Question			Answer	Marks	Guidance
1	(i)		$\frac{1}{\sqrt[3]{1-2x}}=(1-2x)^{-1/3}$	B1	$n = -1/3$. See below **SC** for those with $n = 1/3$
			$=1+(-\frac{1}{3})(-2x)+\frac{(-\frac{1}{3})(-\frac{4}{3})}{2!}(-2x)^2+...$	M1	All three **correct unsimplified binomial** coefficients (not nCr) soi condone absence of brackets only if it is clear from subsequent work that they were assumed
				B1	$1+(2/3)x+...$ www
			$=1+\frac{2}{3}x+\frac{8}{9}x^2+...$	B1	$(8/9)x^2$ www in this term If there is an error, in say, the third coefficient of the expansion then M0B1B0 is possible **SC** For $n = 1/3$ award B1 for $1-(2/3)x$ and B1 for $-(4/9)x^2$ (so max 2 out of the first 4 marks)
			Valid for $-\frac{1}{2}<x<\frac{1}{2}$ or $\lvert x\rvert<\frac{1}{2}$	B1	Independent of expansion. Accept, say, $-1/2<\lvert x\rvert<1/2$ or $-1/2\le x<1/2$ (must be strict inequality for +1/2)
				[5]	
1	(ii)		$\frac{1-3x}{\sqrt[3]{1-2x}}=(1-3x)(1+\frac{2}{3}x+\frac{8}{9}x^2+...)$		
			$=1+\frac{2}{3}x+\frac{8}{9}x^2-3x-2x^2+...$	M1	Use of $(1-3x)\times$ their$\left(1+(2/3)x+(8/9)x^2+\cdots\right)$ and attempt at removal of brackets (condone absence of brackets but must have two terms in x and two terms in x^2)
				A1ft	Correct simplified expansion following their expansion in (i). This mark is dependent on scoring both M marks in (i) and (ii)
			$=1-\frac{7}{3}x-\frac{10}{9}x^2+...$	A1	cao or B3 www in either part **SC** following either M0 or M1, B1 for either a or b correct
				[3]	

Question			Answer	Marks	Guidance
2			$(4+x)^{\frac{3}{2}} = 4^{\frac{3}{2}}(1+\frac{1}{4}x)^{\frac{3}{2}}$	M1	dealing with the '4' to obtain $4^{3/2}(1+\frac{x}{4})^{3/2}$ (or expanding as $4^{3/2}+\frac{3}{2}4^{1/2}x+\left(\frac{3}{2}\right)\left(\frac{1}{2}\right)4^{-1/2}\frac{x^2}{2!}+\ldots$ and having all the powers of 4 correct)
			$= 8(1+\frac{3}{2}(\frac{1}{4}x)+\frac{3}{2}.\frac{1}{2}.\frac{1}{2!}(\frac{1}{4}x)^2+\ldots$	M1	correct binomial coeffs for $n = 3/2$ ie 1, 3/2, 3/2.1/2.1/2! Not nCr form Indep of coeff of x Indep of first M1
			$= 8+3x$	A1	$8 + 3x$ www
			$+3/16\ x^2$	A1	…+ $3/16\ x^2$ www Ignore subsequent terms
			Valid for $-4 < x < 4$ or $\|x\| < 4$	B1	accept ≤ s or a combination of < and ≤ , but not $-4 > x > 4$, $\|x\| > 4$, or say $-4 < x$ condone $-4 < \|x\| < 4$ Indep of all other marks Allow MR throughout this question for $n = m/2$ where $m \in \mathbb{N}$, and m odd and then –1 MR provided it is at least as difficult as the original.
				[5]	

Question			Answer	Marks	Guidance
3	**(i)**		$\frac{x}{(1+x)(1-2x)} = \frac{A}{1+x} + \frac{B}{1-2x}$		
			$\Rightarrow \quad x = A(1-2x) + B(1+x)$	M1	expressing in partial fractions of correct form (at any stage) and attempting to use cover up, substitution or equating coefficients Condone a single sign error for M1 only.
			$x = ½ \Rightarrow ½ = B(1 + ½) \Rightarrow B = 1/3$	A1	www cao
			$x = -1 \Rightarrow -1 = 3A \Rightarrow A = -1/3$	A1	www cao
					(accept A/(1+x) +B/(1-2x) , A = −1/3, B = 1/3 as sufficient for full marks without needing to reassemble fractions with numerical numerators)
				[3]	

