| Question | Scheme | Marks |
|---|---|---|
| **7(a)** | $(a=)\dfrac{4^2}{4}-3\sqrt{4}+8=6$ | B1 cso [1] |
| **(b)** | $\left(\dfrac{dy}{dx}=\right)\dfrac{2x}{4}-3\times\dfrac{1}{2}\times x^{-\frac{1}{2}}$ oe | M1 |
| | $\left(x=4\Rightarrow\dfrac{dy}{dx}=\right)\dfrac{2\times4}{4}-3\times\dfrac{1}{2}\times4^{-\frac{1}{2}}=\dfrac{5}{4}\Rightarrow$ | dM1A1 |
| | $M_n=-\dfrac{1}{"\frac{5}{4}"}$ | M1 (now matches ePen) |
| | $y-6="-\dfrac{4}{5}"(x-4)\Rightarrow 5y+4x-46=0$ * | M1A1 cso [6] |
| **(c)** | Area under $C$ <br> $\left(A_C=\int_1^4\left(\dfrac{x^2}{4}-3\sqrt{x}+8\right)\ dx\right)$ | |
| | $=\left[\dfrac{x^3}{3\times4}-\dfrac{3\times x^{\frac{3}{2}}}{\frac{3}{2}}+8x\right]_1^4$ | M1 |
| | $=\left[\dfrac{4^3}{3\times4}-\dfrac{3\times4^{\frac{3}{2}}}{\frac{3}{2}}+8\times4\right]-\left[\dfrac{1^3}{3\times4}-\dfrac{3\times1^{\frac{3}{2}}}{\frac{3}{2}}+8\times1\right]$ | M1 |
| | $=\dfrac{61}{4}$ | A1 |
| | Area under the line <br> $5\times0+4x-46=0\Rightarrow x(=11.5)$ $A=\dfrac{1}{2}\times("11.5"-4)\times6=\dfrac{45}{2}$ <br> **ALT** $\int_4^{11.5}\left(-\dfrac{4}{5}x+\dfrac{46}{5}\right)dx=\left[-\dfrac{4}{5\times2}x^2+\dfrac{46}{5}x\right]_4^{11.5}$ <br> $=\left(-\dfrac{4}{5\times2}\times11.5^2+\dfrac{46}{5}\times11.5\right)-\left(-\dfrac{4}{5\times2}\times4^2+\dfrac{46}{5}\times4\right)$ | M1A1 |
| | Required area $=\left(\dfrac{61}{4}+\dfrac{45}{2}=\right)\dfrac{151}{4}(=37.75)$ oe | A1 [6] |

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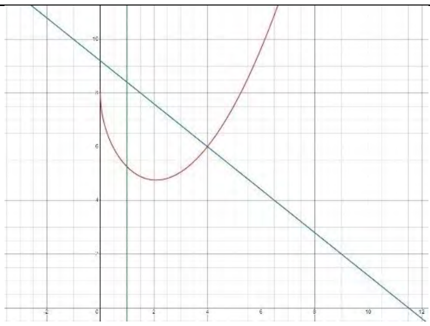
|---|---|---|
| **ALT** | Line - curve<br>$\int_1^4\left(\left(-\frac{4}{5}x+\frac{46}{5}\right)-\left(\frac{x^2}{4}-3\sqrt{x}+8\right)\right)\mathrm{d}x$ or $\int_1^4\left(-\frac{x^2}{4}+3\sqrt{x}-\frac{4}{5}x+\frac{6}{5}\right)\mathrm{d}x$ | |
| | $\left[-\frac{4}{5\times2}x^2+\frac{46}{5}x-\frac{x^3}{4\times3}+\frac{3\times x^{\frac{3}{2}}}{\frac{3}{2}}-8x\right]_1^4$ or $\left[-\frac{x^3}{4\times3}+\frac{3\times x^{\frac{3}{2}}}{\frac{3}{2}}-\frac{4}{5\times2}x^2+\frac{6}{5}x\right]_1^4$ | M1 |
| | $\left(-\frac{4}{5\times2}\times4^2+\frac{46}{5}\times4-\frac{4^3}{4\times3}+\frac{3\times4^{\frac{3}{2}}}{\frac{3}{2}}-8\times4\right)-$<br>$\left(-\frac{4}{5\times2}\times1^2+\frac{46}{5}\times1-\frac{1^3}{4\times3}+\frac{3\times1^{\frac{3}{2}}}{\frac{3}{2}}-8\times1\right)$ or<br>$\left(-\frac{4^3}{4\times3}+\frac{3\times4^{\frac{3}{2}}}{\frac{3}{2}}-\frac{4}{5\times2}\times4^2+\frac{6}{5}\times4\right)-\left(-\frac{1^3}{4\times3}+\frac{3\times1^{\frac{3}{2}}}{\frac{3}{2}}-\frac{1}{5\times2}\times4^2+\frac{6}{5}\times1\right)$ | M1 |
| | $=\frac{127}{20}$ | A1 |
| | Area under the line<br>$5\times0+4x-46=0\Rightarrow x(=11.5)$ $5\times y+4\times1-46=0\Rightarrow x\left(=\frac{42}{5}\right)$<br>$A=\frac{1}{2}\times(\text{"}11.5\text{"}-1)\times\text{"}\frac{42}{5}\text{"}=\frac{45}{2}$ $A=\frac{1}{2}\times(\text{"}11.5\text{"}-1)\times\text{"}\frac{42}{5}\text{"}=\frac{441}{10}$<br>**ALT** $\int_1^{\text{"}11.5\text{"}}\left(-\frac{4}{5}x+\frac{46}{5}\right)\mathrm{d}x=\left[-\frac{4}{5\times2}x^2+\frac{46}{5}x\right]_1^{\text{"}11.5\text{"}}$<br>$=\left(-\frac{4}{5\times2}\times\text{"}11.5\text{"}^2+\frac{46}{5}\times\text{"}11.5\text{"}\right)-\left(-\frac{4}{5\times2}\times1^2+\frac{46}{5}\times1\right)=\frac{441}{10}$ | M1<br>A1 |
| | $\left(\frac{441}{10}-\frac{127}{20}=\right)\frac{151}{4}$ | A1 |
| | Useful diagram  | |
| | | **Total 13 marks** |

