Mark Scheme (Results)

Summer 2018

Pearson Edexcel International GCSE
In Mathematics B (4MB0) Paper 02R

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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)
  - dep – dependent
  - indep – independent
  - 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.
Any case of suspected misread loses A (and B) marks on that part, but can gain the M marks.
If working is crossed out and still legible, then it should be given any appropriate marks, as long as it has not been replaced by alternative work.
If there is a choice of methods shown, then no marks should be awarded, unless the answer on the answer line makes clear the method that has been used.
If there is no answer on the answer line then check the working for an obvious answer.

- **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 in another.

Question	Working Answer	Mark	Notes
1	eg $4x + 6y = 5$ − or $4x + 6y = 5$ − $4x + 2y = 7$ $12x + 6y = 21$ eg $x = \frac{2.5-3y}{2}$ or $\frac{7-2y}{4}$ giving $2(\frac{2.5-3y}{2}) + 3y = 2.5$ oe $y = \frac{2.5-2x}{3}$ or $\frac{7-4x}{2}$ giving $4x + 2(\frac{2.5-2x}{3}) = 7$ oe	4	M1 correct method to eliminate x or y: coefficients of x or y the same **and** correct operation to eliminate selected variable (condone any 1 arithmetic error in multiplication) **or** writing x or y in terms of the other variable and correctly substituting **or** correct inverse matrix, condone 1 error [epen; first variable method is 1st M1]
	Correctly use their value from correct method to obtain y or x OR Repeat above again with the same marking guidance		M1 (DEP) correct method to find second variable using their value from a correct method to find first variable or from repeating above method to find second variable or intent to multiply inverse matrix by correct column vector [epen; second variable attempt eg substitution is 2nd M1]
	$x = 2$		A1 dep on M1 [epen: first A mark is x]
	$y = –0.5$ $(-\frac{1}{2})$		A1 dep on M1 [epen second A mark is y]

Question	Working Answer	Mark	Notes
2 (a)	At least one correct value OR one correct statement eg $1\times5+(-5)\times3+2\times1$ or $-2\times5+7\times3+3\times1$ or $4\times5+-5\times3+1\times1$ (oe)	2	M1 must be adding the values for a correct statement
	$\begin{pmatrix}-8\\14\\6\end{pmatrix}$		A1 for correct column vector with brackets (Fully correct scores M1A1)
(b)	**(BC =)** $\begin{pmatrix}-6 & 4\\2 & -2\end{pmatrix}$	5	B2 (-1eeoo)
	(A − BC =) $\begin{pmatrix}-9 & -3\\6 & 3\end{pmatrix}$		B2 (-1eeoo) ft their BC as long as 2 × 2 matrix
	$\lambda = 3$		B1 dep on previous B2B2 awarded
	$(-15)--6=-3\lambda$ oe $8-2=2\lambda$ oe $1-4=-\lambda$ oe $1--2=\lambda$ oe		NB: if candidate uses only one corresponding value in the matrices to work out λ, then award B4 for a fully correct equation B1 for $\lambda = 3$ dep on previous B4

