General Certificate of Education
June 2006
Advanced Subsidiary Examination

MATHEMATICS **MPC1**
Unit Pure Core 1

Monday 22 May 2006 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.

1 The point A has coordinates $(1, 7)$ and the point B has coordinates $(5, 1)$.

(a) (i) Find the gradient of the line AB. *(2 marks)*

(ii) Hence, or otherwise, show that the line AB has equation $3x + 2y = 17$. *(2 marks)*

(b) The line AB intersects the line with equation $x - 4y = 8$ at the point C. Find the coordinates of C. *(3 marks)*

(c) Find an equation of the line through A which is perpendicular to AB. *(3 marks)*

2 (a) Express $x^2 + 8x + 19$ in the form $(x + p)^2 + q$, where p and q are integers. *(2 marks)*

(b) Hence, or otherwise, show that the equation $x^2 + 8x + 19 = 0$ has no real solutions. *(2 marks)*

(c) Sketch the graph of $y = x^2 + 8x + 19$, stating the coordinates of the minimum point and the point where the graph crosses the y-axis. *(3 marks)*

(d) Describe geometrically the transformation that maps the graph of $y = x^2$ onto the graph of $y = x^2 + 8x + 19$. *(3 marks)*

3 A curve has equation $y = 7 - 2x^5$.

(a) Find $\frac{dy}{dx}$. *(2 marks)*

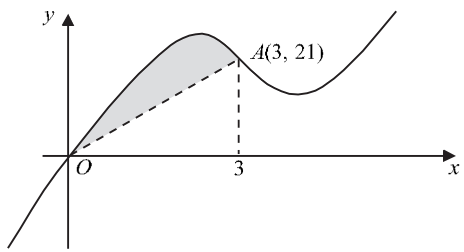
(b) Find an equation for the tangent to the curve at the point where $x = 1$. *(3 marks)*

(c) Determine whether y is increasing or decreasing when $x = -2$. *(2 marks)*

4 (a) Express $(4\sqrt{5} - 1)(\sqrt{5} + 3)$ in the form $p + q\sqrt{5}$, where p and q are integers. *(3 marks)*

(b) Show that $\frac{\sqrt{75} - \sqrt{27}}{\sqrt{3}}$ is an integer and find its value. *(3 marks)*

5 The curve with equation $y = x^3 - 10x^2 + 28x$ is sketched below.



The curve crosses the x-axis at the origin O and the point $A(3, 21)$ lies on the curve.

(a) (i) Find $\frac{dy}{dx}$. *(3 marks)*

(ii) Hence show that the curve has a stationary point when $x = 2$ and find the x-coordinate of the other stationary point. *(4 marks)*

(b) (i) Find $\int (x^3 - 10x^2 + 28x)\,dx$. *(3 marks)*

(ii) Hence show that $\int_0^3 (x^3 - 10x^2 + 28x)\,dx = 56\frac{1}{4}$. *(2 marks)*

(iii) Hence determine the area of the shaded region bounded by the curve and the line OA. *(3 marks)*

6 The polynomial $p(x)$ is given by $p(x) = x^3 - 4x^2 + 3x$.

(a) Use the Factor Theorem to show that $x - 3$ is a factor of $p(x)$. *(2 marks)*

(b) Express $p(x)$ as the product of three linear factors. *(2 marks)*

(c) (i) Use the Remainder Theorem to find the remainder, r, when $p(x)$ is divided by $x - 2$. *(2 marks)*

(ii) Using algebraic division, or otherwise, express $p(x)$ in the form

$$(x-2)(x^2 + ax + b) + r$$

where a, b and r are constants. *(4 marks)*

7 A circle has equation $x^2 + y^2 - 4x - 14 = 0$.

(a) Find:

(i) the coordinates of the centre of the circle; *(3 marks)*

(ii) the radius of the circle in the form $p\sqrt{2}$, where p is an integer. *(3 marks)*

(b) A chord of the circle has length 8. Find the perpendicular distance from the centre of the circle to this chord. *(3 marks)*

(c) A line has equation $y = 2k - x$, where k is a constant.

