Mark Scheme (Results)

Summer 2019

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme.
  Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

- **Types of mark**
  - M marks: method marks
  - A marks: accuracy marks
  - B marks: unconditional accuracy marks (independent of M marks)
- **Abbreviations**
  - cao – correct answer only
  - ft – follow through
  - isw – ignore subsequent working
  - SC - special case
  - oe – or equivalent (and appropriate)

- o dep – dependent
- o indep – independent
- o awrt – answer which rounds to
- o eeoo – each error or omission

- **No working**
  If no working is shown then correct answers normally score full marks
  If no working is shown then incorrect (even though nearly correct) answers score no marks.

- **With working**
  If there is a wrong answer indicated on the answer line always check the working in the body of the script (and on any diagrams), and award any marks appropriate from the mark scheme.
  If it is clear from the working that the "correct" answer has been obtained from incorrect working, award 0 marks.
  If a candidate misreads a number from the question. Eg. Uses 252 instead of 255; method marks may be awarded provided the question has not been simplified. Examiners should send any instance of a suspected misread to review. If there is a choice of methods shown, then award the lowest mark, unless the subsequent working makes clear the method that has been used.

- **Ignoring subsequent work**
  It is appropriate to ignore subsequent work when the additional work does not change the answer in a way that is inappropriate for the question: eg. Incorrect cancelling of a fraction that would otherwise be correct.
  It is not appropriate to ignore subsequent work when the additional work essentially makes the answer incorrect eg algebra. Transcription errors occur when candidates present a correct answer in working, and write it incorrectly on the answer line; mark the correct answer.

- **Parts of questions**
  Unless allowed by the mark scheme, the marks allocated to one part of the question CANNOT be awarded to another.
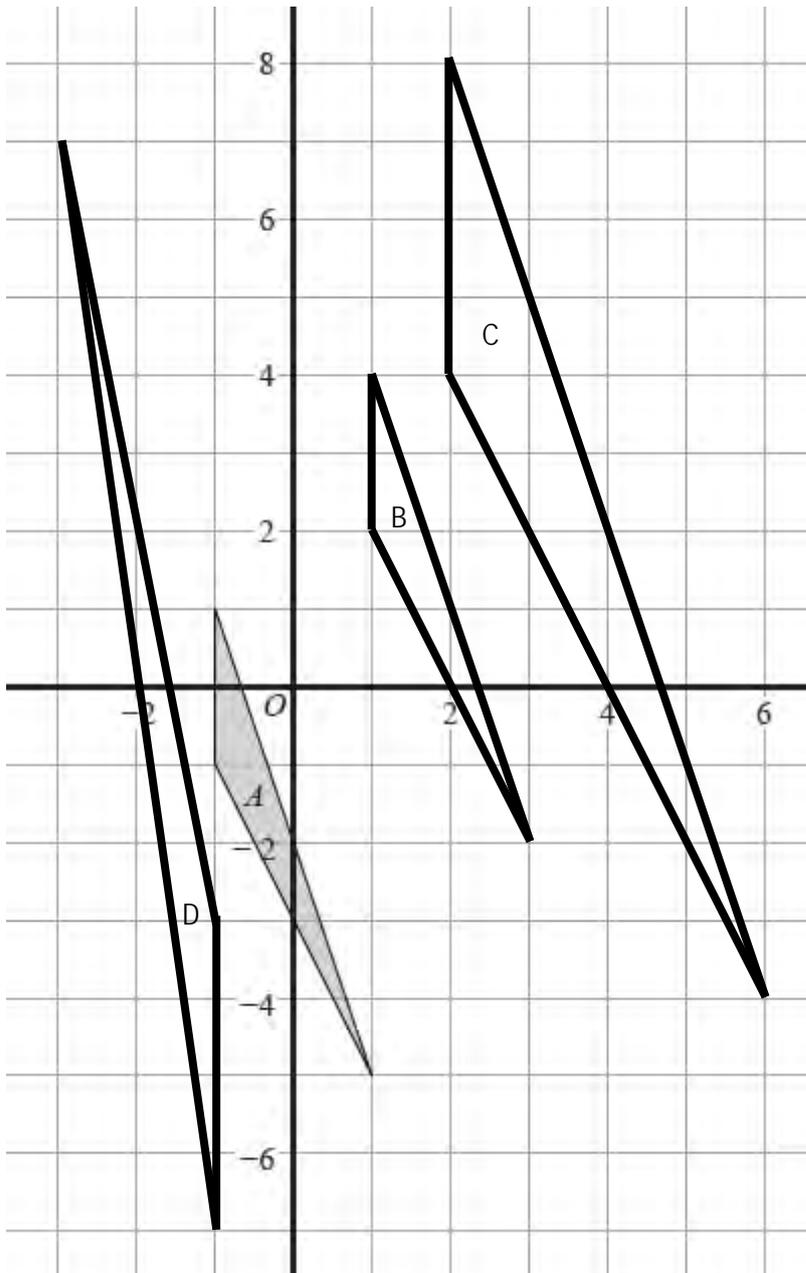
Question		Working	Answer	Mark	Notes
1	(a)	$\left(\dfrac{48}{200}\right) \times 360$		2	M1 Allow 23+47+56+48+26 for denominator.
			86.4		A1 Ignore anything after number (eg. %) Allow 86 with working seen.
	(b)	$23 \times 15 + 47 \times 25 + 56 \times 35 + 48 \times 45 + 26 \times 55$ (=7070) Or $345 + 1175 + 1960 + 2160 + 1430$ (=7070)		4	M2 For M2 require exactly 5 products with at least 4 correct. There must be a clear intention to add seen. 7070 seen gains M2. M1 for freq. $\times$ consistent value within interval For M1 Require 4-6 products with at least 3 correct frequency $\times$ consistent values within their intervals (allow minimum value for this) Products seen beside the table can be awarded this mark if an attempt to total them is seen.
		$\dfrac{"7070"}{200}$			M1 Dependent on at least M1 already gained.
			35		A1 Allow 35.3, 35.35 or 35.4 with working seen. ISW incorrect rounding after any of these values seen. Correct answer with no incorrect working scores full marks.
					Total 6 marks

