C1

1. (*a*) (i) Gradient of $BC = \frac{\text{increase in } y}{\text{increase in } x}$ M1

Gradient of $BC = -4$ (or equivalent) A1

(ii) A correct method for finding the equation of BC using candidate's gradient for BC M1

Equation of BC : $y - (-5) = -4(x - 6)$ (or equivalent)
(f.t. candidate's gradient of BC) A1

Equation of BC : $4x + y - 19 = 0$ (convincing) A1

(iii) Use of $m_{AD} \times m_{BC} = -1$ M1

A correct method for finding the equation of AD using candidate's gradient for AD (M1)

(to be awarded only if corresponding M1 is not awarded in part (ii))

Equation of AD : $y - 4 = {}^{1}/_{4}(x - 8)$ (or equivalent)
(f.t. candidate's gradient of BC) A1

Note: Total mark for part (*a*) is 7 marks

(*b*) An attempt to solve equations of BC and AD simultaneously M1

$x = 4, y = 3$ (convincing) (c.a.o.) A1

(*c*) A correct method for finding the length of BD M1

$BD = \sqrt{68}$ A1

(*d*) A correct method for finding E M1

$E(0, 2)$ A1

2. (*a*) $\frac{2 + 5\sqrt{7}}{4 + \sqrt{7}} = \frac{(2 + 5\sqrt{7})(4 - \sqrt{7})}{(4 + \sqrt{7})(4 - \sqrt{7})}$ M1

Numerator: $8 - 2\sqrt{7} + 20\sqrt{7} - 35$ A1

Denominator: $16 - 7$ A1

$\frac{2 + 5\sqrt{7}}{4 + \sqrt{7}} = -3 + 2\sqrt{7}$ (c.a.o.) A1

Special case

If M1 not gained, allow B1 for correctly simplified numerator or denominator following multiplication of top and bottom by $4 + \sqrt{7}$

(*b*) $\sqrt{360} = 6\sqrt{10}$ B1

$\sqrt{2} \times (\sqrt{5})^3 = 5\sqrt{10}$ B1

$\frac{\sqrt{30} \times \sqrt{8}}{\sqrt{6}} = 2\sqrt{10}$ B1

$\sqrt{360} - \sqrt{2} \times (\sqrt{5})^3 - \frac{\sqrt{30} \times \sqrt{8}}{\sqrt{6}} = -\sqrt{10}$ (c.a.o.) B1

3. (*a*) $\frac{dy}{dx} = 4x - 10$ (an attempt to differentiate, at least one non-zero term correct) M1

An attempt to substitute $x = 3$ in candidate's expression for $\frac{dy}{dx}$ m1

Value of $\frac{dy}{dx}$ at $P = 2$ (c.a.o.) A1

Use of gradient of normal = $\frac{-1}{\text{candidate's value for } \frac{dy}{dx}}$ m1

Equation of normal at P: $y - (-5) = -\,^1/_2(x - 3)$ (or equivalent)

(f.t. candidate's value for $\frac{dy}{dx}$ provided M1 and both m1's awarded) A1

(*b*) An attempt to put candidate's expression for $\frac{dy}{dx} = 0$ M1

x-coordinate of $Q = 2{\cdot}5$

(f.t. one error in candidate's expression for $\frac{dy}{dx}$) A1

4. (*a*) $2(x - 4)^2 - 40$ B1 B1 B1

(*b*) least value $= -20$ (f.t. candidate's value for c) B1

x-coordinate $= 4$ (f.t. candidate's value for b) B1

5. (*a*) $(1 + 2x)^7 = 1 + 14x + 84x^2 \ldots$ B1 B1 B1

(*b*) $(1 - 4x)(1 + 2x)^7 = 1 - 4x + 14x - 56x^2 + 84x^2$

Constant term and terms in x B1

Terms in x^2 B1

(f.t. candidate's expression in (*a*))

$(1 - 4x)(1 + 2x)^7 = 1 + 10x + 28x^2$ (c.a.o.) B1

6. (*a*) (i) An expression for $b^2 - 4ac$, with at least two of a, b, c correct M1

$b^2 - 4ac = (4k + 1)^2 - 4 \times (k + 1) \times (k - 5)$ A1

Putting $b^2 - 4ac = 0$ m1

$4k^2 + 8k + 7 = 0$ (convincing) A1

(ii) An expression for $b^2 - 4ac$, with at least two of a, b, c correct (M1)

(to be awarded only if corresponding M1 is not awarded in part (i))

$b^2 - 4ac = 64 - 112\ (= -48)$ A1

$b^2 - 4ac < 0 \Rightarrow$ no real roots A1

Note: Total mark for part (*a*) is 6 marks

(*b*) Finding critical values $x = -{}^3/_4$, $x = 3$ B1

A statement (mathematical or otherwise) to the effect that

$x \le -{}^3/_4$ or $3 \le x$ (or equivalent)

