

	Give 1 mark for each •	Illustration(s) for awarding each mark	
1(a)	<p>ans: $2y - x = -2$ (3 marks)</p> <ul style="list-style-type: none"> •¹ finds midpoint of BC •² establishes gradient of AM •³ substitutes in general equation 	<ul style="list-style-type: none"> •¹ midpoint BC: (10,4) •² $m_{AM} = \frac{4+2}{10+2} = \frac{1}{2}$ •³ $y - 4 = \frac{1}{2}(x - 10)$ or $y - (-2) = \frac{1}{2}(x - (-2))$ 	
	<p>(b) ans: D(4,1) (3 marks)</p> <ul style="list-style-type: none"> •¹ realising $y = 1$ •² substitutes into equation •³ states coordinates of D 		<ul style="list-style-type: none"> •¹ $y = 1$ •² $2(1) - x = -2; x = 4$ •³ D(4,1)
	<p>(c) ans: proof (2 marks)</p> <ul style="list-style-type: none"> •¹ finds gradient of BD •² makes statement re perpendicular 		
<p>2(a) ans: P(1, $-\frac{25}{2}$) (4 marks)</p> <ul style="list-style-type: none"> •¹ knows to take derivative and equate to 0 •² takes derivative •³ solves to find x - coordinate •⁴ substitutes to find y - coordinate 	<ul style="list-style-type: none"> •¹ $\frac{dy}{dx} = 0$ •² $3x^2 - 15x + 12 = 0$ •³ $x = 1$ [or 4] •⁴ $y = 1^3 - \frac{15}{2}(1) + 12(1) - 18 = -\frac{25}{2}$ 		
<p>(b) ans: Q(6,0) (3 marks)</p> <ul style="list-style-type: none"> •¹ knows to make $y = 0$ •² uses synthetic division to find x 		<ul style="list-style-type: none"> •¹ $y = 0$ •² $\begin{array}{r rrrr} 6 & 1 & -\frac{15}{2} & 12 & -18 \\ & & 6 & -9 & 18 \\ \hline & 1 & -\frac{3}{2} & 3 & 0 \end{array}$ •³ Q(6,0) 	
<ul style="list-style-type: none"> •³ states coordinates of Q 			

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3(a)	ans: 32.6 gigatonnes (3 marks)	
	<ul style="list-style-type: none"> •¹ correct multiplier •² completes calculation •³ calculation 	<ul style="list-style-type: none"> •¹ 0.96 •² $0.96^5 \times 40$ •³ 32.6 gigatonnes
	(b) ans: 31 gigatonnes (3 marks)	
	<ul style="list-style-type: none"> •¹ sets up recurrence relation •² knows to calculate 3 figures •³ final answer 	<ul style="list-style-type: none"> •¹ $U_{n+1} = 0.96^5 U_n + 3.8$ •² 1st year: 36.4; 2nd year: 33.4795 •³ 3rd year: 31 gigatonnes
(c) ans: upper 20.6; lower 16.8 (3 marks)		
	<ul style="list-style-type: none"> •¹ knows limit exists •² finds upper limit •³ finds lower limit 	<ul style="list-style-type: none"> •¹ limit exists since $-1 < 0.96^5 < 1$ •² $L = \frac{3.8}{1 - (0.96)^5} = 20.6$ •³ $20.6 - 3.8 = 16.8$
4(a)	ans: $a = -2$ (2 marks)	
	<ul style="list-style-type: none"> •¹ finds expression for $f(g(-2))$ •² equates to -1 and solves for a 	<ul style="list-style-type: none"> •¹ $f(g(-2)) = f(-1) = 1 + a$ •² $a = -2$
(b) ans: $x = -2, 0, 2$ (5 marks)		
	<ul style="list-style-type: none"> •¹ substitutes •² simplifies •³ equates to 2 and re-arranges •⁴ factorises •⁵ solves for x 	<ul style="list-style-type: none"> •¹ $f(f(x)) = (x^2 - 2)^2 - 2$ •² $x^4 - 4x^2 + 2$ •³ $x^4 - 4x^2 + 2 = 2; x^4 - 4x^2 = 0$ •⁴ $x^2(x^2 - 4) = 0$ •⁵ $x = -2, 0, 2$
5(a)	ans: $x = 1$ (2 marks)	
	<ul style="list-style-type: none"> •¹ realises $y = 0$; equates to 0 •² solves for x 	<ul style="list-style-type: none"> •¹ $3x^2 - 6x + 3 = 0$ •² $3(x - 1)^2 = 0; x = 1$
(b) ans: $b = 2$ (5 marks)		
	<ul style="list-style-type: none"> •¹ integrates expression •² substitutes values •³ simplifies, equates to 1, rearranges •⁴ uses synthetic division to solve •⁵ realises one solution; discards $b^2 - b + 1$ 	<ul style="list-style-type: none"> •¹ $[x^3 - 3x^2 + 3x]_1^b$ •² $(b^3 - 3b^2 + 3b) - (1 - 3 + 3)$ •³ $b^3 - 3b^2 + 3b - 2 = 0$ •⁴ $\begin{array}{r rrrr} 2 & 1 & -3 & 3 & -2 \\ & & 2 & -2 & 2 \\ \hline & 1 & -1 & 1 & 0 \end{array}$ •⁵ $b = 2$

