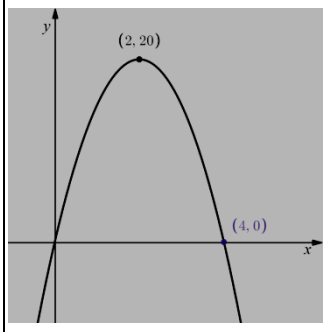
Question Number	Scheme	Marks
9 (a)	 Correct shape and position passing through (0, 0)	B1
	Intersection at (4, 0)	B1
		(2)
(b)	Attempts form of equation. E.g. $y = Ax(x-4)$ or $y = 20 \pm C(x-2)^2$	M1
	Full attempt to find equation. E.g. $20 = A \times 2(2-4) \Rightarrow A = ...$ Or $0 = 20 + C(4-2)^2 \Rightarrow C = ...$	dM1
	$y = -5x(x-4)$, $y = 20 - 5(x-2)^2$ o.e.	A1
		(3)
(c)	Sets $x\left(x^2-4\right) = "-5x(x-4)"$	M1
	$x^3 + 5x^2 - 24x = 0 \Rightarrow x\left(x^2 + 5x - 24\right) = 0$	dM1
	$(x+8)(x-3) = 0 \Rightarrow$ x coordinate of P is -8	ddM1, A1
	$P = \left(-8, -480\right)$	A1
		(5) **(10 marks)**

(a)

B1: ∩ shaped quadratic passing through the origin with maximum on the rhs of the *y*-axis and an intercept on the + ve *x*-axis. Be tolerant of slips of the pen. It must appear in quadrants 3, 1 and 4 Ignore extra graphs (e.g. cubics) if they are superimposed on top of this one.

Score if the intention seems correct but do penalise ∧ shaped "curves"

B1: Intersection at (4, 0). Allow 4 marked on the positive *x*- axis but (0, 4) is B0. Condone graphs that just meet the *x*-axis at 4 for ones that seem to "sit" on the *x* -axis and only appear in quadrant 1.

(b)

M1: Attempts form of equation. E.g. $y = \pm Ax(x-4)$ or $y = 20 \pm C(x-2)^2$. Condone with *A*, *C* =1

It is possible they could try $y = ax^2 + bx + c$ with an attempt to use all three coordinates.

Look for setting up 3 different equations using the given information

- Uses $(0, 0)$ in $y = ax^2 + bx + c \Rightarrow c = 0$
- Uses $(2, 20)$ in $y = ax^2 + bx + c \Rightarrow 20 = 4a + 2b$
- Uses $(4, 0)$ $y = ax^2 + bx + c \Rightarrow 0 = 16a + 4b$ OR $\left.\frac{dy}{dx}\right|_{X=2} = 2ax + b = 0 \Rightarrow 4a + b = 0$

It is acceptable just to state the rhs of the equation. E.g. $Ax(x-4)$

dM1: Full attempt at equation for $f(x)$ with an attempt at finding values for A or C or a,b c

A1: $y = -5x(x-4)$, $y = 20 - 5(x-2)^2$ o.e. such as $y = -5x^2 + 20x$ Allow $f(x) \leftrightarrow y$

The question asks for an expression for $f(x)$ so allow just $5x(4-x)$ o.e.

Allow this to be written down for all 3 marks. ISW after a correct answer.

Allow this to be scored in part (c) if you are certain that this is meant for (b). Use review if unsure.

(c) **All stages of working should be shown in this part so any omissions will be penalised**

M1: Sets $x\left(x^2-4\right)="-5x(x-4)"$ condoning slips

The form of the quadratic must be correct. That is it must pass through (0, 0)

dM1: Multiplies out to reach an equation of the form $px^3+qx^2+rx=0$ from which they factorise (or cancel) out a factor of *x*. This may be implied as the *x* may be cancelled out previously, say on their first line

ddM1: Solves the resulting quadratic via an appropriate method.

Condone the use of a calculator for this mark. The solutions must be correct for their quadratic to score this mark via the calculator.

A1: **Chooses** -8 for *x* coordinate of *P*. If $x=0,3$ are seen they must be rejected or -8 chosen

Can be awarded **choosing** $x=-8$ following sight of a correct quadratic equation $x^2+5x-24=0$

or for **choosing** $x=-8$ following sight of a correct cubic equation $x^3+5x^2-24x=0$

A1: $P=\left(-8,-480\right)$ which may be given separately *x* =.., *y*= ...

