
MATHEMATICS

9709/61

Paper 6

May/June 2016

MARK SCHEME

Maximum Mark: 50

Published

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	Cambridge International AS/A Level – May/June 2016	9709	61

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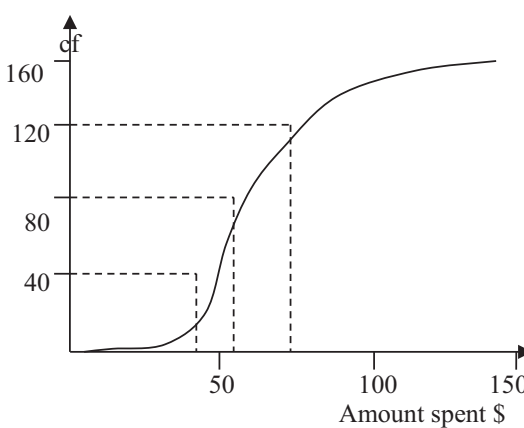
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Question	Answer	Marks	Guidance
1	$z = 1.037$ $1.037 = \frac{1.8 - 1.62}{\sigma}$ $\sigma = 0.18/1.037 = 0.174$	B1 M1 A1 [3]	Rounding to 1.04 Standardising attempt allow cc no sq rt must have a z-value i.e. not 0.8023 or 0.5596.
2	P (throwing a 4) = $(1 - 0.4) / 4 = 0.15$ P(at most 1) = P(0, 1) or $1 - P(2, 3)$ $= (0.85)^3 + {}^3C_1 (0.15) (0.85)^2$ $= 0.939$	M1 A1 M1 M1 A1 [5]	Sensible attempt to find P(1) Correct answer A binomial term with ${}^3C_n$ oe any p Binomial expression with ${}^3C_n$ P(0, 1) or $1 - P(2, 3)$ $p = 0.15$ or 0.85
3 (i)	P (cup of coffee) = $0.6 \times 0.9 + 0.4 \times 0.3 = 0.66$	M1 A1 [2]	Summing two 2-factor probabilities Correct answer accept 0.660
(ii)	P(Not on time no cup of coffee) $= \frac{P(\text{not on time} \cap \text{no cup})}{P(\text{no cup})} = \frac{0.4 \times 0.7}{1 - 0.66}$ $= \frac{0.28}{0.34} = 0.824$	M1 M1 A1 [3]	0.4×0.7 seen as num or denom of a fraction Attempt at P(no cup) as $0.1 \times p_1 + 0.7 \times p_2$ or as $1 - (i)$ seen anywhere
4	$[P(X = 0)] = P(B, B) = 5/7 \times 4/6 = 10/21$ $[P(X = 1)] = P(G, B) + P(B, G) = 2/7 \times 5/6 \times 2 = 10/21$ $[P(X = 2)] = P(G, G) = 2/7 \times 1/6 = 1/21$ $E(X) = 0 + 10/21 + 2/21 = 4/7 (0.571)$ $\text{Var}(X) = 0 + 10/21 + 4/21 - (4/7)^2 = 50/147 (0.340)$	M1 A1 A1 B1 M1 A1 [6]	Attempt to find P(0) or P(1) or P(2) can be seen as P(BB) etc. or table unsimplified P(1) or P(BG)+P(GB) correct P(0) or P(2) correct must see X value Correct answer ft their probs P(1) and P(2) Attempt at $\Sigma x^2 p - [E(X)]^2$
5 (i)	$P(x < 3.0) = P\left(z < \frac{3.0 - 2.6}{0.25}\right)$ $+ P(z < 1.6) = 0.945$	M1 M1 A1 [3]	Standardising no sq rt no cc Correct area i.e. prob > 0.5 legit
(ii)	$X \sim B(500, 0.9452) \sim N(472.6, 25.898)$ $P\left(z > \frac{479.5 - 472.6}{\sqrt{25.89848}}\right) = P(z > 1.3558)$ $= 1 - 0.9125 = 0.0875$	M1 M1 M1 M1 A1 [5]	$500 \times '0.9452'$ and $500 \times '0.9452' \times ('1 - 0.9452')$ seen oe Standardising must have sq rt. All M marks indep cc either 479.5 or 480.5 seen correct area i.e. < 0.5

