1. In uniform or constant speed, the speed is the same during each time interval. In constant acceleration, what is the same in each time interval?

In constant acceleration, the change in speed is the same for each time interval.

6 12
12 24
18 36

2. You and your friend are on your bicycles and accelerate from rest. If your average acceleration is double that of your friend, how will your change in speed compare with your friend's after the same time interval?

2. After the same time interval, your change in speed is twice as great as your friend's.

$a_{av} = \frac{\Delta v}{\Delta t}$

3. In a road test, car A accelerates from rest (0 km/h) to 100.0 km/h in 16.0 s and car B takes 8.0 s in the same test. Which car has the greater average acceleration? By how many times?

Car A

$v_2 = 100.0\ \frac{km}{h}$

$v_1 = 0.0\ km/h$

$\Delta t = 16.0\ s$

$a_{av} = ?$

$a_{av} = \frac{\Delta v}{\Delta t}$

$v_2 = 100\ km/h$

$v_1 = 0.0\ km/h$

$\Delta t = 8.0\ s$

$a_{av} = ?$

A

$a_{av} = \frac{v_2 - v_1}{\Delta t}$

$= \frac{(100.0 - 0)\ km/h}{16.0\ s}$

$= 6.25\ \frac{km/h}{s}$

B

$a_{av} = \frac{v_2 - v_1}{\Delta t}$

$= \frac{(100.0 - 0)\ km/h}{8.0\ s}$

$= 13\ \frac{km/h}{s}$

Car B

Car B has two times the average acceleration of Car A

4. A cyclist increases her speed by 5.0 m/s in a time of 4.5 s. What is her acceleration? a_{av} ?

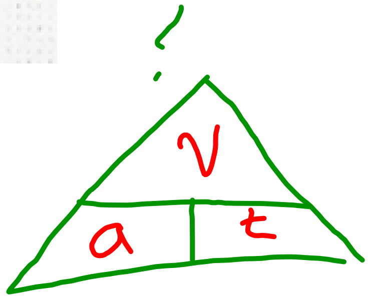
4.

$$\Delta v = 5.0 \text{ m/s}$$
$$\Delta t = 4.5 \text{ s}$$
$$a = ?$$
$$a = \frac{\Delta v}{\Delta t}$$
$$= \frac{5.0 \frac{\text{m}}{\text{s}}}{4.5 \text{ s}}$$
$$= 1.1 \frac{\text{m}}{\text{s}^2}$$

Her acceleration is 1.1 m/s^2.

1.1 m/s/s

5. A roller coaster car accelerates at 8.0 m/s² for 4.0 s. What is the change in the speed of the roller coaster car?



5.

$a_{av} = 8.0\ m/s^2$

$\Delta t = 4.0\ s$

$\Delta v = ?$

$$\Delta v = a_{av}\Delta t$$

$$= 8.0\ \frac{m}{s^2} \times 4.0\ s$$

$$= 32\ \frac{m}{s}$$

The change in speed of the roller coaster car is 32 m/s².

6. The human heart pumps about 60 mL of blood into the aorta during a single stroke, which lasts about 0.1 s. In a single stroke, a pulse of blood is accelerated from rest to about 50 cm/s. Calculate the average acceleration of the blood in metres per second squared.

6.

$$\Delta v = 50\ \frac{\text{cm}}{\text{s}} \times \frac{1\ \text{m}}{100\ \text{cm}} = 0.50\ \frac{\text{m}}{\text{s}}$$

$$\Delta t = 0.1\ \text{s}$$

$$a_{av} = ?$$

$$a_{av} = \frac{\Delta v}{\Delta t}$$

$$= \frac{0.50\ \frac{\text{m}}{\text{s}}}{0.1\ \text{s}}$$

$$= 5\ \frac{\text{m}}{\text{s}^2}$$

5 m/s/s

The acceleration of the blood is 5 m/s^2.

7. A downhill skier moving at 2.5 m/s accelerates to 20.0 m/s in a time of 3.8 s.

(a) Calculate the average acceleration of the skier.

(b) What does this acceleration mean?

