Pure Core 1 Past Paper Questions Pack A: Mark Scheme

Taken from MAME

January 2001

Q	Solution	Marks	Total	Comments
1 (a)	$0, -6$	B1B1	2	
(b)	$(x-1)(x^2-3x-4)$	B1		for $x-1$ factor
	$(x-1)(x+1)(x-4)$	M1A1	3	allow separate factors $(x^2-1)(x-4)$ SR1
	Total		**5**	
2 (a)	$(x-3)^2-2$	M1A1	2	$(x+3)^2-2$ or $(x-3)^2 \pm a$ M1
(b)	c.v $3\pm\sqrt{2}$ or $\frac{6\pm\sqrt{8}}{2}$	M1A1		(M1A0 for one) allow 1.6, 4.4
	$3-\sqrt{2}<x<3+\sqrt{2}$, allow separately	B1	3	$1<x<7$ SR 0/3
	Total		**5**	

Q	Solution	Marks	Total	Comments
5 (a)	$(0<)2x<5 \Rightarrow (0<)x<2.5$	B1	1	in effect, $5\div 2$
(b)	$V=x(5-2x)(8-2x)$	M1		
	$=x(4x^2-26x+40)$	M1		expanding sensible quadratic
	$=4x^3-26x^2+40x$	A1	3	AG
(c)	$\frac{dV}{dx}=12x^2-52x+40$	M1A1		M1 for 2 correct
	$12x^2-52x+40=0$			
	$x=1$ $\left(\text{or } \frac{10}{3}\right)$ [false argument M0]	M1A2	5	M1 for solving quadratic; allow A1 for $\frac{10}{3}$ only or $1, -\frac{10}{3}$
(d)	$18\,(\text{cm}^3)$	B1	1	
	Total		**10**	

June 2001

3 (a)	$(x+2)^2$	M1		
	-9	A1	2	
(b)	$(x+2)^2>9$			
	or one c.v. of 1 or -5 seen	M1		
	$x<-5, \quad x>1$	A1A1	3	M1A1 if only the wraparound is seen i.e. $-5>x>1$ s.r. B1 if one correct inequality, following wrong working
	Total		**5**	

4	$8+4a+2b+4$	M1		a.e.f.
	$=0$	A1		
	$-1+a-b+4=0$	M1A1		
	$a=-3, \quad b=0$	A1A1	6	
	or s.r. maximum mark $\frac{5}{6}$:			
	$(x \quad)(x-2)(x+1)$	M1		
	$(x-2)(x-2)(x+1)$	A1		
	Multiplying out	M1		
	$a=-3, \quad b=0$	A1A1		
	Total		**6**	

6 (a)	$V=x^2h$	B1		
	$A=x^2+4xh$	M1A1	3	
(b)(i)	$v=x^2\left(\frac{3000-x^2}{4x}\right)$	M1		for elimination of h
	$=750x-\frac{1}{4}x^3$	A1	2	a.g.
(ii)	$750-\frac{3}{4}x^2$	M1		differentiation with one term correct
	$=0$	A1		
	$x=10\sqrt{10}$ or $\sqrt{1000}$	A1	3	allow $\pm\sqrt{1000}$
(iii)	Complete substitution of exact x	M1		
	$5000\sqrt{10}$	A1	2	must use exact method
	Total		**10**	

January 2002

3	$x^2+2x(2-x)=3$	M1		for elimination of 1 variable
	$\Rightarrow x^2-4x+3=0$	A1		quadratic equal to zero (3 terms)
	Solution of quadratic	M1		complete method factorising must be correct
	$x=3, \quad y=-1$	A1		} Allow B1 for any pair (x,y) or x's or y's, irrespective of working
	$x=1, \quad y=1$	A1	5	
	Allow if pairing unclear in final answer			trial and error: full marks if full solution obtained
	Total		**5**	

