HIGHER

5.2 Calculus in Kinematics: Displacement, Velocity and Acceleration: 1-hour Pack

EDEXCEL 4MA1 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A cyclist's displacement in metres along a straight road is modelled by $s = 3t^3 - 5t$ for time t seconds.

(a) Find the velocity function $v = ds/dt$ for the cyclist. **(2)**

.....

(b) Calculate the velocity when $t = 2$ seconds. **(1)**

.....

(Total for Question 1 is 3 marks)

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2 A particle moves in a straight line. Its displacement from a fixed point O after t seconds is $s = t^3 - 9t^2$ 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 $s = -t^3 + 9t^2 - 15t + 3$, 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 $v = 18t + 3$ m/s. When $t = 0$ the particle is 0 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 particle moves in a straight line. Its displacement from the fixed point O after t seconds is $s = 2t^3 - 12t^2 + 18t$ metres, for $0 \leq t \leq 5$.
Find the total distance the particle travels in the first 5 seconds.

(Total for Question 5 is 6 marks)

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6 A car accelerates in a straight line. At time t seconds its acceleration is $a = -2t + 2$ m/s^2. When $t = 0$ the speed of the car is 10 m/s.
Find the velocity of the car when $t = 5$.

(Total for Question 6 is 4 marks)

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7 A particle moves in a straight line. Its displacement from a fixed point O after t seconds is $s = t^3 - 9t^2 + 24t + 4$ 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 7 is 5 marks)

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8 A particle P moves along a straight line. Its displacement s metres from a fixed point O after t seconds is $s = t^3 - 15t^2 + 72t$, 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 8 is 5 marks)

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9 A particle moves in a straight line. At time t seconds its velocity is $v = -8t + 5$ m/s. When $t = 0$ the particle is 10 m from a fixed point O.
Find the displacement of the particle from O when $t = 2$.

(Total for Question 9 is 4 marks)

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Mark scheme · 5.2 Calculus in Kinematics: Displacement, Velocity and Acceleration: 1-hour Pack

A correct answer earns full marks unless the question asks for working, a method, proof or explanation.

Question 1

(a) differentiates each term, e.g. $9t^2$ and -5 seen	**M1**
(a) $v = 9t^2 - 5$ cao	**A1**
(a) Answer: $v = 9t^2 - 5$	
(b) $v(2) = 9(2)^2 - 5 = 31$ cao	**B1**
(b) Answer: 31 m/s	

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

$v = ds/dt = -3t^2 + 18t - 15$	**M1**
sets v = 0 and solves the quadratic	**M1**
t = 1 and t = 5	**A1**
substitutes both times into the expression for s	**M1**
s = -4 m when t = 1 and s = 28 m when t = 5	**A1**
Answer: t = 1, s = -4 m; t = 5, s = 28 m	

Question 4

integrates the velocity expression with respect to t	**M1**
$s = 9t^2 + 3t + c$ with all terms correct	**A1**
uses s = 0 when t = 0 to find c = 0	**M1**
s = 42 m cao	**A1**
Answer: s = 42 m	

Question 5

$v = ds/dt = 6t^2 - 24t + 18$	**M1**
sets v = 0 and solves to find when the particle changes direction	**M1**
t = 1 and t = 3	**A1**
finds s at t = 0, 1, 3 and 5: 0, 8, 0, 40	**M1**
adds the magnitudes of the three separate displacements	**M1**
total distance = 56 m cao	**A1**
Answer: Total distance = 56 m	

Question 6

integrates the acceleration with respect to t	**M1**
$v = -t^2 + 2t + c$	**A1**
uses v = 10 when t = 0 to find c = 10	**M1**
v = -5 m/s cao	**A1**
Answer: v = -5 m/s	

Question 7

$v = ds/dt = 3t^2 - 18t + 24$	**M1**
$a = dv/dt = 6t - 18$	**M1**
sets a = 0 and solves	**M1**
t = 3 seconds	**A1**
v = -3 m/s cao	**A1**
Answer: t = 3 s, v = -3 m/s	

Question 8

$v = ds/dt = 3t^2 - 30t + 72$	**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 = 112 m when t = 4 and s = 108 m when t = 6	**A1**
Answer: t = 4, s = 112 m; t = 6, s = 108 m	

Question 9

integrates the velocity expression with respect to t	**M1**
$s = -4t^2 + 5t + c$ with all terms correct	**A1**
uses s = 10 when t = 0 to find c = 10	**M1**
s = 4 m cao	**A1**
Answer: s = 4 m	

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