AQA

AS
Mathematics

7356/2 – Paper 2

Mark scheme

7356
June 2018

Version/Stage: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Mark scheme instructions to examiners

General

The mark scheme for each question shows:
- the marks available for each part of the question
- the total marks available for the question
- marking instructions that indicate when marks should be awarded or withheld including the principle on which each mark is awarded. Information is included to help the examiner make his or her judgement and to delineate what is creditworthy from that not worthy of credit
- a typical solution. This response is one we expect to see frequently. However credit must be given on the basis of the marking instructions.

If a student uses a method which is not explicitly covered by the marking instructions the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

Key to mark types

M	mark is for method
R	mark is for reasoning
A	mark is dependent on M marks and is for accuracy
B	mark is independent of M marks and is for method and accuracy
E	mark is for explanation
F	follow through from previous incorrect result

Key to mark scheme abbreviations

CAO	correct answer only
CSO	correct solution only
ft	follow through from previous incorrect result
'their'	Indicates that credit can be given from previous incorrect result
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
sf	significant figure(s)
dp	decimal place(s)

AS/A-level Maths/Further Maths assessment objectives

AO		Description
AO1	AO1.1a	Select routine procedures
	AO1.1b	Correctly carry out routine procedures
	AO1.2	Accurately recall facts, terminology and definitions
AO2	AO2.1	Construct rigorous mathematical arguments (including proofs)
	AO2.2a	Make deductions
	AO2.2b	Make inferences
	AO2.3	Assess the validity of mathematical arguments
	AO2.4	Explain their reasoning
	AO2.5	Use mathematical language and notation correctly
AO3	AO3.1a	Translate problems in mathematical contexts into mathematical processes
	AO3.1b	Translate problems in non-mathematical contexts into mathematical processes
	AO3.2a	Interpret solutions to problems in their original context
	AO3.2b	Where appropriate, evaluate the accuracy and limitations of solutions to problems
	AO3.3	Translate situations in context into mathematical models
	AO3.4	Use mathematical models
	AO3.5a	Evaluate the outcomes of modelling in context
	AO3.5b	Recognise the limitations of models
	AO3.5c	Where appropriate, explain how to refine models

Examiners should consistently apply the following general marking principles

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to students showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the student to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

Diagrams

Diagrams that have working on them should be treated like normal responses. If a diagram has been written on but the correct response is within the answer space, the work within the answer space should be marked. Working on diagrams that contradicts work within the answer space is not to be considered as choice but as working, and is not, therefore, penalised.

Work erased or crossed out

Erased or crossed out work that is still legible and has not been replaced should be marked. Erased or crossed out work that has been replaced can be ignored.

Choice

When a choice of answers and/or methods is given and the student has not clearly indicated which answer they want to be marked, mark positively, awarding marks for all of the student's best attempts. Withhold marks for final accuracy and conclusions if there are conflicting complete answers or when an incorrect solution (or part thereof) is referred to in the final answer.

Q	Marking Instructions	AO	Marks	Typical Solution
1	Circles correct answer	AO1.1b	B1	$\frac{-1}{6x} + c$
	Total		**1**	

Q	Marking Instructions	AO	Marks	Typical Solution
2	Ticks correct answer	AO1.1b	B1	Figure 3
	Total		**1**	

Q	Marking Instructions	AO	Marks	Typical Solution
3	Expresses $2\log_a 6$ as $\log_a 6^2$ or $\log_a 36$ divides by 3 inside the log term (PI) e.g. $2\log_a\left(\frac{6}{3}\right)$ scores M1 but not $2\frac{\log_a 6}{\log_a 3}$	AO1.1a	M1	$\log_a\left(6^2/3\right)$
	Obtains correct final answer (condone the omission of base a) CAO	AO1.1b	A1	$\log_a 12$
	Total		**2**	

Q	Marking Instructions	AO	Marks	Typical Solution
4	Solves to find $\tan 2\theta$ (allow M1 even if only $+\sqrt{3}$ given PI by any correct final value of θ)	AO1.1a	M1	$\tan 2\theta = \pm\sqrt{3}$
	Obtains at least 3 correct final values for θ ignore extra incorrect terms or terms outside range	AO1.1b	A1	$\tan 2\theta = \sqrt{3} \rightarrow 2\theta = 60°, 240°, 420°, 600°$
	Obtains at least 3 correct final values of θ from $\tan 2\theta = \sqrt{3}$ **and** at least 3 correct values from $\tan 2\theta = -\sqrt{3}$ ignore extra incorrect terms or terms outside range	AO1.1a	M1	$\tan 2\theta = -\sqrt{3} \rightarrow 2\theta = 120°, 300°, 480°, 660°$
	Obtains complete set of exactly 8 correct values for θ	AO1.1b	A1	$\theta = 30°, 60°, 120°, 150°, 210°, 240°, 300, 330°$
	Total		**4**	

