AQA Maths Pure Core 1

Mark Scheme Pack

2006-2014

Version 1.0: 0106

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6360

MPC1 Pure Core 1

Mark Scheme

2006 examination - January series

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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

$\surd$ 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
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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.

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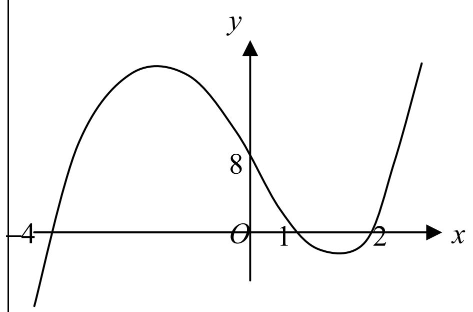
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

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

MPC1

Q	Solution	Marks	Total	Comments
1(a)	$\left(\sqrt{5}\right)^2+2\sqrt{5}-2\sqrt{5}-4=1$	M1 A1	 2	Multiplying out or difference of two squares attempted Full marks for correct answer /no working
(b)	$\sqrt{8}=2\sqrt{2}$; $\sqrt{18}=3\sqrt{2}$ Answer $=5\sqrt{2}$	M1 A1	 2	Either correct Full marks for correct answer /no working
	Total		**4**	
2(a)(i)	$15+4k=7 \quad \Rightarrow 4k=-8 \quad \Rightarrow k=-2$	B1	1	**AG** (condone verification or $y=-2$)
(ii)	$\frac{1}{2}(x_1+x_2)$ or $\frac{1}{2}(y_1+y_2)$ Midpoint coordinates $\left(3,-\frac{1}{2}\right)$	M1 A1	 2	 One coordinate correct implies M1
(b)	Attempt at $\Delta y/\Delta x$ or $y=-\frac{3}{4}x+\frac{7}{4}$ Gradient $AB=-\frac{3}{4}$	M1 A1	 2	(Not *x* over *y*)(may use *M* instead of *A*/*B*) –0.75 etc any correct equivalent
(c)(i)	$m_1m_2=-1$ used or stated Hence gradient $AC=\frac{4}{3}$	1 A1√	 2	 Follow through their gradient of *AB* from part (b)
(ii)	$y-1=\frac{4}{3}(x-1)$ or $3y=4x-1$ etc	B1√	1	Follow through their gradient of *AC* from part (c) (i) must be **normal** & (1,1) used
(iii)	$y=0 \qquad \Rightarrow x-1=-\frac{3}{4}$ $x=\frac{1}{4}$	M1 A1	 2	Putting $y=0$ in their *AC* equation and attempting to find *x* **CSO**. *C* has coordinates $\left(\frac{1}{4},0\right)$
	Total		**10**	
3(a)(i)	$(x-2)^2$ $+5$	B1 B1	 2	$p=2$ $q=5$
(ii)	Minimum point (2, 5) or $x=2,\ y=5$	B2√	2	B1 for each coordinate correct or ft **Alt method** M1, A1 sketch, differentiation
(b)(i)	$12-2x=x^2-4x+9$ $\Rightarrow x^2-2x-3=0$	 B1	 1	Or $x^2-4x+9+2x=12$ **AG** (be convinced) (must have = 0)
(ii)	$(x-3)(x+1)=0$ $x=3,\quad -1$ Substitute one value of *x* to find *y* Points are (3, 6) and (–1, 14)	M1 A1 M1 A1	 4	Attempt at factors or quadratic formula or one value spotted Both values correct & simplified May substitute into equation for *L* or *C* *y*-coordinates correct linked to *x* values
	Total		**9**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
4(a)	$(m+4)^2 = m^2 + 8m + 16$	B1		Condone $4m + 4m$
	$b^2 - 4ac = (m+4)^2 - 4(4m+1) = 0$ $m^2 + 8m + 16 - 16m - 4 = 0$	M1		$b^2 - 4ac$ (attempted and involving m's and no x's) or $b^2 - 4ac = 0$ stated
	$\Rightarrow m^2 - 8m + 12 = 0$	A1	3	**AG** (be convinced – all working correct- $= 0$ appearing more than right at the end)
(b)	$(m-2)(m-6) = 0$	M1		Attempt at factors or quadratic formula
	$m = 2$, $m = 6$	A1	2	**SC B1** for 2 or 6 only without working
	Total		**5**	
5(a)	$(x-4)^2 + (y+3)^2$	B2		B1 for one term correct
	$(11 + 16 + 9 = 36)$ RHS $= 6^2$	B1	3	Condone 36
(b)(i)	Centre $(4, -3)$	B1√	1	Ft their a and b from part (a)
(ii)	Radius = 6	B1√	1	Ft their r from part (a)
(c)(i)	$CO^2 = (-4)^2 + 3^2$	M1		Accept + or – with numbers but must add
	$CO = 5$	A1√	2	Full marks for answer only
(ii)	Considering CO and radius	M1		
	$CO < r \Rightarrow O$ is **inside** the circle	A1√	2	Ft outside circle when 'their CO' $> r$ or on the circle when 'their CO' $= r$ **SC** B1√ *if no explanation given*
	Total		**9**	
6(a)(i)	$\text{p}(2) = 8 + 4 - 20 + 8$	M1		Finding p(2) M0 *long division*
	$= 0$, $\Rightarrow x - 2$ is a factor	A1	2	Shown = 0 **AND** conclusion/ statement about $x - 2$ being a factor
(ii)	Attempt at quadratic factor	M1		or factor theorem again for 2nd factor
	$x^2 + 3x - 4$	A1		or $(x+4)$ or $(x-1)$ proved to be a factor
	$\text{p}(x) = (x-2)(x+4)(x-1)$	A1	3	
(b)		B1		Graph through (0,8) 8 marked
		B1√		Ft "their factors" 3 roots marked on x-axis
		M1		Cubic curve through their 3 points
		A1	4	Correct including x- intercepts correct Condone max on y-axis etc or slightly wrong concavity at ends of graph
	Total		**9**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)	$\frac{dV}{dt} = 2t^5 - 8t^3 + 6t$	M1 A1 A1	 3	One term correct unsimplified Further term correct unsimplified All correct unsimplified (no + c etc)
(ii)	$\frac{d^2V}{dt^2} = 10t^4 - 24t^2 + 6$	M1 A1	 2	One term FT correct unsimplified **CSO**. All correct simplified
(b)	Substitute $t = 2$ into their $\frac{dV}{dt}$ (= 64 – 64 + 12) = 12	M1 A1	 2	 **CSO**. Rate of change of volume is $12\text{m}^3\ \text{s}^{-1}$
(c)(i)	$t = 1 \Rightarrow \frac{dV}{dt} = 2 - 8 + 6$ = 0 ⇒ Stationary value	M1 A1	 2	Or putting their $\frac{dV}{dt} = 0$ **CSO**. Shown to = 0 **AND** statement (If solving equation must obtain $t = 1$)
(ii)	$t = 1 \Rightarrow \frac{d^2V}{dt^2} = -8$ Maximum value	M1 A1√	 2	Sub $t = 1$ into their second derivative or equivalent full test. Ft if their test implies minimum
	Total		**11**	
8(a)	$y_D = 3 + 1 = 4$ or $y_C = 12 - 8 = 4$ Area $ABCD$ $= 3 \times 4 = 12$	M1 A1	 2	Attempt at either y coordinate
(b)(i)	$x^3 - \frac{x^4}{4}$ $(+C)$	M1 A1 A1	 3	Increase one power by 1 One term correct unsimplified All correct unsimplified (condone no +C)
(ii)	Sub limits –1 and 2 into their (b) (i) ans $[8-4] - \left[-1 - \frac{1}{4}\right] = 5\frac{1}{4}$ Shaded area = "their" (rectangle– integral) $= 12 - 5\frac{1}{4} = 6\frac{3}{4}$	M1 A1 M1 A1	 4	May use both –1, 0 and 0, 2 instead Alt method: difference of two integrals **CSO**. Attempted M2, A2
(c)(i)	$\frac{dy}{dx} = 6x - 3x^2$	M1 A1	 2	One term correct All correct (no +C etc)
(ii)	When $x = 1$, $y = 2$ when $x = 1$, $\frac{dy}{dx} = 3$ as 'their' grad of tgt Tangent is $y - 2 = 3(x - 1)$	B1 M1√ A1	 3	May be implied by correct tgt equation Ft their derivative when $x = 1$ Any correct form $y = 3x - 1$ etc
(iii)	Decreasing when $\frac{dy}{dx} = 6x - 3x^2 < 0$ $3(2x - x^2) < 0 \Rightarrow x^2 - 2x > 0$	M1 A1	 2	Watch no fudging here!! May work backwards in proof. **AG** (be convinced no step incorrect)
(d)	Two critical points 0 and 2 $x > 2$, $x < 0$ ONLY	M1 A1	 2	Marked on diagram or in solution or M1 A0 for $0 < x < 2$ or $0 > x > 2$ **SC** B1 for $x > 2$ (or $x < 0$)
	Total		**18**	
	TOTAL		**75**	

Version 1.0: 0706

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MPC1

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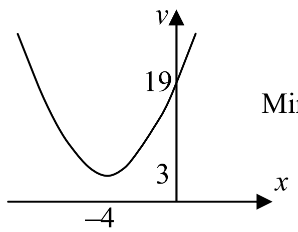
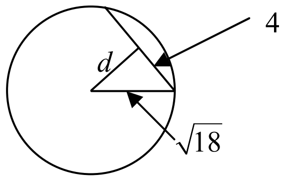
1(a)(i)	Gradient $AB = \dfrac{1-7}{5-1}$	M1		Must be y on top and subtr'n of cords
	$= -\dfrac{6}{4} = -\dfrac{3}{2} = -1.5$	A1	2	Any correct equivalent
(ii)	$y-7=m(x-1)$ or $y-1=m(x-5)$	M1		Verifying 2 points or $y=-\dfrac{3}{2}x+c$
	leading to $3x+2y=17$	A1	2	AG (or grad & 1 point verified)
(b)	Attempt to eliminate x or y : $7x = 42$ etc	M1		Solving $x-4y=8;\quad 3x+2y=17$
	$x=6$	A1		
	$y=-\dfrac{1}{2}$	A1	3	C is point $(6, -\dfrac{1}{2})$
(c)	Grad of perp = – 1 / *their* gradient AB	M1		Or $m_1m_2=-1$ used or stated
	$=\dfrac{2}{3}$	A1√		ft their gradient AB
	$y-7=\dfrac{2}{3}(x-1)$ 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)	$\dfrac{dy}{dx}=-10x^4$	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 $x=-2$ $\quad\dfrac{dy}{dx}=-160$ (or < 0)	B1√		Value of their $\dfrac{dy}{dx}$ when $x = -2$
	($\dfrac{dy}{dx}<0$ hence) y is **decreasing**	E1√	2	ft Increasing if their $\dfrac{dy}{dx}>0$
	Total		**7**	

MPC1 (cont)

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**	

MPC1 (cont)

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 $p(x) = x(x-1)(x-3)$	M1 A1	 2	Or $p(1) = 0 \Rightarrow x - 1$ is a factor attempt 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 coefficients $a = -2$ $b = -1$ $r = -2$ **SC** B1 for $r = -2$ if M0 scored	M1 A1 A1 A1	 4	Or long division (2 terms of quotient) $x^2 - 2x...$ -1 Withhold final A1 for long division unless written as $(x-2)(x^2 - 2x - 1) - 2$
	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 $d^2 = (\text{radius})^2 - 4^2$ $d^2 = 18 - 16$ so perpendicular distance = $\sqrt{2}$	B1 M1 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)	$4(k+1)^2 - 4(2k^2 - 7)$ $4k^2 - 8k - 32 = 0$ or $k^2 - 2k - 8 = 0$ $(k-4)(k+2) = 0$ $k = -2$, $k = 4$	M1 A1 m1 A1	 4	"$b^2 - 4ac$" in terms of k (either term correct) $b^2 - 4ac = 0$ correct quadratic equation in k Attempt to factorise, solve equation 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**	
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Version 1.0 0107

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Registered address: AQA, Devas Street, Manchester M15 6EX *Dr Michael Cresswell Director General*

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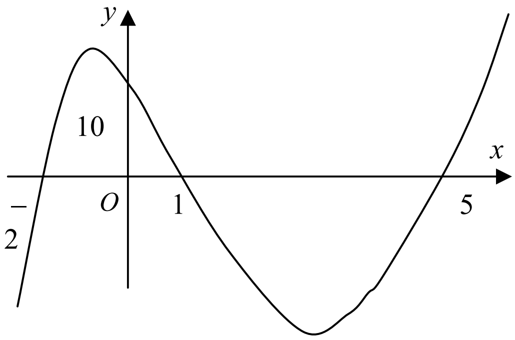
1(a)(i)	p(–2) = –8 –16 +14 + k	M1		or long division or $(x+2)(x^2-6x+5)$
	p(–2) = 0 $\Rightarrow -10+k=0 \quad \Rightarrow k=10$	A1	2	**AG** likely withhold if p(–2) = 0 not seen
	Must have statement if k=10 substitute			
(ii)	$p(x)=(x+2)(x^2+.... \quad 5)$	M1		Attempt at quadratic or second linear
	$p(x)=(x+2)(x^2-6x+5)$	A1		factor $(x-1)$ or $(x-5)$ from factor theorem
	$\Rightarrow p(x)=(x+2)(x-1)(x-5)$	A1	3	Must be written as product
(b)	p(3) = 27 –36 –21 + k	M1		long division scores M0
	(Remainder) = $k-30$ = –20	A1	2	Condone $k-30$
(c)		B1		Curve thro' 10 marked on y-axis
		B1√		**FT** their 3 roots marked on x-axis
		M1		Cubic shape with a max and min
		A1	4	Correct graph (roughly as on left) going beyond –2 and 5 (condone max anywhere between x = –2 and 1 and min between 1 and 5)
	Total		**11**	
2(a)(i)	$y=-\frac{3}{5}x+...$; Gradient AB = $-\frac{3}{5}$	M1		**Attempt** to find $y =$ or $\Delta y/\Delta x$ or $\frac{3}{5}$ or $3x/5$
		A1	2	Gradient correct – condone slip in y = ...
(ii)	$m_1m_2=-1$	M1		Stated or used correctly
	Gradient of perpendicular = $\frac{5}{3}$	A1√		**ft** gradient of AB
	$\Rightarrow y+2=\frac{5}{3}(x-6)$	A1	3	**CSO** Any correct form eg $y=\frac{5}{3}x-12$, $5x-3y=36$ etc
(b)	Eliminating x or y (unsimplified)	M1		Must use $3x+5y=8;\ 2x+3y=3$
	$x=-9$	A1		
	$y=7$	A1	3	B (–9,7)
(c)	$4^2+(k+2)^2 \quad (=25)$ or $16+d^2=25$	M1		Diagram with 3,4, 5 triangle
	k = 1	A1		Condone slip in one term (or $k+2=3$)
	or $k=-5$	A1	3	**SC1** with no working for spotting one correct value of k. Full marks if both values spotted with no contradictory work
	Total		**11**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
3(a)	$\frac{\sqrt{5}+3}{\sqrt{5}-2} \times \frac{\sqrt{5}+2}{\sqrt{5}+2}$	M1		Multiplying top & bottom by $\pm\left(\sqrt{5}+2\right)$
	Numerator $= 5+3\sqrt{5}+2\sqrt{5}+6$	M1		Multiplying out (condone one slip) $\pm\left(\sqrt{5}+3\right)\left(\sqrt{5}+2\right)$
	$= 5\sqrt{5}+11$	A1		
	Final answer $= 5\sqrt{5}+11$	A1	4	With clear evidence that denominator =1
(b)(i)	$\sqrt{45} = 3\sqrt{5}$	B1	1	
(ii)	$\sqrt{20} = \sqrt{4}\sqrt{5}$ or $4\sqrt{5} = \sqrt{4} \times \sqrt{20}$ or attempt to have equation with $\sqrt{5}$ or $\sqrt{20}$ only	M1		Both sides
	$\left[x\, 2\sqrt{5} = 7\sqrt{5} - 3\sqrt{5}\right]$ **or** $x\sqrt{20} = 2\sqrt{20}$	A1		or $x = \sqrt{4}$
	$x = 2$	A1	3	**CSO**
	Total		**8**	
4(a)	$(x+1)^2 + (y-6)^2$	B2		B1 for one term correct or missing + sign
	$(1 + 36 - 12 = 25)$ RHS $= 5^2$	B1	3	Condone 25
(b)(i)	Centre $(-1, 6)$	B1√	1	**FT** their a and b from part (a) or correct
(ii)	Radius = 5	B1√	1	**FT** their r from part (a) RHS must be > 0
(c)	Attempt to solve "their" $x^2 + 2x + 12 = 0$	M1		Or comparing "their" $y_c = 6$ and their $r = 5$ may use a diagram with values shown
	(all working correct) so no real roots or statement that does not intersect	A1	2	$r < y_c$ so does not intersect; condone ± 1 or ± 6 in centre for A1
(d)(i)	$(4-x)^2 = 16 - 8x + x^2$	B1		Or $(-2-x)^2 = 4 + 4x + x^2$
	$x^2 + (4-x)^2 + 2x - 12(4-x) + 12 = 0$ or $(x+1)^2 + (-2-x)^2 = 25$	M1		Sub $y = 4 - x$ in circle eqn (condone slip) or "their" circle equation
	$\Rightarrow 2x^2 + 6x - 20 = 0 \quad \Rightarrow x^2 + 3x - 10 = 0$	A1	3	**AG CSO** (must have = 0)
(ii)	$(x+5)(x-2) = 0 \quad \Rightarrow x = -5, x = 2$	M1		Correct factors or unsimplified solution to quadratic (give credit if factorised in part (i))
	Q has coordinates $(-5, 9)$	A1	2	SC2 if Q correct. Allow x = –5 $y = 9$
(iii)	Mid point of 'their' $(-5, 9)$ and $(2,2)$	M1		Arithmetic mean of **either** x or y coords
	$\left(-1\frac{1}{2}, 5\frac{1}{2}\right)$	A1	2	Must follow from correct value in (ii)
	Total		**14**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
5(a)(i)	$2x^2+2xh+4xh \quad (=54)$	M1		Attempt at surface area (one slip)
	$\Rightarrow x^2+3xh=27$	A1	2	**AG CSO**
(ii)	$h=\dfrac{27-x^2}{3x}$ or $h=\dfrac{9}{x}-\dfrac{x}{3}$ etc	B1	1	Any correct form
(iii)	$V=2x^2h \quad = 18x-\dfrac{2x^3}{3}$	B1	1	**AG** (watch fudging) condone omission of brackets
(b)(i)	$\dfrac{dV}{dx}=18-2x^2$	M1		One term correct "their" V
		A1	2	All correct unsimplified $18-6x^2/3$
(ii)	Sub $x = 3$ into their $\dfrac{dV}{dx}$	M1		Or attempt to solve their $\dfrac{dV}{dx}=0$
	Shown to equal 0 plus **statement** that this implies a stationary point if verifying	A1	2	**CSO** Condone $x=\pm 3$ or $x = 3$ if solving
(c)	$\dfrac{d^2V}{dx^2}=-4x$ $\quad (=-12)$	B1√		**FT** their $\dfrac{dV}{dx}$
	$\dfrac{d^2V}{dx^2}<0$ at stationary point $\Rightarrow$ maximum	E1√	2	**FT** their second derivative conclusion If "their" $\dfrac{d^2y}{dx^2}>0 \Rightarrow$ minimum etc
	Total		**10**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$B\ (0,5)$	B1		
	Area $AOB = \frac{1}{2}\times 1\times 5$	M1		Condone slip in number or a minus sign
	$= 2\frac{1}{2}$	A1	3	
(ii)	$\frac{3x^6}{6}+\frac{2x^2}{2}+5x$ or $\frac{x^6}{2}+x^2+5x$	M1 A1		Raise one power by 1 One term correct
	(may have + c or not)	A1	3	All correct unsimplified
(iii)	Area under curve = $\int_{-1}^{0} \mathrm{f}(x)\,\mathrm{d}x$	B1		Correctly written or $\mathrm{F}(0)-\mathrm{F}(-1)$ correct
	$[0]-\left[\frac{1}{2}+1-5\right]$	M1		Attempt to sub limit(s) of -1 (and 0) Must have integrated
	Area under curve = $3\frac{1}{2}$	A1		**CSO** (no fudging)
	Area of shaded region = $3\frac{1}{2}-2\frac{1}{2}=1$	B1$\surd$	4	**FT** their integral and triangle (very generous)
(b)(i)	$\frac{\mathrm{d}y}{\mathrm{d}x}=15x^4+2$	M1 A1		One term correct All correct (no +c etc)
	when $x=-1$, gradient = 17	A1	3	**cso**
(ii)	$y=\text{"their gradient"}(x+1)$	B1$\surd$	1	Must be finding **tangent** – not normal any form e.g. $y=17x+17$
	Total		**14**	
7(a)	$b^2-4ac = 144-4(k+1)(k-4)$	M1		Clear attempt at b^2-4ac Condone slip in one term of expression
	Real roots when $b^2-4ac \geqslant 0$	B1		Not just a statement, must involve k
	$36-(k^2-3k-4)\geqslant 0$			
	$\Rightarrow k^2-3k-40\leqslant 0$	A1	3	**AG** (watch signs carefully)
(b)	$(k-8)(k+5)$	M1		Factors attempt or formula
	Critical points 8 and –5	A1		
	Sketch or sign diagram **correct,** must have 8 and –5	M1		**+ve** | **- ve** | **+ve** –5 8
	$-5\leqslant k\leqslant 8$	A1	4	
	A0 for $-5 < k < 8$ or two separate inequalities unless word AND used			
	Total		**7**	
	TOTAL		**75**	

Version 1.0: 0607

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6360

MPC1 Pure Core 1

Mark Scheme

2007 examination - June series

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Set and published by the Assessment and Qualifications Alliance.

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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.

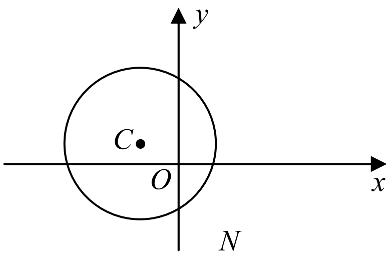
MPC1

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)	$\left.\begin{matrix} y-5 \\ y+1 \end{matrix}\right\} = -\dfrac{3}{2}\left\{\begin{matrix} (x-2) \\ (x-6) \end{matrix}\right.$	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**	

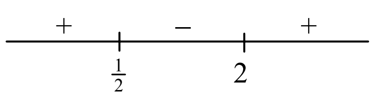
MPC1 (cont)

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		either component correct
		A1	3	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		both x values correct
		A1	4	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		one term correct
		A1		another term correct
		A1	3	all correct (no + c etc)
(ii)	$3t^2-52$	M1		ft one term correct
		A1√	2	ft all "correct"
(b)	$\frac{\mathrm{d}y}{\mathrm{d}t} = 8-104+96$	M1		substitute $t=2$ into their $\frac{\mathrm{d}y}{\mathrm{d}t}$
	$= 0 \Rightarrow$ stationary value	A1		CSO; shown = 0 + statement
	Substitute $t=2$ into $\frac{\mathrm{d}^2y}{\mathrm{d}t^2}$ $(=-40)$	M1		any appropriate test, e.g. $y'(1)$ and $y'(3)$
	$\frac{\mathrm{d}^2y}{\mathrm{d}t^2} < 0 \Rightarrow$ max value	A1	4	all values (if stated) must be correct
(c)	Substitute $t=1$ into their $\frac{\mathrm{d}y}{\mathrm{d}t}$	M1		must be their $\frac{\mathrm{d}y}{\mathrm{d}t}$ NOT $\frac{\mathrm{d}^2y}{\mathrm{d}t^2}$
	Rate of change = 45 $(\mathrm{cm\,s^{-1}})$	A1√	2	ft their $y'(1)$
(d)	Substitute $t=3$ into their $\frac{\mathrm{d}y}{\mathrm{d}t}$	M1		interpreting their value of $\frac{\mathrm{d}y}{\mathrm{d}t}$
	$(27-156+96=-33<0)$			
	$\Rightarrow$ decreasing when $t=3$	E1√	2	allow increasing if their $\frac{\mathrm{d}y}{\mathrm{d}t} > 0$
	Total		**13**	

MPC1 (cont)

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 $CN = -\dfrac{4}{3}$	A1		CSO
	$y = -\dfrac{4}{3}x - 2$ (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**	

MPC1 (cont)

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

Version 1.0: 01.08

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6360

MPC1 Pure Core 1

Mark Scheme

2008 examination - January series

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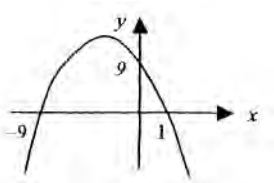
Otherwise we require evidence of a correct method for any marks to be awarded.

