Honours Distance and Acceleration

distance covered by an object traveling at a constant velocity is calculated using the equation

$$\Delta d = v\Delta t$$

If the object is accelerating, this equation can not be used. However, if the acceleration is constant, the graph of this motion would be a straight line. The average velocity is calculated

$v_{average} = \frac{v_o+v_f}{2}$ where v_o is the initial velocity

and v_f is the final velocity

Then the distance traveled by an object with constant acceleration is

$\Delta d = v_{average}\Delta t$ or $\Delta d = \left(\frac{v_o+v_f}{2}\right)\Delta t$

How far does a bus travel in 10.0s if it starts at 2.0m/s, accelerates steadily at 1.0m/s^2, and has a final velocity of 12m/s?

A car rolling down a hill accelerates from rest to 22m/s in 40.0s.

a. What is the average velocity of the car?

b. What is the distance the car rolls down the hill?

1. What is the average speed of a ball bearing rolling down a ramp, accelerating steadily from 8.0m/s to
   a. 12m/s b. 18m/s c. 24m/s

2. How far does a dragster travel in 6.00s, accelerating steadily from 0m/s to 90.0m/s?

3. A skateboarder accelerates steadily from 4.5m/s to 11.5m/s in 6.0s. How far does she travel?

Constant Acceleration from Rest: consider the equation $\Delta d = \left(\frac{v_o+v_f}{2}\right)\Delta t$

If there is constant acceleration and the object starts from rest, then

$v_o = 0$	$v_f = v$	so that	$\Delta v = v$
$d_o = 0$	$d_f = d$	so that	$\Delta d = d$
$t_o = 0$	$t_f = t$	so that	$\Delta t = t$

Now $a = \frac{\Delta v}{\Delta t} = \frac{v}{t}$ which we can rearrange into v = at and substituting that into the original

How far down a smooth ramp does a 5.0 kg cart roll in 8.0s accelerating from rest at $2.5 m/s^2$?

4. A skier accelerates at $1.20 m/s^2$ down an icy slope, starting from rest. How far does she get in
   a. 5.0s b. 10.0s c. 15.0s

5. What is the acceleration of an object that accelerates steadily from rest, traveling 10.0m in 10.0s?

6. How long does it take an airplane, accelerating from rest at $5.0 m/s^2$, to travel 360 m?

Is it possible to calculate final velocity with what we know so far?

Constant acceleration is the slope of a velocity time graph

At zero time the initial velocity is v_o

At time t, the velocity is v_f

Using this information, what is the equation of the line?

If a car with velocity of 2.0m/s at t = 0 accelerates at a rate of $4.0 m/s^2$ for 2.5s, what is its velocity at t = 2.5s?

7. A golf ball rolls up a hill toward a mini-golf hole.
   a. if it starts with a velocity of 2.0m/s and accelerates at a constant rate of $-0.50 m/s^2$, what is its velocity after 2.0s?

   b. if the acceleration occurs for 6.0s, what is its final velocity?

8. A bus traveling at 30.0 km/hr accelerates at a constant $3.5 m/s^2$ for 6.8s. What is its final velocity in km/hr?

Distance when Acceleration and Time are Known

If we know initial velocity, acceleration, and the time interval, we can calculate the distance.

Recall for final velocity: $v_f = v_o + at$ (equation 1)

And for distance: $\Delta d = \left(\frac{v_o + v_f}{2}\right) t$ (equation 2)

Substitute v_f from equation 1 into v_f from equation 2 and simplify.

A car starting from rest accelerates uniformly at 6.1m/s^2 for 7.0s. How far does the car move?

9. An airplane starts from rest and accelerates at a constant 3.00m/s^2 for 30.0s before leaving the ground. What is its distance?

10. Starting from rest, a car moves 110m in the first 5.0s of uniform acceleration. What is the car's acceleration?

Lots More Practice: Be careful. These are all mixed up based on everything we've done! Please answer them on a separate piece of paper showing all work (8 and 9 may be done on these pages)

1. A car accelerates from 0 to 90.0 m/s in 6.0s. What is its acceleration?

2. A rocket accelerates at 40.0m/s^2 for 3.0 min. What is its change in velocity?

3. How long will it take a falling rock, accelerating at 10.0 m/s^2 to reach 112 m/s if it starts from rest?

4. A car enters a tunnel at 24 m/s and accelerates steadily at 2.0 m/s^2. At what speed does it leave the tunnel 8.0s later?

