Pearson Edexcel

Mark Scheme (Results)

Summer 2022

Pearson Edexcel International GCSE

In Further Pure Mathematics (4PM1)

Paper 1

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme - not according to their perception of where the grade boundaries may lie.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification/indicative content will not be exhaustive.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, a senior examiner must be consulted before a mark is given.
- Crossed out work should be marked **unless** the candidate has replaced it with an alternative response.

- **Types of mark**
  - M marks: method marks
  - A marks: accuracy marks
  - B marks: unconditional accuracy marks (independent of M marks)

- **Abbreviations**
  - cao – correct answer only
  - ft – follow through
  - isw – ignore subsequent working
  - SC - special case
  - oe – or equivalent (and appropriate)
  - dep – dependent
  - indep – independent
  - awrt – answer which rounds to
  - eeoo – each error or omission

- **No working**
  If no working is shown then correct answers normally score full marks
  If no working is shown then incorrect (even though nearly correct) answers score no marks.

- **With working**
  You must always check the working in the body of the script (and on any diagrams) irrespective of whether the final answer is correct or incorrect and award any marks appropriate from the mark scheme.

  If it is clear from the working that the "correct" answer has been obtained from incorrect working, award 0 marks.
  If a candidate misreads a number from the question. Eg. Uses 252 instead of 255; method marks may be awarded provided the question has not been simplified. Examiners should send any instance of a suspected misread to review.
  If there is a choice of methods shown, then award the lowest mark, unless the answer on the answer line makes clear the method that has been used.
  If there is no answer achieved then check the working for any marks appropriate from the mark scheme.

- **Ignoring subsequent work**
  It is appropriate to ignore subsequent work when the additional work does not change the answer in a way that is inappropriate for the question: eg. Incorrect cancelling of a fraction that would otherwise be correct.
  It is not appropriate to ignore subsequent work when the additional work essentially makes the answer incorrect eg algebra.
  Transcription errors occur when candidates present a correct answer in working, and write it incorrectly on the answer line; mark the correct answer.

- **Parts of questions**
  Unless allowed by the mark scheme, the marks allocated to one part of the question CANNOT be awarded to another.

General Principles for Further Pure Mathematics Marking

(but note that specific mark schemes may sometimes override these general principles)

Method mark for solving a 3 term quadratic equation:

1. Factorisation:

$(x^2+bx+c)=(x+p)(x+q)$, where $|pq|=|c|$ leading to $x=....$

$(ax^2+bx+c)=(mx+p)(nx+q)$ where $|pq|=|c|$ and $|mn|=|a|$ leading to $x=....$

2. Formula:

Attempt to use the **correct** formula (shown explicitly or implied by working) with values for *a*, *b* and *c*, leading to $x=....$

3. Completing the square:

$x^2+bx+c=0$: $\left(x\pm\frac{b}{2}\right)^2\pm q\pm c=0,\quad q\neq 0$ leading to $x=....$

4. Use of calculators

Unless the question specifically states 'show' or 'prove' accept correct answers from no working. If an incorrect solution is given without any working do not award the Method mark.

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. $(x^n \to x^{n-1})$

2. Integration:

Power of at least one term increased by 1. $(x^n \to x^{n+1})$

Use of a formula:

Generally, the method mark is gained by **either**

quoting a correct formula and attempting to use it, even if there are mistakes in the substitution of values

or, where the formula is not quoted, the method mark can be gained by implication

from the substitution of correct values and then proceeding to a solution.

Answers without working:

The rubric states "Without sufficient working, correct answers may be awarded no marks".

General policy is that if it could be done "in your head" detailed working would not be required. (Mark schemes may override this eg in a case of "prove or show....")

Exact answers:

When a question demands an exact answer, all the working must also be exact. Once a candidate loses exactness by resorting to decimals the exactness cannot be regained.

Rounding answers (where accuracy is specified in the question)

Penalise only once per question for failing to round as instructed - ie giving more digits in the answers. Answers with fewer digits are automatically incorrect, but the isw rule may allow the mark to be awarded before the final answer is given.

International GCSE Further Pure Mathematics – Paper 1 mark scheme

Paper 1		
Question number	Scheme	Marks
1	$\dfrac{2\sqrt{3}-4}{3\sqrt{3}+5}\times\dfrac{3\sqrt{3}-5}{3\sqrt{3}-5}$	M1
	$=\dfrac{18-10\sqrt{3}-12\sqrt{3}+20}{27-25}\left(=\dfrac{38-22\sqrt{3}}{2}\right)$ oe	dM1
	$=19-11\sqrt{3}$ correct working throughout only	A1 (3)
ALT	$2\sqrt{3}-4=\left(3\sqrt{3}+5\right)\left(a+b\sqrt{3}\right)$	M1
	$2\sqrt{3}-4=5a+9b+3\sqrt{3}a+5\sqrt{3}b\Rightarrow "5a+9b"=-4;\ "3a+5b"=2$	dM1
	$15a+27b=-12$ or $25a+45b=-20$	A1
	$15a+25b=10$ $27a+45b=18$	
	$2b=-22\ \Rightarrow b=-11$ $2a=38\ \Rightarrow a=19$	
	$15a-297=-12\Rightarrow a=19$ $57\ +\ 5b=2\ \Rightarrow b=-11$	
	$=19-11\sqrt{3}$ correct working throughout only	(3)
		Total 3 marks

Marks	Notes
M1	For multiplying by $\dfrac{3\sqrt{3}-5}{3\sqrt{3}-5}$ This may be seen as two separate calculations. Note, multiplying by $\dfrac{5-3\sqrt{3}}{5-3\sqrt{3}}$ is valid and will lead to all terms being the opposite and should be marked in the same way.
dM1	Dependent on M1 for attempting to multiply out the numerator and denominator. There may be up to 2 errors or omissions. $\dfrac{38-22\sqrt{3}}{2}$ is sufficient working
A1	For $19-11\sqrt{3}$ (Allow $a=19,\ b=-11$) As this result can be achieved with a calculator, there can be no incorrect working shown for this mark to be awarded.
ALT	
M1	For $\left(3\sqrt{3}+5\right)\left(a+b\sqrt{3}\right)$
dM1	For attempting to multiply out $\left(3\sqrt{3}+5\right)\left(a+b\sqrt{3}\right)$ to reach an expression that can be used to compare coefficients. There may be up to 2 errors or omissions.
A1	For forming 2 correct simultaneous equations and solving correctly to reach $19-11\sqrt{3}$ (Allow $a=19,\ b=-11$). Two common examples are shown in the scheme. As this result can be achieved with a calculator, there can be no incorrect working shown for this mark to be awarded.