(i) Show that the x-coordinate of any point of intersection of the line and the circle satisfies the equation

$$x^2 - 2(k+1)x + 2k^2 - 7 = 0$$ *(3 marks)*

(ii) Find the values of k for which the equation

$$x^2 - 2(k+1)x + 2k^2 - 7 = 0$$

has equal roots. *(4 marks)*

(iii) Describe the geometrical relationship between the line and the circle when k takes either of the values found in part (c)(ii). *(1 mark)*

END OF QUESTIONS

AQA – Core 1 – Jun 2006 – Answers

Question 1:	Exam report
$a)\ i)\ Gradient\ of\ AB = m_{AB} = \frac{y_B - y_A}{x_B - x_A} = \frac{1-7}{5-1} = \frac{-6}{4} = -\frac{3}{2}$ $ii)\ Equation\ of\ AB: y - y_A = m_{AB}(x - x_A)$ $y - 7 = -\frac{3}{2}(x-1)$ $2y - 14 = -3x + 3$ $3x + 2y = 17$ $b)$ solve simultaneously $\begin{cases} 3x + 2y = 17 & (\times 2) \\ x - 4y = 8 \end{cases}$ $\begin{cases} 6x + 4y = 34 \\ x - 4y = 8 & (add) \end{cases}$ *This gives* $7x = 42$ $x = 6$ *AND* $x - 4y = 8$ $6 - 4y = 8 \qquad y = -\frac{1}{2}$ The lines intersect at $(6, -\frac{1}{2})$ $c)$ The gradient of the line perpendicular to AB is $-\frac{1}{m_{AB}} = \frac{2}{3}$ Equation of the line : $y - 7 = \frac{2}{3}(x-1)$ $3y - 21 = 2x - 2$ $2x - 3y = -19$	Part (a)(i) Although most obtained the correct gradient, some omitted the negative sign (particularly those who relied on a sketch for their evaluation) and some had a fraction with the change in *x* as the numerator which immediately scored no marks. Quite a few found mid-points (possibly since that had appeared on previous examinations) and others added the coordinates instead of finding the differences in their quotient expression for the gradient. Part (a)(ii) The use of their gradient to obtain the given equation was the most successful method. Those using $y = mx + c$ had a tendency to introduce a new 'c' by doubling both sides but then substituted their value back into the original equation. The most successful candidates used the formula $y - y_1 = m(x - x_1)$. Some re-arranged the given equation to check the gradient then checked one set of co-ordinates; others checked two points and indicated that a straight line has the form $ax + by = c$. Part (b) Those using substitution often began by using an incorrect rearrangement of one of the equations. If they attempted elimination, sometimes only part of an equation was multiplied by the appropriate constant. Many added the equations instead of subtracting. Of those who wrote $14y = -7$, just as many obtained an incorrect answer of $y = -2$ as the correct answer of $y = -1/2$. Part (c) The condition for perpendicularity was generally known but some were unable to evaluate –1 divided by – 1.5. A few omitted the – sign while some referred to the equation $3x + 2y = 17$ and gave a gradient of -1/3. Once again, those determined to use $y = mx + c$ often made errors in the constant due to the fractional coefficient of *x*. Quite a few did not use the point *A* as instructed, choosing to use the point *C* instead.

Question 2:	Exam report
$a)\ x^2 + 8x + 19 = (x+4)^2 - 16 + 19 = (x+4)^2 + 3$ $b)\ x^2 + 8x + 19 = 0$ *is equivalent to* $(x+4)^2 + 3 = 0$ $(x+4)^2 = -3$ For all x real, $(x+4)^2 \geq 0$, so this equation has no solution. $c)$ The minimum point is $(-4,3)$ The graph crosses the y-axis at (0,19) $d)\ x \xrightarrow[\text{unitsin } x-\text{direction}]{\text{translation } -4} x+4 \xrightarrow{f} (x+4)^2 \xrightarrow[\text{unitsin } y-\text{direction}]{\text{tranlation } 3} (x+4)^2 + 3$ *Tranlation vector* $\begin{bmatrix} -4 \\ 3 \end{bmatrix}$	**Part (a)** Many candidates began by finding the correct values of *p* and *q* . A few wrote $(x - 4)^2$ and some added 16 instead of subtracting 16 so $q = 35$ was sometimes seen. **Part (b)** Very few chose to consider the expression they had in part (a). Practically all candidates decided to find the discriminant instead but its evaluation was often incorrect. Not everyone quoted the expression for the discriminant, $b^2 - 4ac$, correctly. Some attempted to refer to the fact that the curve was completely above the *x*-axis but did not, in general, complete their argument. **Part (c)** The graphs here were disappointing. Although most drew a quadratic shape, there seemed to be little reference to their part (a) and many just tried to plot a few points. Most were able to state the intercept on the *y*-axis. However, sometimes the point (0.19) was shown as the minimum point or a straight line intercept. Several curves were drawn only in the first quadrant, regardless of whether the quoted minimum point was (–4.3) or (4.3). **Part (d)** This was not well answered. 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 incorrect vector stated was $\begin{bmatrix} 8 \\ -19 \end{bmatrix}$.