| Part | Mark | Notes |
|---|---|---|
| (a) | B1 | Correct substitution, no errors and shows $a = 6$ |
| (b) | M1 | For an attempt to differentiate the given function. Simplification not required.<br>See General Guidance for the definition of an attempt. No power of $x$ to increase. |
| | dM1 | For substituting the value of $x = 4$ into their derivative. Can be implied by sight of $\frac{5}{4}$<br>Dependent upon the previous method mark. |
| | A1 | For the correct gradient of $\frac{5}{4}$ |
| | M1 | For finding the negative reciprocal of their gradient. |
| | M1 | For forming the equation of the normal, using the given value for $a$ and their **changed** gradient (ie not the gradient of the tangent). This is not a dependent mark, but the candidate may not use the gradient of the tangent and the gradient used must come from some differentiation work. If the candidate uses $y = mx + c$, a fully correct rearrangement to find $c$ must be shown (this can be implied by a correct c for their equation) and concluded with the equation of the line written. |
| | A1 cso | For the correct equation of the line, minimum steps shown, no errors or omissions. |
| (c) | M1 | For an attempt to integrate the given function.<br>See General Guidance for the definition of an attempt. In this question at least one term correctly integrated and no power of $t$ to decrease. Terms do not need to be simplified.<br>Limits don't need to be present or correct. |
| | M1 | For substituting the correct coordinates into their **changed** expression, the correct way around and subtracting. At least one correct substitution in one term of each limit fully shown. Their limits must be correct. |
| | A1 | For the correct area under the curve.<br>A correct answer here will imply M1 M1 A1 if the integration step has been shown and first M1 awarded.<br>Solutions where the integration step has not been shown will score M0 M0 A0. |
| | M1 | For a correct method to find the area of the triangle using their value for the intersection of line $L$ with the $x$-axis .<br>or<br>Fully correct integration for line and substitution of limits of their 11.5 (following any attempt to find where $L$ crosses the $x$-axis) and 4. May be implied by correct area.<br>Terms do not need to be simplified. |
| | A1 | For the correct area of the triangle |
| | A1 | For the correct area of $\frac{151}{4}$ |

| | | |
|---|---|---|
| **ALT** | M1 | For an attempt to integrate either of the functions as given – there **must** be a subtraction sign if listed separately. Also award this mark for integrating $\int_1^4 \left(-\frac{x^2}{4}+3\sqrt{x}-\frac{4}{5}x+E\right)\mathrm{d}x \quad E \neq 0$ (Combines the constant terms incorrectly) See General Guidance for the definition of an attempt. In this question at least one term correctly integrated and no power of $t$ to decrease. Terms do not need to be simplified. Limits don't need to be present or correct. |
| | M1 | For substituting the correct coordinates into their **changed** expression, the correct way around and subtracting. At least one correct substitution in one term of each limit fully shown. Their limits must be correct. |
| | A1 | For $\frac{127}{20}$ |
| | M1 | For a correct method to find the area of the large triangle using their value for the intersection of line $L$with the $x$-axis . or Fully correct integration for line and substitution of limits of their 11.5 (following any attempt to find where $L$ crosses the $x$-axis) and 4. May be implied by correct area. Terms do not need to be simplified. |
| | A1 | For $\frac{441}{10}$ |
| | A1 | For the correct area of $\frac{151}{4}$ |

Where students have combined expression incorrectly as follows:

$\int_1^4 \left(\left(\frac{x^2}{4}-3\sqrt{x}+8\right)\pm\left(-\frac{4}{5}x+\frac{46}{5}\right)\right)\mathrm{d}x$ If the constant term is unsimplified, the highest mark will be up to M1 M1 A1 M0 A0 A0 if the work is seen for the first 3 marks as described above.

If they have simplified the constant term to give eg

$\pm\left(\frac{x^2}{4}-3\sqrt{x}+\frac{86}{5}\right)\pm\frac{4}{5}x$ or $\pm\left(\frac{x^2}{4}-3\sqrt{x}+\frac{86}{5}\right)\pm\frac{86}{5}x$

The highest mark will be M1 M0 A0 M0 A0 A0 if the first two terms in the curve and any constant term are integrated as per conditions above.