Question number	Scheme	Marks
2 a	$(8x+y)(6x+y)\left[=48x^2+14xy+y^2\right]$ oe	B1 (1)
b	$48x^2+14xy+y^2-2(9x^2+15x^2)$ oe $=14xy+y^2$ *	M1 M1 A1 cso* (3)
ALT	eg $3(y\times 3x)+(y\times 5x)+y^2$ or $y(8x+y)+2(3x\times y)$ or $y\times 3x+y\times 5x+y\times(6x+y)$ or $y(6x+y)+y(8x+y)-y^2$ $=14xy+y^2$ *	M1 M1 A1 cso* (3)
c	$(14xy+y^2=1080,\ 48x^2+14xy+y^2=3432)$ $48x^2+1080=3432$ $(48x^2=2352)$ $x=7$ $y^2+98y-1080(=0)$ $(y-10)(y+108)(=0)$ $y=10$	M1 A1 M1 M1 A1 (5)
ALT	$(14xy+y^2=1080,\ 48x^2+14xy+y^2=3432)$ $x=\dfrac{1080-y^2}{14y}\Rightarrow 48\left(\dfrac{1080-y^2}{14y}\right)^2+\left(\dfrac{1080-y^2}{14y}\right)14y+y^2=3432$ $\Rightarrow y^4-2160y^2+1166400=0$	M1
	$(y^2-1164)(y^2-100)(=0)$ $\left(\Rightarrow y^2=1164 \text{ or } y^2=100 \text{ or } y=\pm 108 \text{ or } y=\pm 10\right)$	M1 (A1 on ePen)
	$y = 10$	A1 (M1 on ePen)
	$14(10)x+100=1080\Rightarrow x=$	M1
	$x=7$	A1
		Total 9 marks

Part	Marks	Notes
(a)	**B1**	For $(8x+y)(6x+y)$ oe
(b)	**M1**	For their "$(8x+y)(6x+y)$" $-2(9x^2+15x^2)$ oe Neither of these expressions need to be in simplified form.
	M1	For correct expansion to give $48x^2+14xy+y^2$ - may be seen in part (a) or for $2(9x^2+15x^2)$ or $18x^2+30x^2$ or $48x^2$ written in any correct form – doesn't need to be simplified.
	A1 cso*	Obtains the given result with no errors seen.
	Note M0 M1 A0 is possible.	
ALT	**M1**	For an attempt to add or subtract separate components to give the area of the cross. Allow 1 omission or up to 2 errors. Examples are given in the MS, though these are not exhaustive.
	M1	All components present and correct and an attempt to simplify.
	A1 cso*	Obtains the given result with no errors seen.
	Note M0 M1 A0 is possible.	
(c)	**M1**	For solving simultaneously, using the correct equations, to obtain $48x^2+1080=3432$
	A1	For $x=7$ (must select the positive solution)
	M1	For substituting their value of x to obtain a 3TQ in terms of y only.
	M1	For an attempt to solve their 3TQ – see general guidance for minimally acceptable attempt.
	A1	For $y=10$ (must reject the other solution) final M1 A1 can be awarded for $y = 10$ with no working shown final M1 A0 can be awarded for $y = 10$ and $y = -108$.
ALT	**M1**	Correct rearrangement for x and correct substitution into $48x^2+14xy+y^2=3432$ reaching an equation of the form $ay^4+by^2+c=0$
	M1 (A1 on ePen)	For an attempt to solve their equation of the form $ay^4+by^2+c=0$ as a quadratic in y^2 (minimally acceptable attempt to solve, see general guidance) (A fully correct solution would give: $y^2=1164$ or $y^2=100$ or $y=\pm108$ or $y=\pm10$)
	A1 (M1 on ePen)	$y = 10$ (must clearly select this solution) 2nd M1 A1 can be awarded if no working and $y = 10$ 2nd M1 A0 can be awarded if no working and $y=\pm108$ and $y=\pm10$ seen
	M1	For substituting their value for y and solving a linear equation to arrive at $x =$
	A1	$x = 7$

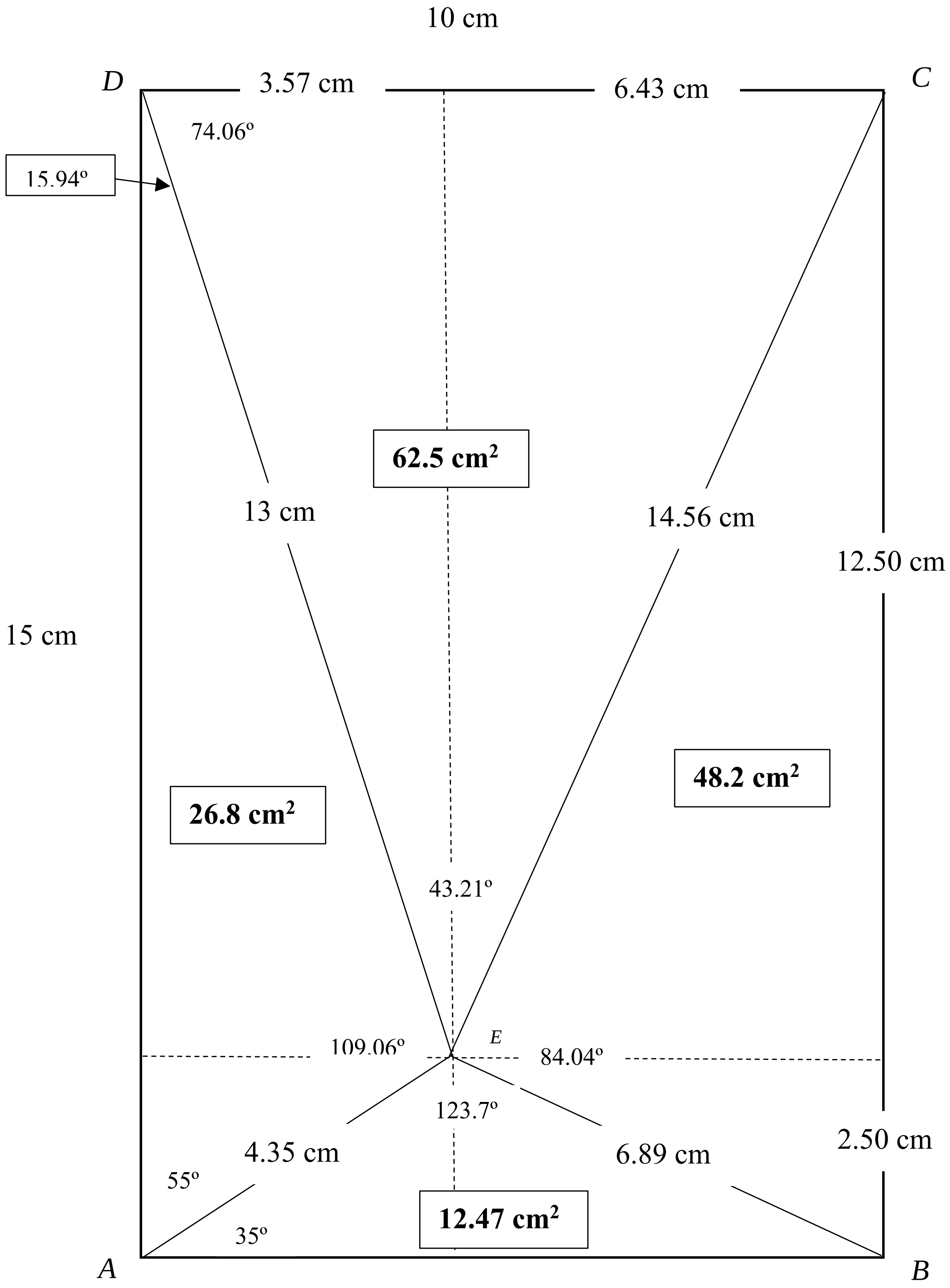
Question number	Scheme	Marks
3	**Working in triangle *AED* – main scheme, ALT1 and ALT2 – first 3 marks:** $\frac{\sin E}{15}=\frac{\sin 55}{13}$ $E = 70.9...°$ or $109...°$ (awrt) $ADE = 180 - 55 -$ "109.1" (=15.9…°) or $180 - 55 -$ "70.9" (=54.0…°)	M1 A1 M1 (B1 on ePen)
Main Scheme	(Let h be the perpendicular height of triangle ADE) $\sin"15.9...°"=\frac{h}{13}$ **Allow use of "54.0"** $h = 3.57...$ or $10.5.....$(awrt) Area = $\frac{1}{2}\times15\times(10-'3.57...')$ **Do not allow use of *h* that has come from "54.0"** $= 48.2\ (\text{cm}^2)$ (awrt)	M1 A1 ddM1 A1 (7)
ALT1	**First 3 marks as main scheme** $\left((AE)^2=\right)13^2+15^2-2\times13\times15\cos("15.9....")°$ **allow use of "54.0...." for "15.9...."** or $(AE=)\sqrt{13^2+15^2-2\times13\times15\cos("15.9....")°}$ **allow use of "54.0...." for "15.9...."** $\frac{AE}{\sin"15.9"}=\frac{13}{\sin 55}$ **allow use of "54.0...." for "15.9...."** $(AE=)$awrt 4.35 or 4.36 **or** awrt12.8 or 12.9 if using using 54.0....rather than 15.9.... **FOR THE NEXT PART DO NOT ALLOW USE OF 54.0 or 12.8……..** $\frac{1}{2}\times"4.35...."\times10\times\sin35$ (Area $AEB = 12.4.....$) $\frac{1}{2}\times"4.35...."\times15\times\sin55$ *or* $\frac{1}{2}\times13\times15\times\sin"15.9...."$ (Area $AED = 26.7.....$) $\frac{1}{2}\times13\times10\times\sin"90-15.9"$ (Area $EDC = 62.5.....$) Area triangle $BCE = (10\times15)-(\text{Area } AEB + \text{Area } AED + \text{Area } EDC)$ awrt $48.2\ (\text{cm}^2)$	 M1 A1 ddM1 A1 (7)
ALT2	**First 5 marks as ALT1** **DO NOT ALLOW USE OF 54.0 or 12.8……..for this 2 marks** $\left((EB)^2=\right)10^2+"4.36"^2-2\times10\times"4.36"\cos(35)°$ or $(EB=)\sqrt{10^2+"4.36"^2-2\times10\times"4.36"\cos(35)°}$ $\frac{\sin EBA}{4.36.....}=\frac{\sin 35}{6.96....}\Rightarrow$ Angle $EBA = 21.2......\Rightarrow$ Angle $EBC = 90-21.2......=68.7......$ Area $= 0.5\times6.96\times15\times\sin(68.7.....)$ Area = awrt48.2	 ddM1 A1 (7)

