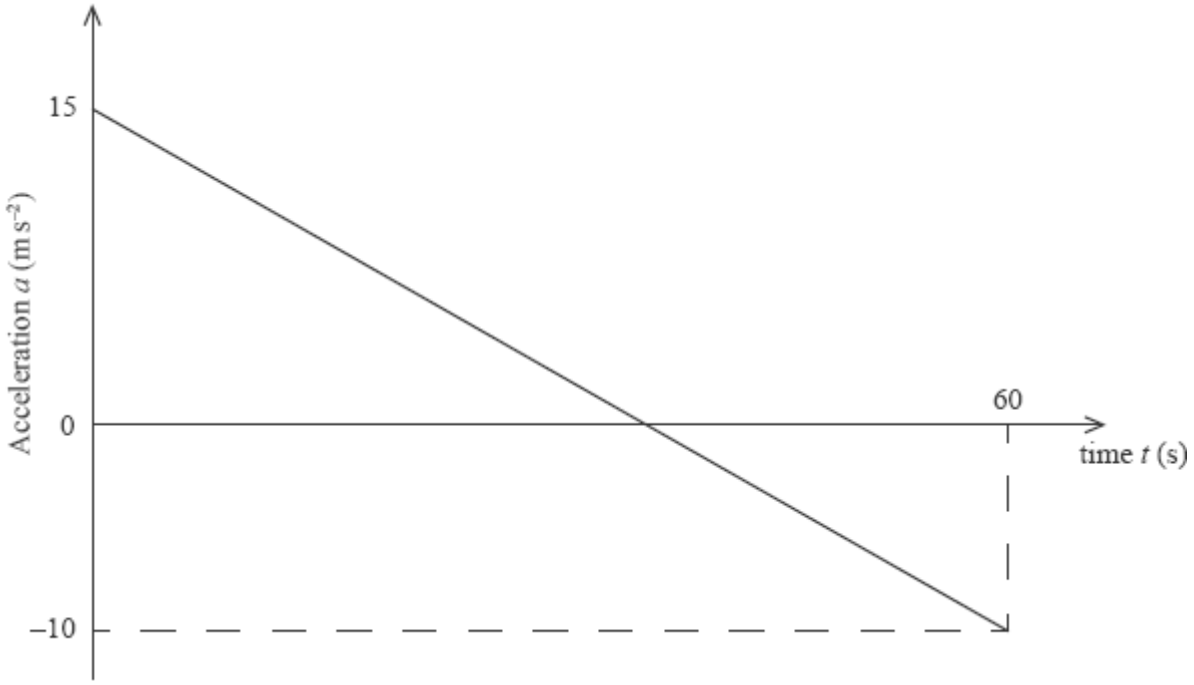
KINEMATICS

1. A jet plane travels horizontally along a straight path for one minute, starting at time $t = 0$, where t is measured in seconds. The acceleration, a, measured in m s^{-2}, of the jet plane is given by the straight line graph below.



(a) Find an expression for the acceleration of the jet plane during this time, in terms of t.

(1)

(b) Given that when $t = 0$ the jet plane is travelling at 125 m s^{-1}, find its maximum velocity in m s^{-1} during the minute that follows.

(4)

(c) Given that the jet plane breaks the sound barrier at 295 m s^{-1}, find out for how long the jet plane is travelling greater than this speed.

(3)

(Total 8 marks)

2. A skydiver jumps from a stationary balloon at a height of 2000 m above the ground. Her velocity, v m s^{-1}, t seconds after jumping, is given by $v = 50(1 - e^{-0.2t})$.

(a) Find her acceleration 10 seconds after jumping.

(3)

(b) How far above the ground is she 10 seconds after jumping?

(3)
(Total 6 marks)

3. A body is moving through a liquid so that its acceleration can be expressed as

$$\left(-\frac{v^2}{200} - 32\right) \text{ m s}^{-2},$$

where v m s^{-1} is the velocity of the body at time t seconds.

The initial velocity of the body was known to be 40 m s^{-1}.

(a) Show that the time taken, T seconds, for the body to slow to V m s^{-1} is given by

$$T = 200\int_V^{40} \frac{1}{v^2 + 80^2}\, \mathrm{d}v.$$

(4)

(b) (i) Explain why acceleration can be expressed as $v\frac{\mathrm{d}v}{\mathrm{d}s}$, where s is displacement, in metres, of the body at time t seconds.

(ii) **Hence** find a similar integral to that shown in part (a) for the distance, S metres, travelled as the body slows to V m s^{-1}.

(7)

(c) **Hence**, using parts (a) and (b), find the distance travelled and the time taken until the body momentarily comes to rest.

(3)
(Total 14 marks)

4. The acceleration in m s^{-2} of a particle moving in a straight line at time t seconds, $t \geq 0$, is given by the formula $a = -\frac{1}{2}v$. When $t = 0$, the velocity is 40 m s^{-1}.

Find an expression for v in terms of t.

(Total 6 marks)

5. The acceleration of a body is given in terms of the displacement s metres as $a = \frac{2s}{s^2 + 1}$.

(a) Give a formula for the velocity as a function of the displacement given that when $s = 1$ metre, $v = 2$ m s^{-1}.

(7)

(b) Hence find the velocity when the body has travelled 5 metres.

(2)

(Total 9 marks)