General Certificate of Education
June 2007
Advanced Subsidiary Examination

MATHEMATICS **MPC1**
Unit Pure Core 1

Monday 21 May 2007 9.00 am to 10.30 am

For this paper you must have: • an 8-page answer book • the **blue** AQA booklet of formulae and statistical tables. You must **not** use a calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is MPC1.
- Answer **all** questions.
- Show all necessary working; otherwise marks for method may be lost.
- The use of calculators (scientific and graphics) is **not** permitted.

Information
- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.

Advice
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.

Answer **all** questions.

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1 The points A and B have coordinates $(6, -1)$ and $(2, 5)$ respectively.

(a) (i) Show that the gradient of AB is $-\frac{3}{2}$. *(2 marks)*

(ii) Hence find an equation of the line AB, giving your answer in the form $ax + by = c$, where a, b and c are integers. *(2 marks)*

(b) (i) Find an equation of the line which passes through B and which is perpendicular to the line AB. *(2 marks)*

(ii) The point C has coordinates $(k, 7)$ and angle ABC is a right angle.

Find the value of the constant k. *(2 marks)*

2 (a) Express $\frac{\sqrt{63}}{3} + \frac{14}{\sqrt{7}}$ in the form $n\sqrt{7}$, where n is an integer. *(3 marks)*

(b) Express $\frac{\sqrt{7}+1}{\sqrt{7}-2}$ in the form $p\sqrt{7} + q$, where p and q are integers. *(4 marks)*

3 (a) (i) Express $x^2 + 10x + 19$ in the form $(x+p)^2 + q$, where p and q are integers. *(2 marks)*

(ii) Write down the coordinates of the vertex (minimum point) of the curve with equation $y = x^2 + 10x + 19$. *(2 marks)*

(iii) Write down the equation of the line of symmetry of the curve $y = x^2 + 10x + 19$. *(1 mark)*

(iv) Describe geometrically the transformation that maps the graph of $y = x^2$ onto the graph of $y = x^2 + 10x + 19$. *(3 marks)*

(b) Determine the coordinates of the points of intersection of the line $y = x + 11$ and the curve $y = x^2 + 10x + 19$. *(4 marks)*

4 A model helicopter takes off from a point O at time $t = 0$ and moves vertically so that its height, y cm, above O after time t seconds is given by

$$y = \frac{1}{4}t^4 - 26t^2 + 96t, \qquad 0 \leqslant t \leqslant 4$$

(a) Find:

(i) $\dfrac{dy}{dt}$; *(3 marks)*

(ii) $\dfrac{d^2y}{dt^2}$. *(2 marks)*

(b) Verify that y has a stationary value when $t = 2$ and determine whether this stationary value is a maximum value or a minimum value. *(4 marks)*

(c) Find the rate of change of y with respect to t when $t = 1$. *(2 marks)*

(d) Determine whether the height of the helicopter above O is increasing or decreasing at the instant when $t = 3$. *(2 marks)*

5 A circle with centre C has equation $(x+3)^2 + (y-2)^2 = 25$.

(a) Write down:

(i) the coordinates of C; *(2 marks)*

(ii) the radius of the circle. *(1 mark)*

(b) (i) Verify that the point $N(0, -2)$ lies on the circle. *(1 mark)*

(ii) Sketch the circle. *(2 marks)*

(iii) Find an equation of the normal to the circle at the point N. *(3 marks)*

(c) The point P has coordinates (2, 6).

(i) Find the distance PC, leaving your answer in surd form. *(2 marks)*

(ii) Find the length of a tangent drawn from P to the circle. *(3 marks)*

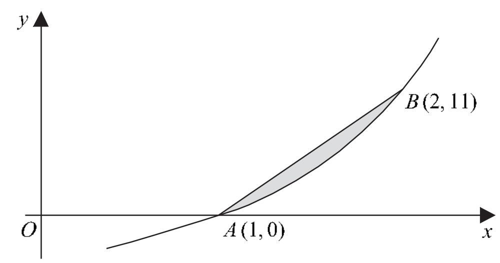
6 (a) The polynomial $f(x)$ is given by $f(x) = x^3 + 4x - 5$.

