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EDEXCEL INTERNATIONAL A LEVEL MATHS: QUESTIONS BY TOPIC

The Binomial Expansion (P2.4)

International A Level Mathematics · P2: Pure Mathematics 2 (WMA12)

20 questions · 134 marks · Mark schemes included

Past papers June 2019 - June 2025 · 1 sub-topic

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HOW TO USE THIS BOOKLET

Questions are grouped by sub-topic and run from the lowest to the highest mark tariff, then oldest paper first.

Click any row below to jump straight to that sub-topic or question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme; < QUESTION brings you back.

A gold bar in the left margin marks exactly where the question sits on the original page.

Diagrams, graphs, grids and tables are printed exactly as they appear in the original papers.

Each question is filed under its main topic; longer questions may also test skills from other topics.

QUESTION	SOURCE	MARKS	PAGE
P2.4a BINOMIAL EXPANSION (POSITIVE INTEGER POWERS)		20 Qs · 134 marks	2
1. Q2	IAL P2 (WMA12) January 2024	3	3
2. Q1	IAL P2 (WMA12) June 2022	4	5
3. Q1	IAL P2 (WMA12) June 2024	5	7
4. Q2	IAL P2 (WMA12) January 2025	5	9
5. Q3	IAL P2 (WMA12) October 2019	6	11
6. Q1	IAL P2 (WMA12) October 2021	6	13
7. Q1	IAL P2 (WMA12) June 2025	6	15
8. Q4	IAL P2 (WMA12) June 2019	7	17
9. Q2	IAL P2 (WMA12) January 2020	7	19
10. Q1	IAL P2 (WMA12) October 2020	7	21
11. Q3	IAL P2 (WMA12) January 2022	7	25
12. Q2	IAL P2 (WMA12) October 2022	7	29
13. Q3	IAL P2 (WMA12) January 2023	7	33
14. Q4	IAL P2 (WMA12) June 2023	7	35
15. Q4	IAL P2 (WMA12) June 2024	7	39
16. Q5	IAL P2 (WMA12) October 2024	7	41
17. Q4	IAL P2 (WMA12) January 2021	8	43
18. Q4	IAL P2 (WMA12) June 2021	8	47
19. Q7	IAL P2 (WMA12) June 2025	8	51
20. Q10	IAL P2 (WMA12) October 2023	12	55



QUESTIONS

20 questions · 134 marks · 1 sub-topic

SUB-TOPIC P2.4a

BINOMIAL EXPANSION (POSITIVE INTEGER POWERS)

Sub-topic P2.4a · 20 questions · 134 marks · lowest tariff first



2. Find the coefficient of the term in x^7 of the binomial expansion of

$$\left(\frac{3}{8} + 4x\right)^{12}$$

giving your answer in simplest form.

(3)



(Total for Question 2 is 3 marks)



1. Find the first four terms, in ascending powers of x , of the binomial expansion of

$$\left(2 + \frac{3}{8}x\right)^{10}$$

Give each coefficient as an integer.

(4)

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Question 1 continued

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(Total 4 marks)

Q1



(Total for Question 1 is 5 marks)



2. (a) Find the first 4 terms, in ascending powers of x , of the binomial expansion of

$$(2 - 5x)^8$$

giving each term in simplest form.

(4)

This expansion is to be used to find an approximation for 2.05^8

- (b) State the value of x that should be used.

(There is no need to carry out this calculation.)

(1)



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3. (a) Find the first 4 terms, in ascending powers of x , in the binomial expansion of

$$\left(1 + \frac{x}{4}\right)^{12}$$

giving each coefficient in its simplest form.

(3)

- (b) Find the term independent of x in the expansion of

$$\left(\frac{x^2 + 8}{x^5}\right)\left(1 + \frac{x}{4}\right)^{12}$$

(3)

Question 3 continued

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Q3

(Total 6 marks)



Question 1 continued

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Q1

(Total 6 marks)



1. (a) Find the first 4 terms, in ascending powers of x , of the binomial expansion of

$$(1 - 4x)^7$$

giving each term in simplest form.

(4)

In the series expansion of

$$(5 + kx)(1 - 4x)^7$$

where k is a constant

the coefficient of the term in x^2 is 1316

- (b) Use the answer to part (a) to find the value of k .

(2)



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4. (a) Find the first four terms, in ascending powers of x , of the binomial expansion of

$$\left(2 - \frac{1}{4}x\right)^6$$

(4)

- (b) Given that x is small, so terms in x^4 and higher powers of x may be ignored, show

$$\left(2 - \frac{1}{4}x\right)^6 + \left(2 + \frac{1}{4}x\right)^6 = a + bx^2$$

where a and b are constants to be found.

(3)



Question 4 continued

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(Total 7 marks)

Q4



Question 2 continued

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Q2

(Total 7 marks)



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1. (a) Find the first 4 terms, in ascending powers of x , of the binomial expansion of

$$\left(2 - \frac{x}{4}\right)^{10}$$

giving each term in its simplest form.

(4)

- (b) Hence find the constant term in the series expansion of

$$\left(3 - \frac{1}{x}\right)^2 \left(2 - \frac{x}{4}\right)^{10}$$

(3)

Question 1 continued

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Question 1 continued

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Question 1 continued

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Q1

(Total 7 marks)



Question 3 continued

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Question 3 continued

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Question 3 continued

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(Total 7 marks)

Q3





Question 2 continued



Question 2 continued

(Total for Question 2 is 7 marks)



Question 3 continued

(Total for Question 3 is 7 marks)



4. The binomial expansion, in ascending powers of x , of

$$(3 + px)^5$$

where p is a constant, can be written in the form

$$A + Bx + Cx^2 + Dx^3 \dots$$

where A , B , C and D are constants.

(a) Find the value of A

(1)

Given that

- $B = 18D$
- $p < 0$

(b) find

(i) the value of p

(ii) the value of C

(6)







(Total for Question 4 is / marks)



4. (a) Find the first 4 terms, in ascending powers of x , of the binomial expansion of

$$(3 + 2x)^6$$

giving each coefficient in simplest form.

(4)

- (b) Hence find the coefficient of x^2 in the expansion of

$$\left(2x^2 - \frac{1}{6x}\right)(3 + 2x)^6$$

(3)

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

$$(2 + ax)^6$$

where a is a non-zero constant. Give each term in simplest form.

(3)

$$f(x) = \left(3 + \frac{1}{x}\right)^2 (2 + ax)^6$$

Given that the constant term in the expansion of $f(x)$ is 576

- (b) find the value of a .

(4)



Question 5 continued

(Total for Question 5 is 7 marks)



Question 4 continued

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Question 4 continued

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Question 4 continued

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Q4

(Total 8 marks)



Question 4 continued

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Question 4 continued

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(Total 8 marks)

Q4

7.

In this question you must show all stages of your working. Solutions relying entirely on calculator technology are not acceptable.

The binomial expansion, in ascending powers of x , of $(1 + kx)^n$ is

$$1 - 24x + 270x^2 + px^3 + \dots$$

where k and p are constants and n is an integer greater than 1

- (a) Use this information to set up and solve two simultaneous equations to find the value of k and the value of n .

(6)

- (b) Hence find the value of p .

(2)







(Total for Question 7 is 6 marks)



Question 10 continued

Question 10 continued

Question 10 continued



Question 10 continued

(Total for Question 10 is 12 marks)

TOTAL FOR PAPER IS 75 MARKS



MARK SCHEMES

official mark schemes, in the same order as the questions



General Principles for Pure Mathematics Marking*(NB specific mark schemes may sometimes override these general principles)***Method mark for solving 3 term quadratic:**

1. Factorisation

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

2. Formula

Attempt to use correct formula (with values for a, b and c)

3. Completing the square

Solving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c$, $q \neq 0$ leading to $x = \dots$ **Method marks for differentiation and integration:**

1. Differentiation

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

2. Integration

Power of at least one term increased by 1 ($x^n \rightarrow x^{n+1}$)**Use of a formula**

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

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Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Answers without working

The rubric says that these may not gain full credit. Individual mark schemes will give details of what happens in particular cases. General policy is that if it could be done "in your head", detailed working would not be required. Most candidates do show working, but there are occasional awkward cases and if the mark scheme does not cover this, please contact your team leader for advice.



General Principles for Pure Mathematics Marking*(But note that specific mark schemes may sometimes override these general principles)***Method mark for solving 3 term quadratic:****1. Factorisation** $(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$, leading to $x = \dots$ $(ax^2 + bx + c) = (mx + p)(nx + q)$, where $|pq| = |c|$ and $|mn| = |a|$, leading to $x = \dots$ **2. Formula**Attempt to use correct formula (with values for a , b and c).**3. Completing the square**Solving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c$, $q \neq 0$, leading to $x = \dots$ **Method marks for differentiation and integration:****1. Differentiation**Power of at least one term decreased by 1. ($x^n \rightarrow x^{n-1}$)**2. Integration**Power of at least one term increased by 1. ($x^n \rightarrow x^{n+1}$)**Use of a formula**

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Method mark for solving 3 term quadratic:

1. Factorisation

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

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

2. Formula

Attempt to use correct formula (with values for a, b and c)

3. Completing the square

Solving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c$, $q \neq 0$ leading to $x = \dots$

Method marks for differentiation and integration:

1. Differentiation

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

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Question Number	Scheme	Marks
1 (a)	$254 = 2 + 3(n-1) \Rightarrow n = \dots$	M1
	85	A1
		(2)
(b)	$\frac{"85"}{2}(2 \times 2 + ("85"-1) \times 3)$	M1
	10 880	A1
		(2)
		4 marks

(a)

M1: Attempts to find the number of terms.