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Question	Answer	Marks	Guidance
(iii)	500×0.9452 and $500 \times (1 - 0.9452)$ are both > 5	B1 ^{ft} [1]	must see at least $500 \times 0.0548 > 5$ or ft their (i) accept $np > 5$, $nq > 5$ if both not $npq > 5$
6 (a) (i)	$9 \times 9 \times 8$	M1 M1	Logical listing attempt
	$= 648$	A1 [3]	
	OR $900 - 28 \times 9 = 648$		
(ii)	(7...in $1 \times 8 \times 4 = 32$ ways	M1	Listing #s starting with 7 or 9 and ending odd
	8 ...in $1 \times 8 \times 5 = 40$	M1	
	9... in $1 \times 8 \times 4 = 32$	M1	
	Total 104 ways	A1 [4]	
(b)	R(6) T(5) D(4)		Mult 3 combs, ${}^6C_x \times {}^5C_y \times {}^4C_z$ Summing 2 or 3 three-factor outcomes can be perms, + instead of $\times$ 2 options correct unsimplified
	$2\ 2\ 3 = {}^6C_2 \times {}^5C_2 \times {}^4C_3 = 600$	M1	
	$2\ 3\ 2 = {}^6C_2 \times {}^5C_3 \times {}^4C_2 = 900$	M1	
	$3\ 2\ 2 = {}^6C_3 \times {}^5C_2 \times {}^4C_2 = 1200$	A1	
	Total = 2700	A1 [4]	
7 (i)	cf 16, 56, 104, 130, 160	M1	Attempt at cf table (up to 160) no graph needed accept %cf but give final
		B1	
		M1	
		A1 [4]	
(ii)	median \$59	B1 ^{ft}	accept 57–60 or ft their graph if used lb, midpts instead of ub or assume linear interpolation. Subt a (sensible) LQ from a sensible UQ (generous) Ans ft need a cf graph and UQ 80–84, LQ
	IQR = $82 - 43 = \$39$	M1 A1 ^{ft} [3]	

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(iii)	160 – 149 = 11 OR 115 is mid pt of last interval so # of shoppers is $30/2 = 15$ (can be implied)	M1 A1 [2]	41–46 Subtracting from 160 can be implied Correct answer accept 9–16
(iv)	mean = $(15 \times 16 + 40 \times 40 + 60 \times 48 + 80 \times 26 + 115 \times 30) / 160$ = $10250 / 160 = \$64.1 = \$64.1$	M1 A1 [2]	Using $\Sigma xf / 160$ with mid-points

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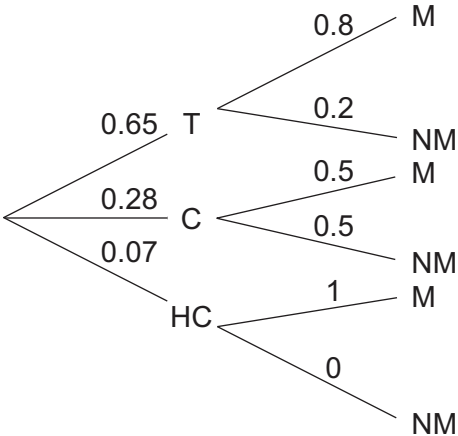
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1 (i)		M1 A1 [2]	Correct shape with either one branch after HC or 2 branches with 0 prob seen correct Labelled and clear annotation All probs correct										
(ii)	$P(C \mid \text{milk}) = \frac{P(\text{coffee} \cap \text{milk})}{P(\text{milk})}$ $= \frac{0.28 \times 0.5}{0.65 \times 0.8 + 0.28 \times 0.5 + 0.07(\times 1)}$ $= \frac{0.14}{0.73}$ $= 0.192$	M1 A1 [3]	Attempt at P(coffee∩ milk)as a two-factor prod only seen as num or denom of a fraction Summing appropriate three 2-factor products seen anywhere (can omit the 1) Correct answer oe										
2 (i)	0.72	B1 [1]											
(ii)	$np = 180 \times 0.72, npq = 180 \times 0.72 \times 0.28$ $X \sim N(129.6, 36.288)$ $P(x > 115) = P\left(z > \frac{115.5 - 129.6}{\sqrt{36.288}}\right)$ $= P(z > -2.341)$ $= 0.990$	B1 M1 M1 M1 A1 [5]	$180 \times 0.72, 180 \times 0.72 \times 0.28$ seen, their values or correct Standardising (±) must have sq rt cc either 115.5 or 114.5 seen Correct area, Φ from final answer attempt fully correct method										
3 (i)	<table border="1"><tr><td>x</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>$P(x)$</td><td>k</td><td>$2k$</td><td>$3k$</td><td>$4k$</td></tr></table> $10k = 1$ $k = 1/10$	x	1	2	3	4	$P(x)$	k	$2k$	$3k$	$4k$	B1 M1 A1 [3]	Probability Distribution Table, either k or correct numerical values Summing probs involving k to = 1, 3 or 4 terms
x	1	2	3	4									
$P(x)$	k	$2k$	$3k$	$4k$									
(ii)	$E(X) = 1/10 + 4/10 + 9/10 + 16/10 = 3$ $\text{Var}(X) = 1/10 + 8/10 + 27/10 + 64/10 - 3^2$ $= 1$	B1 M1 A1 [3]	Correct mean Correct method seen for var, their k and μ										

