Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number	Candidate Number

Core Mathematics C12

Advanced Subsidiary

Wednesday 11 October 2017 – Morning
Time: 2 hours 30 minutes

Paper Reference
WMA01/01

You must have:
Mathematical Formulae and Statistical Tables (Blue)

Total Marks

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B). Coloured pencils and highlighter pens must not be used.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information

- The total mark for this paper is 125.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

1. The line l_1 has equation

$$8x + 2y - 15 = 0$$

(a) Find the gradient of l_1

(1)

The line l_2 is parallel to the line l_1 and passes through the point $\left(-\frac{3}{4}, 16\right)$.

(b) Find the equation of l_2 in the form $y = mx + c$, where m and c are constants.

(3)

Question Number	Scheme	Marks
1.	The line l_1 has equation $8x+2y-15=0$	
(a)	Gradient is -4	B1 **[1]**
(b)	Gradient of parallel line is equal to their previous gradient	M1
	Equation is $y-16="-4"\left(x-\left(-\frac{3}{4}\right)\right)$	M1
	So $y=-4x+13$	A1 **[3]** **(4 marks)**

(a)

B1 Gradient, m, $\frac{dy}{dx}$ given as -4 FINAL ANSWER

Do not allow $-\frac{8}{2}$ or $-\frac{4}{1}$ or $-4\rightarrow\frac{1}{4}$ in part (a). Do not allow if left as $y=-4x+..$

(b)

M1 Gradient of lines are the same. This may be implied by sight of their $'-4'$ in a gradient equation. For example you may see candidates state $y='-4'x+..$ in (a) and then write $y='-4'x+c$ in (b)

M1 For an attempt to find an equation of a line using $\left(-\frac{3}{4},16\right)$ and a numerical gradient (which may be different to the gradient used in part (a)). For example they may try to find a normal! Condone a sign error on one of the brackets. If the form $y=mx+c$ is used they must proceed as far as finding c.

A1 cao $y=-4x+13$ Allow $m=-4, c=13$

Question Number	Scheme	Marks
2.(a)	$(0,3)$	B1
(b)	$(2,-3)$	B1
(c)	$(2,1.5)$ oe	B1
(d)	$(2,-1)$	B1 **[4]** **(4 marks)**

Condone the omission of the brackets. Eg Condone $0,3$ for $(0,3)$

Allow $x=...y=...$

If options are given, Attempt one $=(0,3)$, Attempt two = $(2,5)$, Award B0.

If there is no labelling mark (a) as the first one seen, (b) as the second one seen etc unless it is obvious.

2. The point $P(2, 3)$ lies on the curve with equation $y = \mathrm{f}(x)$.

State the coordinates of the image of P under the transformation represented by the curve with equation

(a) $y = \mathrm{f}(x + 2)$
(1)

(b) $y = -\mathrm{f}(x)$
(1)

(c) $2y = \mathrm{f}(x)$
(1)

(d) $y = \mathrm{f}(x) - 4$
(1)

Question Number	Scheme	Marks
1.	The line l_1 has equation $8x+2y-15=0$	
(a)	Gradient is -4	B1 **[1]**
(b)	Gradient of parallel line is equal to their previous gradient Equation is $y-16="-4"\left(x-\left(-\frac{3}{4}\right)\right)$ So $y=-4x+13$	M1 M1 A1 **[3]** **(4 marks)**

(a)

B1 Gradient, m, $\frac{dy}{dx}$ given as -4 FINAL ANSWER

Do not allow $-\frac{8}{2}$ or $-\frac{4}{1}$ or $-4\rightarrow\frac{1}{4}$ in part (a). Do not allow if left as $y=-4x+..$

(b)

M1 Gradient of lines are the same. This may be implied by sight of their $'-4'$ in a gradient equation. For example you may see candidates state $y='-4'x+..$ in (a) and then write $y='-4'x+c$ in (b)

M1 For an attempt to find an equation of a line using $\left(-\frac{3}{4},16\right)$ and a numerical gradient (which may be different to the gradient used in part (a)). For example they may try to find a normal! Condone a sign error on one of the brackets. If the form $y=mx+c$ is used they must proceed as far as finding c.

A1 cao $y=-4x+13$ Allow $m=-4, c=13$

Question Number	Scheme	Marks
2.(a)	$(0,3)$	B1
(b)	$(2,-3)$	B1
(c)	$(2,1.5)$ oe	B1
(d)	$(2,-1)$	B1 **[4]** **(4 marks)**

Condone the omission of the brackets. Eg Condone $0,3$ for $(0,3)$

Allow $x=...y=...$

If options are given, Attempt one $=(0,3)$, Attempt two = $(2,5)$, Award B0.

If there is no labelling mark (a) as the first one seen, (b) as the second one seen etc unless it is obvious.

Leave blank

3. (a) Express $\dfrac{x^3 + 4}{2x^2}$ in the form $Ax^p + Bx^q$, where A, B, p and q are constants.

(3)

(b) Hence find

$$\int \frac{x^3 + 4}{2x^2}\, \mathrm{d}x$$

simplifying your answer.

(3)

Question Number	Scheme	Marks
3.(a)	$\frac{x^3+4}{2x^2}=\frac{x^3}{2x^2}+\frac{4}{2x^2}=\frac{1}{2}x+2x^{-2}$	M1A1A1 **[3]**
(b)	$\int \frac{x^3+4}{2x^2}\,\mathrm{d}x=\int \frac{1}{2}x+2x^{-2}\,\mathrm{d}x=\frac{1}{4}x^2-2x^{-1}+c$	M1A1A1 **[3]** **(6 marks)**

(a)

M1 For an attempt to divide by $2x^2$. It may be implied if either index or either coefficient is correct.

A1 One correct term. Either $\frac{1}{2}x$ or $+2x^{-2}$. Allow $\frac{1}{2}x^1=0.5x$ or, for this mark only, $+2x^{-2}=+\frac{2}{x^2}$

A1 $\frac{1}{2}x+2x^{-2}$ or $0.5x+2x^{-2}$ Accept $x^1=x$ A final answer of $\frac{1}{2}x+\frac{2}{x^2}$ is M1 A1 A0

(b)

M1 Raises any of the indices by one for their Ax^p+Bx^q

A1 One term both correct and simplified. Accept either $\frac{1}{4}x^2\,/\,0.25x^2$ or $-2x^{-1}\,/-\frac{2}{x}\,/-\frac{2}{x^1}$

A1 $\frac{1}{4}x^2-2x^{-1}+c$ including the +c. Accept equivalents such as $0.25x^2-\frac{2}{x^1}+c$ or $\frac{x^3-8}{4x}+c$

Do not accept expressions like $\frac{1}{4}x^2+-2x^{-1}+c$

4.

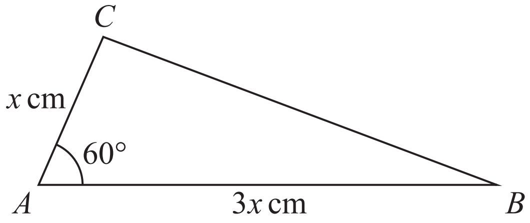

Figure 1

Figure 1 shows a sketch of a triangle ABC with $AB = 3x$ cm, $AC = x$ cm and angle $CAB = 60°$

Given that the area of triangle $ABC = 24\sqrt{3}$

(a) show that $x = 4\sqrt{2}$

(3)

(b) Hence find the exact length of BC, giving your answer as a simplified surd.

