GCE

Mathematics B (MEI)

H640/02: Pure Mathematics and Statistics

Advanced GCE

Mark Scheme for Autumn 2021

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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1. Annotations and abbreviations

Annotation in scoris	Meaning
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
E	Explanation mark 1
SC	Special case
^	Omission sign
MR	Misread
BP	Blank page
Highlighting	
Other abbreviations in mark scheme	**Meaning**
E1	Mark for explaining a result or establishing a given result
dep*	Mark dependent on a previous mark, indicated by *. The * may be omitted if only previous M mark.
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working
AG	Answer given
awrt	Anything which rounds to
BC	By Calculator
DR	This indicates that the instruction **In this question you must show detailed reasoning** appears in the question.

2. Subject-specific Marking Instructions for AS/A Level Mathematics B (MEI)

a a Annotations must be used during your marking. For a response awarded zero (or full) marks a single appropriate annotation (cross, tick, M0 or ^) is sufficient, but not required.

For responses that are not awarded either 0 or full marks, you must make it clear how you have arrived at the mark you have awarded and all responses must have enough annotation for a reviewer to decide if the mark awarded is correct without having to mark it independently.

It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

Award NR (No Response)

- if there is nothing written at all in the answer space and no attempt elsewhere in the script
- OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
- OR if there is a mark (e.g. a dash, a question mark, a picture) which isn't an attempt at the question.

Note: Award 0 marks only for an attempt that earns no credit (including copying out the question).

If a candidate uses the answer space for one question to answer another, for example using the space for 8(b) to answer 8(a), then give benefit of doubt unless it is ambiguous for which part it is intended.

b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct solutions leading to correct answers are awarded full marks but work must not always be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly. Correct but unfamiliar or unexpected methods are often signalled by a correct result following an apparently incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
If you are in any doubt whatsoever you should contact your Team Leader.

c The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.
A method mark may usually be implied by a correct answer unless the question includes the DR statement, the command words "Determine" or "Show that", or some other indication that the method must be given explicitly.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

E
A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep*' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e The abbreviation FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only – differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, what is acceptable will be detailed in the mark scheme. If this is not the case, please escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f Unless units are specifically requested, there is no penalty for wrong or missing units as long as the answer is numerically correct and expressed either in SI or in the units of the question. (e.g. lengths will be assumed to be in metres unless in a particular question all the lengths are in km, when this would be assumed to be the unspecified unit.)
We are usually quite flexible about the accuracy to which the final answer is expressed; over-specification is usually only penalised where the scheme explicitly says so.

- When a value is **given** in the paper only accept an answer correct to at least as many significant figures as the given value.
- When a value is **not given** in the paper accept any answer that agrees with the correct value to **2 s.f.** unless a different level of accuracy has been asked for in the question, or the mark scheme specifies an acceptable range.
  NB for Specification A the rubric specifies 3 s.f. as standard, so this statement reads "3 s.f"

Follow through should be used so that only one mark in any question is lost for each distinct accuracy error.
Candidates using a value of 9.80, 9.81 or 10 for *g* should usually be penalised for any final accuracy marks which do not agree to the value found with 9.8 which is given in the rubric.

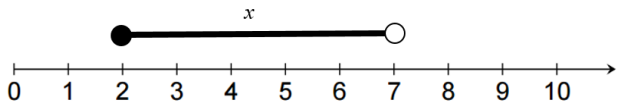
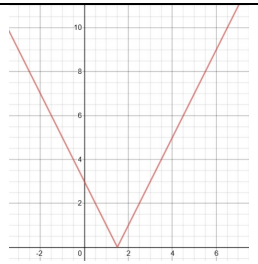
g Rules for replaced work and multiple attempts:

- If one attempt is clearly indicated as the one to mark, or only one is left uncrossed out, then mark that attempt and ignore the others.
- If more than one attempt is left not crossed out, then mark the last attempt unless it only repeats part of the first attempt or is substantially less complete.
- if a candidate crosses out all of their attempts, the assessor should attempt to mark the crossed out answer(s) as above and award marks appropriately.

h For a genuine misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A or B mark in the question. Marks designated as cao may be awarded as long as there are no other errors. If a candidate corrects the misread in a later part, do not continue to follow through. E marks are lost unless, by chance, the given results are established by equivalent working. Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

i If a calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers provided that there is nothing in the wording of the question specifying that analytical methods are required such as the bold "In this question you must show detailed reasoning", or the command words "Show" and "Determine. Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.

j If in any case the scheme operates with considerable unfairness consult your Team Leader.