Look for $254 = 2 + 3(n-1) \Rightarrow n = \dots$, $3n-1 = 254 \Rightarrow n = \dots$ or $\left(\frac{254-2}{3}\right) + 1$ o.e. condoning slips such as writing 254 as 245. The values of a and d must be correct.

Sight of either $\frac{254-2}{3}$, $\frac{252}{3}$ or 84 without any incorrect working can score this mark.

Note that $\frac{254}{3} = 84$ or similar calculations that give non-integer solutions (with no further working e.g. trial and error attempts) score M0 even if rounded

A1: 85.

An answer of 85 **with no incorrect working** or without any working scores both marks

.....
Alt (a) Trial and error attempts

You may see candidates using $2 + (n-1) \times 3$ with various values for n

M1: Attempts $2 + (n-1) \times 3$ with $n = 85$ A1: Achieves $2 + 84 \times 3 = 254$ **and** concludes 85 (terms)

.....
(b)

M1: Attempts the sum formula $\frac{n}{2}(2a + (n-1)d)$ or $\frac{n}{2}(a + l)$ following through on their value for n .

Look for $\frac{"85"}{2}(2 \times 2 + ("85"-1) \times 3)$, $\frac{"85"}{2}(2 \times 254 + ("85"-1) \times -3)$ or $\frac{"85"}{2}(2 + 254)$

The values of a , d and l if used must be correct (condoning a slip such as 245 for 254) but follow through on their value of n from part (a)

A1: 10 880.

This may be awarded even following an 85 in (a) that was found using an incorrect method

10 880 without working or following listing scores both marks.

Listing leading to an incorrect answer scores M0 A0



Question Number	Scheme	Marks
2 (a)	$(2-5x)^8 = 2^8 + {}^8C_1(2)^7(-5x)^1 + {}^8C_2(2)^6(-5x)^2 + {}^8C_3(2)^5(-5x)^3 + \dots$ Constant term 2^8 OR 256 Correct form for terms 3 or 4: ${}^8C_2(2)^6(\pm 5x)^2$ or ${}^8C_3(2)^5(\pm 5x)^3$ Correct un-simplified expansion for 2 out of 3 terms from terms 2, 3 and 4: $\dots + 8(2)^7(-5x)^1 + 28(2)^6(-5x)^2 + 56(2)^5(-5x)^3 + \dots$ Correct simplified expansion $256 - 5120x + 44800x^2 - 224000x^3 + \dots$	B1 M1 A1 A1 (4)
(b)	-0.01	B1 (1) (5 marks)

(a)

 B1: Correct constant term, 2^8 OR 256. It must be on its own and not as ${}^8C_8 2^8$ for example

M1: Correct form for term 3 or term 4. Allow with C notation (o.e).

Examples of correct forms include:

 For term three ${}^8C_2(2)^6 \times (-5x)^2$ and $28 \times 64 \times \pm 25x^2$

 For term four $\binom{8}{3} \times (2)^5 \times -125x^3$ and $\pm 224000x^3$

 Condone a missing sign or bracket. So, allow terms such as ${}^8C_2(2)^6 \times 5x^2$ and $56 \times (2)^5 \times 125x^3$

 Look for the correct binomial coefficient, the correct power of 2 and the correct power of x on $5x$

A1: Two out of three correct un-simplified (or simplified) terms from terms 2, 3 or 4

 $\dots + 8(2)^7(-5x)^1 + 28(2)^6(\pm 5x)^2 + 56(2)^5(-5x)^3 + \dots$

The binomial coefficient must now be numerical.

 A1: $256 - 5120x + 44800x^2 - 224000x^3 + \dots$ which must be in simplest form.

 Accept $256 + -5120x + 44800x^2 - 224000x^3 + \dots$ or a list $256, -5120x, 44800x^2, -224000x^3$.

 Withhold this mark if they decide to divide by 4 for example, but condone the sight of extra terms, for example in x^4 or higher.

(b)

 B1: -0.01 o.e. such as $-\frac{1}{100}$. This must be clearly stated and not embedded in the $(2-5x)^8$

Ignore any attempts to calculate the result

Alt to (a) via a common factor

B1: Takes out a common factor of 2, scored for $2^8(1 \pm kx)^8$

M1: Correct "form" for terms 3 or 4 in expansion of $\left(1 - \frac{5}{2}x\right)^8$. Look for $\frac{8 \times 7}{2} \left(\pm \frac{5}{2}x\right)^2$ or $\frac{8 \times 7 \times 6}{3!} \left(\pm \frac{5}{2}x\right)^3$

As with the main method, condone missing brackets etc. Condone with C notation as in main scheme.

A1: Correct simplified or unsimplified expansion of $\left(1 - \frac{5}{2}x\right)^8$ FYI it is $1 - 20x + 175x^2 - 875x^3 + \dots$

A1: $256 - 5120x + 44800x^2 - 224000x^3 + \dots$. Accept as a list.



General Principles for Core Mathematics Marking

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

Method mark for solving 3 term quadratic:1. Factorisation

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2. Formula

Attempt to use correct formula (with values for a , b and c).

3. Completing the square

Solving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c$, $q \neq 0$, leading to $x = \dots$

Method marks for differentiation and integration:1. Differentiation

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Use of a formula

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Question Number	Scheme	Marks
1 (a)	$y = 2x^2(x-5) = 2x^3 - 10x^2$ $\frac{dy}{dx} = 6x^2 - 20x$ Sets $\frac{dy}{dx} = 0 \Rightarrow 6x^2 - 20x = 0 \Rightarrow x = 0, \frac{10}{3}$ oe	B1 M1 dM1 A1 (4)
(b)	$x \leq 0, \quad x \geq \frac{10}{3}$	M1 A1 (2) (6 marks)
Alt (a)	$\left(\frac{d(uv)}{dx} = uv' + vu' \right) \quad u = 2x^2, u' = 4x, v = x-5, v' = 1$ $\left(\frac{dy}{dx} = \right) Ax(x-5) + Bx^2$ Sets $\frac{dy}{dx} = 0 \Rightarrow 4x(x-5) + 2x^2 = 0 \Rightarrow x = 0, \frac{10}{3}$	B1 M1 dM1 A1

(a)

B1 Expands to a correct form ($y =$) $2x^2(x-5) = 2x^3 - 10x^2$ (may be implied by sight of $\frac{dy}{dx} = 6x^2 - 20x$)If a candidate uses the product rule then award this mark for correct terms for u , u' , v and v' stated or implied.

M1 Differentiated reducing a power by one on one of their terms.

If a candidate uses the product rule then look for $\left(\frac{dy}{dx} = \right) Ax(x-5) + Bx^2$. (Do not award for just differentiating the factor in front of the bracket and the $x-5$)dM1 $\frac{dy}{dx} = 0$ and solves a quadratic equation to find at least one solution. (Usual rules for solving a quadratic). Values such as 0 and 3.33 to imply this mark.It is dependent on the previous method mark. Dividing by x to find one of the solutions is also acceptable for this mark.

Allow answers to be just written down but you may need to check these on your calculator.



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Question Number	Scheme	Marks
2.(a)	Attempts $(x \pm 2)^2 + (y \pm 5)^2 \dots = 0$ (i) Centre $(-2, 5)$ (ii) Radius $\sqrt{50}$ or $5\sqrt{2}$	M1 A1 B1 (3)
(b)	Gradient of radius $= \frac{(5)-4}{(-2)-5} = -\frac{1}{7}$ which needs to be in simplest form Uses $m_2 = -\frac{1}{m_1}$ to find gradient of tangent Equation of tangent $y - 4 = -\frac{1}{7}(x - 5) \Rightarrow y = -\frac{1}{7}x + \frac{29}{7}$	B1ft M1 M1 A1 (4) (7 marks)
Notes		
(a) Note that the open set up here is M1 M1 B1		
M1	Attempts to complete the square on both terms or states the centre as $(\pm 2, \pm 5)$ For completing the square look for $(x \pm 2)^2 + (y \pm 5)^2 \dots = \dots$	
A1	Centre $(-2, 5)$ Allow $x = -2, y = 5$ This alone can score both marks even following incorrect lines eg $(x + 2)^2 + (y - 5)^2 = \dots$ where $\dots$ could be $+$, for example a minus sign or blank	
A1	Radius $\sqrt{50}$ or $5\sqrt{2}$ You may award after a correct answer.	
If a candidate attempts to use $x^2 + y^2 + 2fx + 2gy + c = 0$ then M1 may be awarded for a centre of $(\pm 2, \pm 5)$		
(b) Note that the open set up here is M1 M1 M1 A1		
B1ft	Correct answer for the gradient of the line joining $P(5, 4)$ to their centre. You may award on their centre but the value must be fully simplified.	
M1	Awarded for using $m_2 = -\frac{1}{m_1}$ to find gradient of tangent. Do be aware that some good candidates may do the first two marks at once so you may need to look at what value they are using for the gradient of the tangent.	
M1	For an attempt to find the equation of the tangent using $P(5, 4)$ and a changed gradient. Condone bracketing slips only. If the candidate uses the form $y = mx + c$ they must use x and y the correct way around and proceed as far as $c = \dots$	
A1	$y = -\frac{1}{7}x + \frac{29}{7}$ stated. It must be written in this form. (It cannot be awarded from $y = mx + c$ by just stating $c = -31$)	
.....		
Attempts at (b) using differentiation.		
B1	$x^2 + y^2 + 4x - 10y - 21 = 0 \rightarrow 2x + 2y \frac{dy}{dx} + 4 - 10 \frac{dy}{dx} = 0$	
M1	Substitutes $P(5, 4)$ into an expression of the form $ax + by \frac{dy}{dx} + c + d \frac{dy}{dx} = 0$ AND finds the value of $\frac{dy}{dx} = (7)$. The values of a, b, c and d must be non-zero.	