MPC1

Q	Solution	Marks	Total	Comments
1(a)	Mid-point of BC = (3, –2)	B1 B1	 2	Either coordinate correct Both cords correct. Accept x = 3, y = –2
(b)(i)	$\frac{\Delta y}{\Delta x}=\frac{3-1}{-2-4}$ $=-\frac{1}{3}$	M1 A1	 2	$\pm\frac{2}{6}$ OE implies M1
(ii)	y – 3 = "their grad"(x + 2) or y – 1 = "their grad"(x – 4) Hence $x + 3y = 7$	M1 A1	 2	Or $y = mx + c$ and correct attempt to find c
(iii)	y + 5 = "their grad AB"(x – 2) $y+5=-\frac{1}{3}(x-2)$ or $x + 3y + 13 = 0$	M1 A1	 2	Or "their $x + qy = c$" and attempt to find c OE
(c)	Grad BC = 3 (from $\frac{\Delta y}{\Delta x}=\frac{1+5}{4-2}$ OE) $m_1m_2=-1$ stated **or** grad BC = 3 and grad AB = $-\frac{1}{3}$ **or** grad BC × grad AB ($=3\times-\frac{1}{3}$) Product of gradients = –1 Hence AB and BC are perpendicular	B1 M1 A1 CSO	 3	Or 2 lengths correct: $AB=\sqrt{40}; BC=\sqrt{40}; AC=\sqrt{80}$ Or attempt at Pythagoras or Cosine Rule $AC^2=AB^2+BC^2 \Rightarrow \angle ABC=90°$ Completing proof and statement
	Total		**11**	
2(a)	$\frac{dy}{dx}=4x^3-32$	M1 A1 A1	 3	Reduce one power by 1 One term correct All correct (no + c etc)
(b)	Stationary point $\Rightarrow \frac{dy}{dx}=0$ $\Rightarrow x^3=8$ $\Rightarrow x=2$	M1 A1√ A1	 3	 $x^n=k$ following from their $\frac{dy}{dx}$ CSO
(c)(i)	$\frac{d^2y}{dx^2}=12x^2$	B1√	1	FT their $\frac{dy}{dx}$
(ii)	When x = 2, $\frac{d^2y}{dx^2}$ considered $\Rightarrow$ minimum point	M1 E1√	 2	Or complete test with $2\pm\varepsilon$ using $\frac{dy}{dx}$
(d)	Putting x = 0 into their $\frac{dy}{dx}$ (= –32) $\frac{dy}{dx}<0\Rightarrow$ decreasing	M1 A1√	 2	 Allow "increasing" if their $\frac{dy}{dx}$ > 0
	Total		**11**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
3(a)	$5\sqrt{8} = 10\sqrt{2}$	B1		Or $\frac{5\sqrt{16}+6}{\sqrt{2}}$ gets B1
	$\frac{6}{\sqrt{2}} = \frac{6\sqrt{2}}{2}$ $(=3\sqrt{2})$	M1		then M1 for rationalising; and A1 answer
	Answer = $13\sqrt{2}$	A1	3	$n = 13$
(b)	$\frac{\sqrt{2}+2}{3\sqrt{2}-4} \times \frac{3\sqrt{2}+4}{3\sqrt{2}+4}$	M1		Multiplying top & bottom by $\pm\left(3\sqrt{2}+4\right)$
	Numerator = $6+6\sqrt{2}+4\sqrt{2}+8$	m1		Multiplying out (condone one slip)
	Denominator = 18 – 16 (= 2)	B1		
	Final answer = $5\sqrt{2}+7$	A1	4	
	Total		**7**	
4(a)	$x^2 + (y-5)^2$	B1		$b = 5$
	RHS = 5	B1	2	$k = 5$
(b)(i)	Centre (0, 5)	B1$\sqrt{}$	1	FT their b from part (a)
(ii)	Radius = $\sqrt{5}$	B1$\sqrt{}$	1	FT their k from part (a); RHS must be > 0
(c)(i)	$x^2 + 4x^2 - 20x + 20 = 0$	M1		May substitute into original or "their (a)"
	$\Rightarrow x^2 - 4x + 4 = 0$	A1	2	CSO; AG
(ii)	$(x-2)^2 = 0$ or $x = 2$	M1		
	Repeated root implies tangent	E1		Or $b^2 - 4ac$ shown = 0 plus statement
	Point of contact is $P(2, 4)$	A1	3	
(d)	$\left(CQ^2 =\right) 1^2 + 1^2$	M1		FT their C
	$\sqrt{2} < \sqrt{5} \Rightarrow Q$ lies inside circle	A1 CSO	2	CQ or CQ^2 OE must appear for A1
	Total		**11**	
5(a)	$(9 + x)(1 - x)$	M1		$\pm(9 \pm x)(1 \pm x)$
		A1	2	Correct factors
(b)	$25 - \left(x^2 + 8x + 16\right) = 9 - 8x - x^2$	B1	1	AG
(c)(i)	$x = -4$ is line of symmetry	B1	1	
(ii)	Vertex is (–4, 25)	B1,B1	2	
(iii)		M1 B1 A1	3	General $\cap$ shape –9 and 1 marked on x-axis or stated 9 marked on y-axis and maximum to the left of y-axis Must continue below x-axis at both ends
	Total		**9**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	p(–1) = – 1 + 7 – 6	M1		Finding p(–1)
	= 0 therefore x + 1 is a factor	A1	2	Shown to = 0 **plus statement**
(ii)	$\text{p}(x) = (x+1)(x^2 - x - 6)$	M1		Long division/inspection (2 terms correct)
		A1		Quadratic factor correct
	$\text{p}(x) = (x+1)(x+2)(x-3)$	A1	3	May earn M1,A1 for correct second factor then A1 for $(x+1)(x+2)(x-3)$
(b)(i)	$A(-2, 0)$	B1	1	Condone x = –2
(ii)	$\frac{x^4}{4} - \frac{7x^2}{2} - 6x \quad (+c)$	M1		One term correct
		A1		Another term correct
	(may have + c or not)	A1		All correct unsimplified
	$\left[\frac{81}{4} - \frac{63}{2} - 18\right] - \left[\frac{1}{4} - \frac{7}{2} + 6\right]$	m1		F(3) – F(–1) attempted in correct order
	= – 32	A1	5	CSO; OE
(iii)	Area of shaded region = 32	B1√	1	FT their (b)(ii) but positive value needed
(iv)	$\frac{\text{d}y}{\text{d}x} = 3x^2 - 7$	M1		One term correct
		A1		All correct (no + c etc)
	When x = –1, gradient = – 4	A1	3	CSO
(v)	Gradient of normal = $\frac{1}{4}$	B1√		
	y = "their gradient" (x ± 1)	M1		Must be finding **normal**, not tangent
	$y = \frac{1}{4}(x+1)$	A1	3	CSO; any correct form eg 4y – x = 1
	Total		**18**	
7(a)	$x^2 + 7 = k(3x+1) \Rightarrow x^2 - 3kx + 7 - k = 0$	B1	1	AG
(b)	$b^2 - 4ac = (-3k)^2 - 4(7-k)$	M1		Clear attempt at $b^2 - 4ac$ Condone slip in one term of expression
	(2 distinct roots when) $b^2 - 4ac > 0$	B1		Must involve k
	$9k^2 + 4k - 28 > 0$	A1	3	CSO; AG
(c)	$(9k-14)(k+2)$	M1		Factors or formula correct unsimplified
	Critical points –2 and $\frac{14}{9}$	A1		
	Sketch ∪ or sign diagram correct	M1		sign diagram: **+ve** | **–ve** | **+ve**, boundaries –2 and $\frac{14}{9}$
	$k < -2,\ k > \frac{14}{9}$	A1	4	
	Total		**8**	
	TOTAL		**75**	

Version 1.0: 06.08

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6360

MPC1 Pure Core 1

Mark Scheme

2008 examination - June series

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Set and published by the Assessment and Qualifications Alliance.

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Registered address: AQA, Devas Street, Manchester M15 6EX *Dr Michael Cresswell Director General*

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)

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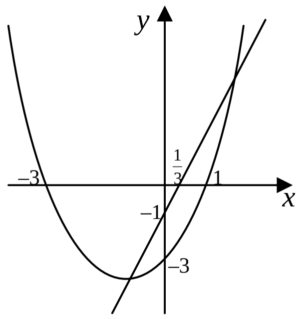
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

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

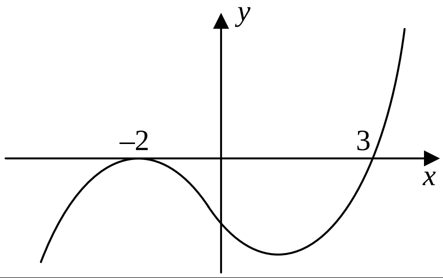
MPC1

Q	Solution	Marks	Total	Comments
1(a)	L: straight line with positive gradient and negative intercept on y-axis cutting at $\left(\frac{1}{3},0\right)$ and $(0,-1)$ (intercepts **stated** or marked on sketch)	B1 B1		Line must cross both axes but need not reach the curve Condone 0.33 or better for $\frac{1}{3}$
	C: **attempt at parabola** $\cup$ or $\cap$ through $(-3,0)$ and $(1,0)$ or values –3 and 1 stated as intercepts on x-axis	B1		
	$\cup$ shaped graph – vertex below x-axis and cutting x-axis twice	M1		
	through $(0,-3)$ and minimum point to left of y-axis	A1	5	(y-intercept or coordinates marked)
(b)	$(x+3)(x-1)=3x-1$ $x^2+3x-x-3-3x+1=0$ $\Rightarrow x^2-x-2=0$	M1 A1	 2	 AG; must have "= 0" and no errors
(c)	$(x-2)(x+1)=0$ $\Rightarrow x=2,\ -1$	M1 A1		$(x\pm1)(x\pm2)$ or use of formula (one slip) correct values imply M1A1
	Substitute one value of x to find y	m1		
	Points of intersection (2, 5) and (–1,–4)	A1	4	May say $x=2, y=5$ etc SC: (2, 5) $\Rightarrow$ B2 $(-1,-4)\Rightarrow$ B2 without working
	Total		**11**	
2(a)	$xy=6$	B1	1	B0 for $\sqrt{36}$ or ± 6
(b)	$\frac{y}{x}=\frac{2\sqrt{3}}{\sqrt{3}}$ or $\sqrt{\frac{12}{3}}$ or $\sqrt{\frac{4}{1}}$ or $\frac{\sqrt{12}}{\sqrt{3}}\times\frac{\sqrt{3}}{\sqrt{3}}$ = 2	M1 A1	 2	Allow M1 for ± 2
(c)	$x^2+2xy+y^2$ or $(\sqrt{3}+2\sqrt{3})^2$ correct	M1		or $\left(\sqrt{3}+\sqrt{12}\right)\left(\sqrt{3}+\sqrt{12}\right)$ expanded as 4 terms – no more than one slip
	Correct with 2 of $x^2, y^2, 2xy$ simplified $3+2\sqrt{36}+12$ or $3^2\times 3$ or $\left(3\sqrt{3}\right)^2$	A1		Correct but unsimplified – one more step
	= 27	A1	3	
	Total		**6**	

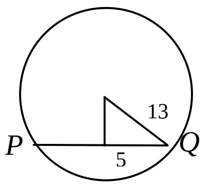
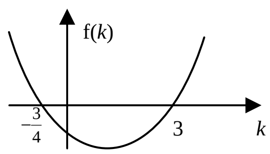
MPC1 (cont)

Q	Solution	Marks	Total	Comments
3(a)	$V = x(9-3x)^2$	M1		Attempt at V in terms of x (condone slip when rearranging formula for $y = 9 - 3x$) or $(9-3x)^2 = 81 - 54x + 9x^2$
	$V = x(81-54x+9x^2)$ $= 81x - 54x^2 + 9x^3$	A1	2	AG; no errors in algebra
(b)(i)	$\frac{dV}{dx} = 81 - 108x + 27x^2$	M1 A1 A1		One term correct Another correct All correct (no + c etc)
	$= 27(x^2 - 4x + 3)$	A1	4	CSO; all algebra and differentiation correct
(ii)	$(x-3)(x-1)$ or $(27x-81)(x-1)$ etc $\Rightarrow x = 1, 3$	M1 A1	2	"Correct" factors or correct use of formula SC: B1,B1 for x = 1, x = 3 found by inspection (provided no other values)
(c)	$\frac{d^2V}{dx^2} = -108 + 54x$ (condone one slip)	M1 A1	2	ft their $\frac{dV}{dx}$ (may have cancelled 27 etc) CSO; all differentiation correct
(d)(i)	$x = 3 \Rightarrow \frac{d^2V}{dx^2} = 54$; $x = 1 \Rightarrow \frac{d^2V}{dx^2} = -54$	B1$\sqrt{}$	1	ft their $\frac{d^2V}{dx^2}$ and their **two** x-values
(ii)	(x =) 1 (gives maximum value)	E1	1	Provided their $\frac{d^2V}{dx^2} < 0$
(iii)	$V_{max} = 36$	B1	1	CAO
	Total		**13**	
4(a)	$\left(x - \frac{3}{2}\right)^2$	B1		Must have $(\ )^2$ $p = 1.5$
	$+\frac{7}{4}$	B1	2	$q = 1.75$
(b)	Minimum value is $\frac{7}{4}$	B1$\sqrt{}$	1	ft their q or correct value
(c)	**Translation** (and **no other** transformation stated)	E1		(**not** shift, move, transformation etc)
	through $\begin{bmatrix} \frac{3}{2} \\ \frac{7}{4} \end{bmatrix}$ (or equivalent in words)	M1 A1	3	M1 for one component correct or ft their p or q values CSO; condone 1.5 right and 1.75 up etc
	Total		**6**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
5(a)	Grad $AC = \frac{15}{3} = 5$	B1		OE
	Equation of AC: $y = m(x+2)$ or $(y-15) = m(x-1)$	M1		Or use of $y = mx + c$ with (–2, 0) or (1, 15) correctly substituted for x and y
	$y = 5x + 10$	A1	3	OE eg $y - 15 = 5(x-1)$, $y = 5(x+2)$
(b)(i)	$\left[16x - \frac{x^5}{5}\right]$	M1 A1 A1		Raise one power by 1 One term correct All correct
	$\left(16 - \frac{1}{5}\right) - \left(-32 + \frac{32}{5}\right)$	m1		$\mathrm{F}(1) - \mathrm{F}(-2)$ attempted
	$= 41\frac{2}{5}$ (or 41.4 , $\frac{207}{5}$ etc)	A1	5	CSO; withhold if + c added
(ii)	Area $\Delta = \frac{1}{2} \times 3 \times 15$ or $22\frac{1}{2}$ or 22.5	B1		Or $\int_{-2}^{1} (5x+10)\,\mathrm{d}x = 22.5$
	Shaded area = "their (b)(i) answer" – correct triangle	M1		Condone "difference" if $\Delta > \int$
	$\Rightarrow$ shaded area $= 18\frac{9}{10}$	A1	3	CSO; OE (18.9 etc)
	Total		**11**	
6(a)	Remainder $= \mathrm{p}(1) = 1 + 1 - 8 - 12$ $= -18$	M1 A1	2	Use of p(1) NOT long division
(b)(i)	$\mathrm{p}(-2) = -8 + 4 + 16 - 12$ $= 0 \Rightarrow (x+2)$ is factor	M1 A1	2	NOT long division $\mathrm{p}(-2)$ shown $= 0$ **and** statement
(ii)	Quad factor by comparing coefficients or $\left(x^2 + kx \pm 6\right)$ by inspection	M1		Or full long division or attempt at Factor Theorem using $\mathrm{f}(\pm 3)$
	$\mathrm{p}(x) = (x+2)(x^2 - x - 6)$	A1		Correct quadratic factor or $(x-3)$ shown to be factor by Factor Theorem
	$\mathrm{p}(x) = (x+2)^2(x-3)$ or $(x+2)(x+2)(x-3)$	A1	3	CSO; SC: B1 for $(x+2)(x{*}{*}{*})(x-3)$ by inspection or without working
(c)(i)	$(k =)\ -12$	B1	1	Condone $y = -12$ or (0, –12)
(ii)		M1 A1 A1	 3	Cubic shape (one max and one min) Maximum at $(-2, 0)$ and through (3, 0) – at least one of these values marked "correct" graph as shown (touching smoothly at –2, 3 marked and minimum to right of y-axis)
	Total		**11**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$(x-8)^2+(y-13)^2$	B1		**Exactly this** with + and squares
	$=13^2$	B1	2	Condone 169
(b)(i)	grad $PC = \dfrac{12}{5}$	B1	1	Must simplify $\dfrac{-12}{-5}$
(ii)	grad of tangent $= \dfrac{-1}{\text{grad } PC} = -\dfrac{5}{12}$	B1$\surd$		Condone $-\dfrac{1}{2.4}$ etc
	tangent has equation $y-1= -\dfrac{5}{12}(x-3)$	M1 A1		ft gradient but M0 if using grad PC Correct – but not in required final form
	$5x+12y=27$ OE	A1	4	MUST have integer coefficients
(iii)	half chord = 5	B1		Seen or stated
	 $d^2=(\text{their } r)^2-5^2$ (provided $r > 5$)	M1		Pythagoras used correctly $d^2=13^2-5^2$
	Distance = 12	A1	3	CSO
	Total		**10**	
8(a)	$b^2-4ac=16k^2-36(k+1)$	M1		Condone one slip
	Real roots: discriminant $\geqslant 0$	B1		
	$\Rightarrow 16k^2-36k-36\geqslant 0$			
	$\Rightarrow 4k^2-9k-9\geqslant 0$	A1	3	AG (watch signs)
(b)	$(4k+3)(k-3)$	M1		Or correct use of formula (unsimplified)
	critical points $(k=)\ -\dfrac{3}{4}\ ,\ 3$	A1		Not in a form involving surds Values may be seen in inequalities etc
	 sketch	M1		Or sign diagram
	$k\geqslant 3,\quad k\leqslant -\dfrac{3}{4}$	A1	4	NMS full marks Condone use of word "and" but final answer in a form such as $3\leqslant k\leqslant -\dfrac{3}{4}$ scores A0
	Total		**7**	
	TOTAL		**75**	

Version 1.0: 0109

General Certificate of Education

Mathematics 6360

MPC1 Pure Core 1

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2009 examination - January series

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MPC1

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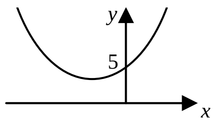
1(a)	$M\,(3, 2)$	B1 B1	2	B1 for each coordinate
(b)	Gradient $AB = \dfrac{-2-6}{5-1} = \left(\dfrac{-8}{4}\right)$	M1		May use coords of M instead of A or B - condone one slip
	$= -2$	A1	2	CSO Answer must be simplified to –2
(c) (i)	Gradient of perpendicular = $\dfrac{1}{2}$	B1√		ft "their" –1/gradient AB
	$\Rightarrow\ y-2=\dfrac{1}{2}(x-3)$	M1		attempt at perp to AB; ft their M coords
	$\Rightarrow\ 2y-4=x-3\ \ \Rightarrow\ x-2y+1=0$ **AG**	A1	3	CSO Must write down the printed answer
(ii)	$k-2(k+5)+1=0$ or $\dfrac{(k+5)-2}{k-3}=\dfrac{1}{2}$	M1		Sub into given line equation or correct expression involving gradients Condone omission of brackets or use of x
	$\Rightarrow k=-9$	A1	2	Condone $x=-9$ *(Full marks for correct answer without working)*
	Total		**9**	
2(a)	$(x-1)(2x-3)$	B1	1	$(1-x)(3-2x)$ or $2(x-1)(x-1.5)$ etc
(b)	Critical values are 1, $1\frac{1}{2}$	B1√		Correct or ft their factors from (a)
	Sign diagram or sketch	M1		+ | – | + (boundaries at 1 and $1\frac{1}{2}$)
	$\Rightarrow 1<x<1\frac{1}{2}$	A1	3	*Full marks for correct inequality without working*
	Total		**4**	
3(a)	$\dfrac{7+\sqrt{5}}{3+\sqrt{5}}\times\dfrac{3-\sqrt{5}}{3-\sqrt{5}}$	M1		Multiply by $\dfrac{3-\sqrt{5}}{3-\sqrt{5}}$ or $\dfrac{\sqrt{5}-3}{\sqrt{5}-3}$
	Numerator $= 21+3\sqrt{5}-7\sqrt{5}-\left(\sqrt{5}\right)^2$	m1		Condone one slip $\quad 16-4\sqrt{5}$
	Denominator = 9 – 5 = 4	B1		(Or 5 – 9 = – 4 from other conjugate)
	Answer $= 4-\sqrt{5}$	A1	4	CSO
(b)	$\sqrt{45}=3\sqrt{5}$	B1		
	$\dfrac{20}{\sqrt{5}}=\dfrac{20\sqrt{5}}{5}$	M1		May score if combined as one expression Must have 5 in denominator
	Sum $= 7\sqrt{5}$	A1	3	
	Total		**7**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$(x+1)^2$	B1		$p = 1$
	$+\ 4$	B1	2	$q = 4$
(ii)	$(x+1)^2 \geqslant 0 \Rightarrow (x+1)^2 + 4 > 0$	E1	1	Condone if they say $(x+1)^2$ *positive*
	$(\Rightarrow x^2 + 2x + 5 > 0$ for all values of $x)$			and adding 4 so always positive
(b)(i)	$x = -1$ **or** $y = 4$	M1		ft their $x = -p$ or $y = q$
	Minimum point is (–1, 4)	A1	2	
(ii)		B1		Sketch roughly as shown
		B1	2	y-intercept 5 or (0, 5) marked or stated
(c)	Translation (not shift, move etc)	E1		and NO other transformation stated
	through $\begin{bmatrix} -1 \\ 4 \end{bmatrix}$ (or 1 left, 4 up etc)	M1		either component correct or ft their $-p$, q
		A1	3	correct translation M1, A1 independent of E mark
	Total		**10**	
5(a)(i)	$\frac{dx}{dt} = 2t^3 - 40t + 66$	M1		one term correct
		A1 A1	 3	another term correct all correct unsimplified (no + c etc)
(ii)	$\frac{d^2x}{dt^2} = 6t^2 - 40$	M1		ft one term correct
		A1√	2	ft all “correct”, 2 terms equivalent
(b)	$\frac{dx}{dt} = 54 - 120 + 66$	M1		substitute $t = 3$ into their $\frac{dx}{dt}$
	$= 0 \Rightarrow$ stationary value	A1		CSO shown = 0 (54 or 2×27 seen) and statement
	Substitute $t = 3$ into $\frac{d^2x}{dt^2}$ (= 14)	M1		
	$\frac{d^2x}{dt^2} > 0 \Rightarrow$ minimum value	A1	4	CSO; all values (if stated) must be correct
(c)	Substitute $t = 1$ into their $\frac{dx}{dt}$	M1		must be their $\frac{dx}{dt}$ NOT $\frac{d^2x}{dt^2}$ etc
	$\frac{dx}{dt} = 28$	A1√	2	ft their $\frac{dx}{dt}$ when $t = 1$
(d)	Substitute $t = 2$ into their $\frac{dx}{dt}$	M1		must be their $\frac{dx}{dt}$ NOT $\frac{d^2x}{dt^2}$ or x
	$= 16 - 80 + 66 = 2$ (> 0)			Interpreting their value of $\frac{dx}{dt}$
	$\Rightarrow$ increasing when $t = 2$	E1√	2	Allow decreasing if their $\frac{dx}{dt} < 0$
	Total		**13**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$\text{p}(2)=8+2-10$	M1		Must find p(2) NOT long division
	$\Rightarrow \text{p}(2)=0 \Rightarrow (x-2)$ is factor	A1	2	Shown = 0 plus a statement
(ii)	Attempt at long division (generous)	M1		Obtaining a quotient x^2+cx+d or equating coefficients (full method)
	$\text{p}(x)=(x-2)(x^2+2x+5)$	A1	2	$a=2$, $b=5$ by inspection B1, B1
(b)(i)	$\dfrac{\text{d}y}{\text{d}x}=3x^2+1$	M1 A1		One term correct All correct – no $+c$ etc
	When $x=2$ $\dfrac{\text{d}y}{\text{d}x}=3\times4+1$	m1		Sub $x=2$ into their $\dfrac{\text{d}y}{\text{d}x}$
	Therefore gradient at Q is 13	A1	4	CSO
(ii)	$y=13(x-2)$	M1		Tangent (NOT normal) attempted ft their gradient answer from (b)(i)
		A1	2	CSO; correct in any form
(iii)	$\int\ldots\,\text{d}x=\dfrac{x^4}{4}+\dfrac{x^2}{2}-10x\ (+c)$	M1 A1 A1	3	one term correct second term correct all correct (condone no +c)
(iv)	$[4+2-20]-[0]=-14$	M1		$\text{F}(2)$ attempted and possibly F(0) Must have earned M1 in (b)(iii)
	Area of shaded region = 14	A1	2	CSO; separate statement following correct evaluation of limits
	Total		**15**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)	$(x-3)^2+(y+5)^2$	B1		One term correct
		B1		LHS correct with + and squares
	$= 25 - 9 + 9 = 25 \quad (= 5^2)$	B1	3	Condone RHS = 25
(b)(i)	$C\ (3, -5)$	B1√		
(ii)	Radius = 5	B1√	2	Correct or ft their RHS provided > 0
(c)(i)	$(7-3)^2 + (-2+5)^2 = 16+9=25$ $\Rightarrow D$ lies on circle *Must see statement*	B1	1	Or sub'n of (7, –2) in original equation $7^2+(-2)^2-42-20+9=0$ Or sub x=7 into eqn & showing y = –2 etc
(ii)	Attempt at gradient of CD as normal	M1		withhold if subsequently uses $m_1m_2=-1$
	grad CD = $\frac{-2-(-5)}{7-3}=\frac{3}{4}$			$\frac{\Delta y}{\Delta x}$ (condone one slip) FT their centre C
	$y+2 = \frac{3}{4}(x-7)$ or $y+5=\frac{3}{4}(x-3)$	A1		Correct equation in any form $y=\frac{3}{4}x-\frac{29}{4}$
	$\Rightarrow 3x-4y=29$	A1	3	CSO ***Integer*** coefficients Condone $4y-3x+29=0$ etc
(d)(i)	$y=kx$ sub'd into original circle equation	M1		or using their completed square form and
	$x^2+(kx)^2-6x+10kx+9=0$			multiplying out
	$\Rightarrow (k^2+1)x^2+2(5k-3)x+9=0$ **AG**	A1	2	CSO must see at least previous line for A1 any error such as $kx^2=\ldots=k^2x^2$ gets A0
(ii)	$4(5k-3)^2-36(k^2+1)$	M1		Discriminant in k (can be seen in quad formula) Condone one slip
	$= 64k^2-120k$	A1		or $8k^2-15k=0$ OE
	Equal roots: $4(5k-3)^2-36(k^2+1)=0$	B1		$b^2-4ac=0$ clearly stated or evident by an equation in k with at most 2 slips.
	$8k^2-15k=0$			
		m1		Attempt to solve ***their*** quadratic or linear equation if k has been cancelled
	$\Rightarrow k=0, \quad k=\frac{15}{8}$	A1	5	OE but must have k=0 If "=0" is not seen but correct values of k are found, candidate will lose B1 mark but may earn all other marks
(iii)	(Line is a) **tangent** (to the circle)	E1	1	Line **touches** circle at one point
	Total		**17**	
	TOTAL		**75**	

