
MATHEMATICS

9709/61

Paper 6

May/June 2017

MARK SCHEME

Maximum Mark: 50

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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Mark Scheme Notes

Marks are of the following three types:

- M Method mark, awarded for a valid method applied to the problem. Method marks are not 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. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.
 - 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).
 - B Mark for a correct result or statement independent of method marks.
- When a part of a question has two or more “method” steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly when there are several B marks allocated. The notation DM or DB (or dep*) is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.
 - The symbol FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only. A and B marks are not given for fortuitously “correct” answers or results obtained from incorrect working.
 - Note: B2 or A2 means that the candidate can earn 2 or 0.
B2/1/0 means that the candidate can earn anything from 0 to 2.

The marks indicated in the scheme may not be subdivided. If there is genuine doubt whether a candidate has earned a mark, allow the candidate the benefit of the doubt. Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored.

- Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.
- For a numerical answer, allow the A or B mark if a value is obtained which is correct to 3 s.f., or which would be correct to 3 s.f. if rounded (1 d.p. in the case of an angle). As stated above, an A or B mark is not given if a correct numerical answer arises fortuitously from incorrect working. For Mechanics questions, allow A or B marks for correct answers which arise from taking g equal to 9.8 or 9.81 instead of 10.

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The following abbreviations may be used in a mark scheme or used on the scripts:

AEF/OE Any Equivalent Form (of answer is equally acceptable) / Or Equivalent

AG Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)

CAO Correct Answer Only (emphasising that no “follow through” from a previous error is allowed)

CWO Correct Working Only – often written by a ‘fortuitous’ answer

ISW Ignore Subsequent Working

SOI Seen or implied

SR Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)

Penalties

MR –1 A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become “follow through” marks. MR is not applied when the candidate misreads his own figures – this is regarded as an error in accuracy. An MR –2 penalty may be applied in particular cases if agreed at the coordination meeting.

PA –1 This is deducted from A or B marks in the case of premature approximation. The PA –1 penalty is usually discussed at the meeting.

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Question	Answer	Marks	Guidance
1(i)	<i>EITHER:</i> $\frac{\sum x}{30} - k = \frac{315}{30} = 10.5$	(M1)	Dividing 315 by ± 30 and + or – from 50.5 need both and no more
	$k = 5.5 - 10.5 = 40$	A1)	Correct answer from correct working
	<i>OR:</i> $\sum x = 50.5 \times 30 = 1515, 1515 - 30k = 315$	(M1)	Mult by 50.5 by 30 and + or – 315 and dividing by ± 30 need all these
	$k = 40$	A1)	Correct answer from correct working. 1200 gets M0
	Total:	2	
1(ii)	<i>EITHER:</i> $\text{var} = 4022/30 - 10.5^2 (= 23.817)$	(M1)	Subst in correct coded variance formula
	$\text{sd} = 4.88$	A1)	
	<i>OR:</i> $\sum x^2 - 2(40)\sum x + 30(40)^2 = 4022, \sum x^2 = 77222$ $\text{Var} = 77222/30 - 50.5^2 (= 23.817)$	(M1)	Expanding with $\pm 40\sum x$ and $\pm 30(40)^2$ seen
	$\text{sd} = 4.88$	A1)	
	Total:	2	

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Question	Answer	Marks	Guidance
2	$P(R) = 4/36 = 1/9$	M1	Attempt at $P(R)$ by probability space diag or listing more than half the options, must see a prob, just a list is not enough
	$P(T) = P(O, E) + P(E, O) = 1/4 + 1/4 = 1/2$ OR $P(R T) = 1/9$	M1	Attempt at $P(T)$ or $P(R T)$ involving more than half the options
	$P(R \cap T) = P(3, 4) + P(4, 3) = 2/36 = 1/18$ OR $P(R T) = 1/9$	B1	Value stated, not from $P(R) \times P(T)$ e.g. from probability space diagram
	As $P(R) \times P(T) = P(R \cap T)$ OR as $P(R T) = P(R)$	M1	Comparing product values with $P(R \cap T)$, or comparing $P(R T)$ with $P(R)$
	The events are independent.	A1	Correct conclusion must have all probs correct
	Total:	5	

