<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Marks</th>
<th>Guidance</th>
</tr>
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</table>
| 1 (i)    | $y' = 1 + 8x^3$  
$y'' = -24x^4$ oe  | M2  
A1 | M1 for just $8x^3$ or $1 - 8x^3$ but not just $-24/x^4$ as AG |
| 1 (ii)   | their $y' = 0$ soi  
$x = -2$  
$y = -3$  
substitution of $x = -2$: $-24/(-2)^4$  
$< 0$ or $= -1.5$ oe correctly obtained isw  | M1  
A1  
A1  
M1  
A1 | A0 if more than one $x$-value  
$x = -2$ must have been correctly obtained for all marks after first M1  
condone any bracket error  
A0 if more than one $y$-value  
signs for gradients identified to verify maximum |
| 1 (iii)  | $y = -5$ soi  
substitution of $x = -1$ in their $y'$  
grad normal = $-1/their \cdot -7$  
y - their(-5) = their $1/7(x - 1)$  
$-x + 7y + 34 = 0$ oe  | B1  
M1  
M1*  
M1dep*  
A1 | may be implied by $-7$  
may be implied by eg $1/7$  
or their(-5) = their $1/7 \times (-1) + c$  
allow eg $y - 1/7x + 34/7 = 0$  
do not allow eg $y = x - 34/7$  
must see = 0  
must follow from M1 A1 A0 M1 or better |
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<td>2 (i)</td>
<td>$3x^2 - 6x - 22$</td>
<td><strong>M1</strong></td>
<td>condone one incorrect term, but must be three terms at least one term correct in their $y'$</td>
</tr>
<tr>
<td></td>
<td>their $y' = 0$ soi</td>
<td><strong>M1</strong></td>
<td>condone “$y = $” may be implied by use of eg quadratic formula, completing square, attempt to factorise</td>
</tr>
<tr>
<td></td>
<td>3.89</td>
<td><strong>A1</strong></td>
<td>if A0A0, SC1 for $\frac{3 \pm 5\sqrt{3}}{3}$ or 1± $\sqrt{3}/3$ or better, or both decimal answers given to a different accuracy or from truncation</td>
</tr>
<tr>
<td></td>
<td>-1.89</td>
<td><strong>A1</strong></td>
<td>3.886751346 and -1.886751346</td>
</tr>
<tr>
<td>2 (ii)</td>
<td>$x^3 - 3x^2 - 22 + 24 = 6x + 24$</td>
<td><strong>M1</strong></td>
<td>may be implied by $x^3 - 3x^2 - 28x [= 0]$</td>
</tr>
<tr>
<td></td>
<td>$x^3 - 3x^2 - 28x [= 0]$</td>
<td><strong>M1</strong></td>
<td>may be implied by $x^2 - 3x - 28[= 0]$</td>
</tr>
<tr>
<td></td>
<td>other point when $x = 7$ isw</td>
<td><strong>A1</strong></td>
<td>dependent on award of both M marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[3]</td>
<td>ignore other values of $x$</td>
</tr>
<tr>
<td>2 (iii)</td>
<td>$F[x] = \frac{x^4}{4} - \frac{3x^3}{3} - \frac{22x^2}{2} + 24x$</td>
<td><strong>M1</strong></td>
<td>allow for three terms correct; condone + c</td>
</tr>
<tr>
<td></td>
<td>$F[0] - F[-4]$</td>
<td><strong>M1dep</strong></td>
<td>allow 0 – $F[-4]$, condone – $F[-4]$, but do not allow $F[-4]$ only</td>
</tr>
<tr>
<td></td>
<td>area of triangle = 48</td>
<td><strong>B1</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>area required = 96 from fully correct working</td>
<td><strong>A1</strong></td>
<td>A0 for – 96, ignore units,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[4]</td>
<td>no marks for 96 unsupported</td>
</tr>
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</table>

| **Alternative method** | **M1** for $\int ((x^3 - 3x^2 - 22 + 24) - (6x + 24))dx$ may be implied by 2\textsuperscript{nd} **M1** |
|                       | $M1^*$ for $F[x] = \frac{x^4}{4} - \frac{3x^3}{3} - \frac{28x^2}{2}$ condone one error in integration |
|                       | **M1dep** for $F[0] - F[-4]$ |
3 (i) \(200 - 2\pi r^2 = 2\pi rh\)
\[h = \frac{200 - 2\pi r^2}{2\pi r}\text{ o.e.}
\]
substitution of correct \(h\) into \(V = \pi r^2 h\)
\(V = 100r - \pi r^3\) convincingly obtained

**M1**
\[100 = \pi r^2 + \pi rh\]

**M1**
\[100r = \pi r^3 + \pi^2 r h\]

**M1**
\[100r = \pi r^3 + V\]

**A1**
\[V = 100r - \pi r^3\]

or

**M1** for \(h = \frac{V}{\pi r^2}\)

**M1** for \(200 = 2\pi r^2 + 2\pi r \times \frac{V}{\pi r^2}\)

**M1** for \(200 = 2\pi r^2 + 2\frac{V}{r}\)

**A1** for \(V = 100r - \pi r^3\) convincingly obtained

**sc3** for complete argument working backwards:
- \(V = 100r - \pi r^3\)
- \(\pi r^2 h = 100r - \pi r^3\)
- \(\pi rh = 100 - \pi r^2\)
- \(100 = \pi rh + \pi r^2\)
- \(200 = A = 2\pi rh + 2\pi r^2\)

**sc0** if argument is incomplete

3 (ii) \(\frac{dV}{dr} = 100 - 3\pi r^2\)
\(\frac{d^2V}{dr^2} = -6\pi r\)

**B2**
**B1** for each term

**B1**

allow 9.42(….) \(r^2\) or better if decimalised

-18.8(….) \(r\) or better if decimalised

3 (iii) their \(\frac{dV}{dr} = 0\) s.o.i.
\(r = 3.26\) c.a.o.

**M1**
must contain \(r\) as the only variable

**A2**
\(A1\) for \(r = (\pm)\sqrt[3]{\frac{100}{3\pi}}\), may be implied by 3.25…

**A1**
deduct 1 mark only in this part if answers not given to 3 sf,

there must be evidence of use of calculus
### Question 4

**Part (i)**

\[ 3x^2 - 12x - 15 \]

**Marks:** 2

- M1 if one term incorrect or an extra term is included.

**Part (ii)**

Their \( \frac{dy}{dx} = 0 \) s.o.i.

- \( x = 5 \)
- \( x = -1 \)

**Marks:** M1

- B1
- B1

### Question 5

\[ y' = 3x^2 - 12x - 15 \]

- use of \( y' = 0 \), s.o.i. ft
- \( x = 5, -1 \) c.a.o.
- \( x < -1 \) or \( x > 5 \) f.t.

**Marks:** M1

- M1
- A1
- A1

- for two terms correct

**Marks:** 5