

Permutations & Combinations 1 MS

Q1.

6 (i) ${}^{10}C_1 + {}^{10}C_3 + {}^{10}C_5 + {}^{10}C_7 + {}^{10}C_9$ $= 512$	M1 A1 A1 [3]	Summing some ${}^{10}C$ combinations with odd numbers, all different At least 3 correct unsimplified expressions Correct answer
(ii) $6! \times 7 \times 6 \times 5$ $= 151200$	B1 M1 A1 [3]	$6!$ seen multiplying by 7P_3 o.e. correct answer
(iii) $12! / (4! \times 7!)$ $= 3960$	B1 M1 A1 [3]	$12!$ Seen dividing by $4!7!$ correct answer

Q2.

7 (i) 362880 (363000)	B1 [1]	
(ii) PG or GP in $8! \times 2 = 80640$ or 7/9 of (i) $362880 - 80640 = 282240$	M1 B1 A1ft [3]	Considering together and also subtracting from their (i) or using probabilities $8! \times 2$ or 80640 seen oe correct answer ft 40320 only
(iii) 9P_3 or ${}^9C_3 \times 3!$ or $9!/6!$ $= 504$	M1 A1 [2]	9P_3 or 9C_3 oe seen allow extra multiplication correct final answer
(iv) ${}^8C_2 \times 3!$ or $504 - {}^8C_3 \times 3!$ or ${}^8P_2 \times 3$ $= 168$	M1 A1 [2]	8C_x or 8P_x seen allow extra mult, or (iii)/9 or (iii)/3 correct final answer
(v) PG and x in $7 \times 2 \times 2$ ways = 28 Answer $504 - 28 = 476$	M1 A1 [2]	$x \times 2 \times 2$ seen or their (iii) - 7 or 7C_1 or 7C_2 correct answer

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Q3.

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

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Q4.

<p>6 (i) ${}^{14}P_{12}$ $= 4.36 \times 10^{10}$</p>	<p>M1 A1 [2]</p>	<p>${}^{14}P_{12}$ seen oe Correct answer</p>
<p>(ii) business people $3! = 6$ students $5! = 120$ married couples ${}^3P_2 \times 2 \times 2 = 24$ total ways = 17280</p>	<p>B1 B1 B1 B1 [4]</p>	<p>3! oe seen, not in denominator 5! oe seen, not in denominator 24 oe seen, not in denominator correct final answer</p>
<p>(iii) Mrs Brown 3 Mrs Lin 10 Student 5 Prob = $3 \times 10 \times 5 \times {}^{11}P_9 / \text{(i)}$</p> <p>= 0.0687</p> <p>OR₁ $3/14 \times 10/13 \times 5/12 = 150/2184$ (0.0687)</p> <p>OR₂ $1 - 3/14 = 11/14$ $1 - 11/14 \times 5/13 = 127/182$ $8/14(4/13 \times 12/12 + 9/13 \times 7/12) +$ $3/14(3/13 \times 12/12 + 10/13 \times 7/12)$ $= 1206/2184$ $1 - (1524 + 1716 - 1206)/2184 = 150/2184$</p>	<p>B1 B1 M1 A1 [4] B1 B1 M1 A1 B1 B1 M1 A1</p>	<p>any 2 of 3, 10, 5 oe seen, not in denominator</p> <p>${}^{11}P_9$ seen multiplied dividing by their (i)</p> <p>correct answer</p> <p>any 2 of numerators 3, 10, 5 oe seen denominators 14, 13, 12 of 3 fractions multiplying 3 separate fractions correct answer</p> <p>$1 - 3/14$ 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</p>

Q5.

<p>4 (i) 90720</p>	<p>B1 [1]</p>	<p>Not $9!/2!2!$</p>
<p>(ii) 3 vowels together $= 3! \times 7!/2!2! = 7560$</p> <p>Prob(not together) = $\frac{90720 - 7560}{90720} = \frac{83160}{90720}$</p> <p>= 0.917 (=11/12)</p>	<p>B1 B1 M1 A1 [4]</p>	<p>3! oe seen multiplied by integer oe 7 or 6! seen multiplied as a num</p> <p>Subt from their (i) or dividing by their (i) or $1 - \text{prob}$</p> <p>Correct answer from correct working</p>
<p>(iii) One S in 5C_3 ways = 10 SS in 5C_2 ways = 10 Total = 20</p> <p>OR 6C_3</p> <p>= 20</p>	<p>M1 M1 A1 [3] M1 M1 A1</p>	<p>5C_3 seen added 5C_2 seen added Correct answer</p> <p>${}^6C_3 \times 2$ or $\div 2$ or $\times 1$ seen 6C_3 only Correct answer</p>

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Q6.