(3)

Question Number	Scheme	Marks
4.(a)	Attempts Area $=\frac{1}{2}ab\sin C \Rightarrow 24\sqrt{3}=\frac{1}{2}3x\times x\sin 60°$	M1
	Uses $\sin 60°=\frac{\sqrt{3}}{2}$ oe $\Rightarrow x^2=32 \Rightarrow x=4\sqrt{2}$	dM1A1*
		[3]
(b)	Uses $BC^2=\left(12\sqrt{2}\right)^2+\left(4\sqrt{2}\right)^2-2\left(12\sqrt{2}\right)\left(4\sqrt{2}\right)\cos 60°$	M1
	$\Rightarrow BC^2=224 \Rightarrow BC=4\sqrt{14}$	A1,A1
		[3] **(6 marks)**

(a)

M1 Attempts to use Area $=\frac{1}{2}ab\sin C$ Score for sight of $24\sqrt{3}=\frac{1}{2}3x\times x\sin 60°$

dM1 Either using $24\sqrt{3}=\frac{1}{2}3x\times x\sin 60°$ with $\sin 60°=\frac{\sqrt{3}}{2}$(which may be implied) to reach a form $x^2=k$

So sight of $x^2=\frac{16\sqrt{3}}{\sin 60°}$ oe $\Rightarrow x=4\sqrt{2}$ would imply $\sin 60°=\frac{\sqrt{3}}{2}$ and $x^2=k$

Or sight of a correct simplified intermediate line followed by the correct answer.

Eg. $24\sqrt{3}=\frac{1}{2}3x\times x\sin 60° \Rightarrow 3x^2=96 \Rightarrow x=4\sqrt{2}$

It cannot be awarded for $24\sqrt{3}=\frac{1}{2}3x\times x\times\frac{\sqrt{3}}{2} \Rightarrow x=4\sqrt{2}$

A1* This is a show that and you must see $x=4\sqrt{2}$ following $x^2=32$ OR $x^2=16\times 2$ or $x=\sqrt{32}$ for the A1* to be scored

If you see a candidate start $41.57=\frac{1}{2}3x\times x\times 0.866 \Rightarrow x^2=32 \Rightarrow x=4\sqrt{2}$ award M1, dM1, A0

Alternatively candidate can assume that $x=4\sqrt{2}$ and attempt $\frac{1}{2}4\sqrt{2}\times 12\sqrt{2}\sin 60°$ for M1, $\frac{1}{2}4\sqrt{2}\times 12\sqrt{2}\times\frac{\sqrt{3}}{2}=24\sqrt{2}$ for dM1 and make a statement for A1*

(b)

M1 Uses the cosine rule $BC^2=\left(4\sqrt{2}\right)^2+\left(12\sqrt{2}\right)^2-2\left(4\sqrt{2}\right)\left(12\sqrt{2}\right)\cos 60°$ Condone missing brackets

Can be scored for $BC^2=(3x)^2+(x)^2-2(3x)(x)\cos 60°$ It can be awarded for an attempt with their x

Also accept the form $\cos 60°=\frac{\left(12\sqrt{2}\right)^2+\left(4\sqrt{2}\right)^2-BC^2}{2\left(12\sqrt{2}\right)\left(4\sqrt{2}\right)}$

A1 $BC^2=224$ May be implied by $BC=\sqrt{224}$ or $4\sqrt{14}$

A1 $BC=4\sqrt{14}$

If you see a candidate start $BC^2=(5.66)^2+(16.97)^2-2(5.66)(16.97)\cos 60° \Rightarrow BC=4\sqrt{14}$ award M1, A1, A0

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5.

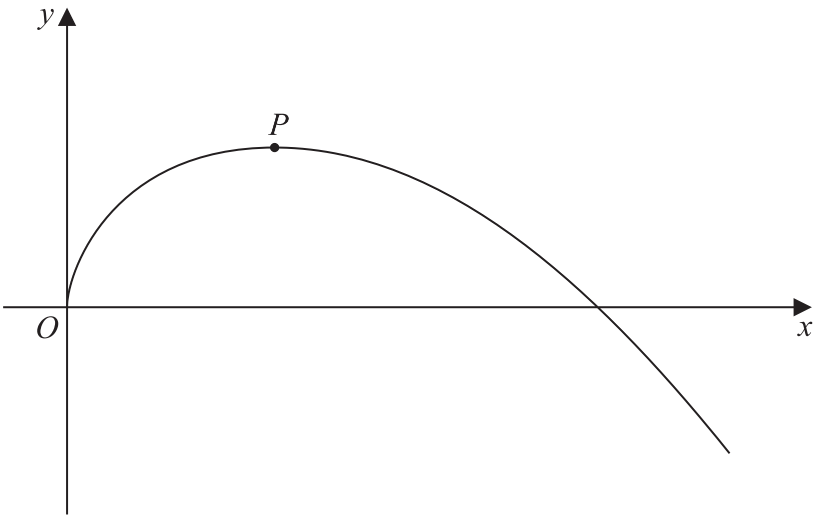


Figure 2

Figure 2 shows a sketch of part of the curve with equation

$$y = 27\sqrt{x} - 2x^2, \qquad x \in \mathbb{R}, x > 0$$

(a) Find $\dfrac{dy}{dx}$

(3)

The curve has a maximum turning point P, as shown in Figure 2.

(b) Use the answer to part (a) to find the exact coordinates of P.

(5)

Question Number	Scheme	Marks
5.(a)	$y = 27x^{0.5} - 2x^2 \Rightarrow \frac{dy}{dx} = \frac{27}{2}x^{-0.5} - 4x$	M1A1A1 **[3]**
(b)	Sets their $\frac{dy}{dx} = 0$	M1
	$\frac{27}{2}x^{-0.5} - 4x = 0 \Rightarrow x^{1.5} = \frac{27}{8} \Rightarrow x = \frac{9}{4}$	dM1,A1
	$x = \frac{9}{4} \Rightarrow y = \frac{243}{8}$	dM1A1
		[5] **(8 marks)**

(a)

M1 Uses $x^n \to x^{n-1}$ at least once. So sight of either index $x^{-0.5}$ / $x^{-\frac{1}{2}}$ or $x = x^1$

A1 Either term correct (may be unsimplified). Eg. $2 \times 2x^1$ is acceptable. The indices must be tidied up however so don't allow $2 \times 2x^{2-1}$

A1 $\frac{dy}{dx} = \frac{27}{2}x^{-0.5} - 4x$ or exact equivalent such as $\frac{dy}{dx} = 13.5 \times \frac{1}{\sqrt{x}} - 4x$.
It must be all tidied up for this mark so do not allow $2 \times 2x$

(b)

M1 States or sets their $\frac{dy}{dx} = 0$ This may be implied by subsequent working.

dM1 Dependent upon the previous M and correct indices in (a). It is awarded for correct index work leading to $x^{\pm 1.5} = k$ Also allow squaring $27x^{-0.5} = 8x \Rightarrow \frac{27^2}{x} = 64x^2 \Rightarrow x^3 =$

A1 $x = \frac{9}{4}$ or exact equivalent. A correct answer following a correct derivative can imply the previous mark provided you have not seen incorrect work.

dM1 Dependent upon the first M1 in (b). For substituting their value of *x* into *y* to find the maximum point. There is no need to check this with a calculator. (*y* appearing from an *x* found from $\frac{dy}{dx} = 0$ is fine.)

A1 $y = \frac{243}{8}$ or exact equivalent (30.375) . You do not need to see the coordinates for this award.
Ignore any other solutions outside the range. If extra solutions are given within the range withhold only this final mark.

Note: This question requires differentiation in (a) and minimal working in (b). A correct answer without any differentiation will not score any marks.

Allow (a) $\frac{dy}{dx} = \frac{27}{2}x^{-0.5} - 4x$ (b) $0 = \frac{27}{2}x^{-0.5} - 4x \Rightarrow x = \frac{9}{4}, y = \frac{243}{8}$ for all marks

Whereas (a) $\frac{dy}{dx} = \frac{27}{2}x^{-0.5} - 4x$ (b) $x = \frac{9}{4}, y = \frac{243}{8}$ scores (a) 3 (b) 0 marks

Leave blank

6. Each year Lin pays into a savings scheme. In year 1 she pays in £600.
Her payments then increase by £80 a year, so that she pays £680 into the savings scheme in year 2, £760 in year 3 and so on. In year N, Lin pays £1000 into the savings scheme.

