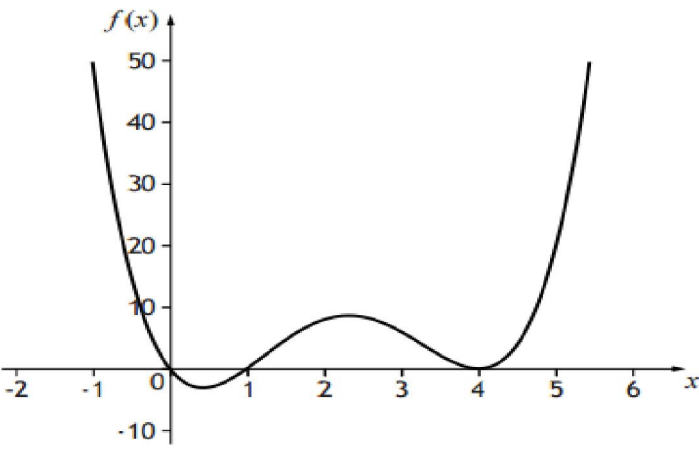
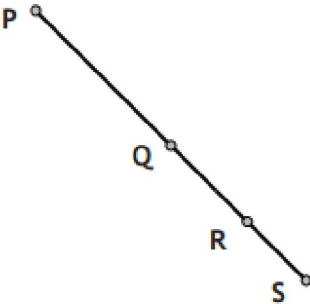


1.	<p>The diagram shows the graph of $f(x) = x(x - p)(x - q)^2$.</p>  <p>(a) Determine the values of p and q. 1</p> <p>(b) Find the equation of the tangent to the curve when $x = 1$. 4</p>
2.	<p>Find the coordinates of the points of intersection of the curve $y = x^3 - 2x^2 + x + 4$ and the line $y = 4x + 4$. 5</p>
3.	<p>Given that $2x^2 + px + p + 6 = 0$ has no real roots, find the range of values for p, where $p \in \mathbb{R}$. 4</p>
4.	<p>(a) Find an equivalent expression for $\sin(x + 60)^\circ$. 1</p> <p>(b) Hence, or otherwise, determine the exact value of $\sin 105^\circ$. 3</p>
5.	<p>(a) Show that $(x + 1)$ is a factor of $x^3 - 13x - 12$. 3</p> <p>(b) Factorise $x^3 - 13x - 12$ fully. 2</p>
6.	<p>Find the rate of change of the function $f(x) = 4 \sin^3 x$ when $x = \frac{5\pi}{6}$. 3</p>

7.	<p>$f(x)$ and $g(x)$ are functions, defined on the set of real numbers, such that $f(x) = 1 - \frac{1}{2}x$ and $g(x) = 8x^2 - 3$.</p> <p>(a) Given that $h(x) = g(f(x))$, show that $h(x) = 2x^2 - 8x + 5$. 3</p> <p>(b) Express $h(x)$ in the form $a(x + p)^2 + q$. 3</p> <p>(c) Hence, or otherwise, state the coordinates of the turning point on the graph of $y = h(x)$. 1</p> <p>(d) Sketch the graph of $y = h(x) + 3$, showing clearly the coordinates of the turning point and the y-axis intercept. 2</p> <p>(a) AB is a line parallel to the line with equation $y + 3x = 25$. A has coordinates $(-1, 10)$. Find the equation of AB. 1</p>
8.	<p>The voltage, $V(t)$, produced by a generator is described by the function $V(t) = 120\sin 100\pi t$, $t > 0$, where t is the time in seconds.</p> <p>(a) Determine the period of $V(t)$. 2</p> <p>(b) Find the first three times for which $V(t) = -60$. 6</p>
9.	<p>In the diagram, P has coordinates $(-6, 3, 9)$,</p> <p>$\vec{PQ} = 6\mathbf{i} + 12\mathbf{j} - 6\mathbf{k}$ and $\vec{PQ} = 2\vec{QR} = 3\vec{RS}$.</p> <p>Find the coordinates of S. 5</p> 
10.	<p>Given that $P(t) = 30e^{t-2}$ decide whether each of the statements below is true or false. Justify your answers.</p> <p>Statement A $P(0) = 30$.</p> <p>Statement B When $P(t) = 15$, the only possible value of t is 1.3 to one decimal place. 6</p>

11.	<p>(a) Given that $(x - 1)$ is a factor of $x^3 + 3x^2 + x - 5$, factorise this cubic fully. 4</p> <p>(b) Show that the curve with equation</p> $y = x^4 + 4x^3 + 2x^2 - 20x + 3$ <p>has only one stationary point.</p> <p>Find the x-coordinate and determine the nature of this point. 5</p>
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1.	<p>(a) Ans: $p = 1, q = 4$</p> <ul style="list-style-type: none"> •¹ state values of p and q 	1	<ul style="list-style-type: none"> •¹ $p = 1, q = 4$
	<p>(b) Ans: $y = 9(x - 1)$</p> <ul style="list-style-type: none"> •² expand brackets •³ differentiate •⁴ calculate gradient of tangent •⁵ substitutes gradient and $(1, 0)$ into equation of line 	4	<ul style="list-style-type: none"> •² $f(x) = x^4 - 9x^3 + 24x^2 - 16x$ •³ $f'(x) = 4x^3 - 27x^2 + 48x - 16$ •⁴ $f'(1) = 4 - 27 + 48 - 16 = 9$ •⁵ $y = 9(x - 1)$

