Topic 8

Binomial Expansion

Bronze, Silver, Gold and Platinum Worksheets for AS Level Mathematics

Teacher Notes

These Bronze, Silver and Gold worksheets are designed to be used either straight after the content has been taught or as part of a skills gap analysis, especially as students move into year 13.

They are drawn from the latest specification questions and legacy questions. The papers are between 25 and 35 marks.

The topic number on this worksheet relates to the corresponding chapter number in the 'Pearson Edexcel AS and A Level Mathematics: Pure Mathematics Year 1/AS' textbook.

Non-Calculator Questions

The new specification allows calculators to be used in all papers. **We have, however, put these questions together with the intention that students can complete them without a calculator.** It's important for pupils to be able to maintain their non-calculator skills, especially on topics such as surds or indices, to support question that use the keywords "show that" or "prove". If you wish to ease the difficulty slightly then you can, of course, allow students to attempt them with the support of a calculator.

Quick Links

(Press Ctrl, as you click with your mouse to follow these links)

- Bronze Questions
- Bronze Mark Scheme
- Silver Questions
- Silver Mark Scheme
- Gold Questions
- Gold Mark Scheme

The Platinum Questions below are taken from the Advanced Extension Award. You can use these in class as high level problem solving questions, either with individual students or as group problem solving exercises. On the Advanced Extension Award students, typically, need to get around 50% to get a Merit and around 70% to get a distinction.

- Platinum Questions
- Platinum Mark Schemes

Extension and Enrichment

If you have students that have enjoyed the challenge of the Gold questions, then they should have a go at the more challenging question from our Advanced Extension Award (AEA) papers. The Mathematics AEA is a single, 3 hour non-calculator paper, taken at the end of year 13. It helps students to develop high level problem solving and proof skills. It is entirely based on the content of the A Level Mathematics Course. No extra material needs to be covered to take the AEA in Mathematics. A second important difference is that marks are awarded for the clarity and quality of their solution. Developing this key skill, alongside the extra problem-solving experience, can pay dividends in the way they approach A Level Mathematics and Further Mathematics problems.

More information about the Advanced Extension Award can be found here on the Pearson Edexcel Website, or here on the Maths Emporium

Bronze Questions

Calculators may not be used

The total mark for this section is 30

Q1

Find the first 3 terms, in ascending powers of x, of the binomial expansion of $(2 - 3x)^5$ giving each term in its simplest form.

(Total for Question 1 is 4 marks)

Q2

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

$$(1 + kx)^{10}$$

where k is a positive constant. Give each term in its simplest form.

(3)

Given that, in this expansion, the coefficients of x and x^3 are equal,

(b) find the exact value of k,

(3)

(c) find the coefficient of x^2

(1)

(Total for Question 2 is 7 marks)

Q3

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

$$(2 + kx)^7$$

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

(4)

Given that the coefficient of x^3 in this expansion is 1890

(b) find the value of k.

(3)

(Total for Question 3 is 7 marks)

Q4

Find the first 3 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.

(Total for Question 4 is 4 marks)

Q5

Find the first 3 terms, in ascending powers of x, of the binomial expansion of $(3 - 2x)^5$, giving each term in its simplest form.

(Total for Question 5 is 4 marks)

Q6

Given that $\begin{pmatrix} 40 \\ 4 \end{pmatrix} = \dfrac{40!}{4!b!}$,

(a) write down the value of b.

(1)

In the binomial expansion of $(1 + x)^{40}$, the coefficients of x^4 and x^5 are p and q respectively.

(b) Find the value of $\dfrac{q}{p}$

(3)

(Total for Question 6 is 4 marks)

End of Questions

Bronze Mark Scheme

Q1

Question number	Scheme	Marks
	$\left[(2-3x)^5\right] = \ldots \quad +\binom{5}{1}2^4(-3x)+\binom{5}{2}2^3(-3x)^2+\ldots,\ \ldots\ldots$	M1
	$=32,\ -240x,\ +720x^2$	B1, A1 , A1
		Total 4
Notes	**M1**: The **method** mark is awarded for an attempt at Binomial to get the second and/or third term – need **correct** binomial coefficient combined **with correct power of *x*.** Ignore errors (or omissions) in powers of 2 or 3 or sign or bracket errors. Accept any notation for ${}^5C_1$ and ${}^5C_2$, e.g. $\binom{5}{1}$ and $\binom{5}{2}$ (unsimplified) or 5 and 10 from Pascal's triangle This mark may be given if no working is shown, but either or both of the terms including x is correct. **B1**: must be simplified to 32 (writing just 2^5 is **B0**). **32** must be the only constant term in the final answer- so 32 +80 - 3x+80 +9 x^2 is B0 but may be eligible for M1A0A0 . **A1**: **is cao and is for** $-240\ x$. (not +-240x) The x is required for this mark **A1**: is c.a.o and is for $720x^2$ (can follow omission of negative sign in working) A list of correct terms may be given credit i.e. series appearing on different lines Ignore extra terms in x^3 and/or x^4 (isw)	
Special Case	Special Case: *Descending powers* of x would be $(-3x)^5+2\times5\times(-3x)^4+2^2\times\binom{5}{3}\times(-3x)^3+..$ i.e. $-243x^5+810x^4-1080x^3+..$ This is a misread but award as s.c. M1B1A0A0 if completely "correct" or M1 B0A0A0 for <u>correct</u> binomial coefficient in any form with the correct power of x	
Alternative Method	**Method 1**: $\left[(2-3x)^5\right]=2^5(1+\binom{5}{1}(-\frac{3x}{2})+\binom{5}{2}(\frac{-3x}{2})^2+..\ )$ is **M1B0A0A0** { The M1 is for the expression **in the bracket** and as in first method– need **correct** binomial coefficient combined with correct power of x. Ignore bracket errors or errors (or omissions) in powers of 2 or 3 or sign or bracket errors} – answers must be simplified to $=32,-240x,+720x^2$ for full marks (awarded as before) $\left[(2-3x)^5\right]=2(1+\binom{5}{1}(-\frac{3x}{2})+\binom{5}{2}(\frac{-3x}{2})^2+..\ )$ would also be awarded **M1B0A0A0** **Method 2: Multiplying out** : B1 for 32 and M1A1A1 for other terms with M1 awarded if x or x^2 term is correct. Completely correct is 4/4	