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Question	Answer	Marks	Guidance
3(i)		M1	Correct shape i.e. 3 branches then 3 by 3 branches, labelled and clear annotation Condone omission of lines for first match result providing the probabilities are there.
		A1	All correct probs with fully correct shape and probs either fractions or decimals not 1.5/5 etc.
	Total:	2	

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Question	Answer	Marks	Guidance
3(ii)	$P(L_1 \text{ given } W_2) = \frac{P(L_1 \cap W_2)}{P(W_2)}$	M1	Attempt at $P(L_1 \cap W_2)$ as a two-factor prod only as num or denom of a fraction
	$= \frac{1/5 \times 3/10}{3/5 \times 7/10 + 1/5 \times 1/3 + 1/5 \times 3/10}$	M1	Attempt at $P(W_2)$ as sum of appropriate 3 two-factor probs OE seen anywhere
		A1	Unsimplified correct $P(W_2)$ num or denom of a fraction
	$= \frac{3/50}{41/75} = 9/82 (0.110)$	A1	
	Total:	4	

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Question	Answer	Marks	Guidance
4(i)	fd 16, 14, 11, 505, 2.5	M1	Attempt at fd (must be at least 3 freq/cw) – may be implied by graph
		A1	Correct heights seen on graph i.e. must see a gap for fd = 2.5 etc.
		B1	Correct end points of bars and correct widths
		B1	labels fd, sec. Time can be optional. Linear axes, condone $0 \leq t < 20$ etc.
	Total:	4	

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Question	Answer	Marks	Guidance
4(ii)	$(10 \times 320 + 30 \times 280 + 50 \times 220 + 80 \times 220 + 120 \times 100) / 1140$	M1	using $\Sigma fx / n$ with mid-point attempt ± 0.5 , not ends not class widths
	$= 45.8$	A1	
	Total:	2	
5(i)	$p = 0.07$	B1	
	$P(2) = {}^{20}C_2 (0.07)^2 (0.93)^{18}$	M1	Bin term ${}^{20}C_x p^x (1-p)^{20-x}$ their p
	$= 0.252$	A1	
	Total:	3	
5(ii)	$P(\text{at least 1 cracked egg}) = 1 - (0.93)^{20} = 1 - 0.2342$	M1	Attempt to find $P(\text{at least 1 cracked egg})$ with their p from (i) allow $1 - P(0, 1)$ OE
	$= 0.766$	A1	Rounding to 0.766
	Total:	2	
5(iii)	$(0.7658)^n < 0.01$	M1	Eqn or inequal containing (their 0.766) ⁿ or (their 0.234) ⁿ , together with 0.01 or 0.99
	$n = 18$	A1	
	Total:	2	

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Question	Answer	Marks	Guidance
6(a)(i)	$z = 0.674$	B1	rounding to ± 0.674 or 0.675
	$0.674 = \frac{6.8 - \mu}{0.25\mu}$	M1	standardising, no cc, no sq rt, no sq, σ may still be present on RHS
		M1	subst and sensible solving for μ must collect terms, no z -value needed can be 0.75 or 0.7734 need a value for μ
	$\mu = 5.82$	A1	
	Total:	4	
6(a)(ii)	$P(X < 4.7) = P\left(z < \frac{4.7 - 5.819}{1.4548}\right)$	M1	$\pm$ standardising no cc, no sq rt, no sq unless penalised in (a)(i)
	$= \Phi(-0.769) = 1 - 0.7791$	M1	correct side for their mean i.e. $1 - \Phi$ (final solution)
	$= 0.221$	A1	
	Total:	3	
6(b)	$P(< 15.75) = P\left(z < \frac{15.75 - 16}{0.2}\right) = 1 - P(z < 1.25) = 1 - 0.8944 = 0.1056$ and $P(> 16.25) = 0.1056$ by sym	*M1	Standardising for 15.75 or 16.25 no cc no sq no sq rt unless penalised in (a)(i) or (a)(ii)
	$P(\text{usable}) = 1 - 0.2112 = 0.7888$	B1	$2\Phi - 1$ OE for required prob, (final solution)
	Usable rods $= 1000 \times 0.7888 =$	DM1	Mult their prob by 1000 dep on recognisable attempt to standardise
	788 or 789	A1	
	Total:	4	