Q	Marking Instructions	AO	Marks	Typical Solution
5	Expands the bracket and obtains any correct form (PI)	AO1.1b	B1	$f^{/}(x) = 4x^2 - 12 + \frac{9}{x^2}$
	Integrates at least one of ‘their’ terms correctly	AO1.1a	M1	$f(x) = \int 4x^2 - 12 + \frac{9}{x^2}\,dx$ $= \frac{4x^3}{3} - 12x - \frac{9}{x} + c$
	Substitutes $x = 3$ into ‘their’ integrated expression and equates to 2	AO1.1a	M1	$f(3) = 36 - 36 - 3 + c = 2$ $c = 5$
	Obtains completely correct expression, must be explicitly stated CAO (ACF)	AO1.1b	A1	$f(x) = \frac{4x^3}{3} - 12x - \frac{9}{x} + 5$
	Total		**4**	

<table>
<tr><th>Q</th><th>Marking Instructions</th><th>AO</th><th>Marks</th><th>Typical Solution</th></tr>
<tr><td rowspan="4">6(a)</td><td>Selects a method leading to any calculation pertaining to one of the following methods seen (not necessarily correct); gradients of sides, lengths of sides or intersection or lengths of diagonals</td><td>AO3.1a</td><td>M1</td><td rowspan="4">Grad BC = -5/2 = Grad DA

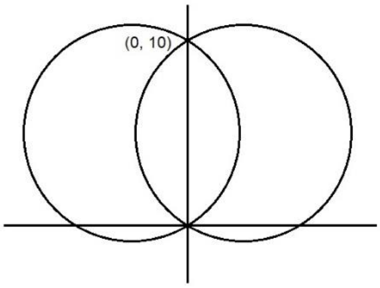
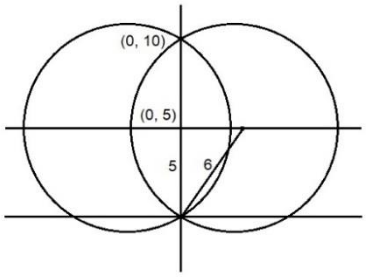
Grad AB = 2/5 = Grad DC

Both pairs of opposite sides have equal gradient so parallel, so ABCD is a parallelogram

Grad BC × grad AB = -1
ABC = 90° therefore all angles in ABCD are 90° so ABCD is a rectangle</td></tr>
<tr><td>Finds gradients of all 4 sides or lengths of all 4 sides or midpoints of both diagonals correctly</td><td>AO1.1b</td><td>A1</td></tr>
<tr><td>Proves one angle is 90° by using gradients or Pythagoras</td><td>AO1.1a</td><td>M1</td></tr>
<tr><td>Completes proof that ABCD is a rectangle. There must be a clear statement that there are 2 pairs of parallel sides and all angles are 90°</td><td>AO2.1</td><td>R1</td></tr>
<tr><td></td><td colspan="4">Note, there are various ways of proving that ABCD is a rectangle
(1 – 5 below score M1 A1 M1 before final required statement for relevant R1 stating how their method used proves a rectangle)
1. As in the typical solution shown: show that both pairs of opposite sides are parallel, show that one angle is 90°.
2. Show that each pair of opposite sides is equal in length, show that one angle is 90°.
3. Show that one pair of opposite sides is parallel and equal in length, show that one angle is 90°.
4. Show that the diagonals bisect (the midpoint of one is also the midpoint of the other) and are equal in length.
5. Show that each pair of opposite sides are parallel and length of the two diagonals are the same
NB May be expressed using vectors
NB Diagonals AC and BD = $\sqrt{377}$</td></tr>
<tr><td rowspan="2">(b)</td><td>Finds correct lengths of two adjacent sides (accept to at least 1dp accuracy)</td><td>AO1.1a</td><td>M1</td><td rowspan="2">AB (= DC) = $\sqrt{261} = 3\sqrt{29}$
BC (= DA) = $\sqrt{116} = 2\sqrt{29}$