Q2

Question Number	Scheme	Marks
(a)	$(1+kx)^{10}$ $1+{}^{10}C_1(kx)+{}^{10}C_2(kx)^2+{}^{10}C_3(kx)^3...$ $1+\left({}^{10}C_1\times...\times x\right)+\left({}^{10}C_2\times...\times x^2\right)+\left({}^{10}C_3\times...\times x^3\right)...$ $=1+10kx,+45k^2x^2+120k^3x^3..$	 M1 B1, A1 **(3)**
(b)	$120k^3=10k$ $k^2=\frac{1}{12}$ so $k=...$ $k=\frac{\sqrt{3}}{6}$ o.e	M1 M1 A1 **(3)**
(c)	$\frac{15}{4}$ o.e.	B1 **(1)** **(7 marks)**

Notes

(a)
M1: All three binomial coefficients must be correct and must be with the correct power of x. (Ignore k) Accept ${}^{10}C_1$ or $\binom{10}{1}$ or 10 **as a coefficient, and** ${}^{10}C_2$ or $\binom{10}{2}$ or 45 **as another and** ${}^{10}C_3$ or $\binom{10}{3}$ or 120 **as another……..**
Pascal's triangle may be used to establish coefficients.
B1: The first two terms correct (i.e. $=1+10kx$)
A1: The third and fourth terms are correct – allow with brackets (kx) (i.e. $45k^2x^2+120k^3x^3$ or $45(kx)^2+120(kx)^3$)
(Accept answers without + signs, can be listed with commas or appear on separate lines)
If extra terms are given then isw
(b)
M1: Sets their **Coefficient** of x equal to their **Coefficient** of x^3 but must have differing powers of k
M1: Divides then takes a square root to give a value for k (May use difference of two squares to find k which is fine)
A1: $k=\frac{1}{\sqrt{12}}$ or $\frac{\sqrt{12}}{12}$ or $\frac{\sqrt{3}}{6}$ o.e. (needs to have just the one positive answer – if negative square root is also given, this is A0)
If there are x terms present e.g. $120k^3x^3=10kx$ then this is M0M0A0
If both powers of k are the same this is also M0M0A0
(c)
B1: $\frac{45}{12}$ or $\frac{15}{4}$ or 3.75 or equivalent Allow $\frac{15}{4}x^2$ (can follow negative value for k)

Q3

Question Number	Scheme	Marks
(a)	$(2+kx)^7$ $2^7 + {}^7C_1 2^6(kx) + {}^7C_2 2^5(kx)^2 + {}^7C_3 2^4(kx)^3 ...$ First term of 128 $({}^7C_1 \times ... \times x) + ({}^7C_2 \times ... \times x^2) + ({}^7C_3 \times ... \times x^3)...$ $=(128 ..) + 448kx + 672k^2x^2 + 560k^3x^3 ..$	 B1 M1 A1, A1 **(4)**
(b)	$560k^3 = 1890$ $k^3 = \frac{1890}{560}$ *so* $k=$ $k = 1.5$ o.e.	M1 dM1 A1 **(3)** **(7marks)**
Alternative method For (a)	$(2+kx)^7 = 2^7(1+\frac{kx}{2})^7$ $2^7(1 + {}^7C_1(\frac{k}{2}x) + {}^7C_2(\frac{k}{2}x)^2 + {}^7C_3(\frac{k}{2}x)^3 \ ...)$ Scheme is applied exactly as before	

Notes

(a)

B1: The constant term should be 128 in their expansion (should not be followed by other constant terms)

M1: Two of the three binomial coefficients must be correct and must be with the correct power of x. Accept ${}^7C_1$ or $\binom{7}{1}$ or 7 **as a coefficient, and** ${}^7C_2$ or $\binom{7}{2}$ or 21 **as another and** ${}^7C_3$ or $\binom{7}{3}$ or 35 **as another……..**

Pascal's triangle may be used to establish coefficients.

A1: Two of the final three terms correct (i.e. two of $448kx + 672k^2x^2 + 560k^3x^3..$).

A1: All three final terms correct. (Accept answers without + signs, can be listed with commas or appear on separate lines)

e.g. The common error $=(128 ..) + 448kx + 672kx^2 + 560kx^3..$ would earn B1, M1, A0, A0, so 2/4 Then would gain a maximum of 1/3 in part (b)

If extra terms are given then isw

If the **final** answer is given as $=(128 ..) + 448kx + 672(kx)^2 + 560(kx)^3..$ with correct brackets and no errors are seen, this may be given full marks. If they continue and remove the brackets wrongly then they lose the accuracy marks.

Special case using Alternative Method: Uses $2\ (1+\frac{kx}{2})^7$ is likely to result in a maximum mark of B0M1A0A0 then M1M1A0

If the correct expansion is seen award the marks and isw

(b)

M1: Sets their **Coefficient** of x^3 equal to 1890. They should have an equation which does not include a power of x. This mark may be recovered if they continue on to get $k = 1.5$

dM1: This mark depends upon the previous M mark. Divides then attempts a cube root of their answer to give k – the intention must be clear. (You may need to check on a calculator) The correct answer implies this mark.

A1: Any equivalent to 1.5 If they give – 1.5 as a second answer this is A0

Q4

Question Number	Scheme	Marks
Way 1	$\left(2-\frac{x}{4}\right)^{10}$ $2^{10}+\underline{\underline{\binom{10}{1}}}2^9\left(-\frac{1}{4}\underline{\underline{x}}\right)+\underline{\underline{\binom{10}{2}}}2^8\left(-\frac{1}{4}\underline{\underline{x}}\right)^2+\ldots$ For <u>either</u> the x term <u>or</u> the x^2 term including a correct <u>binomial coefficient</u> with a <u>correct power of x</u>	M1
	<u>First term of 1024</u>	B1
	$=\underline{1024}-1280x+720x^2$ **Either** $-1280x$ **or** $720x^2$ (Allow +-1280x here)	A1
	Both $-1280x$ and $720x^2$ (Do not allow +-1280x here)	A1 [4]
Way 2	$\left(2-\frac{x}{4}\right)^{10}=2^k\left(1-\underline{\underline{10}}\times\frac{\underline{\underline{x}}}{8}+\underline{\underline{\frac{10\times9}{2}}}\left(-\frac{\underline{\underline{x}}}{8}\right)^2\right)$	M1
	$1024(1\pm.......)$ $=\underline{1024}-1280x+720x^2$	<u>B1</u>A1 A1 [4]

Notes

M1: For <u>either</u> the x term <u>or</u> the x^2 term having correct structure i.e. a <u>correct</u> binomial coefficient in any form with the <u>correct power of x</u>. Condone sign errors and condone missing brackets and allow alternative forms for binomial coefficients e.g. ${}^{10}C_1$ or $\binom{10}{1}$ or even $\left(\frac{10}{1}\right)$ or 10. The powers of 2 or of ¼ may be wrong or missing.

