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MA01

(9660/MA01) Unit P1 Pure Mathematics

Mark scheme

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Key to mark scheme abbreviations
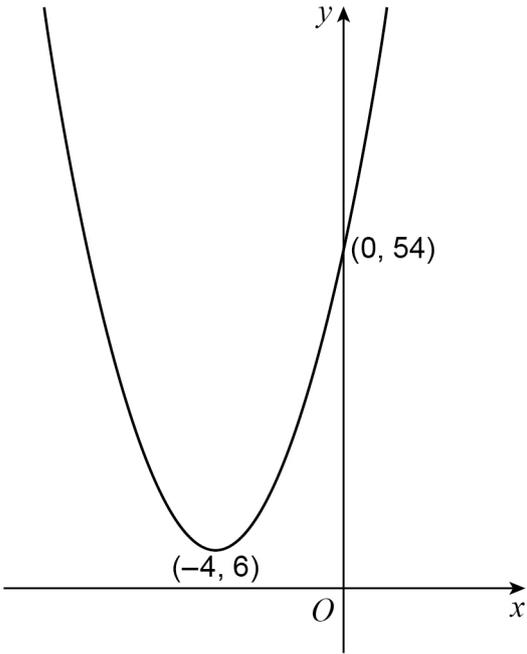
M	Mark is for method
m	Mark is dependent on one or more M marks and is for method
A	Mark is dependent on M or m marks and is for accuracy
B	Mark is independent of M or m marks and is for method and accuracy
E	Mark is for explanation
√ or ft	Follow through from previous incorrect result
CAO	Correct answer 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
sf	Significant figure(s)
dp	Decimal place(s)
ISW	Ignore subsequent working

Q	Answer	Marks	Comments
1(a)(i)	$16p^{\frac{7}{6}}$	**B1**	
		1	

Q	Answer	Marks	Comments
1(a)(ii)	$6p^{\frac{11}{24}}$	**B1**	
		1	

Q	Answer	Marks	Comments
1(b)	$\left[\left(a-5\sqrt{7}\right)^2=\right]$ $a^2-10\sqrt{7}a+175$ or $a^2-5\sqrt{7}a-5\sqrt{7}a+175$	**M1**	Correct expansion of LHS simplified or unsimplified with $\left(5\sqrt{7}\right)^2$ evaluated
	$\left[-10\sqrt{7}a=-30\sqrt{7}\Rightarrow a=\right]$ 3	**A1**	**CAO**
	$\left[a=3\Rightarrow b=a^2+175=\right]$ 184	**A1ft**	**ft** Their a provided it is an integer
		3	

	Question 1 Total	**5**	

Q	Answer	Marks	Comments
2(a)	$(x+4)^2 \ldots$	M1	
	$3(x+4)^2 - 48 + 54$	A1	Allow $3\left((x+4)^2 - 16\right) + 54$ $3\left((x+4)^2 - 16 + 18\right)$ $3\left((x+4)^2 + 2\right)$ Must have correct use of brackets
	$3(x+4)^2 + 6$	A1	CAO
		3	

Q	Answer	Marks	Comments
2(b)		M1	Correctly orientated symmetrical quadratic parabola
		A1ft	Vertex labelled as $(-4, 6)$ **ft** Their $(-b, c)$ from **part (a)** Accept correctly positioned vertex with $x = -4$ and $y = 6$ indicated on the axes
		B1	$(0, 54)$ labelled on y-axis. Condone given as y-value only
		3	

Q	Answer	Marks	Comments
2(c)	Translation	**E1**	
	$\begin{bmatrix} 9 \\ 0 \end{bmatrix}$	**E1ft**	Must be given as a vector **ft** Their x-coordinate of the vertex of C from **part (b)**
		2	

	Question 2 Total	**8**	

Q	Answer	Marks	Comments
3(a)	$\dfrac{y-6}{0-4}$	M1	**oe** Correct method for finding the gradient of *AB*
	$\dfrac{y-6}{0-4} = -\dfrac{1}{4}$ and $[y =]\ 7$	A1	**oe** Setting the expression for the gradient equal to $-\dfrac{1}{4}$ and **AG**