Q	Solution	Marks	Total	Comments
4 (a)	$\frac{dP}{dt} = -3t^2 + 114t + 117$	M1A1	2	M1 if 2 correct terms
(b)(i)	$3t^2 - 114t - 117 = 0$	M1		set $\frac{dP}{dt} = 0$ quadratic only.
	$t = 39(\text{or } -1)$	m1A1	3	allow answer only
(ii)	e.g. $\frac{dy}{dx}$ changes from $+ve$ to $-ve$	M1		allow sketch or values at T point
	Maximum	A1	2	S.R. B1 if not justified S.R. B1 if $\frac{d^2P}{dt^2} = 114 - 6t$ only
(c)(i)	2009√	B1√	1	√ on $t > 0$ from (b)(i)
(ii)	Extinction	B1	1	allow $P = 0$ do not allow "minimum"
	Total		**9**	

Q	Solution	Marks	Total	Comments
8 **(a)**	$\overrightarrow{PQ} = \begin{pmatrix} 5 \\ -5 \end{pmatrix}$	M1		allow if on diagram or if signs incorrect
	$PQ^2 = 5^2 + 5^2$	M1		
	$\sqrt{50} = 5\sqrt{2}$ A.G.	A1	3	B.O.D. unless decimals seen
(b)	$\frac{dy}{dx} = 2x - 4$	M1A1		M1 if one term correct
	$\frac{dy}{dx} = 4$ at Q	M1		use of $x = 4$ in $\frac{dy}{dx}$ [Allow use of $x = -1$ for M1A0]
	$y = 4x + C$	A1		
	$6 = 4 \times 4 + C$ or $y - 6 = 4(x - 4)$	M1		for use of $(4,6)$ in their $y = mx + c$
	$y = 4x - 10$	A1	6	<u>GRAPHICAL/NUMERICAL/FIRST PRINCIPLES</u> full marks if obtain correct gradient otherwise M0
(c)	$\frac{x^3}{3} - 2x^2 + 6x$	M1A1		M1 for 2 terms
	$\left(\frac{64}{3} - 32 + 24\right) - \left(-\frac{1}{3} - 2 - 6\right)$	M1A1		M1 for 4 and −1, correct way round, "integrated expression"
	$\frac{65}{3}$ or 21.7	A1	5	S.R. $\frac{4}{5}$ for correct answer then adjusted in some way <u>ALTERNATIVE</u> $y_1 - y_2 = -x^2 + 3x + 4$ $\int = -\frac{1}{3}x^3 + \frac{3}{2}x^2 + 4x(+C)$ M1A1 [Allow $y_2 - y_1$] $F(4) - F(-1) = 20\frac{5}{6}$ M1A1 [4 out of 5 max]
	Total		**14**	

June 2002

Q	Solution	Marks	Total	Comments
1 **(a)**	$f(1) = 0,\ f(-1) = -4$	B1B1	2	
(b)	Use of Factor Theorem	M1		
	3 linear factors found	A3, 2, 1	4	One mark for each correct factor. NMS but 3 factors correct ¾. SC all signs wrong, ie factors $x+1$, $x-2$, $x-3$: M1A1
	Total		**6**	

3	Elimination of x or of y	M1		
	$2x^2 - x - 3 = 0$ or $4y^2 - 3y - 1 = 0$	A1		ie correctly simplified to 3 non-zero terms
	Valid method for solving quadratic	m1		m0 if trivialised, eg no x term
	Both roots correct	A1		
	Solutions $(-1, 1), \left(\frac{3}{2}, -\frac{1}{4}\right)$	A1	5	Condone vagueness about pairing
	NMS 0/5 if no elimination seen; 3/3 for correct solutions after correct quadratic found			
	Total		**5**	