Area = 174</td></tr>
<tr><td>Obtains correct area (AWRT)</td><td>AO1.1b</td><td>A1</td></tr>
<tr><td></td><td>Total</td><td></td><td>6</td><td></td></tr>
</table>

Q 7	Marking Instructions	AO	Marks	Typical solution
(a)	Takes out a factor of 2, or obtains $a = 2$ by equating coefficients. Note $2(x^2$ – 'anything') or $2(x$ – 'anything'$)^2$ scores M1	AO1.1a	M1	$2\left(x^2 - \frac{5x}{2}\right) + k$
	Expresses as $\left(x - \frac{5}{4}\right)^2$ or obtains $b = \frac{5}{4}$ by equating coefficients	AO1.1a	M1	$2\left(x - \frac{5}{4}\right)^2 + k - \frac{25}{8}$
	Obtains correct expression, If using equating coefficients **must** be put back in given form required	AO1.1b	A1	
(b)	Selects a method using completed square form (recognition that vertex occurs when x = 'their' b), discriminant (any use of $b^2 - 4ac$ seen) or calculus (finds y coordinate of stationary point).	AO3.1a	M1	Typical solution 1 When $x=\frac{5}{4}$ $(x - \frac{5}{4})^2 = 0$ $\left(k - \frac{25}{8}\right) > 3$ $k > \frac{49}{8}$
	Forms an appropriate correct inequality for their chosen method. (first time inequality sign seen in each typical solution scores A1)	AO1.1b	A1	
	Obtains $k > \frac{49}{8}$ (ACF)(OE)	AO1.1b	A1	
				Typical solution 2 $2x^2 - 5x + k = 3$ $2x^2 - 5x + k - 3 = 0$ $5^2 - 4 \times 2 \times (k - 3) < 0$ $k > \frac{49}{8}$
				Typical solution 3 $\frac{dy}{dx} = 4x - 5$ At stationary point $\frac{dy}{dx} = 0$ $4x - 5 = 0$ $x = \frac{5}{4}$ when $x = \frac{5}{4}$ $y = k - \frac{25}{8}$ $k - \frac{25}{8} > 3$ $k > \frac{49}{8}$
	Total	**6**		

Q 8	Marking Instructions	AO	Marks	Typical Solution
(a)	Produces a combined diagram showing circles intersecting at origin and (0, 10) or two separate diagrams. Allow reasonable 'hand drawn' circles which illustrate symmetry. Circles must cut the x axis again. Do not accept circles that go off the page.	AO2.2a	B1	
(b)	Deduces that y coordinate of centre is 5. (PI by any use of $(y - 5)$ in any circle equation or marked on diagram or seen as a y coordinate or used in Pythagoras)	AO2.2a	B1	
	Forms correct equation for x coordinate of centres using Pythagoras (PI)	AO1.1a	M1	$6^2 = 5^2 + a^2$ $a = +\sqrt{11}$ or $-\sqrt{11}$
	Obtains two correct circle equations (either form) Condone 3.3 or better provided $a = \sqrt{11}$ seen earlier	AO1.1b	A1	$(x - \sqrt{11})^2 + (y - 5)^2 = 6^2 = 36$ $(x + \sqrt{11})^2 + (y - 5)^2 = 6^2 = 36$ Or $x^2 + 2\sqrt{11}x + y^2 - 10y = 0$ $x^2 - 2\sqrt{11}x + y^2 - 10y = 0$
	Total		**4**	

Q	Marking Instructions	AO	Marks	Typical Solution
9	Uses $\tan\theta = \frac{\sin\theta}{\cos\theta}$ correctly (PI) (OE)	AO1.1a	M1	$\tan 15° = \frac{\sqrt{(2-\sqrt{3})}}{\sqrt{(2+\sqrt{3})}}$
	Squares and multiplies by appropriate $\frac{\text{conjugate}}{\text{conjugate}}$ or vice versa	AO1.1b	A1	$\tan^2 15° = \frac{2-\sqrt{3}}{2+\sqrt{3}} \times \frac{2-\sqrt{3}}{2-\sqrt{3}}$ $= (2-\sqrt{3})^2$
	Obtains correct values of a and b ($a = 7$, $b = -4$) If no explicit evidence of the use of $\frac{\text{conjugate}}{\text{conjugate}}$ seen award max 1/3 (M1 A0 R0)	AO2.1	R1	$\tan^2 15° = 7 - 4\sqrt{3}$
	Total		**3**	