General Principles for Core Mathematics Marking

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

Method mark for solving 3 term quadratic:1. Factorisation

$$(x^2 + bx + c) = (x + p)(x + q), \text{ where } |pq| = |c|, \text{ leading to } x = \dots$$

$$(ax^2 + bx + c) = (mx + p)(nx + q), \text{ where } |pq| = |c| \text{ and } |mn| = |a|, \text{ leading to } x = \dots$$

2. Formula

Attempt to use the correct formula (with values for a , b and c).

3. Completing the square

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

Method marks for differentiation and integration:1. Differentiation

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

2. Integration

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

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

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

Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Answers without working

The rubric says that these may not gain full credit. Individual mark schemes will give details of what happens in particular cases. General policy is that if it could be done "in your head", detailed working would not be required. Most candidates do show working, but there are occasional awkward cases and if the mark scheme does not cover this, please contact your team leader for advice.



General Principles for Core Mathematics Marking

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

Method mark for solving 3 term quadratic:

1. Factorisation

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

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

2. Formula

Attempt to use correct formula (with values for a , b and c).

3. Completing the square

Solving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c$, $q \neq 0$, leading to $x = \dots$

Method marks for differentiation and integration:

1. Differentiation

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

2. Integration

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

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The rubric says that these may not gain full credit. Individual mark schemes will give details of what happens in particular cases. General policy is that if it could be done "in your head", detailed working would not be required. Most candidates do show working, but there are occasional awkward cases and if the mark scheme does not cover this, please contact your team leader for advice.



General Principles for Core Mathematics Marking

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

Method mark for solving 3 term quadratic:

1. Factorisation

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

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

2. Formula

Attempt to use correct formula (with values for a , b and c).

3. Completing the square

Solving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c$, $q \neq 0$, leading to $x = \dots$

Method marks for differentiation and integration:

1. Differentiation

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

2. Integration

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

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

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

Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Answers without working

The rubric says that these may not gain full credit. Individual mark schemes will give details of what happens in particular cases. General policy is that if it could be done "in your head", detailed working would not be required. Most candidates do show working, but there are occasional awkward cases and if the mark scheme does not cover this, please contact your team leader for advice

Question Number	Scheme	Notes	Marks
1(a)	$h = 0.5$	Correct strip width	B1
	$A \approx \frac{1}{2} \times \frac{1}{2} \{6.792 + 5.113 + 2(6.298 + 5.858 + 5.466)\}$ Correct application of the trapezium rule with their h		M1
	$= 11.79$	Cao	A1
			(3)
(b)(i)	$A \approx 2 \times "11.79"$	Multiplies their answer to (a) by 2	M1
	$= 23.58$	Correct answer or correct ft	A1ft
(b)(ii)	$A \approx "11.79" + 6$	Adds 6 to their answer to (a)	M1
	$= 17.79$	Correct answer or correct ft	A1ft
			(4)
			Total 7

Notes:**(a)**

B1: Correct value for h stated or implied by $\frac{1}{4}\{\dots\}$

M1: Attempts the trapezium rule with their h . Must include the $\frac{1}{2} \times "h"$ but this may be implied by any multiple of the bracket if h is not identified separately. Must have the correct inner bracket structure, though allow if all that is wrong is a miscopy of numerals. May be written as separate trapezia.

Bracketing error $\frac{1}{4}(6.792 + 5.113) + 2(6.298 + 5.858 + 5.466)$ is M0 unless recovered by their answer.

A1: cao 11.79. Must be to 2 d.p. (Note the actual value is 11.78 to 2 d.p. and score no marks if just this is seen)

(b)(i)

M1: For twice their answer to (a), allowing for rounding. No need to carry out the doubling, sight of $2 \times "their (a)"$ is sufficient.

A1ft: For 23.58 or awrt 23.57 following a correct part (a) rounded or truncated to 11.78 (if they use more than 2 d.p. then 23.5745 is the value they should get) **or** follow through their answer to (a) using the same principle. May be given to more than 2 d.p. and isw. (Allow answer to less than 2 d.p. if just trailing zeros are omitted.)

Note: accurate answer is 23.56 to 2 d.p., which is M0A0 if no method is shown.

(ii)

M1: For 6+ their (a) stated or implied (but see note). The 6 need not be simplified if evaluated from an integral (but the integral and substitution must be correct giving an evaluation that simplifies to 6).

A1ft: 17.79 or follow through their answer to (a) + 6 evaluated. May be given to more than 2 d.p. and isw

Note: accurate answer is 17.78 to 2 d.p., which is M0A0 if no method is shown.

Note: Repeated trapezium rule is M0 in (b).



General Principles for Pure Mathematics Marking*(But note that specific mark schemes may sometimes override these general principles)***Method mark for solving 3 term quadratic:**1. Factorisation $(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$, leading to $x = \dots$ $(ax^2 + bx + c) = (mx + p)(nx + q)$, where $|pq| = |c|$ and $|mn| = |a|$, leading to $x = \dots$ 2. FormulaAttempt to use correct formula (with values for a , b and c).3. Completing the squareSolving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c$, $q \neq 0$, leading to $x = \dots$ **Method marks for differentiation and integration:**1. DifferentiationPower of at least one term decreased by 1. ($x^n \rightarrow x^{n-1}$)2. IntegrationPower of at least one term increased by 1. ($x^n \rightarrow x^{n+1}$)**Use of a formula**

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

Method mark for quoting a correct formula and attempting to use it, even if there are small mistakes in the substitution of values.Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.**Exact answers**Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.**Answers without working**The rubric says that these may not gain full credit. Individual mark schemes will give details of what happens in particular cases. General policy is that if it could be done "in your head", detailed working would not be required. Most candidates do show working, but there are occasional awkward cases and if the mark scheme does not cover this, please contact your team leader for advice.

Examples:

e.g. $6x^2 + 6x\left(\frac{324}{x^2}\right) + 2x\left(\frac{324}{x^2}\right)$ scores B1M1A0

e.g. $6x^2 + 8x\left(\frac{972}{3x^2}\right) \Rightarrow S = 6x^2 + \frac{2592}{x}$ scores B1M1A0 (does not write a separate equation for the volume)

e.g. $3x^2h = 972 \Rightarrow S = 6x^2 + 6x\left(\frac{324}{x^2}\right) + 2x\left(\frac{324}{x^2}\right)$
 $= 6x^2 + \frac{2592}{x}$

scores B1M1A1 (separate equation for the volume, a substitution before seeing the $\frac{2592}{x}$ term and $S =$ seen in their solution at some point.

(b) Mark (b), (c), (d) and (e) altogether

B1 $\left(\frac{dS}{dx} = \right) 12x - \frac{2592}{x^2}$ in any form eg $12x - 2592x^{-2}$

(c)

M1 Starts from a derivative of the form $Ax - Bx^{-2}$ oe, sets equal to 0 (seen or implied) where $A \times B > 0$, and solves via a correct method to find an expression or value for $x = \sqrt[3]{\frac{B}{A}}$ (you may need to check this)

$\sqrt[3]{\frac{2592}{12}}$ scores M1.

Stating 6 without a **correct derivative from (b)** is M0.

M1 6 cao with no incorrect working seen in their method. Withhold this mark if ± 6 seen

Minimum acceptable for full marks is $12x - \frac{2592}{x^2} = 0 \Rightarrow x = 6$

Note this final mark is only possible from a correct derivative

(Beware of incorrect derivatives leading to the correct value of x e.g. $6x - \frac{1296}{x^2} = 0 \Rightarrow x = 6$)

(d)

B1ft Correct second derivative. Follow through their first derivative of the form $Ax - Bx^{-2}$ so award for $A + \frac{2B}{x^3}$ or equivalent.

B1 Fully correct justification with a conclusion (or preamble with eg tick/QED etc) following fully correct work to find $\frac{d^2S}{dx^2}$. They must either:

- substitute $x = 6$ into $12 + \frac{5184}{x^3}$ (if evaluated achieving 36) and state e.g. $(36) > 0$ oe **hence minimum**



- justify that as $x > 0$ or $x = 6$ then $12 + \frac{5184}{x^3} > 0$ (or $\frac{d^2S}{dx^2} > 0$) **hence minimum.**

Note this final mark is only possible if $x = 6$ is found correctly in (c) from a correct derivative.