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Question	Answer	Marks	Guidance
7(a)	<i>EITHER:</i> e.g. xxxxx = 5! for the other children	(B1)	5! OE seen alone or mult by integer $k \geq 1$, no addition
	Put y in 6 ways, then 5 then 4 for the youngest children	B1	Mult by 6P3 OE
	Answer $5! \times 6P3 = 14400$	B1)	Correct answer
	<i>OR:</i> total – 3 tog – 2 tog = $8! - 6!3! - 6! \times 2 \times 5 \times 3 = 14400$	(B1)	$8! - 6! \times k \geq 1$ seen
		B1	$6!3!$ or $6! \times 2 \times 5 \times 3$ seen subtracted
		B1)	Correct answer
	Total:	3	
7(b)	$\begin{array}{ccccc} D & W & M & & \\ 2 & 2 & 1 & = & 6C2 \times 4C2 \times 1 = 90 \end{array}$	B1	One correct unsimplified option
	$\begin{array}{ccccc} 3 & 1 & 1 & = & 6C3 \times 4 \times 1 = 80 \end{array}$	M1	Summing 2 or more 3-factor options which can contain perms or 3 factors added. The 1 can be implied
	$\begin{array}{ccccc} 1 & 3 & 1 & = & 6 \times 4C3 \times 1 = 24 \end{array}$	M1	Summing the correct 3 unsimplified outcomes only
	Total=194 ways	A1	
	Total:	4	

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Question	Answer	Marks	Guidance
7(c)	$\begin{array}{ccccc} C & D & S & & \\ 2 & 1 & 1 & = & {}^{26}C_2 \times 9 \times 5 \times 4! & = & 351\,000 \end{array}$	M1	summing 2 or more options of the form (2 1 1), (1 2 1), (1 1 2), can have perms, can be added
	$\begin{array}{ccccc} 1 & 2 & 1 & = & 26 \times {}^9C_2 \times 5 \times 4! & = & 112\,320 \end{array}$	M1	4 relevant products seen excluding 4! e.g. $26 \times 9 \times 8 \times 5$ or $26 \times {}^9P_2 \times 5$ for 2nd outcome, condone $26 \times 9 \times 5 \times 37$ as being relevant
	$\begin{array}{ccccc} 1 & 1 & 2 & = & 26 \times 9 \times {}^5C_2 \times 4! & = & 56\,160 \end{array}$	M1	mult all terms by 4! or 4!/2!
	Total = 519 480	A1	
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1(i)	$4 \times 5.5 + 3x + 90 = 8 \times 29$	M1	An expression to work out total cost of individual items = $8 \times$ mean, x may be implied.
	$112 + 3x = 232$ $x = 40$	A1	Correct complete unsimplified expression / calculation
	(Cost = \$)40	A1	Units not required
	Total:	3	
1(ii)	sd = 0 so all cost the same	M1	Must see comment interpreting sd = 0, OE
	shirts cost $4 \times \$26 = \$104$ AG	A1	See $4 \times \$26$, \$130 – \$26 OE. Must have a final value of \$104 stated
	Total:	2	
2(i)	med = 3.2	B1	Accept 3.2 ± 0.05
	$UQ = 3.65 \leq uq \leq 3.7$ $LQ = 2.55 \leq lq \leq 2.6$	M1	UQ – LQ, UQ greater than <i>their</i> ‘median’, LQ less than <i>their</i> ‘median’
	$IQR = 1.05 \leq iqr \leq 1.15$	A1	Correct answer from both LQ and UQ in given ranges
	Total:	3	
2(ii)	$134 - 24 = 110$	B1	Accept $108 \leq n \leq 112$, n an integer
	Total:	1	