(a) Find the value of N.

(2)

(b) Find the total amount that Lin pays into the savings scheme from year 1 to year 15 inclusive.

(2)

Saima starts paying into a different savings scheme at the same time as Lin starts paying into her savings scheme.

In year 1 she pays in £A. Her payments increase by £A each year so that she pays £$2A$ in year 2, £$3A$ in year 3 and so on.

Given that Saima and Lin have each paid, in total, the same amount of money into their savings schemes after 15 years,

(c) find the value of A.

(3)

Question Number	Scheme	Marks
6. (a)	Uses $1000=600+80(N-1)\Rightarrow N=6$	M1,A1 **[2]**
(b)	Uses $\frac{15}{2}\left(2\times600+(15-1)\times80\right)=(£)17400$	M1 A1 **[2]**
(c)	Total for Saima = $\frac{15}{2}\left(2A+14A\right)=\left(120A\right)$ Sets $120A=17400\Rightarrow A=145$	B1 M1A1 **[3]**
		(7 marks)

(a)

M1 Attempts to use the formula $u_n=a+(n-1)d$ to find the value of '*n*'.
Evidence would be $1000=600+80(N-1)$
Alternatively attempts $\frac{1000-600}{80}+1$ or repeated addition of £80 onto £600 until £1000 is reached

A1 $N=6$ or accept the 6th year (or similar). The answer alone would score both marks.

(b)

M1 Uses a correct sum formula $S=\frac{n}{2}\left(2a+(n-1)d\right)$ with $n=15, a=600, d=80$
Alternatively uses $S=\frac{n}{2}\left(a+l\right)$ with $n=15,\ a=600,\ l=600+14\times80$ or 1720
Accept the sum of 15 terms starting 600 + 680+ 760+ 840+....

A1 cao (£)17400

(c)

B1 Finds the sum for Saima.
Accept unsimplified forms such as $\frac{15}{2}\left(2A+14A\right)$ or $\frac{15}{2}\left(A+15A\right)$ or the simplified answer of $120A$
Remember to isw following a correct answer

M1 Sets their $120A$ equal to their answer to (b) and proceeds to find a value for *A*.
They must be attempting to calculate sums rather than terms to score this mark.
Condone slips on the sum of an AP formula and award for a valid attempt from GP formula.

A1 cao $A=145$

Leave blank

7. $$g(x) = 2x^3 + ax^2 - 18x - 8$$

Given that $(x + 2)$ is a factor of $g(x)$,

(a) show that $a = -3$

(2)

(b) Hence, using algebra, fully factorise $g(x)$.

(4)

Using your answer to part (b),

(c) solve, for $0 \leqslant \theta < 2\pi$, the equation

$$2\sin^3\theta - 3\sin^2\theta - 18\sin\theta = 8$$

giving each answer, in radians, as a multiple of π.

(3)

Question Number	Scheme	Marks
7.	$\mathrm{g}(x)=2x^3+ax^2-18x-8$	
(a)	$\mathrm{g}(\pm2)=0\Rightarrow 2\left(\pm2\right)^3+a\left(\pm2\right)^2+18\left(\pm2\right)-8=0$	M1
	$\Rightarrow 4a=-12 \quad \Rightarrow a=-3$	A1*
		[2]
(b)	$\mathrm{g}(x)=2x^3-3x^2-18x-8=(x+2)(2x^2-7x-4)$	M1 A1
	$=(x+2)(2x+1)(x-4)$	M1A1
		[4]
(c)	$\sin\theta=-\dfrac{1}{2}$ only	B1ft
	$\theta=\dfrac{7}{6}\pi,\dfrac{11}{6}\pi$	M1A1
		[3]
		(9 marks)

(a)

M1 Attempts $\mathrm{g}(\pm2)=0$ This can be implied by subsequent working

Alternatively divides by $(x+2)$ and sets the remainder equal to 0

For division look for a minimum of

$$\begin{array}{r} 2x^2+(a...)x+(...a)..... \\ x+2\overline{\smash{)}2x^3+ax^2-18x-8} \end{array}$$

$$\begin{array}{r} \hline (...a)+.... \end{array}$$

followed by the remainder (involving a) set equal to 0

A1* $a=-3$ or equivalent following a correct linear equation in $4a$ that is readily solvable.

(As a rule accept $4a=-12$ or similar such as $4a=8-36+16$ or $4a+12=0$ I am classing as readily solvable)

Note that this is a given answer and so the candidate **must** proceed from $-16+4a+36-8=0$ oe to score this mark. Expect to see (as a bare minimum) one calculation/process that makes it more solvable.

So $-16+4a+36-8=0\Rightarrow 4a+20-8=0$ could be seen as the bare minimum.

(b)

M1 Attempts to divide $\mathrm{g}(x)$ by $(x+2)$ to produce the quadratic factor.

For division look for the first two terms

$$\begin{array}{r} 2x^2 - 7x\ +\ldots\ldots\ldots \\ x+2\overline{\big)2x^3-3x^2-18x-8} \\ \underline{2x^3+4x^2} \qquad\qquad \\ -7x^2 \qquad\qquad \end{array}$$

For factorisation/ inspection look for the first and last terms $2x^3-3x^2-18x-8=(x+2)(2x^2\ldots\ldots x-4)$.

A1 The correct quadratic factor $(2x^2-7x-4)$

M1 Attempts to factorise the quadratic factor using usual rules. This must appear in part (b)

A1 $\mathrm{g}(x)=(x+2)(2x+1)(x-4)$. Accept $\mathrm{g}(x)=2(x+2)\left(x+\frac{1}{2}\right)(x-4)$

All factors must appear on the same line.

Note: the question asks the candidate to use algebra to factorise $\mathrm{g}(x)$

Candidates who write down $\mathrm{g}(x)=0\Rightarrow x=-2,-\frac{1}{2},4\Rightarrow \mathrm{g}(x)=(x+2)\left(x+\frac{1}{2}\right)(x-4)$ score 0000

Candidates who write down $\mathrm{g}(x)=0\Rightarrow x=-2,-\frac{1}{2},4\Rightarrow \mathrm{g}(x)=(x+2)\big(2x+1\big)(x-4)$ oe score 1000

(c)

B1ft States or implies that $\sin\theta=-\frac{1}{2}$ only. Follow through on all roots $-1\leqslant\sin\theta\leqslant 1$

As long as they don't find values from $\sin\theta=4$ or $\sin\theta=-2$ that implies they have "chosen" $\sin\theta=-\frac{1}{2}$

M1 Uses a correct method to solve an equation of the form $\sin\theta=k,-1\leqslant k\leqslant 1$ by 'arcsin'

You may need to check this using a calculator.

This may be implied by $\sin\theta=-\frac{1}{2}\Rightarrow\theta=-30°$

A1 $\theta=\frac{7}{6}\pi,\frac{11}{6}\pi$ or exact equivalent only.......within the given range. Ignore answers outside this range.

Condone $1.1\dot{6}$ for $\frac{7}{6}$ and $1.8\dot{3}$ for $\frac{11}{6}$

8.

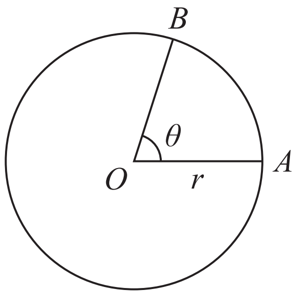


Figure 3

Figure 3 shows a circle with centre *O* and radius *r* cm.

The points *A* and *B* lie on the circumference of this circle.

