0 s?

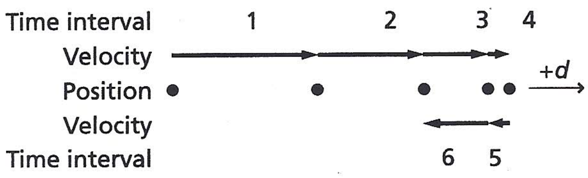
$$\mathbf{v_f = v_i + at}$$
$$\mathbf{= 2.0\ m/s + (-0.50\ m/s^2)(2.0\ s)}$$
$$\mathbf{= 1.0\ m/s}$$

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

$$\mathbf{v_f = v_i + at}$$
$$\mathbf{= 2.0\ m/s + (-0.50\ m/s^2)(6.0\ s)}$$
$$\mathbf{= -1.0\ m/s}$$

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

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



a = 3.5 m/s^2
V_i = 500 m/s
V_f = ?
t = 6.8 s

19. A bus that is traveling at 30.0 km/h speeds up at a constant rate of 3.5 m/s^2. What velocity does it reach 6.8 s later?

1

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

$\frac{30\ km}{hr} \cdot \frac{1000\ m}{1\ km} \cdot \frac{1\ hr}{3600\ s} = 8.3$

$V_f = 8.333 + 3.5(6.8)$
$V_f = 32\ m/s$

$\frac{120\ km}{h} \cdot \frac{1000\ m}{1\ km} \cdot \frac{1\ h}{3600\ s} = 33.3\ m/s$

p65

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

① $v_f = v_i + at$

a = 5.5
v_i = 0
v_f = 28 m/s
t = ?

so $t = \frac{v_f - v_i}{a}$

$= \frac{28\text{ m/s} - 0.0\text{ m/s}}{5.5\text{ m/s}^2}$

$= 5.1$ s

21. 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 3.0 m/s?

a = -2.1 m/s^2
v_i = 22 m/s
v_f = 3 m/s
t = ?

$v_f = v_i + at$ ①

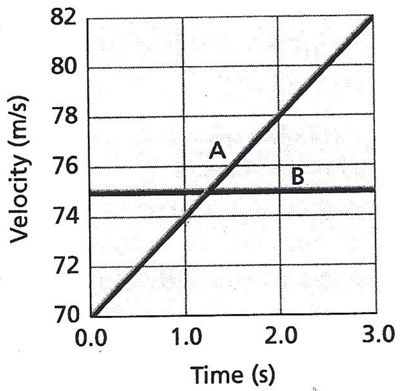
so $t = \frac{v_f - v_i}{a}$

$= \frac{3.0\text{ m/s} - 22\text{ m/s}}{-2.1\text{ m/s}^2}$

$= 9.0$ s

page 67

22. Use **Figure 3-11** to determine the velocity of an airplane that is speeding up at each of the following times.



■ **Figure 3-11**

Graph B represents constant speed. So graph A should be used for the following calculations.

a. 1.0 s

At 1.0 s, v = 74 m/s

b. 2.0 s

At 2.0 s, v = 78 m/s

c. 2.5 s

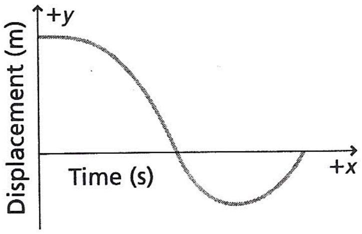
At 2.5 s, v = 80 m/s

23. Use dimensional analysis to convert an airplane's speed of 75 m/s to km/h.

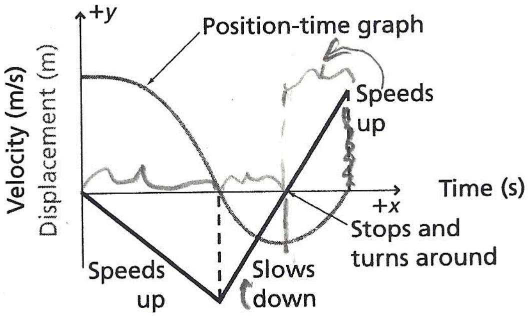
$(75\text{ m/s})\left(\frac{3600\text{ s}}{1\text{ h}}\right)\left(\frac{1\text{ km}}{1000\text{ m}}\right) = 2.7\times10^2\text{ km/h}$

24. A position-time graph for a pony running in a field is shown in **Figure 3-12.** Draw the corresponding velocity-time graph using the same time scale.

