

**MARK SCHEME for the October/November 2010 question paper
for the guidance of teachers**

9709 MATHEMATICS

9709/61

Paper 6, maximum raw mark 50

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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 $\surd$ 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.

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AEF	Any Equivalent Form (of answer is equally acceptable)
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BOD	Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)
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
MR	Misread
PA	Premature Approximation (resulting in basically correct work that is insufficiently accurate)
SOS	See Other Solution (the candidate makes a better attempt at the same question)
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 $\sqrt{}$ " 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.
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1 mean = 18.2 $sd = \sqrt{876/50}$ $= 4.19$	B1 M1 A1 [3]	Correct unsimplified expression seen Correct answer
2 mean = $200 \times 2/15 (= 26.67) (80/3)$ variance = $200 \times 2/15 \times 13/15 (= 23.11)(208/9)$ $P(21 < X < 35) =$ $P\left(\frac{21.5 - 26.67}{\sqrt{23.11}} < z < \frac{34.5 - 26.67}{\sqrt{23.11}}\right)$ $= P(-1.075 < z < 1.629)$ $= 0.8589 + 0.9483 - 1$ $= 0.807$	B1 M1 M1 M1 A1 [5]	mean and variance correct standardising, $\pm$, with or without cc, must have sq rts continuity corrections 20.5 or 21.5, 34.5 or 35.5 $\Phi_1 + \Phi_2 - 1$ answer rounding to 0.807
3 (i) $P(X > 20) = P(z > -6.4/3.7)$ $= P(z > -1.730)$ $= 0.9582$ Number of students = 335 or 336	M1 A1 A1ft [3]	Standardising no cc no sq rt Prob rounding to 0.958 Correct answer ft their prob, must be integer
(ii) $P(\text{very slow}) = 0.05$ $P(0, 1, 2) =$ $(0.95)^8 + {}^8C_1(0.05)^1(0.95)^7 + {}^8C_2(0.05)^2(0.95)^6$ $= 0.6634 + 0.2793 + 0.0515$ $= 0.994$	B1 M1 M1 A1 [4]	0.05 or 0.95 seen Binomial term with ${}^8C_r p^r (1-p)^{8-r}$ seen any p Correct expression for $P(0, 1, 2)$, p close to 0.05 Answer rounding to 0.994
4 (i) $3 = 2x / 10$ $x = 15$ height = freq / class width $= x / 20 = 0.75 \text{ cm}$	M1 A1 M1 A1 [4]	Attempt at using freq density = freq / cw Correct answer Attempt at using fd = freq / cw with different cw from above Correct answer
(ii) mean wt = $(5.5 \times 30 + 15.5 \times 60 + 23 \times 45 + 28 \times 75 + 40.5 \times 60 + 60.5 \times 15) / 285$ $= 26.6 \text{ grams}$	M1 M1 A1 [3]	Using freqs or frequency ratios and mid-points, attempt not ucb, not cw (can do it without x) Correct unsimplified answer can have fr ratios Correct answer