Question			Answer	Marks	AOs	Guidance	
1			$(y =)\ 4(kx)^2 + 8(kx) + 1$ **soi**	**M1**	**1.1a**	$k = \frac{1}{2}$; condone $k = 2$; condone omission of brackets	
			$y = x^2 + 4x + 1$ **isw**	**A1**	**1.1**	must see "$y =$" either here or in first line	
				[2]			
2	(a)		$65 \times \frac{\pi}{180}$ **soi**	**M1**	**1.1a**	may be implied by 1.13(4464…) or 0.36…× π	
			$\frac{13\pi}{36}$	**A1**	**1.1**		
				[2]			
2	(b)		12.1	**B1**	**1.1**	ignore units	
				[1]			
3				**M1** **A1** **A1**	**1.2** **1.1** **2.5**	line from 2 to 7 only (do not need number line) one end correctly shaded both ends correctly shaded	if **M0** allow **SC1** for one end correct
				[3]			
4				**M1** **M1** **A1**	**1.1** **1.1** **1.1**	$y = 2x - 3$ correct in first quadrant; may be implied by reflection or by **A1** reflection of their straight line to form V shape for positive y only symmetrical V shape through (0,3) with vertex at (1.5, 0) ; points may be identified from numbered scale or written separately	condone branches of different lengths
				[3]			
5	(a)		0.14, 0.139 or awrt 0.1385 **isw BC**	**B1**	**1.1**		
				[1]			

Question			Answer	Marks	AOs	Guidance	
5	(b)		P($X \leq 7$) = 0.0248(2…) **soi** or 0.9751 to 0.9752 seen	**M1**	**1.1**	if **M0**, allow **SC1** for awrt 0.0575… **or** 0.943	**NB** 0.975178058
			0.975 **cao**	**A1**	**1.1**		
				[2]			
6	(a)		$\begin{pmatrix} 2\times5+3\times(-1) \\ 2\times3+3\times6 \end{pmatrix}$ **soi**	**M1**	**3.1a**	may be implied if one component fully correct	
			$\sqrt{7^2+24^2}$	**M1**	**1.1**	dependent on award of first **M1**	
			25	**A1**	**1.1**		
				[3]			
6	(b)		$\tan^{-1}\left(\frac{24}{7}\right)$ **oe**	**M1**	**1.1a**	or $\cos^{-1}\left(\frac{7}{25}\right)$ or $\sin^{-1}\left(\frac{24}{25}\right)$ FT their 7, 24 or 25	
			74° or 73.7° or awrt 73.74° or 1.3 or 1.29 or awrt 1.287	**A1**	**1.1**		
				[2]			
7	(a)		$(x-7)^2+(y+3)^2 = 5^2\cos^2\theta + 5^2\sin^2\theta$ **oe**	**M1**	**3.1a**	allow sign error	
			use of $\cos^2\theta + \sin^2\theta = 1$ to eliminate θ	**M1**	**1.1**		
			Alternative centre is (7, –3) and substituted in correct form of equation	**M1**			
			radius is 5 and substituted in correct form of equation	**M1**			
			$(x-7)^2+(y+3)^2 = 5^2$ **oe isw**	**A1**	**1.1**	if **M0M0** allow **SC1** for $y = 5\sin\{\cos^{-1}\left(\frac{x-7}{5}\right)\} - 3$ $x = 5\cos\{\sin^{-1}\left(\frac{y+3}{5}\right)\} + 7$	
				[3]			
7	(b)		(7, –3)	**B1**	**2.2a**	FT their $(x-7)^2+(y+3)^2 = 25$	
				[1]			