ALT3	**Working in triangle *ABE***	M1
	or denoting side AE as $y: 13^2 = 15^2 + y^2 - 2\times y \times 15\cos 55$	
	$\left(\Rightarrow 0 = y^2 - (17.2....)y + 56\right)$	
	$(y =)\text{awrt}\, 4.35\, or\, 4.36$ or $(y =)\text{awrt}\, 12.8$	A1
	$c^2 = \text{"}4.36\text{"}^2 + 10^2 - 2\times\text{"}4.36\text{"}\times 10\cos 35$ **12.8 could also be used for 4.36**	M1
	$(c = \text{awrt}\, 6.89\, \text{or}\, 7.38)$	
	$\dfrac{\sin 35}{\text{"}6.89\text{"or"}7.83\text{"}} = \dfrac{\sin ABE}{\text{"}4.36\text{"or"}12.8\text{"}}$	M1
	angle $ABE = \text{awrt}\, 21.2$ or 85.9 **and** $c = \text{awrt}\, 6.89$ or 7.38	A1
	$\text{Area} = \dfrac{1}{2}\times 15\times\text{"}6.89\text{"}\times\sin(90 - \text{"}21.2\text{"})$	ddM1
	awrt 48.2	A1
		Total 7 marks
If the final answer given rounds to 48.2 and working is present, students may be given full marks if their intermediate values are not given to the degree of accuracy demanded in the mark scheme. Look carefully for answers written on the diagram and award marks.		

Mark	Notes for ALT3
M1	For a correct substitution into the cosine rule to find *AE* as shown
A1	For either y = awrt 4.35/4.36 or y = awrt 12.8
M1	Correct substitution into the cosine rule to find *BE* using their 4.36 or 12.8
M1	Correct substitution into the sine rule to find angle *ABE*
ddM1	For this mark, they must have used y = 4.35/4.36 throughout Correct substitution into the area of a triangle formula as shown
A1	awrt 48.2

Marks	Notes
Working in triangle *AED* – main scheme, ALT1 and ALT2 – first 3 marks:	
M1	For correct use of the sine rule to find angle *AED*
A1	For either $AED = 70.9...°$ or $109...°$ awrt
M1 (B1 on ePen)	For *ADE* = (180 – 55 – their "109".1…)° or 180 – 55 – "70.9" (=54.0…°) It must be clear this is their angle *AED* if the angle is incorrect or for finding "74.1" – the angle which *h* makes with *DE* using "109.1" or "70.9"
Main scheme next 4 marks:	
M1	For $\sin"15.9"...° = \frac{h}{13}$ Use of their 15.9. Allow use of their 54.0…….. **Note, using the same triangle, this could also be presented as:** $\cos"74.1"...° = \frac{h}{13}$
A1	For $h = 3.57...$ or 10.5 (awrt)
ddM1	For area = $\frac{1}{2} \times 15 \times (10 - "3.57...")$ Dependent on both previous method marks – for this mark, candidates must have used angle *ADE* = (180 – 55 – their "109".1…="15.9")° ie **they must have used the obtuse angle found for angle *AED***
A1	For awrt $48.2\ (\text{cm}^2)$ (Units not required)
For all solutions: if the final answer given rounds to 48.2 and working is present, students may be given full marks if their intermediate values are not given to the degree of accuracy demanded in the mark scheme.	
ALT1	
M1	For correct substitution into cosine rule $13^2 + 15^2 - 2 \times 13 \times 15 \cos("15.9....")"°$ or $\sqrt{13^2 + 15^2 - 2 \times 13 \times 15 \cos("15.9....")°}$ Use of their 15.9….. Allow use of their 54.0……..
A1	For awrt 4.36
ddM1	For a **complete** method to find the area of triangle *BCE* as shown in the scheme – use of their values. Dependent on both previous method marks – for this mark, candidates must have used angle *ADE* = (180 – 55 – their "109".1…="15.9")° ie **they must have used the obtuse angle found for angle *AED***
A1	For awrt $48.2\ (\text{cm}^2)$ (Units not required)
ALT2 Final ddM1	For a **complete** method to find area of triangle *BCE* Finds *EB*, finds angle *EBC* Dependent on both previous method marks – for this mark, candidates must have used angle *ADE* = (180 – 55 – their "109".1…="15.9")° ie **they must have used the obtuse angle found for angle *AED***
A1	For awrt $48.2\ (\text{cm}^2)$ (Units not required)
General principles for marking this question with any other method seen: The first 5 marks will be allocated as the main scheme and/or the ALTS The final ddM1 mark will be awarded for a complete method, using their values **but MUST use the obtuse angle as stated in the question.** Final A1 for awrt 48.2	

USEFUL SKETCH


10 cm
D
3.57 cm
6.43 cm
C
74.06°
15.94°
62.5 cm²
13 cm
14.56 cm
12.50 cm
15 cm
48.2 cm²
26.8 cm²
43.21°
109.06°
E
84.04°
123.7°
4.35 cm
6.89 cm
2.50 cm
55°
12.47 cm²
35°
A
B