Q	Answer	Marks	Comments
3(a) ALT	$y - 6 = -\dfrac{1}{4}(x - 4)$ or $y = -\dfrac{1}{4}x + c$	M1	**oe** Correct equation for *AB* or Recognising that equation of *AB* is of the form $y = -\dfrac{1}{4}x + c$ **oe**
	$[x = 0 \Rightarrow]\, y - 6 = -\dfrac{1}{4}(0 - 4)$ and $[y =]\ 7$ or $[x = 4$ and $y = 6 \Rightarrow]\ 6 = -\dfrac{1}{4} \times 4 + c$ and $[c =]\ 7$	A1	**oe** Substituting $x = 0$ into the correct equation for *AB* and **AG** or **oe** Substituting $x = 4$ and $y = 6$ into $y = -\dfrac{1}{4}x + c$ and **AG**
		2	

Q	Answer	Marks	Comments
3(b)	[Gradient of *AD* =] 4	**B1**	
	$y - 6 = 4(x - 4)$ or $y = 4x - 10$	**M1**	**oe** Uses gradient and coordinates of *A* to form a correct equation for line *AD*
	$\left[y = -\dfrac{1}{4}x - \dfrac{3}{2} \text{ and } y = 4x - 10 \Rightarrow \right]$ $(2, -2)$	**A1**	Solves equations simultaneously to give correct coordinates Condone not given as coordinates but must be clearly identified
		3	

Q	Answer	Marks	Comments
3(c)	$(4-0)^2 + (7-6)^2$ or $\sqrt{(4-0)^2 + (7-6)^2}$ or $(4-2)^2 + (6-(-2))^2$ or $\sqrt{(4-2)^2 + (6-(-2))^2}$	**M1**	**oe** Correct method for finding $\lvert AB \rvert$ or $\lvert AB \rvert^2$ or $\lvert AD \rvert$ or $\lvert AD \rvert^2$ **ft** Their coordinates of *D*
	$\left[\lvert AB \rvert = \right]$ $\sqrt{17}$	**A1**	Correct exact length of *AB*
	$\left[\lvert AD \rvert = \right]$ $2\sqrt{17}$	**A1**	Correct exact length of *AD* Allow $\sqrt{68}$
	$\left[\text{Perimeter} = 2\left(\sqrt{17} + 2\sqrt{17}\right) = \right]$ $6\sqrt{17}$	**A1**	**CAO** Correct perimeter
		4	

	Question 3 Total	**9**	

Q	Answer	Marks	Comments
4(a)	$u_2 = k - 8$	M1	May be embedded in expression for u_3 but must be seen
	$u_3 = k - \dfrac{16}{k-8}$ or $\dfrac{k^2 - 8k - 16}{k-8}$	M1	Expression for u_3 simplified or unsimplified
	$\left[3u_3 = 5u_2 + 4 \Rightarrow \right]$ $3\left(k - \dfrac{16}{k-8} \right) = 5(k-8) + 4$	M1	**oe** Substitutes their u_2 and u_3 into $3u_3 = 5u_2 + 4$
	$3k^2 - 24k - 48 = 5k^2 - 76k + 288$	M1	**oe** Fraction cleared and brackets expanded
	$2k^2 - 52k + 336 = 0$ and $k^2 - 26k + 168 = 0$	A1	Rearranged into unsimplified quadratic equation before **AG**
		5	

Q	Answer	Marks	Comments
4(b)	$\left[k^2 - 26k + 168 = 0 \Rightarrow \right]$ $(k-12)(k-14) \; [= 0]$	M1	Correct attempt to solve the quadratic equation. Could be seen as correct substitution into the quadratic formula, simplified or unsimplified
	$k = 12$ and $k = 14$	A1	Award mark if only $k = 14$ seen and no incorrect value of k seen
	$\left[u_4 = \right] 14 - \dfrac{16}{14 - \dfrac{16}{14-8}}$	M1	Substitutes their k into expression for u_4
	$\left[u_4 = \right] \dfrac{214}{17}$	A1	**CAO**
		4	

	Question 4 Total	**9**	

Q	Answer	Marks	Comments
5(a)	$[x - 2 \leq 3x + 6 \leq x + 34 \Rightarrow]$ $-2 \leq 2x + 6 \leq 34$ $-4 \leq x \leq 14$	**M1** **A1**	**oe** Correctly eliminating x from the endpoints **PI** **oe CAO**
		2	

Q	Answer	Marks	Comments
5(b)(i)	$[(6x - 5)(x + 14) =]$ $6x^2 + 79x - 70$ $[6x^2 + 79x - 70 > 126x - 147 \Rightarrow]$ $6x^2 - 47x + 77 > 0$ $(3x - 7)(2x - 11) > 0$	**M1** **M1** **A1**	Correct expansion simplified or unsimplified Correct rearrangement set > 0 **CAO**
		3	