(i) Use the Factor Theorem to show that $x - 1$ is a factor of $f(x)$. *(2 marks)*

(ii) Express $f(x)$ in the form $(x-1)(x^2 + px + q)$, where p and q are integers. *(2 marks)*

(iii) Hence show that the equation $f(x) = 0$ has exactly one real root and state its value. *(3 marks)*

(b) The curve with equation $y = x^3 + 4x - 5$ is sketched below.



The curve cuts the x-axis at the point $A(1, 0)$ and the point $B(2, 11)$ lies on the curve.

(i) Find $\int (x^3 + 4x - 5)\,dx$. *(3 marks)*

(ii) Hence find the area of the shaded region bounded by the curve and the line AB. *(4 marks)*

7 The quadratic equation

$$(2k-3)x^2 + 2x + (k-1) = 0$$

where k is a constant, has real roots.

(a) Show that $2k^2 - 5k + 2 \leqslant 0$. *(3 marks)*

(b) (i) Factorise $2k^2 - 5k + 2$. *(1 mark)*

(ii) Hence, or otherwise, solve the quadratic inequality

$$2k^2 - 5k + 2 \leqslant 0$$ *(3 marks)*

END OF QUESTIONS

AQA – Core 1 – Jun 2007 – Answers

Question 1:	Exam report
$A(6,-1)\quad B(2,5)$ $a)i)\ m_{AB}=\frac{y_B-y_A}{x_B-x_A}=\frac{5+1}{2-6}=\frac{6}{-4}=-\frac{3}{2}$ $ii)\ Equation\ of\ AB: y+1=-\frac{3}{2}(x-6)$ $2y+2=-3x+18$ $3x+2y=16$ $b)i)$ the line perpendicular to AB has gradient $-\frac{1}{m_{AB}}=\frac{2}{3}$ The equation of this line : $y-5=\frac{2}{3}(x-2)$ $3y-15=2x-4$ $2x-3y=-11$ $ii)\ C(k,7)$. the angle ABC is a right angle so the point C belongs to the perpendicular to AB. By substituting : $2\times k-3\times 7=-11$ $2k=10 \qquad k=5$	Part (a)(i) Most candidates were able to show that the gradient was $-\frac{3}{2}$. However, examiners had to be vigilant since fractions such as $\frac{6}{4}$ *and* $\frac{-4}{6}$ were sometimes equated to $-\frac{3}{2}$. Part (a)(ii) Many candidates did not heed the request for integer coefficients and left their answer as $y=-\frac{3}{2}x+8$. Many who attempted to express the equation in the required form were unable to double the 8 and wrote their final equation as $3x + 2y = 8$. Part (b)(i) Most candidates realised that the product of the gradients should be -1. However, not all were able to calculate the negative reciprocal. Others used the incorrect point and therefore found an equation of the wrong line. Part (b)(ii) Many candidates made no attempt at this part of the question. The most successful method was to substitute y = 7 into the answer to part (b)(i) or to equate the gradient to $\frac{2}{3}$. There were also some good answers using a diagrammatic approach. Those using Pythagoras usually made algebraic errors and so rarely reached a solution.

Question 2:	Exam report
$a)\ \frac{\sqrt{63}}{3}+\frac{14}{\sqrt{7}}=\frac{\sqrt{9\times 7}}{3}+\frac{14}{\sqrt{7}}\times\frac{\sqrt{7}}{\sqrt{7}}=\frac{3\sqrt{7}}{3}+\frac{14\sqrt{7}}{7}$ $=\sqrt{7}+2\sqrt{7}=3\sqrt{7}$ $b)\ \frac{\sqrt{7}+1}{\sqrt{7}-2}=\frac{\sqrt{7}+1}{\sqrt{7}-2}\times\frac{\sqrt{7}+2}{\sqrt{7}+2}=\frac{7+2\sqrt{7}+\sqrt{7}+2}{7-4}$ $=\frac{9+3\sqrt{7}}{3}$	Part (a) Some candidates found this part more difficult than part (b) and revealed a lack of understanding of surds. Some managed to express the first term as $\sqrt{7}$ but were unable to deal with the second term. Those who attempted to find a common denominator often multiplied the terms in the numerator and/or added those in the denominator. Very few obtained the correct answer of $3\sqrt{7}$. Part (b) Most candidates recognised the first crucial step of multiplying the numerator and denominator by $\sqrt{7}+2$ and many obtained $\frac{9+3\sqrt{7}}{3}$, but poor cancellation led to a very common incorrect answer of $3\sqrt{7}+3$.