Question		Working	Answer	Mark	Notes
2	(a)	$2.35 \times 10^7 \times 0.48$		2	M1 NB $2.35 \times 10^7 \times 48\%$ is not sufficient for this mark unless it leads to the correct answer.
			1.128×10^7 or 11 280 000		A1 Allow 1.13×10^7 oe eg 11.3×10^6
	(b)	$\left(\dfrac{"11\,280\,000"}{10} \times 3\right)$		2	M1
			3.384×10^6		A1 Allow answers between 3.38×10^6 and 3.39×10^6 inclusive must be in standard form. Allow a final answer of 3.4×10^6 if an acceptable value is seen not written in standard form.
	(c)	"3 384 000" × 1.125		2	M1 NB "3 384 000" × 112.5% is not sufficient for this mark unless their answer is equal to their value × 1.125
			3.807×10^6 or 3 807 000		A1 Allow answers between 3.8×10^6 and 3.814×10^6 inclusive oe
	(d)	$2.5 \times 10^7 \times 1.024 \times 0.976$		2	M1
			2.49856×10^7 or 24 985 600		A1 Allow answers between 24 986 000 and 24 990 000 inclusive oe ISW rounding.
					Total 8 marks

Question		Working	Answer	Mark	Notes
3	(a)	$8 \times (8 + CD) = 10^2$		3	M1 Allow use of *x*, *d*, 2*r* etc.. for *CD* Method to find *DT* does not gain this mark until either an expression involving *CD* or *r* is formed.
		$(CD =) \frac{10^2}{8} - 8 (= 4.5)$ oe			M1 dep. Fully correct expression for *CD* or *r*
			2.25 (cm) oe		A1
	(a) ALT	$10^2 + r^2 = (8 + r)^2$			M1 Correct equation involving *r*.
		$100 = 64 + 16r$ oe			M1 dep. Correct equation involving only linear terms in *r*.
			2.25 (cm) oe		A1
	(b)	$\tan\angle AOC = \frac{10}{"2.25"}$ or $\sin\angle AOC = \frac{10}{8 + "2.25"}$ or $\cos\angle AOC = \frac{"2.25"}{8 + "2.25"}$ $(\Rightarrow \angle AOC = 77.3°)$ Allow $10^2 = (8 + "2.25")^2 + "2.25"^2 - 2 \times (8 + "2.25") \times 2.25 \cos \angle AOC$		3	M1 Any correct expression for sin, cos or tan of $\angle AOC$ or $\angle AOC$ If candidate gives an expression for $\angle ATO$ this mark is only gained when they use $\angle ATO$ to find $\angle AOC$.
		arc length $= \frac{"77.3"}{360} \times 2\pi \times "2.25"$			M1 dep. Do not follow through if $64° \leq \angle AOC \leq 68°$ or $\angle AOC \geq 90°$
			AWRT 3.03 or 3.04 (cm)		A1
					Total 6 marks

Question		Working	Answer	Mark	Notes
4	(a)		Triangle *B* drawn	1	B1 Do not penalise missing label across (a), (c) and (d).
	(b)		Translation $\begin{pmatrix} 2 \\ 3 \end{pmatrix}$	2	B1 B1 These 2 marks are independent. Do not award either if more than one transformations given (including two translations).
	(c)		Triangle *C* drawn	3	B3 $(2,4), (6,-4), (2,8)$ plotted and triangle drawn -1 for each error or omission B2 ft maximum for correct enlargement and centre from incorrect *B*, B1ft maximum for correct enlargement but incorrect centre
	(d)	$\begin{pmatrix} -0.5 & 0 \\ 0.5 & -1 \end{pmatrix}$ " $\begin{pmatrix} 2 & 6 & 2 \\ 4 & -4 & 8 \end{pmatrix}$ " $=$ $\begin{pmatrix} -1 & -3 & -1 \\ -3 & 7 & -7 \end{pmatrix}$		3	M2 for a matrix solution or list of coordinates containing at least 4 correct values seen or for 2 correct coordinates plotted Otherwise M1 for a correctly stated matrix product to calculate the coordinates of triangle *D*
			Triangle *D* drawn		A1 cao

4	(e)	Recognising that $\mathbf{N} = \mathbf{M}^{-1}$		3	M1 Either state $\mathbf{N} = \mathbf{M}^{-1}$ or $\mathbf{NM=I}$ or $\frac{1}{-1 \times -0.5 - 0 \times 0.5}$ seen or $\begin{pmatrix} -1 & 0 \\ -0.5 & -0.5 \end{pmatrix}$ seen.
			$2\begin{pmatrix} -1 & 0 \\ -0.5 & -0.5 \end{pmatrix}$		A2 A1 for one correct row or column including the 2. The factor of 2 may be included in matrix. Any A marks imply M1 if not already awarded.
	(e) ALT	States $\begin{pmatrix} P & Q \\ R & S \end{pmatrix} \text{"} \begin{pmatrix} -1 & -3 & -1 \\ -3 & 7 & -7 \end{pmatrix} \text{"} =$ $\text{"} \begin{pmatrix} 2 & 6 & 2 \\ 4 & -4 & 8 \end{pmatrix} \text{"}$ and states at least 2 linear equations in 2 variables derived from this.			M1
			$\begin{pmatrix} -2 & 0 \\ -1 & -1 \end{pmatrix}$		A2 A1 for one correct row or column or for 3 of the variables listed correctly $P = -2, Q = 0, R = -1, S = -1$
					Total 12 marks