Question			Answer	Marks	Guidance
3	(ii)		$\frac{x}{(1+x)(1-2x)} = \frac{-1/3}{1+x} + \frac{1/3}{1-2x}$		
			$= \frac{1}{3}\left[(1-2x)^{-1} - (1+x)^{-1}\right]$	M1	correct binomial coefficients throughout for first three terms of **either** $(1-2x)^{-1}$ or $(1+x)^{-1}$ oe ie 1,(−1),(−1)(−2)/2 , not nCr form. Or correct simplified coefficients seen.
			$= \frac{1}{3}[1+(-1)(-2x)+\frac{(-1)(-2)}{2}(-2x)^2+... -(1+(-1)x+\frac{(-1)(-2)}{2}x^2+...)]$		
			$= \frac{1}{3}[1+2x+4x^2+... -(1-x+x^2+...)]$	A1 A1	$1 + 2x + 4x^2$ $1 - x + x^2$ (or 1/3/-1/3 of each expression, ft their *A*/*B*) If $k(1-x+x^2)$ (A1) not clearly stated separately, condone absence of inner brackets (ie $1+2x+4x^2$<u>$-1-x+x^2$)</u> **only if** subsequently it is clear that brackets were assumed, otherwise A1A0. [ie $-1-x+x^2$ is A0 unless it is followed by the correct answer] Ignore any subsequent incorrect terms
			$= \frac{1}{3}(3x+3x^2+...) = x + x^2 + ...$ so $a = 1$ and $b = 1$	A1	or from expansion of $x(1-2x)^{-1}(1+x)^{-1}$ www cao
			OR $x(1-x-2x^2) = x(1-(x+2x^2))$	M1	correct binomial coefficients throughout for $(1-(x+2x^2))$ oe (ie 1,-1), at least as far as necessary terms $(1+x)$ (NB third term of expansion unnecessary and can be ignored)
			$= x(1 + x + 2x^2 + (-1)(-2)(x + 2x^2)^2/2 + \ldots\ldots\ldots)$		
			$= x(1 + x + 2x^2 + x^2\ldots\ldots\ldots)$	A2	$x(1+x)$ www
			$= x + x^2\ldots\ldots$ so $a = 1$ and $b = 1$	A1	ww cao
			Valid for $-½ < x < ½$ or $\|x\| < ½$	B1 **[5]**	independent of expansion. Must combine as one overall range. condone ≤ s (although incorrect) or a combination. Condone also, say $-½ < \|x\| < ½$ but not $x < ½$ or $-1 < 2x < 1$ or $-½ > x > ½$

Question			Answer	Marks	Guidance
4			$(1+2x)^{1/2}=1+\frac{1}{2}(2x)+\frac{\frac{1}{2}.(-\frac{1}{2})}{2!}(2x)^2+\frac{\frac{1}{2}.(-\frac{1}{2})(-\frac{3}{2})}{3!}(2x)^3+...$	M1	Do not MR for $n \neq 1/2$ All four correct binomial coeffs (not nCr form) soi Accept **unsimplified** coefficients if a subsequent error when simplifying.
				B1	Condone absence of brackets only if followed by correct work eg $2x^2 = 4x^2$ must be soi for second B mark. $1 + x$ www
			$= 1 + x - ½ x^2 + ½ x^3 + \ldots$	B1 B1	$\ldots - ½ x^2$ www $\ldots + ½ x^3$ www If there is an error in say the third coeff of the expansion, M0, B1, B0, B1 can be scored
			Valid for $\lvert x \rvert < 1/2$ or $-1/2 < x < 1/2$	B1 **[5]**	Independent of expansion $\lvert x \rvert \leq 1/2$ and $-1/2 \leq x \leq 1/2$ are actually correct in this case so we will accept them. Condone a combination of inequalities. Condone also, say $-1/2 < \lvert x \rvert < 1/2$ but not $x < 1/2$ or $-1 < 2x < 1$ or $-1/2 > x > 1/2$