The minor arc *AB* subtends an angle θ radians at *O*, as shown in Figure 3.

Given the length of minor arc *AB* is 6 cm and the area of minor sector *OAB* is 20 cm^2,

(a) write down two different equations in r and θ.

(2)

(b) Hence find the value of r and the value of θ.

(4)

Question Number	Scheme	Marks
8.(a)	$r\theta = 6$ and $\frac{1}{2}r^2\theta = 20$	B1 B1
		[2]
(b)	Substitute $r\theta = 6$ into $\frac{1}{2}r^2\theta = 20 \Rightarrow \frac{1}{2}\times 6r = 20$	M1
	$\Rightarrow r = \frac{20}{3}$	A1
	Substitutes $r = \frac{20}{3}$ in $r\theta = 6 \Rightarrow \theta = \frac{9}{10}$	dM1A1
		[4] **(6 marks)**

This may be marked as one complete question. Eg they may just give the equations $s = r\theta$ and $A = \frac{1}{2}r^2\theta$ in (a)
Don't penalise this sort of error.

(a)

B1 Either $r\theta = 6$ or $\frac{1}{2}r^2\theta = 20$ (or exact equivalents)

Allow $\frac{\theta}{2\pi}\times 2\pi r = 6$ or $\frac{\theta}{2\pi}\times \pi r^2 = 20$ but not $\frac{\theta}{360}\times 2\pi r = 6$ or $\frac{\theta}{360}\times \pi r^2 = 20$

B1 Both $r\theta = 6$ and $\frac{1}{2}r^2\theta = 20$ (or exact equivalents)

Allow $\frac{\theta}{2\pi}\times 2\pi r = 6$ and $\frac{\theta}{2\pi}\times \pi r^2 = 20$ but not $\frac{\theta}{360}\times 2\pi r = 6$ and $\frac{\theta}{360}\times \pi r^2 = 20$

(b)

M1 Combines two equations in r and θ producing an equation in one unknown.

A1 $r = \frac{20}{3}$ or $\theta = \frac{9}{10}$ or exact equivalents.

You may just see answers following correct equations. This is fine for all the marks

dM1 This is dependent upon having started with two equations with correct expressions in r and θ

Look for $..r\theta = ...$ and $..r^2\theta = ...$.

It is awarded for correctly substituting their value of r or θ into one of the equations to find the second unknown.

A1 $r = \frac{20}{3}$ and $\theta = \frac{9}{10}$ or exact equivalents. Condone $6.\dot{6}$ for $\frac{20}{3}$ Do not allow 6.67

9. (a) Given that a is a constant, $a > 1$, sketch the graph of

$$y = a^x, \qquad x \in \mathbb{R}$$

On your diagram show the coordinates of the point where the graph crosses the y-axis.
(2)

The table below shows corresponding values of x and y for $y = 2^x$

x	–4	–2	0	2	4
y	0.0625	0.25	1	4	16

(b) Use the trapezium rule, with all of the values of y from the table, to find an approximate value, to 2 decimal places, for

$$\int_{-4}^{4} 2^x \, \mathrm{d}x$$

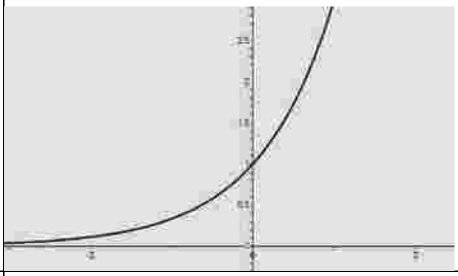
(4)

(c) Use the answer to part (b) to find an approximate value for

(i) $\int_{-4}^{4} 2^{x+2} \, \mathrm{d}x$

(ii) $\int_{-4}^{4} (3 + 2^x) \, \mathrm{d}x$

(4)

Question	Scheme	Marks
9 (a)	 Shape **or** y intercept at 1 Fully correct shape and intercept	B1 B1 **[2]**
(b)	State h = 2, or use of $\frac{1}{2}\times 2$;	B1
	$\underline{\left\{0.0625+16+2\left(\ 0.25+1+4\right)\right\}}$ For structure of $\{................\}$;	M1A1
	$\frac{1}{2}\times 2\times\underline{\{\ 26.5625\}}$ = *awrt* 26.56 Exact answer = $^{425}\!/_{16}$	A1cao
		[4]
(c)(i)	$4\times(b) = awrt\ 106$ Exact answer = $^{425}\!/_{4}$	M1A1ft
(ii)	$24+(b) = awrt\ 50.6$ Exact answer = $^{809}\!/_{16}$	M1A1ft
		[4] **(10 marks)**

(a)

B1 Score for either

- a correct shape for the curve. It must lie only in quadrants 1 and 2 and have a positive and increasing gradient from left to right. The gradient must be approximately 0 at the left hand end. Condone the curve appearing to be a straight line on the rhs. See Practice/Qualification items for clarification. Do not be concerned if it does not appear to be asymptotic to the *x*-axis at the LHS
- intercept at (0,1). Allow 1 being marked on the *y* - axis. Condone (1,0) on the correct axis.

B1 Fully correct. As a guide the gradient of the curve must appear to be 0 at the lh end and it must reach a level that is more than half way below the level of the intercept at (0,1). Allow $x=0, y=1$ in the text, it does not need to be on the sketch. Do not condone (1,0) even on the correct axis for this mark.

(b)

B1 For using a strip width of 2. This may appear in a trapezium rule as $\frac{1}{2}\times 2$ or 1 or equivalent

M1 Scored for the correct $\{......\}$ outer bracket structure. It needs to contain first *y* value plus last *y* value and the inner bracket to be multiplied by 2 and to be the summation of the remaining *y* values in the table with no additional values. If the only mistake is a copying error or is to omit one value from inner bracket this may be regarded as a slip and the M mark can be allowed (An extra repeated term forfeits the M mark however). M0 if values used in brackets are *x* values instead of *y* values

A1 For the correct bracket $\{......\}$

A1 For awrt 26.56. Accept 425/16

NB: Separate trapezia may be used: B1 for *h* =1, M1 for 1/2 *h*(*a* + *b*) used 3 or 4 times (and A1 if it is all correct) Then A1 as before.

Note: As *h* =1 the expression $1\times(16+0.0625)+2\left(0.25+1+4\right)$ will scores B1 M1 A1 with awrt 26.56 scoring the final A1.

(c)(i)

M1 For an attempt at finding $4\times(b)$. Also allow repeating the trapezium rule with each value $\times 4$

A1ft For either awrt 106 or ft on the answer to $4\times(b)$ You may see $425/4$ following 425/16 in (b)

(c)(ii)

M1 For an attempt at $24+(b)$ or $\left[3x\right]_{-4}^{4}+(b)$ Also allow repeating the trapezium rule with each value $+3$

A1ft For either awrt 50.6 or ft on the answer to 24+(b) You may see 809/16

10.