B1: Award this for 1024 when first seen as a distinct constant term (not $1024x^0$) and not 1 + 1024

A1: For one correct term in x with coefficient simplified. Either -1280x or $720x^2$ (allow +-1280x here)

Allow $720x^2$ to come from $\left(\frac{x}{4}\right)^2$ with no negative sign. So use of + sign throughout could give M1 B1 A1 A0

A1: For both correct simplified terms i.e. -1280x and $720x^2$ (**Do not** allow +-1280x here)

Allow terms to be listed for full marks e.g. $\underline{1024}, -1280x, +720x^2$

N.B. If they follow a correct answer by a factor such as $512-640x+360x^2$ then isw

Terms may be listed. Ignore any extra terms.

Notes for Way 2

M1: Correct structure for at least one of the underlined terms. i.e. a <u>correct</u> binomial coefficient in any form with the <u>correct power of x</u>. Condone sign errors and condone missing brackets and allow alternative forms for binomial coefficients e.g. ${}^{10}C_1$ or $\binom{10}{1}$ or even $\left(\frac{10}{1}\right)$ or 10. k may even be 0 or 2^k may not be seen. Just consider the bracket for this mark.

B1: Needs 1024(1…. To become 1024

A1, A1: as before

Q5

Question Number	Scheme	Marks
	$(3-2x)^5 = 243$, $\quad \ldots\ldots + 5\times(3)^4(-2x) = -810x \quad \ldots\ldots$	B1, B1
	$+\dfrac{5\times4}{2}(3)^3(-2x)^2 = \qquad +1080x^2$	M1 A1 (4)
		[4]
Notes	First term must be 243 for **B1**, writing just 3^5 is B0 (Mark their final answers except in second line of special cases below). Term must be simplified to $-810x$ for **B1** The x is required for this mark. The **method** mark **(M1)** is **generous** and is awarded for an attempt at Binomial to get the third term. There must be an x^2 (or no x- i.e. not wrong power) and attempt at Binomial Coefficient and at dealing with powers of 3 and 2. The power of 3 should not be one, but the power of 2 may be one (regarded as bracketing slip). So allow $\binom{5}{2}$ or $\binom{5}{3}$ or ${}^5C_2$ or ${}^5C_3$ or even $\left(\frac{5}{2}\right)$ or $\left(\frac{5}{3}\right)$ or use of '10' (maybe from Pascal's triangle) May see ${}^5C_2(3)^3(-2x)^2$ or ${}^5C_2(3)^3(-2x^2)$ or ${}^5C_2(3)^5(-\frac{2}{3}x^2)$ or $10(3)^3(2x)^2$ which would each score the **M1** **A1** is c.a.o and needs $1080x^2$ (if $1080x^2$ is written with no working this is awarded both marks i.e. **M1 A1.**)	
Special cases	$243+810x+1080x^2$ is **B1B0M1A1** (condone no negative signs) Follows correct answer with $27-90x+120x^2$ can isw here (sp case)– full marks for correct answer Misreads *ascending* and gives $-32x^5+240x^4-720x^3$ is marked as **B1B0M1A0** special case and must be completely correct. *(If any slips could get B0B0M1A0)* Ignores 3 and expands $(1\pm2x)^5$ is **0/4** 243, -810x, 1080x^2 is full marks but 243, -810, 1080 is **B1,B0,M1,A0** NB Alternative method $3^5(1-\frac{2}{3}x)^5 = 3^5 - 5\times3^5\times(\frac{2}{3}x)+\binom{5}{3}3^5\left(-\frac{2}{3}x\right)^2+..$ is **B0B0M1A0** – answers must be simplified to 243 –810x +1080x^2 for full marks (awarded as before) Special case $3(1-\frac{2}{3}x)^5 = 3-5\times3\times(\frac{2}{3}x)+\binom{5}{3}3\left(-\frac{2}{3}x\right)^2+..$ is **B0, B0, M1, A0** Or $\quad 3(1-2x)^5$ is **B0B0M0A0**	

Q6

Question Number	Scheme		Marks
(a)	$\binom{40}{4} = \dfrac{40!}{4!b!}$; $(1+x)^n$ coefficients of x^4 and x^5 are p and q respectively. $b = 36$ Candidates should usually "identify" two terms as their p and q respectively.		B1 (1)
(b)	Term 1: $\binom{40}{4}$ or ${}^{40}C_4$ or $\dfrac{40!}{4!36!}$ or $\dfrac{40(39)(38)(37)}{4!}$ or 91390	Any one of Term 1 or Term 2 correct. (Ignore the label of p and/or q.)	M1
	Term 2: $\binom{40}{5}$ or ${}^{40}C_5$ or $\dfrac{40!}{5!35!}$ or $\dfrac{40(39)(38)(37)(36)}{5!}$ or 658008	Both of them correct. (Ignore the label of p and/or q.)	A1
	Hence, $\dfrac{q}{p} = \dfrac{658008}{91390}\left\{= \dfrac{36}{5} = 7.2\right\}$	for $\dfrac{658008}{91390}$ oe	A1 oe cso (3) **[4]**
	Notes		
(a)	B1: for only $b = 36$.		
(b)	The candidate may expand out their binomial series. At this stage no marks should be awarded until they start to identify either one or both of the terms that they want to focus on. Once they identify their terms then if one out of two of them (ignoring which one is p and which one is q) is correct then award M1. If both of the terms are identified correctly (ignoring which one is p and which one is q) then award the first A1. Term 1 $= \binom{40}{4}x^4$ or ${}^{40}C_4(x^4)$ or $\dfrac{40!}{4!36!}x^4$ or $\dfrac{40(39)(38)(37)}{4!}x^4$ or $91390x^4$, Term 2 $= \binom{40}{5}x^5$ or ${}^{40}C_5(x^5)$ or $\dfrac{40!}{5!35!}x^5$ or $\dfrac{40(39)(38)(37)(36)}{5!}x^5$ or $658008x^5$ are fine for any (or both) of the first two marks in part (b). 2nd A1 for stating $\dfrac{q}{p}$ as $\dfrac{658008}{91390}$ or equivalent. Note that $\dfrac{q}{p}$ must be independent of x. Also note that $\dfrac{36}{5}$ or 7.2 or any equivalent fraction is fine for the 2nd A1 mark. SC: If candidate states $\dfrac{p}{q} = \dfrac{5}{36}$, then award M1A1A0. Note that either $\dfrac{4!36!}{5!35!}$ or $\dfrac{5!35!}{4!36!}$ would be awarded M1A1.		

Silver Questions

Calculators may not be used

The total mark for this section is 25

Q1

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

$$(2 - 5x)^6$$

Give each term in its simplest form.

(Total for Question 1 is 4 marks)

Q2

(a) Find the first 4 terms, in ascending powers of x, of the binomial expansion of $(1 + ax)^7$, where a is a constant. Give each term in its simplest form.

