
MATHEMATICS

9709/61

Paper 6

October/November 2017

MARK SCHEME

Maximum Mark: 50

Published

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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

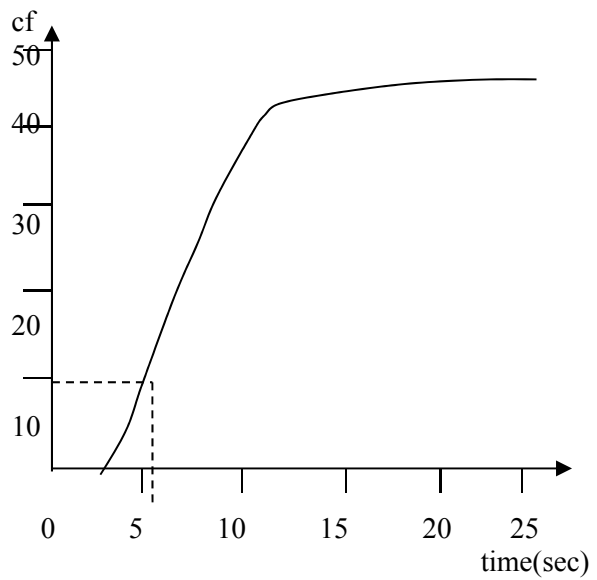
SR Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)

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.

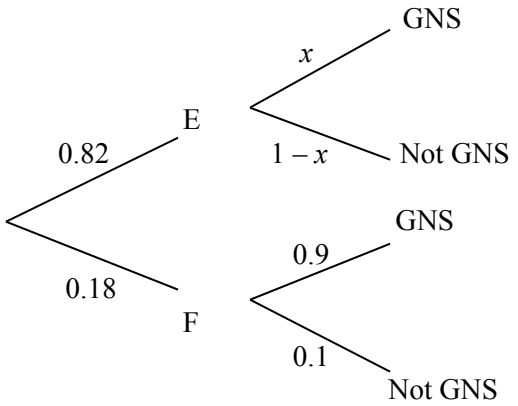
Question	Answer	Marks	Guidance
1	$p + q = 0.45$	M1	Equation involving $\Sigma P(x) = 1$
	$0.15 + 2p + 1.2 + 6q = 3.05$	M1	Equation using $E(X) = 3.05$
	$q = 0.2$	M1	Solving simultaneous equations to one variable
	$p = 0.25$	A1	Both answers correct
		4	

Question	Answer	Marks	Guidance
2(i)	Points (5.5,10), (8.5,25), (11.5,42), (16.5,46), (25.5,48)	B1	Correct cfs values seen listed, in or by table or on graph, 0 not required
		B1	Axes labelled “cumulative frequency” (or cf) and “time [or t etc.] (in) seconds (or sec etc.)”. Linear scales – cf 0–48, time 2.5 – 25.5 (ignore <2.5 on time.) At least 3 values stated on each axis, but (0,0) can be implied without stating.
		B1	All points plotted accurately, (5, 10) etc. scores B0 . Curve or line segments drawn starting at (5.5,10) and passing within ‘1 scale unit’ vertically and horizontally of plotted points
		3	

Question	Answer	Marks	Guidance
2(ii)	$48 - 35 = 13$ $t = 6.5 \text{ sec}$	M1	Subt 35 (checked ± 1 mm on graph) from 48 or 50,
		A1	$6 \leq \text{Ans} \leq 7$
		2	

Question	Answer	Marks	Guidance
3(i)	$p = 0.207$	B1	
		1	
3(ii)	$\text{Var} = 30 \times 0.207 \times 0.793 = 4.92$	B1	
		1	
3(iii)	$P(\geq 2) = 1 - P(0, 1)$	M1	
	$= 1 - (0.793)^{15} - \binom{15}{1}(0.207)(0.793)^{14}$	M1	$1 - P(0, 1)$ seen $n = 15$ $p = \text{any prob}$
	$= 0.848$	A1	
		3	