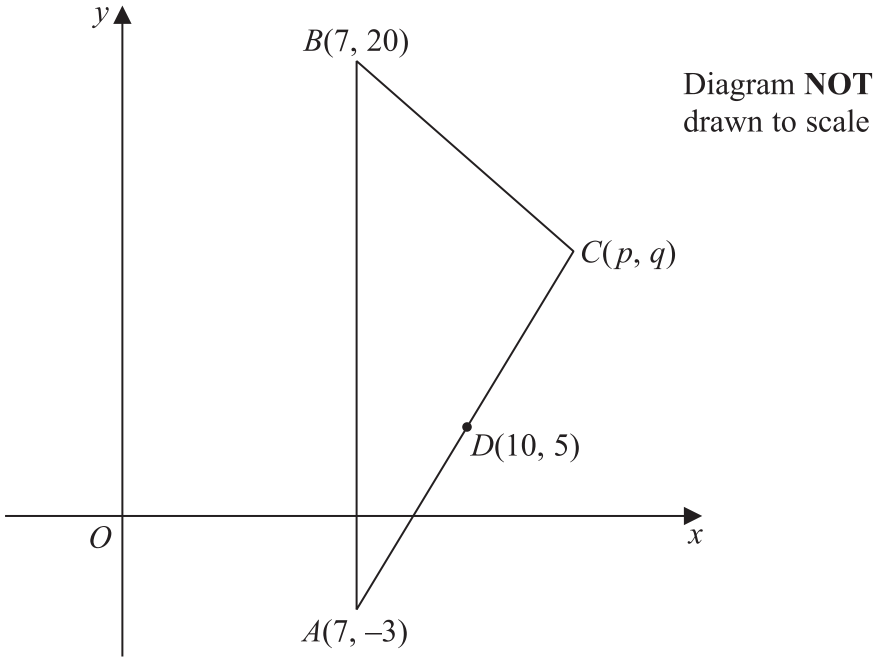


Figure 4

The points $A(7, -3)$, $B(7, 20)$ and $C(p, q)$ form the vertices of a triangle ABC, as shown in Figure 4. The point $D(10, 5)$ is the midpoint of AC.

(a) Find the value of p and the value of q.

(2)

The line l passes through D and is perpendicular to AC.

(b) Find an equation for l, in the form $ax + by = c$, where a, b and c are integers.

(5)

Given that the line l intersects AB at E,

(c) find the exact coordinates of E.

(2)

Question Number	Scheme	Marks
10.(a)	$p=13, q=13$	B1 B1 **[2]**
(b)	Gradient *AD*/ *AC* / *DC*= $\frac{5-(-3)}{10-7}=\left(\frac{8}{3}\right)$	M1
	Gradient DE = $-\frac{3}{8}$	M1, A1
	Equation of l is $(y-5)=\text{"}-\frac{3}{8}\text{"}(x-10)\Rightarrow 3x+8y=70$	M1A1 **[5]**
(c)	Sub $x=7$ into $3x+8y=70\Rightarrow y=\frac{49}{8}$. Hence $C=\left(7,\frac{49}{8}\right)$	M1A1 **[2]** **(9 marks)**

(a)

B1 For either $p=13$ or $q=13$. Score within a coordinate $(13,...)$ or $(...,13)$ Just 13 scores B1B0

B1 For both $p=13$ and $q=13$. Allow $(13,13)$ for both marks.

(b)

M1 For an attempt at the gradient of *AD* or *AC* using their coordinates for *C*

Look for an attempt at $\frac{\Delta y}{\Delta x}$ There must be an attempt to subtract on both the numerator and the denominator. It can be implied by their attempt to find the equation of line *AC*

M1 For an attempt at using $m_2=-\frac{1}{m_1}$ or equivalent to find the gradient of the perpendicular m_2

A1 Gradient of *DE* is $-\frac{3}{8}$ or equivalent

M1 It is for the method of finding a line passing though (10, 5) with a changed gradient. Eg $\frac{8}{3}\rightarrow\frac{3}{8}$

Look for $(y-5)=$ changed $m_1(x-10)$ Both brackets must be correct

Alternatively uses the form $y=mx+c$ AND proceeds as far as c = ..

A1 $3x+8y=70$ or exact equivalent. Accept $\pm A(3x+8y=70)$ where $A\in\mathbb{N}$

(c)

M1 Substitutes $x=7$ in their $3x+8y=70\Rightarrow y=...$

A1 $C=\left(7,\frac{49}{8}\right)$ or exact equivalent. Allow this mark when *x* and *y* are written separately.

Do not allow this A1 if other answers follow $x=7$ $y=\frac{49}{8}$

11. $\mathrm{f}(x) = (a - x)(3 + ax)^5$, where a is a positive constant

(a) Find the first 3 terms, in ascending powers of x, in the binomial expansion of

$$(3 + ax)^5$$

Give each term in its simplest form.

(4)

Given that in the expansion of $\mathrm{f}(x)$ the coefficient of x is zero,

(b) find the exact value of a.

(3)

Question Number	Scheme	Marks
11.(a)	$(3+ax)^5 = 3^5 + \binom{5}{1}3^4.(ax)+\binom{5}{2}3^3.(ax)^2+...$	M1
	$= 243, +405ax+270a^2x^2+...$	B1, A1, A1
		[4]
(b)	$\mathrm{f}(x)=(a-x)(3+ax)^5=(a-x)(243+405ax+270a^2x^2+...)$	
	$-243+405a^2=0 \Rightarrow a^2=\frac{243}{405} \Rightarrow a=\sqrt{\frac{3}{5}}$ or equivalent	M1,dM1A1
		[3]
		(7 marks)

(a)

M1 This method mark is awarded for an attempt at a Binomial expansion to get the second and/or third term – it requires a correct binomial coefficient combined with correct power of 3 and the correct power of *x*. Ignore bracketing errors. Accept any notation for ${}^5C_1,\ {}^5C_2$, e.g. as on scheme or 5, and 10 from Pascal's triangle. This mark may be given if no working is shown, if either or both of the terms including *x* is correct.

An alternative is $(3+ax)^5 = 3^5\left\{1+\frac{ax}{3}\right\}^5 = 3^5\left\{1+5\times\frac{ax}{3}+\frac{5\times4}{2(!)}\times\left(\frac{ax}{3}\right)^2\right.$

In this method it is scored for the correct attempt at a binomial expansion to get the second and/or third term in the bracket of $3^n\left\{1+5\times\frac{ax}{3}+\frac{5\times4}{2(!)}\times\left(\frac{ax}{3}\right)^2 ......\right\}$

Score for binomial coefficient with the correct power of $\left(\frac{x}{3}\right)$ Eg. $5\times\frac{..x}{3}$ or $10\times\left(\frac{..x}{3}\right)^2$

B1 Must be simplified to 243 (writing just 3^5 is B0).

A1 cao and is for one correct from 405*ax*, and $270a^2x^2$ Also allow $270(ax)^2$ with the bracket

A1 cao and is for both of $405a\,x$, and $270a^2x^2$.

Allow $270(ax)^2$ with the bracket correct (ignore extra terms). Allow listing for all marks

It is possible to score 1011 in (a)

There are a minority of students who attempt this in (a)

$\mathrm{f}(x)=(a-x)(3+ax)^5=(a-x)(243+405ax+270a^2x^2+...)$ and go on to expand this.

They can have all the marks in part (a)

(b)

M1 Attempt to set the coefficient of *x* in the expansion of $(a-x)(3+ax)^5$ equal to 0

$(a-x)(3+ax)^5=(a-x)\left(P+Qax+Ra^2x^2+...\right)=aP+\left(a^2Q-P\right)x+...$

For this to be scored you must see an equation of the form $\pm P\pm Qa^2=0$ You are condoning slips/ sign errors

dM1 For $\pm P\pm Qa^2=0 \Rightarrow a=...$ using a correct method. This cannot be scored for an attempt at sq rooting a negative number

A1 $a=\sqrt{\frac{3}{5}}$ or exact equivalent such as $a=\frac{\sqrt{15}}{5}$ You may ignore any reference to $a=-\sqrt{\frac{3}{5}}$

12. (i) Solve, for $0 < \theta \leqslant 360°$,

$$3\sin(\theta + 30°) = 2\cos(\theta + 30°)$$

giving your answers, in degrees, to 2 decimal places.

(*Solutions based entirely on graphical or numerical methods are not acceptable.*)

(4)

(ii) (a) Given that

$$\frac{\cos^2 x + 2\sin^2 x}{1 - \sin^2 x} = 5$$

show that

$$\tan^2 x = k, \qquad \text{where } k \text{ is a constant.}$$

(b) Hence solve, for $0 < x \leqslant 2\pi$,

$$\frac{\cos^2 x + 2\sin^2 x}{1 - \sin^2 x} = 5$$

giving your answers, in radians, to 3 decimal places.