(4)

Given that the coefficient of x^2 in this expansion is 525,

(b) find the possible values of a.

(2)

(Total for Question 2 is 6 marks)

Q3

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

$$(2 + kx)^7$$

where k is a constant. Give each term in its simplest form.

(4)

Given that the coefficient of x^2 is 6 times the coefficient of x,

(b) find the value of k.

(2)

(Total for Question 3 is 6 marks)

Q4

(a) Use the binomial theorem to find all the terms of the expansion of

$$(2 + 3x)^4$$

Give each term in its simplest form.

(4)

(b) Write down the expansion of

$$(2 - 3x)^4$$

in ascending powers of x, giving each term in its simplest form.

(1)

(Total for Question 4 is 5 marks)

Q5

Find the first 4 terms, in ascending powers of x, of the binomial expansion of

$$\left(2 - \frac{1}{2}x\right)^8$$

giving each term in its simplest form.

(Total for Question 5 is 4 marks)

End of Questions

Silver Mark Scheme

Q1

Question Number	Scheme		Marks
	$(2-5x)^6$		
	$(2^6 =)\ 64$	Award this when first seen (not $64x^0$)	B1
	$+6\times(2)^5(-5x)+\dfrac{6\times 5}{2}(2)^4(-5x)^2$	Attempt binomial expansion with correct structure for at least one of these terms. E.g. a term of the form: $\binom{6}{p}\times(2)^{6-p}(-5x)^p$ with $p=1$ or $p=2$ consistently. Condone sign errors. Condone missing brackets if later work implies correct structure and allow alternative forms for binomial coefficients e.g. ${}^6C_1$ or $\binom{6}{1}$ or even $\left(\dfrac{6}{1}\right)$	M1
	$-960x$	Not $+-960x$	A1 (first)
	$(+)6000x^2$		A1 (Second)
			(4)
Way 2	$64(1\pm\ldots\ldots\ldots\ldots)$	**64 and** (1 ± ..... – Award when first seen.	B1
	$\left(1-\dfrac{5x}{2}\right)^6 = 1\ \underline{-6\times\dfrac{5x}{2}}+\underline{\dfrac{6\times 5}{2}\left(-\dfrac{5x}{2}\right)^2}$	Correct structure for at least one of the underlined terms. E.g. a term of the form: $\binom{6}{p}\times(kx)^p$ with $p=1$ or $p=2$ consistently and $k\neq\pm5$ Condone sign errors. Condoned missing brackets if later work implies correct structure but it must be an expansion of $(1-kx)^6$ where $k\neq\pm5$	M1
	$-960x$	Not $+-960x$	A1
	$(+)6000x^2$		A1
			(4)

Q2

Question Number	Scheme	Marks
	(a) $(1+ax)^7 = 1+7ax....$ or $1+7(ax)....$ (<u>Not</u> unsimplified versions)	B1
	$+\frac{7\times 6}{2}(ax)^2 + \frac{7\times 6\times 5}{6}(ax)^3$ Evidence from <u>one</u> of these terms is enough	M1
	$+21a^2x^2$ or $+21(ax)^2$ or $+21(a^2x^2)$	A1
	$+35a^3x^3$ or $+35(ax)^3$ or $+35(a^3x^3)$	A1
		(4)
	(b) $21a^2 = 525$	M1
	$a = \pm 5$ (Both values are required)	A1
	(The answer $a = 5$ with no working scores M1 A0)	(2)
		6
	(a) The terms can be 'listed' rather than added. M1: Requires correct structure: a correct binomial coefficient in any form (perhaps from Pascal's triangle) with the correct power of x. Allow missing a's and wrong powers of a, e.g. $\frac{7\times 6}{2}ax^2$, $\frac{7\times 6\times 5}{3\times 2}x^3$ However, $21+a^2x^2+35+a^3x^3$ or similar is M0. $1+7ax+21+a^2x^2+35+a^3x^3 = 57+.....$ scores the B1 (isw). $\begin{pmatrix}7\\2\end{pmatrix}$ and $\begin{pmatrix}7\\3\end{pmatrix}$ or equivalent such as ${}^7C_2$ and ${}^7C_3$ are acceptable, but <u>not</u> $\left(\frac{7}{2}\right)$ or $\left(\frac{7}{3}\right)$ (unless subsequently corrected). 1st A1: Correct x^2 term. 2nd A1: Correct x^3 term (The binomial coefficients <u>must</u> be simplified). <u>Special case</u>: If $(ax)^2$ and $(ax)^3$ are seen within the working, but then lost… … A1 A0 can be given if $21ax^2$ and $35ax^3$ are <u>both</u> achieved.	
	<u>a's omitted throughout</u>: Note that only the M mark is available in this case. (b) M: Equating their coefficent of x^2 to 525. An equation in a or a^2 alone is required for this M mark, but allow 'recovery' that shows <u>the required coefficient</u>, e.g. $21a^2x^2 = 525 \Rightarrow 21a^2 = 525$ is acceptable, but $21a^2x^2 = 525 \Rightarrow a^2 = 25$ is not acceptable. After $21ax^2$ in the answer for (a), allow 'recovery' of a^2 in (b) so that full marks are available for (b) (but not retrospectively for (a)).	

Q3

Question Number	Scheme	Marks
Q (a)	$(7\times\ldots\times x)$ or $(21\times\ldots\times x^2)$ The 7 or 21 can be in 'unsimplified' form.	M1
	$(2+kx)^7 = 2^7 + 2^6\times 7\times kx + 2^5\times\binom{7}{2}k^2x^2$	
	$= 128;\quad +448kx,\quad +672k^2x^2$ [or $672(kx)^2$]	B1; A1, A1
	(If $672kx^2$ follows $672(kx)^2$, isw and allow A1)	(4)
(b)	$6\times 448k = 672k^2$	M1
	$k = 4$ (Ignore $k = 0$, if seen)	A1 (2)
		[6]
(a)	The terms can be 'listed' rather than added. Ignore any extra terms. M1 for either the x term or the x^2 term. Requires correct binomial coefficient in any form with the correct power of x, but the other part of the coefficient (perhaps including powers of 2 and/or k) may be wrong or missing. Allow binomial coefficients such as $\binom{7}{1}, \left(\frac{7}{1}\right), \binom{7}{2}, {}^7C_1, {}^7C_2$. However, $448+kx$ or similar is M0. B1, A1, A1 for the simplified versions seen above. Alternative: Note that a factor 2^7 can be taken out first: $2^7\left(1+\frac{kx}{2}\right)^7$, but the mark scheme still applies. Ignoring subsequent working (isw): Isw if necessary after correct working: e.g. $128+448kx+672k^2x^2$ M1 B1 A1 A1 $=4+14kx+21k^2x^2$ isw (Full marks are still available in part (b)).	
(b)	M1 for equating their coefficient of x^2 to 6 times that of x… to get an equation in k, … or equating their coefficient of x to 6 times that of x^2, to get an equation in k. Allow this M mark even if the equation is trivial, providing their coefficients from part (a) have been used, e.g. $6\times 448k = 672k$, but beware $k=4$ following from this, which is A0. An equation in k alone is required for this M mark, so… e.g. $6\times 448kx = 672k^2x^2 \Rightarrow k=4$ or similar is M0 A0 (equation in coefficients only is never seen), but … e.g. $6\times 448kx = 672k^2x^2 \Rightarrow 6\times 448k = 672k^2 \Rightarrow k=4$ will get M1 A1 (as coefficients rather than terms have now been considered). The mistake $2\left(1+\frac{kx}{2}\right)^7$ would give a maximum of 3 marks: M1B0A0A0, M1A1	