Question			Answer	Marks	AOs	Guidance	
8			$b^2 = \frac{11.492}{6.8}$ **oe**	**M1**	**3.1a**		
			$b = 1.3$	**A1**	**1.1**		
			$42b + a = 57.2$	**M1**	**1.1**	b may be incorrect numerical value	
			$a = 2.6$	**A1**	**3.2a**		
				[4]			
9	**(a)**		$\frac{5}{9} \times \frac{4}{8} \times \frac{3}{7} \times \frac{4}{6}$ **oe** $\times 4$	**M1** **M1**	**1.1** **1.1**	**M0** if binomial distribution or sampling with replacement used dependent on award of first **M1**	
			Alternative ${}_9C_4$ [= 126] **soi**	**M1**	**1.1**		
			${}_5C_3 \times {}_4C_1$ [= 10×4] **soi**	**M1**	**1.1**		
			$\frac{40}{126}$ *or* $\frac{20}{63}$ or 0.317460…isw or rounded to 2 sf or better	**A1**	**1.1**		
				[3]			

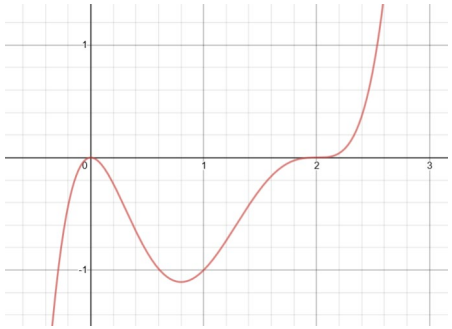
Question			Answer	Marks	AOs	Guidance	
9	(b)		$\frac{4}{9}\times\frac{3}{8}\times\frac{2}{7}\times\frac{5}{6}\times 4$ **oe** *or* $\frac{4}{9}\times\frac{3}{8}\times\frac{2}{7}\times\frac{1}{6}$ **oe**	**M1** **M1**	**3.1b** **1.1**	condone omission of $\times 4$ in first term; **M0** if binomial distribution or sampling with replacement used for addition of their terms; dependent on award of first **M1**	
			Alternative ${}_4C_4 + {}_4C_3 \times {}_5C_1$	**M1** **M1**		for ${}_4C_3 \times {}_5C_1$ for addition of their terms; dependent on award of first **M1**	**NB** $1 + 4\times5 = 21$
			Alternative $\frac{5}{9}\times\frac{4}{8}\times\frac{3}{7}\times\frac{2}{6} + 4\times\frac{4}{9}\times\frac{5}{8}\times\frac{4}{7}\times\frac{3}{6} + 6\times\frac{4}{9}\times\frac{5}{8}\times\frac{4}{7}\times\frac{3}{6}$ **oe** $1 -$ their $\frac{2520}{3024}$	**M1** **M1**		for two of these terms for 1 – the sum of their 3 terms	**NB** $\frac{2520}{3024} = \frac{5}{6}$
			$\frac{1}{6}$ or 0.166666….to 2 sf or better	**A1**	**1.1**		
				[3]			
9	(c)		(3 BF, 1M) + (2BF, 1NBF, 1BM) attempted	**M1**	**3.1b**	**M0** if binomial distribution or sampling with replacement used	
			$\frac{3}{9}\times\frac{2}{8}\times\frac{1}{7}\times\frac{4}{6}\times 4 + \frac{3}{9}\times\frac{2}{8}\times\frac{2}{7}\times\frac{1}{6}\times 12 \left[=\frac{5}{63}\right]$ **oe**	**A1**	**1.1**		
			Alternative ${}_3C_3 \times {}_4C_1 + {}_3C_2 \times {}_2C_1 \times {}_1C_1$ 10	**M1** **A1**		for either term	
			$\frac{10}{21}$ or 0.476190476…to 2 sf or better	**A1**	**1.1**		
				[3]			

