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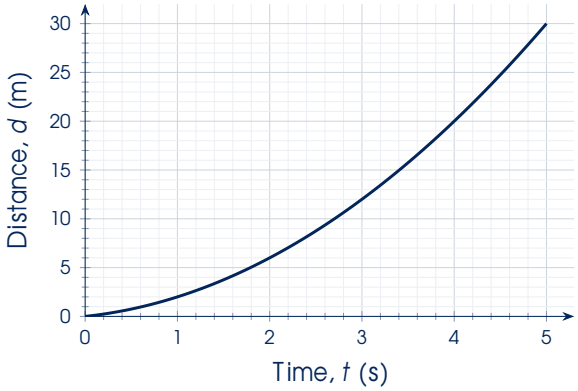
Name ..... Class .....

R15: Instantaneous and average rates

Gradients of chords and tangents as average and instantaneous rates of change

20 marks · 25 minutes · Non-calculator

1) The graph shows the distance, d metres, travelled by a toy car after t seconds.



(a) Find the average speed between $t = 1$ and $t = 4$

..... m/s

(2)

(b) By drawing a tangent, estimate the speed at $t = 3$

..... m/s

(2)

(c) Is the car speeding up or slowing down?

.....

(1)

(d) Give a reason for your answer to (c).

(1)

[Question 1: 6 marks]

2) For the curve $y = x^2$

(a) Find the gradient of the chord from $x = 1$ to $x = 3$

.....

(2)

(b) Find the gradient of the chord from $x = 1.9$ to $x = 2.1$. Use it to estimate the gradient of the curve at $x = 2$

.....

(2)

[Question 2: 4 marks]

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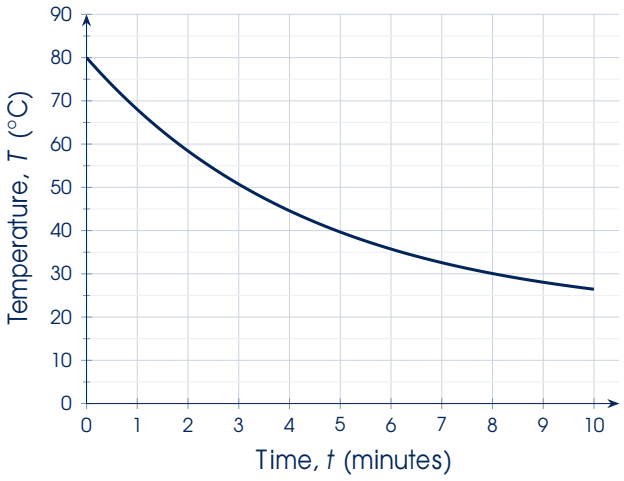
3) The number of bacteria after t hours is $P = 200 \times 1.5^t$. Find the average rate of increase between $t = 0$ and $t = 2$

..... per hour

[Question 3: 2 marks]

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4) The graph shows the temperature, T °C, of a cooling drink after t minutes.



(a) Estimate the rate of change of temperature at $t = 4$

..... °C per minute

(2)

(b) Find the average rate of change between $t = 0$ and $t = 5$

..... °C per minute

(2)

[Question 4: 4 marks]

5) Find the gradient of the chord of $y = x^3$ from $x = 1$ to $x = 2$

.....

[Question 5: 2 marks]

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6) The depth of water in a pool, h cm, after t minutes is $h = 4\sqrt{t}$. Find the average rate of increase in the first 9 minutes.

..... cm per minute

[Question 6: 2 marks]

End of paper – 20 marks in total

Answers and brief mark scheme

Q	Answer	Method / notes
1	(a) 6 (b) about 7 (c) speeding up (d) the curve gets steeper	(a) $\frac{20-2}{4-1}$ (M1); A1. (b) Tangent at $t = 3$ (M1); 6 to 8 (A1). (c) B1. (d) B1.
2	(a) 4 (b) 4	(a) $\frac{9-1}{2}$ (M1); A1. (b) $\frac{4.41-3.61}{0.2}$ (M1); A1.
3	125	$\frac{450-200}{2}$ (M1); A1.
4	(a) about -5.5 (b) about -8	(a) Tangent at $t = 4$ (M1); -4.5 to -6.5 (A1). (b) $\frac{40-80}{5}$ (M1); -7.5 to -8.5 (A1).
5	7	$\frac{8-1}{1}$ (M1); A1.
6	$\frac{4}{3}$	$\frac{12-0}{9}$ (M1); A1 (accept 1.33).