Q	Marking Instructions	AO	Marks	Typical Solution
10	The 3 appropriate ${}_nC_r$ seen (ignore any extras) (PI by 55, 165 and 330 OE)	AO3.1a	M1	${}_nC_2 \quad {}_nC_3 \quad {}_nC_4$
	Forms a correct equation, accept $\frac{3}{2}({}_nC_2 + {}_nC_3) = {}_nC_4$ Allow $\binom{n}{r}$ notation (condone x terms in equation)	AO1.1a	M1	$\frac{3}{2}\left(\frac{n!}{(n-2)!\,2!} + \frac{n!}{(n-3)!\,3!}\right) = \frac{n!}{(n-4)!\,4!}$
	Obtains completely correct equation in terms of factorials. Reaching second line of typical solution scores M1 M1 A1	AO1.1b	A1	$\frac{3}{2}\left(\frac{n(n-1)}{2} + \frac{n(n-1)(n-2)}{6}\right) = \frac{n(n-1)(n-2)(n-3)}{24}$ $18 + 6n - 12 = n^2 - 5n + 6$
	Reduces to a quadratic or solves the quartic (may involve calculator functions)	AO1.1a	M1	$0 = n^2 - 11n = n(n-11)$
	Chooses the correct solution. (The correct value of n scores 5/5 may be found by trial and error)	AO3.2a	A1	$n = 11$
	Total		**5**	

Q	Marking Instructions (I)	AO	Marks	Typical Solution (using r)
11	Obtains correct weld length in terms of h and r	AO1.1b	B1	Length of weld = $w = h + 2\pi r$ Volume = $8000 = \pi r^2 h$
	Obtains formula for h in terms of r or vice versa using volume = 8000	AO3.1b	M1	So $h = \frac{8000}{\pi r^2}$
	Substitutes to get weld length in terms of one variable, obtaining correct formula for w	AO1.1b	A1	$w = \frac{8000}{\pi r^2} + 2\pi r$
	States that for a stationary point the first derivative is zero. (OE)	AO2.4	E1	For minimum length of weld $\frac{dw}{dr} = 0$
	Differentiates correctly (FT provided formula includes negative powers) (accept numerical value of $-\frac{16000}{\pi}$ used)	AO1.1b	B1F	$\frac{-16000}{\pi r^3} + 2\pi = 0$ leading to $\pi^2 r^3 = 8000$
	Solves to find a value of r and a value of h (do not award if the final value of r or h is negative)	AO1.1a	M1	$r = 9.32$ cm $h = 29.3$ cm
	Obtains r = 9 or 9.3 (AWRT) and h = 29, 29.3 (AWRT) or 30	AO1.1b	A1	
	Differentiates 'their' first differential and substitutes in 'their' value of r or h	AO1.1a	M1	$\frac{d^2w}{dr^2} = \frac{48000}{\pi r^4}$
	Sets out a well-constructed mathematical argument, using precise statements throughout to find the values of r (9 or 9.3) and h (29, 29.3 or 30) and justifies the minimum value. Can be awarded if E1 not obtained.	AO2.1	R1	which is positive, so this is a minimum for w
	Total		**9**	

Q	Marking Instructions (II)	AO	Marks	Typical Solution (using *h*)
11				Length of weld = $w = h + 2\pi r$ Volume = $8000 = \pi r^2 h$ $r = \sqrt{\frac{8000}{\pi h}}$ $w = h + 2\pi\sqrt{\frac{8000}{\pi h}}$ $= h + \sqrt{32000\pi}h^{-\frac{1}{2}}$ For minimum length of weld $\frac{dw}{dh} = 0$ $1 - \frac{1}{2}\sqrt{32000\pi}h^{-\frac{3}{2}} = 0$ leading to $h^3 = 8000\pi$ $h = 29.3$ cm $r = 9.32$ cm $\frac{d^2w}{dh^2} = \frac{3}{4}\sqrt{32000\pi}h^{-\frac{5}{2}}$ which is positive, so this is a minimum for w
	Total		**9**	

