

MARK SCHEME for the May/June 2012 question paper
for the guidance of teachers

9709 MATHEMATICS

9709/61

Paper 6, maximum raw mark 50

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1 $z_1 = \frac{30-28.3}{\sqrt{4.5}} = 0.8014$ $z_2 = \frac{25-28.3}{\sqrt{4.5}} = -1.5556$ $\Phi_1 - (1 - \Phi_2) = 0.7884 + 0.9401 - 1$ $= 0.729$	M1 M1 A1 [3]	Standardising at least one value, sq rt.ess; no cc $\Phi_1 + \Phi_2 - 1$ oe Correct answer
2 (i) $0.25p = 0.075$ $p = 0.075/0.25 = 0.3$ (ii) $P(2 M) = \frac{P(2 \text{ and } M)}{P(M)}$ $= \frac{0.45 \times 0.85}{0.3 \times 0.1 + 0.45 \times 0.85 + 0.25 \times 0.3}$ $= \frac{0.3825}{0.4875}$ $= 0.785$	B1 [1] M1 B1 A1 A1 [4]	Answer given, must show some working attempt at cond prob with single prod in num and Σ three 2-factor o.e prods in denom correct numerator of a fraction correct unsimplified denom correct answer
3 (i) $p = 0.1$ (ii) (a) $P(X=1, Y=3) = 0.3 \times 0.2 = 0.06$ $P(X=2, Y=2) = 0.15 \times 0.5 = 0.075$ $P(X=3, Y=1) = 0.3 \times 0.3 = 0.09$ $P(\text{sum is } 4) = 0.225$ (b) $P(X=1, Y=\text{anything}) = 0.3$ $P(X=2, Y=\text{anything}) = 0.15$ $P(X=3, Y=1, 2) = 0.3 \times 0.8 = 0.24$ $P(X=4, Y=1) = 0.2 \times 0.3 = 0.06$ $P(X=5, Y=1) = 0.05 \times 0.3 = 0.015$ $P(\text{product} < 8) = 0.765$ OR $P(Y=1, X=\text{anything}) = 0.3$ $P(Y=2, X=1, 2, 3) = 0.5 \times 0.75 = 0.375$ $P(Y=3, X=1, 2) = 0.2 \times 0.45 = 0.09$ $P(\text{product} < 8) = 0.765$	B1 [1] M1 B1 A1 [3] M1 B1 A1 [3] M1 B1 A1	Summing 2 or 3 options One option correct unsimplified correct final answer Σ 3 or more two-factor options Two correct options Correct answer
4 (i) $P(X < 5) = 1 - P(5, 6, 7)$ $= 1 - (0.21)^5(0.79)^2 {}_7C_5 - (0.21)^6(0.79) {}_7C_6 - (0.21)^7$ $= 0.994$ (ii) $P(\text{at least } 1) = 1 - P(0) = 1 - (0.79)^7$ $= 0.808$ $P(\text{exactly } 3 \text{ weeks}) = (0.808)^3(0.192) {}_4C_3$ $= 0.405$	M1 A1 A1 [3] M1 A1 M1 A1 [4]	Binomial expression with powers $\Sigma 7$ and probs $\Sigma = 1$, and ${}_7C_r$ Correct unsimplified expression Correct answer Attempt to find $P(\text{at least } 1)$ or $1 - P(0 \text{ and } 1)$ Rounding to correct answer Bin expression with powers $\Sigma 4$ and their 0.808 etc. and ${}_4C_3$ Correct answer

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5 (i) Flat screen $\begin{array}{r} 6 \\ 9 \ 5 \\ 6 \ 4 \ 2 \ 1 \\ 7 \ 4 \end{array}$ key 5 8 4 means 0.85 m for flat screen and 0.84 m for conventional (ii) Conventional median = 0.74 conv IQ range = 0.81 – 0.68 = 0.13 (iii) mean = 0.927 sd = 0.0882	conventional $\begin{array}{r} 6 \\ 7 \\ 8 \\ 9 \\ 10 \end{array}$	B1 B1 B1 B1 B1 M1 A1 B1 B1	Correct stem must be integers Correct flat screen leaves Correct conventional screen leaves Key must have units and TV type Correct median Their UQ – their LQ Correct answer Need 3 s.f. (Accept 0.0878 to 0.0889)
6 (i) $-1.253 = \frac{6 - \mu}{\sigma}$ $0.648 = \frac{12 - \mu}{\sigma}$ $\mu = 9.9$ $\sigma = 3.15$ or 3.16 (ii) need $P(z < -1 \text{ or } z > 1)$ $= 1 - \Phi(1) + \Phi(-1)$ $= 2 - 2 \times 0.8413$ $= 0.3174$ number = 317		B1 B1 M1 M1 [Indpt] A1 B1 M1 M1 A1	$Z = \pm 1.253$ $Z = \pm 0.648$ Any equation with μ and σ and a reasonable z value not a prob. Allow cc or –, not $\sqrt{\sigma}$ or σ^2 Att. to solve by substitution or elimination $z = 1$ or -1 seen Correct area i.e. $2 - 2\Phi$ Mult their prob if sensible, by 1000 Accept 317, 317.4, 318
7 (a) (i) 7 couples in 7! ways each couple in 2 ways so $7! \times 2^7$ = 645120 OR $14 \times 12 \times 10 \times 8 \times 6 \times 4 \times 2 =$ 645120 (ii) $7! \times 7! \times 2$ = 50,803,200 (50,800,000) OR $14 \times 6! \times 7!$		B1 M1 A1 B2 A1 B1 B1 B1 B1	7! seen multiplied mult by 2^7 correct final answer correct unsimplified answer correct answer $7! \times 7!$ seen Correct answer $14 \times 7!$ seen Correct answer