Question 3:	Exam report
$y = 7 - 2x^5$ $a)\ \frac{dy}{dx} = 0 - 2\times 5x^4 = -10x^4$ $b)$ Gradient of the tangent is $\frac{dy}{dx}(x=1) = -10\times 1^4 = -10$ $for\ x=1,\ y = 7 - 2\times 1^5 = 5$ the equation of the tangent is : $y - 5 = -10(x-1)$ $10x + y = 15$ $c)\ \frac{dy}{dx}(x=-2) = -10\times(-2)^4 = -160 < 0$ y is decreasing	Part (a) Most candidates answered this part correctly. A few included the 7 or thought the derivative of the first term was 7x and the – sign was sometimes lost. Part (b) Many substituted x = 1 correctly, though it was apparent that they did not recognise this value of –10 to be the gradient of the tangent. Many correctly found y as 5 but stopped there. Again, some correct attempts at the tangent equation using y = mx + c foundered and quite a large number attempted to find the equation of the normal. Part (c) Use of the value of $\frac{dy}{dx}$ was the only acceptable method here. Evaluations of y at different points or finding the second derivative were common but earned no marks.

Question 4:	Exam report
$a)\ (4\sqrt{5}-1)(\sqrt{5}+3) = 4\times 5 + 12\sqrt{5} - \sqrt{5} - 3$ $= 20 - 3 + 12\sqrt{5} - \sqrt{5}$ $= 17 + 11\sqrt{5}$ $b)\ \frac{\sqrt{75}-\sqrt{27}}{\sqrt{3}} = \frac{\sqrt{25\times 3}-\sqrt{9\times 3}}{\sqrt{3}}$ $= \frac{5\sqrt{3}-3\sqrt{3}}{\sqrt{3}} = \frac{2\sqrt{3}}{\sqrt{3}} = 2$	Part (a) Almost everyone recognised that multiplication of the two brackets was required but there were numerous errors with $7\sqrt{5}$ instead of $12\sqrt{5}$ being common and –2 or –4 instead of –3. Although most dealt with the first term correctly and obtained 20, many added $12\sqrt{5}$ and $-\sqrt{5}$ wrongly to get $-11\sqrt{5}$. Part (b) This part was answered more successfully with $\sqrt{\frac{75}{3}} - \sqrt{\frac{27}{3}}$ being the neatest method. Some failed to complete correctly from $\frac{2\sqrt{3}}{\sqrt{3}}$ to 2 and gave an answer of $\sqrt{3}$. A few went 'all round the houses' but got there eventually. Some tried to cancel out $\sqrt{3}$ but only considered one term in the denominator. Multiplying top and bottom by $\sqrt{3}$ caused some problems. A few attempted to combine the 2 terms in the numerator and wrote $\frac{\sqrt{48}}{\sqrt{3}}$ which of course is also an integer!