Question	Answer	Marks	Guidance
4(i)	$\frac{(48.7 \times 12 + 38.1 \times 7)}{19}$	M1	Accept unsimplified (may be separate calculations)
	$= 44.8$	A1	
		2	
4(ii)	$7.65^2 = \frac{\Sigma x^2}{12} - 48.7^2 \quad \Sigma x^2 = 29162.55$	M1	Substitution in one correct variance formula
	$4.2^2 = \frac{\Sigma y^2}{7} - 38.1^2 \quad \Sigma y^2 = 10284.75$	A1	One Σx^2 or Σy^2 correct (can be rounded to 4sf)
	Combined var = $\frac{(29162.55 + 10284.75)}{19} - 44.79^2$ $= \frac{39447.3}{19} - 44.79^2$	M1	Using their Σx^2 and Σy^2 and their 4(i) in the variance formula
	Combined $\sigma = 8.37$ or 8.36	A1	
		4	

Question	Answer	Marks	Guidance
5(i)		B1	Must see at least 4 probs correct including one with an x in, correct shape
		B1	Shape, clear labels/annotation and all probs correct
		2	
5(ii)	$0.82x + 0.18 \times 0.9 = 0.285$	M1	Eqn with x in , two 2-factors on one side
	$x = 0.15$	A1	
		2	
5(iii)	$P(E \text{notGNS}) = \frac{P(E \cap \text{notGNS})}{P(\text{notGNS})}$	M1	Attempt at $P(E \cap \text{not GNS})$ seen as num or denom of fraction
		M1	Attempt at $P(\text{not GNS})$ seen anywhere
	$= \frac{0.82 \times 0.85}{1 - 0.285} = 0.975$	A1	Correct answer
		3	

Question	Answer	Marks	Guidance
6(a)(i)	${}^{40}P_5$	M1	${}^{40}P_x$ or ${}^nP_5$ oe seen, can be mult by $k \geq 1$
	$= 78\,960\,960$	A1	
		2	
6(a)(ii)	not front row e.g. WEJ** in $3 \times 3! = 18$ ways	B1	$3!$ seen mult by $k \geq 1$
	7 rows in $7 \times 18 = 126$ ways	B1	mult by 7
	front row: e.g. *MA** in $4 \times 2 = 8$ ways	M1	attempt at front row arrangements and multiplying by the 7 other rows arrangements, need not be correct
	Total $126 \times 8 = 1008$	A1	
		4	
6(b)	<i>EITHER:</i> e.g. *R** in ${}^8C_3$ ways = 56 ways *L** in ${}^8C_3 = 56$ ways	(M1)	Considering either R or L only in team
	**** in ${}^8C_4 = 70$ ways	M1*	Considering neither in team
		DM1	summing 3 scenarios
	Total 182 ways	A1)	
	<i>OR I:</i> No restrictions ${}^{10}C_4 = 210$ ways	(M1)	${}^{10}C_4 -$, Considering no restrictions with subtraction
	RL = ${}^8C_2 = 28$	M1*	Considering both in team
	$210 - 28$	DM1	subt
	$= 182$ ways	A1)	

Question	Answer	Marks	Guidance
6(b)	OR2: R out in ${}^9C_4 = 126$ ways L out in ${}^9C_4 = 126$ ways	(M1)	Considering either R out or L out
	Both out in ${}^8C_4 = 70$	M1*	Considering both out
		DM1	Summing 2 scenarios and subtracting 1 scenario
	$126 + 126 - 70 = 182$ ways.	A1)	
		4	

Question	Answer	Marks	Guidance
7(i)	$P(< 570) = P\left(z < \frac{570 - 500}{91.5}\right) = P(z < 0.7650)$ $= 0.7779$	M1	Standardising for either 570 or 390, no cc, no sq, no $\sqrt{}$
	$P(< 390) = P\left(z < \frac{390 - 500}{91.5}\right) = P(z < -1.202)$	A1	One correct z value
	$= 1 - 0.8853 = 0.1147$	A1	One correct Φ , final solution
	Large: 0.222 (0.2221) Small: 0.115 (0.1147)	A1	Correct small and large
	Medium: 0.663 (0.6632)	A1FT	Correct Medium rounding to 0.66 or ft 1 – (their small + their large)
		5	