---

7. (a)

$$v_1 = 2.5 \text{ m/s}$$
$$v_2 = 20.0 \text{ m/s}$$
$$a_{av} = ?$$
$$a_{av} = \frac{v_2 - v_1}{\Delta t}$$
$$= \frac{(20.0 - 2.5)\frac{\text{m}}{\text{s}}}{3.8 \text{ s}}$$
$$= 4.6 \frac{\text{m}}{\text{s}^2}$$

The average acceleration of the skier is 4.6 m/s^2.

(b) An acceleration of 4.6 m/s^2 means that the speed of the skier is increasing at a rate of 4.6 m/s every second.

$v_1 = 0$ $v_2 =$ Δt

8. An electric car accelerates from rest to 50.0 km/h in 8.20 s.

(a) What is the average acceleration of the electric car in kilometres per hour per second?

8. (a)

$$v_1 = 0 \text{ km/h}$$
$$v_2 = 50 \text{ km/h}$$
$$\Delta t = 8.20 \text{ s}$$
$$a_{av} = ?$$
$$a_{av} = \frac{v_2 - v_1}{\Delta t} = \frac{\Delta v}{\Delta t}$$
$$= \frac{(50 - 0)\frac{\text{km}}{\text{h}}}{8.20 \text{ s}}$$
$$= 6.1 \frac{\text{km/h}}{\text{s}}$$

6.1 m

(b) Assuming constant acceleration, what time would the car take to accelerate from 40 km/h to 60 km/h?

v_1 v_2

$a_{av} = \frac{\Delta v}{\Delta t}$

$\Delta t = \frac{\Delta v}{a}$

(b) $v_1 = 40$ km/h
$v_2 = 60$ km/h
$a_{av} = 6.1$ (km/h)/s
$\Delta t = ?$

$$a_{av} = \frac{v_2 - v_1}{\Delta t}$$

$$\Delta t = \frac{v_2 - v_1}{a_{av}}$$

$$\Delta t = \frac{(60 - 40)\,\frac{\text{km}}{\text{h}}}{6.1\,\frac{\text{km/h}}{\text{s}}}$$

$= 3.3$ s

40
1 + 6.1
46.1
2 + 6.1
52.2
+ 6.1 58.3

9. A baseball player running at 6.0 m/s slides into home plate and stops in 2.5 s (**Figure 7**). What is the average acceleration of the baseball player?

9. $v_1 = 6.0$ m/s
$v_2 = 0$
$\Delta t = 2.5$ s
$a_{av} = ?$

$$a_{av} = \frac{v_2 - v_1}{\Delta t} = \frac{(0 - 6.0)\frac{m}{s}}{2.5\ s} = -2.4\frac{m}{s^2}$$

The average acceleration of the baseball player is -2.4 m/s^2.

Questions 10–14 require you to rearrange the acceleration equation.

10. You are coasting on your skateboard at 1.4 m/s and you decide to speed up. If you accelerate at 0.50 m/s² for 7.0 s, what is your final speed?

v_i , a , t

$$a = \frac{v_2 - v_1}{\Delta t}$$

$$(a \cdot \Delta t) = v_2 - v_1$$

$$v_2 = (a \cdot \Delta t) + v_1$$

10. $v_1 = 1.4$ m/s

$a_{av} = 0.50$ m/s²

$\Delta t = 7.0$ s

$v_2 = ?$

$$v_2 = v_1 + a_{av}\Delta t$$

$$= 1.4\,\frac{\text{m}}{\text{s}} + \left[0.50\,\frac{\text{m}}{\text{s}^2} \times 7.0\,\text{s}\right]$$

$$= 1.4\,\frac{\text{m}}{\text{s}} + 3.5\,\frac{\text{m}}{\text{s}}$$

$$= 4.9\,\frac{\text{m}}{\text{s}}$$

Your final speed is 4.9 m/s.

11. A train is moving at 5.0 km/h and accelerates at 95 km/h^2 for 0.50 h. What is the final speed at the end of the 0.50 h?

11. $v_1 = 5.0$ km/h

$a_{av} = 95\ km/h^2$

$\Delta t = 0.50$ h

$v_2 = ?$

$$v_2 = v_1 + a_{av}\Delta t$$

$$= 5.0\,\frac{km}{h} + 95\,\frac{km}{h^2} \times 0.50\,h$$

$$= 5.0\,\frac{km}{h} + 48\,\frac{km}{h}$$

$$= 53\,\frac{km}{h}$$

The final speed of the train is 53 km/h.