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5	(i)	<table><tr><td></td><td><i>A</i></td><td><i>B</i></td><td><i>C</i></td><td><i>D</i></td></tr><tr><td>Rick</td><td>1/3</td><td>2/9</td><td>2/9</td><td>2/9</td></tr><tr><td>Brenda</td><td>1/4</td><td>1/4</td><td>1/4</td><td>1/4</td></tr><tr><td>Ali</td><td>2/35</td><td>2/35</td><td>2/7</td><td>3/5</td></tr></table>		<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	Rick	1/3	2/9	2/9	2/9	Brenda	1/4	1/4	1/4	1/4	Ali	2/35	2/35	2/7	3/5	M1	Obtaining probs of each person for each entrance (can be implied or awarded in part (i) or part (ii))
			<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>																		
		Rick	1/3	2/9	2/9	2/9																		
		Brenda	1/4	1/4	1/4	1/4																		
Ali	2/35	2/35	2/7	3/5																				
M1	Considering options 2 meet 1 doesn't, must have at least two 3-factor terms																							
M1	Adding option all three meet, must be added to a prob																							
A1	Correct answer																							
		[4]																						
	(ii)	P(entrance <i>A</i>) = 1/210 (0.00476) P(entrance <i>B</i>) = 1/315 (0.00317) P(entrance <i>C</i>) = 1/63 (0.0159) P(entrance <i>D</i>) = 1/30 (0.0333)	M1	Obtaining a three-factor prob for any entrance																				
		P(same entrance) = 2/35 (0.0571)	M1	Adding four three-factor probabilities for the 4 entrances																				
			A1	Two or more correct entrance probabilities																				
		A1	Correct answer																					
		[4]																						
6	(i)	${}^6P_4 = 6!/2!$ $= 360$	B1	Correct answer																				
			[1]																					
		(ii) $4!/2! = 12$	B1	Correct answer																				
		[1]																						
	(iii)	$4! \times {}^6C_4 = 360$ or ${}^6P_4$	B1	Correct final answer																				
		[1]																						
	(iv)	e.g. 2R 1B 1G, 1R 2B 1G, 1R 1B 2G $= \frac{4!}{2!} + \frac{4!}{2!} + \frac{4!}{2!} = 36$, mult by ${}^6C_3$ total = 720	M1	$4!/2!$ seen																				
			M1	Mult by ${}^6C_3$																				
		A1	Correct answer																					
		[3]																						
	(v)	2R 2B = $4!/2!2! = 6$ Mult by ${}^6C_2$, total = 90 Answer = $360 + 720 + 90 = 1170$	M1	Considering 2 colours e.g. RRBB or RBRR or...																				
			A1	mult by ${}^6C_2$																				
		A1ft	Ft their (iii) + (iv) + (v)																					
		[3]																						

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7	(i) If $y = P(\text{odd number})$ then $P(\text{even number}) = 2y$ $3y + 6y = 1$ so $y = 1/9$ oe. OR prob = $1/3$	M1 A1 [2]	2P(Odd) shown = P(Even) and summed to 1 correct answer accept either
	(ii) Score of 8 means throwing a 6 6 is even so $P(8) = 2/9$ (AG)	B1 B1 [2]	legit justification of use of $2/9$
	(iii) $\text{Var}(X) = (48 + 36 + 98 + 128 + 100)/9 - (58/9)^2$ $= 4.02$ accept 4.025 (326/81)	M1 A1 [2]	Correct method no dividings, 6.44 squared sub numerically Correct answer
	(iv) $P(\text{score } 6, 10) + P(\text{score } 10, 6) + P(\text{score } 8, 8)$ $= 1/81 + 1/81 + 4/81$ $= 6/81$ ($2/27$) (0.0741)	M1 A1 [2]	Summing two different 2-factor probabilities Correct answer
	(v) $P(\text{score } 6, 10) = 1/81$ $P(1^{\text{st}} \text{ score } 6 \text{ given total } 16)$ $= (1/81) \div (6/81)$ $= 1/6$	B1 M1 A1 [3]	$1/81$ seen in numerator Dividing by their (iv) Correct answer

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1 $4p + 5p^2 + 1.5p + 2.5p + 1.5p = 1$ $10p^2 + 19p - 2 = 0$ $p = 0.1$ or -2 $p = 0.1$	M1 A1 A1 [3]	Summing 5 probs to = 1 can be implied For 0.1 seen with or without -2 Choosing 0.1 must be by rejecting -2
2 (i) $\Sigma(x - 50) = 824 - 16 \times 50 = 24$ $\frac{\Sigma(x - 50)^2}{16} - \left(\frac{\Sigma(x - 50)}{16} \right)^2 = 6.5^2$ $\Sigma(x - 50)^2 = 712$	B1 M1 A1 [3]	Correct answer Consistent substituting in the correct coded variance formula OR valid method for Σx^2 then expanding $\Sigma(x - 50)^2$, 3 terms at least 2 correct Correct answer
(ii) new mean = $896/17 (= 52.7)$ $\text{new var} = \frac{712 + 22^2}{17} - \left(\frac{24 + (72 - 50)}{17} \right)^2$ new sd = 7.94	B1 M1 A1 [3]	Correct answer Using the correct coded variance formula with $n = 17$ and new coded mean² OR their $(\Sigma x^2 + 72^2)/17 - \text{their new mean}^2$ Rounding to correct answer, accept 7.95 or 7.98 or 7.91

