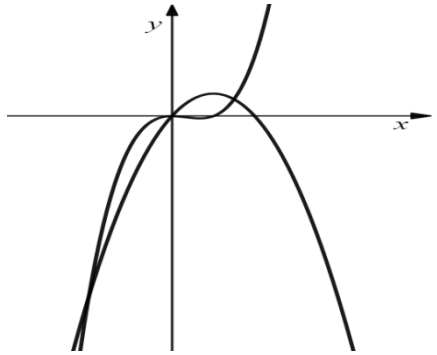
| Question Number | Scheme | Marks |
|---|---|---|
| **7 (a)** | States or implies that $f(x)=\lambda x^2(x-4)$ | M1 |
| | Attempts to find $\lambda$. E.g. $120=\lambda 10^2(10-4)\Rightarrow\lambda=...$ | dM1 |
| | $\{f(x)=\}\ 0.2x^2(x-4)$ | A1 |
| | | **(3)** |
| **(b)** |   "Upside down" parabola | M1 |
| | Passing through *O* and +ve *x* axis > 4 | A1 |
| | | **(2)** |
| **(c)** | Sets $1.2x(8-x)=$ their $0.2x^2(x-4)$ | B1ft |
| | $1.2x(8-x)=0.2x^2(x-4)\Rightarrow x\left(x^2+2x-48\right)=0$ or $\Rightarrow x^3+2x^2-48x=0$ | M1 |
| | $\Rightarrow x=...,...(,0)$ | dM1 |
| | For $x=$ $-8,0,6$ OR one of $(-8,-153.6),(6,14.4)$ | A1 |
| | All of $(-8,-153.6),(6,14.4),(0,0)$ $\left\{\left(-8,-\frac{768}{5}\right),\left(6,\frac{72}{5}\right),(0,0)\right\}$ | A1 |
| | | **(5)** |
| | | **(10 marks)** |

(a)

M1: States or implies that $f(x)=\lambda x^2(x-4)$. Allow with $\lambda$ = 1 (or any other constant). Credited when first seen, but must use this expression to access the dM mark.

dM1: Attempts to find $\lambda$. E.g. $120=\lambda 10^2(10-4)\Rightarrow\lambda=...$

A1: $\{f(x)=\}\ 0.2x^2(x-4)$ o.e. Allow with $(x-0)^2$

Alt: May see attempts at using $f(x)=ax^3+bx^2+cx+d$

M1: States or implies $f(x)=ax^3+bx^2+cx+d$ AND uses (0,0) on curve to deduce $d = 0$

dM1: Full method to find the remaining constants, so $f'(0)=0\Rightarrow c=0$ and $f(4)=0\Rightarrow 64a+16b=0\Rightarrow b=-4a$ then $f(10)=120\Rightarrow 1000a+100b=120\Rightarrow 50a+5b=6\Rightarrow a=..,b=...$

They must set up sufficient equations to be able to solve for all the constants.

A1: For $f(x)=0.2x^3-0.8x^2$ o.e.

Note, do not be concerned if the f(*x*) = … is missing, mark the expression.

(b)

**Note:** If there are multiple attempts with no clearly designated answer, Diagram 1 takes precedence if not crossed out. If Diagram 1 is not used, or is crossed out and no clear statement of answer is given, then an answer in the answer space takes precedence over an answer on Figure 3.

M1: Correct shape, a $\cap$ shape parabola in any position. Be tolerant with the shape, must at least touch the *x*-axis.

A1: Correct shape and position, a $\cap$ shape parabola passing through *O* and the +ve *x* axis to the right hand side of $x = 4$. The graph must **clearly** extend into quadrants 3 and 4, not stop at the *x*-axis.
Ignore any coordinates on the graph, and don't be concerned if the intersection in quadrant 3 is not shown.

(c)

B1ft: Sets $1.2x(8-x) = \text{their } 0.2x^2(x-4)$. It is for a "correct" ft equation on their part (a) as long as their answer to part (a) is a cubic expression.

