

MARK SCHEME for the May/June 2010 question paper
for the guidance of teachers

9709 MATHEMATICS

9709/61

Paper 61, maximum raw mark 50

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	GCE AS/A LEVEL – May/June 2010	9709	61

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B Mark for a correct result or statement independent of method marks.

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1 $a + b = 0.45$ $-3a - b + 1.6 = 0.75$ $a = 0.2 \quad b = 0.25$	B1 M1 A1 A1 [4]	Correct sum probs = 1 o.e. Attempt at $\Sigma xp = 0.75$ Correct a Correct b
2 (i) 0 2 5 6 8 8 1 2 4 6 7 7 9 2 1 2 3 3 3 5 6 7 3 1 5 Key 1 2 represents 12 people	B1 B1 B1 [3]	Correct stem Correct leaves must be sorted and accurate Key; must have people o.e
(ii) median = 19 people LQ = 10, UQ = 24 IQ range = $24 - 10 = 14$ people	B1 B1 B1ft [3]	Correct median Correct quartiles Ft their quartiles
(iii) median because mode could be any number which is duplicated more than twice	B1 [1]	Correct answer must say something about the mode being not much use or another sensible reason
3 $(+/-) 1.045, (+/-) 0.313$ $20.9 - \mu = -0.313 \sigma$ $30 - \mu = 1.045 \sigma$ $\sigma = 6.70$ $\mu = 23.0$	B1, B1 M1 A1 A1 [5]	1 correct z-value, the other correct z-value. Valid attempt to solve 2 equations relating to $\mu, \sigma, 30, 20.9$. No $\sqrt{\sigma}, \sigma^2$ correct answer correct answer
4 (i) $sd = 0$ so all rides must cost the same i.e. the mean.	B1* B1 dep [2]	Must see this and some relevant comment, e.g. no change o.e.
(ii) $1 \times 2.5 + 3 \times 2.5 + 6 \times x = 3.76 \times 10$ $6x = 37.6 - 10$ $x = 4.6$ for revolving drum $\sigma^2 = (2.5^2 \times 1 + 2.5^2 \times 3 + 4.6^2 \times 6)/10 - 3.76^2$ $\sigma = 1.03$	M1 A1 A1 M1 A1 [5]	attempt to find cost of revolving drum ride correct equation correct x substituting in correct variance formula correct answer

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5	(i) $P(X = 2) = (0.25)^2 \times (0.75)^6 \times {}^8C_2$ $= 0.311$	M1 A1 [2]	3 term binomial expression involving ${}^8C$ something, powers summing to 8 correct answer
	(ii) $12 \times 0.25 = 3, < 5$ so not possible	B1 [1]	
	(iii) mean = $40 \times 0.25 (= 10)$ variance = $40 \times 0.25 \times 0.75 (= 7.5)$ $P(X \text{ at least } 13) = P\left(z > \frac{12.5 - 10}{\sqrt{7.5}}\right)$ $= P(z > 0.913)$ $= 1 - \Phi(0.913)$ $= 1 - 0.8194$ $= 0.181$	B1 M1 M1 M1 A1 [5]	40×0.25 and $40 \times 0.25 \times 0.75$ seen, o.e. standardising, $\pm$, with or without cc, must have sq rt continuity correction 12.5 or 13.5 correct area, i.e. < 0.5 legit correct answer
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

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7 (i) $P(1^{\text{st}} \text{ correct}) = 0.7 + 0.2 \times 0.95$ $= 0.89$ AG	B1	
(ii) $P(CC) = 0.7 \times 0.7 (= 0.49)$ $P(CHA) = 0.7 \times 0.2 \times 0.95 (= 0.133)$ $P(HAC) = 0.2 \times 0.95 \times 0.7 (= 0.133)$ $P(HAHP) = 0.2 \times 0.95 \times 0.2 \times 0.65 (= 0.0247)$ $P(\text{both correctly answered}) = 0.781$	M1 M1 M1 B1 B1 A1 [6]	Considering any 2 of CC, CHA, HAC or $HAHP$ [where C = Peter correct, H = ask for help, A = audience correct, P = phone correct] or tree diagram with 'top half' labels and probs shown Considering <i>other 2</i> Summing 4 probabilities Two correct probabilities Three correct probabilities Correct
(iii) $P(\text{audience} \mid \text{both correct})$ $= \frac{P(CHA) + P(HAC) + P(HAHP)}{\text{ans (ii)}}$ $=$ $\frac{0.7 \times 0.2 \times 0.95 + 0.2 \times 0.95 \times 0.7 + 0.2 \times 0.95 \times 0.2 \times 0.65}{0.7807}$ $= 0.2907/0.7807$ $= 0.372$	M1* M1dep A1 [3]	Summing two or three 3-factor terms in numerator of a fraction Dividing by their (ii) Correct answer

