OCR
Oxford Cambridge and RSA

GCE

Mathematics A

H230/01: Pure Mathematics and Statistics

Advanced Subsidiary GCE

Mark Scheme for June 2019

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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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Text Instructions

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
SC	Special case
^	Omission sign
MR	Misread
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 *
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 question included the instruction: In this question you must show detailed reasoning.

Subject-specific Marking Instructions for A Level Mathematics A

a Annotations should be used whenever appropriate during your marking. The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded. For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

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 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
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
Mark for explaining a result or establishing a given result. 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 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 **3 s.f.** unless the question specifically asks for another level of accuracy.
  NB for Specification B (MEI) the rubric is not specific about the level of accuracy required, so this statement reads "2 s.f".

Follow through should be used so that only one mark is lost for each distinct accuracy error.

g Rules for replaced work: if a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests; if there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others. NB Follow these maths-specific instructions rather than those in the assessor handbook.

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 mark in the question. Marks designated as cao may be awarded as long as there are no other errors. E marks are lost unless, by chance, the given results are established by equivalent working. 'Fresh starts' will not affect an earlier decision about a misread. 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, of course, that there is nothing in the wording of the question specifying that analytical methods are required). 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	Mks	AO	Guidance		
1			In all three parts: Allow unsimplified answers. ISW for incorrect simplification. Ignore incorrect dx and/or $\int$					
1	(a)		$3 + 15x^{-4}$ or $3+\frac{15}{x^4}$ oe	B1 M1 A1 [3]	1.1 1.1a 1.1	$3x$ correctly differentiated to 3 kx^{-4} oe $15x^{-4}$ or $\frac{15}{x^4}$ oe		ISW eg $5\times3x^{-4} = \frac{5}{3x^4}$ M1A1
1	(b)		$-60x^{-5}$ or $-\frac{60}{x^5}$ oe	B1f B1f [2]	1.1a 1.1	zero term stated or implied by absence other term, ft their 2nd term in (a) if includes negative index		or ft their 1st term in (a) ISW
1	(c)		$\frac{3x^2}{2}+\frac{5}{2}x^{-2}+c$ or $\frac{3x^2}{2}+\frac{5}{2x^2}+c$ oe	B1 M1 A1 [3]	1.1 1.1a 1.1	$\frac{3x^2}{2}$ kx^{-2} oe All correct and + c. ISW		
2	Other methods are probably equivalent to one these methods. Apply whichever of these methods is closest. Allow + or – instead of ± except for final answer.							
2			$(x-2)^2+\left(y+\frac{k}{2}\right)^2$ Allow + or – in both	M1*	3.1a	$(x–2)^2+y^2+ky+12–4=0$ M1	$(x–2)^2+(y–b)^2=1$ M1	$x^2+y^2–4x+ky+13=1$ M1
			$(x-2)^2+\left(y+\frac{k}{2}\right)^2+12-4-\frac{k^2}{4}$ oe; ignore RHS	A1	1.1	$(x–2)^2+y^2+ky+9=1$ M1	$4+b^2–1=12$ oe M1	$x^2+y^2–4x+ky+4+9=1$ M1
			$\frac{k^2}{4}-8=1$ or $-12+4+\frac{k^2}{4}=1$ oe ft <u>const</u> term depM1*	M1	2.1	$(x–2)^2+(y\pm3)^2=1$ oe A1	$b=\pm3$ A1	$x^2+y^2–4x\pm6y+4+9=1$ or $(x–2)^2+(y\pm3)^2=1$ A1
			$k^2=36$ $k=\pm6$	A1 [4]	1.1	$k=\pm6$ A1	$k=\pm6$ A1	$k=\pm6$ A1

