

| Question | | Answer | Marks | AO | Guidance | | | | | | | | |
|-----------------|---------|--|--------|------|--|------|-----------------|---------|-----|--------|--|--|--|
| 16 | (a) | $\frac{dy}{dx} = 24x^3 + 24x^2 - 42x + 12$ | M1 | 3.1a | allow one sign or coefficient error; must be four terms | | | | | | | | |
| | | their $\frac{dy}{dx} = 0$ | M1 | 1.1 | at least two terms correct | | | | | | | | |
| | | f(k) evaluated, where k is a factor of ± 12 or $\pm \frac{a}{12}$, where a = 1,2,3,4 or 6 | M1 | 2.1 | may be implied by $x = -2$ seen unsupported or $(x + 2)$ identified as factor | | | | | | | | |
| | | $(x + 2)(4x^2 - 4x + 1)$ or $(2x - 1)(2x^2 + 3x - 2)$ | M1 | 3.1a | by inspection or long division; allow one sign error or one coefficient error in trinomial may be implied by $x = \frac{1}{2}$ seen unsupported or $(2x - 1)$ oe identified as factor | | | | | | | | |
| | | $x = -2$ and $x = \frac{1}{2}$ and no others | A1 | 1.1 | may see $x = \frac{1}{2}$ (repeated) A0 for $x = -2$ (repeated) | | | | | | | | |
| | | $(\frac{1}{2}, -\frac{31}{8})$ and $(-2, -82)$ and no others | A1 | 1.1 | | | | | | | | | |
| | | $\frac{d^2y}{dx^2} = 72x^2 + 48x - 42$ | M1* | 1.1 | allow one sign or one coefficient error, FT their $\frac{dy}{dx}$; allow M1 for $12x^2 + 8x - 7$ | | | | | | | | |
| | | $\frac{d^2y}{dx^2} = 150$ when $x = -2$ so minimum value | A1 | 1.1 | NB test indecisive at $x = \frac{1}{2}$ A0 for just eg $\frac{d^2y}{dx^2} > 0$ so minimum | | | | | | | | |
| or eg | | | | | award M1A1 for consideration of gradient either side of -2 , values must be correct to at least 2sf for A1 | | | | | | | | |
| | | <table border="1"> <tr> <td>x</td> <td>-2.1</td> <td>(-2)</td> <td>-1.9</td> </tr> <tr> <td>$\frac{dy}{dx}$</td> <td>-16.224</td> <td>(0)</td> <td>13.824</td> </tr> </table> | x | -2.1 | (-2) | -1.9 | $\frac{dy}{dx}$ | -16.224 | (0) | 13.824 | | | |
| x | -2.1 | (-2) | -1.9 | | | | | | | | | | |
| $\frac{dy}{dx}$ | -16.224 | (0) | 13.824 | | | | | | | | | | |

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|---------------------|------------|-------------------|--|-------------|------------|---|---|-----------------|----|-----|----|-----------|-------------|---|-----|---|-------------------|---|-----|----|----------|----|-----|---|-------------------|---|---------------------|-----|-----|----|
| | | | eg <table border="1" style="margin-left: 20px;"> <tr> <td>x</td> <td>0</td> <td>($\frac{1}{2}$)</td> <td>1</td> </tr> <tr> <td>$\frac{dy}{dx}$</td> <td>12</td> <td>(0)</td> <td>18</td> </tr> </table> <p>dependent on at least two terms correct in derivative; must see values</p> <p>inflection at $(\frac{1}{2}, -\frac{31}{8})$ their $72x^2 + 48x - 42 = 0$ $x = -\frac{7}{6}$ isw</p> | x | 0 | ($\frac{1}{2}$) | 1 | $\frac{dy}{dx}$ | 12 | (0) | 18 | M1 | 3.1a | or eg <table border="1" style="margin-left: 20px;"> <tr> <td>x</td> <td>0</td> <td>($\frac{1}{2}$)</td> <td>1</td> </tr> <tr> <td>y</td> <td>-6</td> <td>(-3.875)</td> <td>-1</td> </tr> </table> <p>or eg</p> <table border="1" style="margin-left: 20px;"> <tr> <td>x</td> <td>0</td> <td>($\frac{1}{2}$)</td> <td>1</td> </tr> <tr> <td>$\frac{d^2y}{dx^2}$</td> <td>-42</td> <td>(0)</td> <td>78</td> </tr> </table> <p>values in table must be correct</p> <p>ignore calculation of associated y-value allow any correct decimals to 3 sf or more</p> | x | 0 | ($\frac{1}{2}$) | 1 | y | -6 | (-3.875) | -1 | x | 0 | ($\frac{1}{2}$) | 1 | $\frac{d^2y}{dx^2}$ | -42 | (0) | 78 |
| x | 0 | ($\frac{1}{2}$) | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $\frac{dy}{dx}$ | 12 | (0) | 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| x | 0 | ($\frac{1}{2}$) | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| y | -6 | (-3.875) | -1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| x | 0 | ($\frac{1}{2}$) | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $\frac{d^2y}{dx^2}$ | -42 | (0) | 78 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | [12] | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | (b) | | | M1 | 1.1 | curve with a minimum in 3 rd quadrant and stationary point of inflection in 4 th quadrant and no other stationary points | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | B1 | 1.1 | (0, -6) identified as y-intercept (intercept must be below the x-axis and above -20) | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | A1 | 1.1 | correct curve with intercepts at $(-a, 0)$ and $(b, 0)$, where $-3 < a < -2.6$ and $0.8 < b < 1.2$; minimum at $(-2, y)$ where $-90 < y < -80$ and inflection for $0 < x < 1$ and y is between the x -axis and the y -intercept | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | [3] | | | | | | | | | | | | | | | | | | | | | | | | | | |