Selections & Arrangements Mark Scheme

1.

(i)	(a)	6	B1 [1]		
(i)	(b)	3×3×3 = 27	M1 A1 [2]	3! + 7×3 3 + 3×6 + 6 3! × 4 + 3 Complete correct method. Allow methods equiv to these. Only allow other methods if they appear correct	(Explanation for 3! × 4 + 3: 123: 3!, 112 & 122: 3!, 223 & 233: 3!, 331 & 311: 3! 111, 222, 333: 3 Candidates need not include this)
(i)	(c)	(i)(b) – 3 If answer is not 24, this method must be explicitly stated in order to give M1A1ft = 24 ft their (i)(b)	M1 A1ft [2]	or 3! + 6×3 or 3! + 3!×3 or 6 + 3!×3!÷2! or 3! × 4 Complete correct method. Allow methods equiv to these. Only allow other methods if they appear correct	or 8 × 3 (Explanation: there are 8 possible orders starting with 1. Candidates need not include this)
(ii)		eg 1123: $\frac{4!}{2!}$ × 3 alone allow M1 for $\frac{4!}{2!}$ × 3! alone eg 1122: $\frac{4!}{2!2!}$ × 3 alone allow M1 for $\frac{4!}{2!2!}$ × 3! alone Total = 54	M2 M2 A1 [5]	3! × $^4C_1$ × 3 or 3! × 12 M1 ÷ 2 M1dep (= 36) 3! × $^4C_2$ M1 ÷ 2 M1dep (= 18) Allow methods equiv to these, eg correctly listing cases Only allow other methods if they appear correct. NB 3×3×2×2 = 36 & 3×3×2 × 1 = 18 are incorrect methods unless clear justification given	This method only scores if 3×3×3×3 –…. is used: No. with 4 rep'ns = 3 M1 No. with 3 rep'ns = $\frac{4!}{3!}$ M1 × 6 (= 24) M1 or 8 × 3 M2 81–('3'+'24') or 81–27 M1 (allow 81–3 or 81–24) 18, 36 only score if a correct method seen,, or eg: 18 orders listed starting with "1" or 18 orders listed with two repetitions

2.

(i)	(a)	$^7P_5$ or $\frac{7!}{2!}$ or 7×6×5×4×3 or $^7C_5$ × 5! alone = 2520	M1 A1 [2]	$^7P_2$ or $\frac{7!}{2!}$ M0A0	$^7C_5$ = 21 or 5! = 120 M0A0 but see (i)(b)
(i)	(b)	$^6P_4$ or $\frac{6!}{2!}$ or 6×5×4×3 or $^6C_4$ × 4! or 360 × 2 (see middle column) = 720	M1 M1 A1 [3]	alone or ×2 only $^6P_4$ × 2 or 6! alone M2 $^6C_4$ × 2 or 6! × 2 alone M0M1 only any other × 2 M0M0 or '2520'×$\frac{2}{7}$ M2A0 (eg (ia)21 (ib) 21×$\frac{2}{7}$= 6 M2A0 but if ans is 6, must see wking) cao	or '2520' – 5 × $^6P_4$ M2 SC ONLY on ft from (i)(a): if (i)(a) 5! = 120, then (i)(b)4!×2=48 alone M1M0A0 Other SC $^5P_3$ × 2 M2 (from a vowel at each end, ie treat as MR) NOT isw eg $\frac{720}{'2520'} = \frac{2}{7}$ M1M1A0
(ii)	(a)	21	B1 [1]		
(ii)	(b)	$^5C_3$ or $\frac{5!}{3!2!}$ or $^5C_5$ seen or 10 seen in num $\frac{^5C_3}{^5C_3+^5C_5}$ oe $\frac{10}{11}$ or 0.909 (3 sf)	M1 M1 A1 [3]	$\frac{5}{7}\times\frac{4}{6}$ oe seen $\frac{5}{7}\times\frac{4}{6}\div(\frac{5}{7}\times\frac{4}{6}+\frac{2}{7}\times\frac{1}{6})$	Allow $^5C_2$ seen BOD

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3.

