Question Number	Scheme	Marks
2a	$\left(\text{f}\left(\frac{3}{2}\right)=\right)\ 4\left(\frac{3}{2}\right)^3-8\left(\frac{3}{2}\right)^2+5\left(\frac{3}{2}\right)+a=0\Rightarrow a=...$	M1
	$\Rightarrow \frac{27}{2}-18+\frac{15}{2}+a=0\Rightarrow a=-3$ *	A1*
		(2)
b	Example where $2x-3$ is a linear factor: $2x-3\overline{)4x^3-8x^2+5x-3}$ $\quad 2x^2-x+1$ $4x^3-6x^2$ $-2x^2+5x$ $-2x^2+3x$ $+2x-3$ $+2x-3$ 0	M1A1
	$(-1)^2-4\times2\times1=-7<0\Rightarrow$ no real roots so $x=\frac{3}{2}$ is the only one real root *	dM1A1*
		(4)
		(6 marks)

(a)

M1 Substitutes $x=\frac{3}{2}$ into the expression, sets equal to 0 (may be implied for this mark) and rearranges to find *a*. Condone invisible brackets for this mark only and condone arithmetical slips in their working.

Substituting $x=-\frac{3}{2}$ is M0 and attempts via long division score M0.

A1* $a=-3$ achieved with no errors seen including the omission of brackets.

There must be sight of $x=\frac{3}{2}$ which may be embedded in the expression or $\text{f}\left(\frac{3}{2}\right)$ followed by at least one intermediate stage of working/manipulation (it may just be the left hand side of the equation), before proceeding to the given answer. The "$=0$" must be seen somewhere in their working before the given answer.

e.g.

$4\left(\frac{3}{2}\right)^3-8\left(\frac{3}{2}\right)^2+5\left(\frac{3}{2}\right)+a=0\Rightarrow a=-3$ is M1A0

$\text{f}\left(\frac{3}{2}\right)=\frac{27}{2}-18+\frac{15}{2}+a=0\Rightarrow a=-3$ is M1A1

Note the trivial case $\text{f}\left(\frac{3}{2}\right)=3+a=0\Rightarrow a=-3$ is M1A0 (not enough shown)

(b) Work done in (a) must be made use of in (b) to gain credit.

M1 Attempts to find a quadratic factor of $4x^3-8x^2+5x-3$ using $2x-3$ as a factor

- score for $2x^2\pm x\pm...$ if algebraic division is used or
- score for $2x^2\pm...x\pm1$ if equating coefficients/inspection used.

Alternatively, they may attempt to find a quadratic factor using $x-\frac{3}{2}$ as a factor so

- score for $4x^2 \pm 2x \pm ...$ if algebraic division is used or
- score for $4x^2 \pm ...x \pm 2$ if equating coefficients/inspection used.

A1 $2x^2 - x + 1$ (for $2x-3$ as the linear factor) or $4x^2 - 2x + 2$ (for $x-\frac{3}{2}$ as the linear factor)

dM1 Attempts to show their quadratic factor has no real roots. It is dependent on the previous method mark. Factorisation attempts are M0. Accept via

- an attempt at $b^2 - 4ac$ for their quadratic factor so score for values correctly embedded in $b^2 - 4ac$ for their quadratic
- an attempt to solve their $2x^2 - x + 1$ or $4x^2 - 2x + 2$ using the quadratic formula with values embedded or via a calculator (you must check their roots are correct for their quadratic)
- an attempt to complete the square e.g. $2\left(x \pm \frac{1}{4}\right)^2 \pm ...$

A1* Requires correct factorisation of the cubic, correct calculation for the quadratic, reason and conclusion

For example, after factorising their cubic to e.g. $(2x-3)(2x^2 - x + 1)$ which does not need to be explicitly stated accept e.g.

- the discriminant of $2x^2 - x + 1$ is $-7 < 0$ so only has a root at $x = \frac{3}{2}$. If correct values are embedded which give -7 then this is fine. (For $4x^2 - 2x + 2$ the discriminant is -28)
- $2x^2 - x + 1 = 0 \Rightarrow x = \frac{1}{4} \pm i\frac{\sqrt{7}}{4}$, $(2x-3) = 0 \Rightarrow x = \frac{3}{2}$ so only one real root. (The roots will be the same for $4x^2 - 2x + 2 = 0$)
- $2x^2 - x + 1 = 0 \Rightarrow 2\left(x - \frac{1}{4}\right)^2 + \frac{7}{8} > 0$, hence $x = \frac{3}{2}$ is the only one real root (The completed square form for $4x^2 - 2x + 2$ could be the same or a multiple of it depending on how they have rearranged their inequality)

There must be some reference to the root $x = \frac{3}{2}$ either by stating it or indicating the linear term has a root (e.g. writing "root from here" next to it), but do not accept incorrect statements such as only real root is $(2x-3)$. Condone "solution" for "root"

Do not allow statements such as "Math error" without interpretation of what this means.

Question Number	Scheme	Marks
3a(i)	$r=\sqrt{(8-2)^2+(-3-5)^2}=10$	M1A1
(ii)	$(x-2)^2+(y-5)^2=100$	A1ft
		(3)
b	Gradient between centre and P $=-\frac{4}{3}$	B1
	Perpendicular gradient $=\frac{3}{4}$	M1
	$y+3=\frac{3}{4}(x-8)$	M1
	$3x-4y-36=0$	A1
		(4)
		(7 marks)

(a)(i) **Mark (i) and (ii) together**

M1 Attempts to find the radius. Score for the values embedded in the expression e.g. $\sqrt{(8-2)^2+(-3-5)^2}$ or $\sqrt{(2-8)^2+(5+3)^2}$. They must be attempting to find the difference in the x coordinates and the difference in the y coordinates.

A1 $(r=)\ 10$ ignore any units ± 10 is A0 Do not accept $\sqrt{100}$ for this mark. isw once a correct answer is seen.

(ii) **Note that if M0 is scored in (a)(i) then this is A0 in (ii)**

A1ft $(x-2)^2+(y-5)^2="100"$ o.e. e.g. $(x-2)^2+(y-5)^2="10^2"$ or $x^2+y^2-4x-10y="71"$ Follow through on their positive single value of r. isw once a correct equation is seen.

(b)

B1 Gradient between centre and P is $-\frac{4}{3}$ (may be implied by their gradient of the tangent)

M1 Attempts to find the negative reciprocal for their gradient. May be embedded within their equation of the tangent.

M1 Attempts to find the equation of the tangent at P using a changed gradient (cannot just be a stated gradient of the tangent which is incorrect and does not follow from any earlier work) and $(8,-3)$

Score for $y+3="\frac{3}{4}"(x-8)$. The coordinates $(8,-3)$ must be correctly placed.

If they use $y=mx+c$ they must proceed as far as $c=...$

A1 $3x-4y-36=0$ o.e. (provided all the coefficients are integers and all terms are on one side of the equation) isw once a correct equation is seen.