Question	Answer	Marks	Guidance
7(ii)	$1.645 = \left(\frac{x - 500}{91.5} \right)$	B1	± 1.645 seen (critical value)
		M1	Standardising accept cc, sq, sq rt
	$x = 651$	A1	$650 \leq \text{Ans} \leq 651$
		3	
7(iii)	$P(x > 610) = 0.1147$ (symmetry)	M1	Attempt to find upper end prob $x > 610$ or $\Phi(x)$, ft their $P(< 390)$ from (i)
	$0.3 + 0.1147 = 0.4147 \Rightarrow \Phi(x) = 0.5853$	M1	Adding 0.3 to <i>their</i> $P(x > 610)$ or subt 0.5 from $\Phi(x)$ or $0.8853 - 0.3$
	$z = 0.215$ or 0.216	M1	Finding $z = \Phi^{-1}(0.5853)$
	$0.215 = \frac{k - 500}{91.5}$	M1	Standardising and solving, accept cc, sq, sq rt
	$k = 520$	A1	
		5	

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Question	Answer	Marks	Guidance
1	<i>EITHER:</i> ($\Sigma x =$) $11.5n = 27 + 10n$	(M1)	Expanding brackets and forming a three term equation involving 27 and at least one term in n , without x
		M1	$10n$ or $11.5n$ seen in expression without x ($1.5n = 27$ implies M2)
	$n = 18$	A1)	
	<i>OR:</i> $11.5 = \frac{27}{n} + 10$	(M1)	Dividing coded sum by n and forming a three term equation involving 11.5 and at least one term in n , without x
		M1	$27/n$ seen in expression without x ($1.5 = \frac{27}{n}$ implies M2)
	$n = 18$	A1)	
		3	

Question	Answer	Marks	Guidance
2(i)	points (50, 14), (80, 62), (100, 132), (120, 140)	B1	Correct cfs values seen listed, in or by table or on graph, 0 not required
		B1	Axes labelled 'cumulative frequency' (or cf) and 'circumference [or cir or c etc.] (in) cm'. Linear scales – c.f. 0–140 circumference 40–120 (ignore <40 on circ.) At least 3 values stated on each axis, but (0,0) can be implied without stating.
		B1	All points plotted accurately
		3	
2(ii)	$140 - 54 = 86$	M1	Finding correct value from graph (checked ± 1 mm) or linear interpolation. Subtraction from 140 can be implied
	Percentage = 61.4%	A1	$60.5\% \leq \text{Ans} \leq 64.5\%$
		2	

Question	Answer	Marks	Guidance
3(i)	<i>EITHER:</i> $P(X=3) = P(RRB) = \frac{2}{6} \times \frac{1}{5} \times \frac{4}{4}$	(M1)	probabilities in order $\frac{2}{p} \times \frac{1}{q} \times \frac{4}{r}$, $p, q, r \leq 6$ and $p \geq q \geq r, r \geq 4$, accept $\times 1$ as $\frac{4}{r}$.
	$= \frac{1}{15}$ AG	A1)	Needs either P(RRB) OE stated or identified on tree diagram.
	<i>OR1:</i> $P(X=3) = P(RRB) = \frac{{}^2C_2}{{}^6C_2} \times \frac{{}^4C_1}{{}^4C_1}$	(M1)	probabilities stated clearly, $\times \frac{{}^4C_1}{{}^4C_1}$ or $\times 1$ or $\times \frac{4}{4}$ included
	$= \frac{1}{15}$ AG	A1)	Needs either P(RRB) OE stated or identified on tree diagram.
	<i>OR2:</i> $P(X=3) = P(RRB) = \frac{{}^2C_1}{{}^6C_1} \times \frac{{}^1C_1}{{}^5C_1} \times \frac{{}^4C_1}{{}^4C_1}$	(M1)	probabilities in order $\frac{{}^2C_1}{{}^6C_1} \times \frac{{}^1C_1}{{}^5C_1} \times \frac{{}^4C_1}{{}^4C_1}$ $p, q, r \leq 6$ and $p \geq q \geq r, r \geq 4$ $(\times \frac{{}^4C_1}{{}^4C_1} \text{ or } \times 1 \text{ or } \times \frac{4}{4} \text{ acceptable})$
	$= 1/15$ AG	A1)	Needs either P(RRB) OE stated or identified on tree diagram.
		2	