Version : 1.0 0609

General Certificate of Education

Mathematics 6360

MPC1 Pure Core 1

Mark Scheme

2009 examination - June series

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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

$\surd$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.

MPC1

Q	Solution	Marks	Total	Comments
1(a)(i)	$y=-\frac{3}{5}x+\frac{11}{5}$ Or correct expression for gradient using two correct points	M1		Attempt at $y = f(x)$ **Or** answer $=\frac{3}{5}$ or $-\frac{3}{5}x$ gets M1 But answer of $\frac{3}{5}x$ gets M0
	(Gradient of AB =) $-\frac{3}{5}$	A1	2	Correct answer scores 2 marks . Condone error in rearranging formula if answer for gradient is correct.
(ii)	$m_1m_2=-1$	M1		Used or stated
	Gradient of perpendicular = $\frac{5}{3}$	A1$\surd$		ft their answer from (a)(i) or correct
	$y-1=\frac{5}{3}(x-2)$ OE	A1	3	$5x-3y=7$; or $y=\frac{5}{3}x+c,\quad c=-\frac{7}{3}$ etc CSO
(b)	Eliminating x or y but must use $3x+5y=11$ & $2x+3y=8$	M1		An equation in x only or y only
	$x = 7$	A1		
	$y = -2$	A1	3	Answer only of $(7, -2)$ scores 3 marks
	Total		**8**	
2(a)	$\frac{5+\sqrt{7}}{3-\sqrt{7}}\times\frac{3+\sqrt{7}}{3+\sqrt{7}}$	M1		
	Numerator = $15+5\sqrt{7}+3\sqrt{7}+7$	m1		Condone one error or omission
	Denominator = $9 - 7$ $(= 2)$	B1		Must be seen as the denominator
	(Answer =) $11+4\sqrt{7}$	A1	4	
(b)	$(2\sqrt{5})^2=20$ *or* $(3\sqrt{2})^2=18$	B1		Either correct
	their $(2\sqrt{5})^2-(3\sqrt{2})^2$	M1		Condone missing brackets and x^2
	$(x^2=20-18)$			$x^2=2 \Rightarrow$ B1, M1
	$(\Rightarrow x=)\ \sqrt{2}$	A1	3	$\pm\sqrt{2}$ scores A0 Answer only of 2 scores B0, M0 Answer only of $\sqrt{2}$ scores 3 marks
	Total		**7**	

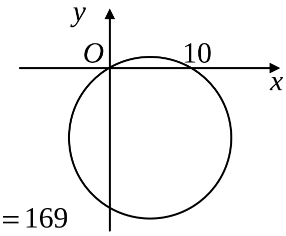
MPC1 (cont)

Q	Solution	Marks	Total	Comments
3(a)	$\frac{dy}{dx} = 5x^4 + 40x$	M1 A1 A1	3	One of these powers correct One of these terms correct All correct (no + c etc)
(b)	$x = -2 \quad \frac{dy}{dx} = 5\times(-2)^4 + (40\times -2)$	M1		Substitute $x = -2$ into their $\frac{dy}{dx}$
	$\frac{dy}{dx} = 5\times 16 + (40\times -2) = 0$			
	$\Rightarrow P$ is stationary point	A1		CSO Shown = 0 plus statement eg "st pt", "as required", "grad = 0"etc
	Or *their* $\frac{dy}{dx} = 0 \quad \Rightarrow x^n = k$	(M1)		
	$x^3 = -8 \quad \Rightarrow x = -2$	(A1)	2	CSO $x = 0$ need not be considered
(c)(i)	$\frac{d^2y}{dx^2} = 20x^3 + 40$	B1√		Correct ft their $\frac{dy}{dx}$
	$= 20\times(-2)^3 + 40$	M1		Subst $x = -2$ into their second derivative
	$(= -160 + 40) \qquad = -120$	A1	3	CSO
(ii)	Maximum (value) their c(i) answer must be < 0 Other valid methods acceptable provided "maximum" is the conclusion	E1√	1	Accept minimum if their $c(i)$ *answer* > 0 and correctly interpreted Parts (i) and (ii) may be combined by candidate but –120 must be seen to award A1 in part (c)(i)
(d)	(When $x = 1$) $y = 13$	B1		
	When $x = 1$, $\frac{dy}{dx} = 5 + 40$	M1		Sub $x = 1$ into their $\frac{dy}{dx}$
	y = (their 45)$x + k$ OE	m1		ft their $\frac{dy}{dx}$
	Tangent has equation $y - 13 = 45(x - 1)$	A1	4	CSO OE $y = 45x + c, \quad c = -32$
	Total		**13**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$\text{p}(3) = 27 - 3 + 6$	M1		p(3) attempted
	(Remainder) = 30	A1		
	Or long division up to remainder	(M1)		
	Quotient= $x^2 + 3x + 8$ and remainder = 30 clearly stated or indicated	(A1)	2	
(ii)	$\text{p}(-2) = -8 + 2 + 6$	M1		p(–2) attempted **:** **NOT** long division
	$\text{p}(-2) = 0 \Rightarrow x + 2$ is factor	A1	2	Shown = 0 plus statement
	Minimum statement required "factor"			May make statement *first* such as "x+2 is a factor if p(–2) = 0"
(iii)	$b = -2$	B1		No working required for B1 + B1
	$c = 3$	B1		Try to mark first using B marks
	or long division/comparing coefficients	(M1)		Award M1 if B0 earned and a clear method is used
	$\text{p}(x) = (x+2)(x^2 - 2x + 3)$	(A1)	2	Must write final answer in this form if long division has been used to get A1
(iv)	$b^2 - 4ac = (-2)^2 - 4 \times 3$	M1		Discriminant correct from their quadratic M0 if b = –1, c = 6 used (using cubic eqn)
	$b^2 - 4ac = -8$ (or < 0) $\Rightarrow$ no (other) real roots	A1		CSO All values must be correct plus statement
	Or $(x-1)^2 + 2$	(M1)		Completion of square for their quadratic
	$(x-1)^2 + 2 > 0$ therefore no real roots Or $(x-1)^2 = -2$ has no real roots	(A1)	2	Shown to be positive plus statement regarding no real roots
(b)(i)	$(y_B =)\ 6$	B1	1	Condone (0, 6)
(ii)	$\frac{x^4}{4} - \frac{x^2}{2} + 6x$	M1		One term correct
		A1		Another term correct
		A1		All correct (ignore + c or limits)
	$\Big[\quad\Big]_{-2}^{0} = 0 - (4 - 2 - 12)$	m1		$\text{F}(-2)$ attempted
	= 10	A1	5	CSO Clearly from F(0) – F(–2)
(iii)	Area of $\Delta = \frac{1}{2} \times 2 \times 6$	M1		Condone – 2 and ft their y_B value **Or** $\int_{-2}^{0} (3x+6)\text{d}x$ and attempt to integrate
	= 6	A1		Must be positive allow –6 converted to +6
	Shaded region area = 10 – 6 = 4	A1	3	CSO 10 must come from correct working
	Total		**17**	

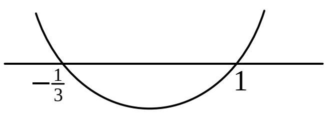
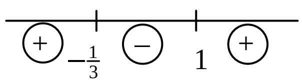
MPC1 (cont)

Q	Solution	Marks	Total	Comments
5(a)(i)	$C\ (5, -12)$	B1	1	
(ii)	Radius = 13 (or $\sqrt{169}$)	B1	1	$\pm\sqrt{169}$ or ± 13 as final answer scores B0
(b)(i)	$(-5)^2 + 12^2$ *or* $25 + 144$ $= 169 \quad \Rightarrow$ circle passes through O	B1	1	Correct arithmetic plus statement Eg "O lies on circle", "as required" etc
(ii)	Sketch 	B1		Freehand circle through origin and cutting positive x-axis with centre in 4th quadrant Condone value 10 missing or incorrect
	$25 + (p + 12)^2 = 169$	M1		Or doubling their y_C-coordinate
	$(p + 12) = \pm 12 \qquad p = -24$	A1	3	Condone use of y instead of p SC B2 for correct value of p stated or marked on diagram
(c)(i)	grad $AC = \dfrac{-12+7}{5+7}$	M1		correct expression, but ft their C
	$= -\dfrac{5}{12}$	A1	2	Condone $\dfrac{5}{-12}$
(ii)	grad tangent $= \dfrac{12}{5}$	B1 √		$\dfrac{-1}{\text{their grad } AC}$
	$y + 7 = \dfrac{12}{5}(x + 7)$	M1		ft "their $\dfrac{12}{5}$" must be **tangent** and not AC
	$\Rightarrow 12x - 5y + 49 = 0$	A1	3	OE with **integer** coefficients with all terms on one side of the equation
	Total		**11**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$(x-4)^2$ *or* $p = 4$	B1		ISW for $p = -4$ if $(x-4)^2$ seen
	$+\,1$ *or* $q = 1$	B1	2	
(ii)	(Minimum value is) 1	B1√	1	Correct or FT "their q" (NOT coords)
(iii)	(Minimum occurs when $x =$) 4	B1√	1	Correct or FT "their p" – may use calculus Condone (p, **) for this B1 mark
(b)(i)	$(x-5)^2 = x^2 - 10x + 25$	B1	1	
(ii)	$(x-5)^2 + (7-x-4)^2$ $= (x-5)^2 + (3-x)^2$	M1		Condone one slip in one bracket May be seen under $\sqrt{\ }$ sign
	$= x^2 - 10x + 25 + 9 - 6x + x^2$ $AB^2 = 2x^2 - 16x + 34$	A1		From a fully correct expression
	$= 2(x^2 - 8x + 17)$	A1	3	AG CSO
(iii)	Minimum $AB^2 = 2\times$ "their (a)(ii)"	M1		Or use of their $x = 4$ in expression Or use of their $B(4, 3)$ and $A(5, 4)$ in distance formula M0 if calculus used Answer only of $2\times$ "their (a)(ii)" scores M1, A0
	Minimum $AB = \sqrt{2}$	A1	2	
	Total		**10**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$k\left(x^2+3\right)=2x+2$			
	$\Rightarrow kx^2-2x+3k-2=0$	B1	1	AG OE all terms on one side and = 0
(b)(i)	Discriminant = $(-2)^2-4k(3k-2)$	M1		Condone one slip (including x is one slip) Condone 2^2 or 4 as first term
	$=4-12k^2+8k$	A1		condone recovery from missing brackets
	Two distinct real roots $\Rightarrow b^2-4ac>0$	B1√		"their discriminant in terms of k" >0
	$4-12k^2+8k>0$			Not simply the statement $b^2-4ac>0$
	$\Rightarrow 12k^2-8k-4<0$			Change from > 0 to < 0 and divide by 4
	$\Rightarrow 3k^2-2k-1<0$	A1	4	AG CSO
(ii)	$(3k+1)(k-1)$	M1		**Correct** factors or **correct** use of formula
	Critical values 1 and $-\frac{1}{3}$	A1		May score M1, A1 for correct critical values seen as part of incorrect final answer with or without working
	Use of sign diagram or sketch  	M1		If previous A1 earned, sign diagram or sketch must be correct for M1 Otherwise, M1 may be earned for an attempt at the sketch or sign diagram using their critical values.
	$\Rightarrow -\frac{1}{3}<k<1$ or $1>k>-\frac{1}{3}$	A1	4	Full marks for correct final answer with or without working $\leqslant$ loses final A mark
	condone $-\frac{1}{3}<k$ AND $k<1$ for full marks but not OR or "," instead of AND			*Answer only* of $1<k<-\frac{1}{3}$ or $k<-\frac{1}{3};k<1$ *etc* scores M1,A1,M0 since the correct critical values are evident *Answer only* of $\frac{1}{3}<k<1$ etc where critical values are not both correct gets M0,M0
	Total		**9**	
	TOTAL		**75**	

Version 1.0 0110

General Certificate of Education

Mathematics 6360

MPC1 Pure Core 1

Mark Scheme

2010 examination - January series

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

Deleted: ¶
XMCA2 ¶
Q ... [1]

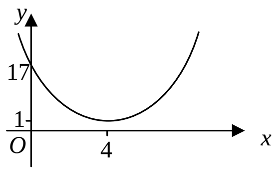
MPC1

Q	Solution	Marks	Total	Comments
1(a)	$p(-3)=(-3)^3-13(-3)-12$	M1		must attempt $p(-3)$ NOT long division
	$=-27+39-12$ $=0 \quad \Rightarrow x+3$ is factor	A1	2	shown $=0$ plus statement
(b)	$(x+3)(x^2+bx+c)$	M1		Full long division, comparing coefficients or by inspection either $b=-3$ or $c=-4$
	(x^2-3x-4) obtained	A1		or M1A1 for either $(x-4)$ or $(x+1)$ clearly found using factor theorem
	$(x+3)(x-4)(x+1)$	A1	3	CSO; must be seen as a product of 3 factors NMS full marks for correct product SC B1 for $(x+3)(x-4)(\ \ )$ or $(x+3)(x+1)(\ \ )$ or $(x+3)(x+4)(x-1)$ NMS
	Total		**5**	
2(a)(i)	grad $AB=\dfrac{7-3}{3-1}$	M1		$\dfrac{\Delta y}{\Delta x}$ correct expression, possibly implied
	$=2$ (must simplify 4/2)	A1	2	
(ii)	grad $BC=\dfrac{7-9}{3+1}=-\dfrac{2}{4}$	M1		Condone one slip **NOT** Pythagoras or cosine rule etc
	grad AB × grad BC $=-1$ $\Rightarrow \angle ABC=90^\circ$ or AB & BC perpendicular	A1	2	convincingly proved plus statement SC B1 for –1/(their grad AB) or statement that $m_1m_2=-1$ for perpendicular lines if M0 scored
(b)(i)	$M\ (0,6)$	B2	2	B1 + B1 each coordinate correct
(ii)	$(AB^2=)\quad (3-1)^2+(7-3)^2$ $(BC^2=)\quad (3+1)^2+(7-9)^2$	M1		either expression correct, simplified or unsimplified
	$AB^2=2^2+4^2$ or $BC^2=4^2+2^2$ or $\sqrt{20}$ found as a length	A1		Must see either AB^2 =.., or BC^2 =...,
	$AB^2=BC^2 \Rightarrow AB=BC$ or $AB=\sqrt{20}$ and $BC=\sqrt{20}$	A1	3	
(iii)	grad $BM=\dfrac{7-6}{3-0}$ or –1/(grad AC) attempted	M1		ft their M coordinates
	$=\dfrac{1}{3}$	A1		correct gradient of line of symmetry
	BM has equation $y=\dfrac{1}{3}x+6$	A1	3	CSO, any correct form
	Total		**12**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	$\dfrac{dy}{dt} = \dfrac{4t^3}{8} - 4t + 4$	M1 A1 A1	3	one term correct another term correct all correct (no + c etc) unsimplified
(ii)	$\dfrac{d^2y}{dt^2} = \dfrac{12t^2}{8} - 4$	M1 A1	2	ft one term "correct" correct unsimplified (penalise inclusion of $+c$ once only in question)
(b)	$t=2$; $\dfrac{dy}{dt} = 4-8+4$ $\dfrac{dy}{dt}=0 \Rightarrow$ stationary value $t=2$; $\dfrac{d^2y}{dt^2}=6-4=2$ $\Rightarrow y$ has MINIMUM value	M1 A1 M1 A1	4	Substitute $t=2$ into their $\dfrac{dy}{dt}$ CSO; shown = 0 plus statement Sub $t=2$ into their $\dfrac{d^2y}{dt^2}$ CSO
(c)(i)	$t=1$; $\dfrac{dy}{dt} = \dfrac{1}{2} - 4 + 4$ $= \dfrac{1}{2}$	M1 A1	2	Substitute $t=1$ into their $\dfrac{dy}{dt}$ OE; CSO NMS full marks if $\dfrac{dy}{dt}$ correct
(ii)	$\dfrac{dy}{dt}>0 \Rightarrow$ **(**depth is) INCREASING	E1$\sqrt{}$	1	allow decreasing if states that their $\dfrac{dy}{dt}<0$ **Reason must be given not just the word increasing or decreasing**
	Total		**12**	
4(a)	$\sqrt{50}=5\sqrt{2}$; $\sqrt{18}=3\sqrt{2}$; $\sqrt{8}=2\sqrt{2}$ At least two of these correct $\dfrac{5\sqrt{2}+3\sqrt{2}}{2\sqrt{2}}$ *Answer* $=4$	M1 A1 A1	3	or $\times\dfrac{\sqrt{8}}{\sqrt{8}}$ or $\left(\times\dfrac{\sqrt{2}}{\sqrt{2}}\right)$ or $\sqrt{\dfrac{25}{4}}+\sqrt{\dfrac{9}{4}}$ any **correct** expression all in terms of $\sqrt{2}$ or with denominator of 8, 4 or 2 simplifying numerator eg $\dfrac{\sqrt{400}+\sqrt{144}}{8}$ CSO
(b)	$\dfrac{(2\sqrt{7}-1)(2\sqrt{7}-5)}{(2\sqrt{7}+5)(2\sqrt{7}-5)}$ *numerator* $= 4\times7-2\sqrt{7}-10\sqrt{7}+5$ *denominator* $=3$ *Answer* $=11-4\sqrt{7}$	M1 m1 B1 A1	4	OE expanding numerator (condone one error or omission) (seen as denominator)
	Total		**7**	

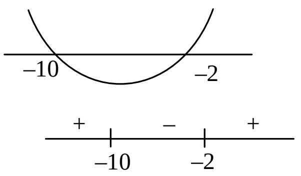
MPC1 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$x^2 - 8x + 15 + 2$	B1		Terms in x must be collected, PI
	their $(x-4)^2 \quad (+k)$	M1		ft $(x-p)^2$ for their quadratic
	$=(x-4)^2+1$	A1	3	ISW for stating $p=-4$ if correct expression seen
(b)(i)		M1		$\cup$ shape in any quadrant (generous)
		A1		correct with min at (4, 1) stated or 4 and 1 marked on axes condone within first quadrant only
		B1	3	crosses y-axis at (0, 17) stated or 17 marked on y-axis
(ii)	$y = k$	M1		$y =$ constant
	$y = 1$	A1	2	Condone $y = 0x + 1$
(c)	Translation (*not shift, move etc*)	E1		and no other transformation
	with vector $\begin{bmatrix}4\\1\end{bmatrix}$	M1		One component correct or ft either their p or q
		A1	3	CSO; condone 4 across, 1 up; or two separate vectors etc
	Total		**11**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$\frac{dy}{dx} = 24x - 19 - 6x^2$	M1 A1		2 terms correct all correct (no + c etc)
	when $x = 2$, $\frac{dy}{dx} = 48 - 19 - 24$	m1		
	$\Rightarrow$ gradient $= 5$	A1	4	CSO
(ii)	grad of normal $= -\frac{1}{5}$	B1$\checkmark$		ft their answer from (a)(i)
	$y + 6 = \left(\textit{their} - \frac{1}{5}\right)(x - 2)$ or $y = \left(\textit{their} - \frac{1}{5}\right)x + c$ and c evaluated using $x = 2$ and $y = -6$	M1		ft grad of their normal using **correct** coordinates BUT must not be tangent condone omission of brackets
	$x + 5y + 28 = 0$	A1	3	CSO; condone all on one side in different order
(b)(i)	$\frac{12}{3}x^3 - \frac{19}{2}x^2 - \frac{2}{4}x^4$	M1 A1 A1		one term correct another term correct all correct (ignore +c or limits)
	$= 32 - 38 - 8$	m1		$F(2)$ attempted
	$= -14$	A1	5	CSO; withhold A1 if changed to +14 here
(ii)	Area $\Delta = \frac{1}{2} \times 2 \times 6 = 6$	B1		condone -6
	Shaded region area $= 14 - 6$	M1		difference of $\pm\left\|\int\right\| \pm\left\|\Delta\right\|$
	$= 8$	A1	3	CSO
	Total		**15**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)	$x=\pm 2$ or $y=\pm 6$ or $(x-2)^2+(y+6)^2$ $C(2,-6)$	M1 A1	 2	 correct
(ii)	$(r^2=)4+36-15$ $\Rightarrow r=5$	M1 A1	 2	(RHS =) *their* $(-2)^2$ + *their* $(6)^2 - 15$ Not ± 5 *or* $\sqrt{25}$
(b)	explaining why $\lvert y_C\rvert > r$; $6>5$ full convincing argument, but must have correct y_C and r	E1 E1	 2	Comparison of y_C and r , eg $-6 + 5 = -1$ or indicated on diagram Eg "highest point is at $y = -1$" scores E2 E1: showing no real solutions when $y=0$ +E1 stating centre or any point below x-axis
(c)(i)	$(PC^2=)\quad (5-2)^2+(k+6)^2$ $=9+k^2+12k+36$ $PC^2=k^2+12k+45$	 M1 A1	 2	ft their C coords and attempt to multiply out **AG** CSO (must see $PC^2=$ at least once)
(ii)	$\left.\begin{array}{l}PC>r\Rightarrow PC^2>25\\ \Rightarrow k^2+12k+20>0\end{array}\right\}$	B1	1	**AG** Condone $\left.\begin{array}{l}k^2+12k+45>25\\ \Rightarrow k^2+12k+20>0\end{array}\right\}$
(iii)	$(k+2)(k+10)$ $k=-2,\ k=-10$ are critical values Use of sketch or sign diagram:  $\Rightarrow\ k>-2,\ k<-10$ Condone $k>-2$ OR $k<-10$ for full marks but not AND instead of OR Take final line as their answer	M1 A1 M1 A1	 4	**Correct** factors or **correct** use of formula May score M1, A1 for correct critical values seen as part of incorrect final answer with or without working. If previous A1 earned, sign diagram or sketch must be correct for M1, otherwise M1 may be earned for an attempt at the sketch or sign diagram using their critical values. $k\geqslant -2,\ k\leqslant -10$ loses final A mark *Answer only* of $k>-2,\ k>-10$ *etc* scores M1, A1, M0 since the critical values are evident. *Answer only* of $k>2,\ k<-10$ *etc* scores M0, M0 since the critical values are not both correct.
	Total		**13**	
	TOTAL		**75**	