(e)

B1 648 cm² (condone lack of units/incorrect units) provided this has come from $x = 6$
Note e.g. $x = -12$ leading to 648 is B0



Question Number	Scheme	Marks
3(a)	$\left(2 + \frac{kx}{8}\right)^7 = 2^7 + \binom{7}{1} 2^6 \left(\frac{kx}{8}\right) + \binom{7}{2} 2^5 \left(\frac{kx}{8}\right)^2 + \binom{7}{3} 2^4 \left(\frac{kx}{8}\right)^3 + \dots$	M1
	$= 128 + 56kx + \frac{21}{2}k^2x^2 + \frac{35}{32}k^3x^3 + \dots$	B1A1A1
		(4)
(b)	$\frac{35}{32}k^3 - \frac{21}{2}k^2 = \frac{21}{2}k^2 - 56k$	M1
	$5k^2 - 96k + 256 = 0 \Rightarrow k = \dots$	dM1
	$k = 16, \frac{16}{5}$	A1
		(3)
		Total 7

(a)

M1 Attempts the binomial expansion **up to at least the third term** with an acceptable structure for either the **3rd or 4th term**. The correct binomial coefficient (allowing alternative notation) must be combined with the correct power of x and the correct power of 2 (oe) but condone if brackets are missing. Condone errors on the first or second term.

M0 for descending powers.

Alternatively writes e.g. $\left(2 + \frac{kx}{8}\right)^7 = 2^7 \left(1 + \frac{kx}{16}\right)^7 = 2^7 \left(1 + \frac{7}{16}kx + \frac{7 \times 6}{2} \left(\frac{kx}{16}\right)^2 + \frac{7 \times 6 \times 5}{6} \left(\frac{kx}{16}\right)^3\right)$ which

can also score M1 for the expansion up to at least the third term with an acceptable structure for either the **3rd or 4th term**. They do not have to multiply out the brackets for this mark but the 2^7 cannot be omitted unless it is later recovered. Condone errors on the first or second term.

Condone missing brackets.

B1 $128 + 56kx$. May be listed but must be simplified. Allow $128\left(1 + \frac{7}{16}kx + \dots\right)$ if the 2^7 is taken out first.

A1 $\frac{21}{2}k^2x^2$ or $\frac{35}{32}k^3x^3$. May be listed, **does not need to be simplified**, but the binomial coefficients must be numerical. Accept $\frac{21}{2}(kx)^2$ or $\frac{35}{32}(kx)^3$ oe e.g. $10.5(kx)^2$ or $1.09375(kx)^3$ for this mark only. Common acceptable terms seen are $\frac{672}{64}(kx)^2$, $\frac{560}{512}(kx)^3$

A1 $\frac{21}{2}k^2x^2$ and $\frac{35}{32}k^3x^3$ or exact simplified equivalent e.g. $10.5k^2x^2$ and $1.09375k^3x^3$. May be listed but must have $k^n x^n$ terms.

Note: isw after correct terms are seen if they try to divide or multiply through or set = 0

(b)

M1 Uses the given information to usually form a cubic equation in k only (or quadratic if they have cancelled a k from each term) using their coefficients from (a) in the correct positions.

e.g. $\frac{35}{32}k^3 - \frac{21}{2}k^2 = \frac{21}{2}k^2 - 56k$ or $\frac{35}{32}k^3 + 56k = 2\frac{21}{2}k^2$

Implied by $5k^2 - 96k + 256 = 0$ or equivalent. (The $= 0$ may be implied by later work)

e.g. $35k^2 - 672k + 1792 = 0$ or $\frac{35}{32}k^2 - 21k + 56 = 0$

Their equation should be able to be simplified to a 3TQ=0

Condone coefficients appearing as rounded decimals.

dM1 Achieves a 3 term cubic or a 3 term quadratic and solves (which may be directly via a calculator) to find a value of k (which may be unsimplified). Usual rules apply for solving a quadratic. Do not be concerned by their rearrangement and the $= 0$ may be implied.

Only allow real solutions.

It is dependent on the first method mark.

A1 16, $\frac{16}{5}$ oe If $k = 0$ is stated then it must be rejected.

Do not isw if they proceed to a range of values e.g. $\frac{16}{5} < k < 16$



Question Number	Scheme	Marks
2a	$\left(f\left(\frac{3}{2}\right)\right) = 4\left(\frac{3}{2}\right)^3 - 8\left(\frac{3}{2}\right)^2 + 5\left(\frac{3}{2}\right) + a = 0 \Rightarrow a = \dots$	M1
	$\Rightarrow \frac{27}{2} - 18 + \frac{15}{2} + a = 0 \Rightarrow a = -3 \quad *$	A1*
		(2)
b	Example where $2x - 3$ is a linear factor: $\begin{array}{r} 2x^2 - x + 1 \\ 2x - 3 \overline{) 4x^3 - 8x^2 + 5x - 3} \\ \underline{4x^3 - 6x^2} \\ -2x^2 + 5x \\ \underline{-2x^2 + 3x} \\ +2x - 3 \\ \underline{+2x - 3} \\ 0 \end{array}$	M1A1
	$(-1)^2 - 4 \times 2 \times 1 = -7 < 0 \Rightarrow \text{no real roots so } x = \frac{3}{2} \text{ is the only one real root } *$	dM1A1*
		(4)
		(6 marks)

(a)

M1 Substitutes $x = \frac{3}{2}$ into the expression, sets equal to 0 (may be implied for this mark) and rearranges to find a . Condone invisible brackets for this mark only and condone arithmetical slips in their working.

Substituting $x = -\frac{3}{2}$ is M0 and attempts via long division score M0.

A1* $a = -3$ achieved with no errors seen including the omission of brackets.

There must be sight of $x = \frac{3}{2}$ which may be embedded in the expression or $f\left(\frac{3}{2}\right)$ followed

by at least one intermediate stage of working/manipulation (it may just be the left hand side of the equation), before proceeding to the given answer. The " $= 0$ " must be seen somewhere in their working before the given answer.

e.g.

$$4\left(\frac{3}{2}\right)^3 - 8\left(\frac{3}{2}\right)^2 + 5\left(\frac{3}{2}\right) + a = 0 \Rightarrow a = -3 \text{ is M1A0}$$

$$f\left(\frac{3}{2}\right) = \frac{27}{2} - 18 + \frac{15}{2} + a = 0 \Rightarrow a = -3 \text{ is M1A1}$$

Note the trivial case $f\left(\frac{3}{2}\right) = 3 + a = 0 \Rightarrow a = -3$ is M1A0 (not enough shown)

(b) Work done in (a) must be made use of in (b) to gain credit.

M1 Attempts to find a quadratic factor of $4x^3 - 8x^2 + 5x - 3$ using $2x - 3$ as a factor

- score for $2x^2 \pm x \pm \dots$ if algebraic division is used or
- score for $2x^2 \pm \dots x \pm 1$ if equating coefficients/inspection used.



Question Number	Scheme	Marks
1 (a)	Attempts $u_3 = 3u_2 - 2u_1 \Rightarrow 4 = 3u_2 - 2 \times 7 \Rightarrow u_2 = \dots$	M1
	$\Rightarrow u_2 = 6$	A1
		(2)
(b)	Attempts $u_4 = 3u_3 - 2u_2 = 3 \times 4 - 2 \times "6" = (0)$	M1
	$\sum_{r=1}^4 (u_r + 2r) = (7 + 2 \times 1) + ("6" + 2 \times 2) + (4 + 2 \times 3) + ("0" + 2 \times 4)$	dM1
	$= 37$	A1
		(3)
		Total 5

(a)

M1: Attempts to use the iteration formula to find u_2 Look for a correct NUMERICAL equation $4 = 3u_2 - 2 \times 7$ o.e. leading to a value for u_2 .It can be implied by sight of $u_2 = 6$

There have been some longer methods seen.

E.g. $u_4 = 12 - 2u_2$ and $u_3 = 3u_2 - 14$ combined by using $12 - 2u_2 = 3(3u_2 - 14) - 2u_2$ The mark is not scored until a value of u_2 is found from a correct NUMERICAL equationA1: $u_2 = 6$. You don't need to see the LHS but if they state $u_3 = 6$ it is A0

6 on its own without any incorrect working scores both marks.

Do not accept partially complete answers such as $\frac{18}{3}$

(b)

M1: Attempts to use the iteration formula to find u_4 . This may be embedded within a sumLook for $u_4 = 3u_3 - 2u_2 = 3 \times 4 - 2 \times "6"$. If (a) is correct, score for sight of $u_4 = 0$ dM1: Full attempt to find $\sum_{r=1}^4 (u_r + 2r)$ Look for $\sum_{r=1}^4 u_r + \sum_{r=1}^4 2r = (7 + (a) + 4 + (3 \times 4 - 2 \times "6")) + (2 + 4 + 6 + 8) =$ Alternatively, you may score for an attempt to find $(7 + 2) + ((a) + 4) + (4 + 6) + (3 \times 4 - 2 \times "6" + 8)$

A1: 37



Question Number	Scheme	Marks
2 (a)	Strip width = 1.5	B1
	$\frac{3}{4}\{4.16 + 2.28 + 2 \times (2.91 + a + 1.73 + 1.37 + 1.43)\} = 19.3 \Rightarrow a = \dots$	M1
	$a = \text{awrt } 2.21$	A1
		(3)
(b)	$\int_{-4}^5 (2f(x) - 3)dx = 2 \times 19.3 - [3x]_{-4}^5$	M1
	$= 11.6$	A1
		(2)
		Total 5

(a)

B1: Correct strip width. Allow for $h = 1.5$. It is implied by sight of $\frac{1.5}{2}\{\dots\dots\dots\}$ o.e.