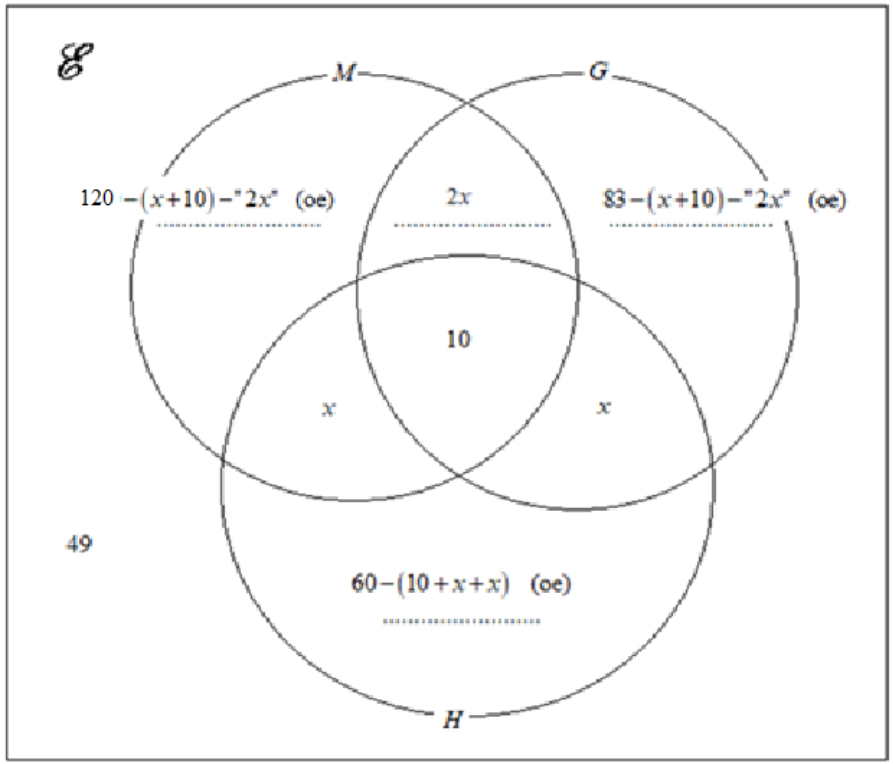
Question	Working Answer	Mark	Notes
3 (a)	one of June: $\frac{\$115}{\$1.72}$ **or** November: $\frac{\$84}{\$1.60}$	3	M1 a correct method to find the cost in £ of a barrel in June or in November (a correct answer assumes the method mark)
	June = **£66.86**		A1 must have 2 dp, condone missing £ [epen: June is 1st A1]
	November = **£52.50**		A1 Accept £52.50 or £52.5,condone missing £ [epen: Nov is 2nd A1]
(b)	% decrease in petrol eg $\frac{132-124}{132}\times 100$ **or** $132\times\left(1-\frac{x}{100}\right)=124$ oe (= 6(.06)%)	3	M1 correct expression or correct equation involving % decrease [epen: method for petrol is 1st M1]
	% decrease in oil eg $\frac{"£66.86"-"£52.50"}{"£66.86"}\times 100$ oe **or** $"6686"\times\left(1-\frac{x}{100}\right)="5250"$ oe (= 21(.478)%)		M1ft correct expression or correct equation involving % decrease [epen: method for oil is 2nd M1]
	6(.06)% and 21(.5)% (cao)		A1 dep on correct calculations with correct values. Accept as whole numbers (6% & 21% or 22%) or better and must be compared. (Must be stated side by side **or** a comment on their relative values made **or** a calculation eg a difference, one as a percentage or fraction of the other, ratio, written with an inequality sign between, etc)

Question	Working Answer	Mark	Notes
4 (a)	$\frac{130}{x}$	1	B1 a correct expression
(b)	$\frac{130}{x-2}$	1	B1 a correct expression
(c)	$"\frac{130}{x-2}"-"\frac{130}{x}"=5$ oe eg $\frac{130}{x-2}=\frac{5x+130}{x}$	1	B1 ft oe a correct equation ft their "(b)" – "(a)" = 5
(d)	$130(x)-130(x-2)=5(x)(x-2)$ oe equation with no denominators	5	M1ft (as long as similar algebraic form as (c) should be) for removing denominators correctly. Condone 1 sign error
	$5x^2 - 10x - 260$ (=0) OR $x^2 - 2x - 52$ (= 0) oe		M1 reducing to a **correct** quadratic equation (NB no ft for this mark)
	$x_{\pm}=\frac{10\pm\sqrt{10^2-4\times5\times(-260)}}{2\times5}$		M1ft oe, solving *their* trinomial quadratic (ie any 3TQ)
	$x_{\pm}=\frac{10\pm\sqrt{5300}}{10}$ OR $\frac{2\pm\sqrt{212}}{2}$ or $\frac{2\pm2\sqrt{53}}{2}$ NB: this ft depends on the previous M mark		A1 ft oe for showing the <u>discriminant correctly simplified dep on previous M1</u> or for correct answers of 8.28 and −6.28 (ie not rejecting −6.28) Answers of 8.28 & −6.28 score M1M1M1A1A0 as long as there is no incorrect working.
	$x = 8.28$ NB: the correct answer of 8.28 scores 5 marks here as long as no incorrect working.		A1 rejecting −6.28 and correct 8.28 May just state 8.28