Can be awarded for $\left(-8,-480\right)$ following sight of a correct quadratic equation $x^2+5x-24=0$

or for $\left(-8,-480\right)$ following sight of a correct cubic equation $x^3+5x^2-24x=0$

Examples of applying the scheme:

Example 1: M1, M0, M0, A0, A0 for 1 out of 5 marks

$$x\left(x^2-4\right)=-5x(x-4)\Rightarrow x=-8\Rightarrow P=\left(-8,-480\right)$$

Example 2: M1, M0, M0, A1, A1 for 3 out of 5 marks

$$x\left(x^2-4\right)=-5x(x-4)\Rightarrow x^3+5x^2-24x=0\Rightarrow x=\left(0,3,\right)-8\Rightarrow P=\left(-8,-480\right)$$

Example 3: M1, M1, M1, A1, A1 for 5 out of 5 marks. The solution of the quadratic is implied (calculator)

$$x\left(x^2-4\right)=-5x(x-4)\Rightarrow x^2+5x-24=0\Rightarrow x=\left(3,\right)-8\Rightarrow P=\left(-8,-480\right)$$

Example 4: M1, M1, M1, A1, A1 for 5 out of 5 marks

$$x\left(x^2-4\right)=-5x(x-4)\Rightarrow x^3+5x^2-24x=0\Rightarrow x\left(x^2+5x-24\right)=0\Rightarrow x=\left(0,3,\right)\underline{\underline{-8}}\Rightarrow P=\left(-8,-480\right)$$

Question Number	Scheme	Marks
	$\mathrm{f}'(x)=4\sqrt{x^3}+\dfrac{k}{x^2}=4x^{\frac{3}{2}}+kx^{-2}$	
10 (a)	$\mathrm{f}''(x)=6x^{\frac{1}{2}}-2kx^{-3}$	M1, A1
	$\mathrm{f}''(2)=6\sqrt{2}-2k\times\dfrac{1}{8}=0\Rightarrow k=24\sqrt{2}$	dM1, A1
		(4)
(b)	$\mathrm{f}'(x)=4x^{\frac{3}{2}}+kx^{-2}\Rightarrow\quad \mathrm{f}(x)=4\times\dfrac{2}{5}x^{\frac{5}{2}}-kx^{-1}\left(+c\right)$	M1, A1 ft
	Uses $P\left(2,8\sqrt{2}\right)\Rightarrow 8\sqrt{2}=4\times\dfrac{2}{5}\times 2^{\frac{5}{2}}-\dfrac{k}{2}+c\Rightarrow c=p\sqrt{2}$	dM1
	$\mathrm{f}(x)=\dfrac{8}{5}x^{\frac{5}{2}}-\dfrac{24\sqrt{2}}{x}+\dfrac{68}{5}\sqrt{2}$	A1
		(4) **(8 marks)**

Relevant work must be done in the correct part of the question.
If they are clearly labelled and they just integrate in (a) and they just differentiate in (b) award no marks but if they use their integration that was in part (a) in part (b) for example they can pick up marks in part (b).

(a)

M1: Differentiates $4\sqrt{x^3}+\dfrac{k}{x^2}$ and achieves at least one index correct. Look for $px^{\frac{1}{2}}-qx^{\cdots}$ or $px^{\cdots}-qx^{-3}$

A1: Correct differentiation, which may be left unsimplified. E.g. $4\times\dfrac{3}{2}\times x^{\frac{1}{2}}-2k\times x^{-3}$ or $6x^{\frac{1}{2}}-2kx^{-3}$

dM1: Sets $\mathrm{f}''(2)=0$ and proceeds to a value for *k*. It is dependent upon the previous M mark. Allow even if called something else

A1: $k=24\sqrt{2}$ or exact equivalent. ISW after a correct exact value

(b)

M1: Integrates $4\sqrt{x^3}+\dfrac{k}{x^2}$ and achieves at least one index correct. Look for $px^{\frac{5}{2}}-qx^{\cdots}$ or $px^{\cdots}-qx^{-1}$

A1ft: Correct integration to $4\times\dfrac{2}{5}x^{\frac{5}{2}}-kx^{-1}$. There is no requirement to simplify or have + *c*

Follow through on their value of *k* but also allow with "*k*" as seen above

dM1: Uses $P\left(2,8\sqrt{2}\right)$ and their $k=...\sqrt{2}$ to find *c* as a multiple of $\sqrt{2}$.

It is dependent upon the previous M mark. Both indices must now be correct

The $...x^{\frac{5}{2}}$ term must produce a term in $\sqrt{2}$

A1: Achieves $\dfrac{8}{5}x^{\frac{5}{2}}-\dfrac{24\sqrt{2}}{x}+\dfrac{68}{5}\sqrt{2}$ for $\mathrm{f}(x)$ Accept any other simplified equivalent.

There is no requirement for $\mathrm{f}(x)=$