Note that $h = -1.5$ is B0 unless recovered later in the working.

M1: 'Correct' attempt at the trapezium rule leading to a value for a .

Look for $\frac{3}{4}\{4.16 + 2.28 + 2 \times (2.91 + a + 1.73 + 1.37 + 1.43)\} = 19.3$ leading to a value for a

Condone a missing trailing bracket.

Condone $\dots\{4.16 + 2.28 + 2 \times (2.91 + a + 1.73 + 1.37 + 1.43)\} = 19.3$ leading to a value for a if $\frac{3}{4}$ not

seen.

Award for the sum of separate trapezia leading to a value for a

You do not need to check their calculation but it must lead to a value for a

A1: $a = \text{awrt } 2.21$.

It is acceptable for the candidate to be working in fractions. Score for $\frac{331}{150}$ or $2\frac{31}{150}$.

ISW after a correct answer.

(b) Answers resulting from attempts at the trapezium rule score M0 A0

M1: Attempts to find $\int_{-4}^5 (2f(x) - 3)dx$ but condone $\int_{-4}^5 (2f(x) \pm 3)dx$

Look for $2 \times 19.3 \pm [3x]_{-4}^5$, $2 \times 19.3 \pm 3 \times 9$ or $2 \times 19.3 \pm 27$ o.e.

If $2 \times 19.3 - [3x]_{-4}^5$ is not seen, look for 2×19.3 combined with a ± 15 **and** a ± 12

So each of $2 \times 19.3 - 15 + 12$, $2 \times 19.3 - ((15) - (12))$, $2 \times 19.3 - (15 + 12)$ and $2 \times 19.3 + 15 - 12$ are M1

Candidates who attempt $2 \times '2.21' - [3x]_{-4}^5$ scores M0 as it uses the value of a

Candidates who attempt $2 \times 19.3 - 3$ scores M0 as no integration of the 3 was attempted (unless you see sight of a ± 15 **and** a ± 12 before the 3 was reached)

A1: 11.6 The answer with no incorrect working can score both marks

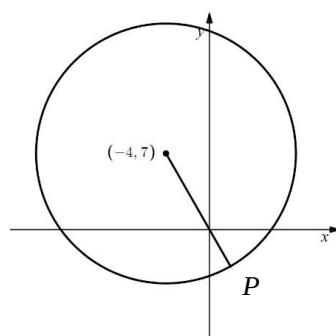


Question Number	Scheme	Marks
3(a)	Attempts to complete the square for both variables $(x+4)^2, (y-7)^2$	M1
	Centre $(-4, 7)$	A1
	Radius = 12	A1
		(3)
(b)	Attempts $\pm \left(12 - \sqrt{4^2 + 7^2} \right)$	M1
	$12 - \sqrt{65}$	A1 ft
		(2)
		Total 5

(a)

M1: Attempts to complete the square for **both** variables. Score for sight of $(x+4)^2 \dots (y-7)^2$ Condone $(x \pm 4)^2, (y \pm 7)^2$ or even with a negative between. It is implied by a centre of $(\pm 4, \pm 7)$ A1: Centre $(-4, 7)$ A1: Radius = 12. May be awarded following a centre of $(\pm 4, \pm 7)$

(b)

M1: Attempts $\pm \left(12 - \sqrt{4^2 + 7^2} \right)$ which may be in decimals. Look for $\pm(12 - 8.06)$ or ± 3.94 following a correct (a)Must be an attempt at subtraction of "12" and $\sqrt{4^2 + 7^2}$ either way around and not additionA1ft: $12 - \sqrt{65}$ but ft on their $12 - \sqrt{65}$ which must be exact and positive. ISW if followed by the decimal answerAlt (b): You may see various attempts using the intersection of their $y = -\frac{7}{4}x$ and the equation of the circle.

The method mark is scored when the equations are solved to find coordinates for P followed by the calculation of distance OP.

M1: Equates their $y = -\frac{7}{4}x$ (must agree with their centre) with either the original equation or their

adapted equation to set up a 3 term quadratic equation in either x or y. This must be solved by an appropriate method which includes use of calculator (you may need to check if just answers are given). Once a value of x and y have been found, score for the use of Pythagoras' theorem (e.g.

 $\sqrt{x^2 + y^2}$) to find the length. It is highly unlikely that an exact answer could be found via this route.

Question Number	Scheme	Marks
4 (a)	$(3+2x)^6$ First term 3^6 or 729 Term in x , x^2 or x^3 : Award for one of ${}^6C_5(3)^5(2x)^1$, ${}^6C_4(3)^4(2x)^2$ or ${}^6C_3(3)^3(2x)^3$ Two of $\dots + 2916x + 4860x^2 + 4320x^3 + \dots$ $(3+2x)^6 = 729 + 2916x + 4860x^2 + 4320x^3 + \dots$	B1 M1 A1 A1
		(4)
(b)	Attempts one correct term $2x^2 \times "729" \text{ or } \pm \frac{1}{6x} \times "4320" x^3$ Attempts to combine the correct two terms $2x^2 \times "729" \pm \frac{1}{6x} \times "4320" x^3 = \dots x^2$ 738 but condone $738x^2$	M1 dM1 A1
		(3)
		Total 7

(a)

B1: Correct first term 3^6 or 729 which must be seen in part (a)

M1: Correct attempt at term 2, 3 or 4. Condone a missing bracket.

Look for the correct binomial coefficient (C notation or bracket form), the correct power of 3 and the correct power of x .So condone attempts such as ${}^6C_4(3)^4 2x^2$ and even ${}^6C_3(3)^3 x^3$

If there isn't an intermediate form given, then the mark is awarded for a correct term 2, 3 or 4.

A1: Two correct and simplified of $\dots + 2916x + 4860x^2 + 4320x^3 + \dots$ A1: $(3+2x)^6 = 729 + 2916x + 4860x^2 + 4320x^3 + \dots$. Allow this to be given/written as a list.

ISW after a correct answer

(b)

M1: Attempts one of the two terms (or one of the two coefficients required to find the coefficient of x^2).Look for $2x^2 \times "729" \text{ or } \pm \frac{1}{6x} \times "4320" x^3$ which may be seen amongst a larger list or sum of terms.Condone slips, e.g 729 written as 792 but the 2 and/or the $\frac{1}{6}$ must be used correctly.dM1: Attempts the term in x^2 or the coefficient in x^2 using a correct combination of terms.Look for $2x^2 \times "729" \pm \frac{1}{6x} \times "4320" x^3$ leading to a single term in x^2 or the combined coefficient of x^2 A1: 738 but condone $738x^2$.

Alt (a) via removal of common factor:

$$(3+2x)^6 = 3^6 \left(1 + \frac{2}{3}x \right)^6 = 3^6 \left(1 + 6 \times \frac{2}{3}x + \frac{6 \times 5}{2} \times \left(\frac{2}{3}x \right)^2 + \frac{6 \times 5 \times 4}{6} \times \left(\frac{2}{3}x \right)^3 + \dots \right)$$

B1: Correct first term 3^6 or 729 implied by $3^6 (1 + \dots x + \dots)$

M1: Correct attempt at term 2, 3 or 4.

Look for a correct binomial coefficient and a correct power of $\frac{2}{3}x$.

See main scheme regarding what you can condone.

A1: Two correct and simplified of $\dots + 2916x + 4860x^2 + 4320x^3 + \dots$

A1: $(3+2x)^6 = 729 + 2916x + 4860x^2 + 4320x^3 + \dots$. Allow as a list



(b)**M1:** Attempts their answer to (a) + $\left[\dots x^2 \right]_{0.5}^{5.5} =$ their answer to (a) + $\dots 5.5^2 - \dots 0.5^2$ May be implied by e.g. their answer to (a) + $2 \times 5.5^2 - 2 \times 0.5^2$ if the integration is not seen explicitly.

Or

their answer to (a) + $\frac{1}{2}(4 \times 0.5 + 4 \times 5.5) \times 5$ (trapezium)oe e.g. their answer to (a) + $(4 \times 0.5 \times 5) + \frac{1}{2}(5 \times (5 \times 5.5 - 5 \times 0.5))$ (rectangle + triangle)

May be implied by their answer to (a) + 60

Condone clear misreads of the 4 in the $4x$ but do not condone a misread of e.g. $4x$ for 4.

Condone clear mis-copy/mis-read of limits as long as they are non-zero E.g. 5 for 5.5.

Condone poor notation e.g. $\int_{0.5}^{5.5} (f(x) + 4x) dx = 30.9 + \int_{0.5}^{5.5} 2x^2 dx = 30.9 + 2 \times 5.5^2 - 2 \times 0.5^2$ **A1ft:** Correct answer of awrt 90.9 or correct ft e.g. $60 +$ their answer to part (a)Allow exact or exact ft answers e.g. $\frac{29081}{320}$ for 90.9Correct answer **only** scores no marks as the questions says “making your method clear”Attempts to use the trapezium rule again by adding $4x$ to the y values score M0 in (b)Note that $30.9 + 4(0.5 + 1.75 + 3 + 4.25 + 5.5) = 90.9$ is fortuitous and scores M0But $30.9 + \frac{1}{2} \times \frac{5}{4}(2 + 22 + 2(7 + 12 + 17)) = 90.9$ scores M1A1

Condone an error with the strip width as in part (a) for this method but the ft is not available in this case.