Question 5:	Exam report
$a)\ i)\ \frac{dy}{dx} = 3x^2 - 20x + 28$ $ii)\ \frac{dy}{dx} = 0 \qquad 3x^2 - 20x + 28 = 0$ $(3x-14)(x-2) = 0$ $x = \frac{14}{3}\ or\ x = 2$ There are two stationary points: $x = 2\ and\ x = \frac{14}{3}$ $b)\ i)\ \int (x^3 - 10x^2 + 28x)dx = \frac{1}{4}x^4 - \frac{10}{3}x^3 + 14x^2 + c$ $ii)\ \int_0^3 (x^3 - 10x^2 + 28x)dx = \left[\frac{1}{4}x^4 - \frac{10}{3}x^3 + 14x^2\right]_0^3$ $= \left(\frac{1}{4}\times 3^4 - \frac{10}{3}\times 3^3 + 14\times 3^2\right) - (0 - 0 + 0)$ $= \frac{225}{4} = 56\frac{1}{4}$ $iii)$ Area shaded $= 56\frac{1}{4} -$ Area of the triangle $= 56\frac{1}{4} - \frac{1}{2}\times 3\times 21 = \frac{99}{4} = 24\frac{3}{4}$	Part (a)(i) Most candidates differentiated correctly. However a few made a slip or misread one of the terms. Part (a)(ii) Although most managed to substitute 2 into their derivative some made numerical errors and some used y or the second derivative. Most who realised that they should equate their derivative to zero (or at least showed their intention though never inserting the = 0) then tried to factorise or use the formula (though it was clear that some did not recognise the quadratic equation as such). It was disappointing that the bracket (3x–14) often produced the solution x = 14 instead of 14/3, and the solution of x = 2 did not always appear. Part (b)(i) The integration was also completed correctly by most candidates, although the 28x was occasionally wrong and some 'hybrid' processes led to terms such as $-\frac{20}{3}$. In part (b)(ii) almost everyone attempted to substitute 3 into their integral but their problems with the ensuing fractions often took pages to resolve, and although most ended 'magically' with the required answer there were many errors en route. A few substituted into the original expression for y instead of the integrated expression. Part (b)(iii) This part was quite well done although again there were errors in evaluating both $\frac{1}{2}\times 21\times 3$ and $56\frac{1}{4} - 31\frac{1}{2}$. Some candidates confused length with area and merely used Pythagoras`s Theorem to find the length of the hypotenuse of the triangle. Those who chose to integrate the equation of the straight line were sometimes successful but many made arithmetic errors.

Question 6:	Exam report
$p(x) = x^3 - 4x^2 + 3x$ $a)\ p(3) = 3^3 - 4\times 3^2 + 3\times 3 = 27 - 36 + 9 = 0$ 3 is a root of p so $(x-3)$ is a factor of p $b)\ x^3 - 4x^2 + 3x = x\left(x^2 - 4x + 3\right) = x(x-1)(x-3)$ $c)\ i)\ r = p(2) = 2^3 - 4\times 2^2 + 3\times 2 = 8 - 16 + 6 = -2$ $ii)$ Long division of $x^3 - 4x^2 + 3x + 0$ by $x - 2$: quotient $x^2 - 2x - 1$ $x^3 - 2x^2$ $-2x^2 + 3x$ $-2x^2 + 4x$ $-x + 0$ $-x + 2$ -2 $x^3 - 4x^2 + 3x = (x-2)\left(x^2 - 2x - 1\right) - 2$	Part (a) Although many candidates showed that p(3) = 0, many lost a mark for failing to include a statement of the implication. Some candidates appeared ignorant of the Factor Theorem and used long division and therefore earned no marks in this part. Part (b) Only about half of the candidates were able to complete this part, although most made an attempt. The term $x^2 - x$ confused some. A few failed to write a product of factors even though this was requested. Part(c)(i) As the question requested the use of the Remainder Theorem, finding p(2) was the only acceptable method here. Many attempted long division and scored no marks. Part (c)(ii) There were many full solutions either by multiplying out and comparing coefficients they are both valid methods or by using long division. The majority of candidates showed poor algebraic skills and were unable to find the correct values of *a* and *b*. No credit was given for stating the value of r obtained in part (i) unless the values of a and b were correct. Full marks were earned by able candidates who simply wrote down the correct values of a, b and r by inspection.

