Question	Scheme	Marks	AOs
7(a)	$\sqrt{4-9x} = 2\left(1 \pm ...\right)^{\frac{1}{2}}$	B1	1.1b
	$\left(1-"\frac{9x}{4}"\right)^{\frac{1}{2}} = ... + \frac{\frac{1}{2}\times\left(-\frac{1}{2}\right)\left("-\frac{9x}{4}"\right)^2}{2!}$ or $... + \frac{\frac{1}{2}\times\left(-\frac{1}{2}\right)\times\left(-\frac{3}{2}\right)\left("-\frac{9x}{4}"\right)^3}{3!}$	M1	1.1b
	$1+\frac{1}{2}\times\left(-\frac{9x}{4}\right)+\frac{\frac{1}{2}\times\left(-\frac{1}{2}\right)\left(-\frac{9x}{4}\right)^2}{2!}+\frac{\frac{1}{2}\times\left(-\frac{1}{2}\right)\times\left(-\frac{3}{2}\right)\left(-\frac{9x}{4}\right)^3}{3!}$	A1	1.1b
	$\sqrt{4-9x} = 2-\frac{9x}{4}-\frac{81x^2}{64}-\frac{729x^3}{512}$	A1	1.1b
		(4)	
(b)	States that the approximation will be an **<u>overestimate</u>** since all terms (after the first one) in the expansion are negative (since $x > 0$)	B1	3.2b
		(1)	
			(5 marks)
Notes:			

(a)

B1: Takes out a factor of 4 and writes $\sqrt{4-9x} = 2\left(1 \pm ...\right)^{\frac{1}{2}}$ or $\sqrt{4}\left(1 \pm ...\right)^{\frac{1}{2}}$ or $4^{\frac{1}{2}}\left(1 \pm ...\right)^{\frac{1}{2}}$

M1: For an attempt at the binomial expansion of $\left(1+ax\right)^{\frac{1}{2}}$ $a \neq 1$ to form term 3 or term 4 with the correct structure. Look for the correct binomial coefficient multiplied by the corresponding power of x e.g.

$\frac{\left(\frac{1}{2}\right)\left(\frac{1}{2}-1\right)}{2!}\left(...x\right)^2$ **or** $\frac{\left(\frac{1}{2}\right)\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-2\right)}{3!}\left(...x\right)^3$ where $... \neq 1$

Condone missing or incorrect brackets around the x terms but the binomial coefficients must be correct. Allow 2! and/or 3! or 2 and/or 6. Ignore attempts to find more terms.

Do not allow notation such as $\binom{\frac{1}{2}}{1}$, $\binom{\frac{1}{2}}{2}$ unless these are interpreted correctly.

A1: Correct expression for the expansion of $\left(1-\frac{9x}{4}\right)^{\frac{1}{2}}$ e.g.

$$1+\frac{1}{2}\times\left(-\frac{9x}{4}\right)+\frac{\frac{1}{2}\times\left(\frac{1}{2}-1\right)\left(\pm\frac{9x}{4}\right)^2}{2!}+\frac{\frac{1}{2}\times\left(\frac{1}{2}-1\right)\times\left(\frac{1}{2}-2\right)\left(-\frac{9x}{4}\right)^3}{3!}$$

which may be left unsimplified as shown but the bracketing must be correct unless any missing brackets are implied by subsequent work. If the 2 outside this expansion is only partially applied to this expansion then score A0 but if it is applied to all terms this A1 can be implied.

OR at least 2 correct simplified terms **for the final expansion** from, $-\frac{9x}{4}$, $-\frac{81x^2}{64}$, $-\frac{729x^3}{512}$

A1: $\sqrt{4-9x} = 2-\frac{9x}{4}-\frac{81x^2}{64}-\frac{729x^3}{512}$ oe and condone e.g. $2+\frac{-9x}{4}-\frac{81x^2}{64}-\frac{729x^3}{512}$

Allow equivalent mixed numbers and/or decimals for the coefficients e.g.:

$\left(\frac{9}{4}, 2\frac{1}{4}, 2.25\right), \left(\frac{81}{64}, 1\frac{17}{64}, 1.265625\right), \left(\frac{729}{512}, 1\frac{217}{512}, 1.423828125\right)$

Ignore any extra terms if found. Allow terms to be "listed" and apply isw once a correct expansion is seen. Allow recovery if applicable e.g. if an "*x*" is lost then "reappears".

Direct expansion in (a) can be marked in a similar way:

$$\sqrt{4-9x} = (4-9x)^{\frac{1}{2}} = 4^{\frac{1}{2}} + \left(\frac{1}{2}\right)4^{-\frac{1}{2}} \times (-9x)^1 + \left(\frac{1}{2}\right)\left(\frac{1}{2}-1\right)4^{-\frac{3}{2}} \times \frac{(-9x)^2}{2!} + \left(\frac{1}{2}\right)\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-2\right)4^{-\frac{5}{2}} \times \frac{(-9x)^3}{3!}$$

B1: For 2 or $\sqrt{4}$ or $4^{\frac{1}{2}}$ as the constant term in the expansion.

M1: Correct form for term 3 or term 4.

E.g. $\left(\frac{1}{2}\right)\left(-\frac{1}{2}\right) \times \frac{(...x)^2}{2!}$ or $\left(\frac{1}{2}\right)\left(-\frac{1}{2}\right)\left(-\frac{3}{2}\right) \times \frac{(...x)^3}{3!}$ where $...\neq 1$

Condone missing brackets around the *x* terms but the binomial coefficients must be correct. Allow 2! and/or 3! or 2 and/or 6. Ignore attempts to find more terms.

Do not allow notation such as $\begin{pmatrix}\frac{1}{2}\\1\end{pmatrix}$, $\begin{pmatrix}\frac{1}{2}\\2\end{pmatrix}$ unless these are interpreted correctly.

A1: Correct expansion (unsimplified as above)

OR at least 2 correct simplified terms from, $-\frac{9x}{4}$, $-\frac{81x^2}{64}$, $-\frac{729x^3}{512}$

A1: $\sqrt{4-9x} = 2 - \frac{9x}{4} - \frac{81x^2}{64} - \frac{729x^3}{512}$ oe and condone e.g. $2 + \frac{-9x}{4} - \frac{81x^2}{64} - \frac{729x^3}{512}$

Allow equivalent mixed numbers and/or decimals for the coefficients e.g.:

$\left(\frac{9}{4}, 2\frac{1}{4}, 2.25\right), \left(\frac{81}{64}, 1\frac{17}{64}, 1.265625\right), \left(\frac{729}{512}, 1\frac{217}{512}, 1.423828125\right)$

Ignore any extra terms if found. Allow terms to be "listed" and apply isw once a correct expansion is seen. Allow recovery if applicable e.g. if an "*x*" is lost then "reappears".

(b)

B1: States that the approximation will be an **overestimate** due to the fact that all terms (after the first one) in the expansion are negative or equivalent statements e.g.

- Overestimate because the terms are negative
- Overestimate as the terms are being taken away (from 2)

Condone "overestimate as every term is negative"

If you think a response is worthy of credit but are unsure then use Review.

This mark depends on having obtained an expansion in (a) of the form

$k - px - qx^2 - rx^3 \quad k, p, q, r > 0$ but note that if e.g. one of the algebraic terms is zero or was "lost" or there are extra negative terms this mark is still available.

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