Dynamics With Calculus : 3

1. A vehicle moves in a straight line so that its velocity v ms^{-1} at time t seconds is given by

June 2018 M2

$$v = \frac{1}{20}(80 + 16t - t^2) \qquad 0 \leqslant t \leqslant 20.$$

At time $t = 0$, the vehicle is at the point A.

(a) Find an expression for the acceleration of the vehicle at time t seconds. [2]

(b) Determine the maximum velocity of the vehicle, showing that the value you have found is a maximum. [4]

(c) Calculate the displacement of the vehicle from A when $t = 20$. [4]

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2. A particle of mass 5 kg moves under the action of a horizontal force given by $F = 30t^{-2} - 30$ N at time t s, where $t > 0$. It also experiences a constant resistance to motion of magnitude 120 N.

June 2014 M2

(a) Show that the motion of the particle satisfies the differential equation

$$\frac{dv}{dt} = 6t^{-2} - 30,$$

where v ms^{-1} is the velocity of the particle at time t s. [2]

(b) Calculate the value of t when the acceleration of the particle is 24 ms^{-2}. [2]

(c) Given that the velocity of the particle is 18 ms^{-1} when $t = \frac{1}{3}$, find an expression for v in terms of t. Hence find the values of t when $v = 10$. [6]

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3. A particle P moves in a straight line so that its acceleration a ms^{-2} at time t s, is given by

June 2010 M2

$a = 3 - 4t$

At time $t = 0$, the particle P passes through the point O and its velocity is -1 ms^{-1}.

(a) Find an expression for the velocity of P at time t s. [4]

(b) Find the values of t when P is instantaneously at rest. [2]

(c) Find the distance between the points at which P is instantaneously at rest. [4]

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4. A particle, of mass 5 kg, moves in a straight line under the action of a single force whose magnitude F N at time t s is given by

June 2008 M2

$$F = 15t^2 - 60t, \qquad t \geqslant 0.$$

(a) Find the acceleration of the particle when $t = 2$. [2]

(b) The velocity of the particle at time t s is denoted by v ms^{-1}. Given that $v = 35$ when $t = 0$, find an expression for v in terms of t. [4]

(c) Calculate the least value of the speed of the particle. [3]

(d) Determine the distance travelled by the particle between $t = 2$ and $t = 8$. [4]