9.3) Constant acceleration formulae

Worked example

A cyclist is travelling along a straight road.
She accelerates at a constant rate from a velocity of 5 ms^{-1} to a velocity of 7.4 ms^{-1} in 50 seconds.
Find:
(a) the distance she travels in these 50 seconds
(b) her acceleration in these 50 seconds.

Your turn

A cyclist is travelling along a straight road.
She accelerates at a constant rate from a velocity of 4 ms^{-1} to a velocity of 7.5 ms^{-1} in 40 seconds.
Find:
(a) the distance she travels in these 40 seconds
(b) her acceleration in these 40 seconds.

a) $230\ m$
b) $0.0875\ ms^{-2}$

Worked example

A particle moves in a straight line from a point A to a point B with a constant deceleration $3\ ms^{-2}$. The velocity of the particle at A is $16\ ms^{-1}$ and the velocity of the particle at B is $4\ ms^{-1}$. Find:

(a) the time taken for the particle to move from A to B.

(b) the distance from A to B.

After reaching B the particle continues to move along the straight line with constant deceleration $3\ ms^{-2}$.
The particle is at the point C 12 seconds after passing through the point A. Find:

(c) the velocity of the particle at C.

(d) The distance from A to C.

Your turn

A particle moves in a straight line from a point A to a point B with a constant deceleration $1.5\ ms^{-2}$. The velocity of the particle at A is $8\ ms^{-1}$ and the velocity of the particle at B is $2\ ms^{-1}$. Find:

(a) the time taken for the particle to move from A to B.

(b) the distance from A to B.

After reaching B the particle continues to move along the straight line with constant deceleration $1.5\ ms^{-2}$.
The particle is at the point C 6 seconds after passing through the point A. Find:

(c) the velocity of the particle at C.

(d) The distance from A to C.

a) 4 s

b) $20\ m$

c) $1\ ms^{-1}$ in the direction $\overrightarrow{BA}$

d) $21\ m$

Worked example

A car moves from traffic lights along a straight road with constant acceleration.
The car starts from rest at the traffic lights and 20 seconds later the car passes a speed-trap where it is registered as travelling at $54\ km\ h^{-1}$. Find:

(a) the acceleration of the car
(b) the distance between the traffic lights and the speed-trap.

Your turn

A car moves from traffic lights along a straight road with constant acceleration.
The car starts from rest at the traffic lights and 30 seconds later the car passes a speed-trap where it is registered as travelling at $45\ km\ h^{-1}$. Find:

(a) the acceleration of the car
(b) the distance between the traffic lights and the speed-trap.

a) $\frac{5}{12}\ ms^{-2} = 0.417\ ms^{-2}$ (3 sf)

b) $187.5\ m$

Worked example

Use the equations $v = u + at$ and $s = \left(\frac{u+v}{2}\right)t$ to derive:

$$v^2 = u^2 + 2as$$

$$s = vt - \frac{1}{2}at^2$$

Your turn

Use the equations $v = u + at$ and $s = \left(\frac{u+v}{2}\right)t$ to derive:

$$s = ut + \frac{1}{2}at^2$$

Shown

Worked example

A particle is moving along a straight line from A to B with constant acceleration $3\ ms^{-2}$.
The velocity of the particle is $5\ ms^{-1}$ in the direction $\overrightarrow{AB}$.
The velocity of the particle at B is $81\ ms^{-1}$ in the same direction.
Find the distance from A to B.

Your turn

A particle is moving along a straight line from A to B with constant acceleration $5\ ms^{-2}$.
The velocity of the particle is $3\ ms^{-1}$ in the direction $\overrightarrow{AB}$.
The velocity of the particle at B is $18\ ms^{-1}$ in the same direction.
Find the distance from A to B.

$31.5\ m$

Worked example

A particle is moving in a straight horizontal line with constant deceleration 6 ms^{-2}.
At time $t = 0$ the particle passes through a point O with speed 23 ms^{-1} travelling towards a point A, where $OA = 40$ m. Find:
(a) the times when the particle passes through A
(b) the value of t when the particle returns to O.

Your turn

A particle is moving in a straight horizontal line with constant deceleration 4 ms^{-2}.
At time $t = 0$ the particle passes through a point O with speed 13 ms^{-1} travelling towards a point A, where $OA = 20$ m. Find:
(a) the times when the particle passes through A
(b) the value of t when the particle returns to O.

a) $t = 2.5$ s, $t = 4$ s
b) $t = 6.5$ s

Worked example

A particle is moving in a straight horizontal line with constant deceleration 6 ms^{-2}.
At time $t = 0$ the particle passes through a point O with speed 23 ms^{-1}.
Find the total distance travelled by the particle between when it first passes O and returns to O

Your turn

A particle is moving in a straight horizontal line with constant deceleration 4 ms^{-2}.
At time $t = 0$ the particle passes through a point O with speed 13 ms^{-1}.
Find the total distance travelled by the particle between when it first passes O and returns to O

$42.25\ m$

Worked example

Two particles P and Q are moving along the same straight horizontal line with constant accelerations 2 and 4 ms^{-2} respectively. At time $t = 0$, P passes through a point A with speed 12 ms^{-1}. One second later Q passes through A with speed 6 ms^{-1}, moving in the same direction as P.

a) Find the value of t where the particles meet.

b) Find the distance of A from the point where the particles meet.

Your turn

Two particles P and Q are moving along the same straight horizontal line with constant accelerations 6 and 8 ms^{-2} respectively. At time $t = 0$, P passes through a point A with speed 10 ms^{-1}. One second later Q passes through A with speed 5 ms^{-1}, moving in the same direction as P.

a) Find the value of t where the particles meet.

b) Find the distance of A from the point where the particles meet.

a) $t = 13.1$ s (3 sf)

b) 644 m (3 sf)

Worked example

A particle moves in a straight horizontal line with constant acceleration from A to B, then B to C.
AB = 3 km and BC = 12 km.
It takes 2 hour from A to B and 4 hours from B to C.
Find:

a) The acceleration of the particle
b) The particle's speed as it passes A

Your turn

A particle moves in a straight horizontal line with constant acceleration from A to B, then B to C.
AB = 4 km and BC = 12 km.
It takes 2 hours from A to B and 3 hours from B to C.
Find:

a) The acceleration of the particle
b) The particle's speed as it passes A

a) $0.8\ km\ h^{-2} = 6.1728 \times 10^{-5}\ ms^{-2}$ (3 sf)
b) $1.2\ km\ h^{-1} = 0.333\ ms^{-1}$ (3 sf)