HARD

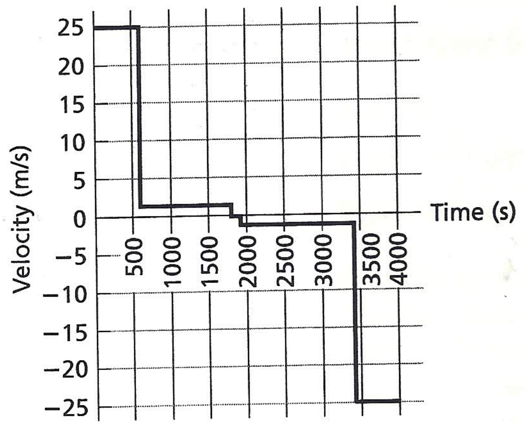


■ **Figure 3-12**



25. A car is driven at a constant velocity of 25 m/s for 10.0 min. The car runs out of gas and the driver walks in the same direction at 1.5 m/s for 20.0 min to the nearest gas station. The driver takes 2.0 min to fill a gasoline can, then walks back to the car at 1.2 m/s and eventually drives home at 25 m/s in the direction opposite that of the original trip.

a. Draw a v-t graph using seconds as your time unit. Calculate the distance the driver walked to the gas station to find the time it took him to walk back to the car.



distance the driver walked to the gas station:

$d = vt$

$= (1.5\ \text{m/s})(20.0\ \text{min})(60\ \text{s/min})$

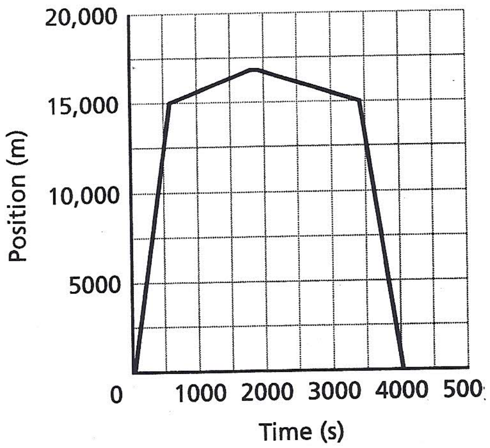
$= 1800\ \text{m}$

$= 1.8\ \text{km}$

time to walk back to the car:

$t = \frac{d}{v} = \frac{1800\ \text{m}}{1.2\ \text{m/s}} = 1500\ \text{s} = 25\ \text{min}$

b. Draw a position-time graph for the situation using the areas under the velocity-time graph.



page 69

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

Vf = 0
Vi = 1.75 m/s
a = −1.75 m/s²
t = ?

$v_f = v_i + at$

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

27. A race car travels on a racetrack at 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?

use this so you don't screw up the signs

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

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

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

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

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

28. 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 this speed?

Vf = 25 m/s
Vi = 15 m/s
Δd = 125 m
Δt ?

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

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

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

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

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

$= 25\ \text{s}$

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

Δt = 4.5 s
Vf = 7.5 m/s
Δd = 19 m
Vi = ?

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

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

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

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

−7.5 m/s

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

Part 2: Constant velocity:

$d_2 = vt = (18.0\text{ m/s})(60.0\text{ s}) = 1.08\times10^3\text{ m}$

Thus $d = d_1 + d_2$

$= 81.0\text{ m} + 1.08\times10^3\text{ m}$

$= 1.16\times10^3\text{ m}$

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

Part 1: Constant velocity:

$d = vt$

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

$= 4902\text{ m}$

vi = 4.3 m/s
df = 5.0×10³ km
t = 19.4 s
a = ?
di = 4902 m

Part 2: Constant acceleration:

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

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

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

Section Review

3.2 Motion with Constant Acceleration pages 65–71

sketch

page 71

34. Acceleration A woman driving at a speed of 23 m/s sees a deer on the road ahead and 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?

vi = 23 m/s
vf = 0
a = ?
t = X
di = 0 m
df = 210 m

Given: vi = 23 m/s, Δd = 210 m, vf = 0
Unknown: a = ?

3

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

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

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

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

no time, use kinematics eqn # 3.

35. Displacement If you were given initial and final velocities and the constant acceleration of an object, and you were asked to find the displacement, what equation would you use?

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

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

Accelerating

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

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

$$= 11.25\text{ m}$$

Constant speed

$$d_f = v_f t_f$$

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

$$= 22.5\text{ m}$$

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

$= 34\text{ m}$

37. Final Velocity A plane travels a distance of 5.0×10^2 m while being accelerated uniformly from rest at the rate of 5.0 m/s^2. What final velocity does it attain?

$v_f^2 = v_i^2 + 2a(d_f - d_i)$ **and** $d_i = 0$, **so**

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

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

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

38. Final Velocity An airplane accelerated uniformly from rest at the rate of 5.0 m/s^2 for 14 s. What final velocity did it attain?

$$v_f = v_i + at_f$$

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

Given — Unknown

39. Distance An airplane starts from rest and accelerates at a constant 3.00 m/s^2 for 30.0 s before leaving the ground.

$v_i = 0$ $v_f = ?$ $d_i = 0$ $d_f = ?$

$a = 3.00\text{ m/s}^2$

$\Delta t = 30.0\text{ s}$

use kinematics eqn #2.

a. How far did it move?

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

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

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

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

1 $v_f = v_i + at_f$

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

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