Q	Answer	Marks	Comments
5(b)(ii)	$x < \dfrac{7}{3}$ or $x > \dfrac{11}{2}$	**B1ft**	**ft** Their answer to **part (b)(i)** **oe**
		1	

Q	Answer	Marks	Comments
5(c)	$-4 \leq x < \dfrac{7}{3}$ or $\dfrac{11}{2} < x \leq 14$	**M1** **A1ft**	**ft** Their answers to **parts (a)** and **(b)(ii)** **M1**: One correct inequality **A1**: Both correct inequalities and no others
		2	

	Question 5 Total	**8**	

Q	Answer	Marks	Comments
6	$2x^2 - 7x + 18 = c + 5x - x^2$	**M1**	Equates the equations of the curves
	$3x^2 - 12x + 18 - c = 0$ and $(-12)^2 - 4(3)(18 - c) \ [= 0]$ or $12c - 72 \ [= 0]$	**M1**	Rearranges to a quadratic set equal to zero and forms correct discriminant for their quadratic equation
	$[12c - 72 = 0 \Rightarrow c =] \ 6$	**A1**	**PI** Correct value of c
	$3x^2 - 12x + 12 = 0$ or $x^2 - 4x + 4 = 0$	**M1**	**PI oe** Substitutes their value for c into their $3x^2 - 12x + 18 - c = 0$
	$\left[x^2 - 4x + 4 = 0 \Rightarrow x = \right] \ 2$	**A1**	**CAO** Correct x-coordinate of P
	$(2, 12)$	**A1**	**CAO** Correct coordinates of P

	Question 6 Total	**6**	

Q	Answer	Marks	Comments
7(a)	$h = 0.6$	B1	
	$\left[\text{With } f(x) = \dfrac{4^x}{x+7} \right]$		
	$\left[I \approx \dfrac{h}{2}\{...\} \right]$	M1	**oe** Summing the areas of the trapezia
	$[\{...\} =] \ f(0) + f(3)$ $+ 2(f(0.6) + f(1.2) + f(1.8) + f(2.4))$		
	$[\{...\} =] \ 0.1428... + 6.4$ $+ 2\begin{pmatrix} 0.3022... + 0.6436... \\ + 1.3779... + 2.9635... \end{pmatrix}$	A1	**oe** Accept rounded or truncated to two decimal places
	$[= 17.1177...]$		
	$[I \approx 0.3 \times 17.1177... =] \ 5.14$	A1	**CAO**
		4	

Q	Answer	Marks	Comments
7(b)	Use more strips (or ordinates)	E1	
		1	

Q	Answer	Marks	Comments
7(c)(i)	Stretch in the y-direction	E1	Both 'stretch' and direction needed
	Scale factor $\dfrac{1}{3}$	E1	'Scale factor' needed. Accept 'sf'
		2	

Q	Answer	Marks	Comments
7(c)(ii)	$5.14 + \dfrac{1}{3} \times 5.14$	**M1**	**ft** Their answer to **part (a)** and their scale factor from **part (c)(i)**
	6.85	**A1**	**CAO**
		2	

	Question 7 Total	**9**	

Q	Answer	Marks	Comments
8(a)	$\left[\dfrac{dy}{dx}=\right]\ 6x-\dfrac{11}{2}-\dfrac{10}{x^2}$	M1 A1	**oe** **M1**: Two correct terms **A1**: Correct derivative
	$\left[x=2\Rightarrow\dfrac{dy}{dx}=\right]\ (6)(2)-\dfrac{11}{2}-\dfrac{10}{2^2}\ [=4]$	M1	Substitutes $x=2$ into their derivative to obtain gradient of *L*
	$y-6=4(x-2)$ and $y=4x-2$	A1	**oe** Uses gradient and coordinates of *P* to form an equation leading to the required result May see $y=4x+c$ and substitution of coordinates of *P* to find *c* but must be a complete method
		4	

Q	Answer	Marks	Comments
8(b)(i)	$[m=]\ -\dfrac{1}{4}$ or $[m=]\ a-3$	B1	Correct gradient of tangent to *D* at $x=3$ given as value or in terms of a
	$-\dfrac{1}{4}=3^2-4(3)+a$ or $-\dfrac{1}{a-3}=4$	M1	Substitutes $x=3$ and $\dfrac{dy}{dx}=-\dfrac{1}{4}$ into $\dfrac{dy}{dx}=x^2-4x+a$ or Sets expression for gradient of normal in terms of a equal to 4
	$[a=]\ \dfrac{11}{4}$	A1	**CAO**
		3	