(7)

Question	Scheme	Marks
12. (i)	$3\sin(\theta+30^\circ)=2\cos(\theta+30^\circ)\Rightarrow\tan(\theta+30^\circ)=\frac{2}{3}$	M1
	$\Rightarrow\theta+30^\circ=\arctan\left(\frac{2}{3}\right)=33.69^\circ,213.69^\circ\Rightarrow\theta=..$	dM1
	$\Rightarrow\theta=3.69^\circ,183.69^\circ$	A1, A1 **[4]**
Alt (i)	$3\sin(\theta+30^\circ)=2\cos(\theta+30^\circ)\Rightarrow3(\sin\theta\cos30^\circ+\cos\theta\sin30^\circ)=2(\cos\theta\cos30^\circ-\sin\theta\sin30^\circ)$	
	$\div\cos\theta\Rightarrow3\tan\theta\cos30^\circ+3\sin30^\circ=2\cos30^\circ-2\tan\theta\sin30^\circ$	M1
	$\Rightarrow\tan\theta=\frac{2\cos30^\circ-3\sin30^\circ}{3\cos30^\circ+2\sin30^\circ}\left(=\text{awrt }0.0645\right)$	dM1
	$\Rightarrow\theta=3.69^\circ,183.69^\circ$	A1 A1
		[4]
(ii)(a)	$\frac{\cos^2x+2\sin^2x}{1-\sin^2x}=5\Rightarrow\frac{\cos^2x+2\sin^2x}{\cos^2x}=5$	M1
	$\Rightarrow1+2\tan^2x=5$	M1
	$\Rightarrow\tan^2x=2$	A1
(ii)(b)	$\tan^2x=2\Rightarrow\tan x=\pm\sqrt{2}$	M1
	$\Rightarrow x=0.955,2.186,4.097,5.328$	M1 A1,A1
		[7]
		(11 marks)

(i)

M1 For stating that $\tan(\theta+30^\circ)=k,\quad k\neq0$ Allow even where the candidate writes $\tan(\theta+30^\circ)=\frac{3}{2}$

dM1 For taking 'arctan' subtracting 30 and proceeding to $\theta=..$ Do not allow mixed units

For $\tan(\theta+30^\circ)=\frac{3}{2}$ it is scored when they reach $\theta=26.3^\circ$

A1 $\theta=3.69^\circ$ or 183.69°

A1 $\theta=3.69^\circ$ and 183.69° only in the range $0\to360$

(ii)(a)

M1 For use of $1-\sin^2x=\cos^2x$ or equivalent.

This may be scored either by setting $\frac{\cos^2x+2\sin^2x}{1-\sin^2x}=\frac{\cos^2x+2\sin^2x}{\cos^2x}$ or $\frac{\cos^2x+2\sin^2x}{1-\sin^2x}=\frac{1+\sin^2x}{1-\sin^2x}$

M1 For dividing **both terms** by $\cos^2x$ and using $\frac{\sin^2x}{\cos^2x}=\tan^2x$ leading to $\tan^2x=k$

In the alternative $\sin^2x=c\Rightarrow\tan^2x=k$ can be done on a calculator

A1 $\tan^2x=2$

(ii)(b)

M1 For taking the square root and stating that $\tan x=\sqrt{k}$ (or $\tan x=-\sqrt{k}$). Accept decimals here. One correct angle would imply this. Allow a solution from $\sin^2x=c$

M1 For taking arctan and finding two of the 4 angles for their $\tan x=\sqrt{k}$ (or $\tan x=-\sqrt{k}$) (Alt for taking arcsin or arcos and finding 2 angles)

Condone slips here. For example, $\tan^2x=2\Rightarrow\tan x=\pm2$ can score M0 M1 if two angles are found.

BUT for example $\tan^2x=2\Rightarrow\tan x=2$ leading to two answers scores M0 M0

A1 Two of awrt $x=0.96,2.19,4.10,5.33$.

Accept degrees here ie accept two of $54.7^\circ,125.3^\circ,234.7^\circ,305.3^\circ$

A1 All four angles in radians (and no extra's within the range) awrt $x=0.955,2.186,4.097,5.328$

Leave blank

13. The circle C has equation

$$(x-3)^2 + (y+4)^2 = 30$$

Write down

(a) (i) the coordinates of the centre of C,

(ii) the exact value of the radius of C.

(2)

Given that the point P with coordinates $(6, k)$, where k is a constant, lies inside circle C,

(b) show that

$$k^2 + 8k - 5 < 0$$

(3)

(c) Hence find the exact set of values of k for which P lies inside C.

(4)

Question Number	Scheme	Marks
13 (a)(i)	$(3,-4)$	B1
(a)(ii)	$\sqrt{30}$	B1
		[2]
(b)	Attempts $(6-3)^2+(k+4)^2, < 30$	M1,M1
	$k^2+8k-5<0$	A1*
		[3]
(c)	Solves quadratic by formula or completion of square to give $k =$	M1
	$k=-4\pm\sqrt{21}$	A1
	Chooses region between two values and deduces $-4-\sqrt{21}<k<-4+\sqrt{21}$	M1
		A1**cao**
		[4]
		(9 marks

(a)(i)(ii)

B1 $(3,-4)$ Accept as $x =$, $y =$ or even without the brackets

B1 $\sqrt{30}$ Do not accept decimals here but remember to isw

(b) This is scored M1 A1 A1 on e -pen. We are marking it M1 M1 A1

M1 Attempts to find the length or length^2 from P $(6,k)$, to the centre of C $(3,-4)$ following through on their C. Look for, using a correct C, either $(6-'3')^2+(k+'4')^2$ or $\sqrt{(6-'3')^2+(k+'4')^2}$

Another way is to substitute $(6,k)$ into $(x-3)^2+(y+4)^2=30$ but it is very difficult to score either of the other two marks using this method.

M1 Forms an inequality by using the length from P to the centre of C < the radius of C
$(6-3)^2+(k+4)^2<30$. In almost all cases I would expect to see < 30 before < 0

Using the alternative method, they would also need the line $(6-3)^2+(k+4)^2<30$. (As if the point lies on another circle, the radius/distance would need to be smaller than 30)

A1* $k^2+8k-5<0$
This is a given answer and you must check that all aspects are correct. **In most cases you should expect to see an intermediate line (with < 30) before the final answer appear with < 0.**

(c)

M1 Solves the equation $k^2+8k-5=0$ by formula or completing the square.
Factorisation to integer roots is not a suitable method in this case and scores M0.
The answers could just appear from a graphical calculator. Accept decimals for the M's only

A1 Accept $k=-4\pm\sqrt{21}$ or exact equivalent $k=\dfrac{-8\pm\sqrt{84}}{2}$

Do not accept decimal equivalents $k=-8.58, (+)0.58$ 2dp for this mark

M1 Chooses inside region from their two roots. The roots could just appear or have been derived by factorisation.

A1 cao $-4-\sqrt{21}<k<-4+\sqrt{21}$ Accept equivalents such as $(-4-\sqrt{21},-4+\sqrt{21})$,
$k>-4-\sqrt{21}$ and $k<-4+\sqrt{21}$, even $k>-4-\sqrt{21}$, $k<-4+\sqrt{21}$

Accept for 3 out of 4 $[-4-\sqrt{21},-4+\sqrt{21}]$, $k>-4-\sqrt{21}$ or $k<-4+\sqrt{21}$, $-4-\sqrt{21}\leqslant k\leqslant -4+\sqrt{21}$

Do not accept $-4-\sqrt{21}<x<-4+\sqrt{21}$ for this final mark

14. A new mineral has been discovered and is going to be mined over a number of years.

A model predicts that the mass of the mineral mined each year will decrease by 15% per year, so that the mass of the mineral mined each year forms a geometric sequence.