Question 3:

$a)\, i)\; x^2+10x+19=(x+5)^2-25+19=(x+5)^2-6$

$ii)$ The minimum point has coordinates $(-5,-6)$

$iii)$ The graph is symmetrical around the line $x=-5$

$$iv)\; x \xrightarrow[\text{units in } x\text{-direction}]{\text{translation } -5} x+5 \xrightarrow{f} (x+5)^2 \xrightarrow[\text{units in } y\text{-direction}]{\text{translation } -6} (x+5)^2-6$$

Translation vector $\begin{bmatrix} -5 \\ -6 \end{bmatrix}$

$b)$ solve simultaneously $\begin{cases} y=x+11 \\ y=x^2+10x+19 \end{cases}$ *by identifying the y's*

$$(y=)x^2+10x+19=x+11$$
$$x^2+9x+8=0$$
$$(x+8)(x+1)=0$$
$$x=-8 \;\; or \;\; x=-1$$

and $y=x+11$ *gives* $y=3$ *or* $y=10$

The points of intersection have coordinates $(-8,3)$ *and* $(-1,10)$

Exam report

Part (a)(i) The completion of the square was done successfully by most candidates, although occasionally + 44 was seen instead of .-6 for q.

Part (a)(ii) Most candidates were able to write down the correct minimum point, although some wrote (5, -6) as the vertex. A few chose to use differentiation but often made arithmetic slips in finding the coordinates of the stationary point.

Part (a)(iii) Although there were correct answers for the equation, the term . line of symmetry. was not well understood by many; typical wrong answers were y = -6, the y-axis and even $y = -x^2 +10x+19$ or other quadratic curves.

Part (a)(iv) The more able candidates earned full marks here. The term translation was required but generally the wrong word was used or it was accompanied by another transformation such as a stretch. The most common (but incorrect) vector stated was $\begin{bmatrix} 10 \\ 19 \end{bmatrix}$. Part (b) There were a number of complete correct solutions here. The errors that did occur usually stemmed from sign slips in rearranging the equations. Some candidates found the x-coordinates and made no attempt at the y-coordinates. A few candidates wrote down the coordinates of at least one point without any working.

Question 4:

$a)\, i)\; \frac{d}{dt}=\frac{1}{4}\times 4t^3-26\times 2t+96=t^3-52t+96$

$ii)\; \frac{d^2y}{dt^2}=3t^2-52$

$b)$ Let's verify that for $t=2,\; \frac{dy}{dt}=0$

$$\frac{dy}{dt}(t=2)=2^3-52\times 2+96=8-104+96=0$$

There is a stationary point when $t=2$.

Let's work out $\frac{d^2y}{dt^2}(t=2)=3\times 2^2-52=12-52=-40<0$

The stationary point is a Maximum.

c) The rate of change is $\frac{dy}{dt}(t=1)=1-52+96=45\,cm/s$

$d)$ The sign of $\frac{dy}{dt}$ at $t=3$

will indicate if the height is increasing or decreasing.

$$\frac{dy}{dt}(t=3)=3^3-52\times 3+96=27-156+96=-33<0$$

The height is decreasing when $t=3$

Exam report

Part (a) Almost all candidates were able to find the first and second derivatives correctly, although there was an occasional arithmetic slip; some could not cope with the fraction term, others doubled 26 incorrectly.

Part (b) Those who substituted t = 2 into $\frac{dy}{dt}$ did not always explain that $\frac{dy}{dt}=0$ is the condition for a stationary point. Many used the second derivative test and concluded that the point was a maximum. Some assumed that a stationary point occurred when t = 2 and went straight to the test for maximum or minimum and only scored half of the marks. A few tested $\frac{dy}{dt}$ on either side of t = 2 correctly, but those who only considered the gradient on one side of the stationary value scored no marks for the test.