Question		Working Answer	Mark	Notes
5	(a)	$\frac{1}{3}$, 0.333	1	B1 decimals to 2 dp or better
	(b)	$\frac{1}{4}$, 0.25	1	B1
	(c)	$2\times\frac{1}{4}\times\frac{1}{3}$	2	M1ft 2 × their "(a)" × their "(c)" as long as probabilities
		$\frac{1}{6}$, 0.167		A1 decimals to at least 2 dp truncated or rounded
	(d)	P(*B*,*O*,*D*) + P(*B*,*C*,*D*) + P(*B*,*C*,*O*,*D*) + P(*B*,*O*,*C*,*D*) + P(*B*,*O*,*A*,*D*) $\frac{1}{2}\times\frac{1}{4} + \frac{1}{2}\times\frac{1}{3} + \frac{1}{2}\times\frac{1}{3}\times\frac{1}{4} + \frac{1}{2}\times\frac{1}{4}\times\frac{1}{3} + \frac{1}{2}\times\frac{1}{4}\times\frac{1}{2}$	4	**(This shows the various probabilities) correct statements score no marks – we must see the probabilities**
		One of P(*B*,*O*,*D*) or P(*B*,*C*,*D*) or P(*B*,*O*,*D*) + P(*B*,*C*,*D*) as probabilities ie $\frac{1}{2}\times\frac{1}{4}$ or $\frac{1}{2}\times\frac{1}{3}$ or $\frac{1}{2}\times\frac{7}{12}$ or $\frac{1}{8}+\frac{1}{6}$ oe		M1
		one of P(*B*,*C*,*O*,*D*) or P(*B*,*O*,*C*,*D*) or P(*B*,*O*,*A*,*D*) as probabilities ie $\frac{1}{2}\times\frac{1}{3}\times\frac{1}{4}$ or $\frac{1}{2}\times\frac{1}{4}\times\frac{1}{3}$ or $\frac{1}{2}\times\frac{1}{4}\times\frac{1}{2}$ oe		M1
		Eg $\frac{1}{2}\times\frac{1}{4}+\frac{1}{2}\times\frac{1}{3}+\frac{1}{2}\times\frac{1}{3}\times\frac{1}{4}+\frac{1}{2}\times\frac{1}{4}\times\frac{1}{3}+\frac{1}{2}\times\frac{1}{4}\times\frac{1}{2}$		M1 (DEP)
		$\frac{7}{16}$, 0.4375		A1 decimals to 2 dp truncated or rounded

Question		Working Answer	Mark	Notes
6	(a)	Triangle *A* drawn and labelled	1	B1 Penalise labelling ONCE
	(b)	$\begin{pmatrix} -2 & 0 \\ 0 & -2 \end{pmatrix}\begin{pmatrix} 2 & 3 & 2 \\ 2 & 2 & 4 \end{pmatrix}$ $\left(\Delta B = \begin{pmatrix} -4 & -6 & -4 \\ -4 & -4 & -8 \end{pmatrix}\right)$	3	M1 showing the correct multiplication in the correct order (NB: order of coordinates can be any) No need to see result of matrix multiplication for this mark
		Triangle *B* drawn and labelled		A2 (-1eeoo) [epen: if 1 error made, then M1A1A0] SC: Triangle *B* drawn and no matrix multiplication seen: deduct 1 mark from M1 A2 for each incorrect coordinate.
	(c)	Either point (0, -4) indicated (cross or dot or similar) OR At least two construction lines through (0, -4) OR one correct coordinate from (2, −4), (3, −4), (2, −2)	3	M1 for information: $\left(\Delta C = \begin{pmatrix} 2 & 3 & 2 \\ -4 & -4 & -2 \end{pmatrix}\right)$
		Triangle *C* drawn and labelled		A2 (-1eeoo) [epen: if 1 error made M1A1A0]
				NB: Award M1 A2 if Δ*C* drawn correctly with no working seen (-1eeoo)
	(d)	Translation (translate)	2	B1cao dep on correct triangle drawn in (c)
		(with vector) $\begin{pmatrix} 0 \\ 6 \end{pmatrix}$		B1cao do not award 6 up, 6 north etc Award no marks if more than one transformation given

