
MATHEMATICS

9709/61

Paper 6

October/November 2016

MARK SCHEME

Maximum Mark: 50

Published

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Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2016	9709	61

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1	$z = 0.674$ $0.674 = \frac{k - 20}{7}$ $k = 24.7$	M1 M1 A1	[3]	± 0.674 seen Standardising no cc, no sq, no sq rt														
2	<table><tr><td>diff</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>prob</td><td>6/36</td><td>10/36</td><td>8/36</td><td>6/36</td><td>4/36</td><td>2/36</td></tr></table> Expectation = $(0+10+16+18+16+10)/36$ = $70/36$ = 1.94	diff	0	1	2	3	4	5	prob	6/36	10/36	8/36	6/36	4/36	2/36	B1 M1 A1 M1 A1	[5]	0, 1, 2, 3, 4, 5 seen in table heading or considering all different differences Attempt at finding prob of any difference 1 correct prob Probs summing to 1
diff	0	1	2	3	4	5												
prob	6/36	10/36	8/36	6/36	4/36	2/36												
3 (i)	$0.9 \times 0.95 \times 0.85 \times 0.1 = 0.0727$	B1	[1]															
(ii)	$P(0, 1, 2)$ $= (0.9)^{12} + {}^{12}C_1 (0.1)(0.9)^{11} + {}^{12}C_2 (0.1)^2(0.9)^{10}$ $= 0.889$	M1 M1 A1	[3]	Bin term ${}^{12}C_x (p)^x (1 - p)^{12 - x}$ $p < 1, x \neq 0$ Bin expression $p = 0.1$ or $0.9, n = 12, 2$ or 3 terms														
(iii)	$X \sim B(50, 0.85)$ Expectation = $50 \times 0.85 (= 42.5)$ Var = $50 \times 0.85 \times 0.15 (= 6.375)$	M1 A1	[2]	50×0.85 seen oe can be implied Correct unsimplified mean and var														
4 (i)	$P(< 1) = P\left(z < \frac{1 - 1.04}{0.017}\right) = P(z < -2.353)$ $= 1 - 0.9907$ $= 0.0093$	M1 M1 A1	[3]	Standardising no cc, no $\sqrt{\quad}$ or sq $1 - \Phi$ (final process)														
(ii)	expected number $1000 \div 1.04 = 961$ or 962	B1	[1]	Or anything in between														
(iii)	$z = -1.765$ $-1.765 = \frac{1 - \mu}{0.017}$ $= 1.03$	B1 M1 A1	[3]	± 1.76 to 1.77 Standardising must have a z-value, allow $\sqrt{\quad}$ or sq														
(iv)	expected number = $1000 \div 1.03 = 971$ or 970	B1✓	[1]	Or anything in between, ft their (iii)														

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5	(a)	e.g. P*N*P*P*L $= \frac{5!}{3!} \times \frac{{}^6P_4}{2!}$ $= 3600$	M1 M1 M1 A1	[4]	Mult by 5! in num Dividing by 3! or 2! Mult by ${}^6P_4$ oe
	(b) (i)	${}^7C_5 \times {}^5C_4 \times {}^2C_1 \times {}^2C_1$ $= 420$	M1 A1	[2]	Mult 4 combs of which three are correct
	(ii)	both in team ${}^6C_4 \times {}^4C_3 \times 2 \times 2 = 240$ $420 - 240 = 180 \text{ ways}$ OR Bat in bowl out + bowl in bat out + both out $= {}^6C_4 \times {}^4C_3 \times 2 \times 2 + {}^6C_5 \times {}^4C_3 \times 2 \times 2 + {}^6C_5 \times {}^4C_4 \times 2 \times 2$ $= 60 + 96 + 24 = 180 \text{ ways}$ OR Bat in bowl out + bat out $= 60 + {}^6C_5 \times {}^5C_4 \times 2 \times 2 = 60 + 120 = 180 \text{ ways}$	M1 M1 A1 M1 A1 A1 M1 A1 A1	[3]	Evaluating both in team and subtracting from (i) 240 seen can be unsimplified fit their 420, their 240 summing 2 or 3 options not both in team 2 or 3 options correct unsimplified Correct ans from correct working As above, or bowl in bat out + bowl out
	(i)	$P(B, B) = 1/4 \times 2/5$ $= 1/10$	M1 A1	[2]	Multiplying two different probs
	(ii)	$P(X = 1) = P(R, R) + P(B, B)$ $= 3/4 \times 4/5 + 1/10$ $= 14/20 \text{ (7/10)}$	M1 M1 A1	[3]	Finding P(R, R) (=3/5) Summing two options
	(iii)	$P(B \mid B)$ $= \frac{P(B \cap B)}{P(B)} = \frac{1/10}{3/4 \times 1/5 + 1/4 \times 2/5}$ $= 2/5$	M1 M1 A1 A1	[4]	their (i) seen as num or denom of a fraction $\frac{3}{4} \times p_1 + \frac{1}{4} \times p_2$ seen anywhere 1/4 (unsimplified) seen as num or denom of a fraction, www