5 $(1+3x)^{\frac{1}{3}} = 1 + \frac{1}{3}(3x) + \frac{\frac{1}{3}.(-\frac{2}{3})}{2!}(3x)^2 + \ldots$ $= 1 + x - x^2 + \ldots$	M1 A1 A1	correct binomial coefficients $1 + x \ldots$ $\ldots - x^2$	ie 1, 1/3, (1/3)(-2/3)/2 not *nCr* form simplified www in this part simplified www in this part, ignore subsequent terms using $(3x)^2$ as $3x^2$ can score M1B1B0 condone omission of brackets if $3x^2$ is used as $9x^2$ do not allow MR for power 3 or -1/3 or similar
Valid for $-1 \le 3x \le 1$ $\Rightarrow$ $-1/3 \le x \le 1/3$	M1 A1 [5]	or $\lvert 3x \rvert \le 1$ oe or $\lvert x \rvert \le 1/3$ (correct final answer scores M1A1)	**condone inequality signs throughout** or say < at one end and ≤ at the other condone $-1/3 \le \lvert x \rvert \le 1/3$, $x \le 1/3$ is M0A0 the last two marks are not dependent on the first three

6(i) $\frac{3+2x^2}{(1+x)^2(1-4x)} = \frac{A}{1+x} + \frac{B}{(1+x)^2} + \frac{C}{1-4x}$ $\Rightarrow 3+2x^2 = A(1+x)(1-4x) + B(1-4x) + C(1+x)^2$ $x = -1 \Rightarrow 5 = 5B \Rightarrow B = 1$ $x = ¼ \Rightarrow 3\frac{1}{8} = \frac{25}{16}C \Rightarrow C = 2$ coeff[t] of x^2: $2 = -4A + C \Rightarrow A = 0$.	M1 B1 B1 E1 [4]	Clearing fractions (or any 2 correct equations) $B = 1$ www $C = 2$ www $A = 0$ needs justification
(ii) $(1 + x)^{-2} = 1 + (-2)x + (-2)(-3)x^2/2! + \ldots$ $= 1 - 2x + 3x^2 + \ldots$ $(1 - 4x)^{-1} = 1 + (-1)(-4x) + (-1)(-2)(-4x)^2/2! + \ldots$ $= 1 + 4x + 16x^2 + \ldots$ $\frac{3+2x^2}{(1+x)^2(1-4x)} = (1+x)^{-2} + 2(1-4x)^{-1}$ $\approx 1 - 2x + 3x^2 + 2(1 + 4x + 16x^2) = 3 + 6x + 35x^2$	M1 A1 A1 A1ft [4]	Binomial series (coefficients unsimplified - for either or $(3+2x^2)(1+x)^{-2}(1-4x)^{-1}$ expanded theirA,B,C and their expansions

7	$\sqrt{4+2x} = 2(1+\frac{1}{2}x)^{\frac{1}{2}}$	**M1**	Taking out 4 oe
	$= 2\{1+\frac{1}{2}.(\frac{1}{2}x)+\frac{\frac{1}{2}.(-\frac{1}{2})}{2!}(\frac{1}{2}x)^2+\frac{\frac{1}{2}.(-\frac{1}{2}).(-\frac{3}{2})}{3!}(\frac{1}{2}x)^3+\ldots\}$	**M1**	correct binomial coefficients
	$= k\left(1+\frac{1}{4}x-\frac{1}{32}x^2+\frac{1}{128}x^3+\ldots\right)$	**A2,1,0**	$\frac{1}{4}x, -\frac{1}{32}x^2, +\frac{1}{128}x^3$
	$= \left(2+\frac{1}{2}x-\frac{1}{16}x^2+\frac{1}{64}x^3+\ldots\right)$	**A1cao**	
	Valid for $-2 < x < 2$.	**B1cao** **[6]**	