Question 7:	Exam report
$x^2+y^2-4x-14=0$ $a)\,i)\,(x-2)^2-4+y^2-14=0$ $(x-2)^2+y^2=18$ The centre C has coordinates (2,0) $ii)$ the radius is $r=\sqrt{18}=\sqrt{9\times 2}=3\sqrt{2}$ $b)$ Call the chord AB and the mid-point of the chord I then the triangle CIA is a right-angled triangle. The perpendicular distance is the length CI. Using Pythagoras' theorem, $\mathrm{CI}^2=CA^2-IA^2$ $=r^2-4^2$ $CI=\sqrt{2}$ $c)\,i)$ By solving the equations simultaneously: $\begin{cases} y=2k-x \\ x^2+y^2-4x-14=0 \end{cases}$ *we obtain, by substitution* $x^2+(2k-x)^2-4x-14=0$ $x^2+4k^2+x^2-4kx-4x-14=0$ $2x^2-4(k+1)x+4k^2-14=0 \quad (\div 2)$ $x^2-2(k+1)+2k^2-7=0$ $ii)$ This equation has equal roots when the discriminant $=0$ $(-2(k+1))^2-4\times 1\times(2k^2-7)=0$ $4(k^2+2k+1)-8k^2+28=0$ $-4k^2+8k+32=0$ $k^2-2k-8=0$ $(k-4)(k+2)=0$ $k=4 \;\; or \;\; k=-2$ $iii)$ The line will be tangent to the circle when $k=4 \; or \; k=-2$	Part (a)(i) It was apparent that some candidates had not covered this part of the specification and they made no progress. Most who had done so, earned the marks here. However a few wrote $(x+2)^2$ or even $(x-2)^2$ and then gave the centre as (– 2,0) Some managed to incorporate the 7 with the y term so wrote the coordinates of the centre as (2,–7). Part (a)(ii) Most candidates were successful in finding the correct radius. However some forfeited one mark by 'meddling' with their equation and putting 18^2 or $\sqrt{18}$ on the right hand side of the equation. Part(b) This part was rarely attempted. Even where a correct diagram was drawn, few recognised that the chord would be bisected. Many assumed that the triangle was right-angled at the centre of the circle. Others drew tangents instead of a chord. Part (c)(i) Many made little progress here. However, it was good to see more able candidates coping well. A few fell at the final line writing (k–1) instead of (k+1); a few lost a mark by not introducing '= 0' as part of the equation of the circle and simply added '= 0' at the end of several lines of working so as to match the printed answer. Many made a slip in squaring (2k–x) and some made gross errors such as writing this as $4k^2+x^2$ or $4k^2-x^2$. Others 'simplified' the equation to $(x-2)+(2k-x)=\sqrt{18}$. Part (c)(ii) Those candidates who made progress here needed both knowledge and algebraic skills and only a small minority completed this part correctly. However more earned some method marks. Use of the correct condition on the discriminant was required but some just tried to solve the equation using the quadratic formula or used ' > 0' instead of ' = 0'. A few attempts at completing the square were seen but most failed to equate the expression to zero. Part (c)(iii) Many candidates who had made no progress in the rest of the question stated that the line would be a tangent to the circle; however several candidates wrote at length about various transformations and completely missed the point.

Key To Mark Scheme And Abbreviations Used In Marking

M	mark is for method		
m or dM	mark is dependent on one or more M marks and is for method		
A	mark is dependent on M or m marks and is for accuracy		
B	mark is independent of M or m marks and is for method and accuracy		
E	mark is for explanation		
√or ft or F	follow through from previous incorrect result	MC	mis-copy
CAO	correct answer only	MR	mis-read
CSO	correct solution only	RA	required accuracy
AWFW	anything which falls within	FW	further work
AWRT	anything which rounds to	ISW	ignore subsequent work
ACF	any correct form	FIW	from incorrect work
AG	answer given	BOD	given benefit of doubt
SC	special case	WR	work replaced by candidate
OE	or equivalent	FB	formulae book
A2,1	2 or 1 (or 0) accuracy marks	NOS	not on scheme
$-x$ EE	deduct x marks for each error	G	graph
NMS	no method shown	c	candidate
PI	possibly implied	sf	significant figure(s)
SCA	substantially correct approach	dp	decimal place(s)

No Method Shown

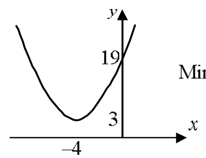
Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks.**

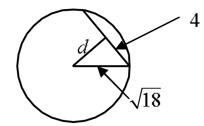
Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks.**

Otherwise we require evidence of a correct method for any marks to be awarded.