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Question	Answer	Marks	Guidance										
2(iii)	$200 - 12 = 188$ less than length l	M1	188 seen, can be implied by answer in range, mark on graph.										
	$l = 4.5$ cm	A1	Correct answer accept $4.4 \leq l \leq 4.5$										
	Total:	2											
3(i)	$k(-2)^2$ is the same as $k(2)^2 = 4k$	B1	need to see $-2^2 k$, $2^2 k$ and $4k$, algebraically correct expressions OE										
	Total:	1											
3(ii)	<table border="1"><tr><td>x</td><td>-2</td><td>-1</td><td>2</td><td>4</td></tr><tr><td>Prob</td><td>$4k$</td><td>k</td><td>$4k$</td><td>$16k$</td></tr></table>	x	-2	-1	2	4	Prob	$4k$	k	$4k$	$16k$	B1	$-2, -1, 2, 4$ only seen in a table, together with at least one attempted probability involving k
	x	-2	-1	2	4								
	Prob	$4k$	k	$4k$	$16k$								
	$4k + k + 4k + 16k = 1$	M1	Summing 4 probs equating to 1. Must all be positive (table not required)										
	$k = 1/25$ (0.04)	A1	CWO										
Total:	3												
3(iii)	$E(X) = -8k + -k + 8k + 64k = 63k$	M1	using Σpx unsimplified. FT their k substituted before this stage, no inappropriate dividing										
	$= 63/25$ (2.52)	A1											
	Total:	2											

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Question	Answer	Marks	Guidance
4	$P(\text{score is } 6) = P(3, 3)$	M1	Realising that score 6 is only $P(3, 3)$
	$= r^2 = 1/36$ $r = 1/6$	A1	Correct ans [SR B2 $r = 1/6$ without workings]
	$P(2, 3) + P(3, 2) = 1/9$ $qr + rq = 1/9$	M1	Eqn involving qr (OE) equated to $1/9$ (r may be replaced by <i>their</i> 'r value')
	$q/6 + q/6 = 1/9$	M1	Correct equation with <i>their</i> 'r value' substituted
	$q = 1/3$	A1	Correct answer seen, does not imply previous M's
	$p = 1 - 1/6 - 1/3 = 1/2$	B1 FT	FT their p + their r + their $q = 1$, $0 < p < 1$
	Total:	6	
5(i)	$(z =) \frac{4.2 - 3.9}{\sigma}$	M1	Standardising, not square root of σ , not σ^2
	$z = 0.916$ or 0.915	B1	Accept $0.915 \leq \pm z \leq 0.916$ seen
	$\sigma = 0.328$	A1	Correct final answer (allow 20/61 or 75/229)
	Total:	3	

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Question	Answer	Marks	Guidance
5(ii)	$z = 4.4 - 3.9/\text{their } 0.328$ or $z = 3.4 - 3.9/\text{their } 0.328$ $= 1.5267$ $= -1.5267$	M1	Standardising attempt with 3.4 or 4.4 only, allow square root of σ , or σ^2
	$\Phi = 0.9364$	A1	$0.936 \leq \Phi \leq 0.937$ or $0.063 \leq \Phi \leq 0.064$ seen
	$\text{Prob} = 2\Phi - 1 = 2(0.9364) - 1$	M1	Correct area $2\Phi - 1$ OE i.e. $\Phi = -(1 - \Phi)$, linked to final solution
	$= 0.873$	A1	Correct final answer from $0.9363 \leq \Phi \leq 0.9365$
	Total:	4	
5(iii)	dividing (0.5) by a larger number gives a smaller z -value or more spread out as sd larger or use of diagrams	*B1	No calculations or calculated values present e.g. $(\sigma =)0.656$ seen Reference to spread or z value required
	Prob is less than that in (ii)	DB1	Dependent upon first B1
	Total:	2	
6(i)	<i>EITHER</i> : Route 1 $A \text{*****} A$ in $9! / 2!2!5! = 756$ ways	(*M1)	<i>Considering AA and BB options with values</i>
	$B \text{*****} B$ in $9! / 4!5! = 126$ ways	A1	Any one option correct
	$756 + 126$	DM1	<i>Summing their AA and BB outcomes only</i>
	Total = 882 ways	A1)	