Question number	Scheme	Marks
4	$(S_4 =)\dfrac{a(1-r^4)}{1-r} = 80$ or $(S_\infty =)\dfrac{a}{1-r} = 81$ or $a + ar + ar^2 + ar^3 = 80$	B1
	$\dfrac{81(1-r)(1-r^4)}{1-r} = 80 \Rightarrow \left(81(1-r^4) = 80\right)$ or $81(1-r) = \dfrac{80(1-r)}{1-r^4}$ $\left(\Rightarrow (81-81r)(1-r^4) = 80(1-r) \Rightarrow 81r^5 - 81r^4 - r + 1 = 0 \Rightarrow (81r^4 - 1)(r-1) = 0\right)$ or $81(1-r) + 81(1-r)r + 81(1-r)r^2 + 81(1-r)r^3 = 80$	M1
	$r^4 = \dfrac{1}{81}$	M1
	$r = \pm\dfrac{1}{3}$	A1
	$[a = 54]$	
	$S_7 = \dfrac{"54"\left(1-\left("\frac{1}{3}"\right)^7\right)}{1-"\frac{1}{3}"}$ or $\dfrac{2186}{27}$ or $81\left(1-\left("\frac{1}{3}"\right)^7\right)$	M1
	$81 - "\dfrac{2186}{27}" = \dfrac{1}{27}$ *	dM1 A1* cso (7)
ALT	FINAL THREE MARKS	
	$S_7 = \dfrac{"54"\left(1-\left("\frac{1}{3}"\right)^7\right)}{1-"\frac{1}{3}"}$ or $\dfrac{2186}{27}$	M1
	$81 - \dfrac{1}{27} = \dfrac{2186}{27}$	ddM1 A1
		Total 7 marks

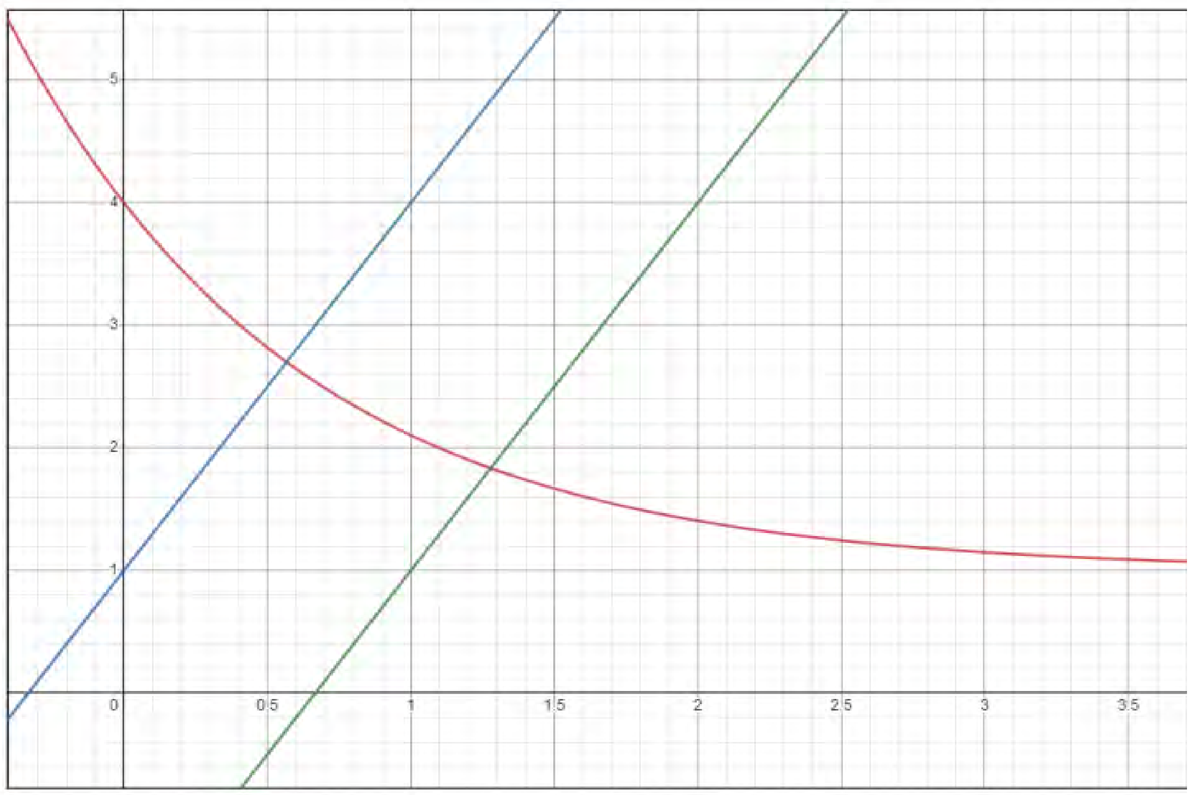
Marks	Notes
B1	For $\frac{a(1-r^4)}{1-r}=80$ or $\frac{a}{1-r}=81$ or $a+ar+ar^2+ar^3=80$
M1	For substituting S_∞ into S_4 and eliminating *a* Students may also rearrange to make *a* the subject of both and then substitute to eliminate *a*. Allow one error in manipulation. Must use a valid method to eliminate. Using their S_∞ and S_4
M1	For reaching $r^4 = \ldots$ or for reaching $81r^5-81r^4-r+1=0$
A1	For $r=\frac{1}{3}$ (accept $\pm$)
M1	Correct substitution into $\frac{a(1-r^7)}{1-r}$ or $a+ar+ar^2+ar^3+ar^4+ar^5+ar^6$ or $81\left(1-r^7\right)$ - using their *a* and their *r*. *r* must be positive. Or $\frac{2186}{27}$
dM1	For $81-"\frac{2186}{27}"$ Dependant on previous method mark. Their *r* must be positive. If *a* and *r* are correct, the evaluation of each part of these calculations need not be shown (can be done on a calculator). If either *a* or *r* are incorrect, their $\frac{2186}{27}$ must have been evaluated and 81 used.
A1 cso*	Obtains the given answer. No incorrect work.
ALT	Final 3 marks
M1	Correct substitution into $\frac{a(1-r^7)}{1-r}$ or $a+ar+ar^2+ar^3+ar^4+ar^5+ar^6$ - using their *a* and their *r*. *r* must be positive.
dM1 **A1**	Must state $81-\frac{1}{27}=\frac{2186}{27}$ (for this ALT, candidates must evaluate and get $\frac{2186}{27}$ It isn't possible to get dM1 A0 on the ALT Dependent on previous method mark.