Question		Working	Answer	Mark	Notes
5	(a)	$(BE^2 =)5^2 + 8^2 - 2(5)(8)\cos(30)$		3	M1 Correct expression for BE^2
		$(BE =)\sqrt{5^2 + 8^2 - 40\sqrt{3}}$			M1 dep. Correct expression for BE. Must demonstrate correct order of operations. We must see $40\sqrt{3}$ or values which round to 69.3, 19.7 or 4.4 to award this mark.
			AWRT 4.44 (cm)		A1
	(b)	$\dfrac{\sin(\angle ABE)}{5} = \dfrac{\sin 30}{"4.44"}$		3	M1 Correct equation involving $\angle ABE$ could be labelled x, θ etc...
		$\sin(\angle ABE) = \dfrac{5\sin 30}{"4.44"}$			M1 dep. Correct expression for any trig ratio of $\angle ABE$ or correct expression for $\angle ABE$
			AWRT 34.3(°)		A1
	(c)	Area of $\triangle ABE = \frac{1}{2}(8)(5)\sin 30$ (=10) or Area of $\triangle ABE =$ $\frac{1}{2} \times 8 \times "4.44" \times \sin "34.3"$		4	M1
		Length scale factor $(k =)\sqrt{\dfrac{18.9 + "10"}{"10"}} (= 1.7)$			M1 dep. This mark is not awarded until a square root is taken if a method involving CD^2 is used.
		$CD = "1.7" \times "4.44"$			M1 dep. Length scale factor multiplied by their value from (a)
			7.55 (cm)		A1 Allow any answer between 7.54 and 7.55 inclusive.
					Total 10 marks

Question	Working	Answer	Mark	Notes
6		$\{b\}, \{a, b, c, d\}, \{a, b\}$ $\{b, c\}, \{b, d\}, \{a, b, c\}$ $\{b, c, d\}, \{a, b, d\}$	B4	B4 all correct exactly 8 sets listed. B3 – 6 or 7 correct B2 – 4 or 5 correct B1 – 2 or 3 correct Do not penalise lack of commas Penalise one mark maximum for any of the following: Repetition within a set eg $\{b,b\}$ Repetition of a set in the list eg. $\{a,b\},...,\{a,b\}$ Repetition of a set in different order $\{a,b\}$, $\{b,a\}$ Missing brackets eg. *ab* (however condone none standard set brackets eg [*a,b*]) Extra sets listed not involving b for example eg $\{a,c\}$ NB Multiples written in sets eg. { *b, ab, bc, bd*} is in this case counted as 4 correct sets with a penalty for missing brackets. (ie 1 mark)
				Total 4 marks

Question		Working	Answer	Mark	Notes
7	(a)	$\frac{3}{5} + \left(\frac{2}{5} \times \frac{2}{5}\right) + \left(\frac{2}{5} \times \frac{3}{5} \times \frac{3}{8}\right)$		3	M2, M1 for either $\frac{2}{5} \times \frac{2}{5}$ or $\frac{2}{5} \times \frac{3}{5} \times \frac{3}{8}$
			$\frac{17}{20}$ or 0.85		A1 oe.
	(a) ALT	$1 - \frac{2}{5} \times \frac{3}{5} \times \frac{5}{8}$			M2, M1 for $\frac{2}{5} \times \frac{3}{5} \times \frac{5}{8}$
			$\frac{17}{20}$ or 0.85		A1 oe
	(b)	$\frac{3}{5} + \frac{2}{5}p = \frac{3}{4}$ or $\left(\frac{3}{4} - \frac{3}{5}\right) \div \frac{2}{5}$		3	M2 or M1 for $\frac{2}{5}p$ (oe) or $\left(\frac{3}{4} - \frac{3}{5}\right)$ seen
			$\frac{3}{8}$ or 0.375		A1 oe
	(b) ALT	$\frac{1}{4} = \frac{2}{5} \times q \left(q = \frac{5}{8}\right)$			M1
		$1 - "\frac{5}{8}"$			M1 dep. Do not award if their value of q is not in the range $0 \le q \le 1$
			$\frac{3}{8}$ or 0.375		A1 oe
	(c)	$\frac{3}{4} \times "\frac{17}{20}"$		2	M1 ft their answer from part (a) only if it is between 0 and 1 inclusive.
			$\frac{51}{80} > \frac{1}{2}$ so yes (Preety should take the tests)		A1 cao must follow from correct part (a) $\frac{51}{80} = 0.6375$ allow any rounded value with full working seen.
					Total 8 marks