12. A car travelling at a constant speed approaches the top of a hill. The car rolls down the hill at an acceleration of 2.0 m/s² for 8.0 s and reaches a final speed of 26 m/s. What was the initial speed of the car before accelerating down the hill?

12.

$a_{av} = 2.0\ \text{m/s}^2$

$v_2 = 26\ \text{m/s}$

$\Delta t = 8.0\ \text{s}$

$v_1 = ?$

Final

$$v_2 = v_1 + a_{av}\Delta t$$

initial →

$$v_1 = v_2 - a_{av}\Delta t$$

$$= 26\ \frac{\text{m}}{\text{s}} - \left(2.0\ \frac{\text{m}}{\text{s}^2} \times 8.0\ \text{s}\right)$$

$$= 26\ \frac{\text{m}}{\text{s}} - 16\ \frac{\text{m}}{\text{s}}$$

$$= 10\ \frac{\text{m}}{\text{s}}$$

The initial speed of the car was 10 m/s.

13. An octopus can accelerate rapidly by squirting a stream of water for propulsion. An octopus moving at 0.10 m/s accelerates at 5.5 m/s² to a final speed of 3.5 m/s. What is the elapsed time during the acceleration?

13.

$$v_1 = 0.10 \text{ m/s}$$
$$v_2 = 3.5 \text{ m/s}$$
$$a_{av} = 5.5 \text{ m/s}^2$$
$$\Delta t = ?$$

$$v_2 = v_1 + a_{av}\Delta t$$

$$\Delta t = \frac{v_2 - v_1}{a_{av}}$$

$v_f - v_i$

$$= \frac{(3.5 - 0.10)\,\frac{\text{m}}{\text{s}}}{5.5\,\frac{\text{m}}{\text{s}^2}}$$

$$= 0.62 \text{ s}$$

14. The NASA space shuttle touches down on a runway at an initial speed of 95 m/s and accelerates at a rate of −4.40 m/s² (Figure 8). How much time does it take for the shuttle to stop?

$V_2 = 0$

14.

$v_1 = 95$ m/s

$v_2 = 0$

$a_{av} = -4.40$ m/s^2

$\Delta t = ?$

$$v_2 = v_1 + a_{av}\Delta t$$

$$\Delta t = \frac{v_2 - v_1}{a_{av}}$$

$$= \frac{(0 - 95)\,\frac{m}{s}}{-4.40\,\frac{m}{s^2}}$$

$$= 22 \text{ s}$$

Pg 410
Q 7-12

$$a_{av} = \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{\Delta t} \quad \frac{v_2 - v_1}{t_2 - t_1}$$

$$v_f = v_i + a \times t$$

$$v_i = v_f - a \times t$$

$$t = \frac{v_2 - v_1}{a_{av}}$$

$$\Delta v = a_{av} \times t$$

$$a = \frac{\Delta v}{\Delta t} \quad \frac{v_2 - v_1}{\Delta t}$$

$$\Delta v = a \times t$$

$$\Delta t = \frac{\Delta v}{a_{av}} = \frac{v_2 - v_1}{a}$$

$$v_2 = v_1 + (a \times t)$$

Read p390 - 393

Q 1.5

Problems: Acceleration

1. A horse cantering across a field at 3 m/s is scared by a sudden noise and rapidly increases its pace. After 3.5 s, it is running at 5.4 m/s. Find its average acceleration.

2. A last minute shopper strides briskly at 0.3 m/s through a mall toward a music store. Noticing the clerk starting to move the CD displays inside the store entrance, the shopper begins to speed walk and in 4 s in moving at 0.8 m/s. Find the average acceleration.

$= v_2 - v_1$

3. Fido runs at 3.7 m/s across the yard, its chain playing out. Suddenly the dog comes to the end of the chain and in 0.5 s, has flipped around and is lying flat on the ground, legs splayed out. Find the dogs average acceleration. (The sign means what motion process occurred?)