3			**DR (**all parts)				
3	**(a)**	**(i)**	Show f(1) = 0	**B1** **[1]**	**1.1a**	Correct working and result seen	
3	**(a)**	**(ii)**	$(x – 1)$ is a factor Attempt find other (quadratic) factor, by any method, but must be seen $(x – 1)(2x^2 + 5x – 3)$ $(x – 1)(2x – 1)(x + 3)$ $x = 1$ or $\frac{1}{2}$ or $–3$	**B1** **M1** **A1f*** **A1** **[4]**	**2.2a** **1.1** **1.1** **2.2a**	stated or implied, eg by attempt ÷ by $(x–1)$ or show that f(–3) = 0 or f($\frac{1}{2}$) = 0 or $x = \frac{-5\pm\sqrt{25-4\times2\times(-3)}}{4}$ Dep A1* cao. SC correct answer no working: B1 only	or $(2x – 1)$ or $(x + 3)$ is factor Inspection: Must have $2x^2$ and ±3 oe ft their quad factor eg correct factors, no working B1 only
3	**(b)**		$\sin\theta = 1$ or $\sin\theta = \frac{1}{2}$ $\theta = 90°, 30^o, 150^o$ $\sin\theta = –3$ gives no solution, or it doesn't exist oe or outside range or impossible or not acceptable oe	**M1** **A3f** **B1** **[5]**	**3.2a** **3.1a** **1.1** **1.1** **2.3**	Use of a root from (a). May be implied Three correct, none incorrect: A3 Three correct and ≥ 1 incorrect: A2 Two correct: A2 One correct: A1 Statement needed. Ignore all else Not incorrect reason eg "no solutionn because minus": B0	ft their (a) for all A-marks **Ignore** any "correct" solutions outside range Just "X" or "Error"not enough because **DR**
4	**(a)**		$3x^2 – 12x + 9 = 0$ $x = 3$ or 1 (3, 0) and (1, 4)	**M1** **A1** **A1f** **A1** **[4]**	**1.1a** **1.1** **1.1** **1.1**	Attempt differentiate & =0 May be implied Correct equation. May be implied by ans **BC** Allow When $x = 3$, $y = 0$; when $x = 1$, $y = 4$	$x(x – 3)^2 = 0$ M1 tp at x =3 A1 ft their equation cao. Must be paired
4	**(b)**		Sketch (drawn in this part) of "+ve" cubic with two SPs, roughly correct shape, or just two TPs shown OR: f(1) = 0 and f(3) = 0, find k for each $k > 0$ or $k < – 4$	**M1** **A1f** **[2]**	**3.1a** **2.2a**	Subst x=1 & x=3 into $y = x^3 – 6x^2 + 9x$ ft (a) ft their (a) Correct ans: M1A1	or identify $k = –4$ and 0. ft (a)

