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

Gradient of $AB = -\frac{1}{3}$ (or equivalent) A1

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

Equation of AB : $y - 3 = -\frac{1}{3}[x - (-7)]$ (or equivalent)

(f.t. candidate's gradient of AB) A1

Equation of AB : $x + 3y - 2 = 0$ (convincing) A1

(iii) Use of $m_L \times m_{AB} = -1$ M1

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

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

Equation of L : $y - 5 = 3[x - (-3)]$ (or equivalent)

(f.t. candidate's gradient of AB) A1

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

(*b*) An attempt to solve equations of AB and L simultaneously M1

$x = -4$, $y = 2$ (convincing) (c.a.o.) A1

(*c*) A correct method for finding at least one coordinate of the mid-point of AB M1

y-coordinate of the mid-point of $AB = 1{\cdot}5$ (or x-coordinate $= -2{\cdot}5$)

$\Rightarrow D$ is not the mid-point of AB **or**

$\Rightarrow L$ is not the perpendicular bisector of AB **or**

$\Rightarrow$ the mid-point does not lie on L A1

Alternative Mark Scheme

A correct method for finding the lengths of two of AB, AD, BD M1

Two of $AB = \sqrt{90}$, $AD = \sqrt{10}$, $BD = \sqrt{40}$

$\Rightarrow D$ is not the mid-point of AB **or**

$\Rightarrow L$ is not the perpendicular bisector of AB **or**

$\Rightarrow$ the mid-point does not lie on L A1 (*d*) A correct method for finding the length of *BD*(*CD*) M1

$BD = \sqrt{40}$ (or equivalent) A1

$CD = \sqrt{10}$ A1

Substitution of candidate's derived values in $\tan ABC = \frac{CD}{BD}$ m1

$\tan ABC = \frac{1}{2}$ (c.a.o.) A1

Special Case

A candidate who has been awarded M0 A0 A0 m0 A0 may be awarded SC1 for one of $AB = \sqrt{90}$, $AC = \sqrt{20}$, $BC = \sqrt{50}$

2. (*a*) $\frac{4\sqrt{2} - \sqrt{11}}{3\sqrt{2} + \sqrt{11}} = \frac{(4\sqrt{2} - \sqrt{11})(3\sqrt{2} - \sqrt{11})}{(3\sqrt{2} + \sqrt{11})(3\sqrt{2} - \sqrt{11})}$ M1

Numerator: $12 \times 2 - 4 \times \sqrt{2} \times \sqrt{11} - 3 \times \sqrt{11} \times \sqrt{2} + 11$ A1

Denominator: $18 - 11$ A1

$\frac{4\sqrt{2} - \sqrt{11}}{3\sqrt{2} + \sqrt{11}} = 5 - \sqrt{22}$ (c.a.o.) A1

Special case

If M1 not gained, allow SC1 for correctly simplified numerator or denominator following multiplication of top and bottom by $3\sqrt{2} + \sqrt{11}$

(*b*) $\frac{7}{2\sqrt{14}} = p\sqrt{14}$, where *p* is a fraction equivalent to $^{1}/_{4}$ B1

$\left(\frac{\sqrt{14}}{2}\right)^3 = q\sqrt{14}$, where *q* is a fraction equivalent to $^{7}/_{4}$ B1

$\frac{7}{2\sqrt{14}} + \left(\frac{\sqrt{14}}{2}\right)^3 = 2\sqrt{14}$ (c.a.o.) B1

3. (*a*) y-coordinate of $P = -4$ B1

$\frac{dy}{dx} = 3x^2 - 2x - 13$

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

An attempt to substitute $x = 2$ in candidate's expression for $\frac{dy}{dx}$ m1

Value of $\frac{dy}{dx}$ at $P = -5$ (c.a.o.) A1

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

Equation of normal to C at P: $y - (-4) = {}^1/_5(x - 2)$ (or equivalent)

(f.t. candidate's value for $\frac{dy}{dx}$ and the candidate's derived y-value at $x = 2$ provided M1 and both m1's awarded) A1

(*b*) Putting candidate's expression for $\frac{dy}{dx} = -8$ M1

An attempt to collect terms, form and solve quadratic equation in a (or x) either by correct use of the quadratic formula or by getting the equation into the form $(ma + n)(pa + q) = 0$, with $m \times p$ = candidate's coefficient of a^2 and $n \times q$ = candidate's constant m1

$3a^2 - 2a - 5 = 0 \Rightarrow a = -1$ or $\frac{5}{3}$ (both values) (c.a.o.) A1