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3 $P(E \text{ and } 12) = \frac{2}{5} \times \frac{4}{36} = \frac{8}{180} (2/45)$ $P(12) = \frac{3}{5} \times \frac{1}{36} + \frac{8}{180} = \frac{11}{180} (0.0611)$ $P(E 12) = \frac{P(E \text{ and } 12)}{P(12)}$ $= \frac{8}{11} (0.727)$ OR list Even: 2 and (4,3) or (3,4) or (2,6) or (6,2) 4 and ditto Gives 8 options Odd: 1 and (6,6) or 3 and (6,6) or 5 and (6,6) Gives 3 options $\text{Prob}(E 12) = 8/11$	M1 A1 M1 A1ft M1dep A1 [6] M1 A1 M1 A1 M1 A1	2/5 or 3/5 mult by dice-related probability seen anywhere $\frac{2}{5} \times \frac{4}{36}$ seen oe Summing two 2-factor probs involving 2/5 and 3/5 3/5 $\times$ 1/36 + their P(E and 12), ft their P(E 12) Subst in condit prob formula, must have a fraction Correct answer List attempt evens 8 options List attempt odds 3 options (Their even)/(their total) Correct answer																														
4 (i) <table border="1" data-bbox="204 1173 641 1554"> <thead> <tr> <th>sugar</th><th></th><th>flour</th></tr> </thead> <tbody> <tr><td></td><td>194</td><td>1 5 9</td></tr> <tr><td></td><td>195</td><td>3</td></tr> <tr><td>8 1</td><td>196</td><td>2 4</td></tr> <tr><td>7</td><td>197</td><td>7</td></tr> <tr><td>9 4 3</td><td>198</td><td></td></tr> <tr><td>4</td><td>199</td><td></td></tr> <tr><td>8</td><td>200</td><td></td></tr> <tr><td>7 4 1</td><td>201</td><td></td></tr> </tbody> </table> key <table border="1" data-bbox="316 1576 421 1653"> <tr> <td>1</td><td>196</td><td>2</td></tr> </table> means 1.961 kg for sugar and 1.962 kg for flour	sugar		flour		194	1 5 9		195	3	8 1	196	2 4	7	197	7	9 4 3	198		4	199		8	200		7 4 1	201		1	196	2	B1 B1 B1 B1ft [4]	Correct stem must be integers. (stem and leaves can be in reverse order) Correct leaves flour must be single and ordered Correct leaves sugar must be single and ordered Correct key needs all this, ft if single leaves and 1.96 etc in stem correct median subt their LQ from their UQ, UQ > med, LQ < med Correct answer [3]
sugar		flour																														
	194	1 5 9																														
	195	3																														
8 1	196	2 4																														
7	197	7																														
9 4 3	198																															
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7 4 1	201																															
1	196	2																														