Examples of minimal acceptable working in (b) for both marks:

$$30.9 + 60 = 90.9$$

$$30.9 + \left[2x^2 \right]_{0.5}^{5.5} = 90.9$$

$$\int_{0.5}^{5.5} f(x) dx + \int_{0.5}^{5.5} 4x dx = 30.9 + 60 = 90.9$$

$$30.9 + 2 \times 5.5^2 - 2 \times 0.5^2 = 90.9$$

All score M1A1



Question Number	Scheme	Marks
2(a)	$u_1 = 7 \Rightarrow u_2 = k - 7$	B1
	$u_2 = k - 7 \Rightarrow u_3 = k + k - 7 \Rightarrow u_4 = k - (2k - 7)$ $u_5 = k + (-k + 7) = 7^*$	M1A1*
		(3)
(b)	$\sum_{r=1}^4 u_r = 30 \Rightarrow 7 + k - 7 + 2k - 7 - k + 7 = 30 \Rightarrow k = \dots$	M1
	$k = 15$	A1cso
		(2)
(c)	$\sum_{r=1}^{150} u_r = 37 \times 30 + 7 + "15" - 7$	M1
	$= 1125$	A1cso
		(2)
		Total 7

General Guidance

Note that it is possible to obtain correct answers in all parts of this question fortuitously.

The A marks should only be awarded following correct work.

(a)

B1: Correct expression for u_2 e.g. $k - 7$ with no incorrect work seen e.g.

$$u_2 = (-1)^7 \times 7 + k = -7 + k \text{ scores B0. Must be seen in part (a).}$$

$$\text{Allow e.g. } u_2 = (-1)^1 \times 7 + k \text{ or e.g. } u_2 = (-1) \times 7 + k \text{ or e.g. } u_2 = -1 \times 7 + k$$

M1: Attempts to use the recurrence formula **to reach the 5th term** but condone **consistent** use of $(n + 1)$ for n on the $(-1)^n$ term so e.g. $u_2 = (-1)^2 \times 7 + k$ is condoned but e.g.

$$u_2 = (-1)^7 \times 7 + k \text{ is M0}$$

Allow even if any slips mean their sequence is not of order 4.

A1*: Obtains $u_5 = 7$ with no errors or omissions. The " $u_5 =$ " must appear at some point but allow e.g. " $u_{4+1} =$ "

$$\text{For reference the terms are: } u_1 = 7, u_2 = k - 7, u_3 = 2k - 7, u_4 = 7 - k, u_5 = 7$$

(a) Alternatives:

$$\boxed{1} \quad u_2 = -u_1 + k, u_3 = -u_1 + 2k, u_4 = u_1 - k, u_5 = u_1 = 7$$

B1: Implied by $u_2 = -u_1 + k$

M1: Attempts to use the recurrence formula **to reach the 5th term** but condone use of $(n + 1)$ for n on the $(-1)^n$ term as above

A1*: Fully correct work to reach $u_5 = 7$

(Allow the above approach to be used with a made up k or a wrong k as the result is independent of k)

$$\boxed{2} \quad u_5 = 7 \Rightarrow u_4 = 7 - k \Rightarrow u_3 = 2k - 7 \Rightarrow u_2 = k - 7 \Rightarrow u_1 = 7 \text{ Hence true.}$$

B1: $u_4 = 7 - k$

M1: Attempts to use the recurrence formula correctly backwards **to reach the 1st term** but condone use of $(n + 1)$ for n on the $(-1)^n$ term as above.

A1*: Fully correct work to reach $u_1 = 7$ with a (minimal) conclusion.



(b)

M1: Adds their first 4 terms, sets = 30 and solves a linear equation for k .
 Condone slips in copying their 4 terms if the intention is clear.
 Allow even if their sequence is of order 2 e.g. $7, k-7, 7, k-7, \dots$

A1: Correct value **from correct work and a correct sequence**.

(c)

Marks in (c) are only available if their sequence is of order 4

M1: **Correct** numerical attempt for the required sum using their k . May be implied by the correct answer or the correct ft answer unless an incorrect method is seen e.g.

$37 \times 30 + u_3 + u_4$ or $38 \times 30 - u_1 - u_2$ score M0

Condone $\frac{150}{4} \times 30$ or 75×15 or 37.5×30 following a **correct sequence** and the

correct value of k .

Allow any equivalent **correct** method e.g. $38 \times 30 - (2 \times "15" - 7 + 7 - "15")$

A1: For 1125 **from correct work and a correct sequence**.

Correct answer **only** scores both marks.

For reference the **correct** sequence is:

n	1	2	3	4
u_n	7	$k-7$	$2k-7$	$7-k$
Value (with $k=15$)	7	8	23	-8

An unusual but correct method in (c) is:

$$\sum_{r=1}^{150} u_r = 38 \times 7 + 38(15-7) + 37(30-7) + 37(7-15) = 1125$$

Example – Candidates who consistently use

$$u_{n+1} = (-1)^{n+1} u_n + k$$

This gives:

(a) $u_1 = 7, u_2 = k+7, u_3 = -7, u_4 = k-7, u_5 = 7$ which scores B0M1A0

(b) $\sum_{r=1}^4 u_r = 30 \Rightarrow 7 + k + 7 - 7 + k - 7 = 30 \Rightarrow k = 15$ which scores M1A0

(c) $\sum_{r=1}^{150} u_r = 37 \times 30 + 7 + "15" + 7 = 1139$ which scores M1A0

For reference this **incorrect** sequence is:

n	1	2	3	4
u_n	7	$k+7$	-7	$k-7$
Value (with $k=15$)	7	22	-7	8



Question Number	Scheme	Marks
3(a)	$2(-3)^3 - (-3)^2 + A(-3) + B = 55$ or e.g. $-54 - 9 - 3A + B = 55$	M1
	$-54 - 9 - 3A + B = 55$ $\Rightarrow 3A - B = -118^*$	A1*
		(2)

(a)

M1: Attempts $f(-3) = 55$. The -3 embedded in the expression set = 55 is sufficient.Condone missing brackets e.g. $2 - 3^3 - -3^2 + A(-3) + B = 55$ Note that $2(-3)^3 - (3)^2 + A(-3) + B = 55$ is acceptable.May be implied by further work. If -3 embedded in the expression is not seen, condone slips in their evaluation provided there is still evidence that the intention was to substitute in -3 and set = 55 but $f(3) = 55$ is M0**A1*:** Completes proof with at least one intermediate simplified and correct line that is not the final line such as $-54 - 9 - 3A + B = 55$ or $118 = -3A + B$. Any incorrect lines written after the start of their 'proof' should be scored A0*Must be the given equation and not e.g. $B = 3A + 118$ unless the correct equation is seen previously but condone $-B + 3A = -118$ $2(-3)^3 - (-3)^2 + A(-3) + B = 55 \Rightarrow 3A - B = -118$ scores M1A0

Tabular or division methods may be seen. The question does not demand use of the factor or remainder theorem so these methods should be rewarded.

The M1 would be scored for a full attempt and A1* for a correct proof.

If you cannot see what they are doing and find it hard to award, then use review.

e.g. long division:

$$\begin{array}{r}
 2x^2 - 7x + A + 21 \\
 x + 3 \overline{) 2x^3 - x^2 + Ax + B} \\
 \underline{2x^3 + 6x^2} \\
 -7x^2 + Ax + B \\
 \underline{-7x^2 - 21x} \\
 (A + 21)x + B \\
 \underline{(A + 21)x + 3(A + 21)} \\
 B - 3A - 63 = 55
 \end{array}$$

Score M1 for obtaining a quotient $\dots x^2 \pm \dots x \pm \dots A + \dots$ and a remainder $\dots A \pm \dots B \pm \dots$ set = 55 where “...” are non-zero constants. Then A1* for a fully correct proof.

e.g. tabular method:

	$2x^2$	$-7x$	$21 + A$
x	$2x^3$	$-7x^2$	$(21 + A)x$
3	$6x^2$	$-21x$	$63 + 3A$

So $B - (63 + 3A) = 55$ etc.Score M1 for obtaining a constant $\dots A + \dots$ where ... are non-zero constants and then sets $B - \text{their constant} = 55$. Then A1* for a fully correct proof.

Question Number	Scheme	Marks
1(a)	$f(-1) = (-1)^4 + a(-1)^3 - 3(-1)^2 + b(-1) + 5 = 4$	M1
	$1 - a - 3 - b + 5 = 4 \Rightarrow a + b = -1$ *	A1*
		(2)
(b)	$f(2) = (2)^4 + a(2)^3 - 3(2)^2 + b(2) + 5 = -23$	M1
	$\Rightarrow 8a + 2b = -32$ oe (eg $4a + b = -16$)	A1
	$b = -1 - a \Rightarrow 4a - 1 - a = -16 \Rightarrow a = \dots$	dM1
	$a = -5, b = 4$	A1
		(4)
		(6 marks)

(a) NB Do not apply a misread on the equation $a + b = -1$ as it gains no extra marks. They can score a maximum of M1A0 M1A1M1A0 if they use an incorrect equation such as $a + b = 1$.