Q	Solution	Marks	Total	Comments
5(a)(i)	Use of quadratic formula	M1		OE; must have numerical values
	$x = \dfrac{-8 \pm \sqrt{8}}{4}$	A1	2	or equivalent surd forms
(ii)	$x <$ lower value or $>$ higher value	M1		With c's values (must have two) M1 if c shows right idea (eg by sketch) M0 if using eg $ab > 0 \Rightarrow a > 0$ or $b > 0$
	Clear and correct solution set	A1F	2	A0 for writing $a > x > b$ (except as FW); ft wrong solutions of quadratic penalised in (i); condone eg '$x < -2.71$ or $x > -1.29$' Condone $\le$ for $<$
(b)	Use of $(x + b)^2 = x^2 + 2bx + b^2$ $A = 2$ and $B = 2$ $C = -1$	M1 A1 A1	 3	PI NMS 3/3, or 1/3 for 2, 4, -9 or 2, 2, 3
(c) (i)	Min value is -1	B1F	1	ft wrong value of C
(ii)	Min at $x = -2$	B1F	1	ft wrong value of B
	Total		**9**	

Q	Solution	Marks	Total	Comments
7 (a)	$\int y \, dx = 12x - 3\left(\frac{1}{3}x^3\right)(+c)$	M1A1		M1 if at least one term correct
	$\int_0^2 y \, dx = 16$	A1	3	
(b)(i)	$y' = -kx$ Gradient at P is -12	M1 A1	 2	where k is a positive constant
(ii)	Use of this gradient to find y_Q $y_Q = 24$	m1 A1F	 2	eg by finding equation of tangent NMS 2/2; ft wrong (negative) gradient
(c)	**Method 1** Area of Δ $OPQ = 24$	A1F		dependent on previous m mark ft wrong value of y_Q
	Required area = 24 – 16 = 8	A1F	2	dependent on all 3 method marks; ft wrong value in (a) <u>or</u> (b)(ii) giving positive answer
	Method 2 Required area $= \int_0^2 \left((24 - 12x) - (12 - 3x^2)\right) dx$	A1F		dependent on previous m mark ft wrong equation of PQ
	... = 8	A1		
	Total		**9**	

November 2002

Q	Solution	Marks	Total	Comments
3 (a)	$f(2) = 8 + 12 - 12 - 8 = 0$	B1	1	Accept NMS
(b)	$x - 2$ (or $x + 1$ or $x + 4$) is a factor	B1	1	May appear in (a) or (c) but use of Factor Theorem must be implied
(c)	$f(x) = (x-2)(x^2 + 5x + 4)$	M1A1		OE; M1 for $5x$ or 4 correct
	$\ldots = (x-2)(x+1)(x+4)$	m1A1	4	2-mark penalty for reversal of signs
				NMS (or repeated use of Factor Theorem) 4/4 all correct, 1/4 for second factor found
	Total		**6**	

5 (a)	Method for solving quadratic	M1		
	$x = \dfrac{-32 \pm \sqrt{72}}{4}$	A1		OE
	$\ldots = -8 \pm \dfrac{3}{2}\sqrt{2}$	B1F	3	Correct use of $\sqrt{72} = 6\sqrt{2}$ OE
(b)(i)	$m = 8$	B1		
	$n = -9$	B1F	2	ft error in finding m
(ii)	So minimum value is -9	B1F	1	ft wrong value for n
	Total		**6**	

Q	Solution	Marks	Total	Comments
7 (a)	y-coordinate of B is $2^3 - 2 = 6$	B1		
	Gradient of AB is $\dfrac{6-0}{2-1}$	M1		ft
	Equation of AB is $y = 6(x-1)$	m1		OE
	ie $6x - y - 6 = 0$	A1F	4	OE but in required form; ft wrong y-coordinate for B
(b)	$\int y\,dx = \frac{1}{4}x^4 - \frac{1}{2}x^2 (+c)$	M1A1		M1 if at least one term correct
	Substitution of $x = 1$	m1		
	$\int_0^1 y\,dx = -\dfrac{1}{4}$	A1F		PI, eg $\int_0^1 y\,dx = \frac{1}{4}$; ft one error in a coefficient
	So area is $\dfrac{1}{4}$	A1F	5	ft negative answer; allow 1/2 for answer $\frac{1}{4}$ not clearly justified eg "$-\frac{1}{4} = \frac{1}{4}$" or using $\int_0^1 y\,dx$ without explanation
	Total		**9**	