Q4

Question Number	Scheme	Marks
	$(2+3x)^4$ - Mark (a) and (b) together	
(a)	$2^4 + {}^4C_1 2^3(3x) + {}^4C_2 2^2(3x)^2 + {}^4C_3 2^1(3x)^3 + (3x)^4$	
	First term of 16	B1
	$\left({}^4C_1 \times ... \times x\right) + \left({}^4C_2 \times ... \times x^2\right) + \left({}^4C_3 \times ... \times x^3\right) + \left({}^4C_4 \times ... \times x^4\right)$	M1
	$=(16+)\ 96x + 216x^2 + 216x^3 + 81x^4$ Must use Binomial – otherwise A0, A0	A1 A1
		(4)
(b)	$(2-3x)^4 = 16 - 96x + 216x^2 - 216x^3 + 81x^4$	B1ft
		(1)
		5
Alternative method (a)	$(2+3x)^4 = 2^4(1+\frac{3x}{2})^4$	
	$2^4(1 + {}^4C_1(\frac{3x}{2}) + {}^4C_2(\frac{3x}{2})^2 + {}^4C_3(\frac{3x}{2})^3 + (\frac{3x}{2})^4)$	
	Scheme is applied exactly as before	
	Notes for Question	
(a)	B1: The constant term should be 16 in their expansion	
	M1: Two binomial coefficients must be correct and must be with the correct power of x. Accept ${}^4C_1$ or $\binom{4}{1}$ or 4 **as a coefficient, and** ${}^4C_2$ or $\binom{4}{2}$ or 6 **as another**…….. Pascal's triangle may be used to establish coefficients.	
	A1: Any two of the final four terms correct (i.e. two of $96x + 216x^2 + 216x^3 + 81x^4$) in expansion following Binomial Method.	
	A1: All four of the final four terms correct in expansion. (Accept answers without + signs, can be listed with commas or appear on separate lines)	
(b)	B1ft: Award for correct answer as printed above or **ft their previous answer** provided it has **five terms** ft and must be **subtracting the** x **and** x^3 **terms**	
	Allow terms in (b) to be in descending order and allow +-96x and +-216x^3 in the series. (Accept answers without + signs, can be listed with commas or appear on separate lines)	
	e.g. The common error $2^4 + {}^4C_1 2^3 3x + {}^4C_2 2^2 3x^2 + {}^4C_3 2^1 3x^3 + 3x^4 = (16) + 96x + 72x^2 + 24x^3 + 3x^4$ would earn B1, M1, A0, A0, and if followed by $=(16) - 96x + 72x^2 - 24x^3 + 3x^4$ gets B1ft so 3/5	
	Fully correct answer with no working can score B1 in part (a) and B1 in part (b). The question stated use the Binomial theorem and if there is no evidence of its use then M mark and hence A marks cannot be earned.	
	Squaring the bracket and squaring again may also earn **B1 M0 A0 A0 B1 if correct**	
	Omitting the final term but otherwise correct is B1 M1 A1 A0 B0ft so 3/5	
	If the series is divided through by 2 or a power of 2 at the final stage after an error or omission resulting in all even coefficients then apply scheme to series before this division and ignore subsequent work (isw)	

Q5

Question Number	Scheme	Marks
Way 1	$\left(2-\frac{1}{2}x\right)^8 = 2^8 + \binom{8}{1}.2^7\left(-\frac{1}{2}x\right)+\binom{8}{2}2^6\left(-\frac{1}{2}x\right)^2+\binom{8}{3}2^5\left(-\frac{1}{2}x\right)^3$	
	First term of 256	B1
	$\left({}^8C_1\times\ldots\times x\right)+\left({}^8C_2\times\ldots\times x^2\right)+\left({}^8C_3\times\ldots\times x^3\right)$	M1
	$=(256)-512x+448x^2-224x^3$	A1, A1
		(4)
		Total 4
Way 2	$\left(2-\frac{1}{2}x\right)^8 = 2^8\left(1-\frac{1}{4}x\right)^8 = 2^8\left(1+\binom{8}{1}.\left(-\frac{1}{4}x\right)+\binom{8}{2}\left(-\frac{1}{4}x\right)^2+\binom{8}{3}\left(-\frac{1}{4}x\right)^3\right)$ Scheme is applied exactly as before except in special case below*	
	Notes for Question	
	B1: The first term should be 256 in their expansion M1: Two binomial coefficients must be correct and must be with the correct power of x. Accept ${}^8C_1$ or $\binom{8}{1}$ or 8 **as a coefficient, and** ${}^8C_2$ or $\binom{8}{2}$ or 28 **as another……..** Pascal's triangle may be used to establish coefficients. A1: Any two of the final three terms correct (but allow +- instead of -) A1: All three of the final three terms correct and simplified. (Deduct last mark for +-512x *and* +-224x^3 in the series). Also deduct last mark for the three terms correct but unsimplified. (Accept answers without + signs, can be listed with commas or appear on separate lines) The common error $\left(2-\frac{1}{2}x\right)^8 = 256+\binom{8}{1}.2^7\left(-\frac{1}{2}x\right)+\binom{8}{2}2^6\left(-\frac{1}{2}x^2\right)+\binom{8}{3}2^5\left(-\frac{1}{2}x^3\right)$ would earn B1, M1, A0, A0 **Ignore extra terms** involving higher powers. Condone terms in reverse order i.e. $=-224x^3+448x^2-512x+(256)$ ***In Way 2 the error** $=2\left(1+\binom{8}{1}.\left(-\frac{1}{4}x\right)+\binom{8}{2}\left(-\frac{1}{4}x\right)^2+\binom{8}{3}\left(-\frac{1}{4}x\right)^3\right)$ giving $=2-4x+\frac{7}{2}x^2-\frac{7}{4}x^3$ is a **special case** B0, M1, A1, A0 i.e. 2/4	

Gold Questions

Calculators may not be used

The total mark for this section is 33

Q1

Find the first 4 terms, in ascending powers of x, of the binomial expansion of

$$\left(1+\frac{3x}{2}\right)^8$$

giving each term in its simplest form.

