

- 1
- (i)
- Complete the square to obtain $(x - 1)^2 + (y + 3)^2 = 36$. (M1)
 - Centre: $(1, -3)$. (A1)
- (ii)
- From $(x - 1)^2 + (y + 3)^2 = 36$, the radius is 6. (B1)

(Total for question 1 is 3 marks)

- 2
- Use $(x - 2)^2 + (y - 5)^2 = r^2$. (M1)
 - Substitute $(4, 9)$ to obtain $r^2 = (4 - 2)^2 + (9 - 5)^2 = 20$. (A1)
 - Equation: $(x - 2)^2 + (y - 5)^2 = 20$. (A1)

(Total for question 2 is 3 marks)

- 3
- (a)
- Use $(x + 2)^2 + (y - 3)^2 = r^2$. (M1)
 - Substitute $(1, 8)$ into the equation. (M1)
 - Obtain $r^2 = (1 + 2)^2 + (8 - 3)^2 = 34$. (A1)
 - Equation: $(x + 2)^2 + (y - 3)^2 = 34$. (A1)
- (b)
- Substitute $(3, 6)$ to show that $(3 + 2)^2 + (6 - 3)^2 = 25 + 9 = 34$. (B1)
- (c)
- Calculate the gradient of the radius as $\frac{6 - 3}{3 - (-2)} = \frac{3}{5}$. (M1)
 - Use perpendicular gradients to obtain the tangent gradient $-\frac{5}{3}$. (A1)
 - Use the point $(3, 6)$ in a line equation with gradient $-\frac{5}{3}$. (M1)
 - Obtain $y = -\frac{5}{3}x + 11$. (A1)
 - Equation: $5x + 3y - 33 = 0$. (A1)

(Total for question 3 is 10 marks)

4

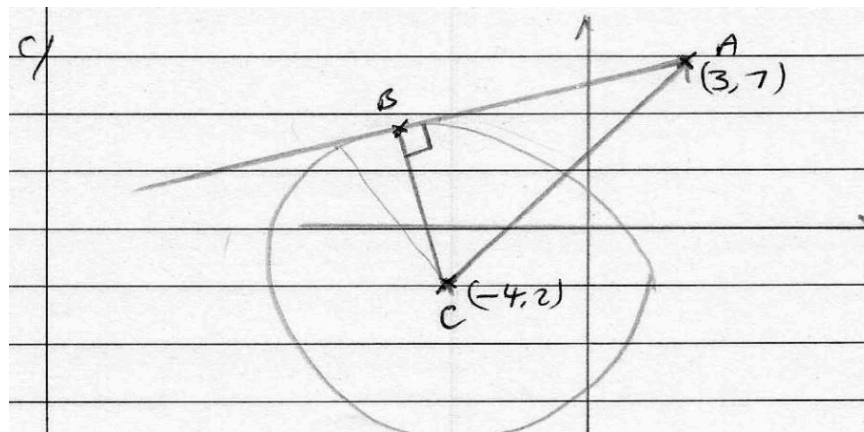
- (a)
- Use the centre-radius form with centre $(2, 5)$ and radius 7. (M1)
 - Equation: $(x - 2)^2 + (y - 5)^2 = 49$. (A1)
- (b)
- Substitute $y = 3x - 1$ into the circle equation to obtain $(x - 2)^2 + (3x - 6)^2 = 49$. (M1)
 - Expand and simplify to $10x^2 - 40x - 9 = 0$. (A1)
 - Apply the quadratic formula to this equation. (M1)
 - Obtain $x = \frac{20 \pm 7\sqrt{10}}{10}$. (A1)
 - Substitute into $y = 3x - 1$ to obtain $y = \frac{50 \pm 21\sqrt{10}}{10}$. (M1)
 - Coordinates: $\left(\frac{20 + 7\sqrt{10}}{10}, \frac{50 + 21\sqrt{10}}{10}\right)$ and $\left(\frac{20 - 7\sqrt{10}}{10}, \frac{50 - 21\sqrt{10}}{10}\right)$. (A1)

(Total for question 4 is 8 marks)

5

- (a)
- Substitute $(1, 5)$ to obtain $1^2 + 5^2 + 8(1) - 4(5) + k = 0$. (M1)
 - Hence $14 + k = 0$, so $k = -14$. (A1)
- (b)
- Substitute $k = -14$ and complete the square to obtain $(x + 4)^2 + (y - 2)^2 = 34$. (M1)
 - Centre: $(-4, 2)$. (A1)
 - Radius: $\sqrt{34}$. (A1)