(i)	(a)	${}^9P_4$ or ${}^{9!}/_{5!}$ or ${}^9C_4 \times 4!$ = 3024	M1 A1 [2]	alone	oe eg ${}^9C_1 \times {}^8C_1 \times {}^7C_1 \times {}^6C_1$ or $9\times8\times7\times6$
(i)	(b)	${}^8P_3$ or $8 \times 7 \times 6$ oe or ${}^8C_3 \times 3!$ $\times 5$ (or ${}^5C_1$) = 1680	M1 M1 A1 [3]	Allow × …. or ÷ ….. Correct × 5 or ${}^8C_3 \times 5$ (or ${}^5C_1$) Not ISW, eg ${}^{1680}/_{3024}$: M1M1A0	or (${}^9P_4$ or "3024") × ${}^5/_9$ M2
				SC: consistent use of with replacement in (i) (or if only (a) or (b) attempted) (ia) M0A0 (ib) 999 × 5 or 4995 M1 M0A0	
(ii)	(a)	${}^5C_3 \times {}^4C_1$ or ${}^5C_4$ oe ${}^5C_3 \times {}^4C_1 + {}^5C_4$ oe correct method so far (= 45) ÷ ${}^9C_4$ Allow anything ÷ ${}^9C_4$ = ${}^5/_{14}$ or 0.357 (3 sfs) oe, eg ${}^{35}/_{98}$ or ${}^{45}/_{126}$	M1 M1 M1 A1 [4]	${}^5C_3 \times {}^4C_1 \times 4!$ (or ${}^5P_3 \times 4 \times 4$) or 5! (or ${}^5P_4$) 960 + 120 oe correct method so far ÷ ${}^9P_4$ [must involve any P or any !] ÷ ${}^9P_4$ Marks must come from one method, not mixture of two methods	${}^5/_9 \times {}^4/_8 \times {}^3/_7 \times {}^4/_6$ Allow × or +… × 4 correct method so far ${}^5/_9 \times {}^4/_8 \times {}^3/_7 \times {}^2/_6$ Allow × or +… or: ${}^5/_9 \times {}^4/_8 \times {}^3/_7 \times {}^4/_6$ or ${}^5/_9 \times {}^4/_8 \times {}^3/_7$ M1 ${}^5/_9 \times {}^4/_8 \times {}^3/_7 \times {}^4/_6 \times 3 + {}^5/_9 \times {}^4/_8 \times {}^3/_7$ M1 NB ${}^5/_9 \times {}^4/_8 \times {}^3/_7 \times 3 = {}^5/_{14}$ M0M0M0A0
(ii)	(b)	9, 8, 7, 4 or 9, 8, 6, 5 No mark yet 2 ÷ ${}^9C_4$ oe Must be (1 or 2 or 4) ÷ ${}^9C_4$ = ${}^1/_{63}$ oe or 0.0159 (3 sfs)	 M1 M1 A1 [3]	${}^1/_9\times{}^1/_8\times{}^1/_7\times{}^1/_6$ × 4! × 2 ¦ ${}^4/_9\times{}^3/_8\times{}^2/_7\times{}^1/_6$ × 2 Allow × or +… fully correct method NB Marks from one method only, not mixed methods	4! + 4! or 2 × 4! oe ÷ ${}^9P_4$ or ÷ (i)(a) oe Must be (96 or 48 or 24) ÷ ${}^9P_4$ ${}^2/_9\times{}^2/_8\times{}^1/_7\times{}^1/_6$ allow × or + … M1 × 4!/4 × 2 fully correct method M1
				SC: consistent use of with replacement in (ii), (or if only (a) or (b) attempted) (iia) $({}^5/_9)^4$ M1 $+ {}^4C_3({}^5/_9)^3({}^4/_9)$ (= 0.400) M1 M0A0 (iib) $({}^1/_9)^4$ (=0.000152) M1 attempt find no of gps M1A0	$1-(({}^4/_9)^4+4({}^4/_9)^3({}^5/_9)+{}^4C_2({}^4/_9)^2({}^5/_9)^2)$ M2 One term missing or extra or wrong M1

4.

ia	5040	B1 1			
b	6! or 5!×6 or 720 ÷ 7! or ÷ "5040" or 1440 or (5! or 6!) × 2 = ${}^2/_7$ oe or 0.286 (3 sf)	M1 M1 A1 3	Any ÷ 7! or "5040" but NOT any × 2	${}^1/_7\times{}^1/_6$ M1* × 6 or × 2 M1 dep*	NOT 6! in denom eg ${}^{6!}/_{5040}$ or ${}^1/_7$ or 0.143 or ${}^1/_{21}$ (3 sfs): M1M1A0
iia	3! × 4! alone or 144 (÷ 7! or "5040") = ${}^1/_{35}$ oe or 0.0286 (3sf)	M1 A1 2	${}^4/_7\times{}^3/_6\times{}^3/_5\times{}^2/_4\times{}^2/_3\times{}^1/_2$ oe or $\frac{1}{7C3or7C4}$		Not 3! × 4! ×… (eg not 3! × 4! × 5) not $\frac{1}{31\times4!}$, not $\frac{1}{144}$ NB no mark for ÷ 7! or "5040" in this part
b	5 seen or 5! seen 3! × 4! × 5 or 5! × 3! or 720 or 5 × 144 (÷7! or "5040") = ${}^1/_7$ oe or 0.143 (3 sf)	M1 M1 A1 3	or 5 × ${}^3/_7\times{}^2/_6\times{}^1/_5$ (× ${}^4/_4\times{}^3/_3\times{}^2/_2$) oe: M2 or 5 × $\frac{1}{7C3or7C4}$: M2 or 5 × "(iia)": M2		or GGGBBBB, BGGGBBB, BBGGGBB, BBBGGGB, BBBBGGG NB no mark for ÷ 7! or "5040" in this part