Part (c) The concept of .rate of change. was not understood by many. Approximately equal numbers of candidates substituted into t = 1 into the expression for y, $\frac{dy}{dt}$ or $\frac{d^2y}{dt^2}$ and so only about one third of the candidates were able to score any marks on this part. Those who used $\frac{dy}{dt}$ often made careless arithmetic errors when adding three numbers.

Part (d) As in part (c), candidates did not realise which expression to use and perhaps the majority wrongly selected the second derivative. It is a general weakness that candidates do not realise that the sign of the first derivative indicates whether a function is increasing or decreasing at a particular point.

Question 5:	**Exam report**
$(x+3)^2+(y-2)^2=25$ $a)\,i)\,C(-3,2)$ $ii)\,Radius\ r=\sqrt{25}=5$ $b)\,i)$ N belongs to the circle if its coodinates satify the equation $(0+3)^2+(-2-2)^2=3^2+4^2=9+16=25$ $N(0,-2)$ belongs to the circle $ii)$ $iii)$ The equation of the normal is the equation of the line CN $m_{CN}=\frac{-2-2}{0+3}=-\frac{4}{3}$ $Equation:\ y+2=-\frac{4}{3}(x-0)$ $3y+6=-4x$ $4x+3y=-6$ $c)\,P(2,6)\quad C(-3,2)$ $i)\,PC=\sqrt{(-3-2)^2+(2-6)^2}=\sqrt{25+16}=\sqrt{41}$ $ii)$ If we call T the point of contact of the tangent from P then the triangle PTC is a right-angled triangle. $PT^2=PC^2-TC^2=\left(\sqrt{41}\right)^2-r^2=41-25=16$ $PT=\sqrt{16}=4$	Part (a) Most candidates found the correct coordinates of the centre, although some wrote these as (3, -2) instead of (-3, 2). Those who multiplied out the brackets were often unsuccessful in writing down the correct radius of the circle. Part (b)(i) Most candidates were able to verify that the point N was on the circle, although some, who had perhaps worked a previous examination question, were keen to show that the distance from C to N was less than the radius and that N lay inside the circle. Part (b)(ii) Most sketches were correct, though some were very untidy with several attempts at the circle so that the diagram resembled a chaotic orbit of a planet. Some candidates omitted the axes and scored no marks. Part (b)(iii) The majority of candidates found the gradient of CN and then assumed they had to find the negative reciprocal of this since the question asked for the normal at N. Reference to their diagram might have avoided this incorrect assumption. Part (c)(i) Most wrote $PC^2=5^2+4^2$, provided they had the correct coordinates of C. However, the length of PC was often calculated incorrectly with answers such as $\sqrt{31}$ and $\sqrt{36}=6$ seen quite often. Part (c)(ii) Although there were many correct solutions seen, Pythagoras' Theorem was often used incorrectly. A large number of candidates wrote the answer as a difference of two lengths such as $\sqrt{41}-5$. Candidates need to realise that obtaining the correct answer from incorrect working is not rewarded; quite a few wrote $\sqrt{41}-\sqrt{25}=\sqrt{16}=4$ and scored no marks. Many who drew a good diagram realised that a tangent from (2,6) touched the circle at (2,2) and so the vertical line segment was of length 4 units.