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Question	Answer	Marks	Guidance
	<i>ORI: Route 2</i> <i>A*****A in ${}^9C_5 \times {}^4C_2 = 756$ ways</i>	(M1)	<i>Considering AA and BB options with values</i>
	<i>B*****B in ${}^9C_4 \times {}^5C_5 = 126$ ways</i>	A1	Any one option correct
	756 + 126	DM1	<i>Summing their AA and BB outcomes only</i>
	Total = 882	A1)	
	Total:	4	

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Question	Answer	Marks	Guidance
6(ii)	<i>EITHER:</i> (The subtraction method) As together, no restrictions $8! / 2!5! = 168$	(*M1)	Considering all As together – 8! seen alone or as numerator – condone $\times 4!$ for thinking A's not identical
	As together and Bs together $7! / 5! = 42$	M1	Considering all As together and all Bs together – 7! seen alone or numerator
		M1	Removing repeated Bs or Cs – Dividing by 5! either expression or 2! 1st expression only – OE
	Total $168 - 42$	DM1	Subt their 42 from their 168 (dependent upon first M being awarded)
	$= 126$	A1)	
	<i>OR1:</i> As together, no restrictions ${}^8C_5 \times {}^3C_1 = 168$	(*M1)	${}^8C_5$ seen alone or multiplied
		M1	${}^7C_5$ seen alone or multiplied
	As together and Bs together ${}^7C_5 \times {}^2C_1 = 42$	M1	First expression $\times {}^3C_1$ or second expression $\times {}^2C_1$
	Total $168 - 42$	DM1	Subt their 42 from their 168 (dependent upon first M being awarded)
	$= 126$	A1)	
	<i>OR2:</i> (The intersperse method)	(M1)	Considering all “As together” with Cs – Mult by 6!
	(AAAA)CCCCC then intersperse B and another B	M1	Removing repeated Cs – Dividing by 5!– [Mult by 6 implies M2]
		*M1	Considering positions for Bs – Mult by 7P2 oe –

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Question	Answer	Marks	Guidance
	$\frac{6!}{5!} \times 7 \times 6 \div 2$	DM1	Dividing by 2! Oe – removing repeated Bs (dependent upon 3rd M being awarded)
	= 126	A1)	
	Total:	5	
7(i)	$P(H) = P(BH) + P(SH) = 0.6 \times 0.05 + 0.4 \times 0.75$	M1	Summing two 2-factor probs using 0.6 with 0.05 or 0.95, and 0.4 with 0.75 or 0.25
	= 0.330 or $\frac{33}{100}$	A1	Correct final answer accept 0.33
	Total:	2	
7(ii)	$P(S H) = \frac{P(S \cap H)}{P(H)} = \frac{0.4 \times 0.75}{0.33} = \frac{0.3}{0.33}$	M1 FT	Their $\frac{P(S \cap H)}{P(H)}$ unsimplified, FT from (i)
	= $\frac{10}{11}$ or 0.909	A1	
	Total:	2	
7(iii)	Var (B) = $45 \times 0.6 \times 0.4$ Var (S) = $45 \times 0.4 \times 0.6$	B1	One variance stated unsimplified
	Variances same	B1	Second variance stated unsimplified and at least one variance clearly identified, and both evaluated <i>or</i> showing equal <i>or</i> conclusion made SR B1 – Standard Deviation calculated Fulfil all the criteria for the variance method but calculated to Standard Deviation
	Total:	2	

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Question	Answer	Marks	Guidance
7(iv)	$1 - P(0, 1)$ $= 1 - [(0.6)^{10} + {}^{10}C_1(0.4)(0.6)^9] = 1 - 0.0464$ OR $P(2, 3, 4, 5, 6, 7, 8, 9, 10)$ $= {}^{10}C_2(0.4)^2(0.6)^8 + \dots + {}^{10}C_9(0.4)^9(0.6) + (0.4)^{10}$	M1 M1	Bin term ${}^{10}C_x p^x (1-p)^{10-x}$ $0 < p < 1$ Correct unsimplified answer
	$= 0.954$	A1	
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Mark Scheme Notes

Marks are of the following three types:

M Method mark, awarded for a valid method applied to the problem. Method marks are not 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. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

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).