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(b) (i) $7C2 = 21$ (ii) all in: 1 all not in: $5C4 = 5$ total 6 (iii) 2 girls in: $6C2 \times 3C2 = 45$ 3 girls in: $6C1 = 6$ Total 51	B1	[1]	
	M1		Considering both cases
	A1	[2]	Correct answer
	M1		Attempt at summing 2 and 3 girls in the team need not see $3C2$
	A1	[2]	Correct answer

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1	$\bar{x} = 4.3$ $sd = \sqrt{\left(\frac{8287.5}{150} - 4.3^2\right)} = \sqrt{36.76} = 6.063$ $\Sigma(x - \bar{x})^2 = 150 \times 6.063^2$ $= 5514 \text{ (5510)}$	B1 M1 M1 A1 [4]	4.3 or 645/150 or 18.49 seen Subst in correct formula to find sd or var or expand $\Sigma(x - \bar{x})^2$ correctly and substitute Mult by 150 Answer rounding to 5510								
2	(i) <table border="1"><tr><td>y</td><td>0</td><td>2</td><td>4</td></tr><tr><td>$P(Y = y)$</td><td>0.42</td><td>0.48</td><td>0.1</td></tr></table> (ii) $0.96 + 0.4 = 1.36$	y	0	2	4	$P(Y = y)$	0.42	0.48	0.1	B1 M1 A1 A1 [4] B1ft [1]	0, 2, 4 only seen for Y no probs needed. Accept other vals if $P(\text{value}) = 0$ seen in table, allow 0002244 with probs Summing two or more 2-factor probs (can be implied) One correct prob Correct table or list Ft their table for Y or X $\Sigma p = 1$
y	0	2	4								
$P(Y = y)$	0.42	0.48	0.1								
3	(i) $P(2 < X < 12) = 1 - P(0, 1, 2, 12)$ $= 1 - (0.35)^{12} - (0.65)(0.35)^{11} {}_{12}C_1 - (0.65)^2(0.35)^{10} {}_{12}C_2 - (0.65)^{12}$ $= 1 - 0.0065359$ $= 0.993$ (ii) $1 - (0.87)^n > 0.95$ $0.05 > (0.87)^n$ $n = 22$	M1 A1 A1 [3] M1 M1 A1 [3]	Using binomial with ${}_{12}C_{\text{something}}$ and powers summing to 12, $\Sigma p = 1$ Correct unsimplified answer Accept 0.994 from correct working only Equality or inequality in $(0.87$ or 0.78 or $0.35)$, power n or $n - 1$, 0.95 or 0.05 Attempt to solve an equation with a power in (can be implied) Correct answer								
4	(i) A: median = 0.186, IQ range = $0.198 - 0.179$ $= 0.019$ (ii) A B 0.15 0.16 0.17 0.18 0.19 0.20 0.21	B1 M1 A1ft [3] B1ft B1 B1 [3]	Subt LQ from their UQ Correct IQ range ft dp in wrong place 2 correct boxes ft (i) OK if superimposed 2 pairs correct whiskers lines up to box not inside Correct uniform scale from at least 0.15 to 0.21 seen. No scale no marks (ii) unless perfect A and B with all 10 values shown								