M1 Attempts to substitute ± 1 into $f(x)$ and set equal to 4 to obtain an equation in a and b . Powers of -1 need not be seen, accept e.g. $1 - a - 3 - b + 5 = 4$. Condone invisible brackets on powers for the M mark, but penalise in the A (if incorrect). Alternatively, attempts long division reaching a remainder which is then set equal to 4. Look for a quotient starting $x^3 + \dots$ and linear remainder in a and b . It may be seen in tabulated form.
Another alternative method: Writes $f(x) = (x+1)(x^3 + \alpha x^2 + \beta x + \gamma) + 4$ (allow with $\gamma = 1$), expands and equates coefficients, and proceeds to eliminate α, β and γ from the equations.

A1* Rearranges the equation with no errors and achieves the given answer with at least one intermediate line with power evaluated. FYI by long division the quotient is $x^3 + (a-1)x^2 + (-a-2)x + a+b+2$ and the remainder is $3-a-b$.
By equating coefficients look for $\gamma + 4 = 5$ (may be implied), $a = \alpha + 1$, $b = \beta + 1$, $-3 = \alpha + \beta$ being solved correctly.

(b)
M1 Attempts to substitute ± 2 into $f(x)$ and set equal to ± 23 to obtain an equation in a and b . Again, accept attempts at long division leading to a remainder linear in a and b (which is $8a + 2b + 9$), which is then set equal to ± 23 , or via equating coefficients (look for at least three equations formed). May have substituted for a or b already.

A1 $8a + 2b = -32$ oe need not be fully gathered but powers should be evaluated. So e.g. accept $16 + 8a - 12 + 2b + 5 = -23$ or accept $16 + 8a - 12 + 2(-a-1) + 5 = -23$ if substitution for b happens first (similar for a). Via equating coefficients, all equations should be correct.

dM1 Attempts to solve simultaneously and achieves a value for a or b . It is dependent on the previous method mark. Allow as long as values for a or b appears after writing out their two equations in both a and b (or solving a linear equation if substitution occurs before remainder theorem). Allow for slips in copying their initial equations.

A1 $a = -5, b = 4$ cao



Summary of changes from Provisional Mark Scheme

A few minor changes were made to the Mark Scheme before marking on the marking service began.

Question Number	Summary of changes
Q03	Removed reference to ePEN marking traits. Added clarification in parenthesis on the M and first A mark how to mark cases where students split into cases for odd and even integers
Q04	Added “at least twice in the x , x^2 and x^3 terms” to the M1 notes
Q06	Added clarification that the 0 ordinate need not be seen, and the coordinates may be seen anywhere.
Q08	Added that part (ii) may be marked as a whole (ii) M1 added “may be seen in (b)”, A1 added “result must be clearly stated but may be seen in (b).”



Question	Scheme	Marks
1(a)	(i) There is a <u>common difference</u> (no common ratio) and so an <u>arithmetic</u> series should be used.	B1
	(ii) $(u_n) = 5 + (n-1)d$ or $(u_n) = 5 + nd$	M1
	$(u_n) = 5 + 0.25(n-1)$ oe	A1
		(3)
(b)	Need $S_n = \frac{n}{2}(2 \times 5 + (n-1) \times 0.25) \geq 350$	M1A1
	$\Rightarrow 0.25n^2 + 9.75n \geq 700 \Rightarrow (n+19.5)^2 - 19.5^2 \geq 2800 \Rightarrow n = \dots$	M1
	So 37 weeks.	A1
		(4)
(7 marks)		

Notes:**(a)(i)**

B1: Identifies that there is a common difference (e.g. goes up in equal amounts) between first and second, and second and third terms, or that the ratio between first and second, and second and third is not the same, and states arithmetic series/sequence to be used.

M1: Attempts general term for A.S. with n or $n-1$ used and their d (which need not be correct).

A1: Correct expression for general term, accept equivalents, eg $4.75 + 0.25n$. May use another label than u_n or no label at all.

(b)

M1: Uses the sum formula for A.S. with their a and d and equates to, or sets inequality with, 350. Accept with any inequality symbol or equality between.

A1: Correct equation/inequality. Accept with any inequality symbol or equality between.

M1: Forms and solves a 3 term quadratic (need not be gathered to one side). Any valid method (including calculator – you may need to check).

A1: 37 weeks selected as answer.

For attempts via listing, send to review.

For use of geometric series:

Case 1: If a student states arithmetic series but uses geometric series formulae, then only the B mark can be scored in (a), but in (b) allow M0A0M1A0 if a correct method is used to solve their equation

$$\frac{5(r^n - 1)}{r - 1} \geq 350 \text{ (or with “=” or “<” etc) to find } n \text{ (so } n = \log_{r,n}(70(r - 1) + 1) \text{ oe)}$$

Case 2: If a student states a geometric series and gives a common ratio, then allow B0M1A0 in (a)

for $(u_n) = 5r^{n-k}$ with $k = n$ or $n-1$ and in (b) allow M1A0 for $\frac{5(r^n - 1)}{r - 1} \geq 350$ and then M1A0 for

a correct method to solve this equation.



(b)

M1: Uses $\tan \theta = \frac{\sin \theta}{\cos \theta}$ with $\cos \theta = \frac{1}{\sqrt{5}}$ and either $\sin \theta = \frac{2}{\sqrt{5}}$ or $\sin \theta = -\frac{2}{\sqrt{5}}$ from (a) which must have

been awarded from a correct method.

Alternatively, from a triangle method, shows the opposite side = 2 in a right-angled triangle and takes the correct ratio

A1: $\tan \theta = -2$ following the award of the M1 in both (i) and (ii)

(ii)(a)

B1: 1 (m) Units are not necessary here but incorrect units e.g. 1 cm would be B0

(ii)(b)

M1: Sets $30t - 40$ equal to any value in degrees where the cosine is -1

So $30t - 40 = 180(2n+1)$, for any $n \in \mathbb{Z}$ is acceptable. Condone $30t - 40 = (2n+1)\pi$,

Condone the result obtained from differentiation with $\sin(30t - 40) = 0 \Rightarrow 30t - 40 = 180(2n+1)$

A1: $30t - 40 = 180 \Rightarrow t = 7\frac{1}{3}$ or 7.33 but condone 7.3. It must follow the award of the M mark

A1: Achieves 7:20 am or 07:20 or any other acceptable way of establishing the exact **time of day** time in hours and minutes. So 7 hours 20 minutes after midnight is fine. **Condone 7:20 but 7:20pm is A0 and 7 hours 20 minutes without reference to after midnight is A0. It must follow correct working and cannot be rounded from a different time value such as 7:19.5**

(ii)(c) Radian attempts can only usually score the first M1.

M1: Sets $4 + 3\cos(30T - 40)^\circ$ equal to 3.5 and proceeds to $\cos(30T - 40)^\circ = k$, $|k| < 1$

A1: Achieves $30T - 40$ equal to any of 99.6, 260.4, 459.6

dM1: Proceeds from $30T - 40$ equal to any of awrt 100, 260, 460 AND uses correct order of operations and working leading to a value for T .

For example, allow for $30T - 40 = \text{awrt } 100 \Rightarrow T = \frac{140}{30}$ or awrt 4.7

$30T - 40 = \text{awrt } 260 \Rightarrow T = \text{awrt } 10$

$30T - 40 = \text{awrt } 460 \Rightarrow T = \frac{500}{30}$ or awrt 16.7

A1: awrt 16.65 following the award of M1, A1 dM1

ISW after a correct answer for T . Ignore any attempts to convert the T value to a time.

A clear method must be shown here, so solutions produced entirely from a calculator will not score.

E.g. $4 + 3\cos(30T - 40)^\circ = 3.5 \Rightarrow T = 16.65$ is 0 marks

A minimal acceptable response for 4 marks would be

$$4 + 3\cos(30T - 40)^\circ = 3.5 \Rightarrow \cos(30T - 40)^\circ = -\frac{1}{6}$$

$$\Rightarrow 30T - 40 = 459.6$$

$$\Rightarrow T = 16.65$$



Question Number	Scheme	Marks
7 (a)	States either $kn = -24$ (1) or $\frac{n(n-1)}{2}k^2 = 270$ (2)	M1
	States both $kn = -24$ (1) and $\frac{n(n-1)}{2}k^2 = 270$ (2)	A1
	Substitutes $k = -\frac{24}{n}$ in equation (2) $\Rightarrow \frac{n(n-1)}{2}\left(-\frac{24}{n}\right)^2 = 270 \Rightarrow n = \dots$	M1
	$n = 16$	A1
	Uses their $n = 16$ in $kn = -24 \Rightarrow k = -\frac{24}{16} = -\frac{3}{2}$	dM1, A1
(b)	$p = \frac{n(n-1)(n-2)}{3!}k^3 = \frac{16 \times 15 \times 14}{6} \times \left(-\frac{3}{2}\right)^3 = \dots$	M1
	$= -1890$	A1
		(8 marks)

(a)

M1: States either $kn = -24$ (1) or $\frac{n(n-1)}{2}k^2 = 270$ (2) accepting equivalents but see note belowThis mark cannot be awarded from $\binom{n}{1}k = -24$ or ${}^nC_2(kx)^2 = 270x^2$, with factorials

$$\frac{n!}{(n-2)!}k^2 = 540$$

or indeed versions including x terms such as $knx = -24x$ unless followed by a correct $kn = -24$ A1: States both $kn = -24$ (1) and $\frac{n(n-1)}{2}k^2 = 270$ (2) accepting equivalentsM1: Forms an equation in one variable leading to a value for k or n It is dependent upon having achieved $kn = \pm 24$ and $\frac{n(n-1)}{2}k^2 = 270$

...