Given that the mass of the mineral mined during year 1 is 8000 tonnes,

(a) show that, according to the model, the mass of the mineral mined during year 6 will be approximately 3550 tonnes.
(2)

According to the model, there is a limit to the total mass of the mineral that can be mined.

(b) With reference to the geometric series, state why this limit exists.
(1)

(c) Calculate the value of this limit.
(2)

It is decided that a total mass of 40 000 tonnes of the mineral is required. This is going to be mined from year 1 to year *N* inclusive.

(d) Assuming the model, find the value of *N*.
(5)

Question Number	Scheme	Marks
14 (a)	$u_6 = 8000 \times (0.85)^5 = 3549.6 \approx 3550$	M1, A1
		[2]
(b)	States $\|r\| < 1$ **or** 0.85 < 1 **and makes no reference to terms**	B1
		[1]
(c)	$S_\infty = \frac{a}{1-r} = \frac{8000}{1-0.85} =$ awrt 53333 53334 $\frac{160\,000}{3}$	M1A1
		[2]
(d)	Uses $S_N = \frac{8000(1-0.85^N)}{1-0.85}$	M1
	$\frac{8000(1-0.85^N)}{1-0.85} = 40000 \Rightarrow 0.85^N = 0.25$	dM1 A1
	$\Rightarrow N = \frac{\log 0.25}{\log 0.85} (=8.53) \Rightarrow N = 9$	M1 A1
		[5] **[10 marks]**

(a)

M1 Attempts $u_6 = 8000 \times (r)^5$ with $r = 0.85$ or 85% or $1-0.15$ or 1-15%

A1* Completes proof. States $u_6 = 8000 \times (0.85)^5$ oe (see above) and shows answer is awrt 3549.6 or 3550

(b)

B1 States $|r| < 1$ or 0.85 < 1 **and makes no reference to terms**

Allow $r < 1$ $-1 < r < 1$ **and makes no reference to terms**

Allow for an understanding of why S_∞ exists. Accept $0.85^n \to 0$ as $n \to \infty$ or $r^n \to 0$ as $n \to \infty$

Do not allow from an incorrect statement... if they give r = 0.15

Do not allow on an explanation that is based around terms.

Eg Do not allow $8000 \times 0.85^{n-1} \to 0$ as $n \to \infty$

Do not allow as $r < 1$ $u_n \to 0$ and so a limit exists

Do not allow if they state 85% is less than 100%

If you feel that a candidate deserves this mark then please seek advice.

(c)

M1 Attempts $S_\infty = \frac{8000}{1-r}$ with $r = 0.85$ oe

A1 $\frac{8000}{1-0.85}$ with an answer of awrt 53333 or 53 334 or $\frac{160\,000}{3}$

(d)

M1 Uses $S_N = \dfrac{8000\left(1-r^N\right)}{1-r}$ with $r = 0.85$ oe and $S_N = 40\,000$

Condone for this mark $r = 0.15$ oe

dM1 Rearranges $\dfrac{8000\left(1-r^N\right)}{1-r} = 40000$ to $r^N = k$ with $r = 0.85$ or 0.15 oe

A1 $0.85^N = 0.25$

M1 Uses logs to solve an equation of the form $a^N = b \quad (a, b > 0)$ It must be a correct method and reach *N* = ...

If you see just the answer from $a^N = b$ look for accuracy of at least 1 dp

This can be scored starting from $40\,000 = 8000 \times ('r')^{N-1}$ but must proceed to *N* =..

A1 cso 9

Note: All marks in this part can be scored using inequalities as long as the final answer is 9. You may withhold the last mark if there are inconsistent inequality signs.

Accept trial and improvement. 1st M1 as above, 2nd M1 either sight of using *N*=8 or *N*=9, A1 correct, 3rd M1 for both *N*=8 and *N*=9, A1 correct answer.

FYI $S_8 = \dfrac{8000\left(1-0.85^8\right)}{1-0.85} = 38800$ AND $S_9 = \dfrac{8000\left(1-0.85^9\right)}{1-0.85} = 40980$

As the question does not have the magic phrase, we must also allow $\dfrac{8000\left(1-r^N\right)}{1-r} = 40000 \rightarrow N = 8.5 \Rightarrow N = 9$ for all marks. If the candidate just writes out line one and puts *N* = 9 we will allow special case 1 1 000

Leave blank

15.

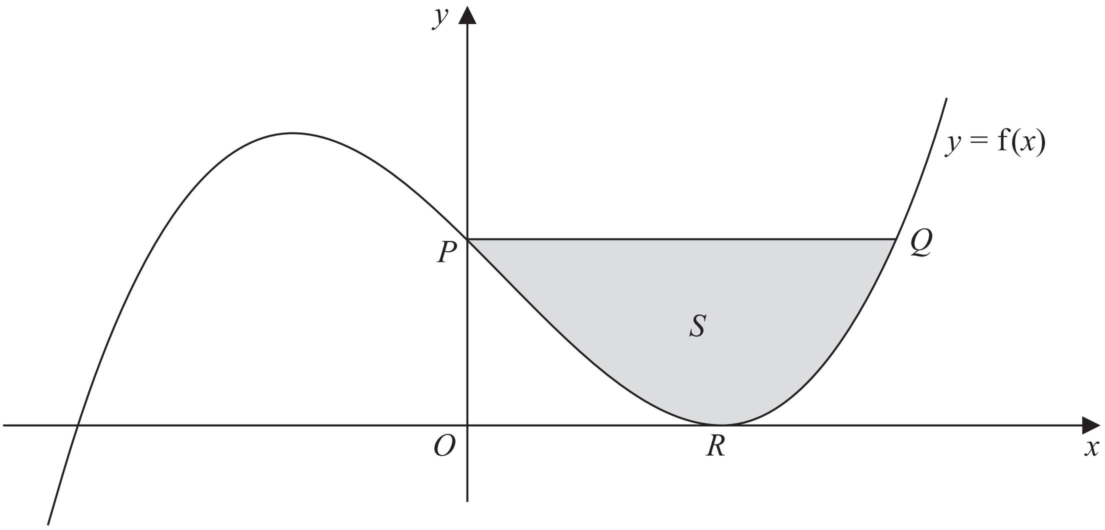


Figure 5

Figure 5 shows a sketch of part of the graph $y = \mathrm{f}(x)$, where

$$\mathrm{f}(x) = \frac{(x-3)^2(x+4)}{2}, \qquad x \in \mathbb{R}$$

The graph cuts the y-axis at the point P and meets the positive x-axis at the point R, as shown in Figure 5.

(a) (i) State the y coordinate of P.

(ii) State the x coordinate of R.

(2)

The line segment PQ is parallel to the x-axis. Point Q lies on $y = \mathrm{f}(x)$, $x > 0$

(b) Use algebra to show that the x coordinate of Q satisfies the equation

$$x^2 - 2x - 15 = 0$$

(3)

(c) Use part (b) to find the coordinates of Q.

(3)

The region S, shown shaded in Figure 5, is bounded by the curve $y = \mathrm{f}(x)$ and the line segment PQ.

(d) Use calculus to find the exact area of S.