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XMCA2

Q	Solution	Marks	Total	Comments
1(a)	$x = -\frac{3}{2}$	B1		Seeing $-\frac{3}{2}$ OE
	p(−1.5)= $2(-1.5)^4 + 3(-1.5)^3 - 8(-1.5)^2 - 14(-1.5) - 3$	M1		Attempting to evaluate p(−1.5 or p(1.5)
	p(−1.5) = 10.125−10.125−18+21−3 = 0] so (2x + 3) is a factor of p(x)]	A1	3	CSO Need both the arithme to show '= 0' and the conclusion.
(b)(i)	$x^3-4x-1=0 \Rightarrow x(x^2-4)-1=0 \Rightarrow x^2-4=\frac{1}{x}$	M1		Dividing throughout by x OE
	$x^2 = \frac{1}{x}+4 \Rightarrow x = \sqrt{\frac{1}{x}+4}$ (since x>0)	A1	2	CSO
(ii)	x_2 = 2.1213 x_3 = 2.1146 x_4 = 2.1149	B1 B1 B1	3	AWRT 2.121 AWRT 2.1146 CAO
	Total		8	
2(a)	$\frac{5+x}{(1-x)(2+x)} = \frac{A}{1-x}+\frac{B}{2+x}$ $\Rightarrow$ 5 + x = A(2 + x) + B (1 − x)	M1		Either multiplication by denominator or cover up rule attempted.
	Substitute x = 1 ; Substitute x = −2	m1		Either use (any) two values o to find A and B or equate coefficients to form and atten to solve A−B=1 and 2A+B=5
	A = 2 , B = 1	A1	3	
(b)(i)	$(1-x)^{-1} = 1+(-1)(-x)+px^2$	M1		$p \neq 0$
	$= 1+x+x^2...$	A1	2	
(ii)	$2^{-1}\left[1+\frac{x}{2}\right]^{-1} = \frac{1}{2}\left[1+(-1)\left(\frac{x}{2}\right)+\frac{(-1)(-2)}{2!}\left(\frac{x}{2}\right)^2+...\right]$	M1		$[1+(-1)\left(\frac{x}{2}\right)+kx^2]$
		A1		Correct expn of $\left(1+\frac{x}{2}\right)^{-1}$
	$\frac{5+x}{(1-x)(2+x)}$ = 2(1−x)$^{-1}$ + (2+x)$^{-1}$	M1		Using (a) with powers '−1'. P
	= $2(1+x+x^2...) + \frac{1}{2}\left(1-\frac{x}{2}+\frac{x^2}{4}+...\right)$	m1		Dep on prev 3Ms
	= 2.5 + 1.75x + 2.125x^2 +…	A1F	5	Ft only on wrong integer valu for A and B, ie simplified (A+1/2B)+(A−1/4B)x+(A+1/8B... [Award equivalent marks for other valid methods.]
	Total		10	

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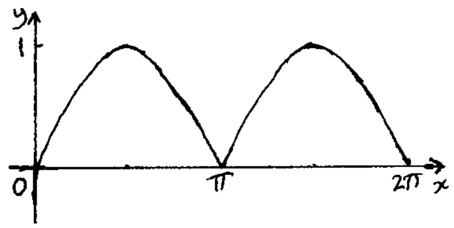
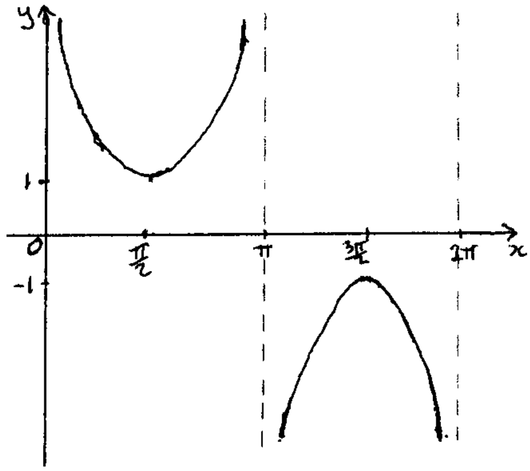
XMCA2 (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)		M1 A1	 2	Modulus graph Correct shape including cusp at (π, 0). Ignore any part of graph beyond $0 \le x \le 2\pi$.
(ii)	$k = 1$	B1	1	
(b)		M1 A1	 2	Two branch curve, genera shape correct. Min at (α, 1) Max at (β, 1 with α roughly halfway between 0 and π, and β roughly halfway between π and 2π and curve asymptotic to x = 0, $x = \pi$ and $x = 2\pi$.
	Total		5	
4(a)	$\frac{dy}{dx} = \frac{(x+2)3e^{3x} - e^{3x}(1)}{(x+2)^2}$	B1 M1 A1	 3	$(e^{3x})' = 3e^{3x}$ Quotient rule OE
(b)	When x = 0, $\frac{dy}{dx} = \frac{6e^0 - e^0}{2^2} = \frac{5}{4}$ $A\left(0, \frac{1}{2}\right)$ Equation of tangent at A: $y - \frac{1}{2} = \frac{5}{4}(x - 0)$	M1 A1F B1 A1	 4	Attempt to find dy/dx at x= ACF
	Total		7	

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XMCA2 (cont)

Q	Solution	Marks	Total	Comments
5	$V = \pi\int_0^1 \cos(x^2)\,dx$	M1 A1		$\int \cos(x^2)\,dx$ Correct limits. (Condone k or missing π until the final mark)

	Applying Simpson's rule to $\int_0^1 \cos(x^2)\,dx$			
	x 0 0.25 0.5 0.75 1	B1		PI
	Y=y^2 1 0.9980(47) 0.9689(12) 0.8459(24) 0.5403(02) [πY vals. 3.1415(9) 3.1354(5) 3.0439(2) 2.6575(5) 1.6974(0)]	B1		PI
	$\frac{0.25}{3}\times\{Y(0)+Y(1)+4[Y(0.25)+Y(0.75)]+2Y(0.5)\}$	M1		Use of Simpson's rule
	$V = \pi\times\frac{10.8539....}{12}$ So V = 2.8416 (to 4 d.p.)	A1	6	CAO
	Total		6	

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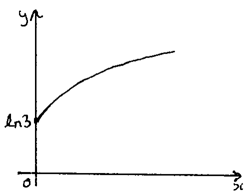
XMCA2 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)		B2,1,0	2	B2 correct sketch-no part c curve in 2^{nd},3^{rd} or 4^{th} quadrants and 'ln3' (B1 for general shape in 1^s quadrant, ignore other quadrants; ln3 not requirec
(ii)	Range of f: f(x) ≥ ln3	M1 A1	2	≥ln3 or >ln3 or f≥ln3 Allow y for f(x).
(b)(i)	$y = f^{-1}(x) \Rightarrow f(y) = x$ $\Rightarrow \ln(2y + 3) = x$ $\Rightarrow 2y + 3 = e^x$ $f^{-1}(x) = \frac{e^x - 3}{2}$	 M1 m1 A1	 3	 $x \Leftrightarrow y$ at any stage Use of $\ln m = N \Rightarrow m = e^{l}$ ACF-Accept y in place of $f^{-1}(x)$
(ii)	Domain of f^{-1} is: $x \geq \ln 3$	B1F	1	ft on (a)(ii) for RHS
(c)	$\frac{d}{dx}[(\ln(2x+3)] = \frac{1}{(2x+3)}\times 2$	M1 A1	2	1/(2x+3)
(d)(i)	P, the pt of intersection of y = f(x) and $y = f^{-1}(x)$, must lie on the line $y = x$; so P has coordinates (α, α). f(α) = α ln(2α+3) = α $\Rightarrow 2\alpha + 3 = e^{\alpha}$	M1; M1 A1	 3	 OE eg $f^{-1}(\alpha) = \alpha$ A.G. CSO

(ii)	$\frac{\mathrm{d}}{\mathrm{d}x}\left[\mathrm{f}^{-1}(x)\right]=\frac{1}{2}\mathrm{e}^{x}$	B1F		$\frac{\mathrm{e}^{\alpha}-3}{2}=\alpha \Rightarrow \mathrm{e}^{\alpha}=2\alpha+3$
	Product of gradients = $\frac{\mathrm{e}^{x}}{2x+3}$ At $P(\alpha, \alpha)$, the product of the gradients is $\frac{\mathrm{e}^{\alpha}}{2\alpha+3}$ = $\frac{2\alpha+3}{2\alpha+3}$ = 1	B1	2	AG CSO
	Total		15	

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XMCA2 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$\frac{\mathrm{d}y}{\mathrm{d}x} = x\,\mathrm{e}^{x} + \mathrm{e}^{x}$.	M1 A1		M1 Product rule OE.
	At stationary point(s) $\mathrm{e}^{x}(x + 1) = 0$	m1		
	$\mathrm{e}^{x} > 0$	E1		OE eg accept $\mathrm{e}^{x} \neq 0$
	Only one value of x for st. pt. Curve has exactly one st pt	A1		CSO with conclusion.
	Stationary point is $(-1, -\mathrm{e}^{-1})$	A1	6	
(b)	Stationary point is $(-1, k - \mathrm{e}^{-1})$	B1F		Or E1 for $y = x\,\mathrm{e}^{x}$ to $y = x\,\mathrm{e}^{x} + k$ is a vertical translation of k units.
	St. pt is on x-axis, so $k = \mathrm{e}^{-1}$.	B1	2	
	Total		8	
8	$\int \frac{1}{y}\,\mathrm{d}y = \int \frac{\cos x}{6+\sin x}\,\mathrm{d}x$	M1		Separating variables with intention to then integrate.
	$\ln y = \ln(6 + \sin x)$ $(+c)$	A1 A1		A1 for each side. Condone missing '+c'
	$\ln 2 = \ln 6 + c$ $\ln y = \ln(6 + \sin x) + \ln 2 - \ln 6$	m1		Substituting $x = 0$, $y = 2$ to find c
	so $y=\frac{1}{3}(6+\sin x)$	A1	5	Correct simplified form not involving logs
	Total		5	
9(a)	$y = \mathrm{e}^{2x} \rightarrow \mathrm{e}^{-2x} \rightarrow 6\mathrm{e}^{-2x}$.			
	Reflection; in the y-axis	M1;A1		
	Stretch,	M1		M1 'Stretch' with either (I) or (II).
	(I) parallel to y-axis, (II) scale factor 6.	A1	4	
				For correct alternatives to the stretch after writing $y = \mathrm{e}^{-2x+\ln 6}$ award B1 for 'translation in x-dirn.' and B1 for the correct vector (OE) noting order of transformations.
(b)(i)	Area of rectangle/shaded region below x-axis = $3k$	B1		

	Area of shaded region above x-axis $= \int_0^k 6e^{-2x}\,dx$	B1		
	$= \left[-3e^{-2x}\right]_0^k = -3e^{-2k} - (-3)$	M1 A1		F(k) − F(0) following an integration. ACF
	Total area of shaded region $= 3k - 3e^{-2k} + 3 = 4$ $3k - 1 - 3e^{-2k} = 0 \Rightarrow (3k-1)e^{2k} - 3 = 0$.	M1 A1	6	AG CSO
(ii)	Let $f(k) = (3k-1)e^{2k} - 3$ $f(0.6) = 0.8e^{1.2} - 3 = -0.3(4..) < 0$ $f(0.7) = 1.1e^{1.4} - 3 = 1.(46..) > 0$	M1		Both f(0.6) and f(0.7) [or better] attempted
	Since change of sign (and f continuous), $0.6 < k < 0.7$	A1	2	AG Note: Must see the explicit reference to 0.6 and 0.7 otherwise A0
	Total		12	

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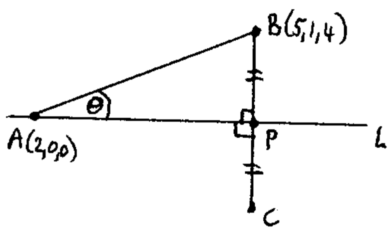
XMCA2 (cont)

Q	Solution	Marks	Total	Comments
10(a)	$\overrightarrow{AB} = \begin{bmatrix}5\\1\\4\end{bmatrix} - \begin{bmatrix}2\\0\\0\end{bmatrix} = \begin{bmatrix}3\\1\\4\end{bmatrix}$	M1 A1		M1 for ± ($\overrightarrow{OB} - \overrightarrow{OA}$) OE for $\overrightarrow{BA}$
	Line AB: $r = \begin{bmatrix}2\\0\\0\end{bmatrix} + \lambda\begin{bmatrix}3\\1\\4\end{bmatrix}$	B1F	3	OE Ft on $\overrightarrow{AB}$
(b)	$\begin{bmatrix}3\\1\\4\end{bmatrix} \bullet \begin{bmatrix}1\\2\\1\end{bmatrix} = 3+2+4 = 9$	M1		$\pm\,\overrightarrow{AB} \bullet$ direction vector of l evaluated
	$\sqrt{3^2+1^2+4^2} = \sqrt{26}$; $\sqrt{1^2+2^2+1^2} = \sqrt{6}$	B1F		Either; Ft on either of c's vectors
	$\sqrt{26}\sqrt{6}\cos\theta = 9$	M1		Use of $\|a\|\|b\|\cos\theta$ = a ▪ b
	$\cos\theta = \dfrac{9}{\sqrt{26}\sqrt{6}} = \dfrac{9}{\sqrt{2}\sqrt{13}\sqrt{2}\sqrt{3}}$ $= \cos\theta = \dfrac{9}{2\sqrt{13}\sqrt{3}} = \dfrac{9}{2\sqrt{39}}$	A1	4	AG CSO
(c)(i)				

	$\overrightarrow{BP} = \begin{bmatrix} 2+p \\ 2p \\ p \end{bmatrix} - \begin{bmatrix} 5 \\ 1 \\ 4 \end{bmatrix} = \begin{bmatrix} p-3 \\ 2p-1 \\ p-4 \end{bmatrix}$	M1 A1		Condone one slip
	$\overrightarrow{BP} \bullet \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} = 0$; $6p = 9 \Rightarrow p = 1.5$	M1 A1		"$\pm\ \overrightarrow{BP} \bullet$ direction vector of $l = 0$". Condone one slip
	P (3.5, 3, 1.5) is mid point of BC	A1	5	
(ii)	$\frac{x_C+5}{2} = 3.5 \quad \frac{y_C+1}{2} = 3 \quad \frac{z_C+4}{2} = 1.5$	M1		
	$\Rightarrow$ C (2, 5, −1)	A1	2	Condone written as a column vector. Award equivalent marks for alternative valid methods.
	Total		14	

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XMCA2 (cont)

Q	Solution	Marks	Total	Comments
11(a)	$\sin(2x + x) = \sin2x\cos x + \cos2x\sin x$	M1		
	$= [2\sin x\cos x]\cos x + [1-2\sin^2 x]\sin x$	B1;B1		B1 for each […]. Accept alternative correct forms for $\cos 2x$
	$= 2\sin x(1-\sin^2 x) + (1-2\sin^2 x)\sin x$	m1		All in terms of $\sin x$
	$= 2\sin x - 2\sin^3 x - \sin x - 2\sin^3 x$			
	$\sin 3x = 3\sin x - 4\sin^3 x$.	A1	5	CSO
(b)	$2\sin 3x = 1 - \cos 2x$			
	$2(3\sin x - 4\sin^3 x) = 1 - \cos 2x$	M1		Using (a)
	$2(3\sin x - 4\sin^3 x) = 1 - (1-2\sin^2 x)$	M1		Equation in $\sin x$
		A1		
	$2\sin x\ (3 - \sin x - 4\sin^2 x) = 0$			
	$[2\sin x = 0]$ $(3 - 4\sin x)(1 + \sin x) = 0$	m1		Factorising/solving quadratic in sin
	$\sin x = 0$; $x = 180°$	B1		
	$\sin x = 0.75$; $x = 48.6°,\ 131.4°$	A1		Ignore solns outside $0°<x<360°$ throughout
	$\sin x = -1$; $x = 270°$	A1	7	
	Total		12	
12(a)(i)	$u = x$ and $\frac{dv}{dx} = \sec^2 x$	M1		Attempt to use parts formula in the 'correct direction'
	$\frac{du}{dx} = 1$ and $v = \tan x$	A1		PI
	….. $= x\tan x - \int \tan x\,dx$	A1		
	$= x\tan x - \ln(\sec x)$ $(+ c)$	A1	4	OE CSO (Condone absence of $+c$)
(ii)	$\int x\tan^2 x\,dx = \int x(\sec^2 x - 1)\,dx$	M1		Use of identity $1 + \tan^2 x = \sec^2 x$

	= [x tan x − ln (sec x)] − $\frac{1}{2}x^2$ (+ c)	A1F	2	[…] ft on (a)(i)
(b)	$x = 2\sin\theta$, dx = 2 cosθ dθ	M1		"dx = f(θ) dθ " OE
	$\int \sqrt{4-x^2}\,\mathrm{d}x = \int \sqrt{4(1-\sin^2\theta)}\,2\cos\theta\,\mathrm{d}\theta$	m1 A1		Eliminating all x's
	= $\int 4\cos^2\theta\,\mathrm{d}\theta$ = $\int 2(\cos 2\theta + 1)\,\mathrm{d}\theta$	m1		Use of cos2θ to integrate cos$^2\theta$.
	= sin 2θ + 2θ (+ c) = $2\sin\theta\sqrt{1-\sin^2\theta}$ + 2θ (+ c)	A1F		Ft a slip
	= $x\sqrt{\left(1-\frac{x^2}{4}\right)} + 2\sin^{-1}\left(\frac{x}{2}\right)$ (+ c)	A1	6	ACF (accept unsimplified)
	Total		12	

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XMCA2 (cont)

Q	Solution	Marks	Total	Comments
13	$x = 3t + t^3$ $\quad y = 8 - 3t^2$ $\frac{\mathrm{d}x}{\mathrm{d}t} = 3 + 3t^2$ $\quad \frac{\mathrm{d}y}{\mathrm{d}t} = -6t$	M1		Both attempted and at least one correct.
	$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{-6t}{3+3t^2}$	M1 A1		Chain rule.
	At P(−4, 5), t = − 1	B1		
	At P(−4, 5), $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{6}{3+3} = 1$			
	Gradient of normal at P is −1	M1		
	Eqn of normal at P: $y - 5 = -1(x+4)$ $y + x = 1$	A1		ACF
	Normal cuts curve C when $8 - 3t^2 + 3t + t^3 = 1$	M1		
	$\Rightarrow t^3 - 3t^2 + 3t + 7 = 0$	A1		
	$\Rightarrow (t+1)(t^2 - 4t + 7) = 0$ (*)	m1		
	$(t^2 - 4t + 7) = 0$ has no real solutions since $(-4)^2 < 4(1)(7)$.	M1		
	t = −1 is only real solution of (*) so normal only cuts C at P, where t = −1 ie the normal does not cut C again.	E1	11	
	Total		11	

Version 1.0

General Certificate of Education
June 2010

Mathematics MPC1

Pure Core 1

Mark Scheme

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It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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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.

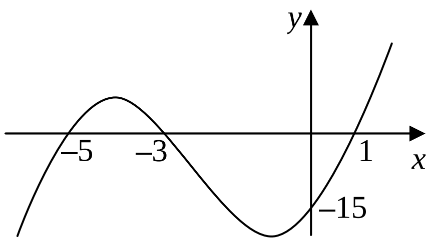
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

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

MPC1

Q	Solution	Marks	Total	Comments
1(a)	$y=\frac{14}{3}-\frac{2}{3}x$	M1		Attempt at $y=\ldots$
	Gradient $AB=-\frac{2}{3}$	A1	2	Condone error in rearranging equation
(b)(i)	$y-7=$"*their grad* AB"$(x-3)$	M1		or $2x+3y=k$ and sub $x=3$, $y=7$ or $y=mx+c$, $m=$ *their grad AB* and attempt to find c using $x=3$, $y=7$
	$y-7=-\frac{2}{3}(x-3)$ OE	A1	2	$2x+3y=27$, $y=-\frac{2}{3}x+9$ etc
(ii)	$m_1m_2=-1$	M1		or *negative reciprocal* (stated or used PI)
	$\Rightarrow$ grad $AD=\frac{3}{2}$	A1√		FT their grad AB
	$y-7=\frac{3}{2}(x-3)$	A1		Any correct equation unsimplified
	$\Rightarrow 3x-2y+5=0$	A1	4	Integer coefficients; all terms on one side, condone different order or multiples. eg $0=4y-6x-10$
(c)	$2x+3y=14$ and $5y-x=6$ used with x or y eliminated (generous)	M1		$2(5y-6)+3y=14$ etc
	$x=4$,	A1		
	$y=2$	A1	3	$B(4,2)$ full marks NMS
	Total		**11**	
2(a)	$\left(3-\sqrt{5}\right)^2=9-6\sqrt{5}+\left(\sqrt{5}\right)^2$	M1		Allow one slip in one of these terms M0 if middle term is omitted
	$=14-6\sqrt{5}$	A1	2	
(b)	$\frac{\left(3-\sqrt{5}\right)^2}{1+\sqrt{5}}\times\frac{1-\sqrt{5}}{1-\sqrt{5}}$	M1		or $\ldots\times\frac{\sqrt{5}-1}{\sqrt{5}-1}$
	$14+6\sqrt{5}\sqrt{5}-6\sqrt{5}-14\sqrt{5}$ $(=44-20\sqrt{5})$	m1		Expanding ***their*** numerator (condone one error or omission)
	(Denominator) $=-4$	B1		Must be seen as denominator
	(Answer) $=-11+5\sqrt{5}$	A1	4	Accept "answer $=5\sqrt{5}-11$"
	Total		**6**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	$\text{p}(-3)=(-3)^3+7(-3)^2+7(-3)-15$ $= -27+63-21-15$ $\text{p}(-3)=0 \Rightarrow (x+3 \text{ is) factor}$	M1 A1	 2	$\text{p}(-3)$ attempted; NOT long division This line alone implies M1 $\text{p}(-3)$ shown = 0 plus statement
(ii)	$\text{p}(x)=(x+3)(x^2+px+q)$ (Quadratic factor) (x^2+4x-5) $(\text{p}(x)=)\quad (x+3)(x-1)(x+5)$	M1 A1 A1	 3	Full long division, comparing coefficients or by inspection either p = 4 or q = –5 or M1 A1 for either x–1 or x+5 ***clearly*** found using Factor Theorem Must be seen as a product of 3 factors NMS full marks for correct product SC B2 for 3 correct factors listed NMS SC B1 for $(x + 3)(x – 1)(\ )$ or $(x + 3)(x + 5)(\ )$ or $(x + 3)(x + 1)(x – 5)$
(b)	$\text{p}(2)=2^3+7\times2^2+7\times2-15$ or (2+3)(2–1)(2+5) (Remainder) = 35	M1 A1cso	 2	NOT long division; must be $\text{p}(2)$ May use "their" product of factors
(c)(i)	$\text{p}(-1)=-16$; $\text{p}(0)=-15$ $\Rightarrow \text{p}(-1)<\text{p}(0)$	B1	1	Values must be evaluated correctly
(ii)	 Cannot score M1A0A1 but can score B0M1A1A1	B1 M1 A1 A1	 4	y- intercept –15 marked or (0,–15) stated Cubic graph – 1 max, 1 min  shape with –5, –3, 1 marked Graph correct with minimum point to left of y-axis and going beyond both –5 and 1 Previous A1 must be scored
	Total		**12**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$\frac{x^5}{5}-\frac{8}{2}x^2+9x$	M1 A1 A1		One term correct Another term correct All correct (may have + c)
	$\frac{32}{5}-16+18$	m1		$\mathrm{F}(2)$ attempted
	$=8\frac{2}{5}$	A1	5	$\frac{42}{5}$, 8.4
(ii)	Shaded area $=18$ – '*their integral*' $= 9\frac{3}{5}$	M1 A1	2	PI by 18 – (a)(i) NMS $\frac{48}{5}$, 9.6 NMS full marks
(b)(i)	$\frac{dy}{dx}=4x^3-8$	M1 A1		One term correct All correct (no + c etc)
	$x=1\Rightarrow\frac{dy}{dx}=4-8$	m1		sub $x=1$ into *their* $\frac{dy}{dx}$
	(Gradient of curve)$=-4$	A1cso	4	No ISW
(ii)	$y-2=-4(x-1)$; $y=-4x+c,\ c=6$	B1√	1	any correct form ; FT *their* answer from (b)(i) but must use x = 1 and y = 2
	Total		**12**	