(Total for Question 1 is 4 marks)

Q2

(a) Find the first 4 terms of the expansion of $\left(1+\frac{x}{2}\right)^{10}$ in ascending powers of x, giving each term in its simplest form.

(4)

(b) Use your expansion to estimate the value of $(1.005)^{10}$, giving your answer to 5 decimal places.

(3)

(Total for Question 2 is 7 marks)

Q3

(a) Find the first four terms, in ascending powers of x, in the binomial expansion of $(1 + kx)^6$, where k is a non-zero constant.

(3)

Given that, in this expansion, the coefficients of x and x^2 are equal, find

(b) the value of k,

(2)

(c) the coefficient of x^3 .

(1)

(Total for Question 3 is 6 marks)

Q4

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

$$(2 - 9x)^4$$

giving each term in its simplest form.

(4)

$$\mathrm{f}(x) = (1 + kx)(2 - 9x)^4, \text{ where } k \text{ is a constant}$$

The expansion, in ascending powers of x, of $\mathrm{f}(x)$ up to and including the term in x^2 is

$$A - 232x + Bx^2$$

where A and B are constants.

(b) Write down the value of A.

(1)

(c) Find the value of k.

(2)

(d) Hence find the value of B.

(2)

(Total for Question 4 is 9 marks)

Q5

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

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

giving each term in its simplest form.

(4)

(b) Use your expansion to estimate the value of $(1.025)^8$, giving your answer to 4 decimal places.

(3)

(Total for Question 5 is 7 marks)

End of Questions

Gold Mark Scheme

Q1

<table>
<tr><th>Question Number</th><th colspan="2">Scheme</th><th>Marks</th></tr>
<tr><td rowspan="7"></td><td colspan="2">$\left(1+\frac{3x}{2}\right)^8$</td><td></td></tr>
<tr><td>$1+12x$</td><td>Both terms correct as printed (allow $12x^1$ but not 1^8)</td><td>B1</td></tr>
<tr><td>$...+\frac{8(7)}{2!}\left(\frac{3x}{2}\right)^2+\frac{8(7)(6)}{3!}\left(\frac{3x}{2}\right)^3+...$
$...+{}^8C_2\left(\frac{3x}{2}\right)^2+{}^8C_3\left(\frac{3x}{2}\right)^3+...$</td><td>$\left(\frac{8(7)}{2!}\times...\times x^2\right)$ or $\left(\frac{8(7)(6)}{3!}\times...\times x^3\right)$ or
$\left({}^8C_2\times...\times x^2\right)$ or $\left({}^8C_3\times...\times x^3\right)$
M1: For <u>either</u> the x^2 term <u>or</u> the x^3 term. Requires <u>correct</u> binomial coefficient in any form <u>with the correct power of x</u>, but the other part of the coefficient (perhaps including powers of 2 and/or 3 or signs) may be wrong or missing.</td><td>M1</td></tr>
<tr><td colspan="2"><u>Special Case:</u> Allow this M1 <u>only</u> for an attempt at a descending expansion provided the equivalent conditions are met for any term <u>other than the first</u>
e.g.
$...+8\left(\frac{3x}{2}\right)^7(1)+\frac{8(7)}{2!}\left(\frac{3x}{2}\right)^6(1)^2+...$
$...+{}^8C_1\left(\frac{3x}{2}\right)^7+{}^8C_2\left(\frac{3x}{2}\right)^6+...$</td><td></td></tr>
<tr><td>$...+63x^2+189x^3+...$</td><td>A1: Either $63x^2$ or $189x^3$
A1: Both $63x^2$ and $189x^3$</td><td>A1A1</td></tr>
<tr><td colspan="2">Terms may be listed but must be positive</td><td></td></tr>
<tr><td colspan="2"></td><td>[4]</td></tr>
<tr><td></td><td colspan="2"></td><td>Total 4</td></tr>
<tr><td></td><td colspan="2">Note it is common not to square the 2 in the denominator of $\left(\frac{3x}{2}\right)$ and this gives $1+12x+126x^2+756x^3$. This could score B1M1A0A0.</td><td></td></tr>
<tr><td></td><td colspan="2">Note $...+{}^8C_2\left(1^4+\frac{3x}{2}\right)^2+{}^8C_3\left(1^3+\frac{3x}{2}\right)^3+...$ would score M0 unless a correct method was implied by later work</td><td></td></tr>
</table>

Q2

Question Number	Scheme	Marks
(a)	$\left(1+\frac{1}{2}x\right)^{10}$ **=** 1 + $\underline{\binom{10}{1}\left(\frac{1}{2}x\right)+\binom{10}{2}\left(\frac{1}{2}x\right)^2+\binom{10}{3}\left(\frac{1}{2}x\right)^3}$	M1 A1
	= 1 + $5x$; + $\frac{45}{4}$(or 11.25)x^2 + $15x^3$ (coeffs need to be these, i.e, simplified)	A1; A1 (4)
	[Allow A1A0, if totally correct with unsimplified, single fraction coefficients)	
(b)	$(1+\frac{1}{2}\times 0.01)^{10}$ = 1 + 5(0.01) + $(\frac{45}{4}$ $or 11.25)(0.01)^2$ + $15(0.01)^3$	M1 A1√
	= 1 + 0.05 + 0.001125 + 0.000015	
	= 1.05114 cao	A1 (3) **[7]**
Notes:	(a) For M1 first A1: Consider underlined expression only. M1 Requires correct structure for at least two of the three terms: (i) Must be attempt at binomial coefficients. [Be generous :allow all notations e.g. ${}^{10}C_2$, even $\left(\frac{10}{2}\right)$; allow "slips".] (ii) Must have increasing powers of x , (iii) May be listed, need not be added; *this applies for all marks.* First A1: Requires **all three** correct terms but need not be simplified, allow 1^{10} etc, ${}^{10}C_2$ etc, and condone omission of brackets around powers of ½x Second A1: Consider as B1: **1 + 5x can score A1 on Epen, even after M0** (b) For M1: Substituting **their** (0.01) into their (a) result [0.1, 0.001, 0.25, 0.025,0.0025 acceptable but **not** 0.005 or 1.005] First A1 (f.t.): Substitution of (**0.01**) into **their 4 termed** expression in (a) **Answer with no working** scores **no marks** (calculator gives this answer)	