Question	Answer	Marks	Guidance								
3(ii)	$P(1) = P(B) = \frac{4}{6} \left(\frac{2}{3} = 0.667 \right)$ $P(2) = P(RB) = \frac{2}{6} \times \frac{4}{5} = \frac{4}{15} \text{ (= 0.267)}$ $P(3) = P(RRB) = \frac{2}{6} \times \frac{1}{5} \times \frac{4}{4} = \frac{1}{15} \text{ (= 0.0667)}$ <table border="1"><tr><td>x</td><td>1</td><td>2</td><td>3</td></tr><tr><td>P</td><td>$\frac{10}{15}$</td><td>$\frac{4}{15}$</td><td>$\frac{1}{15}$</td></tr></table>	x	1	2	3	P	$\frac{10}{15}$	$\frac{4}{15}$	$\frac{1}{15}$	B1	Probability distribution table drawn with at least 2 correct x values and at least 1 probability. All probabilities $0 \leq p < 1$.
		x	1	2	3						
		P	$\frac{10}{15}$	$\frac{4}{15}$	$\frac{1}{15}$						
	B1	P(1) or P(2) correct unsimplified, or better, and identified.									
B1	All probabilities in table, evaluated correctly OE. Additional x values must have a stated probability of 0										
		3									

Question	Answer	Marks	Guidance
4(i)	$P(4, 2H) = \frac{1}{4} \times {}^4C_2 \times \left(\frac{1}{3}\right)^2 \left(\frac{2}{3}\right)^2$	M1	Multiplying their 2H expression by $\frac{1}{4}$ [P(4)]
		M1	Remaining factor is $\left(\frac{1}{3}\right)^2 \left(\frac{2}{3}\right)^2$ [or $\frac{4}{81}$] multiplied by integer value $k \geq 1$ OE
	$= \frac{2}{27} \text{ (0.0741)}$	A1	
		3	
4(ii)	$P(3, 3H) = \frac{1}{4} \times \left(\frac{1}{3}\right)^3 = \frac{1}{108} \text{ (0.00926)}$	B1	
		1	
4(iii)	$P(1, 1H) = \frac{1}{4} \times \frac{1}{3} = \frac{1}{12} \text{ (0.08333)}$	M1	Correct expression for 1 of P(1, 1H), P(2, 2H), P(4, 4H) Unsimplified (or better)
	$P(2, 2H) = \frac{1}{4} \times \left(\frac{1}{3}\right)^2 = \frac{1}{36} \text{ (0.02778)}$	M1	Summing their values for 3 or 4 appropriate outcomes for the ‘game’ with no additional outcomes.
	$P(3, 3H) = \frac{1}{4} \times \left(\frac{1}{3}\right)^3 = \frac{1}{108} \text{ (0.009259)}$		
	$P(4, 4H) = \frac{1}{4} \times \left(\frac{1}{3}\right)^4 = \frac{1}{324} \text{ (0.003086)}$		
	$\text{Prob} = \frac{10}{81} \text{ (0.123)}$	A1	
		3	