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

- When a part of a question has two or more “method” steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly when there are several B marks allocated. The notation DM or DB (or dep*) is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.
- The symbol FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only. A and B marks are not given for fortuitously “correct” answers or results obtained from incorrect working.
- Note: B2 or A2 means that the candidate can earn 2 or 0.
B2/1/0 means that the candidate can earn anything from 0 to 2.

The marks indicated in the scheme may not be subdivided. If there is genuine doubt whether a candidate has earned a mark, allow the candidate the benefit of the doubt. Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored.

- Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.
- For a numerical answer, allow the A or B mark if a value is obtained which is correct to 3 s.f., or which would be correct to 3 s.f. if rounded (1 d.p. in the case of an angle). As stated above, an A or B mark is not given if a correct numerical answer arises fortuitously from incorrect working. For Mechanics questions, allow A or B marks for correct answers which arise from taking g equal to 9.8 or 9.81 instead of 10.

The following abbreviations may be used in a mark scheme or used on the scripts:

AEF/OE Any Equivalent Form (of answer is equally acceptable) / Or Equivalent

AG Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)

CAO Correct Answer Only (emphasising that no “follow through” from a previous error is allowed)

CWO Correct Working Only – often written by a ‘fortuitous’ answer

ISW Ignore Subsequent Working

SOI Seen or implied

SR Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)

Penalties

MR –1 A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become “follow through” marks. MR is not applied when the candidate misreads his own figures – this is regarded as an error in accuracy. An MR –2 penalty may be applied in particular cases if agreed at the coordination meeting.

PA –1 This is deducted from A or B marks in the case of premature approximation. The PA –1 penalty is usually discussed at the meeting.

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Question	Answer	Marks	Guidance
1	$P(6) = 0.3$	B1	SOI
	$P(\text{sum is } 9) = P(3, 6) + P(4, 5) + P(5, 4) + P(6, 3)$	M1	Identifying the four ways of summing to 9 (3,6), (6,3) (4,5) and (5,4)
	$= (0.03 + 0.02) \times 2$	M1	Mult 2 probs together to find one correct prob of (3,6), (6,3) (4,5) or (5,4) unsimplified
	$= 0.1$	A1	OE
	Total:	4	
2	$np = 270 \times 1/3 = 90, npq = 270 \times 1/3 \times 2/3 = 60$	B1	Correct unsimplified np and npq , SOI
	$P(x > 100) = P\left(z > \frac{99.5 - 90}{\sqrt{60}}\right) = P(z > 1.2264)$	M1 M1	$\pm$ Standardising using 100 need sq rt Continuity correction, 99.5 or 100.5 used
	$= 1 - 0.8899$	M1	Correct area $1 - \Phi$ implied by final prob. < 0.5
	$= 0.110$	A1	
	Total:	5	
3(i)	$P(S) = 0.65 \times 0.6 + 0.35 \times 0.75$	M1	Summing two 2-factor probs or $1 - (\text{sum of two 2-factor probs})$
	$= 0.653 \text{ (261/400)}$	A1	
	Total:	2	

