Question Number	Scheme	Notes	Marks
2(a)	$y = 27x^{\frac{1}{2}} - x^{\frac{3}{2}} - 20$ $\Rightarrow \left(\frac{\mathrm{d}y}{\mathrm{d}x} =\right) \frac{27}{2}x^{-\frac{1}{2}} - \frac{3}{2}x^{\frac{1}{2}}$	$x^n \rightarrow x^{n-1}$	M1
		Correct simplified derivative	A1
			(2)
(b)	$\frac{27}{2}x^{-\frac{1}{2}} - \frac{3}{2}x^{\frac{1}{2}} = 0 \Rightarrow x = ...$	Sets their derivative = 0 attempts to solve for *x*	dM1
	$x = 9$	Correct *x* value	A1
	$x = 9 \Rightarrow y = ...$	Uses their *x* value to find a value for *y*	M1
	$y = 34$	Correct *y* value	A1
			(4)
(c)	$\frac{\mathrm{d}^2y}{\mathrm{d}x^2} = \pm Ax^{-\frac{3}{2}} \pm Bx^{-\frac{1}{2}}$ $\left(\frac{\mathrm{d}^2y}{\mathrm{d}x^2}\right)_{x=9} = -\frac{27}{4}(9)^{-\frac{3}{2}} - \frac{3}{4}(9)^{-\frac{1}{2}} \left(= -\frac{1}{2}\right)$	Attempts second derivative and substitutes their *x* **or** considers the sign (for *x* >0)	M1
	$\frac{\mathrm{d}^2y}{\mathrm{d}x^2} = -\frac{27}{4}x^{-\frac{3}{2}} - \frac{3}{4}x^{-\frac{1}{2}}$ $\frac{\mathrm{d}^2y}{\mathrm{d}x^2} < 0$ for x > 0 / when *x* = 9 so maximum	Correct second derivative and conclusion with correct reason	A1
			(2)
			Total 8

Notes

(a)

M1: Power decreased by 1 in at least one term in *x*

A1: Correct, simplified derivative. Accept as shown or $\frac{27}{2\sqrt{x}} - \frac{3}{2}\sqrt{x}$ or with decimal equivalents for coefficients. No need to see the $\frac{\mathrm{d}y}{\mathrm{d}x}$, score for a correct expression.

(b)

Note: Answer only with no initial equation set up scores no marks.

dM1: **Depends on the M in (a).** Sets their derivative equal to 0 and reaches a value *x*. The "=0" may be implied by a clear attempt to solve it. Do not be concerned about the method for solving as long as a value of *x* is reached. If substituting $a = \sqrt{x}$ (or similar) must return to *x* for the method.

A1: Correct value for *x* from correct work. Ignore references to *x* = 0 or any negative values but A0 if extra positive values.

M1: Substitutes their positive *x* value into the curve equation to find a value for *y*. May need to check if no substitution is shown.

A1: Correct *y* value. Ignore reference to any point at *x* = 0 or negative values but A0 if other coordinates with positive *x* are given.

(c) Ignore work relating to *x* = 0 in (c)

M1: Attempts the second derivative achieving the form $\pm Ax^{-\frac{3}{2}} \pm Bx^{-\frac{1}{2}}$ and attempts to use it to classify the stationary point. Look for an attempt at substituting their value or a consideration of the sign.

A1: Correct second derivative and conclusion drawn with supporting evidence from which it is reasonable to deduce the nature. Accept "concave down" for maximum, but not just "concave".

For the evidence accept either evaluation to the correct value $-\frac{1}{2}$, or correct sign deduced from substitution of $x = 9$, or via **statement** it is negative for all $x > 0$ without substitution seen. Use of a value other than $x = 9$ scores A0.

Question Number	Scheme	Notes	Marks
3(a)	$\left(2-\frac{kx}{4}\right)^8 = 2^8+\binom{8}{1}2^7\left(-\frac{kx}{4}\right)+\binom{8}{2}2^6\left(-\frac{kx}{4}\right)^2+\binom{8}{3}2^5\left(-\frac{kx}{4}\right)^3+\ldots$ Or $\left(1-\frac{kx}{8}\right)^8 = 1+\binom{8}{1}\left(-\frac{kx}{8}\right)+\binom{8}{2}\left(-\frac{kx}{8}\right)^2+\binom{8}{3}\left(-\frac{kx}{8}\right)^3+\ldots$		M1
	$= 256-256kx+112k^2x^2-28k^3x^3+\ldots$	$256-256kx$	B1
		$112k^2x^2$ **or** $-28k^3x^3$ (unsimplified)	A1
		$112k^2x^2$ **and** $-28k^3x^3$ (simplified)	A1
			(4)
(b)	$\mathrm{f}(x) = (5-3x)\left(2-\frac{kx}{4}\right)^8 = (5-3x)\left(256-256kx+112k^2x^2-28k^3x^3+\ldots\right)$ Coefficient of x is $5\times -256k - 3\times 256$		M1
	$5\times 256 = 3(-1280k-768) \Rightarrow k = \ldots$	Sets 5×their constant term from (a) = 3×their coefficient of x from f(x) and solves for k	M1
	$k = -\frac{14}{15}$	Correct value.	A1
			(3)
			Total 7

Notes

(a)

M1: Attempts the binomial expansion on $\left(2\pm\frac{kx}{4}\right)^8$ or $\left(1\pm\frac{kx}{\beta}\right)^8$ up to at least the third (x^2) term with an acceptable structure. Look for the correct binomial coefficient (accept alternative notation ${}^nC_r$) combined with the correct power of x but allow if powers of 2 are incorrect and if brackets are missing. M0 for descending powers.

B1: for $256-256kx$, may be listed, must be simplified. Allow for $256(1-kx+\ldots)$ if the 2^8 is taken out first.

A1: Correct third or fourth term, may be listed. Need not be simplified but the binomial coefficients must be numerical. Allow for one term from $256\left(\ldots+\frac{28}{64}(kx)^2-\frac{56}{512}(kx)^3\ldots\right)$ if the 2^8 is taken out first. May have powers as $(kx)^n$ for this mark. Allow for the correct x^2 term if the sign was incorrect in their bracket.

A1: Correct simplified third and fourth terms as shown in scheme, may be listed. Must have k^nx^n terms.

Note: isw after correct terms are seen if they try to divide through.

(b)

M1: Correct strategy for the coefficient of x or the x term. E.g. 5×their $-256k$ – 3×their 256 or may be part of a full expansion – look for (5×their $-256k$ – 3×their 256)x but terms must have been combined.

M1: Sets 5×their constant term from (a) = 3×their coefficient of x from f(x) and solves for k. Should be an equation in k only, but allow recovery if they initially include the x but later cross it out to give a constant for the answer. The attempt at the x coefficient must have been an attempt at a sum of two terms from their expansion of f(x)

A1: Correct value, must be exact. Allow $-0.9\dot{3}$ but not a terminating decimal.