Question	Answer	Marks	Guidance
5(i)	<i>EITHER:</i> $P(> 2) = 1 - P(0, 1, 2)$	(M1)	Binomial term of form ${}^{30}C_x p^x (1-p)^{30-x}$, $0 < p < 1$ any p
	$= 1 - (0.96)^{30} - {}^{30}C_1(0.04)(0.96)^{29} - {}^{30}C_2(0.04)^2(0.96)^{28}$ ($= 1 - 0.2938\dots - 0.3673\dots - 0.2219\dots$)	A1	Correct unsimplified answer
	$= 1 - 0.883103 = 0.117$ (0.116896)	A1)	
	<i>OR:</i> $P(> 2) = P(3, 4, 5, 6, \dots, 30)$	(M1)	Binomial term of form ${}^{30}C_x p^x (1-p)^{30-x}$, $0 < p < 1$ any p
	$= {}^{30}C_3(0.04)^3(0.96)^{27} + {}^{30}C_4(0.04)^4(0.96)^{26} + \dots + (0.04)^{30}$	A1	Correct unsimplified answer
	$= 0.117$	A1)	
		3	

Question	Answer	Marks	Guidance
5(ii)	$np = 280 \times 0.1169 = 32.73, npq = 280 \times 0.1169 \times 0.8831 = 28.9$	M1 FT	Correct unsimplified np and npq , FT their p from (i),
	$P(\geq 30) = P\left(z > \frac{29.5 - 32.73}{\sqrt{28.9}}\right) = P(z > -0.6008)$	M1	Substituting <i>their</i> μ and σ ($\sqrt{npq}$ only) into the Standardisation Formula
		M1	Using continuity correction of 29.5 or 30.5
		M1	Appropriate area Φ from standardisation formula $P(z > \dots)$ in final solution
	$= 0.726$	A1	
		5	

Question	Answer	Marks	Guidance
6(a)(i)	<i>EITHER:</i> 3**, 4**, 6**, 8**	(M1)	${}^5P_2$ or ${}^5C_2 \times 2!$ or 5×4 OE (considering final 2 digits)
	options $4 \times 5 \times 4 = 80$	M1	Mult by 4 or summing 4 options (considering first digit)
		A1)	Correct final answer
	<i>OR:</i> Total number of values: $6 \times 5 \times 4 = 120$	(M1)	Calculating total number of values (with subtraction seen)
	Number of values less than 300: $2 \times 5 \times 4 = 40$	M1	Calculating number of unwanted values
	Number of evens = $120 - 40 = 80$	A1)	Correct final answer
		3	

Question	Answer	Marks	Guidance
6(a)(ii)	3**, 4**, 6**, 8** <i>EITHER:</i> options $4 \times 6 \times 4$ (last)	(M1)	6 linked to considering middle digit e.g. multiplied or in list
		M1	Multiply an integer by 4×4 (condone $\times 16$) (No additional figures present for both M's to be awarded)
	= 96	A1)	
	OR: Total number of values $4 \times 6 \times 6 = 144$	(M1	Calculating total number of values (with subtraction seen)
	Number of odd values $4 \times 6 \times 2 = 48$	M1	Calculating number of unwanted values
	Number of evens = $144 - 48 = 96$	A1)	
		3	
6(b)(i)	252	B1	
		1	

Question	Answer	Marks	Guidance
6(b)(ii)	B (6)G(4)		
	5 0 in ${}^6C_5 (\times {}^4C_0) = 6 \times 1 = 6$ 4 1 in ${}^6C_4 \times {}^4C_1 = 15 \times 4 = 60$ 3 2 in ${}^6C_3 \times {}^4C_2 = 20 \times 6 = 120$	M1	Multiplying 2 combinations ${}^6C_q \times {}^4C_r$, $q + r = 5$, or ${}^6C_5$ seen alone
		M1	Summing 2 or 3 appropriate outcomes, involving perm/comb, no extra outcomes.
	Total = 186 ways	A1	
		3	

Question	Answer	Marks	Guidance
7(i)	$P(> 65) = P\left(z > \frac{65 - 61.4}{12.3}\right) = P(z > 0.2927)$	M1	Standardising no continuity correction, no square or square root, condone $\pm$ standardisation formula
		M1	Correct area (< 0.5)
	$= 1 - 0.6153 = 0.385$	A1	
		3	