Question			Answer	Marks	AOs	Guidance	
9	(d)		not independent since $\frac{10}{21} \neq \frac{20}{63}$ **oe**	**B1**	**2.4**	FT their probabilities	no FT if binomial distribution or sampling with replacement used
			Alternatively not independent since $\frac{20}{63} \times \frac{1}{6} \neq \frac{5}{63}$			FT their calculated probabilities from first three parts	
				[1]			
10	(a)		to account for seasonal variation in **birds oe** or to account for different weather conditions which affects what **birds** are seen **oe**	**B1**	**2.2b**		
				[1]			
10	(b)		positive skew **cao**	**B1**	**1.2**		
				[1]			
10	(c)		eg in lower quartile (or lower tail) eg much lower than median (or middle) **oe** eg frequency of 3 and others have frequency of 2 eg distribution is skewed (so median more appropriate)	**B1**	**2.4**	NB mode is 9	
				[1]			
10	(d)		median is 19.5	**B1**	**1.1**		
			LQ is between 8th and 9th value or UQ is between 24th and 25th value **soi**	**M1**	**1.1**	allow for sight of 11 or 30	
			IQR = 30 – 11 = 19	**A1**	**1.1**		
				[3]			
10	(e)		2015: $32 \leq$ median ≤ 34, much bigger than (their 19.5) in 2019 which supports Ben's first statement **oe** 2015: $31 \leq$ IQR ≤ 34 was (much) bigger than (their 19) in 2019 which does **not** support Ben's second statement **oe**	**B1** **B1**	**2.2b** **2.4**	if **B0B0** allow **SC1** for true – median smaller in 2019 **oe and** false – IQR smaller in 2019 **oe**	
				[2]			

Question			Answer	Marks	AOs	Guidance	
10	(f)		eg other distributions are symmetrical (so could be eg Normal) **oe** eg can't tell how values distributed in each quartile **oe**	**B1**	**2.4**		
				[1]			
11	(a)		$H_0 : \mu = 161.6$ $H_1 : \mu > 161.6$	**B1**	**1.1**	both hypotheses; allow other parameters (but not X or $\bar{X}$) if defined as mean	
			μ is the **population** mean height of adult females (in 2020)	**B1**	**2.5**		
			1-tailed test because it is suspected that the mean height has increased **oe**	**B1**	**2.4**		
				[3]			
11	(b)		use of $\bar{X} \sim N\left(161.6, \frac{1.96}{200}\right)$ soi	**M1**	**3.3**	may see $1.645 = \frac{\bar{X}-161.6}{\sqrt{\frac{1.96}{200}}}$	$\bar{X} = 161.76$ ... implies **M1** only
			awrt $\bar{X} > 161.8$ BC	**A1**	**1.1**	allow if inequality not strict NB 161.76283…	allow eg sample mean > 161.8
				[2]			

Question			Answer	Marks	AOs	Guidance	
11	(c)		the 1st statement is correct because $\bar{X} > 161.8$ **or** $\bar{X} > 161.8$ so the sample mean is in the critical region	**M1**	**2.3**	FT their 161.8 (must be greater than 161.6) or allow if *their* $P(\bar{X} > 161.9)[= 0.00122] < 0.05$ or *their* $z > 1.645$ is considered	critical region must be an upper tail; their probability must be less than 0.5
			the 2nd statement is incorrect because the sample mean is in the critical region **oe** or because the result is significant **oe** **or '…**so/hence the null hypothesis is rejected.' following from the first statement	**A1**	**2.4**	FT their calculated critical region or their calculated probability,	
			the 3rd statement is incorrect; because it is only possible to infer, not prove, using a hypothesis test **oe**	**B1**	**2.2b**	ignore comments about rejecting the null hypothesis **oe**	
				[3]			
12	(a)		#N/A is used to stop the software reading the entry as zero	**B1**	**2.4**	allow so that the cell is ignored **oe** or the software interprets #N/A as no data **oe**	advantage
				[1]			
12	(b)		(30.6, 128) and (1.3,88) ringed	**B1**	**1.1**		
				[1]			
12	(c)		outlier on extreme left **oe** should be removed as nobody could have a BMI this low **oe**	**B1**	**2.4**	need to refer to BMI being implausible	advantage
			outlier with (very) high pulse rate **oe** should not be removed as it is plausible **oe**	**B1**	**2.4**		advantage
				[2]			
12	(d)		no correlation	**B1**	**2.2b**	ignore other comments unless contradictory	
				[1]			
12	(e)		because the value of pmcc is close to 1 or because there is strong correlation **oe**	**B1**	**2.2b**		
				[1]			