Q3

Question number	Scheme	Marks
	(a) $1+6kx$ [Allow unsimplified versions, e.g. $1^6+6(1^5)kx$, ${}^6C_0+{}^6C_1kx$]	B1
	$+\frac{6\times5}{2}(kx)^2+\frac{6\times5\times4}{3\times2}(kx)^3$ [See below for acceptable versions]	M1 A1 (3)
	N.B. THIS NEED NOT BE SIMPLIFIED FOR THE A1 (isw is applied)	
	(b) $6k=15k^2$ $k=\frac{2}{5}$ (or equiv. fraction, or 0.4) (Ignore $k=0$, if seen)	M1 A1cso (2)
	(c) $c=\frac{6\times5\times4}{3\times2}\left(\frac{2}{5}\right)^3=\frac{32}{25}$ (or equiv. fraction, or 1.28)	A1cso (1)
	(Ignore x^3, so $\frac{32}{25}x^3$ is fine)	
		6

	(a) The terms can be 'listed' rather than added. M1: Requires correct structure: 'binomial coefficients' (perhaps from Pascal's triangle), increasing powers of x. Allow a 'slip' or 'slips' such as: $+\frac{6\times5}{2}kx^2+\frac{6\times5\times4}{3\times2}kx^3$, $+\frac{6\times5}{2}(kx)^2+\frac{6\times5}{3\times2}(kx)^3$ $+\frac{5\times4}{2}kx^2+\frac{5\times4\times3}{3\times2}kx^3$, $+\frac{6\times5}{2}x^2+\frac{6\times5\times4}{3\times2}x^3$ <u>But</u>: $15+k^2x^2+20+k^3x^3$ or similar is M0. Both x^2 and x^3 terms must be seen. $\binom{6}{2}$ and $\binom{6}{3}$ or equivalent such as ${}^6C_2$ and ${}^6C_3$ are acceptable, and even $\left(\frac{6}{2}\right)$ and $\left(\frac{6}{3}\right)$ are acceptable for the method mark. A1: Any correct (possibly unsimplified) version of these 2 terms. $\binom{6}{2}$ and $\binom{6}{3}$ or equivalent such as ${}^6C_2$ and ${}^6C_3$ are acceptable. <u>Descending powers of x:</u> Can score the M mark if the required first 4 terms are not seen. <u>Multiplying out</u> $(1+kx)(1+kx)(1+kx)(1+kx)(1+kx)(1+kx)$: M1: A full attempt to multiply out (power 6) B1 and A1 as on the main scheme. (b) M: Equating the coefficients of x and x^2 (even if trivial, e.g. $6k=15k$). Allow this mark also for the 'misread': equating the coefficients of x^2 and x^3. An equation in k alone is required for this M mark, although… …condone $6kx=15k^2x^2\Rightarrow\left(6k=15k^2\Rightarrow\right)k=\frac{2}{5}$.	

Q4.

Question Number	Scheme		Marks
	(a) $(2-9x)^4 = 2^4 + {}^4C_1 2^3(-9x) + {}^4C_2 2^2(-9x)^2$, (b) $f(x) = (1+kx)(2-9x)^4 = A - 232x + Bx^2$		
(a) Way 1	First term of 16 in their final series		B1
	At least one of $({}^4C_1 \times ... \times x)$ or $({}^4C_2 \times ... \times x^2)$		M1
	$= (16) - 288x + 1944x^2$	At least one of $-288x$ or $+1944x^2$	A1
		Both $-288x$ **and** $+1944x^2$	A1
			[4]
(a)	$(2-9x)^4 = (4-36x+81x^2)(4-36x+81x^2)$		
		First term of 16 in their final series	B1
Way 2	$= 16 - 144x + 324x^2 - 144x + 1296x^2 + 324x^2$	Attempts to multiply a 3 term quadratic by the same 3 term quadratic to achieve either 2 terms in x or at least 2 terms in x^2.	M1
	$= (16) - 288x + 1944x^2$	At least one of $-288x$ or $+1944x^2$	A1
		Both $-288x$ **and** $+1944x^2$	A1
			[4]
(a) Way 3	$\{(2-9x)^4 =\}\ 2^4\left(1-\frac{9}{2}x\right)^4$	First term of 16 in final series	B1
	$= 2^4\left(1 + \underline{4\left(-\frac{9}{2}x\right) + \frac{4(3)}{2}\left(-\frac{9}{2}x\right)^2} + ...\right)$	At least one of $\underline{(4 \times ... \times x)\text{ or }\left(\frac{4(3)}{2} \times ... \times x^2\right)}$	M1
	$= (16) - 288x + 1944x^2$	At least one of $-288x$ or $+1944x^2$	A1
		Both $-288x$ **and** $+1944x^2$	A1
			[4]
	Parts (b), (c) and (d) may be marked together		
(b)	$A = "16"$	Follow through their value from (a)	B1ft
			[1]
(c)	$\{(1+kx)(2-9x)^4\} = (1+kx)(16 - 288x + \{1944x^2 + ...\})$	*May be seen in part (b) or (d) and can be implied by work in parts (c) or (d).*	M1
	x terms: $-288x + 16kx = -232x$		
	giving, $16k = 56 \Rightarrow \underline{k = \frac{7}{2}}$	$\underline{k = \frac{7}{2}}$	A1
			[2]
(d)	x^2 terms: $1944x^2 - 288kx^2$		
	So, $B = 1944 - 288\left(\frac{7}{2}\right)$; $= 1944 - 1008 = 936$	See notes	M1
		936	A1
			[2]
			9