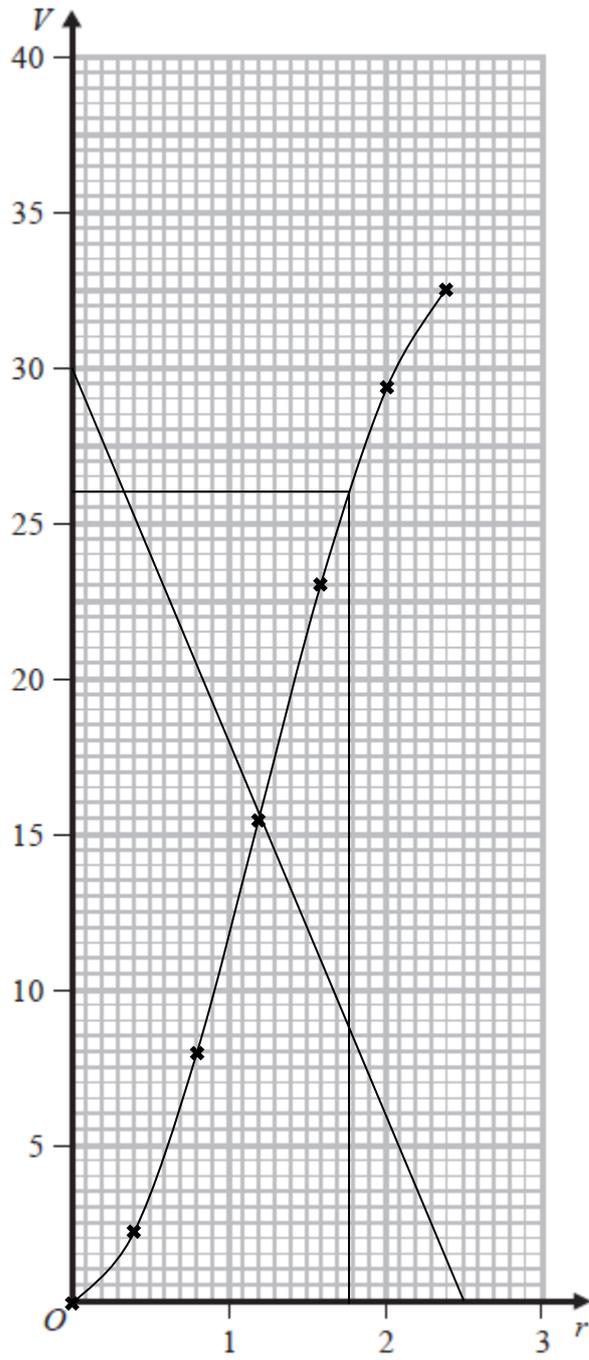| Question		Working	Answer	Mark	Notes
8	(a)	$(P =)4x + (5x + 3) + (2x + 3) + 5x$		2	M1 Sum of four terms in x
			$(P =)16x + 6$ oe		A1
	(b)	$A = \frac{1}{2}\big((2x + 3) + (5x + 3)\big)(4x)$ oe		2	M1 Allow $A = (2x + 3) \times 4x + \frac{1}{2} \times 3x \times 4x$ or $\frac{1}{2}(7x + 6) \times 4x$
			$A = 14x^2 + 12x$		A1 Must be clearly shown with no incorrect steps. At least one correct intermediate step must be seen.
	(c)	$"16x + 6" > 52$		6	M1 Their perimeter > 52, condone $\geq$. or $=$
		$x > 2.875$			A1 ft their answer to part (a) as long as it it a linear expression in x. Allow as a fraction $\frac{23}{8}$ oe allow 2.88. Condone $\geq$ or $=$
		$14x^2 + 12x \leq 162$			M1 Accept < 162 may be inferred by an inequality for x stated inbetween their solutions to their quadratic.
		$(x - 3)(7x + 27) \leq 0$			M1 indep. 'equating' to zero and solving (oe) Independent of previous mark, need not be expressed as inequality, condone an equality or any inequality sign. Must be solving quadratic trinomial. By factorising brackets must expand to give 2 out of 3 terms correct or fully correct substitution into fully correct formula.
		$-\dfrac{27}{7} \leq x \leq 3$			A1 Correct interval accept $x \leq 3$ or $x < 3$ if no other inequality stated in relation to this inequality.
			$2.875 < x \leq 3$		A1 cao. Must follow from completely correct working. Condone only finding critical values in working as long as the working contains no ambiguous or incorrect inequalities.
					Total 10 marks