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5	(i) ${}_{11}C_6 = 462$ OR A3 B3 or A4 B2 or A5 B1 or A6 $= {}_8C_3 + {}_8C_4 \times {}_3C_2 + {}_8C_5 \times {}_3C_1 + {}_8C_6$ $= 56 + 210 + 168 + 28$ $= 462$ (ii) ${}_8C_4 \times {}_3C_2 + {}_8C_5 \times {}_3C_1 + {}_8C_6$ $= 210 + 168 + 28$ $= 406$ (iii) ${}_9C_4 + {}_9C_6 = 126 + 84$ $= 210$ OR 1,2 in A tog with : A1B3 + A2B2 + A3B1 + A4B0 + 1,2 out of A : A3B3 + A4B2 + A5B1 + A6B0 $= {}_6C_1 + {}_6C_2 \times {}_3C_2 + {}_6C_3 \times {}_3C_1 + {}_6C_4 + {}_6C_5 \times {}_3C_3 + {}_6C_6$ $= 6 + 45 + 60 + 15 + 20 + 45 + 18 + 1 = 210$ OR $462 - {}_9C_5 - {}_9C_6$ $= 210$	B1 B1 [1] M1 B1 A1 [3] M1 B1 A1 M1 B1 A1 M1 B1 A1 [3]	$\sum$ 2 or more two-factor terms, P or C any numbers Any correct option unsimplified Correct answer Summing ${}_9C_x + {}_9C_y$ can be mult by 2 no other terms 126 or 84 seen or unsimplified ${}_9C_4, {}_9C_6$ Correct answer $\sum$ 5 or more 2-factor ${}_6P_x$ or ${}_6C_x$ with ${}_3C_x$ or ${}_3P_x$ only (can be mult by 2) 3 or more correct unsimplified options Correct answer subt two ${}_9C_x$ options from their (i) ${}_9C_5$ seen oe if using this method Correct answer																
6	(i) <table border="1"><thead><tr><th></th><th>wrapped</th><th>unwrapped</th><th>total</th></tr></thead><tbody><tr><td>choc</td><td>7</td><td>10</td><td>17</td></tr><tr><td>not choc</td><td>5</td><td>8</td><td>13</td></tr><tr><td>total</td><td>12</td><td>18</td><td>30</td></tr></tbody></table> (ii) 12/30 (0.4) (iii) 10/18 (5/9) (0.556) (iv) 10/17 (0.588) (v) P(2 wrapped) $= 12/30 \times 11/29 \times 18/28 \times 17/27 \times {}_4C_2$ $= 0.368$ (374/1015) OR $({}_{12}C_2 \times {}_{18}C_2)/{}_{30}C_4$ $= 0.368$		wrapped	unwrapped	total	choc	7	10	17	not choc	5	8	13	total	12	18	30	B1 B1 [2] B1ft [1] B1ft [1] B1ft [1] M1 M1 M1 A1 M1 M1 M1 A1 [4]	One correct row or column numbers All correct including labels Ft their table Ft their table Ft their table Mult by ${}_4C_2$ $12 \times 11 \times 18 \times 17$ seen in num $30 \times 29 \times 28 \times 27$ seen in denom Correct answer ${}_{12}C_2$ seen mult or alone in num (not added) ${}_{18}C_2$ seen mult or alone in num (not added) ${}_{30}C_4$ seen in denom Correct answer
	wrapped	unwrapped	total																
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7 (i) $P(> 42) = P\left(z > \frac{42 - 41.1}{3.4}\right)$ $= P(z > 0.2647)$ $= 1 - 0.6045$ $= 0.3955$ Prob = $(0.3955)(0.6045)^2 {}_3C_1$ $= 0.433$ or 0.434 (ii) $-1.282 = \frac{26.5 - \mu}{\sigma}$ $1.645 = \frac{34.6 - \mu}{\sigma}$ $\mu = 30.0$ $\sigma = 2.77$ (iii) $P(B6 < 34.6) = P\left(z < \frac{34.6 - 41.1}{3.4}\right)$ $= P(z < -1.912) = 1 - 0.9720$ $= 0.0280$ $P(B5 < 34.6) = 0.95$ $P(\text{both} < 34.6) = 0.028 \times 0.95$ $= 0.0266$	M1	Standardising no cc no sq rt no sq
	A1	Correct prob rounding to 0.395 or 0.396
	M1	Binomial ${}_3C_x$ powers summing to 3, any p , $\Sigma p = 1$
	A1 [4]	Rounding to correct answer
	B1	± 1.282 seen
	B1	± 1.645 seen
	M1	An eqn with a z-value, μ and σ , no $\sqrt{\sigma}$ no σ^2
	M1	Sensible attempt to eliminate μ or σ by substitution or subtraction
	A1 [5]	Correct answers, accept 30.1, accept 30, rounding to 2.77
	M1	Standardising for B6 no cc no sq rt no sq
	A1	Correct answer rounding to
	M1	Mult by 0.95 or their regurgitated 0.95
	A1 [4]	Correct answer rounding to 0.027, accept 0.027