8 **(a)**	$y' = 4x^3 - 24x^2 + 32x$	M1A2,1	3	M1 if at least one term correct; -1 EE
(b)	$y' = 0$ for $x = 0$	B1		Condone factors instead of values in (b)
	... and when $x^2 - 6x + 8 = 0$	M1		OE method leading to 2 non-zero values
	ie for $x = 2, 4$	A2,1	4	-1 EE
				NMS 1/3 for $x = 2$ or $x = 4$, 2/3 for both, 4/4 for all three correct values
(c)	Values of y for $x < 2$, $x = 2$, $x > 2$	M1A1		or of y' for $x < 2$, $x > 2$ or of y'' for $x = 2$
	Conclusion drawn	E1	3	AG
(d)	Arrival time is 8.24 am	B1B1	2	
	Total		**12**	

January 2003

3 **(a)**	$x(2x + 1) = 3$ or $2x + 1 = \frac{3}{x}$	M1		
	$2x^2 + x - 3 = 0$	A1	2	convincingly obtained (AG)
(b)	Method for solving quadratic	M1		i.e. formula, factors or completing square
	Solutions $(1, 3), \left(-\frac{3}{2}, -2\right)$	A2,1	3	A1 for both x values or one pair correct
				NMS 2/3 for both x values correct, 3/3 all correct
	Total		**5**	

5 **(a)**	$a = -3,\ b = 6$	B1B1	2	
(b)	Method for midpoint	M1		
	M is $\left(-\frac{3}{2}, 3\right)$	A1F	2	ft wrong values in (a); Allow NMS
(c)	Grad of AB is 2	B1F		ft wrong values in (a); PI by next statement
	Grad of perp is $-\frac{1}{2}$	B1F		ft wrong grad for AB
	Line is $y = mx + c$ where $m = -\frac{1}{2}$ and	M1		Allow c's value
	$c = \frac{9}{4}$	A1F	4	ft c's M and c's m; condone wrong form
	Total		**8**	

7 (a)(i)	$y' = 1 - 8x^3$	M1A1	2	M1 if at least one term correct
(ii)	SP $\Rightarrow y' = 0$	M1		PI
	$x_P = \frac{1}{2}$ convincingly shown	A1	2	AG; Allow verification
(iii)	$y_P = \frac{3}{8}$ (=0.375)	B1	1	
(b)(i)	$\int y\,dx = \frac{1}{2}x^2 - \frac{2}{5}x^5 (+c)$	M1A1	2	M1 if at least one term correct
(ii)	Substitution of $x = \frac{1}{2}$	m1		
	Area $= \frac{1}{8} - \frac{2}{160} (= 0.125 - 0.0125)$	A1		This mark awarded if at least one term correct
	$\ldots = \frac{9}{80} (= 0.1125)$	A1	3	
	Total		**10**	

Q	Solution	Marks	Total	Comments
8 (a)	Rationalising denominator	M1		
	Numerator becomes $2\sqrt{2} + 3$	m1A1		
	Denominator = 1, so answer is $2\sqrt{2} + 3$	A1F	4	ft one small error in numerator (ans in reqd form) $2\sqrt{2} + 3$ NMS 3/4
(b)	LHS $= \sqrt{2}x - 2$	B1		Allow B1 for $\sqrt{2}x - \sqrt{4}$
	$\sqrt{2}x - x < 2\sqrt{2} + 2$	M1		Allow M1 even with decimals Allow equality here
	$x < \frac{2\sqrt{2} + 2}{\sqrt{2} - 1}$	A1F	3	or better; ft one error in LHS Allow $x < \frac{2\sqrt{2}+2}{\sqrt{2}-1}$ even if not fully explained (after equations approach)
	Total		**7**	