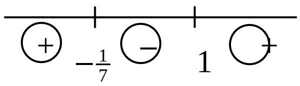
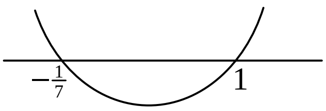
MPC1 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$(x+5)^2 + (y-6)^2 = 5^2$	M1 A1 B1	3	One term correct LHS LHS all correct RHS correct: condone = 25
(b)(i)	sub $x=-2,\ y=2$ into circle equation $3^2+(-4)^2 = 25$ $\Rightarrow$ lies on circle	B1	1	Circle equation must be correct Must have concluding statement
(ii)	Grad $PC = -\frac{4}{3}$ Normal to circle has equation $y-6 = \text{'}\textit{their gradient PC}\text{'}(x+5)$ or $y-2 = \text{'}\textit{their gradient PC}\text{'}(x+2)$ $y-6 = -\frac{4}{3}(x+5)$ or $y-2 = -\frac{4}{3}(x+2)$	B1 M1 A1cso	3	Condone $\frac{4}{-3}$ M0 if tangent attempted or incorrect coordinates used Any correct form eg $4x+3y+2=0$ $y=-\frac{4}{3}x+c,\quad c=-\frac{2}{3}$
(iii)	$PM = \frac{1}{2}\times$ radius $= 2.5$ $PO = \sqrt{8}$ P is closer to the point M	M1 A1cso B1 E1cso	4	**Alternative 1** Attempt at $M\left(-\frac{7}{2},4\right)$ with at least one correct coordinate **and** PM^2 attempted $PM^2 = \frac{9}{4}+4 = \frac{25}{4}$ $PO^2 = 4+4=8$ Statement following correct values
		(M1) (A1cso) (E1cso) (E1)	(4)	**Alternative 2** Attempt at $M\left(-\frac{7}{2},\ 4\right)$ with at least one correct coordinate **and** attempt at vectors or difference of coordinates $\overrightarrow{PM} = \begin{pmatrix}-1.5\\2\end{pmatrix}$ OE P is closer to the point M Components of their $\overrightarrow{PM}$ and $\overrightarrow{OP}$ considered – ***totally independent*** of M1
	Total		**11**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$\text{S.A.} = 4xy + 5xy + 3xy + 6x^2 + 6x^2$ OE	M1		Condone one slip or omission
	$= 12xy + 12x^2$	A1		
	$144 = 12xy + 12x^2$			Must see this line
	$\Rightarrow xy + x^2 = 12$	A1cso	3	AG
(ii)	(Volume =) $\frac{1}{2} \times 3x \times 4x \times y$ OE	M1		
	$= 6x^2 \times \frac{(12 - x^2)}{x}$			Must see $(y =)\frac{(12 - x^2)}{x}$ or $xy = 12 - x^2$ for A1
	$(V =) 72x - 6x^3$	A1	2	AG must be convinced not working back from answer
(b)(i)	$\frac{\mathrm{d}V}{\mathrm{d}x} = 72 - 18x^2$	M1 A1	2	One term correct All correct (no + *c* etc)
(ii)	$x = 2 \Rightarrow \frac{\mathrm{d}V}{\mathrm{d}x} = 72 - 18 \times 2^2$	M1		Substitute $x = 2$ into their $\frac{\mathrm{d}V}{\mathrm{d}x}$
	$\Rightarrow \frac{\mathrm{d}V}{\mathrm{d}x} = 72 - 72 = 0$			
	$\Rightarrow$ stationary (value when x = 2)	A1	2	Shown = 0 plus statement Statement may appear first
(c)	$\frac{\mathrm{d}^2V}{\mathrm{d}x^2} = -36x$	B1$\surd$		FT their $\frac{\mathrm{d}V}{\mathrm{d}x}$
	$\frac{\mathrm{d}^2V}{\mathrm{d}x^2} = -72$ *or* when $x = 2 \Rightarrow \frac{\mathrm{d}^2V}{\mathrm{d}x^2} < 0$			
	$\Rightarrow$ maximum	E1$\surd$	2	FT their $\frac{\mathrm{d}^2V}{\mathrm{d}x^2}$ value when x = 2 with appropriate conclusion
	Total		**11**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)	$2(x-5)^2$ $+\ 3$	B1 B1	 2	$p = 5$ $q = 3$
(ii)	Stating both $(x-5)^2 \geqslant 0$ and $3 > 0$ $\Rightarrow 2x^2 - 20x + 53 > 0$ *or* $2(x-5)^2 + 3 > 0$ $\Rightarrow 2x^2 - 20x + 53 = 0$ has no real roots	M1 A1cso	 2	FT their p & q, but must have $q > 0$ Must have statement and correct p & q.
(b)(i)	$b^2 - 4ac = (k+1)^2 - 4k(2k-1)$ $= -7k^2 + 6k + 1$ real roots $\Rightarrow b^2 - 4ac \geqslant 0$ $-7k^2 + 6k + 1 \geqslant 0$ $\Rightarrow 7k^2 - 6k - 1 \leqslant 0$	M1 A1 B1√ A1cso	 4	Condone one slip (including x is one slip) Condone recovery from missing brackets Their discriminant $\geqslant 0$ (in terms of k) Need not be simplified & may earn earlier AG (must see sign change)
(ii)	$(7k+1)(k-1)$ Critical values $k = 1, -\frac{1}{7}$ Use of sign diagram or sketch   $-\frac{1}{7} \leqslant k \leqslant 1$ Full marks for correct answer NMS Condone $-\frac{2}{14}$ throughout Condone $k \geqslant -\frac{1}{7}$ AND $k \leqslant 1$ for full marks ***Take their final line as their answer.***	M1 A1 M1 A1	 4	**Correct** factors or **correct** use of formula May score M1, A1 for correct critical values seen as part of incorrect final answer with or without working. If previous A1 earned, sign diagram or sketch must be correct for M1 Otherwise M1 may be earned for an attempt at the sketch or sign diagram using ***their*** critical values. $\left(-\frac{1}{7} < k < 1\right)$, $\left(k \geqslant -\frac{1}{7} \text{ OR } k \leqslant 1\right)$, $\left(k \geqslant -\frac{1}{7},\ k \leqslant 1\right)$ score M1A1M1A0 *Answer only of* $k < -\frac{1}{7},\quad k < 1$ etc scores M1, A1, M0 since the critical values are evident. *Answer only of* $\frac{1}{7} \leqslant k \leqslant 1$ etc scores M0, M0 since the critical values are not both correct.
	Total		**12**	
	TOTAL		**75**	

Version1.0

General Certificate of Education (A-level)
January 2011

Mathematics MPC1

(Specification 6360)

Pure Core 1

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$-x$ EE	deduct x marks for each error
NMS	no method shown
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SCA	substantially correct approach
c	candidate
sf	significant figure(s)
dp	decimal place(s)

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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.

MPC1

Q	Solution	Marks	Total	Comments
1(a)	$\frac{dy}{dx} = 18 + 6x - 12x^2$	M1 A1 A1	3	one of these terms correct another term correct all correct (no + c etc) (penalise + c once only in question)
(b)	$18 + 6x - 12x^2 = 0$	M1		putting their $\frac{dy}{dx} = 0$, PI by attempt to solve or factorise
	$6\ (3-2x)(x+1) \quad (= 0)$	m1		attempt at factors of **their quadratic** or use of quadratic equation formula
	$x = -1,\ x = \frac{3}{2}$ OE	A1	3	must see both values unless $x = -1$ is verified separately If M1 not scored, award SC B1 for verifying that $x = -1$ leads to $\frac{dy}{dx} = 0$ and a further SC B2 for finding $x = \frac{3}{2}$ as other value
(c)(i)	$\frac{d^2y}{dx^2} = 6 - 24x$	B1√		FT their $\frac{dy}{dx}$ but $\frac{d^2y}{dx^2}$ must be correct if 3 marks earned in part (a)
	When $x = -1,\ \frac{d^2y}{dx^2} = 6 - (24 \times -1)$	M1		Sub $x = -1$ into 'their' $\frac{d^2y}{dx^2}$
	$\frac{d^2y}{dx^2} = 30$	A1cso	3	
(ii)	Minimum point	E1√	1	must have a value in (c)(i) FT "maximum" if their value of $\frac{d^2y}{dx^2} < 0$
	Total		**10**	

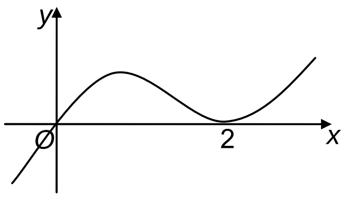
MPC1 (cont)

Q	Solution	Marks	Total	Comments
2(a)	27	B1	1	
(b)	$\frac{4\sqrt{3}+3\sqrt{7}}{3\sqrt{3}+\sqrt{7}} \times \frac{3\sqrt{3}-\sqrt{7}}{3\sqrt{3}-\sqrt{7}}$	M1		
	(Numerator =) $36+9\sqrt{21}-4\sqrt{21}-21$	m1		expanding numerator condone one slip or omission
	(Denominator =) 20	B1		must be seen as denominator
	$\frac{15+5\sqrt{21}}{20}$ $=\frac{3+\sqrt{21}}{4}$	A1cso	4	$m = 3$, $n = 4$ condone $\frac{3}{4}+\frac{\sqrt{21}}{4}$
	Total		**5**	
3(a)(i)	$y=\frac{1}{2}(7-3x)$	M1		attempt at $y = \ldots$ or use of 2 correct points using $\frac{\Delta y}{\Delta x}$
	$\Rightarrow$ gradient $=-\frac{3}{2}$	A1	2	condone slip in rearranging if gradient is correct
(ii)	$y =$ 'their grad' $x + c$ and substitution of $x = 2$, $y = –7$	M1		or using $3x + 2y = k$ with $x = 2$, $y = –7$ and attempt to find k or $y--7=$ 'their grad'$(x-2)$
	$y=-\frac{3}{2}x+c,\quad c=-4$	A1		correct equation in any form $y+7=-\frac{3}{2}(x-2)$, $3x + 2y + 8 = 0$, etc
	$(x=0 \Rightarrow)\ y=-4$	A1cso	3	or y-intercept = –4 or $D(0, –4)$
(b)	$3x+2(1-4x)=7$, $y=1-\frac{4}{3}(7-2y)$	M1		elimination of y (or x) (condone one slip)
	$x=-1$	A1		one coordinate correct
	$y = 5$	A1	3	other coordinate correct coordinates of $A(–1, 5)$
(c)	$(5-2)^2+(k+7)^2=5^2$ (or $k + 7 = 4$ or $k + 7 = –4$)	M1		condone one sign slip within one bracket
	$k=-3$	A1		one correct value of k
	or $k = -11$	A1	3	both correct (and no other values)
	Total		**11**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$\frac{dy}{dx} = -1 - 4x^3$	M1 A1		one of these terms correct all correct (no + c)
	(When $x = 1$, grad =) –5	A1cso	3	(Check that $\frac{dy}{dx}$ is actually correct!)
(ii)	$y - 12 = \text{'their grad'}(x - 1)$	M1		any form of equation through (1, 12) and attempt at c if using $y = mx + c$
	$y = -5x + 17$ (or $y = 17 - 5x$)	A1$\sqrt{}$	2	FT their gradient Condone $y = -5x + c$, $c = 17$ etc
(b)(i)	$14x - \frac{x^2}{2} - \frac{x^5}{5}$	M1 A1 A1		one of these terms correct another term correct all correct (may have + c)
	$[\ ]_{-2}^{1} =$			
	$\left(14 - \frac{1}{2} - \frac{1}{5}\right) - \left(-28 - 2 + \frac{32}{5}\right)$	m1		F(1) and F(–2) attempted
	= 36.9 OE	A1	5	Condone recovery to this value
(ii)	Area $\Delta = \frac{1}{2} \times 3 \times 12$ = 18	M1		Correct area of triangle unsimplified
	$\Rightarrow$ shaded area = 18.9	A1cso	2	
	Total		**12**	

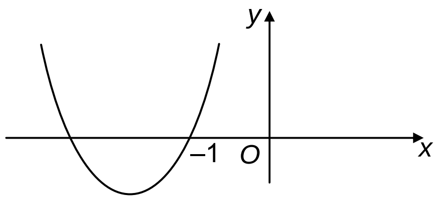
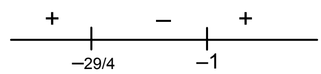
MPC1 (cont)

Q	Solution	Marks	Total	Comments
5(a)(i)		M1 A1 A1	 3	cubic curve with one max and one min (either way up) curve touching positive *x*-axis (either way up) correct graph passing through *O* and touching *x*-axis at 2
(ii)	$x\left(x^2-4x+4\right)=3$ $\Rightarrow x^3-4x^2+4x-3=0$	B1	1	AG (must have = 0)
(b)(i)	$\text{p}(-1)=(-1)^3-4(-1)^2+4(-1)-3$ $(=-1-4-4-3)$ $=-12$	M1 A1	 2	p(–1) attempted (condone one slip) or full long division to remainder must indicate remainder = –12 if long division used
(ii)	$\text{p}(3)=3^3-4\times3^2+4\times3-3$ $\text{p}(3)=27-36+12-3$ $\text{p}(3)=0\Rightarrow x-3$ is factor	M1 A1	 2	p(3) attempted (condone one slip) NOT long division shown = 0 **plus statement**
(iii)	Either $b=-1$ (coefficient of *x* correct) or $c=1$ (constant term correct) $\text{p}(x)=(x-3)\left(x^2-x+1\right)$	M1 A1	 2	allow M1 for full attempt at long division or comparing coefficients if neither *b* nor *c* is correct
(c)	Discriminant of 'their quadratic' $=(-1)^2-4$ Discriminant = –3 (or < 0) $\Rightarrow$ no real roots (Only real root is *x* =) 3	M1 A1cso B1	 3	numerical expression must be seen must have correct quadratic and statement and all working correct
	Total		**13**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$(x+3)^2+(y-1)^2$	B1		condone $(x--3)^2$
	$= 13$	B1	2	condone $\left(\sqrt{13}\right)^2$
(ii)	$x^2+6x+9+y^2-2y+1$	M1		attempt to multiply out both of 'their' brackets; must have *x* and *y* terms
	$x^2+y^2+6x-2y$	A1		both $m = 6$ and $n = -2$
	$-3=0$	A1	3	All correct, $p = -3$ and ... = 0
(b)	$x=0 \;\Rightarrow\; y^2-2y-3=0$			putting $x = 0$ PI
	$\Rightarrow\; (y-3)(y+1)=0$	M1		and attempt to solve or factorise
	$y=3,\; y=-1$	A1		
	$\Rightarrow$ Distance $AB=3+1=4$	A1cso	3	**OR** Pythagoras $d^2=13-3^2$ M1 $d = 2$ A1 distance = $2\times 2 = 4$ A1
(c)(i)	$(-5+3)^2+(-2-1)^2=4+9$			Substitution $x=-5$, $y=-2$ into any correct circle equation
	$=13$			
	$\Rightarrow$ *D* lies on circle	B1	1	convincing verification **plus statement**
(ii)	grad *CD* $= \dfrac{1+2}{-3+5}$	M1		condone one sign slip
	$=\dfrac{3}{2}$ (or 1.5)	A1	2	not $\dfrac{-3}{-2}$
(iii)	Perpendicular gradient $=-\dfrac{2}{3}$	M1		ft their grad *CD* or $m_1m_2=-1$ stated
	Tangent has equation $y+2=-\dfrac{2}{3}(x+5)$	A1	2	any form of correct equation eg $2x + 3y + 16 = 0$ $y=-\dfrac{2}{3}x+c,\; c=-\dfrac{16}{3}$
	Total		**13**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)	(–) $(x+5)^2$	M1		$q = 5$; condone $(-x-5)^2$
	$29 - (x+5)^2$	A1	2	$p = 29$ and $q = 5$
(ii)	$x = -5$ is line of symmetry	B1$\surd$	1	FT $x = -$ ‘their q’ or correct
(b)(i)	$4-10x-x^2 = k(4x-13)$			
	$\Rightarrow x^2+4kx+10x-13k-4=0$			Must see both these lines OE
	$\Rightarrow x^2+2(2k+5)x-(13k+4)=0$	B1	1	AG all correct working and = 0
(ii)	2 distinct roots $\Rightarrow b^2-4ac>0$	B1		stated or used (must be >0)
	Discriminant = $4(2k+5)^2+4(13k+4)$	M1		condone one slip (may be within formula)
	$4\left(4k^2+20k+25+13k+4\right)>0$			or $16k^2+132k+116>0$
	$\Rightarrow 4k^2+33k+29>0$	A1	3	AG >0 must appear before final line
(iii)	$(4k+29)(k+1)$	M1		correct factors or correct unsimplified quadratic equation formula $\dfrac{-33\pm\sqrt{33^2-4\times4\times29}}{8}$
	$k=-\dfrac{29}{4}$, $k=-1$	A1		condone $k=-\dfrac{58}{8}$, –7.25 etc but not left with square roots etc as above
$-\dfrac{29}{4}$		M1		sketch or sign diagram including values 
	$k<-\dfrac{29}{4}$, $k>-1$	A1	4	condone use of **OR** but not **AND**
	Take their final line as their answer			
	Total		**11**	
	TOTAL		**75**	

Version 1.0

General Certificate of Education (A-level)
June 2011

Mathematics — MPC1

(Specification 6360)

Pure Core 1

Final

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Further copies of this Mark Scheme are available from: aqa.org.uk

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Registered address: AQA, Devas Street, Manchester M15 6EX.

Key to mark scheme abbreviations

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
CAO	correct answer only
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
A2,1	2 or 1 (or 0) accuracy marks
$-x$ EE	deduct x marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
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.

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.

MPC1

Q	Solution	Marks	Total	Comments
1(a)	$y=\frac{13}{3}-\frac{7}{3}x$	M1		attempt at $y = a + bx$ or $\frac{\Delta y}{\Delta x}$ with 2 correct points
	(gradient =) $-\frac{7}{3}$	A1	2	condone slip in rearranging if gradient is correct
(b)(i)	$y - 3$ = 'their grad'$(x - -1)$	M1		*or* $7x + 3y = k$ and attempt at k using $x = -1$ and $y = 3$ *or* y = (their m)$x + c$ and attempt at c using $x = -1$ and $y = 3$
	$y-3=-\frac{7}{3}(x+1)$ or $7x+3y=2$ or $y=-\frac{7}{3}x+c,\quad c=\frac{2}{3}$	A1cso	2	correct equation in any form and replacing – – with + sign
(ii)	$(4,-5)$	B1,B1	2	$x = 4$, $y = -5$ withhold if clearly from incorrect working
(c)	$7x + 3y = 13$ and $3x + 2y = 12$ $\Rightarrow$ equation in x or y only	M1		must use correct pair of equations and attempt to eliminate y (or x)
	$x = -2$	A1		
	$y = 9$	A1	3	
	Total		**9**	

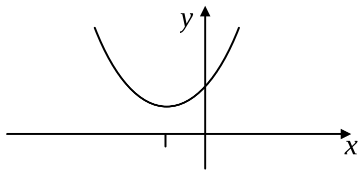
MPC1 (cont)

Q	Solution	Marks	Total	Comments
2(a)(i)	$\sqrt{48} = 4\sqrt{3}$	B1	1	condone k = 4 stated
(ii)	$\dfrac{4\sqrt{3}+6\sqrt{3}}{2\sqrt{3}}$	M1		attempt to write each term in form $k\sqrt{3}$ with at least 2 terms correctly obtained
		A1		correct unsimplified in terms of $\sqrt{3}$ only
	= 5	A1cso	3	must simplify fraction to 5
				Alternative 1 $\times\dfrac{\sqrt{12}}{\sqrt{12}}$ $\left(or \times\dfrac{\sqrt{3}}{\sqrt{3}}\right)$ M1 correct with integer terms $=\dfrac{24+36}{12}$ A1 = 5 A1cso
				Alternative 2 $\dfrac{\sqrt{48}+\sqrt{108}}{\sqrt{12}}$ M1 $=\sqrt{4}+\sqrt{9}$ A1 = 5 A1cso
				Alternative 3 $\sqrt{\dfrac{48}{12}}+2\sqrt{\dfrac{27}{12}}$ M1 $=2+2\sqrt{\dfrac{9}{4}}$ A1 $=5$ A1cso
				if hybrid of methods used, award M1 and most appropriate first A1 NMS (answer =) 5 scores full marks
(b)	$\dfrac{1-5\sqrt{5}}{3+\sqrt{5}}\times\dfrac{3-\sqrt{5}}{3-\sqrt{5}}$	M1		
	(numerator =) $3-\sqrt{5}-15\sqrt{5}+25$	m1		correct unsimplified but must write $5\sqrt{5}\sqrt{5}=25$ PI by 28 seen later
	(denominator = 9 – 5 =) 4	B1		must be seen as denominator
	giving $\dfrac{28-16\sqrt{5}}{4}$			
	(answer =) $7-4\sqrt{5}$	A1	4	m = 7 , n = –4
	Total		**8**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
3(a)	$\left(\dfrac{dV}{dt}=\right)\dfrac{3t^2}{4}-3$	M1 A1	2	one of these terms correct all correct (no + *c* etc)
(b)(i)	$t=1 \Rightarrow \dfrac{dV}{dt}=\dfrac{3}{4}-3$	M1		substituting $t = 1$ into their $\dfrac{dV}{dt}$
	$=-2\dfrac{1}{4}$	A1cso	2	(–2.25 OE) *BUT* must have $\dfrac{dV}{dt}$ correct
(ii)	Volume is decreasing when $t = 1$			must have used $\dfrac{dV}{dt}$ in (b)(i) or starts again
	because $\dfrac{dV}{dt}<0$	E1√	1	must state that $\dfrac{dV}{dt}<0$ (or $-2\dfrac{1}{4}<0$ etc) ft increasing plus explanation if their $\dfrac{dV}{dt}>0$
(c)(i)	$\left(\dfrac{dV}{dt}=0\Rightarrow\right)\dfrac{3t^2}{4}-3=0$	M1		PI by "correct" equation being solved
	$\Rightarrow t^2=4$	A1√		obtaining $t^n=k$ correctly from their $\dfrac{dV}{dt}$
	$t=2$	A1cso	3	withhold if answer left as $t = \pm 2$
(ii)	$\left(\dfrac{d^2V}{dt^2}=\right)\dfrac{3t}{2}$	B1√		(condone unsimplified) ft their $\dfrac{dV}{dt}$
	When $t = 2$, $\dfrac{d^2V}{dt^2}=3$ or $\dfrac{d^2V}{dt^2}>0$	M1		ft their $\dfrac{d^2V}{dt^2}$ and value of *t* from (c)(i)
	$\Rightarrow$ minimum	A1cso	3	
	Total		**11**	