4. (*a*) $4(x - 3)^2 - 225$ B1 B1 B1

(*b*) $4(x - 3)^2 = 225$ (f.t. candidate's values for a, b, c) M1

$(x - 3) = (\pm)\frac{15}{2}$ (f.t. candidate's values for a, b, c) m1

$x = \frac{21}{2}, -\frac{9}{2}$ (both values) A1

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

$b^2 - 4ac = (2k - 5)^2 - 4 \times k \times (k - 6)$ A1

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

$k < -\frac{25}{4}$ (or equivalent) A1

(*b*) $k = -\frac{25}{4}$ [f.t. the end point(s) of the candidate's range in (*a*)] B1

6. (*a*) $\left(1 - \frac{x}{2}\right)^8 = 1 - 4x + 7x^2 - 7x^3 + \ldots$ B1 B1 B1 B1

(– 1 for further incorrect simplification)

(*b*) First term = 2^n B1

$2^n = 32 \Rightarrow n = 5$ B1

Second term = $n \times 2^{n-1} \times ax$ B1

$a = -3$ (f.t. candidate's value for n) B1

7. (*a*) $y + \delta y = 9(x + \delta x)^2 - 8(x + \delta x) - 3$ B1

Subtracting y from above to find δy M1

$\delta y = 18x\delta x + 9(\delta x)^2 - 8\delta x$ A1

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

$\frac{dy}{dx} = \lim_{\delta x \to 0} \frac{\delta y}{\delta x} = 18x - 8$ (c.a.o.) A1

(*b*) $\frac{dy}{dx} = 3 \times (-6) \times x^{-7} - 4 \times \frac{5}{3} \times x^{2/3}$ B1 B1

8. (*a*) Use of $f(3) = 0$ M1

$27p - 117 - 57 + 12 = 0 \Rightarrow p = 6$ (convincing) A1

Special case

Candidates who assume $p = 6$ and show $f(3) = 0$ are awarded B1

(*b*) $f(x) = (x - 3)(6x^2 + ax + b)$ with one of a, b correct M1

$f(x) = (x - 3)(6x^2 + 5x - 4)$ A1

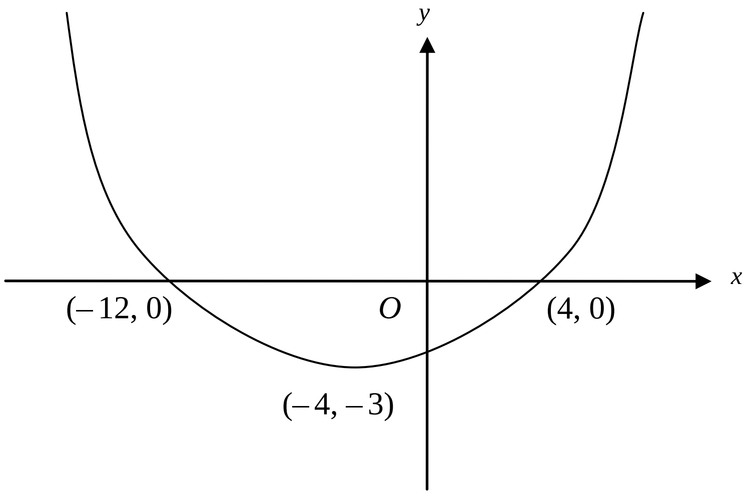
$f(x) = (x - 3)(2x - 1)(3x + 4)$ (f.t. only $6x^2 - 5x - 4$ in above line) A1

Roots are $x = 3, \frac{1}{2}, -\frac{4}{3}$ (f.t. for factors $2x \pm 1$, $3x \pm 4$) A1

Special case

Candidates who find one of the remaining factors,
$(2x - 1)$ or $(3x + 4)$, using e.g. factor theorem, are awarded B1

9. (*a*)



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

(*b*) **Either:**
Any graph of the form $y = af(x)$ (with $a \neq 0$) will intersect the x-axis at (– 6, 0) and (2, 0) and thus not pass through the origin.
Or:
$f(0) \neq 0$ and since $a \neq 0$, $af(0) \neq 0$. Thus any graph of the form $y = af(x)$ will not pass through the origin. E1

10. (*a*)

$L = x + 2y$		
$800 = xy$	(both equations)	M1
$L = x + \frac{1600}{x}$	(convincing)	A1

(*b*)

$\frac{dL}{dx} = 1 + 1600 \times (-1) \times x^{-2}$		B1
Putting derived $\frac{dL}{dx} = 0$		M1
$x = 40, (-40)$	(f.t. candidate's $\frac{dL}{dx}$)	A1
Stationary value of L at $x = 40$ is 80	(c.a.o)	A1
A correct method for finding nature of the stationary point yielding a minimum value (for $x > 0$)		B1