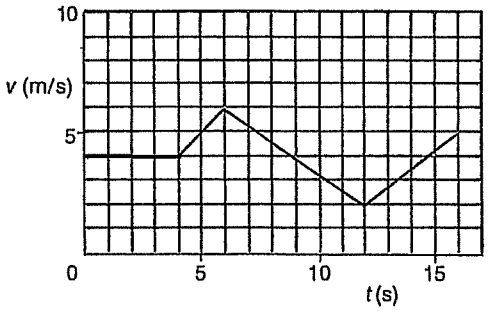
5. The driver of a truck moving at 18 m/s throws on the brakes and stops in 4.0s. What is the acceleration of the truck?

6. A motorcycle stuntperson accelerates from rest to a maximum speed of 35.2m/s at the top of the take-off ramp, then swoops up and over 20 cars. Calculate how long it takes him to accelerate, at an acceleration of 8.8m/s^2.

7. A car accelerates from rest to 8.8m/s in 3.0s in first gear, then changes into second gear. After 8.0s from the start of the trip, the car reaches 22.0m/s and is shifted into third gear. After 7.0s in third gear, it reaches 41.8m/s. Calculate the acceleration in each gear.

8. Here is the velocity time graph of a trip on a bicycle. How fast is the bicycle moving at each of the following times:

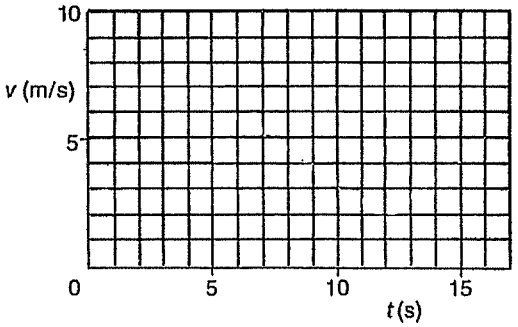
a. 4s b. 6s c. 10s d. 12s



What is the acceleration at:

a. 2s b. 5s c. 7s d. 14s

9. Draw the velocity-time graph of the motion of a bus that accelerates from rest at $1.0 m/s^2$ for 6.0s, then continues on at a constant velocity for 6.0s, then accelerates at $-2.0 m/s^2$ for 3.0s.



10. Two runners accelerate uniformly from rest to $1.40 m/s^2$ for 8.00s.
    a. What is their final speed?
    b. What is their average speed?
    c. How far do they travel?

11. A ball accelerates steadily down a ramp, starting from rest. It goes 2.0m in 4.0s.
    a. What is its average speed?
    b. What is its final speed?
    c. What is its acceleration?

12. A car accelerates from rest at $6.00 m/s^2$. How far does it get between 10.0 and 15.0 s?

13. A skier accelerates steadily down a hill from 3.50m/s to 11.40m/s in 4.20s.
    a. What is the average speed for the trip?
    b. What is the distance travelled?

14. Runner A runs at 6.0m/s for 10.0s. Runner B accelerates from 4.0m/s to 10.0m/s, steadily in 10.0s.
    a. How far does runner A go?
    b. How far does runner B go?
    c. How much farther does runner B travel than runner A?

15. Jack and Jill ran down the hill. Both started from rest and accelerated steadily. Jack accelerated at $0.25 m/s^2$ and Jill at $0.30 m/s^2$. After running for 20.0s Jill fell down.
    a. How far did Jill get before she fell?
    b. How far had Jack travelled when Jill fell?
    c. How fast was Jack running when Jill fell?
    d. How long was it after Jill fell that Jack ran into her and broke his crown?

1. $15 m/s^2$ 2. 7200m/s 3. 11.2s 4. 40.m/s 5. $-4.5 m/s^2$ 6. 4.0s 7. $2.9 m/s^2$, $2.6 m/s^2$, $2.8 m/s^2$ 8.a 4m/s b. 6m/s c.3.0m/s d. 2.0m/s a.$0 m/s^2$ b. $1.0 m/s^2$ c. $-0.67 m/s^2$ d. $0.75 m/s^2$ 10a. 11.2m/s b. 5.60m/s c. 44.8m 11a. 0.50m/s b. 1.0m/s c. $0.25 m/s^2$ 12. 375m 13a. 7.45m/s b. 31.3m 14a. 60.m b. 70.m c. 10.m 15a. 60.m b. 50.m c. 5.0m/s d. 2.0s