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7	(i)	Factory <i>A</i>		Factory <i>B</i>	M1		Attempt at ordering factory <i>B</i>
			3	1 5 8	B1		Correct stem
		9	4	2 4 7 8 9			
		9 8 8 7 4 3 0	5	1 4 6 8			
		5 3 1 1 1	6	4	B1		Correct leaves factory <i>A</i>
		Key: 9 4 2 represents 0.049g for factory <i>A</i> and 0.042 g for factory <i>B</i>			B1		Correct leaves factory <i>B</i>
					B1		Correct key need factory <i>A</i> and factory <i>B</i> and units
[5]							
(ii)	median factory <i>B</i> = 0.048 g				B1		using their key i.e. 48, 0.48 etc or correct
	IQR = UQ – LQ = 0.055 – 0.04				M1		Subt their LQ from their UQ for factory <i>B</i>
	= 0.015				A1	[3]	
(iii)	generally heavier in factory <i>A</i>				B1		oe
	Masses more spread out in factory <i>B</i>				B1	[2]	must refer to context, e.g. mass

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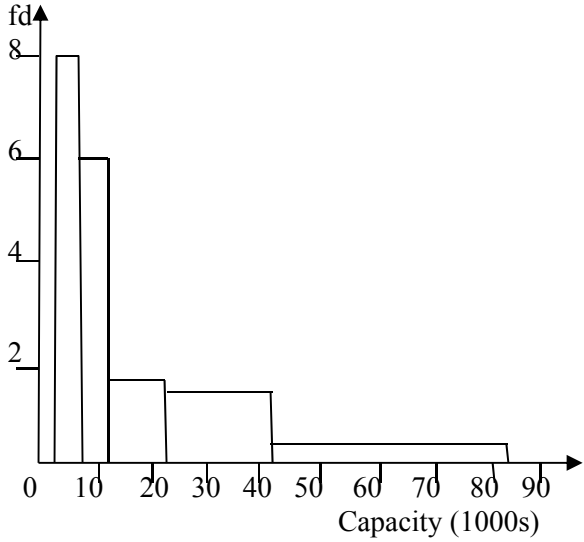
MR –1 A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become “follow through $\frac{1}{2}$ ” marks. MR is not applied when the candidate 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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		A1		Correct unsimplified P(C∩L) as numerator										
		M1		Summing three 2-factor products seen anywhere										
		A1		0.14 (unsimplified) seen as num or denom of a fraction										
		A1	[5]	oe										
2 (i)	$P(1 \text{ T-shirt}) = \frac{{}^3C_1 \times {}^9C_2}{{}^{12}C_3}$ $= 27/55$ AG OR 3/12×9/11×8/10× ³ C ₁ oe $= 27/55$ AG	B1 B1 B1	[3]	Correct num unsimplified Correct denom unsimplified Answer given, so process needs to be convincing										
		M1 M1 A1		Mult 3 probs diff denoms (not a/3 x b/4 x c/5) Mult by ³ C ₁ oe Answer given, so process needs to be convincing										
(ii)	<table><tr><td>X</td><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>Prob</td><td>84/220</td><td>27/55</td><td>27/220</td><td>1/220</td></tr></table>	X	0	1	2	3	Prob	84/220	27/55	27/220	1/220	B1 B1 B1 B1	[4]	0, 1, 2, 3 only seen in top line (condone additional values if Prob stated as 0) One correct prob, correctly placed in table One other correct prob, correctly placed in table One other correct prob ft Σp = 1, 4 values in table
X	0	1	2	3										
Prob	84/220	27/55	27/220	1/220										
3 (i)	Bin (7, 0.8) P(6, 7) = ⁷ C ₆ (0.8) ⁶ (0.2) ¹ + (0.8) ⁷ = 0.577	M1 M1 A1	[3]	⁷ C _n p ⁿ (1-p) ⁷⁻ⁿ seen Correct unsimplified expression for P(6,7)										
(ii)	mean = 100×0.2 = 20 Var = 100×0.2×0.8 = 16 $P(\text{at most } 30) = P\left(z < \frac{30.5 - 20}{\sqrt{16}}\right)$ $= P(z < 2.625)$ $= 0.996$	B1 M1 M1 M1 A1	[5]	Correct unsimplified mean and var Standardising must have sq rt, their μ, variance cc either 29.5 or 30.5 Correct area Φ , from final process										
4 (i)	$P(< 4.5) = P\left(z < \frac{4.5 - 4.2}{0.6}\right) = P(z < 0.5)$ $= 0.6915$ $P(< 3.5) = P\left(z < \frac{3.5 - 4.2}{0.6}\right) = P(z < -1.167)$ $= 1 - 0.8784 = 0.1216$ $0.6915 - 0.1216 = 0.570$	M1 M1 A1	[3]	Standardising once no cc no sq no sq rt Φ ₁ - (1 - Φ ₂) [P ₁ - P ₂ , 1>P ₁ >0.5, 0.5>P ₂ >0] oe										