June 2003

2 (a)	$A = 3,\ B = -2$	B1B1	2	
(b)	Method for solving quadratic	M1		
	$x = -3 \pm \sqrt{2}$ or $\frac{-6 \pm \sqrt{8}}{2}$	A2,1F	3	A1 if one root found or if small error made; ft wrong answer in (a) NB Follow through when $B > 0$: M1A1 for showing that there are no real roots, M1A0 for writing e.g. $x = -3 \pm \sqrt{-2}$ NMS B2 for one exact root, B3 for both; B1 for AWRT -1.59, B1 for AWRT -4.41 (3sf needed)
	Total		**5**	

Q	Solution	Marks	Total	Comments
4 (a)	Gradient is $\frac{3}{2}$	B1		PI
	Equation is $y = \frac{3}{2}x$	B1F	2	ft wrong gradient provided $c = 0$
(b)(i)	Gradient of given line is $-\frac{2}{3}$	B1		PI; or gradient of perp line is $-\frac{2}{3}$; allow AWRT -0.666 or -0.667
	Hence given line perpendicular to OA	E1	2	convincingly shown (AG)
(ii)	Attempt at midpoint of OA	M1		Allow 3/3 for other convincing method
	Midpoint is $\left(1, \frac{3}{2}\right)$	A1		
	This lies on the given line	E1	3	convincingly shown (AG)
	Total		**7**	

Q	Solution	Marks	Total	Comments
6 (a)(i)	$\sqrt{3} = 3^{\frac{1}{2}}$	B1	1	
(ii)	$\frac{3^x}{\sqrt{3}} = 3^{x-\frac{1}{2}}$	B1F	1	ft wrong answer to (i)
(b)	Complete method for finding x	M1		
	$x = -\frac{1}{2}$	A2,1F	3	ft wrong answer to (a)(ii) A1 if one small error made No method or trial method: 1/3 for AWRT -0.500 unless answer justified (verified)
	Total		**5**	

Q	Solution	Marks	Total	Comments
8 (a)	$f(3) = -2,\ f(4) = 0$	B1B1	2	
(b)	Awareness of factor theorem	M1		PI by answers involving 1, 2, 4
	$f(x) = (x-1)(x-2)(x-4)$	A1	2	M1A0 for $(x+1)(x+2)(x+4)$ or for two factors correct
(c)(i)	$y' = 3x^2 - 14x + 14$	B3	3	B1 for each term
(ii)	Gradient at $x = 3$ is -1	B1F		ft one wrong coefficient
	Function is decreasing	E1F	2	ft wrong (non-zero) value for gradient at $x = 3$
				Alternative methods: 2/2 for convincing argument based on SP at $x \approx 3.22$ or values $f(a), f(b)$ where $a \le 3 < b$
(iii)	$\int y\,dx = \frac{1}{4}x^4 - \frac{7}{3}x^3 + 7x^2 - 8x(+c)$	M1A2	3	M1 if at least one term correct; -1 EE
(iv)	Substitution of $x = 1$ and/or $x = 2$	M1		in c's integral (not y or y')
	Both substitutions and subtraction	m1		Subtraction must be right way round
	Area = $\frac{5}{12}$	A1	3	allow AWRT 0.416 or 0.417
	Total		**15**	

November 2003

2 (a)	Method for solving quadratic	M1		Eg 3 numbers in correct formula with at most one error
	$x = \frac{12 \pm \sqrt{8}}{4}$	A2,1	3	OE; A1 if one small error made
(b)	Discriminant $= 144 - 168 < 0$	M1A1	2	OE; eg completing the square
(c)	$144 - 8p = 0 \Rightarrow p = 18$	M1A1	2	NMS 2/2; OE, eg correct factors found
	Total		**7**	