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Question	Answer	Marks	Guidance
3(ii)	$P(Std L) = \frac{P(Std \cap L)}{P(L)} = \frac{0.35 \times 0.25}{1 - 0.6525} = 0.0875/0.3475$	M1	'P(Std)' × 'P(L/Std)' as num of a fraction. Could be from tree diagram in 3(i).
		M1	Denominator (1 - their (i)) or their (i) or 0.65×0.4 (or 0.6) + 0.35×0.25 (or 0.75) = $0.26 + 0.0875$ or P(L) from their tree diagram
	= 0.252 (35/139)	A1	
	Total:	3	
4(a)	$P(x > 0) = P\left(z > \pm \frac{0 - \mu}{\sigma}\right)$ $= P\left(z > \frac{-\mu}{\mu/1.5}\right) \text{ or } P\left(z > \frac{-1.5\sigma}{\sigma}\right)$	M1	±Standardising, in terms of μ and/or σ with 0 - in numerator, no continuity correction, no $\sqrt{}$
	= P($z > -1.5$)	A1	Obtaining z value of ±1.5 by eliminating μ and σ , SOI
	= 0.933	A1	
	Total:	3	
4(b)	$z = -1.151$	B1	± z value rounding to 1.1 or 1.2
	$-1.151 = \frac{70 - 120}{s}$	M1	± Standardising (using 70) equated to a z-value, no cc, no squaring, no $\sqrt{}$
	$\sigma = 43.4$ or 43.5	A1	
	Totals:	3	

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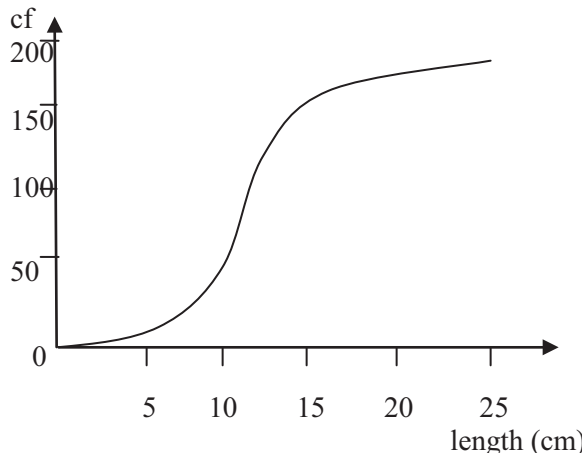
Question	Answer	Marks	Guidance
5(i)	constant probability (of completing)	B1	Any one condition of these two
	independent trials/events	B1	The other condition
	Totals:	2	
5(ii)	$P(5, 6, 7) = {}^7C_5(0.7)^5(0.3)^2 + {}^7C_6(0.7)^6(0.3)^1 + (0.7)^7$	M1 A1	Bin term ${}^7C_x(0.7)^x(0.3)^{7-x}$, $x \neq 0, 7$ Correct unsimplified answer (sum) OE
	$= 0.647$	A1	
	Total:	3	
5(iii)	$P(0, 1, 2, 3, 4) = 1 - \text{their '0.6471'} = 0.3529$	M1	Find $P(\leq 4)$ either by subtracting their (ii) from 1 or from adding Probs of 0,1,2,3,4 with $n=7$ (or 10) and $p = 0.7$
	$P(3) = {}^{10}C_3(0.3529)^3(0.6471)^7$	M1	${}^{10}C_3$ (their 0.353) ³ (1 – their 0.353) ⁷ on its own
	$= 0.251$	A1	
6(a)(i)	First digit in 2 ways. $2 \times 4 \times 3 \times 2$ or $2 \times 4P3$	M1	1, 2 or $3 \times 4P3$ OE as final answer
	Total = 48 ways	A1	
	Total:	2	
6(a)(ii)	$2 \times 5 \times 5 \times 3$	M1 M1	Seeing 5^2 mult; this mark is for correctly considering the middle two digits with replacement Mult by 6; this mark is for correctly considering the first and last digits
	$= 150$ ways	A1	
	Totals:	3	

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Question	Answer	Marks	Guidance
6(b)(i)	OO**** in ${}^{18}C_4$ ways	M1	${}^{18}C_x$ or the sum of five 2-factor products with $n = 14$ and 4, may be $\times$ by 2C2: $4C0 \times 14C4 + 4C1 \times 14C3 + 4C2 \times 14C2 + 4C3 \times 14C1 + 4C4$ ($\times 14C0$)
	= 3060	A1	
	Totals:	2	