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	(ii)	$z = 1.175$ $1.175 = \frac{t - 4.2}{0.6}$ $t = 4.91$	B1 M1 A1	[3] ± 1.17 to 1.18 seen Standardising no cc, allow sq, sq rt with z – value (not $\pm 0.8106, 0.5478, 0.4522, 0.1894, 0.175$ etc.) Correct answer from $z = 1.175$ seen (4sf)
	(iii)	$(0.88)^n < 0.003$ $n > \lg(0.003)/\lg(0.88)$ $n > 45.4$ $n = 46$	M1 M1 A1	[3] Inequality or eqn in 0.88 , power correctly placed using n or $(n \pm 1)$, 0.003 or $(1 - 0.003)$ oe Attempt to solve by logs or trial and error (may be implied by answer) Correct integer answer
	5 (i)	cw 5, 5, 10, 20, 40 fd 8, 6, 1.8, 1.7, 0.2 	M1 M1 A1 B1 B1	 cw either 4 or 5 etc fd or scaled freq [f/their cw attempt] fd may be $\div 1000$ Correct heights seen accurately on diagram Correct bar ends, accurately plotted on axis [5] Labels fd and capacity (thousands) Correct horizontal scale required. Vertical scale linear from 0
	(ii)	$(5 \times 40 + 10 \times 30 + 17.5 \times 18 + 32.5 \times 34 + 62.5 \times 8) / 130$ $= 2420 / 130 = 18.6$ thousand	M1 A1	 [2] $\Sigma fx / 130$ where x is mid point attempt (value within class, not end pt or cw)
	(iii)	median group = 8 – 12 thousand LQ group = 3 – 7 thousand	B1 B1	[2] Thousands not needed