Question	Answer	Marks	Guidance
7(ii)	$P(< 65) = 0.6153$ so $P(< k) = 0.25 + 0.6153 = 0.8653$	B1	
	$z = 1.105$	B1	$z = \pm 1.105$ seen or rounding to 1.1
	$1.105 = \frac{k - 61.4}{12.3}$	M1	standardising allow $\pm$, cc, sq rt, sq. Need to see use of tables backwards so must be a z -value, not $1 - z$ value.
	$k = 75.0$	A1	Answers which round to 75.0. Condone 75 if supported.
		4	
7(iii)	$2.326 = \frac{97.2 - \mu}{\sigma}$	B1	± 2.326 seen (Use of critical value)
	$-0.44 = \frac{55.2 - \mu}{\sigma}$	B1	± 0.44 seen
		M1	An equation with a z -value, μ , σ and 97.2 or 55.2, allow $\sqrt{\sigma}$ or σ^2
		M1	Algebraic elimination μ or σ from <i>their</i> two simultaneous equations
	$\mu = 61.9$ $\sigma = 15.2$	A1	both correct answers
		5	

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October/November 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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

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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.

Question	Answer	Marks	Guidance
1	<i>EITHER:</i> P(at least 1 completes) = $1 - P(0 \text{ people complete})$ = $1 - (0.8)^3$	(M1)	Fully correct unsimplified expression $1 - (0.8)^3$ OE
	$= 0.488 \left(\frac{61}{125} \right)$	A1)	
	<i>OR1:</i> $P(1, 2, 3) = {}^3C_1(0.2)(0.8)^2 + {}^3C_2(0.2)^2(0.8) + (0.2)^3$	(M1)	Unsimplified correct 3 term expression
	$= 0.488 \left(\frac{61}{125} \right)$	A1)	
	<i>OR2:</i> $0.2 + 0.8 \times 0.2 + 0.8 \times 0.8 \times 0.2$	(M1)	Unsimplified sum of 3 correct terms
	$= 0.488 \left(\frac{61}{125} \right)$	A1)	
		2	

Question	Answer	Marks	Guidance
2	$\Sigma(x - 45) = 1218 - 20 \times 45 = 318$	B1	
	$\frac{\Sigma(x - 45)^2}{20} - \left(\frac{\Sigma(x - 45)}{20} \right)^2 = 4.2^2$	M1	Fully correct substitution in the correct coded variance formula with their $\Sigma(x - 45)$ OR valid method for $\Sigma x^2 = 74\,529$ ($4.2^2 = \frac{\Sigma x^2}{20} - \left(\frac{1218}{20} \right)^2$) and expanding $\Sigma(x-45)^2$ correctly $= \Sigma x^2 - 90\Sigma x + 20 \times 45^2 = '74\,529' - 90 \times 1218 + 40\,500 = 5409$
	$\Sigma(x - 45)^2 = 5409$	A1	
		3	

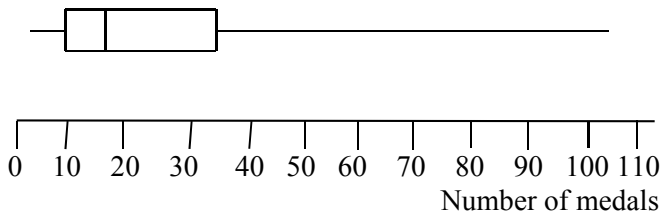
Question	Answer	Marks	Guidance
3(i)		M1	Correct shape
		A1	All correct labels and probabilities
		2	

