Question Number	Scheme	Marks
5(a)	$3^3+3^2(p+3)-3+q=0$	M1
	eg $\Rightarrow 27+9p+27-3+q=0 \Rightarrow 9p+q=-51$*	A1*
		(2)
(b)	$(-p)^3+(p+3)(-p)^2-(-p)+q=9$	M1
	eg $-p^3+p^3+3p^2+p+q=9 \Rightarrow 3p^2+p+q-9=0$*	A1*
		(2)
(c)	$3p^2+p+q-9=0$ $\Rightarrow 3p^2+p-51-9p-9=0$ $\Rightarrow 3p^2-8p-60=0$	M1
	$p=6$	A1
	$q=-51-9p=-105$	A1
		(3)
(d)	$\mathrm{f}(x)=x^3+9x^2-x-105$ $\mathrm{f}(x)=(x-3)(...x^2+...x+...)$	M1
	$\mathrm{g}(x)=x^2+12x+35$	A1
		(2)
		Total 9

(a)

M1 Attempts to use the factor theorem by setting $\mathrm{f}(\pm 3)=0$. Score for the values embedded in the expression leading to an equation in *p* and *q*. The = 0 may be implied by later work for this mark.
Alternatively, there may be other attempts eg to divide algebraically by $x-3$

$$
\begin{array}{r|l}
 & x^2+(p+6)x+3p+17 \\
\hline
x-3 & x^3+(p+3)x^2 \qquad\qquad -x \qquad +q \\
 & x^3 \qquad -3x^2 \\
 & \qquad (p+6)x^2 \qquad\qquad -x \\
 & \qquad (p+6)x^2+(-3p-18)x \\
 & \qquad\qquad\qquad (3p+17)x \qquad +q \\
 & \qquad\qquad\qquad (3p+17)x-9p-51
\end{array}
$$

$\Rightarrow -9p-51=q \Rightarrow 9p+q=-51$

To score the method mark they would need to proceed as far as equating *q* with their "$-9p-51$" to achieve an equation in *p* and *q*.
With alternative methods look for a correct method, condoning slips and invisible brackets leading to an equation in *p* and *q*.

A1* Correct proof with no errors including brackets. There must be at least one intermediate stage of working and $=0$ must be seen at some point in their solution via the factor theorem method.
e.g. $3^3+(p+3)\times 3^2-3+q=0 \Rightarrow 9p+q=-51$ scores M1A0 (no intermediate stage seen)
$27+(p+3)\times 9-3+q=0 \Rightarrow 51+9p+q=0 \Rightarrow 9p+q=-51$ scores M1A1

(b)

M1 Attempts the remainder theorem by setting $f(\pm p)=9$ oe Award for e.g.

$(-p)^3+(p+3)(-p)^2+p+q=9$ condoning sign slips and invisible brackets.

Alternatively, they may attempt to divide algebraically by $x+p$ leading to a remainder in terms of p^2, p and q which is equated to 9. Condone slips in their working.

$$\begin{array}{r|l} & x^2 \quad +3x \quad -1-3p \\ \hline x+p & x^3+(p+3)x^2 \quad -x \quad +q \\ & x^3 \quad px^2 \\ & \quad 3x^2 \quad -x \\ & \quad 3x^2 \quad +3px \\ & \quad\quad (-1-3p)x \quad +q \\ & \quad\quad (-1-3p)x+(-1-3p)p \end{array}$$

With alternative methods look for a correct method, leading to a remainder in terms of p^2, p and q which is equated to 9

A1* Correct proof with no errors including brackets. There must be at least one intermediate stage of working before proceeding to the final answer

e.g. $(-p)^3+(p+3)(-p)^2-(-p)+q=9\Rightarrow 3p^2+p+q-9=0$ scores M1A0 (no intermediate stage)

$(-p)^3+(p+3)(-p)^2-(-p)+q=9\Rightarrow 3p^2+p+q=9\Rightarrow 3p^2+p+q-9=0$ scores M1A1

(c)

M1 Attempts to use both given equations to form a 3TQ equation in p (or q). (terms do not need to be all on one side and condone the omission of = 0)

Do not be too concerned by slips in their substitution/rearrangements or miscopying of the given equations. May be implied by either a correct value for p or a correct value for q

A1 $p=6$ (ignore any reference to $-\frac{10}{3}$)

A1 $q=-105$ only

(d)

M1 Uses their values for p and q and a correct strategy (inspection or long division) to obtain the quadratic factor.

Via inspection score for $x^2+...x\pm\frac{"q"}{3}$

Via long division score for proceeding as far as $x^2\pm"(p+6)"x$. If they attempt algebraic division in (a) you may need to check their quotient with their value for p to see if the method mark can be scored. They may also restart which is acceptable.

Condone the use of a negative value for p for this mark (eg even if $p=-6\Rightarrow 0x$)

A1 $x^2+12x+35$ oe eg $(x+5)(x+7)$ Allow embedded as $(x-3)(x^2+12x+35)$ and condone poor notation such as $f(x)=x^2+12x+35$. Also allow this mark to be scored if seen within their long division.

Question Number	Scheme	Marks
6(a)(i)	Centre is (–4, 2)	B1
(ii)	$x^2+y^2+8x-4y=0$ $\Rightarrow (x+4)^2+(y-2)^2-16-4=0 \Rightarrow r=...$	M1
	$r=2\sqrt{5}$ oe	A1
		(3)
(b)	$x^2+y^2+8x-4y=0,\ x+2y+10=0$ $\Rightarrow (-2y-10)^2+y^2+8(-2y-10)-4y=0$ or $x^2+\left(\frac{-x-10}{2}\right)^2+8x-4\left(\frac{-x-10}{2}\right)=0$	M1
	$y^2+4y+4=0$ or e.g. $x^2+12x+36=0$	A1
	$(y+2)^2=0 \Rightarrow y=...$ or e.g. $(x+6)^2=0 \Rightarrow x=...$	dM1
	(–6, –2)	A1
		(4)
(c)	$x+2y+10=0 \Rightarrow m_T=-\frac{1}{2} \Rightarrow m_N=2$ or $m_N=\frac{"2"-("-2")}{"-4"-("-6")}$	M1
	Usually either $y-2=2(x+4)$ or $y+2=2(x+6)$	dM1
	$y=2x+10$	A1
		(3)
		Total 10

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

B1 Correct centre. Allow written as $x=-4,\ y=2$

(ii)

M1 Correct method for the radius. Award for $(x\pm a)^2+(y\pm b)^2....\Rightarrow r=\sqrt{"a^2"+"b^2"}=...$ or maybe seen using the general equation of a circle e.g. $x^2+2gx+y^2+2fy+c=0 \Rightarrow r=\sqrt{f^2+g^2-c}$
May be implied by a correct radius for their centre if no method is shown.

A1ft $r=2\sqrt{5}$ or exact equivalent eg $\sqrt{20}$. Do not accept $\pm$.
Only follow through their centre with coordinates $(\pm 4, \pm 2)$

(b) Note that answer only scores 0 marks.

M1 Uses both equations to eliminate one variable. Condone slips in substituting in. Also allow use of the equation of the circle in the form $(x-a)^2+(y-b)^2=r^2$ oe allowing for slips in manipulation