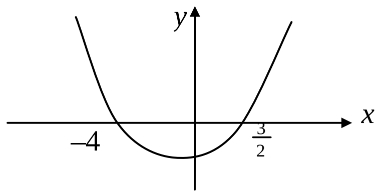
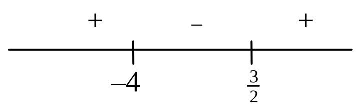
MPC1 (cont)

Q	Solution	Marks	Total	Comments
4(a)	$\left(x+2.5\right)^2$	B1		$p=\frac{5}{2}$
	$q=7-\text{'their' }p^2$	M1		unsimplified attempt at $q=7-\text{'their' }p^2$ $q=7-\frac{25}{4}=\frac{3}{4}$
	$\left(x+2.5\right)^2+0.75$ ***mark their final line as their answer***	A1	3	
(b)(i)	$x=-$ 'their' p or $y=$ 'their' q	M1		or $x=-\frac{5}{2}$ cao found using calculus
	$\left(-\frac{5}{2},\ \frac{3}{4}\right)$	A1cao	2	condone correct coordinates stated $x=-2.5$, $y=0.75$
(ii)	$x=-\frac{5}{2}$	B1√	1	correct *or* ft " $x=-\text{'their' }p$ "
(iii)		B1		y intercept = 7 stated or seen in table as $y=7$ when $x=0$ or 7 marked as intercept on y-axis (any graph)
		M1		$\cup$ shape
		A1	3	vertex above x-axis in correct quadrant and parabola extending beyond y-axis into first quadrant
(c)	Translation	E1		and no other transformation
	through $\begin{bmatrix}-\frac{5}{2}\\ \frac{3}{4}\end{bmatrix}$	M1		ft either 'their' $-p$ or 'their' q or one component correct for M1
		A1cao	3	both components correct for A1; may describe in words or use a vector
	Total		**12**	

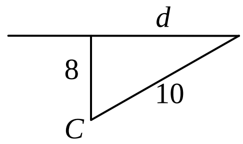
MPC1 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$p(3)=3^3-2\times3^2+3\,(=27-18+3)$	M1		p(3) attempted; not long division
	$=12$	A1	2	
(b)	$p(-1)=(-1)^3-2(-1)^2+3$	M1		p(–1) attempted; not long division
	$p(-1)=-1-2+3=0 \Rightarrow x+1$ is a factor	A1cso	2	correctly shown = 0 plus statement
(c)(i)	Quadratic factor (x^2-3x+3)	M1		$b=-3$ or $c=3$ by inspection or full long division attempt or comparing coefficients
	$(p(x)=)\quad(x+1)(x^2-3x+3)$	A1	2	must see correct product
(ii)	Discriminant of quadratic $b^2-4ac=(-3)^2-4\times3$	M1		'their' discriminant considered possibly within quadratic equation formula
	$\left.\begin{array}{l}b^2-4ac<0\Rightarrow\text{no real roots from quadratic}\\ \Rightarrow\text{only one real root}\end{array}\right\}$	A1cso	2	
	Total		**8**	
6(a)	$\int_{-1}^{1}(x^3-2x^2+3)\,dx$			
	$=\left[\dfrac{x^4}{4}-\dfrac{2x^3}{3}+3x\right]_{-1}^{1}$	M1 A1 A1		one term correct another term correct all correct (condone + c)
	$=\left(\dfrac{1}{4}-\dfrac{2}{3}+3\right)-\left(\dfrac{1}{4}+\dfrac{2}{3}-3\right)$	B1√		'their' F(1) – F(–1) with $(-1)^3$ etc evaluated correctly but must have earned M1
	$=4\dfrac{2}{3}$	A1cso	5	$\dfrac{14}{3}$, $\dfrac{56}{12}$ etc but combined as single fraction
(b)	Area of Δ $\left(=\dfrac{1}{2}\times2\times2\right)$ $=2$	B1		PI
	Shaded region has area $4\dfrac{2}{3}-2$	M1		$\pm$ their (a) $\pm$ their Δ area
	$=2\dfrac{2}{3}$	A1cso	3	$\dfrac{8}{3}$, $\dfrac{32}{12}$ etc but combined as single fraction
	Total		**8**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$8-6x > 5-4x-8$	M1		multiplying out correctly and $>$ sign used
	$11 > 2x$			
	$x < 5\frac{1}{2}$ $\left(or\ x < \frac{11}{2} \right)$	A1cso	2	accept $5.5 > x$ OE
(b)	$2x^2 + 5x - 12 \geqslant 0$			
	$(x+4)(2x-3)$	M1		correct factors (or roots unsimplified) $\frac{-5 \pm \sqrt{121}}{4}$
	Critical values are -4 and $\frac{3}{2}$	A1		both CVs correct; condone $\frac{6}{4}, -\frac{16}{4}$ etc here but must be single fractions
		M1		sketch or sign diagram including values 
	$x \leqslant -4$, $x \geqslant \frac{3}{2}$ ***take their final line as their answer***	A1	4	fractions must be simplified condone use of **OR** but not **AND**
	Total		**6**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
8(a)	$(x-3)^2+(y+8)^2$	B1		accept $(y--8)^2$
	$=100$	B1	2	condone RHS $=10^2$ or $k=10^2$
(b)	$y=0 \Rightarrow$ 'their'$(x-a)^2+b^2=k$	M1		**Alternative** 
	$(x-3)^2=36$ or $x^2-6x-27\ (=0)$ (PI)	A1		
	$\Rightarrow x=-3,\ 9$	A1	3	$(d^2=)\ 10^2-8^2$ M1 $d^2=36$ A1 or $d=6$ $\Rightarrow x=-3,\ 9$ A1
(c)	Line CA has gradient $-\dfrac{2}{5}$	M1		
	CA has equation $(y+8)=-\dfrac{2}{5}(x-3)$	A1		any form of correct equation eg $y=-\dfrac{2}{5}x+c,\quad c=-\dfrac{34}{5}$
	$2x+5y+34=0$	A1cso	3	integer coefficients - all terms on 1 side
(d)(i)	their $(x-3)^2+(2x+1+8)^2$ *or* $x^2+(2x+1)^2-6x+16(2x+1)\quad(+73)$	M1		substituting $y=2x+1$ correctly into LHS of "their" circle equation and attempt to expand in terms of x only
	$x^2-6x+9+4x^2+36x+81=100$ *or* $x^2+4x^2+4x+1-6x+32x+16+73=100$	A1		any correct equation (with brackets expanded)
	$\Rightarrow 5x^2+30x-10=0$			must see this line or equivalent
	$\Rightarrow x^2+6x-2=0$	A1cso	3	AG; all algebra must be correct
(ii)	$(x+3)^2=11$	M1		or correct use of formula must get as far as $x=\dfrac{-6\pm\sqrt{44}}{2}$
	$x=-3\pm\sqrt{11}$	A1cso	2	exactly this
	Total		**13**	
	TOTAL		**75**	

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General Certificate of Education (A-level)
January 2012

Mathematics MPC1

(Specification 6360)

Pure Core 1

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

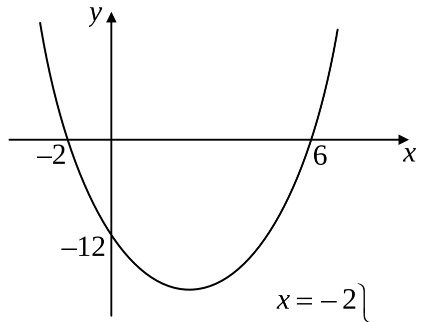
MPC1

Q	Solution	Marks	Total	Comments
1(a)	$\left(OA^2=\right)6^2+(-4)^2$; $\left(OB^2=\right)(-2)^2+7^2$	M1		either correct PI by 52 or 53 seen
	$\left(OA^2=\right)52$ **and** $\left(OB^2=\right)53$ or $\left(OA=\right)\sqrt{52}$ **and** $\left(OB=\right)\sqrt{53}$	A1		both correct values 52 or $\sqrt{52}$ **and** 53 or $\sqrt{53}$ seen
	$OA=\sqrt{52}$ and $OB=\sqrt{53}$ $\Rightarrow OA<OB$	A1	3	or $OA^2=52$ *and* $OB^2=53$ correct working + concluding statement involving *OA* and/or *OB*
(b)(i)	grad $AB=\dfrac{7+4}{-2-6}$	M1		condone one sign error
	$=-\dfrac{11}{8}$	A1	2	
(ii)	$y--4=$ 'their grad AB'$(x-6)$ or $y-7=$ 'their grad AB'$(x--2)$	M1		or $y=$ 'their grad AB' $x+c$ and attempt to find c using $x=6$, $y=-4$ or $x=-2$, $y=7$
	$y+4=-\dfrac{11}{8}(x-6)$ OE	A1		any correct form *eg* $y=-\dfrac{11}{8}x+\dfrac{34}{8}$ but must simplify $--$ to +
	$\Rightarrow 11x+8y=34$	A1	3	condone $8y+11x=34$ or any multiple of these equations
(c)	(grad AC =) $\dfrac{8}{11}$	B1$\surd$		FT -1 / 'their grad AB'
	$\dfrac{4}{k-6}=$ '*their* $\dfrac{8}{11}$' OE $\Rightarrow 2k-12=11$	M1		equating gradients; LHS must be correct and RHS is "attempt" at perp grad to *AB*
	$\Rightarrow k=\dfrac{23}{2}$	A1cso	3	$k=11.5$ OE
	Total		**11**	

(c) ***Alternative:*** Eqn AC : $(y+4)=$ '*their* $\dfrac{8}{11}$' $(x-6)$ B1$\surd$ $(11y=8x-92)$ **AND** must sub $y=0$ for M1

or $(y-0)=$ '*their* $\dfrac{8}{11}$' $(x-k)$ B1$\surd$ **AND** must sub $x=6$, $y=-4$ for M1

MPC1 (cont)

Q	Solution	Marks	Total	Comments
2(a)	$(x-6)(x+2)$	B1	1	ISW for $x=6,\ x=-2$ etc
(b)				
	$\left.\begin{array}{l} x=-2 \\ x=6 \end{array}\right\}$	B1√		correct x values *or* FT 'their' factors (x-intercepts stated ***or*** marked on sketch) may be seen in (a)
	$y=-12$	B1		(stated ***or*** –12 marked on sketch)
	$\cup$ – shaped curve	M1		approximately
	"correct" shape in all 4 quadrants with minimum to right of y-axis	A1	4	
(c)(i)	$(x-2)^2$	M1		$p=2$
	$(x-2)^2-16$	A1	2	$p=2$ and $q=16$
(ii)	(Minimum value is) –16	B1√	1	FT ' their $-q$ '
(d)	Replacing each x by $x+3$ **OR** adding 2 to their quadratic	M1		in original equation or 'their' completed square or factorised form or replacing y by $y-2$
	$\left.\begin{array}{l} y=\left[(x+3)^2-4(x+3)-12\right]+2 \\ \text{or} \quad y=(x+1)^2-14 \\ \text{or} \quad y=x^2+2x-13 \\ \text{or} \quad y-2=(x-3)(x+5) \end{array}\right\}$	A1	2	OE any correct equation in x and y **unsimplified**
	Total		**10**	

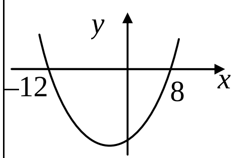
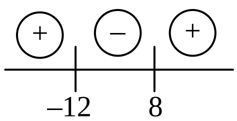
MPC1 (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	$\left(3\sqrt{2}\right)^2 = 18$	B1	1	
(ii)	$\left(3\sqrt{2}-1\right)^2 = \text{'}\textit{their}\ 18\text{'} - 3\sqrt{2} - 3\sqrt{2} + 1$	M1		FT their $\left(3\sqrt{2}\right)^2$
	$= 18 - 3\sqrt{2} - 3\sqrt{2} + 1$	A1		$\left(= 19 - 6\sqrt{2}\right)$
	$\left(3+\sqrt{2}\right)^2 = 9 + 3\sqrt{2} + 3\sqrt{2} + 2$	B1		$\left(= 11 + 6\sqrt{2}\right)$
	$\Rightarrow$ Sum = 30	A1cso	4	
(b)	$\dfrac{4\sqrt{5}-7\sqrt{2}}{2\sqrt{5}+\sqrt{2}} \times \dfrac{2\sqrt{5}-\sqrt{2}}{2\sqrt{5}-\sqrt{2}}$	M1		
	Numerator = $8\left(\sqrt{5}\right)^2 - 4\sqrt{5}\sqrt{2} - 14\sqrt{5}\sqrt{2} + 7\left(\sqrt{2}\right)^2$	m1		correct unsimplified $\left(= 54 - 18\sqrt{10}\right)$
	Denominator $= \left(2\sqrt{5}\right)^2 - \left(\sqrt{2}\right)^2$ $= 18$	B1		must be seen as denominator
	$\Rightarrow$ Answer $= 3 - \sqrt{10}$	A1cso	4	
	Total		**9**	

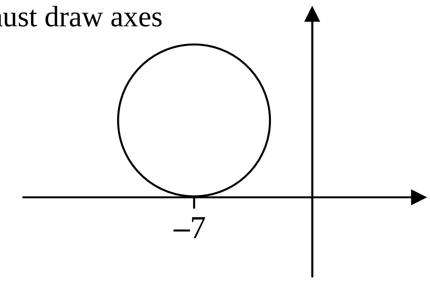
MPC1 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$\left(\frac{\mathrm{d}y}{\mathrm{d}x}=\right)\ 5x^4-6x+1$	M1 A1 A1	3	one term correct another term correct all correct (no + c etc)
(ii)	$\left(\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=\right)\ 20x^3-6$	B1$\surd$	1	FT 'their' $\frac{\mathrm{d}y}{\mathrm{d}x}$
(b)	$x=-1 \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x}=5(-1)^4-6(-1)+1\ \ (=12)$ $\Rightarrow\ y=12(x+1)$	M1 A1cso	2	must sub $x=-1$ into 'their' $\frac{\mathrm{d}y}{\mathrm{d}x}$ any correct form with $(x--1)$ simplified condone $y=12x+c,\quad c=12$
(c)	$x=1 \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x}=5-6+1$ $\frac{\mathrm{d}y}{\mathrm{d}x}=0 \Rightarrow$ stationary point when $x=1$, $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=14$ $\Rightarrow$ (B is a) minimum (point)	M1 A1cso E1	3	sub $x=1$ into their $\frac{\mathrm{d}y}{\mathrm{d}x}$ shown $=0$ plus correct statement or $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=20-6>0$ $\Rightarrow$ (B is a) minimum (point) must have correct $\frac{\mathrm{d}y}{\mathrm{d}x}$ and $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$ for E1
(d)(i)	$\frac{x^6}{6}-\frac{3x^3}{3}+\frac{x^2}{2}+5x$ $\left[\frac{1}{6}-1+\frac{1}{2}+5\right]-\left[\frac{1}{6}+1+\frac{1}{2}-5\right]$ $=\ 8$	M1 A1 A1 m1 A1cso	5	one term correct another term correct all correct (may have $+c$) 'their' F(1) – F(–1) with powers of 1 and –1 evaluated correctly
(ii)	'their answer to part (i)' -2 $\Rightarrow$ Area $=6$	M1 A1cso	2	
	Total		**16**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$p(-2) = (-2)^3 + (-2)^2 c + (-2)d - 12$	M1		p(–2) attempted *or* long division by x+2 as far as remainder
	‘their’ $-8 + 4c - 2d \ -12 = -150$	m1		putting expression for remainder = –150
	$\Rightarrow \ 2c - d + 65 = 0$	A1cso	3	**AG** terms all on one side in any order (check that there are no errors in working)
(b)	$p(3) = 3^3 + 3^2 c + 3d - 12$	M1		p(3) attempted *or* long division by x–3 as far as remainder
	$9c + 3d + 15 = 0$	A1	2	any correct equation with terms collected eg $3c + d = -5$
(c)	$\left.\begin{array}{l} 2c - d + 65 = 0 \\ 3c + d + \ \ 5 = 0 \end{array}\right\} \Rightarrow 5c = -70$	M1		Elimination of c or d
	$\Rightarrow \ c = -14$, $d = 37$ OE	A1 A1	 3	value of c ***or*** d correct unsimplified both c and d correct unsimplified
	Total		**8**	
6(a)	Sides are x and $x + 4$ $\left.\begin{array}{l} \Rightarrow \ x + x + x + 4 + x + 4 > 30 \\ \quad or \ \ 2x + 2x + 8 > 30 \\ \quad or \ \ 2(2x+4) > 30 \\ \quad or \ \ 4x + 8 > 30 \end{array}\right\}$			must see this line OE
	$(\Rightarrow 4x > 22)$ $\Rightarrow 2x > 11$	B1	1	**AG** (be convinced) condone 11 < 2x
(b)	$x(x+4) < 96$			must see this line OE
	$\Rightarrow x^2 + 4x - 96 < 0$	B1	1	**AG**
(c)	$(x+12)(x-8)$	M1		correct factors or correct quadratic equation formula
	Critical values 8, –12	A1		
	 or 	M1		sketch or sign diagram
	$\Rightarrow -12 < x < 8$	A1cso	4	accept $x < 8$ **AND** $x > -12$ but **not** $x < 8$ **OR** $x > -12$ **nor** $x < 8$ **,** $x > -12$
(d)	$5\frac{1}{2} < x < 8$	B1	1	
	Total		**7**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$(x+7)^2+(y-5)^2$	M1		one term correct ; condone $(x--7)^2$
		A1		both terms correct with squares and plus sign between terms
	$(x+7)^2+(y-5)^2 \quad = 5^2$	A1cao	3	condone 25 for 5^2
(b)(i)	$C(-7, 5)$	B1$\sqrt{}$		correct or FT 'their' circle equation
(ii)	$r = 5$	B1$\sqrt{}$	2	correct or FT 'their' $r^2 > 0$ condone $\sqrt{25}$ etc but not $\pm\sqrt{25}$
(c)	must draw axes 	M1		freehand circle with C correct or FT 'their C' for quadrant of centre
		A1	2	circle touching x-axis at -7 with -7 marked (need not show 5 on y-axis) but circle must not touch y-axis
(d)(i)	$x^2+(kx+6)^2+14x-10(kx+6)+49=0$			clear attempt to sub $y = kx+6$ into original or 'their' circle equation …
	$x^2+k^2x^2+12kx+36+14x$ $-10kx-60+49=0$	M1		…***and*** attempt to multiply out
	$(1+k^2)x^2+2kx+14x+25=0$ $\Rightarrow (k^2+1)x^2+2(k+7)x+25=0$	A1cso	2	**AG** condone $x^2(1+k^2)+2x(7+k)+\ldots$ etc
(ii)	Equal roots '$b^2-4ac=0$'	B1		allow statement alone if discriminant in terms of k attempted
	$\left[2(k+7)\right]^2-4\times 25(k^2+1)$	M1		discriminant (condone one slip)
	$4\{k^2+14k+49-25k^2-25\}=0$ $-24k^2+14k+24=0$			
	$\Rightarrow 12k^2-7k-12=0$	A1	3	**AG** all working correct but = 0 must appear before last line
(iii)	$(4k+3)(3k-4)$	M1		correct factors or correct use of formula as far as $k=\dfrac{7\pm\sqrt{49+576}}{24}$
	$\Rightarrow k=-\dfrac{3}{4},\ k=\dfrac{4}{3}$ OE are values of k for which line is a tangent	A1	2	
	Total		**14**	
	TOTAL		**75**	

Version 1.0

General Certificate of Education (A-level)
June 2012

Mathematics MPC1

(Specification 6360)

Pure Core 1

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Key to mark scheme abbreviations

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
CAO	correct answer only
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
A2,1	2 or 1 (or 0) accuracy marks
–*x* EE	deduct *x* marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
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.

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**.

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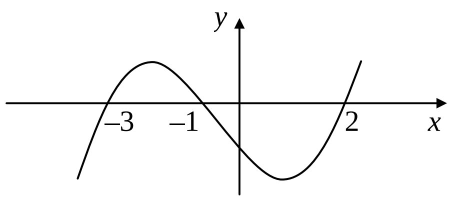
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

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

MPC1

Q	Solution	Marks	Total	Comments
1	$\frac{5\sqrt{3}-6}{2\sqrt{3}+3} \times \frac{2\sqrt{3}-3}{2\sqrt{3}-3}$	M1		
	(Numerator $=$) $30-15\sqrt{3}-12\sqrt{3}+18$	m1		correct $\left(=48-27\sqrt{3}\right)$
	(Denominator $=12-9=$) 3	B1		must be seen as denominator
	$\left(\frac{48-27\sqrt{3}}{3}\right)=16-9\sqrt{3}$	A1	4	CSO; accept $16+-9\sqrt{3}$
	Total		**4**	
2(a)(i)	$y=\frac{4}{3}x-\frac{7}{3}$	M1		$y=\pm\frac{4}{3}x+k$ or $\frac{\Delta y}{\Delta x}$ with 2 **correct** points
	$\Rightarrow$ grad $AB=\frac{4}{3}$	A1	2	condone slip in rearranging if gradient is correct; condone 1.33 or better
(ii)	$y=$ 'their grad' $x+c$ **and** attempt to use $x=3,\ y=-5$	M1		***or*** $y--5=$ 'their grad AB' $(x-3)$ ***or*** $4x-3y=k$ and attempt to find k using $x=3$ and $y=-5$
	$\left.\begin{array}{l} y+5=\frac{4}{3}(x-3) \\ or\ y=\frac{4}{3}x-\frac{27}{3}\end{array}\right\}$	A1		correct equation in any form but must simplify $--$ to $+$
	$4x-3y=27$	A1	3	integer coefficients in required form eg $-8x+6y=-54$
(b)	$4x-3y=7$ and $3x-2y=4$ $\Rightarrow 8x-9x=14-12$ etc	M1		must use **correct pair** of equations and **attempt** to eliminate x or y (generous)
	$x=-2$	A1		
	$y=-5$	A1	3	or $D\ (-2,-5)$
(c)	$4(k-2)-3(2k-3)=7$ $4k-8-6k+9=7$	M1		sub $x=k-2,\ y=2k-3$ into $4x-3y=7$ and attempt to multiply out with all k terms on one side (condone one slip)
	$\Rightarrow k=-3$	A1	2	
	Total		**10**	

MPC1

Q	Solution	Marks	Total	Comments
3(a)(i)	$\mathrm{p}(-1) = (-1)^3 + 2(-1)^2 - 5(-1) - 6$	M1		$\mathrm{p}(-1)$ attempted **not** long division
	$\mathrm{p}(-1) = -1 + 2 + 5 - 6 = 0 \Rightarrow x+1$ is a factor	A1	2	CSO; correctly shown = 0 plus statement
(ii)	Quad factor in this form: $(x^2 + bx + c)$	M1		long division as far as constant term ***or*** comparing coefficients, ***or*** $b = 1$ ***or*** $c = -6$ by inspection
	$x^2 + x - 6$	A1		correct quadratic factor
	$[\mathrm{p}(x) =]\ (x+1)(x+3)(x-2)$	A1	3	**must** see correct product
(b)	$\mathrm{p}(0) = -6$; $\mathrm{p}(1) = -8$	M1		**both** $\mathrm{p}(0)$ and $\mathrm{p}(1)$ attempted **and** at least one value correct
	$\Rightarrow \mathrm{p}(0) > \mathrm{p}(1)$	A1	2	**AG** both values correct plus correct statement involving p(0) and p(1)
(c)		M1 A1 A1	3	cubic with one max and one min with $-3, -1, 2$ marked correct with minimum to right of *y*-axis AND going beyond –3 and 2
	Total		**10**	