<p>2 (i) each in 2 ways = 2^{12} = 4096</p>	M1 A1	[2]	2^{12} seen Correct answer
<p>(ii) $\frac{12!}{7!5!}$ = 792</p>	B1	[1]	

Q7.

<p>3 (a) $G R L$ $11 \ 7 \ 7 = 15C11 \times 10C7 \times 8C7 = 1310400$ $13 \ 6 \ 6 = 15C13 \times 10C6 \times 8C6 = 617400$ $15 \ 5 \ 5 = 15C15 \times 10C5 \times 8C5 = 14112$</p> <p>Total = 1941912 (1940000)</p> <p>(b) e.g. * E * R * E (GG) N * A * E * gives 6 ways for G</p> <p>$\frac{7!}{3!} \times 6$ or $8!/3! - 2 \times 7!/3!$ = 5040 ways.</p>	M1 A1 M1		<p>Multiplying 3 combinations One of 1310400, 617400, 14112 seen Adding 3 options</p>
	A1	[4]	Correct answer
	B1		$7! / 3!$ Or $7!/3!3!$ seen oe
	B1		Multiplying by 6 (gaps) oe
	B1	[3]	Correct final answer

Q8.

<p>4 (i) $3! \times 4! \times 8! \times 3!$</p> <p>= 34 836 480 (34 800 000)</p>	M1 M1		<p>Multiplying 3 factorials together Multiplying by 3!</p>
	A1	[3]	Correct answer
<p>(ii) ${}^3C_2 \times {}^4C_2 \times {}^8C_2$</p> <p>= 504</p>	M1		<p>Multiplying (only) 3 combinations together</p>
	A1	[2]	Correct answer
<p>(iii) Fr Fa H</p> <p>$3 \ 1 \ 2 = {}^8C_3 \times {}^3C_1 \times {}^4C_2 = 1008$</p> <p>$3 \ 2 \ 1 = {}^8C_3 \times {}^3C_2 \times {}^4C_1 = 672$</p> <p>$4 \ 1 \ 1 = {}^8C_4 \times {}^3C_1 \times {}^4C_1 = 840$</p> <p>total ways = 2520</p>	M1 M1 A1		<p>Multiplying 3 combinations, only Summing 3 options 3 correct combination answers</p>
	A1	[4]	Correct answer

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Q9.

<p>5 (i) ${}_{11}C_6 = 462$ OR A3 B3 or A4 B2 or A5 B1 or A6 $= {}_8C_3 + {}_8C_4 \times {}_3C_2 + {}_8C_5 \times {}_3C_1 + {}_8C_6$ $= 56 + 210 + 168 + 28$ $= 462$</p>	<p>B1 B1</p>	
<p>(ii) ${}_8C_4 \times {}_3C_2 + {}_8C_5 \times {}_3C_1 + {}_8C_6$ $= 210 + 168 + 28$ $= 406$</p>	<p>M1 B1 A1</p>	<p>[1] Σ 2 or more two-factor terms, P or C any numbers Any correct option unsimplified Correct answer</p>
<p>(iii) ${}_9C_4 + {}_9C_6 = 126 + 84$ $= 210$ OR 1,2 in A tog with : A1B3 + A2B2 + A3B1 + A4B0 + 1,2 out of A : A3B3 + A4B2 + A5B1 + A6B0 $= {}_6C_1 + {}_6C_2 \times {}_3C_2 + {}_6C_3 \times {}_3C_1 + {}_6C_4 + {}_6C_5 \times {}_3C_3 + {}_6C_4 \times {}_3C_2 + {}_6C_5 \times {}_3C_1 + {}_6C_6$ $= 6 + 45 + 60 + 15 + 20 + 45 + 18 + 1 = 210$ OR $462 - {}_9C_5 - {}_9C_5$ $= 210$</p>	<p>M1 B1 A1 M1 B1 A1</p>	<p>Summing ${}_9C_x + {}_9C_y$ can be mult by 2 no other terms 126 or 84 seen or unsimplified ${}_9C_4, {}_9C_6$ Correct answer Σ 5 or more 2-factor ${}_6P_x$ or ${}_6C_x$ with ${}_3C_x$ or ${}_3P_x$ only (can be mult by 2) 3 or more correct unsimplified options Correct answer subt two ${}_9C_x$ options from their (i) ${}_9C_5$ seen oe if using this method Correct answer</p>
	<p>[3]</p>	