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3 (i) $\frac{7!}{3!} \times 2$ $= 1680$ (ii) ${}^6C_4 = 15$ (iii) 1E in ${}^6C_3$ ways $= 20$ (iv) need 2Es in ${}^6C_2$ ways = 15 ways need 3Es in ${}^6C_1 = 6$ ways total = 15 + 20 + 15 + 6 = 56 ways	B1 B1 [2] B1 [1] M1 A1 [2] M1 A1 M1 A1ft [4]	$\frac{7!}{3!}$ or 840 seen or implied correct answer correct answer $k \times {}^6C_a$ or $k \times {}^bC_3$ (k a constant) or ${}^6P_d$ or ${}^eP_3$ seen correct final answer attempt to find ways with 2Es or 3Es ${}^6C_2$ oe and ${}^6C_1$ oe seen summing ways for no Es, 1E, 2Es and 3Es correct final answer, ft on their four answers												
4 (i) mean = $11/6$ ($1\frac{5}{6}$, 1.83) $sd = \sqrt{(1+1+1+4+9+9)/6 - (11/6)^2}$ $= \sqrt{29}/6$ (0.898) (ii) <table><tr><td>x</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>Pr</td><td>9/36</td><td>6/36</td><td>13/36</td><td>4/36</td><td>4/36</td></tr></table> (iii) $p = 1/3$ $np = 8$ $n = 24$ Var = $24 \times 1/3 \times 2/3 = 16/3$ (5.33)	x	2	3	4	5	6	Pr	9/36	6/36	13/36	4/36	4/36	B1 M1 A1 [3] B1 B1 M1 A1 [4] B1 M1 A1ft [3]	correct answer numerical use of a correct sd/variance formula correct answer all correct x values P(2) and P(6) correct considering more than 1 case for a sum of 3 or 4 or 5 P(3), P(4) and P(5) correct correct p using $np = 8$ to find n or $8(1 - p)$ to find var, $0 < p < 1$ correct answer, ft their p
x	2	3	4	5	6									
Pr	9/36	6/36	13/36	4/36	4/36									

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5 (i)					
	Designer	Not designer	Total		
H-h shoes	2	4	6		
L-h shoes	1	3	4		
Sports	5	5	10		
Total	8	12	20		
(ii) 1/20 (0.05)				B1	one row or column correct
(iii) 10/20 (1/2, 0.5)				B1 [2]	all correct
(iv) 2/8 (1/4, 0.25)				B1 ft [1]	correct answer, ft their table
(v) $P(D) = 8/20$ (0.4) $P(S) = 10/20$ (0.5) $P(D \cap S) = 5/20$ (0.25) Not independent as $P(D) \times P(S) \neq P(D \cap S)$				B1 ft [1]	correct answer, ft their table
[OR ₁ $P(D S) = \frac{P(D \cap S)}{P(S)} = \frac{5}{10}$ $P(D) = \frac{8}{20}$ Not independent as $P(D S) \neq P(D)$				M1	finding $P(D \cap S)$ and comparing with their $P(D) \times P(S)$
[OR ₂ $P(S D) = \frac{P(S \cap D)}{P(D)} = \frac{5}{8}$ $P(S) = \frac{10}{20}$ Not independent as $P(S D) \neq P(S)$				A1 ft [2]	correct conclusion, ft their table
(vi) $P(\text{at most } 4) = 1 - {}^7C_5(0.4)^5(0.6)^2 - {}^7C_6(0.4)^6(0.6)^1 - (0.4)^7$ $= 0.904$				M1 M1 A1 [3]	bin probability of form ${}^7C_r p^r (1-p)^{7-r}$, $r \neq 0$ or 7 bin expression for $1 - P(5, 6, 7)$ or $P(0, 1, 2, 3, 4)$, any p correct answer

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6	(i)	$\frac{34.1 - \mu}{\sigma} = 1.751$	B1	±1.751 seen
		$\frac{26.7 - \mu}{\sigma} = -0.524$	B1	±0.524 seen
		$\mu = 28.4, \sigma = 3.25$	M1	a standardising equation with a z-value, μ and σ
			M1	valid attempt to eliminate μ or σ
	(ii)		A1	correct answers
		$\Phi\left(\frac{34.5 - 32.9}{2.4}\right) - \Phi\left(\frac{33.5 - 32.9}{2.4}\right)$	M1	one numerical standardising expression, no cc, no square root, can have 34
		$= \Phi(0.667) - \Phi(0.25)$	M1	subtracting two areas
		$= 0.7477 - 0.5987$	A1	correct answer
		$= 0.149$		
	(iii)	$\Phi\left(\frac{t - 32.9}{2.4}\right) - \Phi\left(\frac{31.8 - 32.9}{2.4}\right) = 0.5$	M1	using 2 standardising expressions to give an equation involving subtraction and 0.5, oe
		$\Phi\left(\frac{t - 32.9}{2.4}\right) - (1 - 0.6765) = 0.5$		
		$\Phi\left(\frac{t - 32.9}{2.4}\right) = 0.8235$	M1	adding their tail to 0.5 oe
		$\frac{t - 32.9}{2.4} = 0.929$	M1	solving a standardised equation, must be a z-value from their 0.8235
		$t = 35.1$	A1	correct final answer