2.	<p>Ans: $(-1, 0), (0, 4), (3, 16)$</p> <ul style="list-style-type: none"> •¹ sets equation of curve equal to equation of line •² equates to zero •³ factorises fully •⁴ calculates x-coordinates •⁵ calculates y-coordinates 	5	<ul style="list-style-type: none"> •¹ $x^3 - 2x^2 + x + 4 = 4x + 4$ •² $x^3 - 2x^2 - 3x = 0$ •³ $x(x + 1)(x - 3) = 0$ •⁴ $x = 0, x = -1, x = 3$ •⁵ $(0, 4), (-1, 0), (3, 16)$
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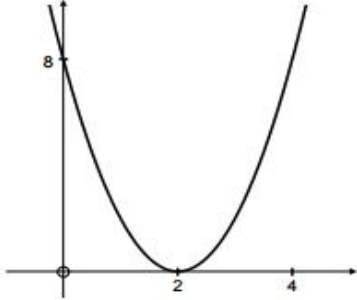
3.	Ans: $-4 < p < 12$ • ¹ know discriminant < 0 • ² simplify • ³ factorise LHS • ⁴ correct range	4	• ¹ $b^2 - 4ac < 0$ and $a = 2$, $b = p$, $c = p + 6$ stated or implied by • ² • ² $p^2 - 8p - 48 < 0$ • ³ $(p - 12)(p + 4) < 0$ • ⁴ $-4 < p < 12$
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4.	(a) • ¹ correct expansion (b) • ² any expression equivalent to $\sin 105^\circ$ • ³ correct exact value equivalents • ⁴ correct answer	4	• ¹ $\sin x^\circ \cos 60^\circ + \cos x^\circ \sin 60^\circ$ • ² $\sin(45 + 60)^\circ$ or equivalent • ³ $\frac{1}{\sqrt{2}} \times \frac{1}{2} + \frac{1}{\sqrt{2}} \times \frac{\sqrt{3}}{2}$ • ⁴ $\frac{1 + \sqrt{3}}{2\sqrt{2}}$ or $\frac{\sqrt{2} + \sqrt{6}}{4}$
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5.	(a) • ¹ know to use $x = -1$ • ² complete synthetic division • ³ recognition of zero remainder	3	• ¹ $ \begin{array}{r rrrr} -1 & 1 & 0 & -13 & -12 \\ & & -1 & -1 & 12 \\ \hline & 1 & -1 & -12 & 0 \end{array} $ • ² $ \begin{array}{r rrrr} -1 & 1 & 0 & -13 & -12 \\ & & -1 & -1 & 12 \\ \hline & 1 & -1 & -12 & 0 \end{array} $ • ³ $(x + 1)$ is a factor as remainder is zero
	(b) Ans: $(x + 1)(x + 3)(x - 4)$ • ⁴ identify quotient • ⁵ factorised fully	2	• ⁴ $x^2 - x - 12$ • ⁵ $(x + 1)(x + 3)(x - 4)$
	Notes Alternative methods of showing $(x + 1)$ is a factor, such as long division, inspection and evaluating are perfectly acceptable.		

6.	Ans: $\frac{3\sqrt{3}}{2}$ • ¹ start to differentiate • ² complete differentiation • ³ evaluate $f'\left(\frac{5\pi}{6}\right)$	3	• ¹ $3 \times 4 \sin^2 x$ • ² $\times \cos x$ • ³ $12 \left(\frac{1}{2}\right)^2 \times \frac{-\sqrt{3}}{2} = 12 \times \frac{1}{4} \times \frac{-\sqrt{3}}{2} = \frac{-3\sqrt{3}}{2}$
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7.

(a)	Ans: $h(x) = 2x^2 - 8x + 5$ • ¹ correct substitution • ² squaring • ³ expanding and simplifying	3	• ¹ $h(x) = 8\left(1 - \frac{1}{2}x\right)^2 - 3$ • ² $1 - x + \frac{1}{4}x^2$ • ³ $h(x) = 2x^2 - 8x + 5$
(b)	Ans: $2(x-2)^2 - 3$ • ⁴ identify common factor • ⁵ complete the square • ⁶ process for q	3	• ⁴ $2(x^2 - 4x \dots)$ stated or implied by • ³ • ⁵ $2(x-2)^2 \dots$ • ⁶ $2(x-2)^2 - 3$
Notes Values for p and q must be consistent with the value for a .			
(c)	Ans: $(2, -3)$ • ⁷ state turning point	1	• ⁷ $(2, -3)$
(d)	Ans:  • ⁸ correct shape • ⁹ annotation, including y -axis intercept	2	• ⁸ parabola with minimum turning point labelled (positioned consistently with answer to (b)) • ⁹ $(0, 8)$