Q	Solution	Marks	Total	Comments
4 (a)	$A = \frac{1}{2}(2+t)(6-t)$	M1		
	$\dots = 6 + 2t - \frac{1}{2}t^2$	A1	2	Convincingly shown (AG)
(b)(i)	$A' = 2 - t$	M1A1	2	M1 if at least one non-zero term correct
(ii)	$\dots = 0$ when $t = 2$	A1	1	AG; allow verification here
(c)(i)	$P(4,0),\ Q(0,4)$	B1	1	
(ii)	Grad of $PQ = -1$	B1F	1	ft wrong coords for P, Q
(iii)	Eqn of line with correct grad	M1		Allow c's grad given in (ii)
	Eqn of PQ is $x + y = 4$	A1	2	OE
	Total		**9**	

Q		Solution	Marks	Total	Comments
7	(a)	At P, Q, $2x = -2x^2 + x + 6$	M1		
		$2x^2 + x - 6 = 0$	A1		
		$(2x-3)(x+2) = 0$	m1		OE, eg correct use of correct formula; condone verification of $x = \frac{3}{2}$
		So $x_P = \frac{3}{2}$ (AG) and $x_Q = -2$	A1	4	
	(b)	Area $T = \frac{1}{2}\left(\frac{3}{2}\right)(3) = \frac{9}{4}$	M1A1	2	OE, e.g. integration
	(c)(i)	$\int ...\mathrm{d}x = -\frac{2}{3}x^3 + \frac{1}{2}x^2 + 6x (+c)$	B3	3	B1 for each term
	(ii)	$\int_0^{\frac{3}{2}} \left(-2x^2 + x + 6\right)\mathrm{d}x = \frac{63}{8}$	B1		No credit for $\int_{-2}^{\frac{3}{2}} \left(-2x^2 x + 6\right)\mathrm{d}\,x$
		So area of $R = \frac{63}{8} - \frac{9}{4} = \frac{45}{8}$	M1A1F	3	ft wrong values
		Alternative methods for (c) (ii):			
		Method 1: $\int_0^{\frac{3}{2}} \left(-2x^2 - x + 6\right)\mathrm{d}\,x \frac{45}{8}$	M1A2,1		
		Method 2 $\int_0^{\frac{3}{2}} \left(2x^2 + x - 6\right)\mathrm{d}\,x$	MIAO		Unless right answer legitimately obtained
		Total		**12**	

January 2004

3	(a)	$f(2) = 0$	B1	1	Allow NMS
	(b)	$x - 2$ is a factor	B1	1	or $x + 3$ if from Factor Theorem
	(c)	$f(x) = (x-2)(x^2 + 6x + 9)$	M1A1		M1 if $6x$ or 9 correct
		$\ldots = (x-2)(x+3)^2$	m1A1	4	**NMS** 1/4 for 2nd factor, 4/4 all correct If c divides by $x + 2$, give M1 if $2x$ or -9 appears If c writes $x + 2$ and $x - 3$ as factors, give B1 If c's answer is $(x+2)(x-3)^2$, give B2
		Total		**6**	

Q		Solution	Marks	Total	Comments
5	(a)	Grad of L is negative	B1		Allow NMS
		Grad of L is $(\pm)\ \frac{2}{3}$	B1	2	PI; condone $(\pm)\ \frac{2}{3}x$; allow NMS
	(b)	Perp grad is $\frac{3}{2}$	B1F	1	Condone $\frac{3}{2}\ x$; ft wrong answer to (a)
	(c)	Req'd line is $y - 1 = \frac{3}{2}\ (x - 4)$	M1		OE; B1 for full verification
		ie $3x - 2y = 10$	A1	2	Convincingly shown (AG)
	(d)	Elimination of x or y	M1		
		Pt of int is (6, 4)	A2, 1	3	2/3 for non-algebraic method
	(e)	Shortest length is $\sqrt{13}$	m1A1F	2	ft one error in (d); allow AWRT 3.61
		Total		**10**	