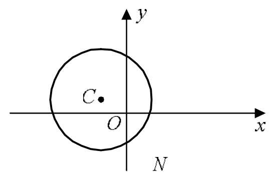
Question 6:	**Exam report**
$a)\,f(x)=x^3+4x-5$ $i)$ Let's work out $f(1)$ $f(1)=1^3+4\times1-5=1+4-5=0$ 1 is a root of f so $(x-1)$ is a factor of f. $ii)\,f(x)=(x-1)(x^2+x+5)$ $iii)$ The discriminant of x^2+x+5 is $1^2-4\times1\times5=-19<0$ x^2+x+5 has no real roots The only real root of f is 1. $b)\,i)\int(x^3+4x-5)dx=\frac{1}{4}x^4+2x^2-5x+c$ $ii)$ Mark the point C(2,0). Area of the shaded region is Area of ABC $-\int_1^2 f(x)dx$ $A=\frac{1}{2}\times1\times11-\left[\frac{1}{4}x^4+2x^2-5x\right]_1^2=\frac{11}{2}-\left[(4+8-10)-\left(\frac{1}{4}+2-5\right)\right]$ $A=\frac{11}{2}-2-\frac{11}{4}=\frac{22-8-11}{4}=\frac{3}{4}$	Part (a)(i) Most candidates realised the need to find the value of f(x) when x = 1. However, it was also necessary, after showing that f(1) = 0, to write a statement that the zero value implied that x -1 was a factor. Part (a)(ii) Those who used inspection were the most successful here. Methods involving long division or equating coefficients usually contained algebraic errors. Part (a)(iii) This section seemed unclear to some candidates. Many tried to find the discriminant but used the coefficients of the cubic equation. Many who used the quadratic thought that in order to have one real root the discriminant had to be zero, no doubt thinking the question was asking about equal roots. Some correctly stated that 1 was the only real root but many were obviously confused by the terms "factor" and "root" and stated that "x-1 was a root". Part (b)(i) Most candidates were well versed in integration and earned full marks here. Part (b)(ii) The correct limits were usually used, although many sign/arithmetic slips occurred after substitution of the numbers 1 and 2. Very few candidates realised the need to find the area of a triangle as well and so failed to subtract the value of the integral from the area of the triangle in order to find the area of the shaded region.

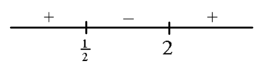
Question 7:	Exam report
$(2k-3)x^2+2x+(k-1)=0$ *has real roots* This means that the discriminat ≥ 0 $2^2-4\times(2k-3)\times(k-1)\geq 0$ $4-8k^2+20k-12\geq 0$ $-8k^2+20k-8\geq 0 \quad (\div -4)$ $2k^2-5k+2\leq 0$ $b)\, i)\; 2k^2-5k+2=(2k-1)(k-2)$ $ii)\; (2k-1)(k-2)\leq 0$ *critical values* : $\frac{1}{2}$ *and* 2 $\frac{1}{2}\leq k\leq 2$	Part (a) Only the more able candidates were able to complete this proof correctly. Many began by stating that the discriminant was less than or equal to zero, no doubt being influenced by the printed answer. Part (b)(i) The factorisation was usually correct. Part (b)(ii) Most candidates found the critical values, but many then either stopped or wrote down a solution to the inequality without any working. Many candidates wrongly thought the solution was $k\leq\frac{1}{2}, k\leq 2$. Candidates are advised to draw an appropriate sketch or sign diagram so they can deduce the correct interval for the solution.

GRADE BOUNDARIES						
Component title	Max mark	A	B	C	D	E
Core 1 – Unit PC1	75	60	52	44	37	30

Q	Solution	Marks	Total	Comments
1(a)(i)	Gradient $AB = \dfrac{-1-5}{6-2}$ or $\dfrac{5--1}{2-6}$	M1		$\pm\dfrac{6}{4}$ implies M1
	$= \dfrac{-6}{4} = -\dfrac{3}{2}$	A1	2	AG
(ii)	$\left.\begin{array}{l} y-5 \\ y+1 \end{array}\right\} = -\dfrac{3}{2}\left\{\begin{array}{l}(x-2) \\ (x-6)\end{array}\right.$	M1		or $y = -\dfrac{3}{2}x + c$ and attempt to find c
	$\Rightarrow 3x + 2y = 16$	A1	2	OE; must have integer coefficients
(b)(i)	Gradient of perpendicular $= \dfrac{2}{3}$	M1		or use of $m_1 m_2 = -1$
	$\Rightarrow y - 5 = \dfrac{2}{3}(x-2)$	A1	2	$3y - 2x = 11$ (no misreads permitted)
(ii)	Substitute $x = k,\ y = 7$ into their (b)(i)	M1		or grads $\dfrac{7-5}{k-2} \times \dfrac{-3}{2} = -1$
	$\Rightarrow 2 = \dfrac{2}{3}(k-2) \Rightarrow k = 5$	A1	2	or Pythagoras $(k-2)^2 = (k-6)^2 + 8$
	Total		**8**	
2(a)	$\dfrac{\sqrt{63}}{3} = \sqrt{7}$ or $\dfrac{3\sqrt{7}}{3}$	B1		or $\dfrac{\left(\sqrt{7}\sqrt{63} + 14\times 3\right)}{3\sqrt{7}}$
	$\dfrac{14}{\sqrt{7}} = 2\sqrt{7}$ or $\dfrac{14\sqrt{7}}{7}$	B1		or $\dfrac{\sqrt{7}}{\sqrt{7}}(\quad)$ M1
	$\Rightarrow$ sum $= 3\sqrt{7}$	B1	3	$\Rightarrow$ correct answer with all working correct A2
(b)	Multiply by $\dfrac{\sqrt{7}+2}{\sqrt{7}+2}$	M1		
	Denominator $= 7 - 4 = 3$	A1		
	Numerator $= \left(\sqrt{7}\right)^2 + \sqrt{7} + 2\sqrt{7} + 2$	m1		multiplied out (allow one slip) $9 + 3\sqrt{7}$
	Answer $= \sqrt{7} + 3$	A1	4	
	Total		**7**	

