Question Number	Scheme	Marks
4.(a)	$\left(2-\frac{1}{4}x\right)^6 = 2^6, +{}^6C_1 2^5\left(-\frac{1}{4}x\right)^1 + {}^6C_2 2^4\left(-\frac{1}{4}x\right)^2 + {}^6C_3 2^3\left(-\frac{1}{4}x\right)^3 + \ldots$	B1, M1
	$= 64 - 48x + 15x^2 - 2.5x^3$	A1 A1 **(4)**
(b)	$\left(2-\frac{1}{4}x\right)^6 + \left(2+\frac{1}{4}x\right)^6 = \left(64-48x+15x^2-2.5x^3\right)+\left(64+48x+15x^2+2.5x^3\right)$	M1
	$\approx 128 + 30x^2$	B1ft A1 **(3)** **(7 marks)**

Notes

(a)

B1 For either 2^6 or 64. Award for an unsimplified ${}^6C_0 2^6\left(-\frac{1}{4}x\right)^0$

M1 For an attempt at the binomial expansion. Score for a correct attempt at term 2, 3 or 4.

Accept sight of ${}^6C_1 2^5\left(\pm\frac{1}{4}x\right)^1$ ${}^6C_2 2^4\left(\pm\frac{1}{4}x\right)^2$ ${}^6C_3 2^3\left(\pm\frac{1}{4}x\right)^3$ condoning omission of brackets.

Accept any coefficient appearing from Pascal's triangle. FYI 6, 15, 20

A1 For any two simplified terms of $-48x + 15x^2 - 2.5x^3$

A1 For $64 - 48x + 15x^2 - 2.5x^3$ ignoring terms with greater powers. This may be awarded in (b) if it is not fully simplified in (a). Allow the terms to be listed $64, -48x, 15x^2, -2.5x^3$. Isw after sight of correct values. The expression written out without any method can be awarded all 4 marks.

(b) **Note that this is now marked M1 B1 A1**

M1 For adding two sequences that must be of the correct form with the correct signs.

Look for $\left(A - Bx + Cx^2 - Dx^3\right)+\left(A + Bx + Cx^2 + Dx^3\right)$ but condone

$\left(A - Bx + Cx^2\right)+\left(A + Bx + Cx^2\right)$

For this to be scored there must be some negative terms in (a)

B1ft For one correct term (follow through). Usually a = 128 but accept either $a = 2\times$'their'+ve 64

or $b = 2\times$'their' $+ ve$ 15

A1 For $128 + 30x^2$. CSO so must be from $\left(64-48x+15x^2-2.5x^3\right)+\left(64+48x+15x^2+2.5x^3\right)$

Allow $a = 128, b = 30$ following correct work.

This is a show that question so M1 must be awarded. It must be their final answer so do not isw here.

.....

Alternative method in (a):

$$\left(2-\frac{1}{4}x\right)^6 = 2^6\left(1-\frac{1}{8}x\right)^6 = 2^6\left(1+6\left(-\frac{1}{8}x\right)+\frac{6\times5}{2}\left(-\frac{1}{8}x\right)^2+\frac{6\times5\times4}{3!}\left(-\frac{1}{8}x\right)^3+\ldots\right)$$

B1 For sight of factor of either 2^6 or 64

M1 For an attempt at the binomial expansion seen in at least one term within the brackets.
Score for a correct attempt at term 2, 3 or 4.

Question Number	Scheme	Marks
	Accept sight of $6\left(\pm\frac{1}{8}x\right)^1 \ \frac{6\times5}{2}\left(\pm\frac{1}{8}x\right)^2 \ \frac{6\times5\times4}{3!}\left(\pm\frac{1}{8}x\right)^3$ condoning omission of brackets	
A1	For any two terms of $64-48x+15x^2-2.5x^3$	
A1	For all four terms $64-48x+15x^2-2.5x^3$ ignoring terms with greater powers	
	……..	
	Attempts to multiply out	
B1	For 64	
M1	Multiplies out to form $a+bx+cx^2+dx^3+...$ and gets *b*, *c* or *d* correct.	
A1A1	As main scheme	

Question Number	Scheme	Marks
5.(a)	$\frac{dP}{dx} = 12 - \frac{3}{2}x^{\frac{1}{2}}$	M1A1
	Sets $\frac{dP}{dx} = 0 \rightarrow 12 - \frac{3}{2}x^{\frac{1}{2}} = 0 \rightarrow x^n = \ldots$	dM1
	$x = 64$	A1
	When $x = 64 \Rightarrow P = 12 \times 64 - 64^{\frac{3}{2}} - 120 = \ldots$	M1
	Profit = (£) 136 000	A1
		(6)
(b)	$\left(\frac{d^2P}{dx^2}\right) = -\frac{3}{4}x^{-\frac{1}{2}}$ and substitutes in their $x = 64$ to find its value or state its sign	M1
	At $x = 64$ $\frac{d^2P}{dx^2} = -0.09375 < 0 \Rightarrow$ maximum	A1
		(2)
		(8 marks)

Notes

You should mark parts a and b together. You may see work in (a) from (b)

(a)

M1 Attempts to differentiate $x^n \rightarrow x^{n-1}$ seen at least once. It must be an x term and **not** the $120 \rightarrow 0$

A1 $\frac{dP}{dx} = 12 - \frac{3}{2}x^{\frac{1}{2}}$ with no need to see the lhs. Condone $\frac{dy}{dx}$ all of the way through part (a).

dM1 Sets their $\frac{dP}{dx} = 0$ and proceeds to $x^n = k, k > 0$. Dependent upon the previous M. Don't be too concerned with the mechanics of process. Condone an attempted solution of $\frac{dP}{dx} \ldots 0$ where **...** could be an inequality

A1 $x = 64$. Condone $x = \pm 64$ here

M1 Substitutes their solution for $\frac{dP}{dx} = 0$ into P and attempts to find the value of P.

The value of x must be positive. If two values of x are found, allow this mark for any attempt using a positive value.

A1 CSO. Profit = (£) 136 000 or 136 thousand but not 136 or P = 136.

This cannot follow two values for x, eg $x = \pm 64$ Condone a lack of units or incorrect units such as $

(b)

M1 Achieves $\frac{d^2P}{dx^2} = kx^{-\frac{1}{2}}$ and attempts to find its value at $x = ''64''$

Alternatively achieves $\frac{d^2P}{dx^2} = kx^{-\frac{1}{2}}$ and attempts to state its sign. Eg $\frac{d^2P}{dx^2} = -\frac{3}{4}x^{-\frac{1}{2}} < 0$

Allow $\frac{d^2P}{dx^2}$ appearing as $\frac{d^2y}{dx^2}$ for the both marks.

A1 Achieves $x = 64$, $\frac{d^2P}{dx^2} = -\frac{3}{4}x^{-\frac{1}{2}}$ and states $\frac{d^2P}{dx^2} = -\frac{3}{32} < 0$ (at $x = 64$) then the profit is maximised.