7 (a)	$m = 3, n = -8$	B1B1	2	
(b)	Method for solving quadratic	M1		
	$x = -3 \pm \sqrt{8}$ or $\dfrac{-6 \pm \sqrt{32}}{2}$	A1		
	$\ldots = -3 \pm 2\sqrt{2}$	B1	3	This mark is for $\sqrt{8} = 2\sqrt{2}$ or $\sqrt{32} = 4\sqrt{2}$
(c)	$-3 - 2\sqrt{2} < x < -3 + 2\sqrt{2}$	B1F	1	ft wrong answers or forms penalised in (b); allow $-5.83 < x < -0.17$; condone $\le$ for $<$
	Total		**6**	

Q	Solution	Marks	Total	Comments
8(a)(i)	$y' = 3x^2 - 6x + 3$	M1A1	2	M1 if at least one term correct
(ii)	Solving quadratic $y' = 0$	m1		Allow verification here
	SP is (1,1)	A1A1	3	NMS $x = 1$ B1, $y = 1$ B1 provided y correct
(b)(i)	$\int y \, dx = \frac{1}{4}x^4 - x^3 + \frac{3}{2}x^2 \ (+c)$	B3,2,1	3	B1 for each term
(ii)	Substitution of $x = 3$	M1		In c's integral (not y or y'); M0 for attempting $\int_3^9 y \, dx$
	$\int_0^3 y \, dx = \frac{81}{4} - 27 + \frac{27}{2} = \frac{27}{4}$	A1		
	ie half of $\frac{1}{2}(3 \times 9)$			OE, eg integration
	hence result	A1	3	Convincing shown (AG)
	Total		**11**	

June 2004

Q	Solution	Marks	Total	Comments
1(a)	$x^2 + 2x - 3 = 0$	B1	1	convincingly shown (AG)
(b)	Solution of quadratic	M1		Two solutions needed (M1A0 for $x = -1$ or 3)
	Solutions are (1, 1), (–3, –7)	A2,1	3	A1 for both x values or one pair; NMS 1/3
	Total		**4**	

Q	Solution	Marks	Total	Comments
5(a)	$(\sqrt{3} - \sqrt{2})(\sqrt{3} + \sqrt{2}) = 1$	B1	1	Condone answer 3 – 2
(b)(i)	Rationalising denominator	M1		Method must be shown
	Expanding numerator	m1		To give $m + n\sqrt{6}$, not necessarily simplified
	$k = 5 - 2\sqrt{6}$	A1	3	
(ii)	Rationalising denominator	M1		using original k or answer to (i)
	$1/k = 5 + 2\sqrt{6}$	A1	2	
	Total		**6**	

6(a)(i)	$\int y\,dx = \frac{1}{4}x^4 - x^3 + 3x^2 (+c)$	M1A1	2	M1 if one term or all powers correct. Accept unsimplified
(ii)	Substitution and subtraction Definite integral = 18	m1 A2, 1F	3	Subtraction must be the right way ft one wrong coefficient in (i); A1 if only one (perhaps repeated) error
(b)(i)	$y' = 3x^2 - 6x + 6$	M1A1	2	M1 if at least one term correct
(ii)	y increasing if $y'>0$	M1		
	Completing square	m1		or using discriminant
	$y' > 0$ for all x	A1	3	
	Total		**10**	

7(a)	At B, $2x + 3x = 15$	M1		OE elimination
	B is (3, 3)	A1	2	
(b)	Good attempt at equation of CD	M1		Linear equation, with same grad as AB (attempted)
	Gradient of CD correct Constant correct	A1 A1F	3	NMS $2x + 3y = 30$; 3/3 $2x + 3y = k$; 2/3 $2x + 3y =$ (other); 0/3 ft wrong grad: eqn satisfied by (6,6)
(c)	D is (0, 10)	A1F	1	ft wrong equation for CD
(d)	Complete method for area	M2		
	Area = 22.5	A2,1	4	A1 if at least relevant area correct
	Total		**10**	