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4	(i)	$p = 0.66$ $X \sim B(15, 0.66)$ $P(\text{at least } 14) = P(14, 15) =$ ${}^{15}C_{14} (0.66)^{14} (0.34) + (0.66)^{15}$ $= 0.0171$	M1 M1 A1 [3]	Bin term ${}^{15}C_x p^x (1 - p)^{15-x}$ seen any p Unsimplified correct expression for $P(14, 15)$
	(ii)	$(0.87)^n < 0.04$ $n = 24$	M1 M1 A1 [3]	Eqn involving 0.87, power of n, 0.04 only Solving by logs or trial and error(can be implied). Must be exponential equation
5	(i)	Bronlea Rogate 6 3 0 4 5 7 7 7 4 3 1 0 1 3 5 6 8 8 7 5 4 2 1 2 3 3 6 3 2 3 4 5 4 Key 3 1 5 represents 13 kph for Bronlea and 15 kph for Rogate	B1 B1 B1 B1	Correct single stem Correct ordered leaves Bronlea Correct ordered leaves Rogate Correct overall shape
	(ii)	median Bronlea = 23 km per hour IQ range Rogate = 23 – 7 = 16	B1 M1 A1 [3]	Units not necessary Subt their LQ <14 from their UQ>14 from Rogate leaf
	(iii)	Rogate is less windy than Bronlea	B1 [1]	Not a comparison of a statistic but interpretation of information
	6	(i)	$P(x > 10.2) = P\left(z > \frac{10.2 - 9.5}{1.3}\right)$ $= P(z > 0.53846)$ $= 1 - 0.7046$ $= 0.295$	M1 M1 A1 [3]
(ii)		$z = -1.282$ $-1.282 = \frac{t - 9.5}{1.3}$ $t = 7.83$	B1 M1 A1 [3]	$\pm$ rounding to 1.28 seen Standardising correctly can be $\pm z$ value here Correct answer from $z = -1.282$ only
(iii)		$P(x < 8.8) = 0.2954$ by symmetry Days = 365×0.2954 = 107 or 108	B1 M1 A1 [3]	oe method, FT <i>their 0.2954 from (i)</i> Mult a probability <1 by 365 Correct answer (no decimals)
7		(a) (i)	$\frac{10!}{2!3!} = 302400$	B1 [1]