Question number	Scheme	Marks
5 a	$(2+3x)^{-1}=\frac{1}{2}\left(1+\frac{3}{2}x\right)^{-1}$ so $p=\frac{1}{2}$ and $q=\frac{3}{2}$ oe	B1 B1 (2)
b	$\left(\frac{1}{2}\right)\left[1+(-1)\left("\frac{3}{2}"x\right)+\frac{(-1)(-2)}{2!}\left("\frac{3}{2}"x\right)^2+\frac{(-1)(-2)(-3)}{3!}\left("\frac{3}{2}"x\right)^3+\ldots\right]$ $\frac{1}{2}-\frac{3}{4}x+\frac{9}{8}x^2-\frac{27}{16}x^3+\ldots$	M1 A1ft A1 (3)
c	$\frac{1}{2}-\frac{3}{4}x+\frac{9}{8}x^2-\frac{27}{16}x^3+\frac{1}{2}x-\frac{3}{4}x^2+\frac{9}{8}x^3+\ldots$ $\frac{1}{2}-\frac{1}{4}x+\frac{3}{8}x^2-\frac{9}{16}x^3$	M1 A1 (2)
d	$\int_0^{0.5}\left(\frac{1}{2}-\frac{1}{4}x+\frac{3}{8}x^2-\frac{9}{16}x^3\right)dx=\frac{1}{2}x-\frac{1}{8}x^2+\frac{1}{8}x^3-\frac{9}{64}x^4$ $\frac{1}{2}\left(\frac{1}{2}\right)-\frac{1}{8}\left(\frac{1}{2}\right)^2+\frac{1}{8}\left(\frac{1}{2}\right)^3-\frac{9}{64}\left(\frac{1}{2}\right)^4=0.2256$ for awrt 0.2256	M1 A1 M1 A1 (4)
		Total 11 marks

Part	Marks	Notes
(a)	**B1**	For $p=\frac{1}{2}$ or 2^{-1} or $q=\frac{3}{2}$
	B1	For $p=\frac{1}{2}$ or 2^{-1} and $q=\frac{3}{2}$
		NB $\frac{1}{2}\left(1+\frac{3}{2}x\right)^{-1}$ scores B1 B1
(b)	**M1**	For an attempt to expand $(1+qx)^{-1}$ with their value of q up to the term in x^3 It is not necessary to see p at this stage. The definition of an attempt is as follows: • The first term must be 1 • The next term must be correct for their value of q • The powers of qx must be correct eg $(qx)^2$ • The denominators must be correct Simplification not required. Do not allow missing brackets unless recovered later – this is a general point of marking.
	A1ft	For at least 3 terms fully correct and unsimplified for their value of q. It is not necessary to see p at this point.
	A1	For all 4 terms correct, all simplified.
	If there are any other methods used – send this to review please.	
(c)	**M1**	For multiplying their expansion by $(1+x)$ There must be a clear attempt to multiply to get 7 terms, allow up to 2 errors. Ignore terms with powers higher than 3.
	A1	For all 4 terms correct, ignore terms with powers higher than 3.
(d)	**M1**	For a minimally acceptable attempt to integrate an expression with at least 3 terms, which must include a term in x^3 See general guidance for definition of minimally acceptable attempt.
	A1ft	For a fully correct integration of their expression (defined as above for the M mark).
	M1	For substitution of limits into a changed expression, the correct way round – this can be implied if the final answer is correct. We don't need to see 0 substituted in.
	A1	For awrt 0.2256 (Note the calculator value is 0.2288461……)

Question number	Scheme	Marks
6 a	**0** | *0.25* | *0.5* | **1** | *1.5* | **2** | *3* **4(.00)** | *3.34* | *2.82* | **2.1(0)** | *1.67* | **1.41** | *1.15*	B2 (2)
b	Points plotted within half a square Points joined with a smooth curve	B1 ft B1 ft (2)
c	$x = e^{-x} \Rightarrow 3x + 1 = 1 + 3e^{-x}$ or sight of $y = 3x + 1$ and $y = 1 + 3e^{-x}$ $y = 3x + 1$ drawn. Intersection is at $x = 0.5$ or 0.6	M1 M1 A1 (3)
d	$\ln(x-1)^3 = -3x \Rightarrow \ln(x-1) = -x$ $\Rightarrow 3x - 3 = 3e^{-x} \Rightarrow 3x - 2 = 1 + 3e^{-x}$ $y = 3x - 2$ drawn. Intersection is at $x = 1.2$ or 1.3	M1 M1 M1 A1 (4)
ALT – first 2 marks	$(x-1)^3 = e^{-3x} \Rightarrow \left(\sqrt[3]{(x-1)^3} = \sqrt[3]{e^{-3x}}\right) \Rightarrow x - 1 = e^{-x}$ $3x - 3 = 3e^{-x} \Rightarrow 3x - 2 = 1 + 3e^{-x}$	M1 M1
		Total 11 marks

Part	Marks	Notes
(a)	**B2**	B2 for all 3 values correct (condone 2.1 for 2.10) (B1 for 2 values correct)
(b)	**B1ft**	For all of the points plotted within half a square, allow use of their values. Points must be checked carefully, including using the zoom tool on ePen if necessary.
	B1ft	For all of their points joined with a smooth curve. Be cautious to not award this mark if straight lines are drawn between the points plotted.
(c)	**M1**	For multiplying both sides by 3 and adding 1 to both sides or sight of $y = 3x + 1$
	M1	For $y = 3x + 1$ drawn – the line must intersect the curve and pass through a minimum of 2 correct points – eg (0, 1) and (1, 4) M1 M1 if the correct straight line is drawn, without working.
	A1	$x = 0.5$ or 0.6
(d)	**M1**	For use of $\log_a x^k = k \log_a x$ and simplifying to give the expression shown in the scheme.
	M1	For removing logs, multiplying both sides by 3 and subtracting 2 to give the expression shown. Award M1 M1 if $y = 3x - 2$ or any equivalent form is seen eg $y = 1 + 3(x - 1)$
	M1	$y = 3x - 2$ drawn – the line must intersect the curve and pass through a minimum of 2 correct points M1 M1 M1 if the correct straight line is drawn, without working.
	A1	$x = 1.2$ or 1.3
ALT first 2 marks	**M1**	For removing logs and cube rooting each side to arrive at the expression shown in the scheme.
	M1	For multiplying by 3 and subtracting 2 to give the expression shown Award M1 M1 if $y = 3x - 2$ or any equivalent form is seen eg $y = 1 + 3(x - 1)$


5
4
3
2
1
0
0.5
1
1.5
2
2.5
3
3.5

Question number	Scheme	Marks
7 a (i)	$f(x) = \int (4x^3 - 12x^2 - 19x + 12)\,dx = \frac{4}{4}x^4 - \frac{12}{3}x^3 - \frac{19}{2}x^2 + 12x + D$ oe	M1 A1
	For the point $(4, -104)$ it follows that	
	$-104 = (4)^4 - 4(4)^3 - \frac{19}{2}(4)^2 + 12(4) + D$ *	M1 A1* cso
	$-104 = 256 - 256 - 152 + 48 + D \Leftrightarrow D = 0$*	(4)
a (ii)	$x = 0.5$ $\quad f'(x) = 4(0.5)^3 - 12(0.5)^2 - 19(0.5) + 12 = 0$	M1
	$f''(x) = 12x^2 - 24x - 19$	M1
	$x = 0.5$ $\quad f''(x) = 12(0.5)^2 - 24(0.5) - 19 (= -28) < 0$ Therefore maximum *	A1 cso (3)
b (i)	$f'(x) = (2x-1)(2x^2 - 5x - 12)$	M1
	$f'(x) = (2x-1)(2x+3)(x-4) \rightarrow x =$	M1
	$x = -\frac{3}{2}$ or $x = 4$, $\left[x = \frac{1}{2}\right]$	A1
	$A\left(-\frac{3}{2}, -\frac{333}{16}\right)$ $\quad B(4, -104)$	A1 A1 (5)
b (ii)	$f''(x) = 12(-1.5)^2 - 24(-1.5) - 19 (= 44) > 0$ Therefore minimum	ddM1 A1
	$x = 4$ $\quad f''(x) = 12(4)^2 - 24(4) - 19 (= 77) > 0$ Therefore minimum	A1
	(Read notes carefully for allocation of these marks)	(3)
	Alternative	
	As we have a maximum at $x = 0.5$ and C is a continuous curve	{ddM1}
	$x = -\frac{3}{2}$ is a minimum and $x = 4$ is a minimum	{A1}{A1} (3)
		Total 15 marks