Question	Working Answer	Mark	Notes
7 (a)	$x(3x^2 - 14x + 15)$ or $(3x - 5)(x^2 - 3x)$ or $3x^2(x - 3) - 5x(x - 3)$oe **or** Showing $(x - 3)$ divides into $(3x^3 - 14x^2 + 15x)$, $3x^2$ times	3	M1 do not award this mark if a student has divided throughout by, for example, x and not shown it factorised
	$x(3x-5)(x-3)$ or $(3x^2 - 5x)(x - 3)$ or an answer of $3x^2 - nx$ or $x(3x - n)$		A1 numerator in completely factorised form or $(3x^2 - 5x)(x - 3)$
	$x(3x-5)$ OR $3x^2-5x$		A1
(b)	$\frac{dy}{dx} = "6x-5"$ or quotient rule: fully correct method [**or** $3x^2 - 5x = 0$ $x = 0$ or $x = 5/3$]	4	M1ft one term correct ft from (a) as long as y of the form $ax^2 + bx$ **or** for finding the two x intercepts of $y = x(3x - 2)$ oe but must clearly not be using $y = 0$
	$\frac{dy}{dx} = "6x-5" = 0$ **[or** (minimum value occurs when $x =$) $\frac{0+5/3}{2}$]		M1 (DEP) **NB:** Their derivative must be of the form $ax + b$ **or** for dividing the sum of the x intercepts by 2
	$\left(\frac{5}{6}, \frac{-25}{12}\right)$ or (awrt 0.83, awrt −2.1) or for $x = \frac{5}{6}$ or awrt 0.83, y = $\frac{-25}{12}$ oe or awrt −2.1		A1 for a correct x coordinate A1 for a correct y coordinate May be given as a coordinate or as separate values A correct x value from no incorrect working gains M1M1A1 Correct x and y values from no incorrect working gains M1M1A1A1

Question	Working Answer	Mark	Notes
8 (a)	151	1	B1
(b)		3	B1 for 2*x* correct B1B1 all 3 other regions correct (or B1B0 for 1 or 2 other regions correct) just *M* may be 110 – 3*x* oe, just *G* may be 73 – 3*x* oe just *H* may be 50 – 2*x* oe (Must be given in terms of *x* for the award of these marks)

Question	Working Answer	Mark	Notes
(c)	$49+"\left(120-\left(x+10\right)-2x\right)"+"2x"+"\left(83-\left(x+10\right)-2x\right)"$ $+x+10+x+"\left(60-\left(x+x+10\right)\right)"=200$ [49 + (110 – 3x) + 2x + (73 – 3x) + x +10 + x + (50 – 2x) = 200] oe eg (110 – 3x) + 2x + (73 – 3x) + x +10 + x + (50 – 2x) =151	3	M1ft oe eg (**NB:** their eight terms = 200 or terms without 49 = 151oe and allow 1 sign slip or omission of 1 term only)
	Fully correct		M1 (DEP) – ie not ft and no sign errors or missing term
	x = 23		A1 cao
(d)	2 × "23" + 10 (= 56)	2	M1ft from their value of x (ft for +ve x values only)
	$\frac{56}{120}$, $\frac{28}{60}$, $\frac{7}{15}$, awrt 0.466...		A1oe allow decimals truncated or rounded to 2 dp

