Mark scheme

Permutations and combinations

Additional Mathematics 0606 · Questions from Paper 1 and Paper 2

Total marks

67

MARKS FOR EACH QUESTION

1	2	3	4	5	6	7	8	9	10	Total
3	4	5	5	6	4	7	10	11	12	**67**

Question 1 **[3]**

1	$\frac{(n-4)(n+1)!}{(n-4)!5!} = \frac{(n+2)!}{(n-5)!7!}$ leading to $7\times6 = n+2$	**2**	**B1** for 7×6 or 42 seen as a result of simplification of the numerical factorials **B1** for $n+2$ seen as a result of simplification of the algebraic factorials
	$n = 40$	**B1**	

Question 2 **[4]**

2(a)	${}^5C_2 \times {}^8C_4$ oe	**M1**	
	700	**A1**	
2(b)	$3\times6!$ oe	**M1**	
	2160	**A1**	

Question 3 **[5]**

3 **(i)** 40320 B1

(ii) $\frac{8\times7\times6\times5\times4}{5\times4\times3\times2(\times1)}$ or $\frac{8!}{5!\times3!}$ M1

56 A1

(iii) uses 5, 4 and 3 only M1

60 A1 [5]

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Question 4 **[5]**

4(a)	103 680	**2**	**M1** for $k \times 5! \times 4! \times 3!$ where $k = 1, 2, 3, 6$
4(b)	270	**3**	**M2** for ${}^5C_1 \times {}^4C_2 \times {}^3C_1 + {}^5C_1 \times {}^4C_1 \times {}^3C_2 +$ ${}^5C_2 \times {}^4C_1 \times {}^3C_1$ oe OR **M1** for at least one correct product If 0 scored then **SC1** for a final answer of 540 or 264

Question 5 **[6]**

5(a)(i)	12	**2**	**B1** for $3! \times 2!$ or ${}^2P_2 \times {}^3P_3$ oe
5(a)(ii)	72	**2**	**B1** for $5! - 4! \times 2!$ oe or $6 \times 2! \times 3!$ oe
5(b)	4200	**2**	**B1** for ${}^{10}C_3 \times {}^7C_3 \left[\times {}^4C_4 \right]$ oe or ${}^{10}C_4 \times {}^6C_3 \left[\times {}^3C_3 \right]$ oe

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Question 6 **[4]**

6	$\frac{n!}{(n-5)!5!} - \frac{(n-1)!}{(n-6)!5!}$ $\frac{(n-1)!\times[n-(n-5)]}{(n-5)!5!}$	**M1**	For substituting ${}^{n}C_5$ and ${}^{n-1}C_5$
	$\frac{(n-1)!}{(n-6)!5!}\left(\frac{n}{n-5}-1\right)$ oe	**M1**	**dep** on previous **M1** awarded For Factorising $\frac{(n-1)!}{(n-6)!5!}$ or $\frac{(n-1)!}{(n-5)!5!}$ Do not allow if using ${}^{n-1}C_4$ to simplify the left-hand side
	$\frac{(n-1)!}{(n-6)!5!}\left(\frac{5}{n-5}\right)$ oe	**M1**	**dep** on at least one previous **M1** awarded Simplifying fraction
	Completes argument: $\frac{(n-1)!}{(n-6)!5!}\left(\frac{5}{n-5}\right)=\frac{(n-1)!}{(n-1-4)!4!}={}^{n-1}C_4$	**A1**	
	Alternative 1		
	$\frac{n!}{(n-5)!5!} - \frac{(n-1)!}{(n-6)!5!}$	**(M1)**	For substituting ${}^{n}C_5$ and ${}^{n-1}C_5$
	$\frac{1}{(n-6)!}=\frac{n-5}{(n-5)!}$ or $n!=n\times(n-1)!$	**(B1)**	**dep** on previous **M1** awarded
	$\frac{(n-1)!\times[n-(n-5)]}{(n-5)!5!}$	**(M1)**	**dep** on previous **M1** awarded factorising $(n-1)!$ in the fraction
	$\frac{(n-1)!\times5}{(n-5)!5!}=\frac{(n-1)!}{(n-5)!4!}={}^{n-1}C_4$	**(A1)**	
	Alternative 2		
	$\frac{n!}{(n-5)!5!} - \frac{(n-1)!}{(n-6)!5!}$	**(M1)**	For substituting ${}^{n}C_5$ and ${}^{n-1}C_5$ could be implied by expansions of the factorial
	$\frac{n(n-1)(n-2)(n-3)(n-4)}{5!} - \frac{(n-1)(n-2)(n-3)(n-4)(n-5)}{5!}$	**(B1)**	**dep** on previous **M1** awarded
	$\frac{(n-1)(n-2)(n-3)(n-4)[n-(n-5)]}{5!}$	**(M1)**	**dep** on previous **M1** awarded factorising $(n-1)(n-2)(n-3)(n-4)$ in the fraction