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1	(i) $\bar{x} = 18.9$ (132/7) sd = 12.3	B1 B1 [2]	
	(ii) median	B1 [1]	
	(iii) mode inappropriate because it is 10 and this is the lowest value. mean inappropriate because it is affected by the outlier (of 48).	B1 B1 [2]	Sensible reason allow if seen in (ii) Sensible reason allow if seen in (ii) not 'outliers' in plural
2	(i) $P(x > 10.9) = P(z > \frac{10.9 - 11}{0.095})$ $= P(z > -1.0526)$ $= 0.8538$ (0.854)	M1 A1 [2]	Standardising, no cc, no sq rt Rounding to correct answer
	(ii) $P(\text{at least } 2 < 10.9) = 1 - P(0, 1)$ $= 1 - (0.8538)^6 - {}^6C_1(0.1462)(0.8538)^5$ $= 0.215$	M1 A1ft A1 [3]	Bin expression with $\sum$ powers = 6, ${}^6C_x$, $p + q = 1$. Reasonably correct unsimplified expression ft their (i) Rounding to correct answer
	3 median $A = 2.0 - 2.1$ or $\bar{x}_A = 2.0 - 2.1$ median $B = 3.8 - 3.9$ or $\bar{x}_B = 3.4 - 3.5$ Country B has heavier babies on average IQ range $A = 2.4 - 1.5 = 0.9$ or sd = $0.5 - 0.7$ IQ range $B = 4.5 - 2.2 = 2.3$ or sd = $1.2 - 1.4$ Country B has greater spread of weights	M1 A1 B1 M1 A1 A1 [6]	For finding medians or using mid-pts and freqs to find means, or seen on 2 box-plots Correct medians or means for A and B Correct statement allow '...higher median...' etc. Finding spreads by IQ range or range or sd or 2 box-plots Correct IQ range or sd for A and B (± 0.1 kg) or correct IQR on box-plots Correct statement
4	(i) $P(X < 2\mu) = P\left(z < \frac{2\mu - \mu}{\sigma}\right)$ $= P(z < \mu/\sigma) = P(z < 5/3)$ $= 0.952$	M1 A1 A1 [3]	Standardising, and attempt to get 1 variable, no cc, no $\sqrt{\quad}$, no sq $\pm 5/3$ seen oe Rounding to correct answer
	(ii) $P\left(X < \frac{\mu}{3}\right) = P\left(z < \frac{-2\mu}{3\sigma}\right)$ $\frac{-2\mu}{3\sigma} = 1.047$ $\mu = -1.57\sigma$	M1 B1 A1 [3]	standardising attempt resulting in $z \leq -$ some μ/σ allow $\pm \left(\frac{\mu/3 - \mu}{\sigma}\right)$ ± 1.047 seen correct single number, answer must have a minus sign and $\mu = \dots\sigma$
	5 (i) (2,12), (3, 8), (4, 6), (6, 4), (8,3), (12,2) $P(Q) = 6/144$ (1/24) (0.0417)	M1 A1 [2]	Listing or picking out at least 3 different options from a 12 by 12 (mult) table or seeing 3, 4, 5 or 6/144 Correct answer