Question		Working Answer	Mark	Notes
9	(a)	$\angle OAC = \angle OBC = 90^o$ (or shown as 40 + 50)	3	M1 shown on diagram or used/stated
		$\angle ACB = 80^o$		A1
		2 reasons – (tangent) & ($\angle$s of quadrilateral) OR splitting into 2 triangles and using Tangent, angles in triangle total 180° or OC bisects AOB (or is bisector) OR using isosceles triangle oe (accept symbols for angles, triangles, etc)		B1 dep on M1 awarded for 2 correct reasons using underlined words as a minimum (for their method used)
	(b)	eg $\tan"40"^o = \frac{10}{BC}$ OR $\tan 50^o = \frac{BC}{10}$ OR $\frac{BC}{\sin 50} = \frac{10}{\sin"40"}$ oe	3	M1ft correct first stage to find *BC* ft their "80" gained in (a) for $\angle ACB$
		eg (*BC* =)10 × tan 50° or $\frac{10}{\tan"40"^\circ}$ or $\frac{10\sin 50^\circ}{\sin"40"^\circ}$ oe		M1ft fully correct calculation for *BC*
		BC = 11.917535...→**11.9 cm**		A1 awrt 11.9
	(c)	ΔOAC or ΔOBC = 0.5 × 10 × "11.9" (= 59.58767...) OR ΔOAB = 0.5 × 10 × 10 × sin100° (= 49.24038...) OR ΔACB = 0.5 × "11.9" × "11.9" × sin"80" (= 69.93497...)	3	M1ft their *BC*
		For 2 × 0.5 × 10 × "11.9" oe OR 0.5 ×10 × 10 × sin100° + 0.5 ×"11.9"×"11.9"×sin"80" oe		M1ft their *BC*
		OACB = awrt **119 (cm^2)**		A1cao
	(d)	Sector *OAB* = $\frac{100}{360} \times \pi \times 10^2$ (=87.27)	3	M1
		Shaded region = "119" – "87.27"		M1 ft(DEP) (*OACB* must be bigger than sector *OAB* for ft)
		Area of shaded region = answer in range **31.7 - 31.9 (cm^2)**		A1

Question		Working Answer	Mark	Notes
10	(a)(i)	$\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$	2	B1oe
	(ii)	$\overrightarrow{OC} = \mathbf{a} + 2\mathbf{b}$		B1oe
	(b)	$\overrightarrow{OP} = \frac{1}{\mu}"(\mathbf{a} + 2\mathbf{b})"$	1	B1oe ft
	(c)	$(\overrightarrow{AP} = \frac{1}{\lambda}"(\mathbf{b} - \mathbf{a})")$	2	
		$\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP} = \mathbf{a} + \frac{1}{\lambda}"(\mathbf{b} - \mathbf{a})"$ OR $\overrightarrow{OP} = \overrightarrow{OB} + \overrightarrow{BP} = \mathbf{b} - \frac{\lambda - 1}{\lambda}"(\mathbf{b} - \mathbf{a})"$ OR $\overrightarrow{OP} = \overrightarrow{OB} + \overrightarrow{BP} = \mathbf{b} + \frac{\lambda - 1}{\lambda}(\mathbf{a} - \mathbf{b})$ oe		M1ft
		$\overrightarrow{OP} = \left(1 - \frac{1}{\lambda}\right)\mathbf{a} + \frac{1}{\lambda}\mathbf{b}$		A1 oe as long as terms in a together [allow $\overrightarrow{OP} = \left(1 - \frac{\lambda - 1}{\lambda}\right)\mathbf{b} + \frac{\lambda - 1}{\lambda}\mathbf{a}$]
	(d)	Equating components of **a**: $"\left(1 - \frac{1}{\lambda}\right)" = "\frac{1}{\mu}"$ oe	4	M1 ft their values M2 for $1 - \frac{2}{\mu} = \frac{1}{\mu}$
		Equating components of **b**: $"\frac{1}{\lambda}" = "\frac{2}{\mu}"$ oe		M1 ft their values
		$\mu = 3 \quad \lambda = \frac{3}{2}$ (from no incorrect working)		A1, A1 from no incorrect working [epen: μ is 1st A1 and λ 2nd A1]