5	**(a)**		eg $9^2 + 4 = 85$ <u>and</u> 85 is multiple of 5 or $85 = 5\times17$ or $85 \div 5=17$ or 85 has a factor of 5 (or 17)	**B1** **[1]**	**1.1**	oe Not just "and 85 is not prime" One correct example and one incorrect B1	Condone eg $9^2+4 = 85 \div 5=17$
5	**(b)**		$(2k)^2 + 1 = 4k^2 + 1$ (k an integer) or eg $(2k + 2)^2 + 1 = 4k^2 + 8k + 5$ which is not a multiple of 4	**B1**	**2.2a**	Allow any letter, even n	Allow omission of "(k an integer)" in both places
			$(2k + 1)^2 + 1 = 4k^2 + 4k + 1 + 1$ (k an integer) $= 4(k^2 + k) + 2$ or $4k^2 + 4k + 2$	**M1** **A1***	**1.1** **1.1**	Attempt expand & add 1, eg $4k^2+1+1$: M1 Must see one of these forms	Same marks for $(2k – 1)^2 + 1$
			Any sensible explanation why this is not mult of 4 eg This is of the form 4 × integer + 2 $4k^2$ & $4k$ are mults of 4 but when + 2, not mult of 4	**A1** dep*	**2.2a**	eg $4(k^2 + k)$ is a multiple of 4 2 is not a multiple of 4 $k^2 + k + \frac{1}{2}$ not an integer Other correct methods may be seen	Not just "This is not a mult of 4" Not "This is mult of 2, not of 4" Numerical examples: no mks
			Alternative method <u>n even</u> n^2 is mult of 4, hence $n^2 + 1$ is not mult of 4 or n^2 is even, so $n^2 + 1$ is odd so not mult of 4 <u>n even</u>, $n + 1$ is odd. $(n + 1)^2 + 1$ $= n^2 + 2n + 2$ n^2 and $2n$ are mults of 4, hence $n^2 + 2n + 2$ is not	**B1** **M1** **A1** **A1** **[4]**			
6	**(a)**		$\frac{1}{2}xy\sin 60 = \sqrt{3}(x+y)$ Must have xy, not ab May be implied by next line $\frac{1}{2}\left(\frac{\sqrt{3}}{2}\right)xy = \sqrt{3}(x+y)$ **oe** $\Rightarrow 4x + 4y = xy$ **(AG)**	**M1** **A1** **[2]**	**1.1a** **2.1**	Verification method: eg substitute $4x + 4y$ for xy in $\frac{1}{2}\left(\frac{\sqrt{3}}{2}\right)xy = \sqrt{3}(x+y)$ M1 obtain $\sqrt{3}(x+y) = \sqrt{3}(x+y)$ A1	Condone incorrect use of brackets eg $x+ y(\sqrt{3})$, if next line shows intention is correct Must show sufficient working to justify the given answer
6	**(b)**		Angle ABC is 90°	**B1***	**3.1a**	May be implied by correct trig statement	Possibly on diagram

			$\cos 60 = \frac{x}{y}$ or $\frac{x}{y} = \frac{1}{2}$ or $y = 2x$	**B1**	**1.1**	or any correct x, y equn eg $\frac{x}{\sin 30} = \frac{y}{\sin 90}$	Dep B1*
			$4x + 4(2x) = x(2x)$ oe or $4(\frac{y}{2}) + 4y = y \times \frac{y}{2}$ oe	**M1**	**1.1**	or $\sqrt{3}(x + 2x) = \frac{1}{2} \times x \times 2x \times \frac{\sqrt{3}}{2}$	Obtain a correct equation in x or y only
			$(\Rightarrow x(x-6) = 0)$ or $\Rightarrow y(y-12) = 0)$ $x = 6,\ y = 12$	**A1** **[4]**	**1.1**	No need to consider $x = 0$ or $y = 0$	
7	**(a)**		ke^{kx}	**B1** **[1]**	**1.2**	Ignore "$y =$" if seen	
7	**(b)**		(Gradient of tangent is) $\frac{1}{2}e^{\frac{1}{2}\times 2}$ ignore eg "$y =$"	**M1**	**1.1a**	Subst $k = \frac{1}{2}$ $x = 2$ into their (a)	Allow decimals throughout
			$= \frac{1}{2}e$	**A1f**	**1.1**	ft (a) May be implied by next line	May be implied by 1.36 or 1.35 ft (a) ft their gradient, so long as it involves e (possibly implied by decimal)
			(Equation of tangent is) $y - e = \frac{1}{2}e(x-2)$ or $y = \frac{1}{2}ex + c$ AND sub (2, e)	**M1**	**1.1**	M1 for attempt find equation of tangent by correct method	
			$y = \frac{1}{2}ex$ (cao), Passes through (0, 0) or $x = 0 \Rightarrow y = 0$ or y-int is 0 oe	**A1** **[4]**	**2.2a**	or verify, eg: $0 - e = \frac{1}{2}e(0-2)$ so $-e = -e$ $y - 1.36x = 0$ $0 - 1.36\times 0 = 0$	A1 for obtain **correct** equation and state or show or verify that it passes thro' (0, 0) **No ft.**