(c)



- Use the centre $C = (-4, 2)$ to calculate $AC = \sqrt{7^2 + 5^2} = \sqrt{74}$. (M1)
- State that $BC = \sqrt{34}$. (B1)
- Use the fact that a radius is perpendicular to a tangent at the point of contact, so triangle ABC is right-angled at B . (B1)
- Apply Pythagoras: $AB^2 + 34 = 74$, giving $AB^2 = 40$. (M1)
- Hence $AB = \sqrt{40} = 2\sqrt{10}$. (A1)

(Total for question 5 is 10 marks)

6

- (a)
- Calculate $DE^2 = 7^2 + 3^2 = 58$. (B1)
 - Calculate $EF^2 = 3^2 + 7^2 = 58$. (B1)
 - Calculate $DF^2 = 4^2 + 10^2 = 116$. (B1)
 - Since $DE^2 + EF^2 = DF^2$, conclude that $\angle DEF = 90^\circ$. (C1)
- (b)
- Since $\angle DEF = 90^\circ$, identify DF as a diameter. (B1)
 - Find the midpoint of D and F : $\left(\frac{-3+1}{2}, \frac{2-8}{2}\right)$. (M1)
 - Centre: $(-1, -3)$. (A1)
- (c)
- Use the centre $(-1, -3)$ to write $(x+1)^2 + (y+3)^2 = r^2$. (M1)
 - Since $DF = \sqrt{116}$ is the diameter, obtain $r = \frac{\sqrt{116}}{2} = \sqrt{29}$ and $r^2 = 29$. (A1)
 - Equation: $(x+1)^2 + (y+3)^2 = 29$. (A1)

(Total for question 6 is 10 marks)

7

- (a)
- Complete the square to obtain $(x-3)^2 + (y+1)^2 = 16$. (M1)
 - Centre: $(3, -1)$. (A1)
 - Radius: 4. (A1)
- (b)
- Set $x = 0$ to obtain $9 + (y+1)^2 = 16$. (M1)
 - Solve to obtain $y = -1 \pm \sqrt{7}$. (A1)
 - Coordinates: $(0, -1 + \sqrt{7})$ and $(0, -1 - \sqrt{7})$. (A1)

(Total for question 7 is 6 marks)

8

- Recognise that the centre is the midpoint of the diameter AB . (B1)
- Calculate the midpoint as $\left(\frac{-3+13}{2}, \frac{5-4}{2}\right) = \left(5, \frac{1}{2}\right)$. (A1)
- Calculate the diameter length as $\sqrt{16^2 + 9^2} = \sqrt{337}$. (M1)
- Hence find the radius $r = \frac{\sqrt{337}}{2}$. (A1)
- Obtain $r^2 = \frac{337}{4}$. (A1)
- Equation: $(x-5)^2 + \left(y - \frac{1}{2}\right)^2 = \frac{337}{4}$. (A1)

(Total for question 8 is 6 marks)

9

- (a)
- Use $(x - 1)^2 + (y - 5)^2 = r^2$. (M1)
 - Substitute $A(-4, 3)$ into the equation. (M1)
 - Calculate $r^2 = (-5)^2 + (-2)^2 = 29$. (A1)
 - Equation: $(x - 1)^2 + (y - 5)^2 = 29$. (A1)
- (b)
- Calculate the radius gradient as $\frac{3 - 5}{-4 - 1} = \frac{2}{5}$. (M1)
 - Hence the tangent gradient is $-\frac{5}{2}$. (A1)
 - Use the point $(-4, 3)$ to obtain $y = -\frac{5}{2}x - 7$. (M1)
 - Equation: $5x + 2y + 14 = 0$. (A1)

(Total for question 9 is 8 marks)

10

- Since the tangent gradient is 2, use the perpendicular radius gradient $-\frac{1}{2}$. (B1)
- Form $-\frac{1}{2} = \frac{7 - k}{3 - 5}$. (M1)
- Solve to obtain $k = 6$. (A1)
- Substitute the centre $(5, 6)$ and point $(3, 7)$ to obtain $r^2 = (3 - 5)^2 + (7 - 6)^2 = 5$. (M1)
- Equation: $(x - 5)^2 + (y - 6)^2 = 5$. (A1)

(Total for question 10 is 5 marks)