Question			Answer	Marks	AOs	Guidance	
12	(f)		86.784, 86.78 or 86.8	B1	3.4	isw	
				[1]			
13	(a)		mean = 1.5 BC	B1	1.1		
			sd = 1.1, 1.10 or awrt 1.096 BC	B1	1.1		
				[2]			
13	(b)		$n = 10$ and $p = 0.15$	B1	3.3		
				[1]			
13	(c)		<table><tr><td>N</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5 +</td></tr><tr><td>O</td><td>19</td><td>35</td><td>28</td><td>13</td><td>5</td><td>0</td></tr><tr><td>E</td><td>19.7</td><td>34.7</td><td>27.6</td><td>13.0</td><td>4.0</td><td>1.0</td></tr></table>	M1 M1 A1	3.4 3.4 1.1	use of B(10, p) FT their p to find at least 2 probabilities; may be unsimplified multiplying their binomial probabilities by 100 all correct to 1 dp or better; must add up to 100	must see at least 2 probabilities for **M1** must see at least 2 expected values calculated for **M1**
				[3]			
13	(d)		close match between theoretical (or expected) and observed frequencies so model is a good fit	B1	3.5a	FT dependent on award of **M1M1** in **(c)** and all frequencies calculated	
				[1]			
14	(a)		$2x(x-2)^3 + x^2 \times 3(x-2)^2$	M1 A1	3.1a 1.1	product rule & chain rule; allow one error	
			$(x-2)$ identified as factor	M1	2.1		
			$x(x-2)^2(5x-4)$ **cao**	A1	1.1		
				[4]			
			Alternative $5x^4 - 24x^3 + 36x^2 - 16x$	M1 A1		NB from $x^5 - 6x^4 + 12x^3 - 8x^2$ expand brackets and differentiate; allow one error	
			$(x-2)$ identified as factor	M1			
			$x(x-2)^2(5x-4)$ **cao**	A1			
				[4]			

Question			Answer	Marks	AOs	Guidance	
14	(b)		*their* $\frac{dy}{dx} = 0$ **soi**	**M1**	**2.1**		
			$x = 0, 2, \frac{4}{5}$	**A1**	**1.1**		
			(0,0) and (2.0)	**A1**	**1.1**		
			(0.8, – 1.10592) or (0.8, $-\frac{3456}{3125}$)	**A1**	**2.2a**	accept – 1.10592 to 2 sf or better	
				[4]			
14	(c)		2nd derivative = – 16 at (0,0) so max 2nd derivative = 5.76 at (0.8, – 1.10592) so min eg gradient = 1 at $x = 1$ and 33 at $x = 3$ so inflection at $x = 2$ eg $y = –1$ at $x = 1$ and $y = 9$ at $x = 3$ so inflection at $x = 2$ NB 2nd derivative test is indecisive at $x = 2$	**B1** **B1** **B1**	**1.1** **1.1** **3.1a**	or for any of the three points: considers y or $\frac{dy}{dx}$ or $\frac{d^2y}{dx^2}$ either side of correct stationary point accompanied by suitable commentary; must see numerical values	
				[3]			
14	(d)			**M1** **A1**	**1.1** **1.1**	shape of curve correct with max, min and inflection correct intercepts marked on sketch or identified next to graph	
				[2]			