MPC1

Q	Solution	Marks	Total	Comments
4(a)(i)	$3x^2+3x^2+xy+xy+3xy+3xy$	M1		correct expression for surface area
	$6x^2+8xy=32$			$2(3x^2+xy+3xy)=32$ etc
	$\Rightarrow 3x^2+4xy=16$	A1	2	**AG** be convinced
(ii)	$(V=)3x^2y$ OE	M1		correct volume in terms of x and y
	$=3x\left(\dfrac{16-3x^2}{4}\right)$ **or** $=3x^2\left(\dfrac{16-3x^2}{4x}\right)$			OE
	$=12x-\dfrac{9x^3}{4}$	A1	2	CSO **AG** be convinced that all working is correct
(b)	$\left(\dfrac{dV}{dx}=\right)12-\dfrac{27}{4}x^2$	M1 A1	2	one of these terms correct all correct with 9 × 3 evaluated (no + c etc)
(c)(i)	$x=\dfrac{4}{3}\Rightarrow\dfrac{dV}{dx}=12-\dfrac{27}{4}\times\left(\dfrac{4}{3}\right)^2$	M1		attempt to sub $x=\dfrac{4}{3}$ into '*their*' $\dfrac{dV}{dx}$
	$\dfrac{dV}{dx}=12-\dfrac{27}{4}\times\dfrac{16}{9}=12-12$			or $12-\dfrac{432}{36}=12-12$ or $12-\dfrac{48}{4}=0$ etc
	$\dfrac{dV}{dx}=0\Rightarrow$ stationary value	A1	2	CSO; shown = 0 plus statement
(ii)	$\dfrac{d^2V}{dx^2}=-\dfrac{27x}{2}$ OE	B1√		FT for '*their*' $\dfrac{dV}{dx}=a+bx^2$
	when $x=\dfrac{4}{3}$, $\dfrac{d^2V}{dx^2}<0\Rightarrow$ maximum	E1√	2	**or** sub of $x=\dfrac{4}{3}$ into '*their*' $\dfrac{d^2V}{dx^2}$ $\Rightarrow$ maximum
	$\left(\text{FT } \textit{"minimum"} \text{ if their } \dfrac{d^2V}{dx^2}>0\right)$			E0 if numerical error seen
	Total		**10**	

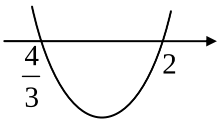
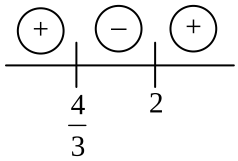
MPC1

Q	Solution	Marks	Total	Comments
5(a)(i)	$\left(x-\frac{3}{2}\right)^2$	M1		or $p = 1.5$ stated
	$\left(x-\frac{3}{2}\right)^2+\frac{11}{4}$	A1	2	$(x-1.5)^2 + 2.75$
	Mark their final line as their answer			
(ii)	$x=\frac{3}{2}$	B1✓	1	correct or FT their " $x = p$ "
(b)(i)	$x^2-3x+5=x+5 \Rightarrow x^2=4x$	M1		eliminating x or y and collecting like terms (condone **one** slip) **or** $(y-5)^2-3(y-5)+5=y$ $\Rightarrow y^2-14y+45=0$
	$(x\neq 0)$ $\Rightarrow x=4$	A1		
	$y=9$	A1	3	
(ii)	$\frac{x^3}{3}-\frac{3x^2}{2}+5x\ (+c)$	M1 A1 A1	3	one of these terms correct another term correct all correct (need not have $+c$)
(iii)	$[\ ]_0^4=\frac{4^3}{3}-3\times\frac{4^2}{2}+5\times 4$	M1		must have earned M1 in part(b)(ii) $\mathrm{F}(\text{their } x_B)\ \{-\mathrm{F}(0)\}$ "correctly sub'd"
	$=17\frac{1}{3}$	A1		$\left(\frac{64}{3}-24+20=\right)\ \frac{52}{3}$ or $\frac{104}{6}$ etc condone 17.3 but not $16\frac{4}{3}$ etc
	Area trapezium $=\frac{1}{2}(x_B)(5+y_B)$	B1✓		FT their numerical values of x_B, y_B Area = $\frac{1}{2}\times 4\times 14$ (= 28)
	Area of shaded region $=28-17\frac{1}{3}$			
	$=10\frac{2}{3}$	A1	4	CSO; $\frac{32}{3}$, accept 10.7 or better
	Total		**13**	

MPC1

Q	Solution	Marks	Total	Comments
6(a)	$(x-5)^2+(y-8)^2$	B1		
	$= 25$	B1	2	condone 5^2
(b)(i)	$(2-5)^2+(12-8)^2$			or $AC^2 = 3^2+4^2$
	$= 9+16 \quad = 25$			hence $AC = 5$; (also radius = 5)
	$\Rightarrow A$ lies on circle	B1	1	CSO
				$(\Rightarrow$ radius $= AC)$ $\Rightarrow A$ lies on circle
	(must have concluding statement and circle equation correct if using equation)			(must have concluding statement & RHS of circle equation correct or r =5 stated if Pythagoras is used)
(ii)	grad $AC = -\dfrac{4}{3}$	B1		
	Gradient of tangent is $\dfrac{3}{4}$	B1√		FT their –1/ grad AC
	$y-12 =$ '*their tangent grad*' $(x-2)$	M1		**or** y = '*their tangent grad*' $x + c$ & attempt to find c using $x = 2$, $y = 12$
	$y-12=\dfrac{3}{4}(x-2)$ ***or*** $y=\dfrac{3}{4}x+\dfrac{21}{2}$ etc	A1		correct equation in any form
	$3x-4y+42=0$	A1	5	CSO; must have integer coefficients with all terms on one side of equation accept $0=8y-6x-84$ etc
(c)(i)	$(CM^2=)\quad (7-5)^2+(12-8)^2$	M1		**or** $(CM^2=)\quad 20$
	$\left(\Rightarrow CM=\sqrt{20}\right) \quad \Rightarrow (CM=)\quad 2\sqrt{5}$	A1	2	
(ii)	$PM^2=PC^2-CM^2 \quad = 25-20$	M1		Pythagoras used correctly
				eg $d^2+\left(2\sqrt{5}\right)^2=5^2$
	$\Rightarrow PM=\sqrt{5}$	A1		
	Area $\Delta\, PCQ=\sqrt{5}\times 2\sqrt{5}$			
	$= 10$	A1	3	CSO
	Total		**13**	

MPC1

Q	Solution	Marks	Total	Comments
7(a)(i)	$\left.\begin{array}{l}(\text{Increasing} \Rightarrow)\ \dfrac{\mathrm{d}y}{\mathrm{d}x} > 0 \\ 20x - 6x^2 - 16 > 0\end{array}\right\}$ either	M1		correct interpretation of y increasing
	$\Rightarrow 6x^2 - 20x + 16 < 0$ *or* $(2)\ (10x - 3x^2 - 8) > 0$			must see at least one of these steps before final answer for A1
	$\Rightarrow 3x^2 - 10x + 8 < 0$	A1	2	CSO **AG** no errors in working
(ii)	$(3x-4)(x-2)$	M1		correct factors or correct use of quadratic equation formula as far as $\dfrac{10 \pm \sqrt{4}}{6}$
	CVs are $\dfrac{4}{3}$ and 2	A1		condone $\dfrac{8}{6}$ and $\dfrac{12}{6}$ here but not in final line
	 	M1		sketch or sign diagram
	$\dfrac{4}{3} < x < 2$	A1	4	or $2 > x > \dfrac{4}{3}$
				accept $x < 2$ **AND** $x > \dfrac{4}{3}$
	Mark their final line as their answer			but **not** $x < 2$ **OR** $x > \dfrac{4}{3}$
				nor $x < 2$, $x > \dfrac{4}{3}$

MPC1

Q	Solution	Marks	Total	Comments
7(b)(i)	$x = 2$; $\left(\frac{dy}{dx} =\right)$ $40 - 24 - 16$	M1		sub $x = 2$ into $\frac{dy}{dx}$ and simplify terms
	$\frac{dy}{dx} = 0 \Rightarrow$ tangent at P is parallel to the x-axis	A1	2	must be all correct working plus statement
(ii)	$x = 3$; $\frac{dy}{dx} = 20\times3 - 6\times3^2 - 16$	M1		must attempt to sub $x = 3$ into $\frac{dy}{dx}$
	(= 60–54–16) $= -10$	A1		
	Gradient of normal $= \frac{1}{10}$	A1√		$\frac{-1}{\text{"}their\ -10\text{"}}$
	Normal: $(y - -1) = \text{'their grad'}(x - 3)$	m1		normal attempted with correct coordinates used and gradient obtained from their $\frac{dy}{dx}$ value
	$y + 1 = \frac{1}{10}(x - 3)$	A1		any correct form, eg $10y = x - 13$ but must simplify – – to +
	(Equation of tangent at P is) $y = 3$	B1		
	$x = 43$	A1	7	CSO; $\Rightarrow$ $R\,(43, 3)$
	Total		**15**	
	TOTAL		**75**	

Version

General Certificate of Education (A-level)
January 2013

Mathematics MPC1

(Specification 6360)

Pure Core 1

Final

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MPC1

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1(a) (i)	$21+5k=1$			condone $3\times7+5k=1$
	$\Rightarrow k=-4$	B1	1	**AG** condone $y=-4$
(ii)	$(x=)\ 2$	B1		
	$(y=)\ -1$	B1	2	midpoint coords are (2, –1)
(b)	$y=\frac{1}{5}-\frac{3}{5}x$	M1		obtaining $y=a\pm\frac{3}{5}x$ or $\frac{\Delta y}{\Delta x}=\frac{-4-2}{7--3}$ or $\frac{-1-2}{2--3}$ or $\frac{-4--1}{7-2}$ condone **one** sign error in expression
	(Gradient AB =) $-\frac{3}{5}$	A1	2	allow – 0.6 , $\frac{6}{-10}$ etc for A1 & condone error in rearranging if gradient is correct .
(c)	Perp grad = $\frac{5}{3}$	M1		–1/ "their" grad AB
	$y-2=\frac{5}{3}(x+3)$ *or* $y=\frac{5}{3}x+c,\quad c=7$ etc	A1		correct equation in any form (must simplify $x--3$ to $x+3$ *or* c to a single term equivalent to 7)
	$5x-3y+21=0$	A1	3	or any multiple of this with integer coefficients –terms in any order but all terms on one side of equation
(d)	$3x+5y=1$ and $5x+8y=4$ $\Rightarrow P\ x=Q$ or $R\ y=S$	M1		must use **correct** pair of equations **and** attempt to eliminate y (or x) (generous)
	$x=12$	A1		
	$y=-7$	A1	3	(12, –7)
	Total		**11**	

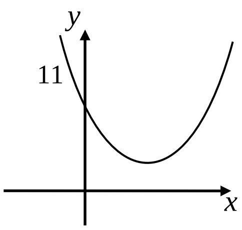
MPC1 (cont)

Q	Solution	Marks	Total	Comments
2(a)	$\left(\frac{dy}{dt}=\right)\frac{4t^3}{8}-2t$	M1 A1	2	one of these terms correct all correct (no + c etc)
(b)(i)	$t=1 \Rightarrow \frac{dy}{dt}=\frac{4}{8}-2$	M1		Correctly sub t = 1 into their $\frac{dy}{dt}$
	$=-1\frac{1}{2}$	A1cso	2	must have $\frac{dy}{dt}$ correct (watch for t^3 etc)
(ii)	$\frac{dy}{dt}<0$			must have used $\frac{dy}{dt}$ in part (b)(i)
	$\Rightarrow$ (height is) **decreasing** (when t = 1)	E1√	1	must state that "$\frac{dy}{dt}<0$" or "$-1.5<0$" or the equivalent in words FT their value of $\frac{dy}{dt}$ with appropriate explanation and conclusion
(c)(i)	$\left(\frac{d^2y}{dt^2}=\right)\ \frac{4}{8}\times 3t^2-2$	M1		Correctly differentiating their $\frac{dy}{dt}$ even if wrongly simplified
	$\left(t=2,\ \frac{d^2y}{dt^2}=\right)\ 4$	A1cso	2	Both derivatives correct and simplified to 4
(ii)	$\Rightarrow$ minimum	E1√	1	FT their numerical value of $\frac{d^2y}{dt^2}$ from part (c) (i)
	Total		**8**	

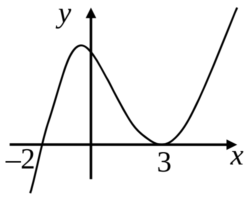
MPC1 (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	$\sqrt{18} = 3\sqrt{2}$	B1	1	Condone $k = 3$
(ii)	$\dfrac{2\sqrt{2}}{3\sqrt{2}+4\sqrt{2}}$	M1		attempt to write each term in form $n\sqrt{2}$ with at least 2 terms correct
		A1		correct unsimplified
	$=\dfrac{2}{7}$	A1	3	
				or $\times\dfrac{\sqrt{2}}{\sqrt{2}}$ M1 integer terms $=\dfrac{4}{6+8}$ A1 $=\dfrac{2}{7}$ A1
(b)	$\dfrac{7\sqrt{2}-\sqrt{3}}{2\sqrt{2}-\sqrt{3}}\times\dfrac{2\sqrt{2}+\sqrt{3}}{2\sqrt{2}+\sqrt{3}}$	M1		
	(numerator =) $14\times2-2\sqrt{6}+7\sqrt{6}-3$	m1		correct unsimplified but must simplify $\left(\sqrt{2}\right)^2$, $\left(\sqrt{3}\right)^2$ and $\sqrt{2}\times\sqrt{3}$ correctly
	(denominator = 8 – 3 =) 5	B1		must be seen or identified as denominator giving $\dfrac{25+5\sqrt{6}}{5}$
	(Answer =) $5+\sqrt{6}$	A1cso	4	$m = 5$, $n = 6$
	Total		**8**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$(x-3)^2$	M1		or $p=3$ seen
	$(x-3)^2 + 2$	A1	2	
(ii)	$(x-3)^2 = -2$	M1		FT their positive value of q
	No (real) square root of -2 therefore equation has no real solutions	A1cso	2	**not** use of discriminant for graphical approach see below to see if SC1 can be awarded
(b)(i)	$x =$ 'their' p *or* $y =$ 'their' q	M1		or $x=3$ found using calculus
	Vertex is at $(3, 2)$	A1cao	2	
(ii)		B1		y intercept = 11 ***stated*** or ***marked on y-*** axis (as y intercept of any graph)
		M1		$\cup$ shape (generous)
		A1	3	above x-axis , vertex in first quadrant crossing y-axis into second quadrant
(iii)	Translation	E1		and no other transformation
	through $\begin{bmatrix} -3 \\ -2 \end{bmatrix}$	M1		FT negative of BOTH 'their' vertex coords
		A1	3	**both** components **correct** for A1; may describe in words or use a column vector
	Total		**12**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$\text{p}(-1) = (-1)^3 - 4\times(-1)^2 - 3(-1) + 18$	M1		p(–1) attempted **not** long division
	$(= -1 - 4 + 3 + 18) = 16$	A1	2	
(b)(i)	$\text{p}(3) = 3^3 - 4\times 3^2 - 3\times 3 + 18$	M1		p(3) attempted **not** long division
	$\text{p}(3) = 27 - 36 - 9 + 18 = 0 \Rightarrow x - 3$ is a factor	A1	2	shown = 0 plus statement
(ii)	Quadratic factor $(x^2 - x + c)$ or $(x^2 + bx - 6)$	M1		$-x$ or –6 term by inspection *or* full long division by $x - 3$ *or* comparing coefficients *or* p(–2) attempted
	Quadratic factor $\left(x^2 - x - 6\right)$	A1		correct quadratic factor (or x+2 shown to be factor by Factor Theorem)
	$\left[\text{p}(x) =\right] \; (x-3)(x-3)(x+2)$	A1	3	or $\left[\text{p}(x) =\right] \; (x-3)^2(x+2)$ must see product of factors
(c)		M1		cubic curve with one maximum and one minimum
		A1		meeting x-axis at –2 and touching x-axis at 3
	Final A1 is dependent on previous A1 and can be withheld if curve has very poor curvature beyond $x = 3$, V shape at $x = 3$ etc	A1	3	graph as shown , going beyond $x = -2$ but condone max on or to right of y-axis
	Total		**10**	

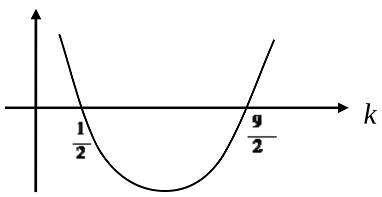
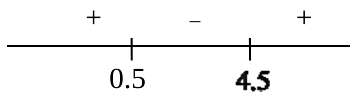
MPC1 (cont)

Q	Solution	Marks	Total	Comments
6(a)	(Gradient = 10 – 6 + 5) = 9	B1		correct gradient from sub x =1 into $\frac{\mathrm{d}y}{\mathrm{d}x}$
	$y-4=\text{"}\mathit{their}\ 9\text{"}(x-1)$ *or* $y=\text{"}\mathit{their}\ 9\text{"}x+c$ **and** attempt to find c using x =1 and y = 4	M1		must attempt to use given expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$ **and** must be attempting tangent and not normal **and** coordinates must be correct
	$y=9x-5$	A1	3	condone $y=9x+c, \ldots \quad c=-5$
(b)	$(y=)\frac{10}{5}x^5-\frac{6}{3}x^3+5x+C$	M1		one term correct
		A1 A1		another term correct all integration correct including + C
	4 = 2 – 2 + 5 + C $\Rightarrow C=-1$	m1		substituting both x =1 and y = 4 **and** attempting to find C
	$y=2x^5-2x^3+5x-1$	A1cso	5	must have y = ... and coefficients simplified
	Total		**8**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$x=0 \Rightarrow y^2-4y-12 \ (=0)$	M1		sub $x = 0$ & correct quadratic in y *or* $(y-2)^2=16$ *or* $(y-2)^2-16=0$
	$(y-6)(y+2) \quad (=0)$	A1		correct factors *or* formula as far as $\dfrac{4\pm\sqrt{64}}{2}$ *or* $y-2=\pm\sqrt{16}$
	$\Rightarrow y=-2,\ 6$	A1	3	condone $(0, -2)$ & $(0, 6)$
(b)	$(x+3)^2-9+(y-2)^2-4\,(=12)$	M1		***correct*** sum of square terms **and** attempt to complete squares (or multiply out) PI by next line
	$\left(r^2=\right) \quad 9+4+12$	A1		$\left(r^2=\right)25$ seen on RHS
	$\left(\Rightarrow r=\right)\ 5$	A1	3	$r=\sqrt{25}$ or $r=\pm 5$ scores A0
(c)(i)	$\left(CP^2=\right) \quad (2--3)^2+(5-2)^2$	M1		condone one sign slip within one bracket
	$\Rightarrow \left(CP=\right) \quad \sqrt{34}$	A1	2	$n=34$
(ii)	$PQ^2=CP^2-r^2=34-25$	M1		Pythagoras used correctly with values FT "their" r and CP
	$\left(\Rightarrow PQ=\right) \quad 3$	A1	2	
	Total		**10**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
8(a)	$2x^2 - x - 1 = 2kx - 3k$ $2x^2 - x - 1 - 2kx + 3k = 0$ OE $\Rightarrow 2x^2 - (2k+1)x + 3k - 1 = 0$	B1	1	equated and multiplied out and all 5 terms on one side and = 0 **AG** (correct with no trailing = signs etc)
(b)(i)	$(2k+1)^2 - 4 \times 2(3k-1)$	M1		clear attempt at $b^2 - 4ac$
	$(2k+1)^2 - 4 \times 2(3k-1) > 0$	B1		discriminant > 0 which must appear before the printed answer
	$4k^2 + 4k + 1 - 24k + 8 > 0$			
	$\Rightarrow 4k^2 - 20k + 9 > 0$	A1cso	3	**AG** (all working correct with no missing brackets etc)
(ii)	$4k^2 - 20k + 9 = (2k-9)(2k-1)$	M1		correct factors or correct use of formula as far as $\frac{20 \pm \sqrt{256}}{8}$
	critical values are $\frac{1}{2}$ and $\frac{9}{2}$	A1		condone $\frac{4}{8}$, $\frac{36}{8}$ etc here but must combine sums of fractions
		M1		sketch or sign diagram including values 
	$k < \frac{1}{2}$, $k > \frac{9}{2}$ ***Take their final line as their answer***	A1	4	fractions must be simplified condone use of OR but not AND
	Total		**8**	
	TOTAL		**75**	

Version 1.0

General Certificate of Education (A-level)
June 2013

Mathematics MPC1

(Specification 6360)

Pure Core 1

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Key to mark scheme abbreviations

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
CAO	correct answer only
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
A2,1	2 or 1 (or 0) accuracy marks
–*x* EE	deduct *x* marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
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.

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**.

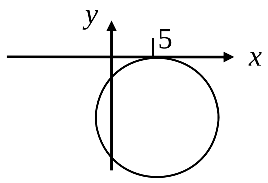
Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

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.