Question	Working Answer	Mark	Notes
(e)	$(\left\|\overrightarrow{OC}\right\| =)\sqrt{6^2+(2\times 8)^2} = \quad 2\sqrt{73}$ (=17.088) **OR** $\overrightarrow{OP} = "\frac{1}{3}"\mathbf{a} + "\frac{2}{3}"\mathbf{b}$ (using "(c)")	3	M1 oe correct method to find OC
	$\left\|\overrightarrow{OP}\right\| = "\frac{1}{\mu}"\times"\left\|\overrightarrow{OC}\right\|" = \frac{1}{"3"}\times"17.088"$ **OR** $\left\|\overrightarrow{OP}\right\| = \sqrt{\left(\left("\frac{1}{3}"\times 6\right)^2 + \left("\frac{2}{3}"\times 8\right)^2\right)}$		M1 (DEP)
	OP = **5.7, 5.70**		A1 cao
	(Extend OB to X st CX // AO. PT is the perpendicular from P to OB. Therefore $\Delta s\begin{matrix}OCX\\OPT\end{matrix}$ are similar so $PT = \frac{1}{"3"}CX = \frac{1}{"3"}OA$)		(definition of T)
(f)	Area of triangle $OPB = \left(\frac{1}{2}\times OB\times PT\right) = \frac{1}{2}\times 8\times\left(\frac{1}{"3"}\times 6\right)$ (= 8) **OR** Height of $\Delta APC = \left(\frac{2}{3}\times\left\|\overrightarrow{OA}\right\|\right) = \frac{2}{3}\times 6$ (= 4) **OR** Area of $\Delta AOC = \frac{1}{2}\times 6\times 16$ (= 48) and $OP : PC = 1 : 2$	3	M1 or use of trig eg angle ACO = $\tan^{-1}\left(\frac{6}{16}\right)$(= 20.556...) and $CP = \frac{2}{3}\times"17.088.."$ (=11.392) oe
	(Area of ΔAPC = $2^2\times"$area of $\Delta OPB"$ =) 4 × "8" **OR** (Area of ΔAPC =) $\frac{1}{2}\times"\left(\frac{2}{3}\times 6\right)"\times(2\times 8)$ **OR** (Area of $\Delta APC = \frac{2}{3}\times$ Area of $\triangle AOC$ =) $\frac{2}{3}\times"48"$		M1 (DEP - any numbers in " " must come from correct working) Or 0.5 × 16 × 11.392... × sin(20.556...) oe
	32 (cm^2) (32 from no incorrect working gains M1M1A1)		A1 cao

Question	Working Answer	Mark	Notes
11 (a)	5.3, 8.2, 11.7 NB: Penalise incorrect rounding ONCE only in question	3	B1, B1, B1 [epen: order is strictly as in table for B1's]
(b)	–1 mark for straight line segments (be generous between plots from $x = 0.5$ to $x = 1$, $x = 3$ to $x = 5$) points missed by more than ½ ss missed segments each point not plotted (if unsure, use point at which curve passes through) each point incorrectly plotted tramlines very poor curve NB: Accuracy for both plotting and drawing is $\pm\frac{1}{2}ss$	3	B3 ft
(c)	5.3 (± 0.05)	1	B1 or ft their lowest value from graph

Question	Working Answer	Mark	Notes
(d)	Straight line touching curve at (3, "11.7")	3	M1 award for clear intention of tangent at correct place
	A correct method seen to calculate gradient of their tangent gradient $= \frac{y_2 - y_1}{x_2 - x_1}$		M1 (DEP) for a correct method to find gradient ft their tangent (readings taken from anywhere on line)
	7.6 – 8.6 (fyi: Tangent is $y = 8.111x - 12.666$)		A1 dep on first M1 answer in this range inclusive
(e)	eg $2x^2 - 3x + \frac{8}{x} = 4x + 4$ or $2x^2 - 3x + \frac{8}{x} - (4x + 4) = 0$ oe	5	M1 show division by x or $4x + 4$ seen
	Clear understanding that y = 4x + 4 is the line to be drawn eg states $y = 4x + 4$ or draws table of values or correct line labelled oe		A1
	$y = 4x + 4$ drawn, eg straight line going through "(0, 4)" and "(4, 20)"		B1dep on seeing 4x + 4 previously
	x = 0.85 – 0.95		B1 dep on correct line drawn and passing through graph at this point
	x = 3.7 - 3.85		B1 dep on correct line drawn and passing through graph at this point
	NB: 2nd and 3rd B marks dependent on B1 mark having been attained.		No line then the last 3 B marks cannot be awarded