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(ii)	e.g. *W*****W*, **W*****W, W*****W**	M1	8! Seen mult or alone. Cannot be embedded (arrangements of other 8 letters).
	$\frac{8!}{3!} \times 3(\text{for the Ws})$ = 20160	M1 M1 A1 [4]	Dividing by 3! (removing repeated L's) Mult by 3 (different W positions) may be sum of 3 terms
(b)	S(5) A(7) C(4) 1 3 2 : $5 \times {}^7C_3 \times {}^4C_2 = 1050$ 1 4 1 : $5 \times {}^7C_4 \times 4 = 700$ 2 3 1 : ${}^5C_2 \times {}^7C_3 \times 4 = 1400$ 3 2 1 : ${}^5C_3 \times {}^7C_2 \times 4 = 840$ (Outcomes : Options)	M1 A1	Mult 3 combinations, ${}^5C_x$, ${}^7C_y$, ${}^4C_z$ (not 5 x 7 x 4) 2 correct options unsimplified
	Total = 3990	M1 A1 [4]	Summing only 3 or 4 correct outcomes involving combs or perms

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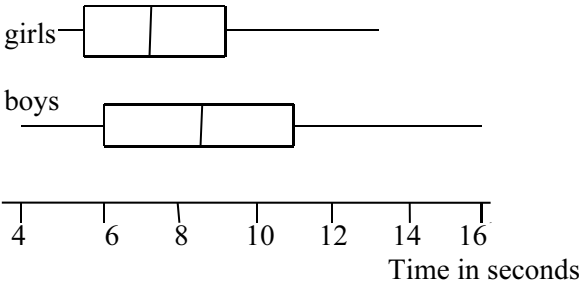
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1 (i)	<table><tr><td></td><td>Wears specs</td><td>Not wears specs</td><td>Total</td></tr><tr><td>RH</td><td>6</td><td>19</td><td>25</td></tr><tr><td>Not RH</td><td>2</td><td>3</td><td>5</td></tr><tr><td>Total</td><td>8</td><td>22</td><td></td></tr></table>		Wears specs	Not wears specs	Total	RH	6	19	25	Not RH	2	3	5	Total	8	22		B1	One correct row or col including total other than the Total row/column
		Wears specs	Not wears specs	Total															
	RH	6	19	25															
	Not RH	2	3	5															
Total	8	22																	
(ii)	$P(X) = 25/30, P(Y) = 8/30$	B1 [2]	All correct																
	$P(X) \times P(Y) = 25/30 \times 8/30 = 200/900 = 2/9$ $P(X \cap Y) = 6/30 = 1/5 \neq P(X) \times P(Y)$	M1	$P(X)$ or $P(Y)$ from their table or correct from question (denom 30) oe																
	Not independent	M1 A1 [3]	Comparing their $P(X) \times P(Y)$ (values substituted) with their evaluated $P(X \cap Y)$ – not $P(X) \times P(Y)$																
2 (i)		B1	Labels ‘time’ and ‘seconds’, ‘boys’ and ‘girls’ on correct plots and scaled line																
		B1	One box and whisker all correct on graph paper – ignore boy or girl label																
		B1 [3]	Second box and whisker all correct (on graph paper and ignore boy/girl label) on SAME scaled line.																
	(ii)	girls smaller range or IQ range than boys /girls less spread out oe girls generally quicker than boys or girls median<boys median (not mean) oe boys almost symmetrical, girls +vely skewed oe	B1 B1 [2]	Any 2 comments – MUST be a comparison															
3 (i)	$P(0) = 6/36, P(1) = 10/36, P(2) = 8/36$	B1	Table oe seen with 0, 1, 2, 3, 4, 5 (6 if $P(6) = 0$)																
	$P(3) = 6/36, P(4) = 4/36, P(5) = 2/36$	B1 M1 A1 [4]	Any three probs correct $\Sigma p = 1$ and at least 3 outcomes All probs correct																
	mean score = $(0 \times 6 + 1 \times 10 + 16 + 18 + 16 + 10)/36$	M1	Using Σxp (unsimplified) on its own – condone																
	$= 70/36$ (35/18, 1.94)	A1 [2]	Σp not =1																