Question	Answer	Marks	Guidance
3(ii)	$P(F P) = \frac{P(F \cap P)}{P(P)}$	M1	P(P) consistent with their tree diagram seen anywhere
	$= \frac{0.15 \times 0.65}{0.85 + 0.15 \times 0.65}$ or $\frac{0.15 \times 0.65}{1 - 0.15 \times 0.35}$	A1	Correct unsimplified P(P) seen as num or denom of a fraction
	$= \frac{0.0975}{0.9475}$	M1	P(F ∩ P) found as correct product or consistent with their tree diagram seen as num or denom of a fraction
	$= \frac{39}{379} = 0.103$	A1	
		4	

Question	Answer					Marks	Guidance
4(i)	x	−3	0	5	32	B1	At least 3 different correct values of X (can be unsimplified)
	Prob	1/6	1/2	1/6	1/6	B1	Four correct probabilities in a Probability Distribution table
						B1	Correct probs with correct values of X
						3	

Question	Answer	Marks	Guidance
4(ii)	$E(X) = -3/6 + 5/6 + 32/6 = 34/6 = 17/3 \text{ (5.67)}$	M1	Subst their attempts at scores in correct formula as long as ‘probs’ sum to 1
	$\text{Var}(X) = 9/6 + 25/6 + 1024/6 - (34/6)^2$	M1	Subst their attempts at scores in correct var formula
	$= 144 \left(\frac{1298}{9} \right)$	A1	Both answers correct
		3	

Question	Answer	Marks	Guidance
5(i)	<pre> 0 2 2 5 6 9 1 0 0 0 2 2 3 3 4 7 7 8 8 2 8 8 3 4 5 8 4 4 5 6 5 7 8 2 8 9 10 4 key 2 8 means 28 medals </pre>	B1	Stem, digits 5, 7, 9 can be missing here, can be upside down
		B1	All leaves in correct order increasing from stem, (5, 7 and 9 can be missing), condone commas
		B1	Reasonable shape, requires all values of the stem, only one line for each stem and leaves must be lined up. Can be upside down or sideways. No commas. Condone one 'leaf' error.
		B1	Correct key must state 'medals' or have 'medals' in leaf heading or title
		4	

Question	Answer	Marks	Guidance
5(ii)	Med = 17 LQ = 10 UQ = 35 	B1	Median correct
		B1	LQ and UQ correct
		B1	Uniform scale from 2 to 104 (need 3 identified points min) and label including medals (can be in title)
		B1 FT	Correct box med and quartiles on diagram, FT their values
		B1	Correct end-whiskers from ends of box but not through box
		5	

Question	Answer	Marks	Guidance
6(i)	${}^{18}P_5$	M1	${}^{18}P_x$ or ${}^yP_5$ OE seen, $0 < x < 18$ and $5 < y < 18$, can be mult by $k \geq 1$
	= 1 028 160	A1	
		2	

Question	Answer	Marks	Guidance
6(ii)	<i>EITHER:</i> e.g. *** (CCCC)***** in $5! \times 14$ ways	(B1)	$5!$ OE mult by $k \geq 1$, considering the arrangements of cars next to each other
	= 1680	B1	Mult by 14 OE, (or 14 on its own) considering positions within the line
	P (next to each other) = $1680/1\,028\,160$	M1	Dividing by (i) for probability
	P(not next to each other) = $1 - 1680/1\,028\,160$	M1	Subtracting prob from 1 (or their ' $5! \times 14$ ' from (i))
	$= 0.998 \left(\frac{611}{612} \right)$ OE	A1)	
	<i>OR1:</i> $\frac{5! \times 14!}{18!} = 0.001634$	(B1)	$5!$ OE mult by $k \geq 1$ (on its own or in numerator of fraction) considering the arrangements of cars next to each other
		B1	Multiply by $14!$, (or $14!$ on its own) considering all ways of arranging spaces with 5 cars together
		M1	Dividing by $18!$, total number of ways of arranging spaces
	$1 - 0.001634$	M1	Subtracting prob from 1 (or ' $5! \times 14!$ ' from $18!$)
	= 0.998(366)	A1)	
	<i>OR2:</i> 4 together – $2 \times 5! \times 14C12 = 21\,840$ 3, 1, 1 – $3 \times 5! \times 14C11 = 131\,040$ 3, 2 – $2 \times 5! \times 14C12 = 21\,840$ 2,2,1 – $3 \times 5! \times 14C11 = 131\,040$ 2,1,1,1 – $4 \times 5! \times 14C10 = 480\,480$ 1,1,1,1,1 – $5! \times 14C9$ or $14P5 = 240\,240$	(M1)	Listing the six correct scenarios (only): 4 together; 3 together and 2 separate; 3 together and 2 together; two sets of 2 together and 1 separate; 2 together and 3 separate; 5 separate.
		M1	Summing total of the six scenarios, at least 2 correct unsimplified

