HIGHER ONLY
HIGHER TIER

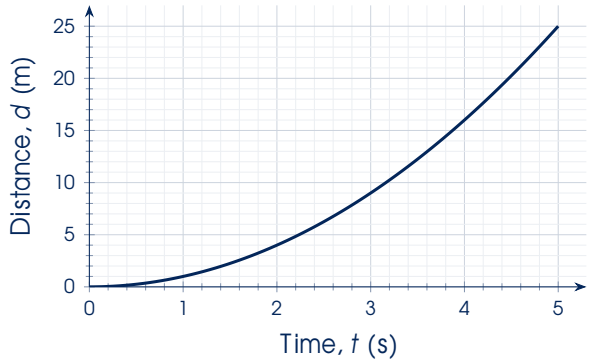
Name ..... Class .....

R15: Average and instantaneous rates

Reason about chords, tangents and rates of change

20 marks · 25 minutes · Non-calculator

1) The graph shows $d = t^2$.



(a) Show that the average speed between $t = 1$ and $t = 4$ is 5 m/s.

(2)

(b) Explain why you need a tangent to find the speed at $t = 3$

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(2)

(c) Explain how the graph shows that the object is speeding up.

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(1)

[Question 1: 5 marks]

2) Explain the difference between an average rate of change and an instantaneous rate of change.

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[Question 2: 2 marks]

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3) For $y = x^2$, show that the chord from $x = 2$ to $x = 2.1$ has gradient 4.1. Explain why this is close to the gradient of the curve at $x = 2$

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[Question 3: 3 marks]

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4) $P = 100 \times 2^t$. Show that the average rate of increase between $t = 0$ and $t = 3$ is 233.3 per hour (to 1 d.p.).

[Question 4: 2 marks]

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5) Ben says the gradient of a chord always equals the gradient of the curve at the midpoint of the chord. Use $y = x^3$ from $x = 0$ to $x = 2$ to show he is wrong. (The gradient of $y = x^3$ at $x = 1$ is 3.)

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[Question 5: 3 marks]

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6) Explain why two people drawing tangents at the same point may get slightly different gradients.

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[Question 6: 1 marks]

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7) A drink cools from 80 °C to 40 °C in 5 minutes. Show that the average rate of change is −8 °C per minute.

[Question 7: 2 marks]

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8) Explain what it means when a distance–time curve becomes less steep.

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[Question 8: 2 marks]

End of paper – 20 marks in total

Answers and brief mark scheme

Q	Answer	Method / notes
1	(a) Shown (b) Explanation (c) Explanation	(a) $\frac{16-1}{3}$ (M1); C1. (b) The gradient keeps changing (C1); tangent gives the gradient at one point (C1). (c) It gets steeper (C1).
2	Explanation	Average is over an interval (chord) (C1); instantaneous is at one point (tangent) (C1).
3	Shown	$\frac{4.41-4}{0.1}$ (M1); 4.1 (A1); the chord is very short (C1).
4	Shown	$\frac{800-100}{3}$ (M1); C1.
5	Shown	Chord gradient $\frac{8-0}{2} = 4$ (M1); $4 \neq 3$ (M1); C1.
6	Explanation	Tangents are drawn by eye (C1).
7	Shown	$\frac{40-80}{5}$ (M1); C1.
8	Slowing down	Smaller gradient (C1); lower speed (C1).