Question		Working	Answer	Mark	Notes
9	(a)	$\sqrt{(2x-1)^2 + y^2} = \sqrt{98}$		5	M1 Correct use of modulus to form any correct equation
		$(2x-1) + (y+3) = 7$			M1 oe e.g. $2x + y = 5$
		$(2x-1)^2 + (5-2x)^2 = 98$ oe			M1 dep. on both previous M marks. Remove square-roots and substitute to gain an equation in terms of x only. May be seen in expanded form. Eg. $-4x^2 + 4x + 97 = 25 + 4x^2 - 20x$ For this and next M mark allow a maximum of 1 sign or numerical error.
		$8x^2 - 24x - 72 = 0$			M1 dep. previous mark. Expand and attempt to form 3 term quadratic For this and previous M mark allow a maximum of 1 sign or numerical error.
			$x^2 - 3x - 9 = 0$		A1 As answer given sufficient working must be shown. No incorrect work can be seen.
	(b)(i)	$x = \dfrac{-(-3) \pm \sqrt{(-3)^2 - 4(1)(-9)}}{2(1)}$ or $\left(x - \dfrac{3}{2}\right)^2 - \dfrac{9}{4} - 9 = 0$		2	M1 Solving quadratic using formula or completing square
			$x = \dfrac{3 + 3\sqrt{5}}{2}$		A1 Accept other equivalent exact forms eg $\dfrac{3+\sqrt{45}}{2}$ Do not accept $\pm$ for the final answer, they must indicate positive solution. Do not isw answer given as a decimal.

	(b)(ii)	$y = 5 - 2\left(\dfrac{3 + 3\sqrt{5}}{2}\right)$		2	M1 Substitute their x which must be an expression involving surds into linear equation to find y If using equation for y^2 must obtain $y^2 = 98 - 49 - 12\sqrt{5}$ or simpler to gain this mark.
			$y = 2 - 3\sqrt{5}$		A1 As answer given sufficient working must be shown Allow $y^2 = 49 - 12\sqrt{5}$ from modulus equation and expansion of $\left(2 - 3\sqrt{5}\right)^2 = 49 - 12\sqrt{5}$ along with an appropriate comment. Do not isw answer given as a decimal.
	(c)	$(|\mathbf{q}|^2 =)$ $\left(2 - 3\sqrt{5} + 3\right)^2 + \left(-(2 - 3\sqrt{5})\right)^2$		3	M1 Attempt $|\mathbf{q}|^2 = q_1{}^2 + q_2{}^2$ - allow in terms of y or x Eg. $(y + 3)^2 + y^2$ or $(8 - 2x)^2 + (5 - 2x)^2$ Allow an expression for $|\mathbf{q}|$
		$= 25 - 30\sqrt{5} + 45 + 45 - 12\sqrt{5} + 4$			M1 dep expand brackets must involve surds. Allow square root of this.
			$119 - 42\sqrt{5}$ or $7\left(17 - 6\sqrt{5}\right)$		A1 cao Do not isw answer given as a decimal.
					Total 12 marks