Q	Solution	Marks	Total	Comments
3(a)(i)	$(x+5)^2$	B1		$p = 5$
	-6	B1	2	$q = -6$
(ii)	$x_{\text{vertex}} = -5$ (or their $-p$)	B1√		may differentiate but must have $x = -5$
	$y_{\text{vertex}} = -6$ (or their q)	B1√	2	and $y = -6$. Vertex $(-5, -6)$
(iii)	$x = -5$	B1	1	
(iv)	Translation (not shift, move etc)	E1		and NO other transformation stated
	through $\begin{bmatrix} -5 \\ -6 \end{bmatrix}$ (or 5 left, 6 down)	M1 A1	3	either component correct M1, A1 independent of E mark
(b)	$x + 11 = x^2 + 10x + 19$			quadratic with all terms on one side of equation
	$\Rightarrow x^2 + 9x + 8 = 0$ or $y^2 - 13y + 30 = 0$	M1		
	$(x+8)(x+1) = 0$ or $(y-3)(y-10) = 0$	m1		attempt at formula (1 slip) or to factorise
	$\left.\begin{array}{l} x = -1 \\ y = 10 \end{array}\right\}$ or $\left.\begin{array}{l} x = -8 \\ y = 3 \end{array}\right\}$	A1 A1	4	both x values correct both y values correct and linked
				SC $(-1, 10)$ B2, $(-8, 3)$ B2 no working
	Total		**12**	
4(a)(i)	$t^3 - 52t + 96$	M1 A1 A1	3	one term correct another term correct all correct (no $+ c$ etc)
(ii)	$3t^2 - 52$	M1 A1√	2	ft one term correct ft all "correct"
(b)	$\dfrac{dy}{dt} = 8 - 104 + 96$	M1		substitute $t = 2$ into their $\dfrac{dy}{dt}$
	$= 0 \Rightarrow$ stationary value	A1		CSO; shown = 0 + statement
	Substitute $t = 2$ into $\dfrac{d^2y}{dt^2}$ $(= -40)$	M1		any appropriate test, e.g. $y'(1)$ and $y'(3)$
	$\dfrac{d^2y}{dt^2} < 0 \Rightarrow$ max value	A1	4	all values (if stated) must be correct
(c)	Substitute $t = 1$ into their $\dfrac{dy}{dt}$	M1		must be their $\dfrac{dy}{dt}$ NOT $\dfrac{d^2y}{dt^2}$
	Rate of change = 45 $\left(\text{cm s}^{-1}\right)$	A1√	2	ft their $y'(1)$
(d)	Substitute $t = 3$ into their $\dfrac{dy}{dt}$	M1		interpreting their value of $\dfrac{dy}{dt}$
	$(27 - 156 + 96 = -33 < 0)$			
	$\Rightarrow$ decreasing when $t = 3$	E1√	2	allow increasing if their $\dfrac{dy}{dt} > 0$
	Total		**13**	