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Question	Answer	Marks	Guidance																																																							
6(b)(ii)	<table><tr><td>Choc</td><td colspan="2">Not Choc</td></tr><tr><td>0</td><td colspan="2">$6 = 1 \times {}^{16}C_6 = 8008$ 0.2066</td></tr><tr><td>1</td><td colspan="2">$5 = {}^4C_1 \times {}^{16}C_5 = 17472$ 0.4508</td></tr><tr><td>2</td><td colspan="2">$4 = {}^4C_2 \times {}^{16}C_4 = 10920$ 0.2817</td></tr><tr><td>OR</td><td></td><td></td></tr><tr><td></td><td>Choc</td><td>Oats</td><td>Ginger</td></tr><tr><td></td><td>0</td><td>0</td><td>6</td></tr><tr><td></td><td>0</td><td>1</td><td>5</td></tr><tr><td></td><td>0</td><td>2</td><td>4</td></tr><tr><td></td><td>1</td><td>0</td><td>5</td></tr><tr><td></td><td>1</td><td>1</td><td>4</td></tr><tr><td></td><td>1</td><td>2</td><td>3</td></tr><tr><td></td><td>2</td><td>0</td><td>4</td></tr><tr><td></td><td>2</td><td>1</td><td>3</td></tr><tr><td></td><td>2</td><td>2</td><td>2</td></tr></table>	Choc	Not Choc		0	$6 = 1 \times {}^{16}C_6 = 8008$ 0.2066		1	$5 = {}^4C_1 \times {}^{16}C_5 = 17472$ 0.4508		2	$4 = {}^4C_2 \times {}^{16}C_4 = 10920$ 0.2817		OR				Choc	Oats	Ginger		0	0	6		0	1	5		0	2	4		1	0	5		1	1	4		1	2	3		2	0	4		2	1	3		2	2	2	B1	The correct number of ways with one of 0, 1 or 2 chocs , unsimplified or any three correct number of ways of combining choc/oat/ginger, unsimplified
	Choc	Not Choc																																																								
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	Total = 36400 ways	M1	sum the number of ways with 0, 1 and 2 chocs and two must be totally correct, unsimplified OR sum the nine combinations of choc, ginger, oats, six must be totally correct, unsimplified																																																							
	Probability = $36400/{}^{20}C_6$	M1	dividing by ${}^{20}C_6$ (38760) oe																																																							
	= 0.939 (910/969)	A1																																																								
	Totals:	4																																																								
7(i)	freq = fd × cw 10, 40, 120, 30	M1 A1	Attempt to multiply at least 3 fds by their ‘class widths’																																																							
	Totals:	2																																																								

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7(ii)	<table><tr><td>length</td><td>< 5</td><td>< 10</td><td>< 20</td><td>< 25</td></tr><tr><td>cf</td><td>10</td><td>50</td><td>170</td><td>200</td></tr></table> 	length	< 5	< 10	< 20	< 25	cf	10	50	170	200	B1 B1 M1 A1	3 or more correct cfs heights on graph 10, 50, 170, 200 Labels correct cf and length(cm), linear scales from zero (allow 0.5 on horizontal axis) Attempt (at least three) at plotting at upper end points (either 5 or 5.5, 10 or 10.5 etc.) Starting at (0, 0) polygon or smooth curve increasing with plotted points at lengths 5, 10, 20 and 25
	length	< 5	< 10	< 20	< 25								
cf	10	50	170	200									
Totals:	4												
7(iii)	median = 14.2	B1	Median (accept 13.2 – 15.2)										
	‘18.5’ – ‘10’	M1	Subt their LQ from their UQ if reasonable from their graph										
	IQ range = 8.5	A1FT	Correct FT using LQ = 10 and UQ between 17.5 and 19.5										
	Totals:	3											
7(iv)	mean = $(2.5 \times 10 + 7.5 \times 40 + 15 \times 120 + 22.5 \times 30) / 200$	M1	Using mid points (± 0.5) and their frequencies from 7(i) in correct formula										
	= 14	A1											
	Totals:	2											