Q	Solution	Marks	Total	Comments
1(a)(i)	Gradient $AB = \frac{1-7}{5-1}$	M1		Must be y on top and subtr'n of cords
	$= -\frac{6}{4} = -\frac{3}{2} = -1.5$	A1	2	Any correct equivalent
(ii)	$y-7 = m(x-1)$ or $y-1 = m(x-5)$	M1		Verifying 2 points or $y = -\frac{3}{2}x + c$
	leading to $3x + 2y = 17$	A1	2	AG (or grad & 1 point verified)
(b)	Attempt to eliminate x or y : $7x = 42$ etc	M1		Solving $x - 4y = 8$; $3x + 2y = 17$
	$x = 6$	A1		
	$y = -\frac{1}{2}$	A1	3	C is point $(6, -\frac{1}{2})$
(c)	Grad of perp = – 1 / *their* gradient AB	M1		Or $m_1 m_2 = -1$ used or stated
	$= \frac{2}{3}$	A1√		ft their gradient AB
	$y-7 = \frac{2}{3}(x-1)$ or $3y - 2x = 19$	A1	3	CSO Any correct form of equation
	Total		**10**	
2(a)	$(x+4)^2$	B1		$p = 4$
	$+3$	B1	2	$q = 3$
(b)	$(x+4)^2 = -3$ or "their" $(x+p)^2 = -q$	M1		Or discriminant = 64 –76
	No real square root of –3	A1	2	Disc < 0 so no real roots (all correct figs)
(c)	 Minimum (– 4, 3)	B1√		ft their $-p$ and q (or correct)
	graph	B1		Parabola (vertex roughly as shown)
		B1	3	Crossing at $y = 19$ marked or (0, 19) stated
(d)	Translation (and no additional transf'n)	E1		Not shift, move, transformation, etc
	through $\begin{bmatrix}-4\\3\end{bmatrix}$	M1		One component correct eg 3 units up
		A1	3	All correct – if not vector – must say 4 units in negative x- direction, to left etc
	Total		**10**	
3(a)	$\frac{dy}{dx} = -10x^4$	M1		kx^4 condone extra term
		A1	2	Correct derivative unsimplified
(b)	When $x = 1$, gradient = –10	B1√		FT their gradient when $x = 1$
	Tangent is	M1		Attempt at y & tangent (**not** normal)
	$y - 5 = -10(x-1)$ *or* $y + 10x = 15$ etc	A1	3	CSO Any correct form
(c)	When $x = -2$ $\frac{dy}{dx} = -160$ (or < 0)	B1√		Value of their $\frac{dy}{dx}$ when $x = -2$
	($\frac{dy}{dx} < 0$ hence) y is **decreasing**	E1√	2	ft Increasing if their $\frac{dy}{dx} > 0$
	Total		7	

Q	Solution	Marks	Total	Comments
4(a)	$4\left(\sqrt{5}\right)^2 + 12\sqrt{5} - \sqrt{5} - 3$	M1		Multiplied out At least 3 terms with $\sqrt{5}$ term
	$4\left(\sqrt{5}\right)^2 = 4 \times 5 \quad (= 20)$	B1		
	Answer $= 17 + 11\sqrt{5}$	A1	3	
(b)	Either $\sqrt{75} = \sqrt{25}\sqrt{3}$ or $\sqrt{27} = \sqrt{9}\sqrt{3}$	M1		Or multiplying top and bottom by $\sqrt{3}$
	Expression = $\dfrac{5\sqrt{3} - 3\sqrt{3}}{\sqrt{3}}$	A1		or $\dfrac{\sqrt{225} - \sqrt{81}}{3}$ or $\sqrt{25} - \sqrt{9}$ or 5–3
	= 2	A1	3	CSO
	Total		**6**	
5(a)(i)	$\dfrac{dy}{dx} = 3x^2 - 20x + 28$	M1 A1 A1	3	One term correct Another term correct All correct (no + c etc)
(ii)	Their $\dfrac{dy}{dx} = 0$ for stationary point	M1		Or realising condition for stationary pt
	$(x-2)(3x-14) = 0$	m1		Attempt to solve using formula/ factorise
	$\Rightarrow x = 2$	A1		Award M1, A1 for verification that
	or $x = \dfrac{14}{3}$	A1	4	$x = 2 \Rightarrow \dfrac{dy}{dx} = 0$ then may earn m1 later
(b)(i)	$\dfrac{x^4}{4} - \dfrac{10x^3}{3} + 14x^2 \quad (+c)$	M1 A1 A1	3	One term correct unsimplified Another term correct unsimplified All correct unsimplified (condone missing + c)
(ii)	$\left[\dfrac{81}{4} - 90 + 126\right] \quad (-0)$	M1		Attempt to sub limit 3 into their (b)(i)
	$= 56\frac{1}{4}$	A1	2	AG Integration, limit sub'n all correct
(iii)	Area of triangle = $31\frac{1}{2}$	B1		Correct unsimplified $\frac{1}{2} \times 21 \times 3$
	Shaded Area = $56\frac{1}{4} -$ *triangle area*	M1		
	$= 24\frac{3}{4}$	A1	3	Or equivalent such as $\dfrac{99}{4}$
	Total		**15**	