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Qu	Answer	Marks	Guidance
4 (i)	$1845/9 (= 205)$ $c = 2205 - 205 = 2000$ OR $\Sigma x = 2205 \times 9 (= 19845)$ $\Sigma x - \Sigma c = 1845$ $\Sigma c = 19845 - 1845 = 18000$ $c = 2000$	M1 A1 M1 A1 [2]	Accept $(1845 \pm \text{anything})/9$ For 2205×9 seen
(ii)	$\text{var} = \frac{477450}{9} - 205^2$ $= 11025$ OR $\text{var} = \frac{43857450}{9} - 2205^2$ $= 11025$	M1 A1 M1 A1 [2]	For $\frac{477450}{9} - (\text{their coded mean})^2$ For their $\Sigma x^2/9 - 2205^2$ where Σx^2 is obtained from expanding $\Sigma(x - c)^2$ with $2c\Sigma x$ seen
(iii)	new total $= 2120.5 \times 10 = 21205$ new price $= 21205 - 19845$ $= 1360$	M1 A1 [2]	Attempt at new total
5 (i)	$z = 1.015$ $1.015 = \frac{70 - 69}{\sigma}$ $\sigma = 0.985 (200/203)$	B1 M1 A1 [3]	Accept z between ± 1.01 and 1.02 Standardising
(ii)	$58 + 9 = 67$ $P(> 67) = P\left(z > \frac{67 - 69}{0.9852}\right)$ $= P(z > -2.03)$ $= 0.9788$ 300×0.9788 $= 293.6$ so 293	M1 M1 M1 M1 A1 [5]	$58 + 9$ seen or implied (or $69 - 58$ or $69 - 9$) Standardising $\pm z$ no cc allow their sd (must be +ve) Alt. 1 $69 - 58 = 11$, $P(>9) = P\left(z > \frac{9 - 11}{0.9852}\right)$ Alt. 2 $69 - 9 = 60$, $P(>58) = P\left(z > \frac{58 - 60}{0.9852}\right)$ Correct prob area Multiply their prob (from use of tables) by 300 – accept 293 or 294 from fully correct working

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Qu	Answer	Marks	Guidance
6 (i)	7560 ways	B1 [1]	
(ii)	RxxxxxxxG in $\frac{7!}{4!}$	B1	7! alone seen in num or 4! alone in denom Must be in a fraction. $\frac{7 \times 2}{4 \times 2}$ gets full marks
	= 210 ways	B1 [2]	
(iii)	eg EEEEExxxxx in $\frac{6!}{2!}$	B1	6! or $5! \times 6$ seen in numerator or on own Can be $6! \times k$ but not $6! \pm k$
	= 360 ways	B1 [2]	
(iv)	1 R eg RVG or RVN or RGN = 3	B1 [1]	
(v)	no Rs eg VGN or 3C3 ways = 1 2 Rs eg RRV or 3C1 ways = 3	M1	Summing at least 2 options for R
	Total = 7	A1 A1 [3]	Correct outcome for no Rs or 2 Rs – evaluated
7 (i)	${}^{12}C_8 (0.65)^8(0.35)^4 + {}^{12}C_9 (0.65)^9(0.35)^3 + {}^{12}C_{10} (0.65)^{10}(0.35)^2$	M1 M1 A1 [3]	Bin term with ${}^{12}C_r p^r (1-p)^{12-r}$ seen $r \neq 0$ any $p < 1$ Summing 2 or 3 bin probs $p = 0.65$ or 0.35 , $n = 12$
	= 0.541		
(ii)	$P(\overline{RRRR}) = 0.35 \times 0.35 \times 0.35 \times 0.65$	M1	Mult 4 probs either $(0.35)^3(0.65)$ or $(0.65)^3(0.35)$
	= 0.0279	A1 [2]	
(iii)	$P(7) = 0.2039$ (unsimplified)	B1	${}^{12}C_7 (0.65)^7(0.35)^5$
	Mean = 250×0.2039 (= 50.9798) Var = $250 \times 0.2039 \times (1 - 0.2039)$ (= 40.5851)	B1	Correct unsimplified np and npq using ‘their 0.2039’ but not 0.65 or 0.35
	$P(> 54) = P\left(\frac{54.5 - 50.9798}{\sqrt{40.5851}}\right)$	M1	Standardising need sq rt – must be from working with 54
	= $P(z > 0.5526)$	M1	cc either 53.5 or 54.5
	= $1 - \Phi(0.5526) = 1 - 0.7098$	M1	correct area < 0.5 i.e. $1 - \Phi$ - must be from working with 54
	= 0.290	A1 [6]	