1. A body with constant acceleration starts with velocity 15 m/s. At the end of the eleventh second its velocity is 48 m/s. What is its acceleration?

u = 15 m/s, v = 48 m/s, t = 11 s

$v = u + at \quad a = \frac{v-u}{t} = 3\ m\ s^{-2}$

2. A body starts from a fixed point *O* with initial velocity −10 m/s and uniform acceleration 4 m/s2. Find:

a the displacement of the particle from *O* after six seconds

$x = ut + \frac{at^2}{2} \quad x = -10 \times 6 + \frac{4 \times 6^2}{2} = 12\ m$

b the velocity of the particle after six seconds

$v = u + at \quad v = -10 + 4 \times 6 = 14\ m\ s^{-1}$

c the time when the velocity is zero

$v = u + at \quad 0 = -10 + 4t \quad t = 2.5\ s$

d the distance travelled in the first six seconds

Position at the time 2.5 s (at that point body turns around) is

$x = -10 \times 2.5 + \frac{4 \times 2.5^2}{2} = -12.5\ m$

So distance is 12.5+12.5+12=37 m

3. **a** A stone is thrown vertically upwards from ground level at 21 m/s.

i What is its height above the ground after two seconds?

Let choose up as positive

$x = 21t - \frac{9.8t^2}{2} \quad t = 2\ s \quad x = 22.4\ m$

ii What is the maximum height reached by the stone?

$v^2 = u^2 + 2as \quad 0 = 21^2 - 2 \times 9.8s \quad s = 22.5\ m$

b If the stone is thrown vertically upwards from a cliff 17.5 m high at 21 m/s:

i how long will it take to strike the ground at the base of the cliff?

$x = 17.5 + 21t - 4.9t^2 \quad x = 0 \quad 4.9t^2 - 21t - 17.5 = 0$

$t = \frac{21 + \sqrt{21^2 + 4 \times 4.9 \times 17.5}}{2 \times 4.9} = 5\ s$

ii what is the velocity of the stone when it hits the ground?

$v = u + at \;\; v = 21 - 9.8 \times 5 = -28\, m\, s^{-1}$

4. A basketball is thrown vertically upwards with a velocity of 14 m/s. Find:
a the time taken by the ball to reach its maximum height

$v = u + at \;\; 0 = 14 - 9.8t \;\; t = \frac{14}{9.8} = 1.43\, s$

b the greatest height reached by the ball

$v^2 = u^2 + 2as \;\; 0 = 14^2 - 2 \times 9.8s \;\; s = 10\, m$

c the time taken for the ball to return to the point from which it is thrown

$t = 2 \times \frac{14}{9.8} = 2.86\, s$

5. A car sliding on ice is decelerating at the rate of 0.1 m/s2. Initially the car is travelling at 20 m/s. Find:
a the time taken before it comes to rest

$v = u + at \;\; 0 = 20 - 0.1t \;\; t = 200\, s$

b the distance travelled before it comes to rest

$v^2 = u^2 + 2as \;\; 0 = 20^2 - 2 \times 0.1s \;\; s = 2000\, m$

6. An object is dropped from a point 100 m above the ground. The acceleration due to gravity is 9.8 m/s2. Find:
a the time taken by the object to reach the ground

$s = ut + \frac{at^2}{2} \;\; u = 0 \;\; 100 = \frac{9.8t^2}{2} \;\; t = 4.5\, s$

b the velocity at which the object hits the ground

$v = u + at \;\; v = 9.8 \times 4.5 = 44.3\, m\, s^{-1}$

7. An object is projected vertically upwards from a point 50 m above ground level (acceleration due to gravity is 9.8 m/s2). If the initial velocity is 10 m/s, find:
a the time taken by the object to reach the ground (give answer correct to two decimal places)

$x = 50 + 10t - 4.9t^2 \;\; x = 0 \;\; 4.9t^2 - 10t - 50 = 0$
$t = \frac{10 + \sqrt{10^2 + 4 \times 4.9 \times 50}}{2 \times 4.9} = 4.37\, s$

b the velocity at that point

$v = u + at \quad v = 10 - 9.8 \times 4.37 = -32.86\ m\ s^{-1}$

8. A book is pushed across a table and is subjected to a retardation of 0.8 m/s2 due to friction (retardation is acceleration opposite in direction to motion). If the initial speed of the book is 1 m/s, find:
a the time taken for the book to stop

$v = u + at \quad 0 = 1 - 0.8t \quad t = 1.25\ s$

b the distance over which the book slides

$s = ut + \frac{at^2}{2} \quad s = 1 \times 1.25 - \frac{0.8 \times 1.25^2}{2} = 0.625\ m$

9. A box is pushed across a bench and is subjected to a constant retardation, *a* m/s2, due to friction. The initial speed of the box is 1.2 m/s and the box travels 3.2 m before stopping. Find:
a the value of *a*

$v^2 = u^2 + 2as \quad 0 = 1.2^2 - 2a \times 3.2 \quad a = 0.23\ m\ s^{-2}$

b the time taken by the box before it comes to rest

$s = \frac{v + u}{2} t \quad 3.2 = \frac{1.2}{2} t \quad t = 5.3\ s$

10. A particle travels in a straight line with a constant velocity of 4 m/s for 12 seconds. It is then subjected to a constant acceleration in the opposite direction for 20 seconds which returns the particle to its original position. Find:
a the acceleration of the particle

In 12 seconds particle will travel 48 m.

$x = x_0 + ut + \frac{at^2}{2} \quad 0 = 48 + 4 \times 20 - \frac{a \times 20^2}{2} \quad a = 0.64\ m\ s^{-2}$

b the time the particle is travelling back towards its original position

Find time taken to stop. $v = u + at \quad 0 = 4 - 0.64t \quad t = 6.25\ s$
So time of the travel in the opposite direction 20-6.25=13.75 s

11. A child slides from rest down a slide 4 m long. The child undergoes constant acceleration and reaches the end of the slide travelling at 2 m/s. Find:
a the time taken to go down the slide

$s = \frac{v + u}{2} t \quad 4 = \frac{2}{2} t \quad t = 4\ s$

b the acceleration which the child experiences

$v = u + at \quad 2 = 0 + a \times 4 \quad a = 0.5\ m\ s^{-2}$