Q	Marking Instructions	AO	Marks	Typical Solution
12(a)	Uses model to form one correct equation (PI by a=200) (ACF) Accept 1.105a + 1.221b = 331	AO3.1b	M1	$290 = a + b$ $331 = ae^{0.1} + be^{0.2}$
	Forms a second correct equation (ACF)	AO1.1a	M1	$290e^{0.1} = ae^{0.1} + be^{0.1}$ $b = \frac{(331-290e^{0.1})}{(e^{0.2}-e^{0.1})} = 90.3 = 90$ to the nearest integer
	Obtains correct a AWRT 200 and b AWRT 90 (AG) Only award if **both** previous M1's achieved. Do not award marks retrospectively for correct values of a and b used in part (b)	AO1.1b	A1	so $a = 200$
(b)	Substitutes t = 3 and evaluates CAO	AO3.4	B1	$200e^{0.3} + 90e^{0.6} = 434$
(c)	Forms inequality (accept < or >) (condone use of equation) FT 'their' value of a, but b must be 90	AO1.1a	M1	$90e^{0.2t} > 200e^{0.1t}$
	Uses logs or calculator to solve 'their' inequality (or equation) If using trial and error must see t=7 and t=8 tested	AO1.1a	M1	$e^{0.1t} > \frac{200}{90}$ $0.1t > \ln\left(\frac{200}{90}\right)$ $t > 10\ln\left(\frac{200}{90}\right) = 7.985$
	Interprets final result. (Do not accept 2025)	AO3.2a	A1	Just less than 8 so during 2024
(d)	Gives one limitation of the model. Eg. Model must break down as both n_A and n_B will tend to infinity / model assumes nothing changes / no attempt to control the diseases / all the trees have died / finite number of trees / cure for the disease might be found / other factors such as drought could affect the model / etc.	AO3.5b	E1	Eventually all of the trees will die so the model will no longer be accurate.
	Total		**8**	

Q	Marking Instructions	AO	Marks	Typical Solution
13	Circles correct answer	AO1.1b	B1	0.16
	Total		**1**	

Q	Marking Instructions	AO	Marks	Typical Solution
14	Circles correct answer	AO1.1b	B1	24.8
	Total		**1**	

Accept probabilities as percentages in all questions

Q	Marking Instructions	AO	Marks	Typical Solution
15(a)	Calculates $P(X \leq 2)$ or $P(X \leq 3)$ using the binomial dist	AO3.4	M1	$P(X \leq 2) = 0.55(177\ldots)$ $(P(X \leq 3) = 0.80(589\ldots)$ $P(X \geq 3) = 1 - P(X \leq 2) = 0.448$
	Obtains correct answer AWRT 0.448	AO1.1b	A1	
15(b)	Calculates the cube of their answer to (a). Do not accept as part of a larger calculation or multiples of their cube.	AO1.1a	M1	$0.448\ldots^3$ = 0.090 (3dp)
	Obtains correct answer(FT if AWFW 0.0899 to 0.0901)	AO1.1b	A1F	
15(c)	States first appropriate assumption in context	AO3.5b	E1	The probability of hitting the bullseye is fixed at 0.3 or Hitting the bullseye with each dart is independent of hitting the bullseye with any other dart or There are 2 possible outcomes, hit bullseye or does not hit bullseye
	States second appropriate assumption in context Accept probability of hitting bullseye 'is constant' Do not accept 'fixed number of trials'	AO3.5b	E1	
	Total		**6**	

Q	Marking Instructions	AO	Marks	Typical Solution
16	Sets up enumerated population using valid numbering stating range used (PI)	AO2.4	E1	Give each student a number from (000)1 to 3200 or equivalent
	Explains how to obtain sample with respect to a specified range of random numbers. Accept random number generator / calculator set to give numbers from 1 to 3200 Do not accept 'drawn from a hat' (impractical for 3200 population)	AO2.4	E1	Generate random four digit integers using calculator
	Explains how to deal with repeats and random numbers outside range (PI by **both** 'different' numbers and 'numbers from 1 to 3200' seen).	AO2.4	E1	Ignore repeats and any (random) numbers outside the range
	Explains how to select the 60 (expresses idea of matching numbers to students or selecting them)	AO2.4	E1	Continue until 60 different numbers have been identified and select the students given those numbers
	Total		**4**	