7	**(c)**		$3e^{x} = 1 - 2e^{\frac{1}{2}x}$	**M1**	**3.1a**	oe	Allow decimals throughout
			$3(e^{\frac{1}{2}x})^2 + 2e^{\frac{1}{2}x} - 1 = 0$ or eg $3u^2 + 2u - 1 = 0$ or $3y + 2\sqrt{y} - 1 = 0$	**M1**	**3.1a**	Attempt write quadratic equation in $e^{\frac{1}{2}x}$ or attempt a substitution and form QE Allow one sign error	Allow substitute x or $y = e^{\frac{1}{2}x}$
			$((3e^{\frac{1}{2}x} - 1)(e^{\frac{1}{2}x} + 1) = 0)$			May not be seen	
			$e^{\frac{1}{2}x} = -1$: no solutions stated	**B1**	**2.3**	eg "Cannot be negative" or "Impossible" or just "X"	
			$e^{\frac{1}{2}x} = \frac{1}{3}$ oe	**A1**	**2.1**	or $\frac{1}{2}x = \ln\frac{1}{3}$ or $\frac{1}{2}x = -1.10$	not just eg $u = \frac{1}{3}$
			$x = 2\ln\frac{1}{3}$ or $\ln\frac{1}{9}$ or $-2\ln 3$ or $-\ln 9$ or -2.20	**A1**	**1.1**		
			$y = 3\exp(\ln\frac{1}{9}) = \frac{1}{3}$ or 0.333				
			Point of intersection is $(\ln\frac{1}{9}, \frac{1}{3})$	**A1**	**2.2a**	or equivalent exact or (–2.20, 0.333) (3 sf) If any extra points of intersection: A0	Correct ans, with no working or irrelevant working: SC B2
				[6]			
8	**(a)**		$\frac{2143}{5}$ or 428.6 or 429	**M1**	**1.1a**	M1 for $\frac{2143}{4}$ or 535.75 or 534 or 0.534	or $\frac{2143}{4.5}$ or 476 or 0.476
			Height = 0.429 (3 sf) (cm)	**A1**	**1.1**	Allow without "cm"	eg $\frac{1000}{428.6}$ M1A0
				[2]			
8	**(b)**		Non-numerical data oe	**B1**	**1.2**	Indication of numerical data needed, eg Boundaries need to be between 2 numbers Cannot be measured. Qualitative data. No range of values	**NOT** "No class boundaries", "No class widths", "Not g'ped data", "Need continuous data" "No range" Ignore all else
				[1]			
9	**(a)**		$\frac{\Sigma fx}{\Sigma f}$ $(= \frac{72}{30})$	**M1**	**1.1a**	attempted. May be implied by working seen or eg ≥ 2 terms in numerator correct Dep $\div \Sigma f$ (NOT = 7)	Allow end points or incorrect midpoints
			= 2.4	**A1**	**1.1**		
				[2]			

9	**(b)**		1	**B1** **[1]**	**1.2**	Ignore method except 0, 0, 1, 1, 7, 9, 12 or 7, 12, 9, 1, 0, 1, 0 B0	
9	**(c)**		The median is less influenced than the mean by the one student in the 21 - 30 class	**B1** **[1]**	**3.4**	or equivalent statement. Must clearly refer to the **actual** outlier in 21 - 30 class	Not "It's the same as the mode". Ignore "skew".
10	**(a)**		LA4 Large increase in numbers travelling by tram etc or Increase in tram etc greater than the others or There was an increase from 65 to 2495	**B1*** **B1** **[2]**	**2.2b** **2.2b**	Not eg "LA4 or LA1", but allow "LA4 and possibly LA1, but less likely" Dep 1st B1* Allow any description of "tram etc" No need to mention "tram" if clear	
10	**(b)**		Ratio for bus is approx same as ratio for all people or Recognition that total number has increased No reason to suggest new bus routes	**B1*** **B1** **[2]**	**2.2a** **2.3**	Must include comment on total number Must refer to data in table Dep 1st B1*	Not Bus growth is greater than other forms of transport Ignore all else. Eg "True .... but possibly not true ....": ignore the first part.
10	**(c)**		LA1, because: decrease in number driving cars despite increase in total number of people or all other LAs had increased numbers driving or $\geq$ 2 LA1 public transport categories increased	**B1** **B1** **[2]**	**2.2b** **2.2b**	Must state LA1, but no mark for this yet eg LA1 is the only LA with decrease in driving: B1B1	Ignore all else
11	**(a)**		e.g. The probability of side effects is the same for each patient (or is constant) e.g. The patients (or cases) are independent oe e.g. Patients form random sample of the population	**B1** **[1]**	**1.2**	oe, in context Allow any indication of context, eg "patient" or "side effects"	NOT Prob of patients getting side effects is indep or random. Ignore all else

