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Mudiant Unionlin (Rectilinear Motion)

(Haf 2006)

3. A particle P , of mass 3 kg, moves along the horizontal x -axis under the action of a resultant force F N. Its velocity v ms⁻¹ at time t seconds is given by

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

- (a) Given that the particle is at the origin O when $t = 1$, find an expression for the displacement of the particle from O at time t s. [4]
- (b) Find the acceleration of the particle at time t s. [2]
- (c) Find the power of the force F when $t = 1.5$. [3]

(Haf 2007)

1. A particle P is projected from the origin O so that it moves along the x -axis. At time t s after projection, the velocity of the particle, v ms⁻¹, is given by

$$v = 3t^2 - 24t + 45.$$

- (a) Show that P first comes to instantaneous rest when $t = 3$. [2]
- (b) Find an expression for the acceleration of P at time t s. [2]
- (c) Find an expression for the displacement of P from O at time t s. [3]
- (d) Find the distance travelled by the particle in the first 3 seconds of its motion. [2]
- (e) Find the distance travelled by the particle in the first 4 seconds of its motion. [2]

(Haf 2008)

3. 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

$$F = 15t^2 - 60t, \quad t \geq 0.$$

- (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]

(Haf 2009)

1. A particle moves along the x -axis and its velocity $v \text{ ms}^{-1}$ at time $t \text{ s}$ is given by

$$v = \cos 2t - 3 \sin t.$$

- (a) Find the acceleration of the body when $t = \pi$. [4]
- (b) Given that $x = 4$ when $t = 0$, calculate the distance of the particle from the origin O when $t = \frac{\pi}{4}$. [6]

(Haf 2010)

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

$$a = 3 - 4t.$$

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 $t \text{ s}$. [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]

(Haf 2011)

1. A particle moves along the x -axis and its velocity $v \text{ ms}^{-1}$ at time $t \text{ s}$ is given by

$$v = 12 \sin 3t - 8 \cos 2t.$$

- (a) Find an expression for the acceleration of the particle at time $t \text{ s}$. [3]
- (b) Given that at time $t = 0$ the particle is at the origin O , find an expression for the displacement of the particle from O at time $t \text{ s}$. [5]

(Haf 2012)

1. A particle moves in a straight line with velocity $v \text{ ms}^{-1}$ at time $t \text{ s}$, where

$$v = 4 \cos 2t.$$

Calculate the distance travelled by the particle between $t = 0$ and $t = \frac{\pi}{6} \text{ s}$. [3]

(Haf 2013)

5. A particle moves along a straight horizontal line. Its velocity $v \text{ ms}^{-1}$ at time $t \text{ s}$, is given by

$$v = 2t(t - 6).$$

- (a) Find the set of values of t for which the velocity of the particle is negative. [2]
- (b) Find the total distance travelled by the particle in the interval $0 \leq t \leq 9$. [5]

(Haf 2014)

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.

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

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

where $v \text{ ms}^{-1}$ 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]

(Haf 2015)

2. An object of mass 50 kg moves in a straight horizontal line under the action of a constant horizontal force of magnitude 1600 N acting along the line. The resistance to motion of the object is proportional to time t seconds. At time t seconds, the velocity of the object is $v \text{ ms}^{-1}$ and at time $t = 2$, it is moving with velocity 41 ms^{-1} and acceleration -4 ms^{-2} .

(a) Show that v satisfies the differential equation

$$\frac{dv}{dt} = 32 - 18t. \quad [4]$$

(b) Find an expression for v in terms of t and determine the times when the velocity of the object is 28 ms^{-1} . [6]

(Haf 2016)

1. A particle of mass 4 kg moves along the x -axis, starting, when $t = 0$, from the point where $x = 3$. At time t s, its velocity $v \text{ ms}^{-1}$ is given by

$$v = 12t^2 - 7kt + 1,$$

where k is constant.

When $t = 2$, the displacement of the particle from the origin is 16 m.

(a) Determine the value of k . [5]

(b) Calculate the magnitude of the force acting on the particle when $t = 5$. [4]

(Haf 2017)

2. A particle P , of mass 0.8 kg, moves along the x -axis so that its velocity at time t seconds is $v \text{ ms}^{-1}$, where $v = 4t^3 - 6t + 7$. Given that the displacement of P is 5 m from the origin when $t = 0$, find

(a) the displacement of P from the origin when $t = 2$, [5]

(b) the force acting on P when $t = 3$. [4]

(Haf 2018)

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

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

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]