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5.

i	$7! \div 3!$ $7! \div 2!$ $\div 2!$ $\div 3!$ $= 420$	M1 M1dep A1 3	But NOT ${}^7P_4$ or $7!/(7-4)!$ if seen	$\frac{7!}{3!+2!}$: M1M0 $\frac{7!}{3! \times n!}$ any n: M1M0
iia	${}^5C_3$ or ${}^{10}C_4$ seen ${}^5C_3 \times {}^{10}C_4$ $= 2100$	M1 M1 A1 3	or 10 or 210	$\frac{{}^5C_3 \times {}^{10}C_4}{\text{anything}}$ M1M1A0 ${}^5P_3 \times {}^{10}P_4$ or 60×5040 or 302400: SC B1
b	${}^4C_2 \times {}^9C_4$ or ${}^4C_3 \times {}^9C_3$ or 756 or 336 ${}^4C_2 \times {}^9C_4 + {}^4C_3 \times {}^9C_3$ or 1092 $\div 2100$ or $\div$ (iia) dep $\geq$ one M1 scored $= \frac{13}{25}$ or 0.52 "2100" – (${}^4C_3 \times {}^9C_4$ or ${}^4C_2 \times {}^9C_3$) or "2100" – (504 or 504) M1 "2100" – (${}^4C_3 \times {}^9C_4 + {}^4C_2 \times {}^9C_3$) M1 $\div$ "2100" or (iia) dep $\geq$ M1 M1	M1 M1 M1dep A1 4	$\frac{3}{5}$ or $\frac{4}{10}$ oe $\frac{3}{5} \times (1 - \frac{4}{10})$ or $(1 - \frac{3}{5}) \times \frac{4}{10}$ $\frac{3}{5} \times (1 - \frac{4}{10}) + (1 - \frac{3}{5}) \times \frac{4}{10}$ $= \frac{13}{25}$ $\frac{3}{5}$ or $\frac{4}{10}$ oe M1 $\frac{3}{5} + \frac{4}{10} - \frac{3}{5} \times \frac{4}{10}$ M1 $\frac{3}{5} + \frac{4}{10} - \frac{3}{5} \times \frac{4}{10} - \frac{3}{5} \times \frac{4}{10}$ M1 $= \frac{13}{25}$ A1	Not from incorrect wking SC $\frac{1}{5} \times \frac{9}{10}$ or $\frac{4}{5} \times \frac{1}{10}$ M1 $\frac{1}{5} \times \frac{9}{10} + \frac{4}{5} \times \frac{1}{10}$ M1 ($= \frac{13}{50}$ A0) Not from incorrect wking ie P(WA or GA or both) Must be correct figures ie P(WA or GA but not both) Must be correct figures SC: ${}^4P_2 \times {}^9P_4 + {}^4P_3 \times {}^9P_3$: M1 $\div$ (iia) M1dep Careful: 336 or 756 can be obtained by incorrect methods.

6.

i	${}^4C_2 \times {}^6C_3 \times {}^5C_4$ or $6 \times 20 \times 5$ $= 600$	M1M1 A1 3	M1 for any 2 correct combs seen, even if added
ii	$\frac{2}{4}$ or $\frac{{}^3C_1}{{}^4C_2}$ or $\frac{{}^3C_1 \times {}^6C_3 \times {}^5C_4}{{}^4C_2 \times {}^6C_3 \times {}^5C_4}$ or $\frac{{}^3C_1 \times {}^6C_3 \times {}^5C_4}{\text{'600'}}$ $= \frac{1}{2}$ oe	M1 A1 2	or $\frac{1}{4} \times 1 + \frac{3}{4} \times \frac{1}{3}$ or $\frac{1}{4} \times 2$ or $\frac{1}{4} + \frac{1}{4}$
iii	${}^3C_1 \times {}^6C_3$ $(\times {}^4C_4)$ + ${}^3C_2 \times {}^6C_3 \times {}^5C_4$ 360	M1M1 A1 3	M1 either product seen, even if $\times$ or $\div$ by something

7.