8.	<p>(a)</p> <p>Ans: $\frac{1}{50}$ sec or 0.02 sec</p> <ul style="list-style-type: none"> •¹ knows how to find period •² correct answer 	<p>2</p> <ul style="list-style-type: none"> •¹ $T = \frac{2\pi}{100\pi}$ •² $\frac{1}{50}$ or 0.02 									
	<p>(b)</p> <p>Ans: $\frac{7}{600}$, $\frac{11}{600}$, and $\frac{19}{600}$ sec</p> <ul style="list-style-type: none"> •¹ equating function with -60 •² rearranging •³ solve equation for $100\pi t$ •⁴ process solutions for t •⁵ knowing to use period or demonstrating another solution from the third quadrant •⁶ third value for t 	<p>6</p> <ul style="list-style-type: none"> •¹ $120\sin 100\pi t = -60$ •² $\sin 100\pi t = -\frac{1}{2}$ <table border="1" style="margin-left: auto; margin-right: auto;"> <tbody> <tr> <td style="text-align: center;">•³</td> <td style="border-right: 1px dashed black;"></td> <td style="text-align: center;">•⁴</td> </tr> <tr> <td style="border-right: 1px dashed black;">•³ $100\pi t = \frac{7\pi}{6}$</td> <td style="border-right: 1px dashed black;">and</td> <td>•⁴ $\frac{11\pi}{6}$</td> </tr> <tr> <td style="border-right: 1px dashed black;">•⁴ $t = \frac{7}{600}$</td> <td style="border-right: 1px dashed black;">and</td> <td>•⁴ $\frac{11}{600}$</td> </tr> </tbody> </table> <ul style="list-style-type: none"> •⁵ $T = \frac{1}{50}$ or $100\pi t = 3\pi + \frac{\pi}{6}$ •⁶ $\frac{19}{600}$ 	• ³		• ⁴	• ³ $100\pi t = \frac{7\pi}{6}$	and	• ⁴ $\frac{11\pi}{6}$	• ⁴ $t = \frac{7}{600}$	and	• ⁴ $\frac{11}{600}$
• ³		• ⁴									
• ³ $100\pi t = \frac{7\pi}{6}$	and	• ⁴ $\frac{11\pi}{6}$									
• ⁴ $t = \frac{7}{600}$	and	• ⁴ $\frac{11}{600}$									
9.	<p>Ans: $S(5, 25, -2)$</p> <ul style="list-style-type: none"> •¹ find coordinate of Q or component vector \mathbf{q} •² sets up vector equation for \mathbf{r} •³ find coordinate of R or component vector \mathbf{r} •⁴ sets up vector equation for \mathbf{s} •⁵ find coordinate of S 	<p>5</p> <ul style="list-style-type: none"> •¹ $\mathbf{q} = \mathbf{p} + \overline{PQ} = \begin{pmatrix} 0 \\ 15 \\ 3 \end{pmatrix}$ or $Q(0, 15, 3)$ •² $\mathbf{r} = \mathbf{q} + \overline{QR} = \begin{pmatrix} 0 \\ 15 \\ 3 \end{pmatrix} + \begin{pmatrix} 3 \\ 6 \\ -3 \end{pmatrix}$ •³ $\mathbf{r} = \begin{pmatrix} 3 \\ 21 \\ 0 \end{pmatrix}$ or $R(3, 21, 0)$ •⁴ $\mathbf{s} = \mathbf{r} + \overline{RS} = \begin{pmatrix} 3 \\ 21 \\ 0 \end{pmatrix} + \begin{pmatrix} 2 \\ 4 \\ -2 \end{pmatrix}$ •⁵ $S(5, 25, -2)$ 									

10.	<p>Ans: A False and B True</p> <ul style="list-style-type: none"> •¹ valid reason for statement A •² selecting true or false for statement A with valid reason •³ setting $P(t) = 15$ •⁴ taking log to base e •⁵ completing valid reason •⁶ selecting true or false for statement B with valid reason 	6	<ul style="list-style-type: none"> •¹ $P(0) = 30e^{-2} = 4.06$ •² false, since $P(0) \neq 30$ (do not award without valid reason) •³ $15 = 30e^{t-2}$ •⁴ $\ln e^{t-2} = \ln 0.5$ •⁵ $t - 2 = \ln 0.5$ $t = \ln 0.5 + 2 \quad (1.3)$ •⁶ true, since $t = 1.3$ to one decimal place and there is only one solution (do not award without valid reason)
	<p>Notes Substituting $t = 1.3$ into $P(t) = 30e^{t-2}$ is not sufficient to show that statement B is true, since it does not prove that $t = 1.3$ is the <u>only</u> solution.</p>		
11.	<ul style="list-style-type: none"> •⁵ ss start to differentiate •⁶ pd complete derivative and equate to 0 •⁷ ic factorise •⁸ pd process for x •⁹ ic justify nature and state conclusion 		<ul style="list-style-type: none"> •⁵ two non-zero terms correct •⁶ $4x^3 + 12x^2 + 4x - 20 = 0$ •⁷ $4(x - 1)(x^2 + 4x + 5)$ •⁸ $x = 1$ •⁹ nature table and minimum

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