

	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 $y - 4 = \frac{1}{2}(x - 10)$ 	
	<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 (3 marks)</p> <ul style="list-style-type: none"> •¹ finds gradient of BD •² knows condition for perp. lines •³ makes statement re perpendicular 		<ul style="list-style-type: none"> •¹ $m_{BD} = -2$ •² $m_1 \times m_2 = -1$ [stated or implied] •³ $\frac{1}{2} \times -2 = -1$ so AM and BD are perp.
2(a)	<p>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 •³ states coordinates of Q 		<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)

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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 and correct rounding 	<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 •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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5(c)	ans: $y = 6x - 9$ (4 marks) <ul style="list-style-type: none"> •¹ finds 'c' •² knows to differentiate •³ substitutes to find gradient •⁴ substitutes into general equation 	<ul style="list-style-type: none"> •¹ when $x = 2, y = 3; Q(2,3)$ •² $\frac{dy}{dx} = 6x - 6$ •³ when $x = 2; \frac{dy}{dx} = 6$ •⁴ $y - 3 = 6(x - 2)$
6(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 $(x + 6)^2 + (y - 3)^2 = 20$
7(a)	ans: BE = 3 units (2 marks) <ul style="list-style-type: none"> •¹ uses $\tan \frac{\pi}{3}$ •² finds length 	<ul style="list-style-type: none"> •¹ evidence •² BE = 3
(b)	ans: proof (4 marks) <ul style="list-style-type: none"> •¹ finds length BC •² Finds area of triangle AEB •³ states length BD and finds area of triangle BCD •⁴ completes simplification to answer 	<ul style="list-style-type: none"> •¹ $\frac{5}{\sqrt{2}}$ •² $\frac{9\sqrt{3}}{2}$ units² •³ BD = BC; area = $\frac{25}{4}$ units² •⁴ $\frac{1}{4}(18\sqrt{3} + 25)$ units²
8(a)	ans: $m = 2400$ml (4 marks) <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)	ans: 4800 feet (1 mark) <ul style="list-style-type: none"> •¹ knows to sub into function and evaluate 	<ul style="list-style-type: none"> •¹ $4(2400) - \frac{(2400)^2}{1200} = 4800\text{feet}$