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6	(i)	e.g. (OAEE)(CPNHGN) or cv $\frac{4!}{2!} \times \frac{6!}{2!} \times 2 = 8640$	M1 M1 A1	[3]	4!/2! or 6!/2! seen anywhere All multiplied by 2 oe
	(ii)	First Method Total ways = $10!/2!2! = 907200$ EE together in $9!/2!$ ways = 181440 EE not together = $907200 - 181440 = 725760$ OR Second Method C P N H G N O A in $8!/2!$ ways ↑ Insert E in 9 ways Insert 2nd E in 8 ways, $\div 2$ Total = $8!/2! \times 9 \times 8 \div 2 = 725760$	B1 M1 M1 A1 B1 M1 M1 A1	[4]	Total ways together correct EE together attempt alone Considering total – EE together 8!/2! Seen Interspersing an E, x n where n=7,8,9. Condone additional factors. Mult by $9 \times 8 (\div 2)$, ${}^9C_2$ or ${}^9P_2$ only oe
	(iii)	First Method EN** in ${}^6C_2$ ways = 15 different ways EENN in 1 way Total 16 ways OR Second Method Listing with at least 8 different correct options Listing all correct options Total = 15 different ways EENN in 1 way Total 16 ways	M1 M1 A1 B1 A1 M1 M1 A1 B1 A1	[5]	${}^6C_x$ or ${}^yC_2$ seen alone or mult by $k > 1$, $x < 6$, $y > 2$ ($1 \times 1 \times$) ${}^6C_2$ seen strictly alone or added to their EENN only Value stated or implied by final answer correct value stated Award 16 SRB2 if no method is present

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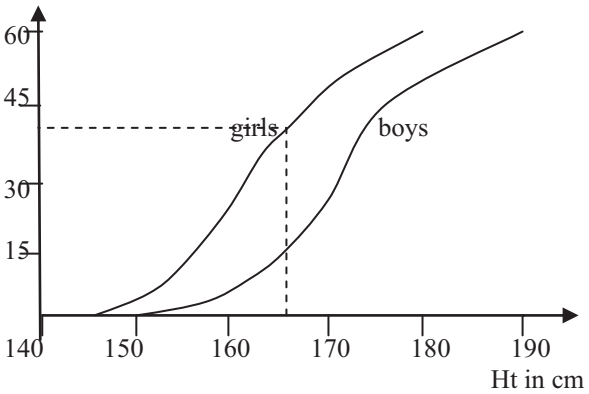
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1	total ways $^{10}C_5=252$ MW together e.g. (MW)*** in $^8C_3$ ways = 56 MW not together = $252 - 56$ = 196 ways OR 1 $2^8C_4 + ^8C_5$ $2^8C_4 = 2 \times 70 = 140$; $^8C_5 = 56$ $2^8C_4 + ^8C_5 = 196$ OR 2 $2^9C_5 - ^8C_5$ $2^9C_5 = 2 \times 126 = 252$; $^8C_5 = 56$ $2^9C_5 - ^8C_5 = 196$	M1 B1 A1 M1 B1 A1 M1 B1 A1	[3]	$^{10}C_5 - \dots$ or $252 - \dots$ 252 and 56 seen, may be unsimplified $2^nC_4 + ^nC_5$ 140 and 56 seen may be unsimplified $2^9C_5 - \dots$ 252 and 56 seen, may be unsimplified
2 (i)	$p = 1/3$ $P(\geq 2) = 1 - P(0, 1) = 1 - (2/3)^4 - ^4C_1(1/3)(2/3)^3$ or $P(2,3,4) = ^4C_2(1/3)^2(2/3)^2 + ^4C_3(1/3)^3(2/3) + (1/3)^4$ = $\frac{11}{27}$, 0.407	M1 M1 A1	[3]	Bin term $^4C_x p^x (1-p)^{4-x}$ $0 < p < 1$ Correct unsimplified answer
(ii)	$P(\text{sum is } 5) = P(1, 1, 1, 2) \times 4 = (1/3)^4 \times 4$ = $\frac{4}{81}$, 0.0494	M1 M1 A1	[3]	1, 1, 1, 2 seen or 4 options Mult by $(1/3)^4$
3 (i)	e.g. **5 in $^3P_2$ ways = 6 **7 in $^3P_2 = 6$ Total 12 AG OR listing 457, 547, 467, 647, 567, 657, 475, 745 465, 645, 675, 765 Total 12 AG	M1 M1 A1 M1 M1 A1	[3]	Recognising ends in 5 or 7, can be implied Summing ends in 5 + ends in 7 oe Correct answer following legit working Listing at least 5 different numbers ending in 5 Listing at least 5 different numbers ending in 7
(ii)	1 digit in 2 ways 2 digits in *5 or *7 = $^3P_1 \times 2 = 6$ 4 digits in ***5 or ***7 = $^3P_3 \times 2 = 12$ Total ways = 32	M1 A1 A1	[3]	Consider at least 3 options with different number of digits. If no working, must be 3 or 4 from 2, 6, 12, 12 One option correct from 1, 2 or 4 digits
4 (i)	64/250, 0.256	B1	[1]	oe
(ii)	190/250, 0.76(0)	B1	[1]	oe