Q	Marking Instructions	AO	Marks	Typical Solution
17	Comments on the lack of common units or mentions any of these units grams(g)/kg/millilitres(ml)/litres(l)	AO2.3	E1	There are no units stated so they could all be different
	Develops the point to show their knowledge of the large data set, must see grams (g) and millilitres(ml)	AO2.4	E1	Butter and margarine would be measured in grams whilst oils would be measured in millilitres
	Total		**2**	

Q	Marking Instructions	AO	Marks	Typical Solution
18 (a)	Identifies Donovan	AO1.2	B1	First Outlier Donovan Reason A data entry error has been made (should be 5 not 50)
	Infers a reason for Donovan • a data entry error has been made • Donovan gets nervous/stressed under exam conditions and performed poorly in most recent test • Donovan is not a very good player despite a lot of practice • Just started playing so practised longer hours but performed poorly in exam • External factors/illness Accept other reasonable reason linking Donovan's practice time to their performance in the exam.	AO2.2b	E1	
	Identifies Collins	AO1.2	B1	
	Infers a reason for Collins • a data entry error has been made • naturally very good piano player so does little practice • 'Lucky' test score Accept other reasonable reason linking Collins's practice time to their performance in the exam.	AO2.2b	E1	Second outlier Collins Reason Naturally very able student.
18(b)(i)	Describes correlation correctly, at least strong positive. Accept non – linear correlation, but do not accept numerical value to indicate strength	AO2.5	B1	Strong Positive Correlation
18(b)(ii)	Interprets correlation in context (as given in typical solution OE) Do not accept the better you do in the exam the more you practised	AO3.2a	E1	Students who complete more practice perform better in the exam
	Total		**6**	

Accept percentages throughout this question

Q	Marking Instructions	AO	Marks	Typical Solution
19	States both hypotheses correctly for one-tailed test accept 'population proportion' = 0.7 or 70%, but NOT x = or $\bar{x}$ = or μ =	AO2.5	B1	X = number of seeds which germinate H_0:p=0.7 H_1:p>0.7
	States model used **PI** can also be implied by 0.0278 or 0.00684	AO3.3	M1	Under null hypothesis X~B(20,0.7)
	Calculates $P(X \geq 18)$ *or* $P(X \geq 19)$, (PI by 0.035(5) or 0.0076) but not $P(X = 18)$ or $P(X = 19)$	AO1.1a	M1	$P(X \geq 18) = 1 - P(X \leq 17)$ $= 1 - 0.965$
	Obtains correct probability for $P(X \geq 18)$	AO1.1b	A1	$= 0.035$
	Evaluates binomial model by comparing 0.035(5) or 0.0076 with 0.05 but **not** $P(X = 18)$ or $P(X = 19)$	AO3.5a	M1	0.035 < 0.05
	Infers H_0 rejected (FT 0.0076), condone 'accept H_1'	AO2.2b	A1F	Reject H_0
	Concludes correctly in context. 'Sufficient evidence' or equivalent required. Only award for full complete correct solution.	AO3.2a	R1	There is sufficient evidence to conclude that the new seeds are more likely to germinate.
	Total		**7**	

Q	Alternative Marking Instructions	AO	Marks	Typical Solution
19	States both hypotheses correctly for one-tailed test accept 'population proportion' = 0.7 or 70%, but NOT x = or $\bar{x}$ = or μ =	AO2.5	B1	X = number of seeds which germinate H_0:p=0.7 H_1:p>0.7
	States model used **PI** can also be implied by 0.0716 or 0.0278	AO3.3	M1	Under null hypothesis X~B(20,0.7)
	Finds $P(X \geq 17)$ **and** $P(X \geq 18)$ but not $P(X=17)$ or $P(X=18)$ accept 0.035	AO1.1a	M1	$P(X \geq 17) = 0.1071 > 0.05$ and $P(X \geq 18) = 0.0355 < 0.05$
	Identifies correct critical region	AO1.1b	A1	Hence $X \geq 18$ is critical region
	Evaluates Binomial model by comparing $X = 18$ with critical region (condone CR of $X \geq 17$)	AO3.5a	M1	X = 18 is in critical region
	Infers H_0 rejected, condone 'accept H_1' FT CR of $X \geq 17$	AO2.2b	A1F	Reject H_0
	Concludes correctly in context. 'Sufficient evidence' or equivalent required. Only award for full complete correct solution.	AO3.2a	R1	There is sufficient evidence to conclude that the new seeds are more likely to germinate.
	Total		**7**	

	TOTAL		**80**	