Question			Answer	Marks	AOs	Guidance	
15	(a)		$a = 0.01$ and $r = 0.99$	B1	2.1		
			a and r substituted in $\frac{a}{1-r}$ **oe** seen	M1	1.1	a or r must be correct	
			$\frac{0.01}{1-0.99}$ **oe** = 1	A1	2.4		
				[3]			
15	(b)		(n =) 312	M1	3.1a	allow 313	
			$\frac{0.01(1-0.99^n)}{1-0.99}$ or $\sum_1^n 0.99^{n-1} \times 0.01$ evaluated	M1	1.1	n = 312 or 313; condone n = 6	
			awrt 0.9565 or 0.9570 > 0.95 so model predicts Layla will beat him within 6 years **oe**	A1	3.4		
				[3]			
			Alternative $\frac{0.01(1-0.99^n)}{1-0.99} = 0.95$	M1		may use cdf from geometric distribution; allow > or ≥ instead of =	
			$0.99^n = 0.05$	M1		attempt to simplify as far as "$0.99^n =$ "	
			n = 298.1 weeks < 312 (or 313) so model predicts Layla will beat him within 6 years **oe**	A1			
				[3]			
15	(c)		Layla thinks she will improve (by practising), so she should become increasingly likely to beat Kofi **oe** or Layla thinks she is more likely to beat Kofi because he doesn't practise (but Layla does) **oe**	B1	3.5a		
				[1]			
15	(d)		probability of Layla winning increases as r increases **oe**	B1	2.4	**B0** for eg probability of Layla winning increases exponentially	
				[1]			

Question			Answer	Marks	AOs	Guidance	
15	(e)		$k(1 + 4 + 9 + 16 + 25 + 36 + 49 + 64) = 1$ **soi**	**M1**	**3.3**		
			$k = \frac{1}{204} (= 0.00490 \ldots)$	**A1**	**1.1**		
			$P(X \leq 6) = \frac{91}{204} (0.44607 \ldots) < 0.95$ so Layla's statement not consistent with her model **oe**	**A1**	**3.5a**		
				[3]			
16			$u = 1 + \sqrt{x}$	**B1**	**3.1a**	for use in substitution	No marks for attempts based solely on integration by parts
			$\frac{du}{dx} = \frac{1}{2} x^{-\frac{1}{2}}$	**M1**	**1.1**	allow **M1** for $x^{-\frac{1}{2}}$	
			$\sqrt{x} = u - 1$	**M1**	**1.1**	allow sign error	
			$\int \frac{(u-1)^2 \times 2(u-1)}{u} \, du$	**A1**	**3.1a**	du may be seen later	
			$\frac{2(u^3 - 3u^2 + 3u - 1)}{u}$ soi	**M1**	**2.1**	allow sign errors and/or omission of 2	
			$2\left[\frac{u^3}{3} - \frac{3u^2}{2} + 3u - \ln u\right]$	**M1** **A1**	**3.1a** **1.1**	divides their cubic through by u and integrates dependent on award of first two **M** marks; allow sign errors and coefficient errors	must have $\ln u$
			$\frac{2(1+\sqrt{x})^3}{3} - 3(1+\sqrt{x})^2 + 6(1+\sqrt{x}) - 2\ln(1+\sqrt{x})$ $+c$ **oe isw**	**A1**	**3.2a**	if answer fully correct but either $+ c$ or du not seen then withhold final **A1**	
				[8]			

Question			Answer	Marks	AOs	Guidance	
			Alternative $x = u^2$	**B1**		*or* $u = \sqrt{x}$	may see $u = \frac{1}{1+\sqrt{x}}$ or $e^u = (1+)\sqrt{x}$
			$\frac{dx}{du} = 2u$	**M1**		allow **M1** for $\frac{du}{dx} = x^{-\frac{1}{2}}$	
			$\sqrt{x} = u$	**M1**		$x = u^2$	
			$\int \frac{u^2 \times 2u}{1+u} du$	**A1**			
			$(2u^2 - 2u + 2) - \frac{2}{1+u}$ from long division **oe**	**M1**		allow sign errors and/or omission of 2	
			$\frac{2u^3}{3} - u^2 + 2 - 2\ln(1+u)$	**M1** **A1**		integration attempted; allow sign errors and coefficient errors	
			$\frac{2x\sqrt{x}}{3} - x + 2\sqrt{x} - 2\ln(1+\sqrt{x}) + c$	**A1**		if answer fully correct but either + *c* or d*u* not seen then withhold final **A1**	
				[8]			

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