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(iii)	$P(X) = 80/250 = 8/25$ $P(Y) = 100/250 = 2/5$ $P(X \cap Y) = 32/250 = 16/125$ $P(X) \times P(Y) = \frac{8}{25} \times \frac{2}{5} = \frac{16}{125}$ Since $P(X) \times P(Y) = P(X \cap Y)$ therefore independent	M1 M1 B1 M1 A1	 [5]	attempt at $P(X)$ attempt at $P(Y)$ oe comparing $P(X) \times P(Y)$ and $P(X \cap Y)$ so long as independence has not been assumed correct answer with all working correct
5 (i)	cf 	B1 B1 B1 B1	 [4]	Horizontal axis from min of 140 to 190 and vertical axis from 0 to minimum of 60 and two CF graphs on the same set of axes. Labels: CF; height (ht) in cm; girls; boys in correct places CF graph going through (150, 0), (160, 20), (170, 43), (180, 55) and (190, 60) CF graph going through (140, 0), (150, 12), (160, 33), (170, 50), (180, 60) [and (190, 60)]
(ii)	42 (± 1) shorter than 165. $(18(\pm 1))/60 \times 100$ $= 30\% (\pm 1.7\%)$	M1 M1 A1	 [3]	Line or reading from 165 on their cf graph oe subtracting from 60
(iii)	can see which is taller; see which of boys or girls is more spread out	B1	[1]	any sensible comment in context
6 (i)	$P(\text{small}) = P\left(z < \frac{95 - 150}{50}\right)$ $= P(z < -1.1)$ $= 1 - 0.8643$ $= 0.136$	M1 M1 A1	 [3]	$\pm$ standardising using 95, no cc, no sq, no sq rt $1 - \Phi$ (in final answer)
(ii)	$z = 1.282$ $1.282 = \frac{x - 150}{50}$ $x = 214 \text{ g}$	B1 M1 A1	 [3]	$\pm$ rounding to 1.28 Standardised eqn in their z allow cc
(iii)	$P(\text{small}) = 0.1357$, $P(\text{large}) = 0.1357$ symmetry $P(\text{medium}) = 1 - 0.1357 \times 2 = 0.7286$ AG	B1	[1]	Correct answer legit obtained
(b)	Expected cost per banana $= 0.1357 \times 10 + 0.1357 \times 25 + 0.7286 \times 20 = 19.3215$ cents Total cost of 100 bananas $= 1930$ (cents) (\$19.30)	*M1 DM1 A1	 [3]	Attempt at multiplying each 'prob' by a price and summing Mult by 100

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7	(i)	$P(2) = {}^7C_2(0.1)^2(0.9)^5$ $= 0.124$	M1 A1	[2]	Bin term ${}^7C_2p^2(1-p)^5$ $0 < p < 1$
	(ii)	$(0.15)^1(0.1)^2(0.75)^2 \times 5!/2!2!$ $= 0.0253$ or $81/3200$	M1 M1 A1	[3]	Mult probs for options, $(0.15)^a(0.1)^b(0.75)^c$ where $a + b + c$ sum to 5 Mult by $5!/2!2!$ oe
	(iii)	mean = 365×0.15 (= 54.75 or 219/4) Var = $365 \times 0.15 \times 0.85$ (= 46.5375 or 3723/80) $P(x > 44) = P\left(z > \frac{44.5 - 54.75}{\sqrt{46.5375}}\right)$ $= P(z > -1.5025)$ $= 0.933$	B1 M1 M1 M1 A1	[5]	Correct unsimplified mean and var, oe $\pm$ Standardising need sq rt cc either 44.5 (or 43.5) Φ Correct answer accept 0.934