(6)

Question Number	Scheme		Marks
15. (a)(i)	18		B1
(ii)	3		B1
			[2]
(b)	$\frac{(x-3)^2(x+4)}{2}='18'$		M1
	$\left(x^2-6x+9\right)(x+4)=36$		
	$\Rightarrow x^3-2x^2-15x+36=36$		dM1
	$\Rightarrow x^3-2x^2-15x=0 \Rightarrow x^2-2x-15=0$		A1*
			[3]
(c)	$x=5$		B1
	$y=\frac{(5-3)^2(5+4)}{2} \Rightarrow (5,18)$		M1A1
			[3]
(d)	**Method 1**	**Method 2** OR	
	$\int\left(\frac{1}{2}x^3-x^2-\frac{15}{2}x+18\right)\mathrm{d}x=\frac{1}{8}x^4-\frac{1}{3}x^3-\frac{15}{4}x^2+18x$	$\int\left(-\frac{1}{2}x^3+x^2+\frac{15}{2}x\right)\mathrm{d}x=-\frac{1}{8}x^4+\frac{1}{3}x^3+\frac{15}{4}x^2$	M1A1
	Uses their 5 as the upper limit (and subtracts 0) to obtain an area	Uses their 5 as the upper limit (and subtracts 0) to obtain area	M1
	Area of rectangle = 90	Implied by correct answer $57\frac{7}{24}$	B1
	Use = Area of rectangle – Area beneath curve	Implied by subtraction in the integration	dM1
	$=90-32\frac{17}{24}=57\frac{7}{24}$ $\left(\frac{1375}{24}\right)$	$=57\frac{7}{24}$ $\left(\frac{1375}{24}\right)$	A1cso
			[6] **(14 marks)**

(a)(i)

B1 18 $P(0,18)$ or even P =18 is fine but do not allow $P(18,0)$

(a)(ii)

B1 3 $R(3,0)$ or even R =3 is fine but do not allow $R(0,3)$ or if they state 3 and -4

(b)

M1 Sets $\text{f}(x) = \text{their '18'}$ It can be implied by sight of $(x-3)^2(x+4) = 2\times\text{their } 18$

dM1 Attempts to multiply out $(x-3)^2(x+4)$ using a correct method. **Accept working for this expansion from elsewhere in the question. (It may be scribbled out which is fine BUT it must be seen**)
Expect to see $(x^2 \pm 6x \pm 9)(x+4)$ "multiplied" out to a cubic.

A1* Reaches the given answer of $x^2-2x-15=0$ following $x^3-2x^2-15x=0$ with no errors

(c)

B1 States $x=5$

M1 Attempts to find the y coordinate of Q by substituting their 5 into $\text{f}(x)$
Alternatively implies the y coordinate by using the same value as their answer to a(i)

A1 cao $(5,18)$ Allow written as $x=5, y=18$ It must be seen in part (c)

(d) Decide the method first:

……

Method one: Curve and line separate

M1 For integrating what they think is their $\text{f}(x)$ which must be cubic.
All powers must be raised by one for this to be scored.

A1 Correct $\frac{1}{8}x^4 - \frac{1}{3}x^3 - \frac{15}{4}x^2 + 18x$ which may be unsimplified

M1 Uses an upper limit of their 5 (and 0) in their integrated function.
This may appear as two separate integrals 0 to 3 then 3 to 5

B1 Area of rectangle = 90 or 18×5
.

M1 Uses area of rectangle $-$ area under curve (either way around). It is dependent upon both previous M's

A1 cso $57\frac{7}{24}$ Note $-57\frac{7}{24}$ is A0

……

Method two: Curve - line or line - curve

M1 For integrating what they think is their $\pm(\text{'18'} - \text{f}(x))$ which must be cubic.
All powers must be raised by one for this to be scored.

A1 Correct $\pm\left(-\frac{1}{8}x^4 + \frac{1}{3}x^3 + \frac{15}{4}x^2\right)$ which may be unsimplified

M1 Uses an upper limit of their 5 (and 0) in their integrated function.
This may appear as two separate integrals 0 to 3 then 3 to 5

B1 Area of rectangle implied by $\pm57\frac{7}{24}$ **There is no need to use a calculator on incorrect functions (score B0)**

M1 Uses area of rectangle $-$ area under curve (either way around). It is dependent upon both previous M's
Can be awarded on line 1

A1 cso $57\frac{7}{24}$ Note $-57\frac{7}{24}$ is A0

……

Special case: There will be quite a few candidates who believe that the equation is $y = x^3 - 2x^2 - 15x + 36$

(d)	**Method 1** $\int\left(x^3-2x^2-15x+36\right)\mathrm{d}x=\frac{1}{4}x^4-\frac{2}{3}x^3-\frac{15}{2}x^2+36x$	**Method 2** OR $\int\left(-x^3+2x^2+15x-18\right)\mathrm{d}x=-\frac{1}{4}x^4+\frac{2}{3}x^3+\frac{15}{2}x^2-18x$	M1A0
	Uses their 5 as the upper limit (and subtracts 0) to obtain an area	Uses their 5 as the upper limit (and subtracts 0) to obtain area	M1
	Area of rectangle = 90	Implied by answer $\pm 24\frac{7}{12}$	B1
	Use = Area of rectangle – Area beneath curve	Implied by subtraction in the integration	M1
	$=90-65\frac{10}{24}=24\frac{7}{12}$	$=24\frac{7}{12}$	A0
			4/6

……

For answers without working which seem to be quite common

Eg. Area $=90-\int_0^5\frac{(x-3)^2(x+4)}{2}\mathrm{d}x=\frac{1375}{24}$ score M0 A0 M1 (limits) B1 (90) M0 (Both M's needed) A0 for 2/6

……

Handy Marking guide for 15 d,

Ist M1	For integrating a cubic that resulted from Multiplying out $\frac{(x-3)^2(x+4)}{2}$, $(x-3)^2(x+4)$ or solving $\frac{(x-3)^2(x+4)}{2}=\text{"18"}$ Don't worry if there are errors. Score for a cubic going to a quartic with all powers being raised by one
A1	Can only be scored for: Method one $\frac{1}{8}x^4-\frac{1}{3}x^3-\frac{15}{4}x^2+18x$ Method two $\pm\left(-\frac{1}{8}x^4+\frac{1}{3}x^3+\frac{15}{4}x^2\right)$
M1	Uses their 5 as the upper limit (and subtracts 0) to obtain an area
B1	Method One for sight of 90 or 18×5 Method Two for a (correct) answer of $\pm57\frac{7}{24}=\frac{1375}{24}$ or $\pm24\frac{7}{12}=\pm\frac{295}{12}$ in the special case
dM1	It is dependent upon both previous M's Method One Rectangle - area under curve Method Two Awarded on line 1 for integral (curve-18) either way around
A1	Cso $57\frac{7}{24}$ or $\frac{1375}{24}$

16. $\mathrm{f}(x) = ax^3 + bx^2 + 2x - 5$, where a and b are constants

The point $P(1, 4)$ lies on the curve with equation $y = \mathrm{f}(x)$.

The tangent to $y = \mathrm{f}(x)$ at the point P has equation $y = 12x - 8$

Calculate the value of a and the value of b.

(5)

Question Number	Scheme	Marks
16.	$\frac{dy}{dx}=3ax^2+2bx+2$	B1
	Sub $x=1, y=4 \Rightarrow y=ax^3+bx^2+2x-5$ or $x=1$ into $ax^3+bx^2+2x-5=12x-8$	M1
	Sub $x=1, \frac{dy}{dx}=12 \Rightarrow 3a+2b+2=12$	M1
	Solves simultaneously $a+b=7, 3a+2b=10 \Rightarrow a=-4, b=11$	dM1A1
		[5]
		(5 marks)

B1 States or uses $\frac{dy}{dx}=3ax^2+2bx+2$

M1 Attempts to substitute $x=1, y=4$ in $y=f(x) \Rightarrow a+b+2-5=4$

This also can be scored by to substituting $x=1$ into $ax^3+bx^2+2x-5=12x-8 \Rightarrow a+b+2-5=12-8$

M1 Attempts to substitute $x=1, \frac{dy}{dx}=12$ in their $\frac{dy}{dx}=3ax^2+2bx+2$

dM1 Solves simultaneously to find both *a* and *b*. Both M's must have been awarded. Allow from a graphical calculator. Sight of both values is sufficient.

A1 $a=-4, b=11$