Part	Marks	Notes
(a) (i)	**M1**	Attempt to integrate – see general guidance for minimally acceptable attempt – at least one term must be fully correct in this integration (unsimplified).
	A1	Fully correct integration – does not need to include a constant of integration, need not be simplified.
	M1	Substitution of $x = 4$ and $y = -104$ into their expression, which must include a constant of integration.
	A1 cso	Obtains the given result, making it clear the constant of integration is 0 or listing fully the function at the end after fully correct working. There must be no incorrect working for this final mark to be awarded.
Note: candidates may assume $D = 0$ & show, by substituting, (4, -104) lies on the curve **final M1 A1**		
(a) (ii)	**M1**	Substitution of $x = 0.5$ into $f'(x)$ and shows $f'(x) = 0$. A candidate may also solve f'(x) = 0 and solve to get $x = 0.5$.
	M1	For finding $f''(x)$ - see general guidance for minimally acceptable attempt at differentiation. At least one term must be fully correct for this differentiation.
	A1 cso*	Substitutes $x = 0.5$ into a fully correct second derivative, shows that the result is negative and draws a conclusion. This can be as simple as "shown" or #. It is not necessary to work out the actual value of $f''(0.5)$ if clear substitution is shown, but if calculated, it must be correct. No incorrect work for this mark to be awarded. Note: as always, this A mark must follow 2 M1 marks.

(b)	Part (i) and (ii) may be marked together	
(i)	**M1**	A clear attempt to divide by $(2x-1)$ or compare coefficients. The student must arrive at a quadratic factor of the form $(2x^2+Ax-12)$ if dividing It is also possible to divide by $\left(x-\frac{1}{2}\right)$ and arrive at a quadratic factor of the form $4x^2+Bx-24$
	M1	Uses a complete method to solve their 3TQ, see general guidance for a minimally acceptable attempt. Must progress to $x=$.
	A1	$x=-\frac{3}{2}$ or $x=4$ Award M1 M1 A1 if **both** correct values are given without working.
	A1	$A\left(-\frac{3}{2},-\frac{333}{16}\right)$ or $B(4,-104)$ Allow x = and y = (clearly paired) for **both** final A marks.
	A1	$A\left(-\frac{3}{2},-\frac{333}{16}\right)$ and $B(4,-104)$ accept 20.8 or better – answer is 20.8125
	Factorising in (a)(ii) and then using in this part can be awarded the marks above.	
(b) (ii)	**ddM1**	Correctly substitutes $x=-\frac{3}{2}$ or $x=4$ into their $f''(x)$. Their values Dependent on both previous M marks in part (b). A fully correct evaluation of the second derivative can imply this mark ie sight of 77 and 44. Part (i) and (ii) may be marked together
	A1	Substitutes $x=-1.5$ **or** $x=4$ into a fully correct second derivative, shows that the result is positive and draws the conclusion this is a minimum. It is not necessary to work out the actual value of $f''(x)$ if clear substitution is shown, but if calculated, it must be correct.
	A1	Substitutes $x=-1.5$ **and** $x=4$ into a fully correct second derivative, shows that the result is positive and draws the conclusion that both values of x give a minimum. It is not necessary to work out the actual value of $f''(x)$ if clear substitution is shown, but if calculated, it must be correct.
ALT	**ddM1**	For stating the curve is continuous and there is a maximum at $x=0.5$ Dep both previous M
	A1	For stating "as we have a maximum at $x=0.5$" and progressing to state either A or B must be a minimum.
	A1	Fully correct conclusion, stating A and B must both be minimum points.
There **MUST** be an appropriate justification for these marks to be awarded, such as that given in M1		

Question number	Scheme	Marks
8 a	$\frac{4}{3}\pi r^3 = 500$ so $r^3 = \frac{3\times 500}{4\pi}$ therefore $r = 4.92$ accept awrt 4.92	M1 A1 (2)
b	$\delta A = 20$	B1
	$(A = 4\pi r^2) \to \left(\frac{\mathrm{d}A}{\mathrm{d}r}\right) = 8\pi r$	M1
	$\delta r \approx \frac{\mathrm{d}r}{\mathrm{d}A}\delta A = 20\times\frac{1}{8\pi r}$	M1
	When $r = 4.92$ $\delta r \approx \frac{20}{8\pi(4.92)} = 0.16(16204507)$	dM1
	or 0.1617428283 if 4.92 used 0.16 cm accept awrt to 0.16	A1 (5)
		Total 7 marks

Part	Marks	Notes
(a)	**M1**	For correct substitution into the formula for volume of a sphere and correct rearrangement to give r or r^3.
	A1	For $r = 4.92$
(b)	**B1**	For $\delta A = 20$ - may be stated explicitly or implicit in working. Accept $\frac{\mathrm{d}A}{\mathrm{d}t} = 20$
	M1	For $8\pi r$ A may be replaced with another variable, eg S
	M1	For $\delta r \approx \frac{\mathrm{d}r}{\mathrm{d}A}\delta A$ and substitution of 20 and their expression for $\frac{\mathrm{d}A}{\mathrm{d}r}$ Condone poor notation if substitution and their expression for $\frac{\mathrm{d}A}{\mathrm{d}r}$ is correct. Eg accept $\frac{\mathrm{d}r}{\mathrm{d}t} = \frac{\mathrm{d}r}{\mathrm{d}A}\times\frac{\mathrm{d}A}{\mathrm{d}t}$ if using their expression for $\frac{\mathrm{d}A}{\mathrm{d}r}$
	dM1	For substitution of their value for r into their expression (as given above, poor notation condoned) for δr Dependent on previous method mark.
	A1	For 0.16 cm (units not required)
	Without appropriate calculus – no marks may be awarded for this question.	

