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

Gradient of $AB = -{}^1/_2$ (or equivalent) A1

(ii) A correct method for finding the equation of *AB* using the candidate's value for the gradient of *AB*. M1

Equation of AB : $y - 3 = -{}^1/_2\,(x - 12)$ (or equivalent)

(f.t. the candidate's value for the gradient of *AB*) A1

(*b*) (i) Use of gradient $L \times$ gradient $AB = -1$ M1

Equation of L : $y = 2x - 1$ A1

(f.t. the candidate's value for the gradient of *AB*)

(ii) A correct method for finding the coordinates of *D* M1

$D(4, 7)$ (convincing) A1

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

$AD = \sqrt{45}$ A1

$BD = \sqrt{80}$ A1

(*c*) (i) A correct method for finding the coordinates of *E* M1

$E(8, 15)$ A1

(ii) *ACBE* is a kite (c.a.o.) B1

2. (*a*) $\dfrac{3\sqrt{3} + 1}{5\sqrt{3} - 7} = \dfrac{(3\sqrt{3} + 1)(5\sqrt{3} + 7)}{(5\sqrt{3} - 7)(5\sqrt{3} + 7)}$ M1

Numerator: $45 + 21\sqrt{3} + 5\sqrt{3} + 7$ A1

Denominator: $75 - 49$ A1

$\dfrac{3\sqrt{3} + 1}{5\sqrt{3} - 7} = 2 + \sqrt{3}$ (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 $5\sqrt{3} - 7$

(*b*) $\sqrt{12} \times \sqrt{24} = 12\sqrt{2}$ B1

$\dfrac{\sqrt{150}}{\sqrt{3}} = 5\sqrt{2}$ B1

$\dfrac{36}{\sqrt{2}} = 18\sqrt{2}$ B1

$(\sqrt{12} \times \sqrt{24}) + \dfrac{\sqrt{150}}{\sqrt{3}} - \dfrac{36}{\sqrt{2}} = -\sqrt{2}$ (c.a.o.) B1

3. (*a*) $\frac{dy}{dx} = 2x - 8$

(an attempt to differentiate, at least one non-zero term correct) M1

An attempt to substitute $x = 6$ in candidate's expression for $\frac{dy}{dx}$ m1

Value of $\frac{dy}{dx}$ at $P = 4$ (c.a.o.) A1

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

Equation of normal to C at P: $y - 2 = -{}^{1}/_{4}(x - 6)$ (or equivalent)

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

(*b*) Putting candidate's expression for $\frac{dy}{dx} = 2$ M1

x-coordinate of $Q = 5$ A1

y-coordinate of $Q = -1$ A1

$c = -11$ A1

(f.t. candidate's expression for $\frac{dy}{dx}$ and at most one error in the enumeration of the coordinates of Q for all three A marks provided both M1's are awarded)

4. (*a*) $(1 + x)^6 = 1 + 6x + 15x^2 + 20x^3 + \ldots$

All terms correct B2

If B2 not awarded, award B1 for three correct terms

(*b*) An attempt to substitute $x = 0{\cdot}1$ in the expansion of part (*a*)

(f.t. candidate's coefficients from part (*a*)) M1

$1{\cdot}1^6 \approx 1 + 6 \times 0{\cdot}1 + 15 \times 0{\cdot}01 + 20 \times 0{\cdot}001$

(At least three terms correct, f.t. candidate's coefficients from part (*a*))

A1

$1{\cdot}1^6 \approx 1{\cdot}77$ (c.a.o.) A1

5. (*a*) $a = 4$ B1

$b = -1$ B1

$c = 7$ B1

(*b*) An attempt to substitute 1 for x in an appropriate quadratic expression

(f.t. candidate's value for b) M1

Greatest value of $\dfrac{1}{4x^2 - 8x + 29} = \dfrac{1}{25}$ (c.a.o.) A1

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

$b^2 - 4ac = (2k)^2 - 4 \times (k - 1) \times (7k - 4)$ A1

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

$6k^2 - 11k + 4 > 0$ (convincing) A1

Finding critical values $k = {}^1/_2$, $k = {}^4/_3$ B1

A statement (mathematical or otherwise) to the effect that

$k < {}^1/_2$ or $k > {}^4/_3$ (or equivalent)

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

Deduct 1 mark for each of the following errors

the use of non-strict inequalities

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

7. (*a*) $y + \delta y = -3(x + \delta x)^2 + 8(x + \delta x) - 7$ B1

Subtracting y from above to find δy M1

$\delta y = -6x\delta x - 3(\delta x)^2 + 8\delta x$ A1

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

$\frac{dy}{dx} = \lim_{\delta x \to 0} \frac{\delta y}{\delta x} = -6x + 8$ (c.a.o.) A1

(*b*) $\frac{dy}{dx} = 9 \times \frac{5}{4} \times x^{1/4} - 8 \times -\frac{1}{3} \times x^{-4/3}$ B1, B1

