Edexcel AS Mathematics Variable acceleration

Section 1: Using calculus

Exercise level 2

1. Particle P has a displacement, *s* m, from a fixed point O given by $s = 6t^2 - t^3$, where *t* is the time in seconds.
    (i) Sketch the displacement-time and velocity-time graphs for the time interval $0 \le t \le 6$.
    (ii) Find the times when the particle is at O.
    (iii)Find the greatest displacement from O within the time $0 \le t \le 6$.
    (iv)Find the greatest speed attained in this same time interval.

2. A particle A travels such that its displacement, *s* m, at time *t* seconds is given by $s = t^3 - 12t$. Initially it is at point O.
    (i) Find the initial velocity of A and the distance between its positions when $t = 0$ and $t = 4$.
    (ii) Show that the particle changes direction between $t = 0$ and $t = 4$.
    (iii)Find the total distance travelled in the interval $0 \le t \le 4$.

3. A vehicle starts from rest at point A and moves such that its acceleration *a* ms^{-2} after *t* seconds is $a = 6 - 2t$. The vehicle comes to rest again at B. Find the distance AB and the greatest speed attained in moving from A to B.

4. The acceleration *a* ms^{-2} at time *t* s of a particle P is given by $a = 6t - 4$. Initially the particle is at rest at the origin.
    (i) Find expressions for the velocity and displacement at time *t*.
    (ii) At what time(s) is the particle at the origin?
    (iii)Find the distance travelled in the first second.

5. A particle P starting from rest moves so that its velocity *v* ms^{-1} at time *t* s $v = 12t^2 - 4t^3$.
    (i) Find the distance the particle travels before next coming to rest.
    (ii) Find the maximum acceleration in the first 2 seconds of motion.
    (iii)Find the maximum speed attained in the first 3 seconds of motion.

6. A scientist knows that the acceleration *a* ms^{-2} of an object at time *t* s under certain conditions is proportional to $(1 + 3t^2)$. Measurement shows that when $t = 3$ the acceleration is 14 ms^{-2} and the velocity is 25 ms^{-1}. Find expressions for the acceleration and velocity at time *t* and hence find the initial velocity.

7. A particle travels in a straight line so that its displacement *s* m from a fixed point after *t* seconds is $s = 41 + t^3 + t^2 + 12t$. Show that the particle never changes its direction of motion.

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8. An object moves along a straight line PQ so that at time t seconds its displacement in metres from the fixed point O on the line is given by $s = 2t^3 - 3t$ for $0 \leq t \leq 2$.

    P   O   Q   +

    (i)   Find the expressions for the velocity and acceleration of the object at time t.
    (ii) When is the velocity zero?
    (iii) Sketch the velocity–time and acceleration–time graphs for $0 \leq t \leq 2$.
    (iv) Describe the motion of the object for $0 \leq t \leq 2$.
    (v)   Calculate the total displacement and the total distance travelled between $t = 0$ and $t = 2$.

9. A particle starting from rest at O moves along a straight line OA so that its acceleration a ms^{-2} after t seconds is $a = 24t - 12t^2$.
    (i)   Find when it again returns to O and its velocity at this time.
    (ii) Find its maximum displacement from O during this interval.
    (iii) What is its maximum velocity and its greatest speed during this interval?