(i)	${}^{5!}/_2$ $= 60$	M1 A1 2	Allow 5P3
(ii)	4! $= 24$	M1 A1 2	Allow $2 \times 4!$
(iii)	${}^2/_5 \times {}^3/_4$ or3/5×2/4 $\times 2$ $= {}^3/_5$ oe	M1 M1 A1 3	allow M1 for ${}^2/_5 \times {}^3/_5 \times 2$ or ${}^{12}/_{25}$ or $(6 \times 3!) \div$**(i)** M2 or $3! \div$**(i)**, $6 \div$**(i)**, $(6+6) \div$**(i)**, $6k \div$**(i)** or 6×6 or 36 or 1-correct answer M1 (k,integer ≤ 5)

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8.

i	$^8C_3$ $= 56$		M1 A1 2		
ii	$^7C_2$ or or $^7P_2$ / $^8P_3$ ÷($^8C_3$ or "56") only $= {}^3/_8$	$^1/_8$ not from incorrect × 3 only or $^1/_8+{}^7/_8\times{}^1/_7+{}^7/_8\times{}^6/_7\times{}^1/_6$	M1 M1 A1 3	$^8C_1+{}^7C_1+{}^6C_1$ or 21 or 8×7×6 or $^-/_8\times{}^-/_7\times{}^-/_6$ indep, dep ans < 1	$^7/_8\times{}^6/_7\times{}^5/_6$ 1 – prod 3 probs
iii	$^8P_3$ or 8×7×6 or $^8C_1\times{}^7C_1\times{}^6C_1$ or 336 1 ÷ $^8P_3$ only $= {}^1/_{336}$ or 0.00298 (3 sf)		M1 M1 A1 3	$^1/_8\times{}^1/_7\times{}^1/_6$ only M2	If × or ÷: M1 $(^1/_8)^3$ M1

9.

(i) (a)	8! = 40320	M1 A1 2		Allow $^4P_4$ & $^3P_3$ instead of 3! & 4! thro'out Q6
(b)	$^4/_8\times{}^4/_7\times{}^3/_6\times{}^3/_5\times{}^2/_4\times{}^2/_3\times{}^1/_2$ × 2 $= {}^1/_{35}$ or 0.0286 (3 sfs)	M1 M1dep A1 3	4! × 4! ÷ 8! × 2 allow 1 – above for M1 only oe, eg $^{1152}/_{40320}$	4! × 4! + 4! × 4! ÷ 8!
(ii)(a)	4! × 4! = 576	M1 A1 2	allow 4! × 4! × 2: M1	
(b)	$^1/_{16}$ or 0.0625	B1 1		
(c)	Separated by 5 or 6 qus stated or illus $^1/_4\times{}^1/_4\times 3$ or $^1/_{16}\times 3$ ($^1/_4\times{}^1/_4$ or $^1/_{16}$ alone or ×(2 or 6): M1) $^3/_{16}$ or 0.1875 or 0.188	M1 M2 A1 4	allow 5 only or 6 only or (4, 5 or 6) can be impl by next M2 or M1 3! × 3! × 3 (3!× 3! alone or ×(2 or 6); or (3! + 3!) × 3: M1) (÷ 576) correct ans, but clearly B, J sep by 4: M0M2A0 1- P(sep by 0, 1, 2, 3, (4)) M1 $1-(^1/_4+{}^1/_4+{}^1/_4\times{}^3/_4+{}^1/_4\times{}^1/_2)$ or $1-(^1/_4\times{}^1/_4+{}^1/_2\times{}^1/_4+{}^3/_4\times{}^1/_4+1\times{}^1/_4+{}^3/_4\times{}^1/_4)$ M2 (one omit: M1)	

10.

(i)	$\frac{^7C_2 \times {}^8C_3}{^{15}C_5}$ $= {}^{56}/_{143}$ or $^{1176}/_{3003}$ or 0.392 (3sfs)	M1 M1 A1 3	$^7C_2$ x $^8C_3$ or 1176 : M1 (Any C or P)/$^{15}C_5$: M1 (dep < 1) or $\frac{7}{15}\times\frac{6}{14}\times\frac{8}{13}\times\frac{7}{12}\times\frac{6}{11}$ or 0.0392: M1 $\times{}^5C_2$ or × 10 : M1 (dep ≥4 probs mult) if 2↔3, treat as MR max M1M1
(ii)	3! x 2! or $^3P_3$ x $^2P_2$ not in denom = 12	M1 A1 2	BABAB seen: M1 120-12: M1A0 NB $^{4!}/_{2!}$ = 12: M0A0