QQQ – Mechanics Year 1 – Chapter 11 – Variable Acceleration (Calculus) (Version 2)

Total Marks: 26

(26 = Platinum, 23 = Gold, 21 = Silver, 18 = Bronze)

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1. In this question you must show detailed reasoning.

A particle moves in a straight line. Its velocity v m s^{-1} after t s is given by $v = t^3 - 5t^2$.

(a) Find the times at which the particle is stationary. **[2]**

(b) Find the total distance travelled by the particle in the first 6 seconds. **[3]**

(Total 5 marks)

2. A particle, P, is moving along a straight line such that its acceleration a m s^{-2}, at any time, t seconds, may be modelled by

$$a = 3 + 0.2t$$

When $t = 2$, the velocity of P is k m s^{-1}

(a) Show that the initial velocity of P is given by the expression $(k - 6.4)$ m s^{-1} **[4 marks]**

(b) The initial velocity of P is one fifth of the velocity when $t = 2$

Find the value of k. **[2 marks]**

(Total 6 marks)

3. A particle P is moving in a straight line. At time t seconds P has velocity v m s^{-1} where $v = (2t + 1)(3 - t)$.

(a) Find the deceleration of P when $t = 4$. **[2]**

(b) State the positive value of t for which P is instantaneously at rest. **[1]**

(c) Find the total distance that P travels between times $t = 0$ and $t = 4$. **[3]**

(Total 6 marks)

4. A car, starting from rest, is driven along a horizontal track.

The velocity of the car, v m s^{-1}, at time t seconds, is modelled by the equation

$$v = 0.48t^2 - 0.024t^3 \quad \text{for } 0 \leqslant t \leqslant 15$$

(a) Find the distance the car travels during the first 10 seconds of its journey. **[3 marks]**

(b) Find the maximum speed of the car.

Give your answer to three significant figures. **[4 marks]**

(c) Deduce the range of values of t for which the car is modelled as decelerating. **[2 marks]**

(Total 9 marks)