Q	Solution	Marks	Total	Comments
6(a)	$p(3) = 27 - 36 + 9$ $p(3) = 0 \Rightarrow x - 3$ is a factor	M1 A1	2	Finding p(3) and **not** long division Shown = 0 **plus a statement**
(b)	$x(x^2 - 4x + 3)$ or $(x-3)(x^2 - x)$ attempt	M1		Or $p(1) = 0 \Rightarrow x - 1$ is a factor attempt
	$p(x) = x(x-1)(x-3)$	A1	2	Condone $x + 0$ or $x - 0$ as factor
(c)(i)	$p(2) = 8 - 16 + 6$ (Remainder is) -2	M1 A1	2	Must use p(2) and **not** long division
(ii)	Attempt to multiply out and compare	M1		Or long division (2 terms of quotient)
	coefficients $a = -2$	A1		$x^2 - 2x\ldots$
	$b = -1$	A1		-1
	$r = -2$	A1	4	Withhold final A1 for long division unless written as $(x-2)(x^2 - 2x - 1) - 2$
	SC B1 for r = –2 if M0 scored			
	Total		**10**	
7(a)(i)	$(x-2)^2$ centre has x-coordinate = 2 and y-coordinate = 0	M1 A1 B1	3	Attempt to complete square for x M1 implied if value correct or –2 Centre (2,0)
(ii)	RHS $= 18$ Radius = $\sqrt{18}$ Radius = $3\sqrt{2}$	B1 M1 A1	3	Withhold if circle equation RHS incorrect Square root of RHS of equation (if > 0)
(b)	Perpendicular bisects chord so need to use Length of 4	B1		
	$d^2 = (\text{radius})^2 - 4^2$ $d^2 = 18 - 16$	M1		
	so perpendicular distance = $\sqrt{2}$	A1	3	
(c)(i)	$x^2 + (2k - x)^2 - 4x - 14 = 0$ $(2k - x)^2 = 4k^2 - 4kx + x^2$ $\Rightarrow 2x^2 + 4k^2 - 4kx - 4x - 14 = 0$ $(\Rightarrow x^2 + 2k^2 - 2kx - 2x - 7 = 0)$ $\Rightarrow x^2 - 2(k+1)x + 2k^2 - 7 = 0$	M1 B1 A1	3	AG (be convinced about algebra and = 0)
(ii)	$4(k+1)^2 - 4(2k^2 - 7)$	M1		"$b^2 - 4ac$" in terms of k (either term correct)
	$4k^2 - 8k - 32 = 0$ or $k^2 - 2k - 8 = 0$	A1		$b^2 - 4ac = 0$ correct quadratic equation in k
	$(k-4)(k+2) = 0$	m1		Attempt to factorise, solve equation
	$k = -2$, $k = 4$	A1	4	SC B1, B1 for –2 , 4 (if M0 scored)
(iii)	Line is a tangent to the circle	E1	1	Line touches circle at one point etc
	Total		**17**	
	TOTAL		**75**	