11			**See exemplars at end. Allow 2 sf throughout**					
11	**(b)**		H_0: $p = 0.097$ where p is the proportion of patients experiencing side-effects (within a year) or 9.7% of patients experience side-effects	**B1**	**1.1**	Allow "possibility" or, "probability" Not p = percentage having disease	**If 2-tail test:** H_o: $p = 0.097$ (defined p) B1	
			H_1: $p > 0.097$ or > 9.7% exp side-effects	**B1**	**2.5**	One error, eg undefined p, p = 9.7% B1B0	H_1: $p \neq 0.097$ B0	
			B(450, 0.097) & $X = 50$ (allow 51)	**M1**	**3.3**	stated or implied eg by 0.138 or 0.107 or 0.108 or 0.862 or 0.893 or 0.0308 or 0.0366 NB 0.138 seen (or 0.107 or 0.108 or 0.862 or 0.893) implies M1 even if part of incorrect statement, eg $P(X \leq 51) = 0.107$ or $P(X > 51) = 0.138$	M1	
			$P(X \geq 51) = 1 - 0.862 = 0.138$ (3 sf)	**A1**	**3.4**	cao **BC**	A1	
			Compare 0.1	**A1f**	**1.1**	Dep 0.138 or 0.107 or 0.108 only	Comp 0.05 A1 No more marks	
			Insufficient evidence to reject H_0 Allow "Not reject H_0" Allow Accept H_0	**M1**	**1.1**	Must see this statement oe Dep 0.138 or 0.107 or 0.108 or $P(X \geq 51$ or $50)$ stated	Condone "Reject H_1" Might be implied by conclusion NB possible opposite conclusion on ft	
			No evidence (at 10% level) that proportion experiencing side-effects in one year under new treatment is greater than under standard treatment	**A1f**	**2.2b**	Any equivalent statement, in context, not definite, eg allow "likelihood", "percentage" Ignore all else ft only their $P(X \geq 51)$ and NB possible opposite conclusion on ft 0.108 seen: max B1B1M1A0A1M1A1 Bin(450, 0.1) <u>used</u>: max B1B1M0A0A0M1A1	NOT eg "change" NOT "proportion experiencing side effects is not significantly greater" Context can be implied by, eg, "patients", "proportion"	
				[7]				

12			P(1st HGP′ & 2nd GP′ or 1st HGP & 2nd GP′ or 1st HG′ & 2nd GP′) $= \frac{25}{100}\times\frac{36}{99}+\frac{3}{100}\times\frac{37}{99}+\frac{15}{100}\times\frac{37}{99}$	**M1** **M1** **M1** **A1** **[4]**	**3.1b** **1.1** **2.1** **1.1**	One of the following expressions seen: M1 Another seen: M1 $\frac{25}{100}\times\frac{...}{99}$ or $\frac{3}{100}\times\frac{...}{99}$ or $\frac{15}{100}\times\frac{...}{99}$ or $(\frac{8}{100}\times\frac{...}{99}+\frac{7}{100}\times\frac{...}{99})$ 3rd M1 for all correct	P(1st HGP′ & 2nd GP′ or 1st {H – HGP′} & 2nd GP′) $= \frac{25}{100}\times\frac{36}{99}+\frac{18}{100}\times\frac{37}{99}$ or $\frac{43}{100}(\frac{25}{43}\times\frac{36}{99}+\frac{18}{43}\times\frac{37}{99})$ or $\frac{18}{100}\times\frac{...}{99}$ M2 or $\frac{43}{100}(\frac{25}{43}\times\frac{...}{99})$ M1 or $\frac{43}{100}(\frac{18}{43}\times\frac{...}{99})$ M2