(f.t. candidate's derived critical values) B2

Deduct 1 mark for each of the following errors

the use of strict inequalities

the use of the word 'and' instead of the word 'or'

7. (*a*) $y + \delta y = 5(x + \delta x)^2 + 8(x + \delta x) - 11$ B1

Subtracting y from above to find δy M1

$\delta y = 10x\delta x + 5(\delta x)^2 + 8\delta x$ A1

Dividing by δx and letting $\delta x \to 0$ M1

$\frac{dy}{dx} = \lim_{\delta x \to 0} \frac{\delta y}{\delta x} = 10x + 8$ (c.a.o.) A1

(*b*) $\frac{dy}{dx} = 6 \times \frac{2}{3} \times x^{-1/3} + 5 \times -2 \times x^{-3}$ (completely correct answer) B2

(**If B2 not awarded**, award B1 for at least one correct non-zero term)

8. Attempting to find $f(r) = 0$ for some value of r M1

$f(-1) = 0 \Rightarrow x + 1$ is a factor A1

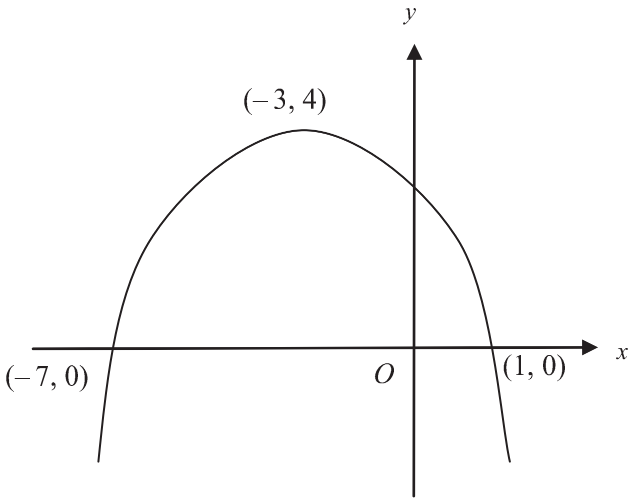
$f(x) = (x + 1)(8x^2 + ax + b)$ with one of a, b correct M1

$f(x) = (x + 1)(8x^2 - 10x + 3)$ A1

$f(x) = (x + 1)(2x - 1)(4x - 3)$ (f.t. only $8x^2 + 10x + 3$ in above line) A1

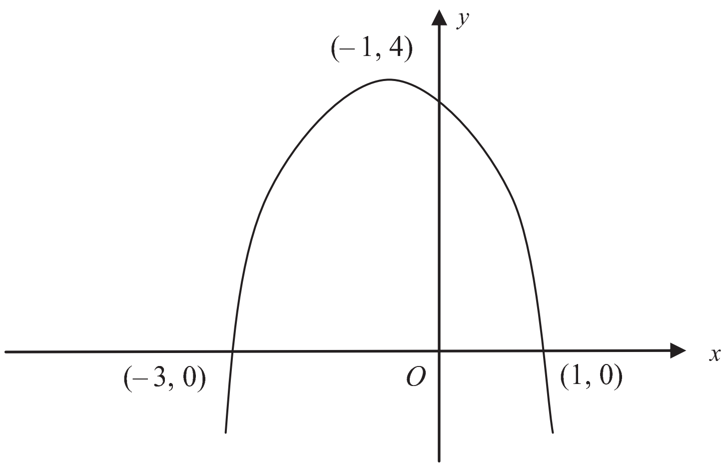
$x = -1, {}^1/_2, {}^3/_4$ (f.t. for factors $2x \pm 1$, $4x \pm 3$) A1

9. (*a*)



Concave down curve with y-coordinate of maximum = 4 B1
x-coordinate of maximum = – 3 B1
Both points of intersection with x-axis B1

(*b*)



Concave down curve with y-coordinate of maximum = 4 B1
x-coordinate of maximum = – 1 B1
Both points of intersection with x-axis B1

Note: A candidate who draws a curve with no changes to the original graph is awarded 0 marks (both parts)

10. (*a*) (i) $(2x \times x) + (2x \times x) + (2x \times y) + (2x \times y) + (x \times y) + (x \times y) = 108$ M1

$6xy + 4x^2 = 108 \Rightarrow xy = 18 - \frac{2x^2}{3}$ (convincing) A1

(ii) $V = 2x \times x \times y = 2x(xy) \Rightarrow V = 36x - \frac{4x^3}{3}$ (convincing) B1

(*b*) $\frac{dV}{dx} = 36 - 3 \times \frac{4x^2}{3}$ B1

Putting derived $\frac{dV}{dx} = 0$ M1

$x = 3, (-3)$ (f.t. candidate's $\frac{dV}{dx}$) A1

Stationary value of V at $x = 3$ is 72 (c.a.o) A1

A correct method for finding nature of the stationary point yielding a maximum value (for $0 < x$) B1