Question	Answer	Marks	Guidance
	Total = 1 026 480	A1	Total of 1 026 480
		M1	Dividing their 1 026 480 by their 6(i)
	$1\,026\,480 \div 1\,028\,160 = 0.998(366)$	A1)	
		5	

Question	Answer	Marks	Guidance
6(iii)	R(5) W(4) B(3)	B1	$5C1 \times 4C1 \times 3C1$ or better seen i.e. no. of ways with 3 different colours
	Scenarios No. of ways		
	1 1 1 $= 5 \times 4 \times 3 = 60$		
	0 1 2 $= 4 \times {}^3C_2 = 12$	M1	Any of ${}^5C_2$ or ${}^4C_2$ or ${}^3C_2$ seen multiplied by $k > 1$ (can be implied)
	0 2 1 $= {}^4C_2 \times 3 = 18$		
	1 0 2 $= 5 \times {}^3C_2 = 15$	A1	2 correct unsimplified 'no. of ways' other than $5C1 \times 4C1 \times 3C1$
	2 0 1 $= {}^5C_2 \times 3 = 30$		
	1 2 0 $= 5 \times {}^4C_2 = 30$	M1	Summing no more than 7 scenario totals containing at least 6 correct scenarios
	2 1 0 $= {}^5C_2 \times 4 = 40$		
	Total = 205	A1	
	OR		
	${}^{12}C_3 -$	M1	Seeing ' ${}^{12}C_3 -$ ', considering all selections of 3 cars
	$- {}^5C_3$	M1	Subt ${}^5C_3$ OE, removing only red selections
	$- {}^4C_3$	M1	Subt ${}^4C_3$ OE, removing only white selections
	$- {}^3C_3$	M1	Subt ${}^3C_3$ OE, removing only black selections
	= 205	A1	Correct answer
		5	

Question	Answer	Marks	Guidance
7(i)	$P(t > 6) = P\left(z > \frac{6-5.3}{2.1}\right) = P(z > 0.333)$	M1	Standardising, no continuity correction, no sq, no sq rt
	$= 1 - 0.6304$	M1	Correct area $1 - \Phi (< 0.5)$, final solution
	$= 0.370$ or 0.369	A1	
		3	
7(ii)	$z = 1.645$	B1	± 1.645
	$1.645 = \frac{x-5.3}{2.1}$	M1	Standardising, no continuity correction, allow sq, sq rt. Must be equated to a z-value
	$x = 8.75$ or 8.755 or 8.7545	A1	
		3	
7(iii)	$n = 10, p = 0.05$	M1	Bin term $^{10}C_x p^x (1-p)^{10-x}$
	$P(0, 1, 2) = (0.95)^{10} + ^{10}C_1(0.05)(0.95)^9 + ^{10}C_2(0.05)^2(0.95)^8$	M1	Correct unsimplified answer
	$= 0.988$ (0.9885 to 4 sf)	A1	
		3	
7(iv)	$P(\text{misses bus}) = P(t < 0)$	*M1	Seeing t linked to zero
	$= P\left(z < \frac{0-5.3}{2.1}\right) = P(z < -2.524) = 1 - \Phi(2.524)$	DM1	Standardising with $t = 0$, no continuity correction, no sq, no sq rt
	$= 1 - 0.9942$		
	$= 0.0058$	A1	
		3	