4. On a time-velocity graph, periods of no acceleration have what slope?

5. During a period of acceleration, the plot line of a time-velocity graph will have a slope of what sign?

6. Explain the appearance and slope of the portion of a time-velocity graph describing deceleration.

7. A moose sees an "intruder"). How long does it take the moose, running at 1.4 m/s, to reach 2.7 m/s if it accelerates at 0.3 m/s^2?

8. During the final run of the go-cart competition, a driver pushes with their hands on the road to make the cart go faster. The cart, moving at 2.7 m/s, undergoes an acceleration of 0.2 m/s2 for 5.4 s. By that time, it is going how fast?

Pg 410 7-, 2

7. $V_1 = 0$ $a = \frac{\Delta V}{\Delta t}$ $\frac{V_2 - V_1}{\Delta t}$

$V_2 = 6.0 m/s$ $\frac{6.0 - 0}{3.0}$

$t = 3.0s$

$a =$ $= 2.0$

The acceleration was 2.0 m/s/s

8. $v_1 =$ $\Delta V = a \times t$

$v_2 =$

$a = 45 m/s^2$ $= 45 \times 0.10$

$t = 0.10 s$ $= 4.5 m/s$

The change in speed is 4.5 m/s.

9. $v_1 = 0$

$v_2 = 35 km/h$

$a =$

$t = 4.0 min$

$$a = \frac{v_2 - v_1}{t}$$

$$\frac{35 - 0}{4} = 8.8$$

The acceleration is 8.8 Km/h/min

min	
0	0
1	8.8
2	17.6
3	26.4
4	35.2

10. v_1 > 5.0 m/s
v_2
$a = 0.10 \text{ m/s}^2$
$t = ?$

$$t = \frac{\Delta V}{a} = \frac{5.0}{0.10}$$

$= 50 \text{ s}$

The time was 50 seconds.

12. $v_1 = ?$

$v_2 = 9.7 m/s$

a $0.50 m/s^2$

$t = 15 s$

$v_1 = v_2 - (a \times t)$

$= 9.7 - (0.5 \times 15)$

$= 9.7 - 7.5$

$= 2.2 m/s$

The initial speed was 2.2 m/s

$\frac{9.7 m}{s} \times \frac{1 km}{1000 m} \times \frac{3600 s}{1 h} = 34.9 km/h$

7. 4.0

$V_1 = 0 m/s$

$V_2 = 6.0 m/s$

$\Delta t = 3.0 s$

$a =$

$$a = \frac{V_2 - V_1}{\Delta t}$$

0	0	
1	2 m/s	
2	4 m/s	
3	6 m/s	

$$\frac{6.0 - 0}{3}$$

2 m/s/s

8.

$\Delta V = a \times t$

1) $\Delta V =$

$\Delta t = 0.10 s$

$a = 45 m/s^2$

45×0.10

$= 4.5 m/s$

My change in speed is 4.5 m/s

9. $V_1 = 0$ $\quad a = \frac{V_2 - V_1}{\Delta t}$

$V_2 = 35 Km/h$

$\Delta t = 4 min$ $\quad 4 \times 60 = 240s$ $\quad = \frac{35 - 0}{240s}$

$a =$

$\frac{35-0}{4 min} = 8.8 Km/h/min$ $\quad = 0.13 Km/h/s$

10. $\Delta v = 5.0 \text{ m/s}$ $t = \frac{\Delta v}{a} = \frac{5.0}{0.10}$

$\Delta t = ?$

$a = 0.10 \text{ m/s}^2$ $= 50 \text{ s}$

It takes 50 s.

11. $V_2 = ?$

$V_1 = 0$

$a = 1.5\,Km/s^2$

$t = 1.0\,ms \div 1000 = 0.001\,s$

$1000\,ms = 1\,s$

$V_2 = V_1 + a \times t$

$= 0 + 1.5\,Km/s^2 \times 0.001\,s$

$= 0.0015\,m/s$

12. $V_1 = ?$ $V_1 = V_2 - a \times t$

$V_2 = 9.7 m/s$ $= 9.7 - (15 \times 0.5)$

$\Delta t = 15 s$

$a = 0.50 m/s^2$ $= 9.7 - 7.5$

$= 2.2 m/s$

$\frac{9.7 m}{s} \times \frac{3600 s}{1 h} \times \frac{1 Km}{1000 m}$ $34.9 Km/h$