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5 (i) Zotoc: $z = \frac{367 - 320}{21.6} = 2.176$ Ganmor: $z = \frac{367 - 350}{7.5} = 2.267$ $P(\text{Zotoc}) = 0.985$ $P(\text{Ganmor}) = 0.988$	M1	Standardising either car's fuel, no cc, no sq, no $\sqrt{}$
	A1	Correct answer
	A1 [3]	Correct answer
(ii) $z = 0.23$ $0.23 = \frac{x - 320}{21.6}$ $x = 324.968$ $d = 4.97$	B1	± 0.23 seen
	M1	Standardising either car, no cc, no sq rt, no sq
	M1ind	$320 + d - 320$ i.e. just d on num
	A1 [4]	Correct answer, -4.97 gets A0
6 (i) constant/given prob, independent trials, fixed/given no. of trials, only two outcomes	B1	One option correct
	B1 [2]	Three options correct
(ii) $P(8, 9, 0, 1) =$ ${}^9C_8(0.3)^8(0.7) + (0.3)^9 + (0.7)^9 + {}^9C_1(0.3)(0.7)^8$ $= 0.196$	M1	One term seen involving $(0.3)^x(0.7)^{9-x}({}^9C_x)$
	A1	Correct unsimplified expression
	A1	Correct answer
	[3]	
(iii) mean $= 90 \times 0.3 = 27$ var $= 18.9$ $P(X > 35) = 1 - \Phi\left(\frac{35.5 - 27}{\sqrt{18.9}}\right)$ $= 1 - \Phi(1.955) = 0.0253$ $P(X < 27) = \Phi\left(\frac{26.5 - 27}{\sqrt{18.9}}\right) = 1 - \Phi(0.115)$ $= 0.4542$ Total prob $= 0.480$ accept 0.48	B1	Expressions for 27 and 18.9 (4.347) seen
	M1	Standardising one expression, must have sq rt in denom, cc not necessary
	M1	Continuity correction applied at least once
	M1	$(1 - \Phi_1) + (1 - \Phi_2)$ accept $(0.0329 + 0.5)$ if no cc
	A1	Rounding to correct answer
	[5]	

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7 (i) 4M 2W or 5M 1W chosen in ${}^{10}C_4 \times {}^9C_2 + {}^{10}C_5 \times {}^9C_1$ $= 9828$	M1 A1 A1 [3]	At least 1 of ${}^{10}C_4 \times {}^9C_2$ and ${}^{10}C_5 \times {}^9C_1$ seen Correct unsimplified expression Correct answer
(ii) ${}^9C_3 \times {}^8C_1 + {}^9C_4 = 798$ Prob = $798/9828 = 0.0812$	M1 A1 [2]	One of ${}^9C_3 \times {}^8C_1$ and ${}^9C_4 \times ({}^8C_0)$ seen Correct answer
(iii) Albert + not T... ${}^9C_3 \times {}^8C_2 + {}^9C_4 \times {}^8C_1$ $= 3360$ Tracey + not A... ${}^9C_4 \times {}^8C_1 + {}^9C_5$ $= 1134$ Number of ways = 4494	M1 A1 A1 [3]	One of ${}^9C_3 \times {}^8C_2$ or ${}^9C_4 \times {}^8C_1$ or ${}^9C_5 \times ({}^8C_0)$ seen Unsimplified 3360 or 1134 seen Correct final answer
(iv) $6! - 4! \times 5 \times 2$ or $6! - 5! \times 2 (= 480)$ OR $4! \times 5 \times 4$ or $4! \times {}^5P_2 (= 480)$ prob = $480/6! = 2/3 (0.667)$ OR using probabilities...as above OR Women together $5!/4! (= 5)$ Women not together = $15 - 5 = 10$ total ways MMMMWW = $6!/4!2! = 15$ prob = $2/3$	B1 M1 A1 [3] B1 M1 A1	$6! - 4! \times 5 \times 2$ or $6! - 5! \times 2$ or $4! \times 5 \times 4$ or $4! \times {}^5P_2$ dividing by $6!$ correct answer 5 or 10 seen Dividing by 15 Correct answer

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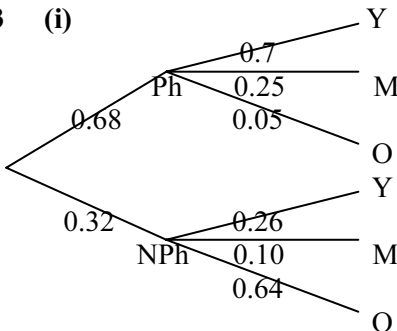
The following abbreviations may be used in a mark scheme or used on the scripts:

