Kinematics with Variable Acceleration (From OCR 4728)

Q1, (Jan 2006, Q3)

A motorcyclist starts from rest at a point O and travels in a straight line. His velocity after t seconds is $v\,\text{m s}^{-1}$, for $0 \leqslant t \leqslant T$, where $v = 7.2t - 0.45t^2$. The motorcyclist's acceleration is zero when $t = T$.

(i) Find the value of T. [4]

(ii) Show that $v = 28.8$ when $t = T$. [1]

For $t \geqslant T$ the motorcyclist travels in the same direction as before, but with constant speed $28.8\,\text{m s}^{-1}$.

(iii) Find the displacement of the motorcyclist from O when $t = 31$. [6]

Q2, (Jan 2007, Q5)

A particle starts from rest at a point A at time $t = 0$, where t is in seconds. The particle moves in a straight line. For $0 \leqslant t \leqslant 4$ the acceleration is $1.8t\ \text{m s}^{-2}$, and for $4 \leqslant t \leqslant 7$ the particle has constant acceleration $7.2\,\text{m s}^{-2}$.

(i) Find an expression for the velocity of the particle in terms of t, valid for $0 \leqslant t \leqslant 4$. [3]

(ii) Show that the displacement of the particle from A is 19.2 m when $t = 4$. [4]

(iii) Find the displacement of the particle from A when $t = 7$. [5]

Q3, (Jun 2007, Q6)

A particle starts from rest at the point A and travels in a straight line. The displacement s m of the particle from A at time t s after leaving A is given by

$$s = 0.001t^4 - 0.04t^3 + 0.6t^2, \quad \text{for } 0 \leqslant t \leqslant 10.$$

(i) Show that the velocity of the particle is $4\,\text{m s}^{-1}$ when $t = 10$. [3]

The acceleration of the particle for $t \geqslant 10$ is $(0.8 - 0.08t)\,\text{m s}^{-2}$.

(ii) Show that the velocity of the particle is zero when $t = 20$. [5]

(iii) Find the displacement from A of the particle when $t = 20$. [6]

Q4, (Jan 2011, Q6)

The velocity $v\,\text{m s}^{-1}$ of a particle at time t s is given by $v = t^2 - 9$. The particle travels in a straight line and passes through a fixed point O when $t = 2$.

(i) Find the displacement of the particle from O when $t = 0$. **[4]**

(ii) Calculate the distance the particle travels from its position at $t = 0$ until it changes its direction of motion. **[6]**

(iii) Calculate the distance of the particle from O when the acceleration of the particle is $10\,\text{m s}^{-2}$. **[5]**

Q5, (Jun 2014, Q3)

A particle P travels in a straight line. The velocity of P at time t seconds after it passes through a fixed point A is given by $(0.6t^2 + 3)\,\mathrm{m\,s^{-1}}$. Find

(i) the velocity of P when it passes through A, **[1]**

(ii) the displacement of P from A when $t = 1.5$, **[4]**

(iii) the velocity of P when it has acceleration $6\,\mathrm{m\,s^{-2}}$. **[3]**

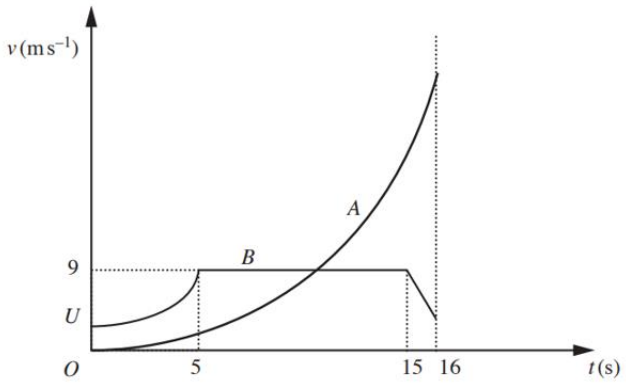
Q6, (Jun 2015, Q6)

A particle P moves in a straight line on a horizontal surface. P passes through a fixed point O on the line with velocity $2\,\mathrm{m\,s^{-1}}$. At time t s after passing through O, the acceleration of P is $(4 + 12t)\,\mathrm{m\,s^{-2}}$.

(i) Calculate the velocity of P when $t = 3$. **[4]**

(ii) Find the distance OP when $t = 3$. **[4]**

Q7, (Jun 16, Q7)



The diagram shows the (t, v) graphs for two particles A and B which move on the same straight line. The units of v and t are $\mathrm{m\,s^{-1}}$ and s respectively. Both particles are at the point S on the line when $t = 0$. The particle A is initially at rest, and moves with acceleration $0.18t\,\mathrm{m\,s^{-2}}$ until the two particles collide when $t = 16$. The initial velocity of B is $U\,\mathrm{m\,s^{-1}}$ and B has variable acceleration for the first five seconds of its motion. For the next ten seconds of its motion B has a constant velocity of $9\,\mathrm{m\,s^{-1}}$; finally B moves with constant deceleration for one second before it collides with A.

(i) Calculate the value of t at which the two particles have the same velocity. **[4]**

For $0 \leqslant t \leqslant 5$ the distance of B from S is $(Ut + 0.08t^3)\,\mathrm{m}$.

(ii) Calculate U and verify that when $t = 5$, B is 25 m from S. **[4]**

(iii) Calculate the velocity of B when $t = 16$. **[5]**

Q8, (OCR 4761, Jan 2008, Q5)

Fig. 5

A toy car is moving along the straight line Ox, where O is the origin. The time t is in seconds. At time $t = 0$ the car is at A, 3 m from O as shown in Fig. 5. The velocity of the car, v m s^{-1}, is given by

$$v = 2 + 12t - 3t^2.$$

Calculate the distance of the car from O when its acceleration is zero. [8]