6	Completes argument: $\frac{(n-1)(n-2)(n-3)(n-4)}{4!}=\frac{(n-1)!}{4!(n-5)!}={}^{n-1}C_4$	**(A1)**	

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Question 7 **[7]**

7(a)(i)	5040	**B1**	
7(a)(ii)	2520	**B1**	
7(a)(iii)	There are 504 codes less than 1000 $5040-504=4536$	**2**	**M1** for *their* **(i)** -504 or $9\times$(a product of 3 relevant numbers)
7(b)	With family: 462	**B1**	
	Without family: 55	**B1**	
	Total: 517	**B1**	

Question 8 **[10]**

8(a)(i)	30 240	**B1**	
8(a)(ii)	720	**B1**	the number of passwords with no symbols. Not part of a product
	29 520	**B1**	
8(a)(iii)	$(6\times5)\times6\times(4\times3)=2160$ oe	**2**	**B1** for (6×5) and (4×3) soi

8(b)	1 of each and 6 police officers = 20	**B1**	For ${}^4C_1\times{}^5C_1\times{}^6C_6$ must be evaluated, could be implied by a correct total
	2 of each and 4 police officers = 900	**B1**	For ${}^4C_2\times{}^5C_2\times{}^6C_4$ must be evaluated, could be implied by a correct total
	3 of each and 2 police officers = 600	**B1**	For ${}^4C_3\times{}^5C_3\times{}^6C_2$ must be evaluated, could be implied by a correct total
	4 of each and no police officers = 5	**B1**	For ${}^4C_4\times{}^5C_4$ must be evaluated, could be implied by a correct total
	Total = 1525	**B1**	

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Question 9 [11]

9(a)(i)	2520	**B1**	
9(a)(ii)	360	**B1**	
9(a)(iii)	1080	**B1**	
9(a)(iv)	6 or 8 to start with No of ways = $2\times5\times4\times3\times2$ = 240	**B1**	
	9 to start with No of ways = $1\times5\times4\times3\times3$ = 180	**B1**	
	Total number of ways = 420	**DB1**	Dependent on both previous B marks

9(a)(iv)	**Alternative 1** All numbers > 6000 – all odd numbers > 6000	**B1**	plan and attempt to use, must be using 1080
	$1080-180-480$	**B1**	for 180 and 480
	Total number of ways = 420	**DB1**	Dependent on both previous B marks
	Alternative 2 Even numbers > 60000 : Odd numbers > 60000 7 : 11	**B1**	correct ratio
	Total number of ways = $\frac{7}{18}\times1080$	**B1**	
	= 420	**DB1**	Dependent on both previous B marks
9(b)(i)	480700	**B1**	
9(b)(ii)	26460	**B1**	
9(b)(iii)	With brother and sister $^{23}C_5 = 33649$	**B1**	for $^{23}C_5$ or $^{23}C_5\times{}^{k}C_k$
	Without brother and sister $^{23}C_7 = 245157$	**B1**	for $^{23}C_7$ or $^{23}C_7\times{}^{k}C_k$
	Total number of ways = 278806	**B1**	for $^{23}C_5 + {}^{23}C_7$ and evaluation

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Question 10 **[12]**

10(a)(i)	${}^8C_6 \times {}^6C_4$	**B1**	either ${}^8C_6$ or ${}^6C_4$
	420	**B1**	
10(a)(ii)	${}^{12}C_8 + {}^{12}C_{10}$	**B2**	B1 for each
	= 561	**B1**	
	Alternate scheme: $1001 - \left(2 \times {}^{12}C_9\right)$	**B1 B1**	
	= 561	**B1**	
10(b)(i)	136 080	**B1**	
10(b)(ii)	No of ways ending with 0 - 15 120	**B1**	
	No of ways ending with 5 - 13 440	**B1**	
	Total 28 560	**B1**	
10(b)(iii)	Starting with 6 or 8 - 13 440	**B1**	
	Starting with 7 or 9 - 16 800	**B1**	
	Total = 30 240	**B1**	

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