HIGHER

5.2 Calculus in Kinematics: Displacement, Velocity and Acceleration: 30-minute Pack

EDEXCEL 4MA1 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A particle moves in a straight line. Its displacement from the fixed point O after t seconds is $s = -t^3 + 15t^2 - 72t$ metres, for $0 \leq t \leq 7$.
Find the total distance the particle travels in the first 7 seconds.

(Total for Question 1 is 6 marks)

2 A particle moves in a straight line. Its displacement from a fixed point O after t seconds is $s = t^3 - 9t^2 + 3$ metres.
Find the time at which the acceleration of the particle is zero, and find the velocity of the particle at this time.

(Total for Question 2 is 5 marks)

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3 A particle P moves along a straight line. Its displacement s metres from a fixed point O after t seconds is $s = t^3 - 15t^2 + 72t + 4$, for $t \geq 0$.
Find the times at which P is instantaneously at rest, and the displacement of P from O at each of these times.

(Total for Question 3 is 5 marks)

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4 A particle moves in a straight line. At time t seconds its velocity is $v = 6t^2 + 6t$ m/s. When $t = 0$ the particle is -3 m from a fixed point O.
Find the displacement of the particle from O when $t = 2$.

(Total for Question 4 is 4 marks)

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5 A car accelerates in a straight line. At time t seconds its acceleration is $a = -2t - 7$ m/s^2. When $t = 0$ the speed of the car is 0 m/s.
Find the velocity of the car when $t = 3$.

(Total for Question 5 is 4 marks)

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Mark scheme · 5.2 Calculus in Kinematics: Displacement, Velocity and Acceleration: 30-minute Pack

Question 1

$v = ds/dt = -3t^2 + 30t - 72$	**M1**
sets $v = 0$ and solves to find when the particle changes direction	**M1**
$t = 4$ and $t = 6$	**A1**
finds s at $t = 0$, 4, 6 and 7: 0, -112, -108, -112	**M1**
adds the magnitudes of the three separate displacements	**M1**
total distance = 120 m cao	**A1**

Answer: Total distance = 120 m

Question 2

$v = ds/dt = 3t^2 - 18t$	**M1**
$a = dv/dt = 6t - 18$	**M1**
sets $a = 0$ and solves	**M1**
$t = 3$ seconds	**A1**
$v = -27$ m/s cao	**A1**

Answer: t = 3 s, v = -27 m/s

Question 3

$v = ds/dt = 3t^2 - 30t + 72$	**M1**
sets $v = 0$ and solves the quadratic	**M1**
$t = 4$ and $t = 6$	**A1**
substitutes both times into the expression for s	**M1**
$s = 116$ m when $t = 4$ and $s = 112$ m when $t = 6$	**A1**

Answer: t = 4, s = 116 m; t = 6, s = 112 m

Question 4

integrates the velocity expression with respect to t	**M1**
$s = 2t^3 + 3t^2 + c$ with all terms correct	**A1**
uses $s = -3$ when $t = 0$ to find $c = -3$	**M1**
$s = 25$ m cao	**A1**

Answer: s = 25 m

Question 5

integrates the acceleration with respect to t	**M1**
$v = -t^2 - 7t + c$	**A1**
uses $v = 0$ when $t = 0$ to find $c = 0$	**M1**
$v = -30$ m/s cao	**A1**

Answer: v = -30 m/s

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