M1: Valid attempt to solve an equation of the form $1.2x(8-x) = \text{cubic}$ with their cubic (and their quadratic $1.2x(8-x)$ if they incorrectly try to simplify this) to reach at least a gathered cubic with no constant, or a quadratic in *x*. The *x* may be cancelled, e.g $1.2x(8-x) = 0.2x^2(x-4) \Rightarrow$ Quadratic equation in *x*. Do not allow solutions which reach a cubic with non-zero constant and simply state answers from a calculator. This is for progressing via algebra to a point at which a quadratic (possibly tacit in a cubic with no constant) can be identified.

dM1: Attempts to solve the resulting (possibly tacit) 3 term quadratic equation, usual rules. Allow solutions from calculator as long as a quadratic can be identified in their equation. You may need to check their values (both must be correct).

A1: Either all three *x* coordinates stated as answers (the 0 must be present but may have been given earlier), or one correct coordinate pair from $(-8, -153.6), (6, 14.4)$

A1: All three of $(-8, -153.6), (6, 14.4), (0, 0)$, accept as $x = \ldots$, $y = \ldots$ for each as long as they are paired correctly. The (0,0) may be stated earlier, so check the whole solution if it is not listed at the end.

| Question Number | Scheme | Marks |
|---|---|---|
| **8 (a) (i)** | $x=4, \mathrm{f}'(x)=10,\ \mathrm{f}'(x)=3\sqrt{x}+kx^2 \Rightarrow 10=3\sqrt{4}+4^2k \Rightarrow k=...$ | M1 |
| | $10=3\times 2+k\times 16 \Rightarrow k=\frac{1}{4}$ * | A1* |
| **(ii)** | $x=4, y=12$ on $y=10x+c \Rightarrow 12=10\times 4+c$ | M1 |
| | $\Rightarrow c=-28$ | A1 |
| | | **(4)** |
| **(b)** | $\mathrm{f}''(x)=\frac{3}{2}x^{-\frac{1}{2}}+\frac{1}{2}x$ | M1 A1ft |
| | $\{\Rightarrow \mathrm{f}''(4)\}=\frac{11}{4}$ | A1 |
| | | **(3)** |
| **(c)** | $\mathrm{f}(x)=2x^{\frac{3}{2}}+\frac{1}{12}x^3+d$ | M1, A1ft |
| | Uses $P(4,12) \Rightarrow 12=2\times 8+\frac{1}{12}\times 4^3+d \Rightarrow d=...$ | dM1 |
| | $\{\mathrm{f}(x)=\}\ 2x^{\frac{3}{2}}+\frac{1}{12}x^3-\frac{28}{3}$ | A1 |
| | | **(4)** |
| | | **(11 marks)** |

Note: If work is done out of order (e.g. if an attempt to find f($x$) is made in part (a) but no attempt is made at (c)) then allow the M1A1 marks for differentiation in (b) and integration in (c) for the work in part (a) as long is it is clear it is an attempt at the correct process. However, e.g. an attempt at integration with a decrease in power should not be awarded the marks for (b).

(a)(i)

M1: Attempts to solve $\mathrm{f}'(4)=10$ to find $k$. Alternatively, substitutes $x$ =4 and $k=\frac{1}{4}$ into f'($x$) and evaluates.

A1*: Shows that $k=\frac{1}{4}$ with a correct intermediate line where powers/roots have been evaluated, and with no incorrect steps. Alternatively, correctly reaches f'(4) = 10 and conclude $k=\frac{1}{4}$

(ii)

M1: Substitutes $x=4, y=12$ in $y=10x+c$

Alternatively, substitutes $x$ = 4, $y$ = 12 and $m$ = 10 into $y-y_1=m(x-x_1)$

A1: Correct value for $c$ which may be embedded in the equation, e.g. $y=10x-28$, as long as no incorrect value for $c$ is subsequently given.

(b)

M1: Differentiates with attempt to decrease power by 1 in each term. This should be to a form $Ax^{-\frac{1}{2}}+Bx$ but allow if a slip in one power has occurred before differentiating.

A1ft: $\frac{3}{2}x^{-\frac{1}{2}}+\frac{1}{2}x$ Allow for $\frac{3}{2}x^{-\frac{1}{2}}+2kx$ without $k$ replaced or follow through their $k$ if they use a different value than the one given. Need not be simplified.