Q	Solution	Marks	Total	Comments
5(a)(i)	Centre $(-3, 2)$	M1		± 3 or ± 2
		A1	2	correct
(ii)	Radius = 5	B1	1	accept $\sqrt{25}$ but not $\pm\sqrt{25}$
(b)(i)	$3^2 + (-4)^2 = 9 + 16 = 25$			
	$\Rightarrow N$ lies on circle	B1	1	must have $9 + 16 = 25$ or a statement
(ii)		M1		must draw axes; ft their centre in correct quadrant
		A1	2	correct (reasonable freehand circle enclosing origin)
(iii)	Attempt at gradient of CN	M1		withhold if subsequently finds tangent
	grad $CN - -\frac{4}{3}$	A1		CSO
	$y = -\frac{4}{3}x - 2$ (or equivalent)	A1√	3	ft their grad CN
(c)(i)	$P(2,6)$ Hence $PC^2 = 5^2 + 4^2$	M1		"their" PC^2
	$\Rightarrow PC = \sqrt{41}$	A1	2	
(ii)	Use of Pythagoras correctly	M1		
	$PT^2 = PC^2 - r^2 = 41 - 25$, where T is a point of contact of tangent	A1√		ft their PC^2 and r^2
	$\Rightarrow PT = 4$	A1	3	**Alternative** sketch with vertical tangent M1 showing that tangent touches circle at point (2, 2) A1 hence $PT = 4$ A1
	Total		**14**	

Q	Solution	Marks	Total	Comments
6(a)(i)	$f(1) = 1 + 4 - 5$	M1		must find $f(1)$ NOT long division
	$\Rightarrow f(1) = 0 \Rightarrow (x-1)$ is factor	A1	2	shown $= 0$ plus a statement
(ii)	Attempt at $x^2 + x + 5$	M1		long division leading to $x^2 \pm x + \ldots$ or equating coefficients
	$f(x) = (x-1)(x^2 + x + 5)$	A1	2	$p = 1$, $q = 5$ by inspection scores B1, B1
(iii)	$(x =)\ 1$ is real root	B1		
	Consider $b^2 - 4ac$ for their $x^2 + x + 5$	M1		not the cubic!
	$b^2 - 4ac = 1^2 - 4 \times 5 = -19 < 0$			
	Hence no real roots (or only real root is 1)	A1	3	CSO; all values correct plus a statement
(b)(i)	$\int \ldots \, dx = \frac{x^4}{4} + 2x^2 - 5x\ (+c)$	M1 A1 A1	3	one term correct unsimplified second term correct unsimplified all correct unsimplified
(ii)	$[4 + 8 - 10] - \left[\frac{1}{4} + 2 - 5\right]$	M1		correct use of limits 1 and 2; $F(2) - F(1)$ attempted
	$= 4\frac{3}{4}$	A1		
	Area of $\Delta = \frac{1}{2} \times 11 = 5\frac{1}{2}$	B1		correct unsimplified
	$\Rightarrow$ shaded area $= 5\frac{1}{2} - 4\frac{3}{4}$			combined integral of $7x - 6 - x^3$ scores M1 for limits correctly used then
	$= \frac{3}{4}$	A1	4	A3 correct answer with all working correct
	Total		**14**	
7(a)	$b^2 - 4ac = 4 - 4(k-1)(2k-3)$	M1		(or seen in formula) condone one slip
	Real roots when $b^2 - 4ac \geqslant 0$	E1		must involve $f(k) \geqslant 0$ (usually M1 must be earned)
	$4 - 4(2k^2 - 5k + 3) \geqslant 0$			
	$\Rightarrow -2k^2 + 5k - 3 + 1 \geqslant 0$			at least one step of working justifying $\leqslant 0$
	$\Rightarrow 2k^2 - 5k + 2 \leqslant 0$	A1	3	AG
(b)(i)	$(2k-1)(k-2)$	B1	1	
(ii)	(Critical values) $\frac{1}{2}$ and 2	B1√		ft their factors or correct values seen on diagram, sketch or inequality or stated
		M1		use of sketch / sign diagram
	$\Rightarrow 0.5 \leqslant k \leqslant 2$	A1	3	M1A0 for $0.5 < k < 2$ or $k \geqslant 0.5$, $k \leqslant 2$
	Total		7	
	TOTAL		**75**	