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

Total Marks: 25

(25 = Platinum, 23 = Gold, 20 = Silver, 17 = Bronze)

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1. A particle moves along a straight line. Its velocity v m s^{-1} at time t s is given by $v = 2t + 0.6t^2$.

Find an expression for the acceleration of the particle at time t. **[2]**

(Total 2 marks)

2. The displacement, r metres, of a particle at time t seconds is

$$r = 6t - 2t^2$$

(a) Find the value of r when $t = 4$ **[1 mark]**

(b) Determine the range of values of t for which the displacement is positive. **[2 marks]**

(Total 3 marks)

3. A particle moves in a straight line with acceleration a m s^{-2}, at time t seconds, where

$$a = 10 - 6t$$

The particle's velocity, v m s^{-1}, and displacement, r metres, are both initially zero.

Show that

$$r = t^2(5 - t)$$

Fully justify your answer. **[4 marks]**

(Total 4 marks)

4. A sports scientist is modelling the speed of an athlete who ran a 100-metre race.

The speed, v m s^{-1}, of the athlete at time t seconds after the start of the 100-metre race is given by

$$v = 1.8 + 3.8t - 0.25t^2$$

(a) State the initial speed of the athlete according to the model. **[1 mark]**

(b) **(i)** Find an expression, in terms of t, for the acceleration of the athlete. **[2 marks]**

(ii) Hence find the maximum speed of the athlete.

Fully justify your answer. **[4 marks]**

(c) The official maximum speed recorded, by the scientist, for the athlete was 12.4 m s^{-1}

Evaluate the accuracy of the model used by the scientist. **[1 mark]**

(Total 8 marks)

5.

In this question you must show all stages of your working.

Solutions relying entirely on calculator technology are not acceptable.

A fixed point O lies on a straight line.

A particle P moves along the straight line such that at time t seconds, $t \geqslant 0$, after passing through O, the velocity of P, v m s^{-1}, is modelled as

$$v = 15 - t^2 - 2t$$

(a) Verify that P comes to instantaneous rest when $t = 3$ **(1)**

(b) Find the magnitude of the acceleration of P when $t = 3$ **(3)**

(c) Find the total distance travelled by P in the interval $0 \leqslant t \leqslant 4$ **(4)**

(Total 8 marks)