Question		Working	Answer	Mark	Notes
10	(a)		$2 \times 1^3 + a \times 1^2 + b \times 1 + 10 = 3$	1	B1 oe
	(b)	$\left(f^{/}(x) =\right)6x^2 + 2ax + b$		3	M1 at least two of these terms shown
		$6 \times 1^2 + 2a \times 1 + b = -8$			M1 dep clear indication of substitution for $x = 1$ into their derivative and equates to -8
			$2a + b = -14$		A1 Note that answer given in question
	(c)	Correct method for solving 2 linear simultaneous equations		3	M1ft Correct method to form an equation in a single variable. Allow a maximum of 1 sign or numerical error. Either $a = \pm 5$ or $b = \pm 4$ with no incorrect working seen implies this.
			$a = -5$		A1 cao
			$b = -4$		A1 cao
	(d)	$6x^2 - 10x - 4 = -4$		3	M1 Substitutes their a and their b into their $f^{/}(x)$ and equate to -4
		$x(3x - 5) = 0$			M1 dep. Solve their 2 or 3 term quadratic. By factorising brackets must expand to give 2 out of 3 terms correct or fully correct substitution into fully correct formula. They must have a factorised expression with 2 factors
			$x = 0$ and $x = \frac{5}{3}$		A1 cao for $x = \frac{5}{3}$ accept 1.67 or better.
					Total 10 marks

Question	Working	Answer	Mark	Notes
11 (a)	$15 - 6r > 0$		2	M1 Consideration that $h > 0$ Alternatively award for 2.5 oe. seen in working.
		$r = 2.5$		A1 Do not isw. Allow $r < 2.5$ or $r \leq 2.5$
(b)	$(V =)\dfrac{1}{3}\pi r^2 h + \dfrac{2}{3}\pi r^3$		3	M1
	$(V =)\dfrac{1}{3}\pi r^2(15 - 6r) + \dfrac{2}{3}\pi r^3$ or $(V =)\dfrac{1}{3}\pi r^2(h + 2r)$			M1 Substitutes $h = 15 - 6r$ to obtain an expression in π and r only or fully factorise expression for V. Must have V in the form $(V =)\dfrac{1}{3}\pi r^2 h + \dfrac{n}{3}\pi r^3$ to award this method mark.
		$V = \dfrac{1}{3}\pi r^2(15 - 4r)$		A1 Answer given must see evidence of both factorisation and substitution to award this mark. Penalise lack of $V=$ for this mark only.
(c)		2.2, 15.4, 23.1	3	B3 Penalise rounding to 1dp. once only. Treat 15.3 and 23.0 as rounding errors.
(d)	At least 5 points plotted correctly		2	M1 ft. points from (c) as long as at least B1 gained in (c). Points clearly plotted correct to ½ a small square or if not clearly plotted a curve drawn which goes within ½ a small square of the correct points. Measure closest point on curve to the correct point not necessarily horizontally or vertically.
		Fully correct curve		A1 ignore anything to the right of r=2.4
(e)		Value must be read from their graph (eg. 1.8)	1	B1 ft. their graph. Answer given to accuracies beyond 2 dp. should not gain this mark. Answer must be consistent with their graph.

(f)	$(V =)30 - 12r$		3	M1
	Line with negative gradient, y-intercept of 30 and only one intersection point with curve drawn.			M1 indep Line through (1,18) and (2,6) would imply both this and the previous M mark.
		15 or 16		A1 cao Must come from correct line drawn.
				Total 14 marks