The process of forming the equation must be credible so look for $k = \frac{\pm 24}{n}$ being substituted and

$$\text{NOT } k = \pm 24 - n \quad \text{FYI the equation in } k \text{ is } \Rightarrow -\frac{24}{k}\left(-\frac{24}{k} - 1\right) \times \frac{k^2}{2} = 270 \Rightarrow k = \dots$$

A1: For either $n = 16$ following a correctly solved equation in n .or $k = -\frac{3}{2}$ if the equation in k was formed.Look for correct working leading to the value for n . For example, forming a linear equation is

$$\text{sufficient. } \frac{n(n-1)}{2}\left(-\frac{24}{n}\right)^2 = 270 \Rightarrow \frac{288(n-1)}{n} = 270 \Rightarrow 288n - 288 = 270n \Rightarrow n = 16$$

dM1: Uses $k = \pm \frac{24}{n}$ o.e. with their $n = '16'$ to find k or their $k = '-\frac{3}{2}'$ to find n 

This mark may be implied. It is dependent upon the **previous M**

So, if they have scored the previous M, achieved $n=8$ and $k = \frac{24}{n}$ award for $k=3$

A1: $n=16$ and $k = -\frac{3}{2}$ following the award of all previous marks

.....
The demand of the question is that they show all stages of their working.

Example I

If a candidate states both equations $kn = -24$, $\frac{n(n-1)}{2}k^2 = 270$, shows a **correct intermediate line in a single variable** then follows this with correct $n=16$ and $k = -\frac{3}{2}$ **without the necessary working** they can be awarded SC: 1, 1, 1, 0, 1, 0

Example II

If a candidate states both equations $kn = -24$, $\frac{n(n-1)}{2}k^2 = 270$ and follows this with correct $n=16$ and $k = -\frac{3}{2}$ without any necessary intermediate equations and working they can be awarded SC: 1, 1, 0, 1, 0, 0

If the SC is seen in part (a), they can go on to score both marks in (b) for correct answers

.....
 (b)

M1: Uses $p = \frac{n(n-1)(n-2)}{3!}k^3$ with their values for n and k found from part (a) to find a value for p .

This can be implied by a 'correct' answer for their values of n and k .

Allow fractional values for both n and k

Allow this to be scored by candidates who perhaps have only one equation, usually $kn = -24$ and go on to state for example that $n = 4$ and $k = -6$ and then find $p = -864$

Values cannot be made up without an attempt in part (a) scoring at least one mark

A1: -1890 following correct values for n and k .

It must follow correct equations in part (a) but allow the values to be found from equations containing terms including factorial and/or combination notation.

Question Number	Scheme	Marks
10.(i)(a)	$(3+2x)^6$ Any correct form for any term of ${}^6C_1 3^5 (2x)^1$ or ${}^6C_2 3^4 (2x)^2$ or ${}^6C_4 3^2 (2x)^4$ Any two correct: $t(2) = 6 \times 3^5 \times (2x)^1$, $t(3) = 15 \times 3^4 \times (2x)^2$ $t(5) = 15 \times 3^2 \times (2x)^4$ All 3 terms correct 2nd term = $2916x$, 3rd term = $4860x^2$, 5th term = $2160x^4$	M1 A1 A1 (3)
(b)	Method using consecutive terms of a GP e.g. $\frac{2160x^4}{4860x^2} = \frac{4860x^2}{2916x}$ $\Rightarrow \dots x = \dots$ $\Rightarrow x = \frac{15}{4}$	M1 dM1 A1 (3)
(ii) (a)	Attempts to use $S_\infty = \frac{a}{1-r} \Rightarrow \frac{8}{5} = \frac{\sin^2 \theta}{1-2\cos \theta}$ $\Rightarrow \frac{8}{5} = \frac{1-\cos^2 \theta}{1-2\cos \theta}$ $\Rightarrow 8-16\cos \theta = 5-5\cos^2 \theta$ $\Rightarrow 5\cos^2 \theta - 16\cos \theta + 3 = 0$	M1 dM1 A1* (3)
(b)	Solves $5\cos^2 \theta - 16\cos \theta + 3 = 0 \Rightarrow \cos \theta = \frac{1}{5}$ Attempts $ar = \sin^2 \theta \times 2\cos \theta = \left(1 - \left(\frac{1}{5}\right)^2\right) \times 2 \times \frac{1}{5}$ $= \frac{48}{125}$	B1 M1 A1 (3)
		(12 marks)

(i) (a)

M1: For an attempt at using the binomial expansion to find **one** of the required terms.Condone the omission of the brackets on the $2x$ terms. Allow using combination notation.

Don't be concerned over any labelling (2nd term). May be awarded from a full expansion

A1: Any **two** correct terms, simplified or not. The ${}^6C_2$ must now be numerical.

Don't be concerned by labelling and accept as part of a large list or expansion

A1: All three terms correct and simplified.

They may be part of a larger or complete expansion, which is fine. Look for the 2nd, 3rd and 5th termsAccept the 3 terms with +s between. So accept for example $2916x + 4860x^2 + 2160x^4$ Note that the expansion can be done by $(3+2x)^6 = 3^6 \left(1 + \frac{2}{3}x\right)^6$ The unsimplified versions of the terms are:

$$t(2) = 3^6 \times 6 \left(\frac{2}{3}x\right) \quad t(3) = 3^6 \times \frac{6 \times 5}{2} \left(\frac{2}{3}x\right)^2 \quad \text{and} \quad t(5) = 3^6 \times \frac{6 \times 5 \times 4 \times 3}{4 \times 3 \times 2 \times 1} \left(\frac{2}{3}x\right)^4$$



(i)(b)

M1: Uses the fact that the 2nd, 3rd and 5th terms of their binomial expansion in (a) are consecutive terms of a GP to set up an equation in x .

There are a few ways in which the equation could be set up so look carefully at what is written.

The most common ways are $\frac{2160x^4}{4860x^2} = \frac{4860x^2}{2916x}$, $\frac{4860x^2}{2160x^4} = \frac{2916x}{4860x^2}$ and

$2160x^4 = \frac{4860x^2}{2916x} \times 4860x^2$. Condone slips e.g. 2196 for 2916

The candidates **must** be using what they believe are the 2nd, 3rd and 5th terms of the binomial expansion and not the 2nd, 3rd or 4th or any other combination.

If a list is given it must be the 2nd, 3rd and 5th terms in $a + bx + cx^2 + dx^3 + ex^4 + \dots$ where $a, b, c, d \neq 0$

dM1: It is dependent upon the first M and having the correct index on the powers of x .

It is for proceeding to an equation of the form $\dots x = \dots$

A1: $x = \frac{15}{4}$ or exact equivalent. Condone an extra $x = 0$

.....
If there are unlabelled/mislabelled terms in (a) that are used in (b) and you feel that they deserve more credit than that afforded by the scheme, please use review. A common error is described below.

It seems that some candidates are finding the terms in x^2 , x^3 and x^5 in (i) (a) and (b). We will treat as a SC **only when appearing in both parts**. FYI: These are $4860x^2$, $4320x^3$ and $576x^5$. These values would score M1 in (i)(a) for the x^2 term and potentially M1, dM1 (when proceeding to $\dots x = \dots$) in (i)(b)

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(ii)(a) Allow use of a different parameter, e.g. $\theta \leftrightarrow x$

M1: Attempts to use $S_{\infty} = \frac{a}{1-r} \Rightarrow \frac{8}{5} = \frac{\sin^2 \theta}{1-2\cos \theta}$ Condone slips only. The formula must be correct

dM1: Uses the identity $\sin^2 \theta = 1 - \cos^2 \theta$ to form an equation in just $\cos \theta$

A1*: Completes proof with sufficient working.

Condone one slip in notation. E.g. $\sin \theta^2 \leftrightarrow \sin^2 \theta$, $\cos \leftrightarrow \cos \theta$ but the final line must be correct and include the $= 0$

(ii)(b)

B1: States or uses $\cos \theta = \frac{1}{5}$

M1: Attempts $ar = \sin^2 \theta \times 2 \cos \theta = \left(1 - \left(\frac{1}{5}\right)^2\right) \times 2 \times \frac{1}{5}$

Alternatively finds the value of θ from their $\cos \theta = \frac{1}{5}$ and uses this in $ar = \sin^2 \theta \times 2 \cos \theta$

A1: $\frac{48}{125}$ or exact equivalent. Eg. 0.384.

It cannot be scored by rounding a non exact answer or from a decimal value of θ

So, for example, answers of $\frac{48}{125}$ achieved using a value of $\theta = 78.46 \dots$ don't score the final A1