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	(ii) $P(\text{both} > 8) = 1/3 \times 1/3$ $= 1/9 = P(R) (16/144)$	M1 A1 [2]	Squaring a sensible prob or picking out 12 – 25 options Correct answer
	(iii) since $P(R \text{ and } Q) = 0$ Yes, R and Q are exclusive	B1* B1dep [2]	o.e. in words
	(iv) $P(R \text{ and } Q) = 0 \neq P(R) \times P(Q)$ or $P(R Q) = 0, \neq P(R)$ No, not independent	B1* B1dep [2]	o.e. in words
6	(i)	B1 B1 B1 [3]	0, 1, 2 only in table or listed with some prob 3, 4... if in table must have blank or 0 for prob One correct probability All correct
	(ii) $E(X) = 8/7 (1.14) \text{ AG}$ $\text{Var}(X) = 12/7 - (8/7)^2$ $= 20/49 (0.408)$	B1 M1 A1 [3]	Legitimate correct given answer rounding to 1.14 Correct method with mean ² subt numerically no dividing by anything Correct final answer
	(iii) $P(G NA) = \frac{P(G \cap NA)}{P(NA)}$ $= \frac{2/5 \times 1/4}{2/5 \times 1/4 + 3/5 \times 9/10}$ $= \frac{5}{32} (0.156)$	M1 M1 A1 A1 [4]	Attempt at $P(G \cap NA)$ or $P(G \cap A)$ as numerator of a fraction Attempt at $P(NA)$ or $P(A)$ in form of summing two 2-factor products, seen anywhere Correct unsimplified denominator of a fraction Correct answer
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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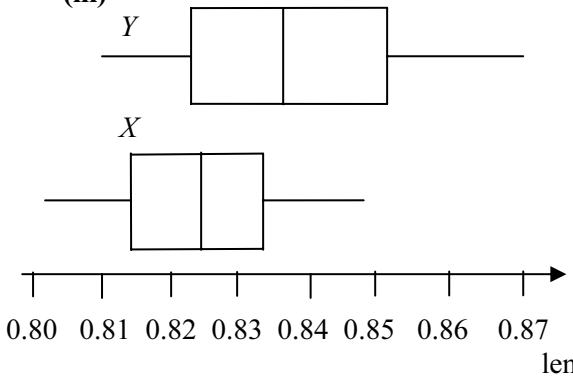
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1 $\frac{{}^{13}C_3 \times {}^{39}C_4}{{}^{52}C_7}$ $= 0.176$ OR $P(RRR) =$ $\frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{39}{49} \times \frac{38}{48} \times \frac{37}{47} \times \frac{36}{46} \times {}^7C_3$ $= 0.176$	M1	Using combinations with attempt to evaluate product of 2 in num and only 1 in denom
	M1	Correct numerator or denominator
	A1	Correct answer
	M1	OR Multiplying 3 unequal red probs with 4 unequal non-red probs
	M1	Multiplying a probability by ${}^7C_3$
	A1 [3]	Correct answer
2 (i) $\bar{x} = 130 - 287/82$ $= 126.5$ (126, 127) cm	M1	287/82 seen added or subd to 130
	A1 [2]	OR 287 seen added or subd to 82×130 Correct answer
(ii) $\frac{\Sigma(x-130)^2}{82} - (-3.5^2) = 6.9^2$ $\Sigma(x-130)^2 = 4908.5$ cm (4910)	M1	$6.9^2 + (\pm \text{their coded mean})^2$ seen or implied
	A1 [2]	correct answer
3 (i) $P(> 5) = {}^7C_6(0.6)^6(0.4) + (0.6)^7$ $= 0.1306 + 0.02799$ $= 0.159$	M1	Summing 2 or 3 binomial probs of the form ${}^7C_r(0.6)^r(0.4)^{7-r}$
	A1 [2]	Correct answer
(ii) $P(\text{bark}) = P(\text{park, bark}) + P(\text{not park, bark})$ $= 0.6 \times 0.35 + 0.4 \times 0.75$ $= 0.51$	M1	Summing two appropriate 2-factor probabilities
	A1 [2]	Correct answer
(iii) Variance (number of times) = 7.2	B1 [1]	Correct final answer