AEF	Any Equivalent Form (of answer is equally acceptable)
AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
BOD	Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)
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
MR	Misread
PA	Premature Approximation (resulting in basically correct work that is insufficiently accurate)
SOS	See Other Solution (the candidate makes a better attempt at the same question)
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 $\sqrt{}$ " 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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1 Normal mean 60 kg, variance 90 kg ²	B1 B1 [2]	Any sensible values (mean 40–80 kg, variance 16–225 kg ²), could give s.d. 4–15 kg												
2 (i) <table border="1"><tr><td><i>x</i></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Prob</td><td><i>k</i></td><td>2<i>k</i></td><td>3<i>k</i></td><td>4<i>k</i></td><td>5<i>k</i></td></tr></table> $15k = 1$ $k = 1/15$ (0.0667)	<i>x</i>	1	2	3	4	5	Prob	<i>k</i>	2 <i>k</i>	3 <i>k</i>	4 <i>k</i>	5 <i>k</i>	M1 M1 A1 [3]	1, 2, 3, 4, 5 seen, together with some probabilities involving <i>k</i> but not <i>x</i> summing probs involving <i>k</i> to 1 correct answer
<i>x</i>	1	2	3	4	5									
Prob	<i>k</i>	2 <i>k</i>	3 <i>k</i>	4 <i>k</i>	5 <i>k</i>									
(ii) $E(X)$ $= k + 4k + 9k + 16k + 25k$ $= 55k = 11/3$ (3.67)	M1 A1ft [2]	using Σpx no dividing correct answer, ft on $55k$, $0 < k < 1$												
3 (i) 	M1 A1 [2]	Y = young, M = middle-aged, O = old Correct shape with Ph, NPh first All probabilities and correct												
(ii) $P(\text{Ph} \mid M) = \frac{0.68 \times 0.25}{0.68 \times 0.25 + 0.32 \times 0.1}$ $= 0.842$ (170/202)	B1 M1 A1 [3]	For correct numerator using cond prob formula with numerator < denominator For attempt at P(35 – 60 years old), involving the sum of two 2-factor probs, seen anywhere Correct answer												
4 (i) $\bar{x} = 60 + 245/70$ $= 63.5$	M1 A1 [2]	245/70 seen Correct answer												
(ii) $\Sigma(x - 50) = \Sigma x - \Sigma 50$ $= 245 + 70 \times 60 - 70 \times 50$ $= 945$	M1 A1 [2]	Any valid method, involving 70 Correct answer												
(iii) coded mean $= 945/70 = 13.5$ $\frac{\Sigma(x - 50)^2}{70} - \left(\frac{945}{70}\right)^2 = 10.6^2$ $\Sigma(x - 50)^2 = 20623$ (20600)	M1 A1 [2]	Using variance formula with coded mean Correct answer												