8. **Either:** showing that $f(2) = 0$

Or: trying to find $f(r)$ for at least two values of r M1

$f(2) = 0 \Rightarrow x - 2$ is a factor A1

$f(x) = (x - 2)(6x^2 + ax + b)$ with one of a, b correct M1

$f(x) = (x - 2)(6x^2 - x - 2)$ A1

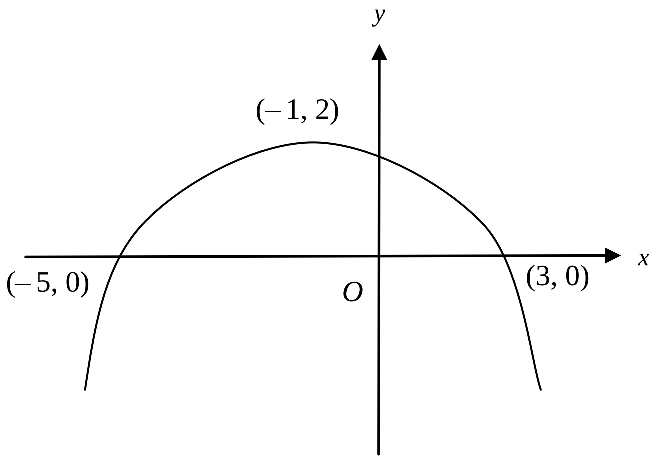
$f(x) = (x - 2)(3x - 2)(2x + 1)$ (f.t. only $6x^2 + x - 2$ in above line) A1

$x = 2, {}^2/_3, -{}^1/_2$ (f.t. for factors $3x \pm 2$, $2x \pm 1$) A1

Special case

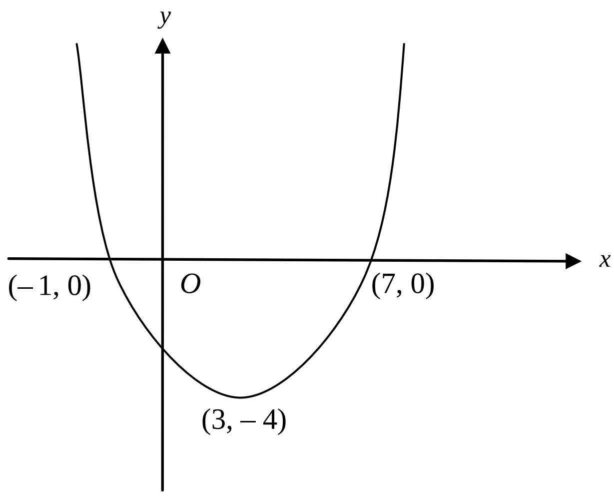
Candidates who, after having found $x - 2$ as one factor, then find one of the remaining factors by using e.g. the factor theorem, are awarded B1 for final 4 marks

9. (*a*) (i)



Concave down curve with *y*-coordinate of maximum = 2	B1
x-coordinate of maximum = – 1	B1
Both points of intersection with *x*-axis	B1

(ii)



Concave up curve with *x*-coordinate of minimum = 3	B1
y-coordinate of minimum = – 4	B1
Both points of intersection with *x*-axis	B1

(*b*) $x = 3$ (c.a.o.) B1

10. (*a*) $\frac{dy}{dx} = 3x^2 + 18x + 27$ B1

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

$3(x + 3)^2 = 0 \Rightarrow x = -3$ (c.a.o) A1

$x = -3 \Rightarrow y = 4$ (c.a.o) A1

(*b*) **Either:**

An attempt to consider value of $\frac{dy}{dx}$ at $x = -3^-$ and $x = -3^+$ M1

$\frac{dy}{dx}$ has same sign at $x = -3^-$ and $x = -3^+ \Rightarrow (-3, 4)$ is a point of inflection A1

Or:

An attempt to find value of $\frac{d^2y}{dx^2}$ at $x = -3$, $x = -3^-$ and $x = -3^+$ M1

$\frac{d^2y}{dx^2} = 0$ at $x = -3$ and $\frac{d^2y}{dx^2}$ has different signs at $x = -3^-$ and $x = -3^+$

$\Rightarrow (-3, 4)$ is a point of inflection A1

Or:

An attempt to find the value of y at $x = -3^-$ and $x = -3^+$ M1

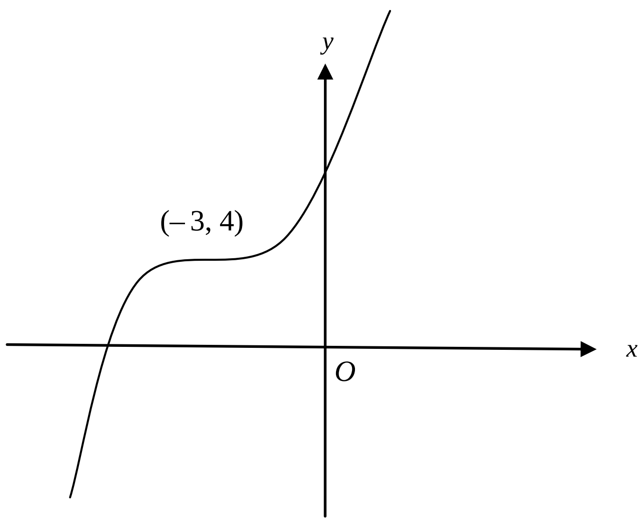
Value of y at $x = -3^- < 4$ and value of y at $x = -3^+ > 4 \Rightarrow (-3, 4)$ is a point of inflection A1

Or:

An attempt to find values of $\frac{d^2y}{dx^2}$ and $\frac{d^3y}{dx^3}$ at $x = -3$ M1

$\frac{d^2y}{dx^2} = 0$ and $\frac{d^3y}{dx^3} \neq 0$ at $x = -3 \Rightarrow (-3, 4)$ is a point of inflection A1

(*c*)



G1