Q	Answer	Marks	Comments
8(b)(ii)	$\left[\dfrac{\mathrm{d}y}{\mathrm{d}x} = x^2 - 4x + \dfrac{11}{4} \Rightarrow\right]$	M1	**ft** Their value of a from **part (b)(i)** **M1**: Two correct terms **A1**: Fully correct integration and must have $+c$
	$[y =]\ \dfrac{1}{3}x^3 - 2x^2 + \dfrac{11}{4}x + c$	A1ft	
	$10 = \dfrac{1}{3}\left(3^3\right) - 2\left(3^2\right) + \dfrac{11}{4}(3) + c$	M1	**oe** Substitutes the coordinates into their integral
	$y = \dfrac{1}{3}x^3 - 2x^2 + \dfrac{11}{4}x + \dfrac{43}{4}$	A1	**CAO**
		4	

	Question 8 Total	**11**	

Q	Answer	Marks	Comments
9(a)	$[\mathrm{p}(-3)=]\ (-3)^3+b(-3)^2-31(-3)-52$	M1	**oe** Substitutes $x=-3$ into $\mathrm{p}(x)$
	$(-27)+9b+93-52=77$ and $b=7$	A1	**oe** Powers and product evaluated and set equal to 77 **AG** Must use the Remainder Theorem
		2	

Q	Answer	Marks	Comments
9(b)(i)	$[\mathrm{p}(4)=]\ (4)^3+7(4)^2-31(4)-52$	M1	**oe** Substitutes $x=4$ into $\mathrm{p}(x)$
	$64+112-124-52=0$	A1	**oe** Powers and product evaluated before setting equal to zero Must use the Factor Theorem
		2	

Q	Answer	Marks	Comments
9(b)(ii)	$\left[x^3 + 7x^2 - 31x - 52 = \right]$ $(x-4)\left(x^2 + 11x + 13 \right)$	M1 A1	Expresses $\mathrm{p}(x)$ as the product of $(x-4)$ and a quadratic factor **M1**: Coefficient of x or constant term correct **A1**: Correct expression **PI**
	$x^{\frac{1}{2}} + 11x^{-\frac{1}{2}} + 13x^{-\frac{3}{2}}$	M1	**oe** **ft** Their factorised numerator Correct integrand with fraction cleared
	$\left[\int x^{\frac{1}{2}} + 11x^{-\frac{1}{2}} + 13x^{-\frac{3}{2}} \, \mathrm{d}x = \right]$ $\dfrac{2}{3}x^{\frac{3}{2}} + 2(11)x^{\frac{1}{2}} + (-2)(13)x^{-\frac{1}{2}} \; [+c]$	M1	**ft** Their integrand Two correct terms simplified or unsimplified
	$\left[\int x^{\frac{1}{2}} + 11x^{-\frac{1}{2}} + 13x^{-\frac{3}{2}} \, \mathrm{d}x = \right]$ $\dfrac{2}{3}x^{\frac{3}{2}} + 22x^{\frac{1}{2}} - 26x^{-\frac{1}{2}} + c$	A1	**CAO** Coefficients simplified Must have $+c$
		5	

	Question 9 Total	**9**	

Q	Answer	Marks	Comments
10	$\left[\dfrac{ar^4}{ar} = \dfrac{12}{96} \Rightarrow r =\right] \quad \dfrac{1}{2}$	**B1**	Correct value of r
	$[a =] \quad 192$	**B1ft**	Correct value of a **ft** Their r
	$\dfrac{192}{1-\frac{1}{2}}$ or $\dfrac{192\left(1-\left(\frac{1}{2}\right)^k\right)}{1-\frac{1}{2}}$	**M1**	**PI** **oe** Correct expression for the sum to infinity or the sum of the first k terms with values substituted **ft** Their values for a and r
	$\dfrac{192}{1-\frac{1}{2}} - \dfrac{192\left(1-\left(\frac{1}{2}\right)^k\right)}{1-\frac{1}{2}}$	**M1**	**PI** **oe** Correct expression for $\displaystyle\sum_{n=1}^{\infty} u_n - \sum_{n=1}^{k} u_n$ with values substituted Must be working with correct values of a and r
	$\left[384 \times \left(\dfrac{1}{2}\right)^k =\right] \quad 3 \times 2^{7-k}$	**M1** **A1**	**M1**: Expression in correct form with at least two of a, b or c correct **A1**: Correct answer in the correct form

| | **Question 10 Total** | **6** | |