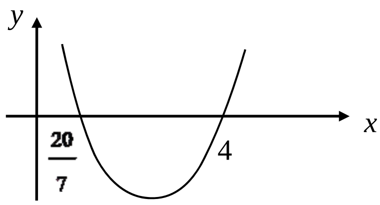
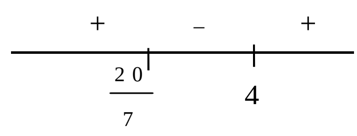
Q	Solution	Marks	Total	Comments
1(a)	$3p-4(p+2)+5=0$	M1		condone omission of brackets or one sign error
	$(\Rightarrow p=)\ -3$	A1	2	
(b)	$y=\frac{3}{4}x+\frac{5}{4}$	M1		rearranging into form $y=\pm\frac{3}{4}x+c$
	(gradient AB =) $\frac{3}{4}$	A1	2	condone slips in rearranging if gradient is correct .
(c)	(gradient AC =) $\frac{k-2}{-5-1}$	M1		*or* $\frac{2-k}{1--5}$ (condone one sign error)
	"their" $\frac{(k-2)}{-6}\times\frac{3}{4}=-1$ *OE*	m1		product of grads = –1 in terms of k
	$(\Rightarrow k=)\ 10$	A1	3	
(d)	$3x-4y+5=0$ and $2x-5y=6$ $\Rightarrow Px=Q$ or $Ry=S$	M1		must use "correct" pair of equations **and** attempt to eliminate y (or x) (generous)
	$x=-7$	A1		
	$y=-4$	A1	3	$(-7,-4)$
	Total		**10**	

Q	Solution	Marks	Total	Comments
2(a)(i)	$\left(\sqrt{48}\ =\ \right)4\sqrt{3}$	B1	1	condone $n = 4$. No ISW.
(ii)	$\sqrt{12}\ = 2\sqrt{3}$ and $\sqrt{48}\ = 4\sqrt{3}$	M1		(FT 'their' n) $2x\sqrt{3} = 7\sqrt{3} - 4\sqrt{3}$
	$(x =)\dfrac{7\sqrt{3} - 4\sqrt{3}}{2\sqrt{3}}$	A1		correct quotient unsimplified or correct equation in integers eg $6x = 21 - 12$
	$= \dfrac{3}{2}$	A1cso	3	accept 1.5 but not $\dfrac{9}{6}$ etc **alternative 1** $x = \dfrac{7\sqrt{3} - \sqrt{48}}{\sqrt{12}} \times \dfrac{\sqrt{12}}{\sqrt{12}}$ M1 integer terms $= \dfrac{42 - 24}{12}$ A1 $= \dfrac{3}{2}$ A1
(b)	$\dfrac{11\sqrt{3} + 2\sqrt{5}}{2\sqrt{3} + \sqrt{5}} \times \dfrac{2\sqrt{3} - \sqrt{5}}{2\sqrt{3} - \sqrt{5}}$	M1		
	(numerator =) $22 \times 3 + 4\sqrt{15} - 11\sqrt{15} - 2 \times 5$	A1		correct unsimplified but must simplify $\left(\sqrt{3}\right)^2$, $\left(\sqrt{5}\right)^2$ and $\sqrt{3} \times \sqrt{5}$ correctly
	(denominator = 12 – 5 =) 7	B1		must be seen or identified as denominator giving $\dfrac{56 - 7\sqrt{15}}{7}$
	(Answer =) $8 - \sqrt{15}$	A1cso	4	$m = 8$
	Total		**8**	

Q	Solution	Marks	Total	Comments
3(a)	$(x-5)^2+(y+7)^2$	M1		one term correct
		A1		both terms correct and added
	$(x-5)^2+(y+7)^2=49$	A1cao	3	must see 49 not just 7^2 condone $(x-5)^2+(y--7)^2=49$
(b)(i)	(Centre is) (5, –7)	B1√	1	correct or FT their a and b
(ii)	Radius = 7	B1√	1	condone $\sqrt{49}$ but **not** ± 7 or $\pm\sqrt{49}$ correct or FT their $\sqrt{k}$ provided $k > 0$
(c)(i)		M1		freehand circle with centre in correct quadrant or FT from their **(b)(i)** must have both axes shown clearly
		A1	2	correct position cutting negative y-axis twice and touching x-axis at $x = 5$ 5 must be marked on x-axis or centre clearly marked as (5, –7) must have correct centre and radius in **(b)**
(ii)	$x=5$	B1		
	$y=-14$	B1	2	(5, –14)
(d)	Translation	E1		and no other transformation
	through $\begin{bmatrix} 6 \\ * \end{bmatrix}$	M1		
	$\begin{bmatrix} 6 \\ -7 \end{bmatrix}$	A1cso	3	both components correct for A1; may describe in words or use a column vector
	Total		**12**	

Q	Solution	Marks	Total	Comments
4(a)	$\mathrm{f}(-3) = (-3)^3 - 4\times(-3) + 15$ $\mathrm{f}(-3) = -27 + 12 + 15$	M1		f(–3) attempted **not** long division
	$= 0 \Rightarrow x+3$ is a factor	A1	2	shown = 0 plus statement
(ii)	Quadratic factor $(x^2 - 3x + 5)$	M1		$-3x$ or + 5 term by inspection *or* full long division attempt
	$(\mathrm{f}(x) =)\ (x+3)(x^2-3x+5)$	A1	2	must see correct product
(b) (i)	$\left(\frac{\mathrm{d}y}{\mathrm{d}x} =\right) 4x^3 - 16x + 60$	M1 A1		one of these terms correct another term correct
		A1	3	all correct (no +*c* etc)
(ii)	$4x^3 - 16x + 60 = 0$			must see this line OE
	$\Rightarrow x^3 - 4x + 15 = 0$	B1	1	**AG**
(iii)	Discriminant of quadratic = $(-3)^2 - 4\times 5$	M1		discriminant of " their" quadratic or correct use of quad eqn "formula"
	$b^2 - 4ac = -11$ (*or* $b^2 - 4ac < 0$) therefore quadratic has no (real)roots Hence only stationary point is when $x = -3$	A1	2	**correct discriminant** evaluated correctly (or shown to be < 0) with appropriate conclusion **plus** final statement
(iv)	$\left(\frac{\mathrm{d}^2y}{\mathrm{d}x^2} =\right) 12x^2 - 16$	B1√		
	$= 12(-3)^2 - 16$ (*or* $12\times 9 - 16$ etc)	M1		sub $x = -3$ into "their" $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$
	$= 92$	A1	3	
(v)	Minimum **since** $\frac{\mathrm{d}^2y}{\mathrm{d}x^2} > 0$ (*or* 92 > 0 etc)	E1√	1	FT appropriate conclusion from their value from **(iv)** **plus** reason treat parts **(iv)** & **(v)** holistically
	Total		**14**	

Q	Solution	Marks	Total	Comments
5(a)(i)	$2(x+1.5)^2$	M1		OE
	$2(x+1.5)^2+0.5$	A1	2	$2\left(x+\frac{3}{2}\right)^2+\frac{1}{2}$ OE
(ii)	(Minimum value is) 0.5	B1√	1	ft their q
(b)(i)	$\left(AB^2=\right)\ (x+3)^2+(3x+9-5)^2$	M1		condone one sign error inside one bracket
	$(3x+4)^2=9x^2+24x+16$	B1		OE
	$AB^2=x^2+6x+9+9x^2+24x+16=10x^2+30x+25$ $\Rightarrow AB^2=5(2x^2+6x+5)$	A1cso	3	**AG**
(ii)	*Either* $\sqrt{5\times\text{'}\mathit{their}\text{'}\ \textbf{(a)(ii)}}$ *or* $5\times\text{'}\mathit{their}\text{'}\ \textbf{(a)(ii)}$	M1		using their minimum value from **(a)(ii)** and 5 provided "their" **(a)(ii)** > 0
	(Minimum length of AB =) $\frac{1}{2}\sqrt{10}$	A1cso	2	
	Total		**8**	
6(a)	$\frac{dy}{dx}=5x^4-4x$	M1 A1		one of these terms correct all correct (no +c etc)
	$\left(=5(-1)^4-4(-1)\right)\quad =9$	A1		
	Tangent has equation $y=\text{'}\mathit{their}\ 9\text{'}\,x+c$ **and** $6=\text{'}\mathit{their}\ 9\text{'}(-1)+c\quad\Rightarrow c=\ldots$	m1		tangent using 'their' gradient, and attempt to find c using $x=-1$ and $y=6$
	$\Rightarrow y=9x+15$	A1	5	equation must be seen in this form
(b)(i)	When $x=2$, $y=2^5-2\times2^2+9=32-8+9=33$ $(k=)$ 33	B1	1	be convinced that they are using **curve** equation **NMS** $k=33$ scores B0
(ii)	When $x=2$, $y=9\times2+15=33$ so lies on tangent	B1	1	be convinced that they are using **tangent** equation **and** have statement

Q	Solution	Marks	Total	Comments
6(c)(i)	$\frac{x^6}{6}-\frac{2x^3}{3}+9x$	M1 A1 A1		one of these terms correct another term correct all correct (may have +c)
	$\left[\frac{2^6}{6}-\frac{2\times2^3}{3}+9\times2\right]-\left[\frac{(-1)^6}{6}-\frac{2\times(-1)^3}{3}+9\times(-1)\right]$	m1		F(2) – F(–1) unsimplified FT “their terms” from integration
	$\left[\frac{64}{6}-\frac{16}{3}+18\right]-\left[\frac{1}{6}+\frac{2}{3}-9\right]$			$=\frac{70}{3}-\left(-\frac{49}{6}\right)$
	= 31.5 $\left(or\ \frac{189}{6}\ etc\right)$	A1	5	condone single fraction
(ii)	Area of trapezium = $\frac{1}{2}\times3\times(6+'their'k)$	B1√		= 58.5 when k = 33
	Shaded area = **Trapezium** – ‘their’ **(c)(i)** value	M1		
	= 27	A1	3	OE eg $\frac{162}{6}$
	Total		**15**	
7(a)	$(k-2)^2-4\times(2k-7)(k-3)$	M1		discriminant – condone one slip –condone omission of brackets
	$k^2-4k+4-4(2k^2-6k-7k+21)$	A1		
	“their” $-7k^2+48k-80\geqslant0$	B1		real roots condition ; f(k) $\geqslant$ 0 must appear before final line
	$7k^2-48k+80\leqslant0$	A1cso	4	**AG** (all working correct with no missing brackets etc)
(b)	$7k^2-48k+80=(7k-20)(k-4)$	M1		correct factors (or roots unsimplified) $\frac{48\pm\sqrt{64}}{14}$
	critical values are 4 and $\frac{20}{7}$	A1		accept $\frac{56}{14}$, $\frac{40}{14}$ etc here
		M1		sketch or sign diagram including values 
	$\frac{20}{7}\leqslant k\leqslant4$ ***Take their final line as their answer***	A1cao	4	fractions must be simplified here
	Total		**8**	
	TOTAL		**75**	

A-LEVEL
Mathematics
Pure Core 1 – MPC1
Mark scheme

6360
June 2014

Version/Stage: Final V1.0

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from aqa.org.uk

Key to mark scheme abbreviations

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
CAO	correct answer only
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
A2,1	2 or 1 (or 0) accuracy marks
–*x* EE	deduct *x* marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
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.

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	Mark	Total	Comment
1 (a)(i)	Grad $AB = \frac{-5-2}{3--1}$ OE	M1		correct unsimplified eg $\frac{2--5}{-1-3}$
	$= -\frac{7}{4}$	A1	2	
(ii)	$\left.\begin{array}{l} y--5 = \text{'their grad'} \ (x-3) \\ y-2 = \text{'their grad'} \ (x--1) \end{array}\right\}$	M1		either pair of coordinates used correctly and attempt to find c if using $y=mx+c$
	$\left.\begin{array}{l} y-2=-\frac{7}{4}(x+1) \\ y+5=-\frac{7}{4}(x-3) \\ y=-\frac{7}{4}x+\frac{1}{4} \end{array}\right\}$	A1		OE, any form of correct equation with – – simplified to +
	$7x+4y=1$	A1	3	integer coefficients & in this form
(b)(i)	(M) $(1,-1.5)$	B1	1	condone $x=1,\ y=-\frac{3}{2}$
(ii)	Perp grad = $\frac{4}{7}$	B1$\checkmark$		perp grad = –1/ 'their' grad AB
	$y--\frac{3}{2}=\text{'their'}\frac{4}{7}(x-1)$	M1		ft 'their M' but must have attempted perpendicular gradient
	$y+\frac{3}{2}=\frac{4}{7}(x-1)$	A1	3	**any** correct form with – – simplified to + eg $8x-14y=29$ **;** $y=\frac{4}{7}x+c,\ c=-\frac{29}{14}$
(c)	$(AC^2=)\ \ (k--1)^2+(2k+3-2)^2$	M1		$(k+1)^2+(2k+1)^2$
	$k^2+2k+1+4k^2+4k+1=13$ $5k^2+6k-11=0$	A1		
	$(5k+11)(k-1)=0$	A1		correct factors or correct use of formula as far as $\frac{-6\pm\sqrt{256}}{10}$
	$\Rightarrow k=1,\quad k=-\frac{11}{5}$	A1	4	
	Total		**13**	

(a) (i) **NMS** grad $AB = -\frac{7}{4}$ earns 2 marks.

(ii) must simplify $y--5$ to $y+5$ or $x--1$ to $x+1$ for first **A1**

Condone $8y+14x=2$ etc for final **A1**, but not $7x+4y-1=0$ etc

(b)(ii) If their gradient of AB is m, then use of $-m$ or $1/m$ can earn **M1**. For **A1**, $1/\left(\frac{7}{4}\right)$, $\frac{14.5}{7}$ etc must be simplified.

Q	Solution	Mark	Total	Comment
2	$\frac{15+7\sqrt{3}}{9+5\sqrt{3}} \times \frac{9-5\sqrt{3}}{9-5\sqrt{3}}$	M1		writing correct quotient and multiplying by correct conjugate of denominator
	(Numerator =) $135-75\sqrt{3}+63\sqrt{3}-105$	A1		$30-12\sqrt{3}$
	(Denominator = $81-45\sqrt{3}+45\sqrt{3}-75$) $=6$	B1		must be seen as denominator
	$\left(\frac{30-12\sqrt{3}}{6}=\right)$ $5-2\sqrt{3}$	A1cso	4	units (cm) need not be given
	Alternative			
	$(9+5\sqrt{3})(m+n\sqrt{3})$			
	$=9m+15n+5m\sqrt{3}+9n\sqrt{3}$	(M1)		must be correct
	$9m+15n=15, \quad 5m+9n=7$	(A1)		both equations correct
	$m=5 \quad , \quad n=-2$	(A1)		either correct
	$5-2\sqrt{3}$	(A1)		
	Total		**4**	
	No marks if candidate uses $\frac{9+5\sqrt{3}}{15+7\sqrt{3}}$ Condone multiplication by $9-5\sqrt{3}$ instead of $\frac{9-5\sqrt{3}}{9-5\sqrt{3}}$ for **M1 only if** subsequent working shows multiplication by **both** numerator and denominator – otherwise **M0**. May use alternative conjugate $\frac{15+7\sqrt{3}}{9+5\sqrt{3}} \times \frac{5\sqrt{3}-9}{5\sqrt{3}-9}$ **M1** numerator $=12\sqrt{3}-30$ **A1** denominator = –6 **B1** Ignore any incorrect units			

Q	Solution	Mark	Total	Comment
3 (a)(i)	$\left(\frac{dy}{dx}=\right)\quad 10x^4+20x^3$	M1 A1	2	one term correct all correct (no $+c$ etc)
(ii)	$\left(\frac{d^2y}{dx^2}=\right)\quad 40x^3+60x^2$	B1√	1	ft their $\frac{dy}{dx}$
(b)(i)	$\left(\frac{dy}{dx}=\right)\quad 10-20\quad =-10$	B1√		correctly sub $x=-1$ into their $\frac{dy}{dx}$ and evaluated correctly
	$\frac{dy}{dx}<0$ (therefore y is) decreasing	E1√	2	Must state "decreasing" **and** $\frac{dy}{dx}<0$ ft 'therefore y is increasing' **and** reason if their value of $\frac{dy}{dx}>0$
(ii)	(When $x=-1$) $\quad y=2$	B1		
	$y-\text{'their'}2=\text{'their grad'}(x--1)$ but must be tangent and not normal	M1		ft 'their' value of $\frac{dy}{dx}$ when $x=-1$ and 'their' y-coordinate
	$y-2=-10(x+1)$ *or* $y=-10x-8$ etc	A1	3	any correct tangent eqn from correct $\frac{dy}{dx}$
(c)	$\left(\frac{dy}{dx}=\right)\quad 10(-2)^4+20(-2)^3$	M1		correctly sub $x=-2$ into their $\frac{dy}{dx}$
	$=160-160=0\ \Rightarrow$ **stationary** point (when $x=-2$)	A1		correctly shown that $\frac{dy}{dx}=0$ **plus** correct statement
	$\left(\frac{d^2y}{dx^2}=\right)\quad 40(-2)^3+60(-2)^2$	M1		correctly sub $x=-2$ into their $\frac{d^2y}{dx^2}$ or other suitable test for max/min
	$=-320+240=-80<0$ (Therefore) **maximum** (point at Q)	A1	4	**either** $\frac{d^2y}{dx^2}=-320+240<0$ **or** $\frac{d^2y}{dx^2}=-80<0$ **plus** conclusion
	Total		**12**	

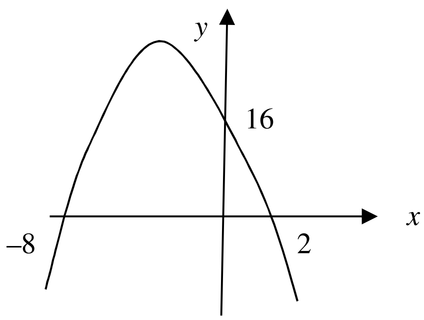
(b) (i) Accept "gradient is negative so decreasing" for **E1**

Do **not** accept "because **it** is negative" or "$\frac{dy}{dx}=-10$" as reasons for **E1**

(ii) May earn **M1** for attempt to find c using $y=mx+c$ if clearly finding tangent and not normal.
Must simplify $x--1$ to $x+1$ for **A1**

(c) May write "their" $10x^4+20x^3=0$ and attempt to find x for first **M1**
leading to "$x=-2$ …stationary pt" for **A1**

PMT

Q	Solution	Mark	Total	Comment
4				
(a)(i)	$k-(x+3)^2$	**M1**		*or* $x^2+6x-16=(x+3)^2-25$ *or* q = 3 stated
	$25-(x+3)^2$	**A1**	**2**	
(ii)	(Max value =) 25	**B1√**	**1**	ft their p
(b)(i)	$(8+x)(2-x)$	**B1**	**1**	
(ii)		**M1**		∩ shape
		A1		curve roughly symmetrical with max to left of y-axis, curve in all 4 quadrants **and** y-intercept 16 stated or marked on y-axis
	crosses x-axis at –8 and 2	**B1**	**3**	correct - stated or marked on x-axis
	Total		**7**	
(a)(i)	**Example** $16-(x+3)^2-9$ earns **M1**			
(ii)	(–3, 25) scores **B0** since maximum value not identified Allow maximum given as " $y=25$ "			
(b)(i)	Condone $-(x-2)(x+8)$, $(x-2)(-x-8)$ etc			
(ii)	Withhold **B1** if more than 2 intercepts			

Q	Solution	Mark	Total	Comment
5 (a)	$(-3)^3 + c(-3)^2 + d(-3) + 3$	M1		p(–3) attempted
	$-27 + 9c - 3d + 3 = 0$ $\Rightarrow 3c - d = 8$	A1	2	must see this line or equivalent, **and** must have = 0 on right or left before final result **AG** be convinced
(b)	$2^3 + c\times 2^2 + d\times 2 + 3 = 65$	M1		p(2) attempted & … = 65
	$8 + 4c + 2d + 3 = 65$	A1	2	correct equation in any form simplifying powers of 2 eg $4c + 2d = 54$
(c)	$5c = 35$ *or* $10d = 130$ OE	M1		correct elimination of c or d using both $3c - d = 8$ and their equation from (b)
	$c = 7$	A1		
	$d = 13$	A1	3	
	Total		**7**	

(a)	May use long division by $x + 3$ but must reach remainder term for **M1** Condone missing brackets in p(–3) expression if recovered later as –27 +9c +… to earn **A1**
	Treat parts **(b)** and **(c)** holistically
(b)	May use long division by $x - 2$ as far as remainder and equate their remainder to 65 for **M1**
(c)	**Example** $4c + 2(3c - 8) = 54$ earns **M1** for eliminating d if equation in part **(b)** is correct

Q	Solution	Mark	Total	Comment
6 (a)(i)	$x^3 - x^2 - 5x + 7 = x + 7$	M1		
	$\Rightarrow x^3 - x^2 - 5x = x$			must see this line OE eg $x^3 - x^2 - 6x = 0$
	$(x \neq 0) \Rightarrow x^2 - x - 6 = 0$	A1	2	AG
(ii)	$(x-3)(x+2)$	M1		correct
	$x = 3, \quad x = -2$	A1		both x values correct
	$A(-2,5)$ **and** $C(3,10)$	A1	3	both pairs of coordinates correct
(b)	$\frac{x^4}{4} - \frac{x^3}{3} - \frac{5x^2}{2} + 7x \quad (+c)$	M1 A1 A1	3	2 terms correct another term correct all correct
(c)	$F(-2) = \left[\frac{(-2)^4}{4} - \frac{(-2)^3}{3} - \frac{5(-2)^2}{2} + 7(-2)\right]$	M1		F('their'–2) correctly substituting into their answer to (b) , but must have scored M1 in part (b)
	F(0) – F(–2) = $0 - \left(\frac{16}{4} + \frac{8}{3} - \frac{20}{2} - 14\right) \quad = \frac{52}{3}$	A1		correct value using limits correctly
	Area of trapezium = $\left(\frac{1}{2}(5+7)\times 2\right) = 12$	B1		or rectangle plus triangle
	Area of $R = \frac{52}{3} - 12 = \frac{16}{3}$	A1	4	$5\frac{1}{3}$ or $5.\dot{3}$
	Total		**12**	

(a)(ii)	**NMS either** $(-2,5)$ **or** $(3,10)$ scores **SC1** and **both correct** scores **SC3** Allow "when $x = 3, \quad y = 10$ **and** when $x = -2, \quad y = 5$" instead of coordinates for final **A1**
(c)	Condone missing brackets around "their" –2 for **M1** and if recovered and correct on next line for **A1** Area of trapezium found by integration $\int_{-2}^{0} (x+7)\,dx = \left[\frac{x^2}{2} + 7x\right]_{-2}^{0} = 12$ earns **B1** Accept rounded answer of 5.3 etc after correct exact answer seen.

Q	Solution	Mark	Total	Comment
7 (a)	$(x-5)^2+(y--6)^2$	M1		one term correct
		A1		LHS correct with perhaps extra constant terms
	$(x-5)^2+(y+6)^2=20$	A1	3	equation completely correct
(b) (i)	$C(5,-6)$	B1√	1	correct or ft their **(a)**
(ii)	(radius =) $\sqrt{20}$	M1		correct or ft 'their' $\sqrt{k}$ provided RHS > 0
	$= 2\sqrt{5}$	A1	2	must see $\sqrt{20}$ **first**
(c)	Grad $AC=\dfrac{-6--2}{5-3}$ $(=-2)$	M1		correct unsimplified, ft their coords of C
	Grad of tangent $=\dfrac{1}{2}$	B1√		ft their $-1/$ grad AC
	Equation of tangent is $(y--2)=\text{"their}\dfrac{1}{2}\text{"}(x-3)$	M1		clear attempt at **tangent** not normal through $(3,-2)$
	$y+2=\dfrac{1}{2}(x-3)$	A1		correct equation in any form but $y--2$ must be simplified to $y+2$
	$x-2y=7$	A1 cso	5	
(d)	$AB^2+(\text{their } r)^2=6^2$	M1		Pythagoras used with 6 as hypotenuse
	$d^2+20=36$ or $(AB^2)=36-20$	A1		values correct with $(2\sqrt{5})^2=20$ PI
	$AB^2=16$ Hence $AB=4$	A1cso	3	notation all correct
	Total		**14**	

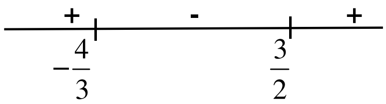
(a) $(x-5)^2+(y--6)^2=\left(\sqrt{20}\right)^2$ scores full marks

If final equation is correct then award 3 marks, treating earlier lines with extra terms etc as rough working.
If final equation has sign errors then check to see if M1 is earned.
Example $(x-5)^2+(y+6)^2-25+36+41=0$ earns **M1 A1** but if this is part of preliminary working and final equation is offered as $(x-5)^2+(y+6)^2=20$ then award **M1 A1 A1.**
Example $(x-5)^2+(y-6)^2=20$ earns **M1 A0 ; Example** $(x+5)^2+(y-6)^2=20$ earns **M0**

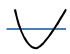
(b)(ii) Candidates may still earn A1 here provided RHS of circle equation is 20.
Example $(x+5)^2+(y-6)^2=20$ earns **M0** in **(a)** but can then earn **M1 A1** for radius = $\sqrt{20}=2\sqrt{5}$
NMS or no $\sqrt{20}$ seen; " radius $=2\sqrt{5}$ " scores **SC1** since question says "show that"

(c) May earn second **M1** for attempt to find c using $y=mx+c$ if clearly finding tangent and not normal.
If their gradient of AC is m, then use of $-m$ or $1/m$ with correct coordinates can earn second **M1**

(d) **Example** $AB=36-(2\sqrt{5})^2=16=4$ scores **M1 A1 A0** for poor notation
NMS $AB=4$ scores **SC1** since no evidence that exact value of radius has been used.

Q	Solution	Mark	Total	Comment
8				
(a)	$3-6x-15x-10>0$	M1		Correctly multiplied out with >0
	$-21x>7$			
	$\Rightarrow x<-\frac{1}{3}$	A1cso	2	all working correct
(b)	$6x^2-x-12\leqslant 0$			
	$(3x+4)(2x-3)$	M1		correct factors or correct use of formula as far as $\frac{1\pm\sqrt{289}}{12}$
	CVs are $-\frac{4}{3},\ \frac{3}{2}$	A1		
		M1		use of sign diagram or graph with CVs clearly shown
	$-\frac{4}{3}\leqslant x\leqslant\frac{3}{2}$	A1	4	*or* $\frac{3}{2}\geqslant x\geqslant -\frac{4}{3}$
	Total		**6**	
	TOTAL		**75**	

(a) Allow final answer in form $-\frac{1}{3}>x$.

(b) For second **M1**, if critical values are correct then sign diagram or sketch  must be correct ***with correct CVs marked***.
However, if CVs are not correct then second **M1** can be earned for attempt at sketch or sign diagram but ***their CVs*** MUST be marked on the diagram or sketch.
Final **A1,** inequality must have x and no other letter.
Final answer of $x\leqslant\frac{3}{2}$ AND $x\geqslant-\frac{4}{3}$ (with or without working) scores 4 marks .

(A) $-\frac{4}{3}<x<\frac{3}{2}$ (B) $x\leqslant\frac{3}{2}$ OR $x\geqslant-\frac{4}{3}$ (C) $x\leqslant\frac{3}{2}$, $x\geqslant-\frac{4}{3}$ **(D)** $-\frac{4}{3}\leqslant k\leqslant\frac{3}{2}$
with or without working each score 3 marks (**SC3**)

Example NMS $\frac{4}{3}\leqslant x\leqslant\frac{3}{2}$ scores **M0** (since one CV is incorrect)

Example NMS $x<\frac{3}{2}$, $x<-\frac{4}{3}$ scores **M1 A1 M0** (since both CVs are correct)