	Question Notes	
(a) **Ways 1 and 3**	**B1 cao**	16
	M1	Correct binomial coefficient associated with correct power of x *i.e* $\left({}^4C_1 \times ... \times x\right)$ or $\left({}^4C_2 \times ... \times x^2\right)$ They may have 4 and 6 or 4 and $\frac{4(3)}{2}$ or even $\binom{4}{1}$ and $\binom{4}{2}$ as their coefficients. Allow missing signs and brackets for the M marks.
	1st A1	At least one of $-288x$ or $+1944x^2$ (allow +- 288x)
	2nd A1	Both $-288x$ **and** $+1944x^2$ (May list terms separated by commas) Also full marks for correct answer with no working here. Again allow +- 288x
	Note	If the candidate then divides their final correct answer through by 8 or any other common factor then isw and mark correct series when first seen. So (a) B1M1A1A1 .It is likely that this approach will be followed by (b) B0, (c) M1A0, (d) M1A0 if they continue with their new series e.g. $2-36x+283x^2+...$ (Do not ft the value 2 as a mark was awarded for 16)
Way 2b	**Special Case**	**Slight Variation on the solution given in the scheme** $(2-9x)^4 = (2-9x)(2-9x)(4-36x+81x^2)$ $= (2-9x)(8-108x+486x^2+...)$
		$= 16 - 216x + 972x^2 - 72x + 972x^2$ — First term of 16: **B1**; Multiplies out to give either 2 terms in x or 2 terms in x^2.: **M1**
		$= (16) - 288x + 1944x^2 + ...$ — At least one of $-288x$ or $+1944x^2$: **A1**; Both $-288x$ **and** $+1944x^2$: **A1**
		Parts (b), (c) and (d) may be marked together.
(b)	**B1ft**	Must **identify** $A = 16$ or $A =$ *their* constant term found in part (a). Or may write just 16 if this is clearly their answer to part (b). If they expand their series and have 16 as first term of a series it is not sufficient for this mark.
(c)	**M1**	Candidate shows intention to multiply $(1+kx)$ by part of their series from (a) e.g. Just $(1+kx)(16-288x+...)$ or $(1+kx)(16-288x+1944x^2+...)$ are fine for M1.
	Note	This mark can also be implied by candidate multiplying out to find **two terms** (or coefficients) in x. i.e. f.t. their $-288x+16kx$ N.B. $-288kx = -232x$ with no evidence of brackets is M0 – allow copying slips, or use of factored series, as this is a method mark
	A1	$k = \frac{7}{2}$ o.e. so 3.5 is acceptable
(d)	**M1**	Multiplies out their $(1+kx)(16-288x+1944x^2+...)$ to give **exactly** two terms (or coefficients) in x^2 and attempts to find B using these two terms and a numerical value of k.
	A1	936
	Note	Award A0 for $B = 936x^2$ But allow A1 for $B = 936x^2$ **followed by** $B = 936$ and treat this as a correction Correct answers in parts (c) and (d) with no method shown may be awarded full credit.

Q5

Question number	Scheme	Marks
(a).	$(1+\frac{x}{4})^8 = 1+2x+..,\ \ ......$	B1
	$+\frac{8\times7}{2}(\frac{x}{4})^2+\frac{8\times7\times6}{2\times3}(\frac{x}{4})^3,$	M1 A1
	$= \quad +\frac{7}{4}x^2+\frac{7}{8}x^3$ or $= \quad +1.75x^2+0.875x^3$	A1 (4)
(b)	States or implies that $x = 0.1$	B1
	Substitutes their value of x (provided it is <1) into series obtained in (a)	M1
	i.e. $1 + 0.2 + 0.0175 + 0.000875,\ = 1.2184$	A1 cao (3) 7
Alternative for (b) Special case	Starts again and expands $(1+0.025)^8$ to $1+\ 8\times0.025\ +\frac{8\times7}{2}(0.025)^2+\frac{8\times7\times6}{2\times3}(0.025)^3,\ =1.2184$ (Or $1 + 1/5 + 7/400 + 7/8000 = 1.2184$)	B1,M1,A1
Notes	**(a) B1** must be simplified The **method** mark **(M1)** is awarded for an attempt at Binomial to get the third and/or fourth term – need correct binomial coefficient combined with correct power of x. Ignore bracket errors or errors in powers of 4. Accept any notation for ${}^8C_2$ and ${}^8C_3$, e.g. $\binom{8}{2}$ and $\binom{8}{3}$ (unsimplified) or 28 and 56 from Pascal's triangle. (The terms may be listed without + signs) First **A1** is for two completely correct unsimplified terms **A1** needs the fully simplified $\frac{7}{4}x^2$ *and* $\frac{7}{8}x^3$. **(b) B1** – states or uses x =0.1 or $\frac{x}{4}=\frac{1}{40}$ **M1** for substituting their value of x (0 < x <1) into expansion (e.g. 0.1 (correct) or 0.01, 0.00625 or even 0.025 but **not** 1 nor 1.025 which would earn **M0**) **A1** Should be answer printed cao (not answers which round to) and should follow correct work. **Answer with no working at all** is B0, M0, A0 States 0.1 then just writes down answer is B1 M0A0	

Platinum Questions

Calculators may not be used

The total mark for this section is 15

1 In the binomial expansion of

$$\left(1+\frac{12n}{5}x\right)^n$$

the coefficients of x^2 and x^3 are equal and non-zero.

(a) Find the possible values of n.

(4)

(b) State, giving a reason, which value of n gives a valid expansion when $x = \frac{1}{2}$

(2)

(Total for Question 1 is 6 marks)

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2 In the binomial expansion of

$$(1 - 4x)^p, \quad |x| < \tfrac{1}{4},$$

the coefficient of x^2 is equal to the coefficient of x^4 and the coefficient of x^3 is positive.

Find the value of p.

(Total for Question 2 is 9 marks)

End of Questions

Platinum Mark Scheme

Question	Scheme	Marks
1. (a)	$\frac{n(n-1)}{2!}\left(\frac{12n}{5}\right)^2 = \frac{n(n-1)(n-2)}{3!}\left(\frac{12n}{5}\right)^3$	M1
	$3\times5 = n(n-2)\times12$ or $4n^2-8n-5=0$ (o.e.)	A1
	$(2n+1)(2n-5)=0$	dM1
	$\underline{n=-\frac{1}{2},\frac{5}{2}}$	A1 (4)
(b)	$n=-\frac{1}{2}$ in $\left\|\frac{12nx}{5}\right\|<1$ gives $\|x\|<\frac{5}{6}$ and $n=\frac{5}{2}$ in $\left\|\frac{12nx}{5}\right\|$ gives $\|x\|<\frac{1}{6}$	M1
	So should choose $n=-\frac{1}{2}$	A1 (2)
		[6]

2.	$(1-4x)^p =$	
	$\frac{p(p-1)}{2!}(-4x)^2 + \frac{p(p-1)(p-2)}{3!}(-4x)^3 + \frac{p(p-1)(p-2)(p-3)}{4!}(-4x)^4 \ldots$	M1 at least x^2 term
	Equation: $\frac{p(p-1)}{2!}\times4^2 = \frac{p(p-1)(p-2)(p-3)}{4!}\times4^4$ attempt equation	M1 (ignore x's)
	$1 = \frac{(p-2)(p-3)\times16}{12}$ cancel or factor $p(p-1)$	M1
	i.e. $0 = 4p^2 - 20p + 21$	A1
	i.e. $0 = (2p-3)(2p-7)$ solving	M1
	i.e. $p = \frac{3}{2}$ or $\frac{7}{2}$ both	A1
	coefficient of $x^3 > 0 \Rightarrow p(p-1)(p-2) < 0$ x^3 coefficient examined	M1
	so $p \neq 0$ and $p \neq 1$	A1
	$p \neq \frac{7}{2}$ $\therefore p = \frac{3}{2}$	A1
		(9 marks)