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6	ans: 58 (3 marks) <ul style="list-style-type: none"> •¹ knows to take logs •² releases the power •³ answer 	<ul style="list-style-type: none"> •¹ $\log 2^{-0.04t} = \log 0.2$ •² $-0.04t \log 2 = \log 0.2$ •³ $t = 58$
7(a)	ans: (-2,1) (3 marks) <ul style="list-style-type: none"> •¹ substitutes eq.of line in eq. of circle •² simplifies and solves for x •³ substitutes to find y 	<ul style="list-style-type: none"> •¹ $x^2 + (2x + 5)^2 - 4x + 2(2x + 5) - 15 = 0$ •² $5(x + 2)^2 = 0; x = -2$ •³ $y = 2(-2) + 5; y = 1$
(b)	ans: $(x + 6)^2 + (y - 3)^2 = 20$ (3 marks) <ul style="list-style-type: none"> •¹ establishes coordinates of B •² finds r^2 •³ substitutes into general circle equation 	<ul style="list-style-type: none"> •¹ B(-6,3) •² $r^2 = 20$ •³ $(x + 6)^2 + (y - 3)^2 = 20$
8(a)	ans: Proof (1 mark) <ul style="list-style-type: none"> •¹ uses trig ratios and equates 	<ul style="list-style-type: none"> •¹ $\cos x = \frac{AB}{4}, \sin x = \frac{BC}{6}$ $4\cos x + 6\sin x = 6.72$
(b)	ans: 35° (7 marks) <ul style="list-style-type: none"> •¹ recognising as $k\cos(\dots)$ equation •² finds $k \cos \alpha$ and $k \sin \alpha$ •³ finds k •⁴ finds α •⁵ sets up equation to solve •⁶ finds solutions for $\cos(x - 56 \cdot 3)$ •⁷ finds solution and decides correct ans. 	<ul style="list-style-type: none"> •¹ $k \cos(x - \alpha) = k \cos x \cos \alpha + k \sin x \sin \alpha$ •² $k \cos \alpha = 4$ and $k \sin \alpha = 6$ for marks 1&2 both must be stated explicitly •³ $k^2 = 4^2 + 6^2 \therefore k = \sqrt{52}$ •⁴ $\tan \alpha = \frac{6}{4}, \alpha = 56.3^\circ$ •⁵ $\sqrt{52} \cos(x - 56.3) = 6.72$ •⁶ $x - 56.3 = 21.3 \text{ and } 338.7$ •⁷ $x = 77.4 \text{ and } 395.0$ then decides 35° as domain is $0 < x < 45$

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9(a)	<p>ans: $m = 2400\text{ml}$ (4 marks)</p> <ul style="list-style-type: none"> •¹ knows to differentiate and equate to 0 •² differentiates •³ solves for x •⁴ justifies maximum 	<ul style="list-style-type: none"> •¹ $H'(m) = 0$ •² $4 - \frac{1}{600}m = 0$ •³ $m = 2400$ •⁴ table of values; second derivative
(b)	<p>ans: 4800 feet (1 mark)</p> <ul style="list-style-type: none"> •¹ knows to sub into function and evaluate 	<ul style="list-style-type: none"> •¹ $4(2400) - \frac{(2400)^2}{1200} = 4800\text{feet}$

Total: 60 marks