Question number	Scheme	Marks
9 a	$\left(ax^4 = 3x^4\right) \Rightarrow a = 3$	B1
	$\left(4c = 64\right) \Rightarrow c = 16$	B1
	$\left(bx^3 - 4ax^3 = 4x^3\right) \Rightarrow b - 4a = 4$ or $\left(4ax^2 - 4bx^2 + cx^2 = -36x^2\right)$ $\Rightarrow 4a - 4b + c = -36$ *or* $\left(4bx - 64x = 0x\right) \Rightarrow 4b - 64 = 0$	M1
	$b = 16$	A1 (4)
b	$\int_0^2 (x^3 + x^2 - 6x)\mathrm{d}x = \left[\frac{x^4}{4} + \frac{x^3}{3} - \frac{6}{2}x^2\right]_0^2$	B1 (M1 on ePen) M1
	$= \left(\text{"}\frac{2^4}{4} + \frac{2^3}{3} - 3(2)^2\text{"}\right) - (0)$	M1 (A1 on ePen)
	$= \pm\frac{16}{3}$ oe	A1 (M1 on ePen)
	$\left(\left[\text{"}\frac{x^4}{4} + \frac{x^3}{3} - 3x^2\text{"}\right]_x^0 = \pm\frac{16}{3} \Rightarrow\right)(0) - \left(\text{"}\frac{x^4}{4} + \frac{x^3}{3} - 3x^2\text{"}\right) = \pm\frac{16}{3}$ oe	M1
	$3x^4 + 4x^3 - 36x^2 + 64 = 0$	A1
	$\left(x - 2\right)^2 (3x^2 + 16x + 16) = 0$ *	A1* cso (7)
ALT	$\int_x^2 (x^3 + x^2 - 6x)\mathrm{d}x = \left[\text{"}\frac{x^4}{4} + \frac{x^3}{3} - 3x^2\text{"}\right]_x^2$	B1 (M1 on ePen) M1
	$= \left(\text{"}\frac{2^4}{4} + \frac{2^3}{3} - 3(2)^2\text{"}\right) - \left(\text{"}\frac{x^4}{4} + \frac{x^3}{3} - 3(x)^2\text{"}\right)$	M1 (A1 on ePen)
	$\pm\left(-\frac{16}{3} - \frac{x^4}{4} - \frac{x^3}{3} + 3x^2\right) = 0$	A1 (M1 on ePen)
	$3x^4 + 4x^3 - 36x^2 + 64 = 0$	M1 A1
	$\left(x - 2\right)^2 (3x^2 + 16x + 16) = 0$ *	A1
c	(When $(x - 2) = 0$ $x = 2$ and when $3x^2 + 16x + 16 = 0$) $(3x + 4)(x + 4) = 0$ so $x = -\frac{4}{3}$ and $x = -4$	M1 A1
	($x \neq -4$ as it is to the left of the point at $x = -3$) $x = -\frac{4}{3}$	M1
	When "$x = -\frac{4}{3}$" $y = \left(\text{"}-\frac{4}{3}\text{"}\right)^3 + \left(\text{"}-\frac{4}{3}\text{"}\right)^2 - 6\left(\text{"}-\frac{4}{3}\text{"}\right) = \frac{200}{27}$	dM1
	So $A = \left(-\frac{4}{3}, \frac{200}{27}\right)$	A1 (5)
		Total 16 marks

Part	Mark	Notes
(a)	B1	$a = 3$
	B1	$c = 16$
	M1	For a clear process to equate coefficients to find either of the equations $b - 4a = 4$ or $4a - 4b + c = -36$ or $4b - 64 = 0$. Allow one error. For algebraic division: there must be a complete attempt to divide by $x^2 + px + q$ and reach an expression of the form $3x^2 + rx + 16,\ p, q, r \neq 0$
	A1	$b = 16$
Full marks may be awarded for all of *a*, *b* and *c* appearing correctly with no method shown. Embedded *a*, *b* and *c* should be awarded full marks.		
(b)	B1 (M1 on ePen)	Correct limits of $x = 0$ and $x = 2$ – or used later in working.
	M1	For a minimally acceptable attempt to integrate any 3 term cubic of the form $x^3 + fx^2 + gx$. Limits do not need to be present. See general guidance for the definition of a minimally acceptable attempt.
	M1 (A1 on ePen)	Substitution of their limits into any changed expression, the correct way round minimum 3 terms. Sub of 0 not needed. Allow this mark to be implied by a fully correct value.
	A1 (M1 on ePen)	Either for a fully correct substitution, or for $\pm\frac{16}{3}$
	M1	For $(0) - \left("\frac{x^4}{4} + \frac{x^3}{3} - 3x^2"\right) = \pm\frac{16}{3}$ oe. Allow use of their integrated expression and their $\pm\frac{16}{3}$ which can be in any equivalent form, including an unevaluated expression. Allow use of *n* rather than *x*. The limit of 0 need not be seen.
	A1	For $3x^4 + 4x^3 - 36x^2 + 64 = 0$ Allow use of *n* rather than *x*. $\frac{16}{3}$ must have been evaluated.
	A1* cso	For $(x-2)^2(3x^2 + 16x + 16) = 0$ .No errors in working. Candidates can use *n* throughout.
ALT	B1 (M1 on ePen)	Correct limits of $x = x$ and $x = 2$ – seen on the integral or used later in working. These can be either way round.
	M1	For a minimally acceptable attempt to integrate any 3 term cubic of the form $x^3 + fx^2 + gx$. Limits do not need to be present. See general guidance for the definition of a minimally acceptable attempt.
	M1 (A1 on ePen)	For substitution of both of their limits into any changed expression. Minimum 3 terms
	A1 (M1 on ePen)	For $\pm\left(-\frac{16}{3} - \frac{x^4}{4} - \frac{x^3}{3} + 3x^2\right) = 0$
	M1	For a valid attempt to multiply their equation throughout to arrive at integer coefficients.
	A1 A1	As main scheme. Candidates can use *n* throughout.
(c)	M1	For a complete and minimally acceptable attempt to solve $3x^2 + 16x + 16 = 0$ to give $x =$ See general guidance for definition of minimally acceptable. Some candidates may have factorised in part b), if used in part c), marks can be awarded
	A1	For $x = -\frac{4}{3}$ and $x = -4$
	M1	Chooses "$x = -\frac{4}{3}$" , can be stated explicitly or used later implicitly. Allow choice of their *x* coordinate for $-3 < x < 0$
	dM1	For substituting $x = "-\frac{4}{3}"$ into $y = x(x+3)(x-2)$ Allow substitution of their *x*, dependent on previous method mark
	A1	$A = \left(-\frac{4}{3}, \frac{200}{27}\right)$ students may list $x = -\frac{4}{3}, y = \frac{200}{27}$

Question number	Scheme	Marks
10 a (i)	$\overrightarrow{OP} = \overrightarrow{OA} + \frac{3}{4}\overrightarrow{AB} = \mathbf{a} + \frac{3}{4}(-\mathbf{a}+\mathbf{b})$ or $\overrightarrow{OB} + \frac{1}{4}\overrightarrow{BA} = \mathbf{b} + \frac{1}{4}(\mathbf{a}-\mathbf{b})$	M1
	$\overrightarrow{OP} = \frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}$	A1
(ii)	$\overrightarrow{MN} = \overrightarrow{MO} + \frac{1}{2}\overrightarrow{OP} = -\frac{1}{2}\mathbf{a} + \frac{1}{2}\left(\text{"}\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}\text{"}\right)$ or $\frac{1}{2}\overrightarrow{AO} + \frac{1}{2}\overrightarrow{OP}$	M1
	$\overrightarrow{MN} = -\frac{3}{8}\mathbf{a} + \frac{3}{8}\mathbf{b}$	A1 (4)
b	$\overrightarrow{OC} = \lambda\mathbf{b}$	B1
	$\overrightarrow{AN} = \left(\overrightarrow{AO} + \overrightarrow{ON}\right) = -\mathbf{a} + \frac{1}{2}\left(\text{"}\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}\text{"}\right) = -\frac{7}{8}\mathbf{a} + \frac{3}{8}\mathbf{b}$ or $\overrightarrow{AN} = \overrightarrow{AP} + \overrightarrow{PN} =$	M1
	$\overrightarrow{OC} = \overrightarrow{OA} + \mu\overrightarrow{AN} = \mathbf{a} + \mu\left(-\mathbf{a} + \frac{1}{2}\left(\text{"}\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}\text{"}\right)\right)$	M1 (A1 on ePen)
	$= \mathbf{a} - \frac{7}{8}\mu\mathbf{a} + \frac{3}{8}\mu\mathbf{b}$ *or* $\left(1 - \frac{7}{8}\mu\right)\mathbf{a} + \frac{3}{8}\mu\mathbf{b}$	A1 (M1 on ePen)
	$\therefore \lambda = \frac{3}{8}\mu$ and $0 = 1 - \frac{7}{8}\mu \Rightarrow \mu = \frac{8}{7}$ $\quad \therefore \lambda = \frac{3}{7}$	M1 (A1 on ePen)
	$\overrightarrow{OC} = \frac{3}{7}\mathbf{b}$	A1 (6)
ALT	$\overrightarrow{AC} = -\mathbf{a} + \lambda\mathbf{b}$	B1
	$\overrightarrow{AN} = \left(\overrightarrow{AO} + \overrightarrow{ON}\right) = -\mathbf{a} + \frac{1}{2}\left(\text{"}\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}\text{"}\right) = -\frac{7}{8}\mathbf{a} + \frac{3}{8}\mathbf{b}$ or $\overrightarrow{AN} = \overrightarrow{AP} + \overrightarrow{PN} =$	M1
	$\overrightarrow{AC} = \mu\overrightarrow{AN} = \mu\left(-\mathbf{a} + \frac{1}{2}\left(\text{"}\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}\text{"}\right)\right)$	M1 (A1 on ePen)
	$= -\frac{7}{8}\mu\mathbf{a} + \frac{3}{8}\mu\mathbf{b}$	A1 (M1 on ePen)
	$\therefore \lambda = \frac{3}{8}\mu$ and $0 = 1 - \frac{7}{8}\mu \Rightarrow \mu = \frac{8}{7}$ $\quad \therefore \lambda = \frac{3}{7}$	M1 (A1 on ePen)
	$\overrightarrow{OC} = \frac{3}{7}\mathbf{b}$	A1 (6)