s

Qu 11(b) Examplar solutions

A H_0: $p = 0.097$
H_1: $p > 0.097$ B1B0

$P(X \geq 51) = 0.138$ M1A1
$0.138 > 0.1$ A1

Reject H_1 M1A0

B H_0: $p = 0.097$
H_1: $p > 0.097$ where p = %age exp'ng side effects B1B0

$P(X \geq 51) = 0.107$ M1A0
$0.107 > 0.1$ A1

Not reject H_0 M1A0

C H_0: $p = 0.097$
H_1: $p > 0.097$ where p = proportion exp'ng side effects B1B1

Bin(450, 0.097)
$P(X \leq 51) = 0.138$ M1A1
$0.138 > 0.1$ A1

Not reject H_0 M1
Under new treatment there is not a greater prop exp side effects A0

D H_0: $p = 0.097$
H_1: $p > 0.097$ where p = P(a patient exp side effects) B1B1

$P(X \leq 51) = 0.108$ M1A0
$0.108 > 0.1$ A1

Not reject H_0 M1
There is not enough evidence that the alternative hypothesis is correct (No context) A0

E Let p be the probability
H_0: $p = 0.097$
H_1: $p > 0.097$ B1B0

Bin(51, 0.097) Ignore because next line is correct
$P(X \leq 51) = 0.138$ M1A1
$0.138 > 0.1$ A1

Not reject H_0 M1
Under new treatment there is not a greater prop exp side effects A0

F $H_0 = 0.097$
$H_1 > 0.097$ B0B0
Bin(450, 0.1)
$P(X \geq 51) = 0.192$ M0A0
$0.192 > 0.1$ A0
Reject H_1 M1
Insuff evidence that under new treatment there is a greater prop exp side effects A1

G H_0: $p = 0.097$

H_1: $p > 0.097$ where p = P(a patient exp side effects)	B1B1
Bin(450, 0.097), $X = 51$ or $X = 50$	M1
$p = 0.0308$	A0
$0.0308 < 0.1$	A0
Reject H_0	M0
There is evidence that under new treatment there is a greater prop exp side effects	A0

J H_0: $p = 0.097$

H H_0: $p(X = 0.097)$

H_1: $p(X > 0.097)$	B0B0
$P(X \geq 51) = 0.0308$	M1A0
$0.0308 < 0.1$	A0
Reject H_0	M1
There is enough evidence that a greater prop exp side effects	A1f

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I H_0: $p = 0.097$

H_1: $p > 0.097$	B1B0
$p = 0.138$	M1A1
	A0
Reject H_1	M1
	A0

H_1: $p > 0.097$	B1B0
$X \sim$Bin(450, 0.097)	
$p = 0.893$	M1A0
$0.893 > 0.1$	A0
Not reject H_0	M0 A0

K H_0: $p = 0.097$

H_1: $p > 0.097$ p is the likelihood of a patient exp side effects	B1B1
$P(X \geq 51) = 0.893$	M1A0
$0.893 > 0.1$	A0
Not reject H_0	M1
No reason to think proportion decreased	A1

L H_0: $p = 0.97$

H_1: $p = 0.97$	B0B0
$P(X \geq 50) = 0.0366$	M1A0
$0.0366 < 0.1$	A0
Reject H_0 There is evidence prop has increased	M1A1f

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