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5	(i)	<table><tr><td>2 to 4</td><td>4 to 6</td><td>6 to 7</td><td>7 to 8</td><td>8 to 10</td><td>10 to 16</td></tr><tr><td>20</td><td>44</td><td>34</td><td>30</td><td>30</td><td>36</td></tr></table>	2 to 4	4 to 6	6 to 7	7 to 8	8 to 10	10 to 16	20	44	34	30	30	36	M1 A1 A1 [3]	Using fd to evaluate freqs Any four correct All correct
	2 to 4	4 to 6	6 to 7	7 to 8	8 to 10	10 to 16										
	20	44	34	30	30	36										
(ii)	mid-points 3, 5, 6.5, 7.5, 9, 13 $E(X) = (3 \times 20 + 5 \times 44 + 6.5 \times 34 + 7.5 \times 30 + 9 \times 30 + 13 \times 36) / 194 = 1464/194$ $= 7.55$	M1 A1ft [2]	5 or 6 correct mid-points Correct answer, ft on 6 correct mid-points and the frequencies in their table													
(iii)	$p = 60/194$ (0.309) $P(1) = 2 \times (60/194)(134/193)$ $= 8040/18721$ (0.429)	B1ft M1 A1 [3]	60/194 seen, ft on (their 30 + their 30) / their total multiplying a probability by 2 Correct answer													
6	(i)	${}^{14}P_{12}$ $= 4.36 \times 10^{10}$	M1 A1 [2]	${}^{14}P_{12}$ seen oe Correct answer												
	(ii)	business people $3! = 6$ students $5! = 120$ married couples ${}^3P_2 \times 2 \times 2 = 24$ total ways = 17280	B1 B1 B1 B1 [4]	3! oe seen, not in denominator 5! oe seen, not in denominator 24 oe seen, not in denominator correct final answer												
	(iii)	Mrs Brown 3 Mrs Lin 10 Student 5 Prob = $3 \times 10 \times 5 \times {}^{11}P_9$ / (i) $= 0.0687$ OR_1 $3/14 \times 10/13 \times 5/12 = 150/2184$ (0.0687) OR_2 $1 - 3/14 = 11/14$ $1 - 11/14 \times 5/13 = 127/182$ $8/14(4/13 \times 12/12 + 9/13 \times 7/12) +$ $3/14(3/13 \times 12/12 + 10/13 \times 7/12)$ $= 1206/2184$ $1 - (1524 + 1716 - 1206)/2184 = 150/2184$	B1 B1 M1 A1 [4] B1 B1 M1 A1 B1 B1 M1 A1	any 2 of 3, 10, 5 oe seen, not in denominator ${}^{11}P_9$ seen multiplied dividing by their (i) correct answer any 2 of numerators 3, 10, 5 oe seen denominators 14, 13, 12 of 3 fractions multiplying 3 separate fractions correct answer $1 - 3/14$ seen $1 - 11/14 \times 5/13$ seen attempt to find P(Mrs Lin not behind a student and Mrs Brown not in front row), involving $8/14 \times \text{prob} + 3/14 \times \text{prob}$ correct answer												

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7 (i) $z = 0.807$ $0.807 = \frac{10 - 8.2}{\sigma}$ $s = 2.23$	B1 M1 A1 [3]	0.807 seen standardising, must have σ, no sq rt, no cc and a z-value correct answer
(ii) $P(> 1 \text{ min from mean}) = P(\text{mod } z > \frac{1}{2.23})$ $= P(z > 0.4484)$ $= (1 - 0.6729) \times 2$ $= 0.654$	M1 M1 A1 [3]	standardising, their sd, no cc and adding two areas using $1 - \Phi(z)$ correct answer
(iii) $P(> 2 \text{ longer}) = 1 - P(0, 1, 2 \text{ longer})$ $= 1 - \{(0.79)^6 + {}^6C_1(0.21)(0.79)^5 + {}^6C_2(0.21)^2(0.79)^4\}$ $= 0.112$	M1 A1 A1 [3]	binomial term ${}^6C_x p^x (1 - p)^{6-x}$ correct unsimplified answer correct answer
(iv) $\mu = 35 \times 0.5 = 17.5$ $\sigma^2 = 35 \times 0.5 \times 0.5 = 8.75$ $P(X < 16) = \Phi\left(\frac{15.5 - 17.5}{\sqrt{8.75}}\right)$ $= 1 - \Phi(0.676)$ $= 1 - 0.7505$ $= 0.2495 \text{ (0.249 or 0.250)}$ OR ${}^{35}C_0 0.5^0 0.5^{35} + {}^{35}C_1 0.5^1 0.5^{34} + {}^{35}C_2 0.5^2 0.5^{33} + \dots$ $= 8582372584/2^{35} = 0.250$	B1 M1 M1 M1 A1 [5] M1 A1 M1 A1 A1	17.5 and 8.75 or $\sqrt{8.75}$ seen standardising, with or without cc, must have sd in denom continuity correction 15.5 or 16.5 only, seen using $1 - \Phi(z)$ correct answer binomial term ${}^{35}C_x 0.5^x 0.5^{35-x}$ at least 2 correct terms ($x \geq 0$) seen summing 16 or 17 terms correct expression correct answer