General principles for marking part (b) – if in any doubt about allocating marks – send to review

B1 Writes a valid vector with a parameter in terms of **a** or **b** which leads to finding $\overrightarrow{OC}$
M1 M1 A1 Writes a second valid vector with a different parameter, in terms of **a** and **b**, following a distinct different route, which leads to finding $\overrightarrow{OC}$
M1 Compares components with two different parameters and arrives at a value for μ or λ
A1 correct vector

c	(Area triangle) $OAP = \frac{3}{4}$ (Area triangle) OAB	B1
	(Area triangle) $OMN = \frac{1}{4}$ (Area triangle) $OAP = \frac{3}{16}$ (Area triangle) OAB	B1
	(Area quadrilateral) $AMNP =$ $\frac{3}{4}$ (Area triangle) $OAB - \frac{3}{16}$ (Area triangle) OAB	M1
	$= \frac{9}{16}$ (Area triangle) $OAB \quad k = \frac{9}{16}$	A1 (4)
ALT	$\frac{(\text{Area triangle})OAP}{(\text{Area triangle})\ OAB} = \frac{3}{4}$	B1
	$\left(\frac{\text{Area triangle } OMN}{\text{Area triangle } OAP} = \frac{1}{4}\right) \Rightarrow \frac{(\text{Area quadrilateral})\ MNAP}{(\text{Area triangle})\ OAP} = \frac{3}{4}$	B1
	$\frac{(\text{Area quadrilateral})MNAP}{(\text{Area triangle})\ OAP} \times \frac{(\text{Area triangle})\ OAP}{(\text{Area triangle})\ OAB} = \frac{3}{4} \times \frac{3}{4}$	M1
	$k = \frac{9}{16}$	A1 (4)
	Total 14 marks	

Part	Marks	Note
(a) (i)	**M1**	For stating **or** using $\overrightarrow{OP} = \overrightarrow{OA} + \frac{3}{4}\overrightarrow{AB}$ or for $\mathbf{a} + \frac{3}{4}(-\mathbf{a}+\mathbf{b})$ or $\overrightarrow{OB} + \frac{1}{4}\overrightarrow{BA}$ or $\mathbf{b} + \frac{1}{4}(\mathbf{a}-\mathbf{b})$ (can be implied by correct vector)
	A1	For $\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}$ or valid alternative form such as $\frac{\mathbf{a}+3\mathbf{b}}{4}$ or $\frac{1}{4}(\mathbf{a}+3\mathbf{b})$
(ii)	**M1**	For stating **or** using $\overrightarrow{MN} = \overrightarrow{MO} + \frac{1}{2}\overrightarrow{OP}$ or $\frac{1}{2}\overrightarrow{AO} + \frac{1}{2}\overrightarrow{OP}$ or $-\frac{1}{2}\mathbf{a} + \frac{1}{2}\left(\text{their } \overrightarrow{OP}\right)$
	A1	$-\frac{3}{8}\mathbf{a} + \frac{3}{8}\mathbf{b}$ or valid alternative form such as $\frac{-3\mathbf{a}+3\mathbf{b}}{8}$ or $\frac{1}{8}(-3\mathbf{a}+3\mathbf{b})$ (can be implied by correct vector)
(b)	**B1**	$\overrightarrow{OC} = \lambda\mathbf{b}$ or any equivalent statement involving a parameter, in terms of **b**.
	M1	A fully correct method to find $\overrightarrow{AN}$ using their $\overrightarrow{OP}$ $\overrightarrow{AN} = -\mathbf{a} + \frac{1}{2}\left(\text{"}\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}\text{"}\right)$
	M1 (A1 on ePen)	**Using** $\overrightarrow{OC} = \overrightarrow{OA} + \mu\left(\text{their } \overrightarrow{AN}\right)$ in terms **a** and **b** $\overrightarrow{OC} = \overrightarrow{OA} + \mu\overrightarrow{AN} = \mathbf{a} + \mu\left(-\mathbf{a} + \frac{1}{2}\left(\text{"}\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}\text{"}\right)\right)$ Simplification not required
	A1 (M1 on ePen)	$= \mathbf{a} - \frac{7}{8}\mu\mathbf{a} + \frac{3}{8}\mu\mathbf{b}$ *or* $\left(1 - \frac{7}{8}\mu\right)\mathbf{a} + \frac{3}{8}\mu\mathbf{b}$ either of these forms, ready for comparing coefficients
	M1 (A1 on ePen)	For correctly equating their components with two different parameters and attempting to solve, reaching values for μ or λ We need to see two equations here, leading to a value for one of the parameters.
	A1	$\overrightarrow{OC} = \frac{3}{7}\mathbf{b}$
ALT	**B1**	$\overrightarrow{AC} = -\mathbf{a} + \lambda\mathbf{b}$ or any equivalent statement involving a parameter, in terms of **a** and **b**.
	M1	A fully correct method to find $\overrightarrow{AN}$ using their $\overrightarrow{OP}$ $\overrightarrow{AN} = -\mathbf{a} + \frac{1}{2}\left(\text{"}\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}\text{"}\right)$
	M1 (A1 on ePen)	$\overrightarrow{AC} = \mu\left(-\mathbf{a} + \frac{1}{2}\left(\text{"}\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}\text{"}\right)\right)$ using their $\overrightarrow{AN}$
	A1 (M1 on ePen)	Correct vector for $\overrightarrow{AC}$
	M1 (A1 on ePen) A1	Marks allocated as main scheme
(c) BOTH SCHEMES	**B1**	Correct statement
	B1	Correct statement
	M1	Uses their statements to carry out a relevant calculation
	A1	Correct value for k

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