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4	(i) ends cola, $5!/2!2! = 30$ ends green tea, $5!/3!2! = 10$ ends orange juice, $5!/3!2! = 10$ total = 50 ways OR $P(\text{ends same}) = \frac{3}{7} \times \frac{2}{6} + \frac{2}{7} \times \frac{1}{6} + \frac{2}{7} \times \frac{1}{6}$ $= \frac{5}{21}$ $\frac{5}{21} \times \frac{7!}{3!2!2!} = 50 \text{ ways}$	M1 A1 A1 M1 A1 A1 [3]	Considering all three options Any one option correct Correct answer OR Considering all three options Correct fraction Correct answer										
	(ii) colas together, no restrictions, $5!/2!2!$ = 30 ways colas together and green tea together, $4!/2!$ = 12 ways $30 - 12 = 18 \text{ ways.}$ OR₁ Attempt to list OR₂ $3 \times \frac{4 \times 3}{2} = 18$	M1 A1 M1 A1 A1 M1A1 M1A1 A1 M1 A1 M1 A1 A1 [5]	Considering all colas together, or 5! seen Correct answer Considering all colas tog and all green tea tog, or 4! seen Correct answer Correct final answer OR ₁ 10 or more, 12 or more correct 14 or more, 16 or more correct 18 correct OR ₂ Considering all colas together, or 3! seen 3 ways for colas and orange juice Considering green teas not together 4×3 or $(4 \times 3)/2$ Correct final answer										
5	(i) $P(2) = P(0,2) + P(2,0)$ $= 6/10 \times 3/7 + 3/10 \times 4/7$ $= 30/70 = 3/7 \text{ AG}$	M1 A1 [2]	Summing two 2-factor probabilities Correct answer legit obtained										
	(ii) <table border="1"><tr><td>x</td><td>0</td><td>2</td><td>4</td><td>6</td></tr><tr><td>$P(X = x)$</td><td>24/70</td><td>30/70</td><td>13/70</td><td>3/70</td></tr></table>	x	0	2	4	6	$P(X = x)$	24/70	30/70	13/70	3/70	B1 B1 [2]	Correct values for rv X Correct probs
x	0	2	4	6									
$P(X = x)$	24/70	30/70	13/70	3/70									
	(iii) $E(X) = 13/7$ $\text{Var}(X) = 120/70 + 208/70 + 108/70 - (13/7)^2$ $= 2.78$	B1ft M1 A1 [3]	Using variance formula correctly with mean ² subtracted numerically, no extra division Correct final answer										
	(iv) $P(A2 \mid \text{Sum } 2) = \frac{3/10 \times 4/7}{30/70}$ $= 0.4$	M1 A1 [2]	Correct numerator with a $0 < \text{denom} < 1$ Correct answer										

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6 (i) for X : Median = 0.825 cm IQ range = 0.019 cm (0.833 – 0.814)	B1 B1 [2]	Correct median Correct IQ range
(ii) $q = 4$ $r = 2$ SR $q = 0.824$ and $r = 0.852$	B1 B1 [2] B1	Must be 4 and 2 not 3 and 1
(iii)  length in cm	B1 B1 ft B1 ft B1 [4]	Labels X , Y and length/cm, linear scale from 0.80 to 0.87 and both on one diagram Correct median and quartiles for X ft theirs must be a box Correct median and quartiles for Y ft theirs must be a box Whiskers correct no line through middle
(iv) Y has longer insects on average Y has larger range	B1 B1 [2]	Correct statement about lengths Correct statement about spreads
7 (i) $0.431 = \frac{135 - \mu}{\sigma}$ $-0.842 = \frac{127 - \mu}{\sigma}$ $\sigma = 6.29$ $\mu = 132$	B1 B1 M1 A1 A1 [5]	One $\pm z$ -value correct, accept 0.430 A second $\pm z$ -value correct Solving two equations relating μ , σ , 135, 127 and their z -values (must be z -values) Correct answer accept 6.28 Correct answer
(ii) $P(X < 145) = P\left(z < \frac{145 - 132.3}{6.284}\right)$ $= P(z < 2.023)$ $= 0.978$	M1 M1 A1 [3]	Standardising no sq rt no cc Correct use of normal tables Answer rounding to 0.978 or 0.979
(iii) $p = 1/3$ $P(\text{at least } 2) = 1 - P(0, 1)$ $= 1 - [(2/3)^8 + {}^8C_1 \times (1/3)^1 (2/3)^7]$ $= 0.805$	M1 A1 A1 [3]	Binomial expression with powers summing to 8 and ${}^8C_{\text{something}}$. (any p) Correct unsimplified expression Answer rounding to 0.805