

MARK SCHEME for the October/November 2012 series

9709 MATHEMATICS

9709/61

Paper 6, maximum raw mark 50

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	GCE AS/A LEVEL – October/November 2012	9709	61

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AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
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1 $P(0) = 7/10 \times 6/9 \times 5/8 = 210/720$ $P(1) = 3/10 \times 7/9 \times 6/8 \times 3C1 = 378/720$ $P(2) = 3/10 \times 2/9 \times 7/8 \times 3C2 = 126/720$ $P(3) = 3/10 \times 2/9 \times 1/8 = 6/720 (1/120)$	B1 B1 B1 B1 [4]	Finding $P(0, 1, 2, 3)$ 1 or 2 correct 3 correct All correct															
2 $\Sigma x - \Sigma 36 = -60$ $\Sigma x = 24 \times 36 - 60 = 804$ OR $\bar{x} = 36 - 60/24 = 33.5$ $\Sigma x = 33.5 \times 24 = 804$ $\Sigma x^2 - 2.36 \Sigma x + \Sigma 36^2 = 227.6$ $\Sigma x^2 = 27011.76 (27000)$ OR $227.76/24 - (-2.5)^2 = sd^2 = 3.24$ $\Sigma x^2/24 - (33.5)^2 = 3.24$ $\Sigma x^2 = 27011.76 (27000)$	M1 A1 [2] M1 A1 M1 M1 A1 [3] M1 M1 A1	Expanding brackets ie mult by 24 and sub 60 Correct answer Dividing by 24 and sub from 36 Correct answer Expanding brackets with $36 \Sigma x$ and $\Sigma 36^2$ min $\Sigma x^2 - 2 \times 36 \Sigma x + \Sigma 36^2 = 227.6$ seen Correct answer $227.76/24 - (\text{their coded mean})^2$ seen $\Sigma x^2/24 - (\bar{x})^2 = \text{their var if +ve seen o.e.}$ Correct answer															
3 (i) $z = -1.036 = \frac{73 - 75}{\sigma}$ $\sigma = 1.93$	B1 M1 A1 [3]	$\pm$ correct z value accept ± 1.037 Equation with 73, 75, σ and a z value Rounding to correct answer															
(ii) $P(> 77) = 0.15$ $P(< 3) = P(0, 1, 2)$ $= (0.85)^8 + {}_8C_1(0.15)(0.85)^7 + {}_8C_2(0.15)^2(0.85)^6$ $= 0.895$	M1 M1 A1 [3]	Prob rounding to 0.15 and 0.85 ${}_8C_x p^x (1-p)^{8-x}$ seen any $p, 0 < p < 1$ Correct answer															
4 (i) <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td></td><td>14</td><td>3</td></tr> <tr><td></td><td>15</td><td>3 4 5</td></tr> <tr><td></td><td>16</td><td>1 4 8 8</td></tr> <tr><td></td><td>17</td><td>3 7</td></tr> <tr><td></td><td>18</td><td>5</td></tr> </table> Key: 14 3 represents 14300 dollars		14	3		15	3 4 5		16	1 4 8 8		17	3 7		18	5	B1 B1 B1 [3]	Correct stem Correct leaves Key need dollars
	14	3															
	15	3 4 5															
	16	1 4 8 8															
	17	3 7															
	18	5															
(ii) $LQ = 15400$	B1 [1]	Correct answer															
(iii) $5/11 \times 4/10 \times 2/9 \times 3C2 = 4/33 (0.121)$ OR $\frac{5C2 \times 2C1}{11C3}$	B1 B1 B1 [3]	Mult 3 diff fractions or (5C2 or 2C1) seen in num Mult by 3C2 o.e. or correct denom Correct answer															
5 (i) $P(> 1) = 1 - (0.95)^{20} - (0.95)^{19}(0.05) {}^{1}_{20}C_1$ $= 0.264$	M1 M1 A1 [3]	Binomial term ${}^{20}C_x (0.05)^x (0.95)^{20-x}$ Correct unsimplified expression Correct answer															

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(ii) Profit 19 or 20 work = $450 \times 10 - 480$ $= 4020$ Profit < 19 work = -480 Expected profit = $4020 \times (1 - 0.264) - 480 \times 0.264$ $= \\$2830$ (\$2832) Or $-480 + 4500(1 - 0.264) = 2830$	B1 M1 M1 A1 [4]	4020 seen Multiplying 4020 by their (i) or their $(1 - (i))$ Multiplying 480 by $[1 - \text{their (i)}]$ and subtracting Rounding to correct answer
6 (i) $p = 0.2$ $\mu = 96 \times 0.2 = 19.2$ $\sigma^2 = 96 \times 0.2 \times 0.8 = 15.36$ $P(< 20) = P(z < \frac{19.5 - 19.2}{\sqrt{15.36}}) = P(z < 0.07654)$ $= 0.531$	B1 M1 M1 M1 A1 [5]	96×0.2 and $96 \times 0.2 \times 0.8$ seen standardising must have sq rt continuity correction either 19.5 or 20.5 correct area (> 0.5) correct value
(ii) $P(OT B) = \frac{0.2 \times 0.6}{0.05 \times 0.3 + 0.2 \times 0.6 + 0.75}$ $= \frac{0.12}{0.885}$ $= 0.136$ (8/59)	B1 M1 A1 A1 [4]	their $0.2 \times (0.6 \text{ or } 0.4)$ as numerator of a fraction attempt at $P(B)$ or $P(NB)$ anywhere involving sum of 2 or 3 products correct unsimplified num or denom of a fraction correct answer
7 (a) $\frac{10!}{5!4!} = 1260$	M1 A1 [2]	$10!$ or ${}_{10}P_{10}$ seen in num or alone or dividing by $5!4!$ only Correct final answer
(b) (i) ${}_8P_4$ or ${}_8C_4 \times 4!$ $= 1680$	M1 A1 [2]	${}_8P_4$ or ${}_8C_4$ oe seen allow extra multiplication Correct answer
(ii) $6C2 \times 4!$ $= 360$ OR $6P4$ or $4 \times 3 \times 6 \times 5 = 360$	M1 M1 A1 [3]	$6C2$ or $6P2$ seen multiplied Mult by $4!$ Correct answer Award full marks
(c) A B C 1 1 7 = $9C1 \times 8C1 \times 7C7$ (oe) $\times {}_3C_1 = 216$ 1 3 5 = $9C1 \times 8C3 \times 5C5$ (oe) $\times 3! = 3024$ 3 3 3 = $9C3 \times 6C3 \times 3C3$ (oe) = 1680 Total = 4920 ways	M1 M1 M1 A1 A1 [5]	Summing at least two options of 1, 1, 7 or 1, 3, 5 or 3, 3, 3 Mult an option by $3C1$ or $3!$ or $3C3$ Any one of the 2nd term being $x C y$ seen mult, fitting with the first (x could be 2, 4, 5, 6 or 8) and corresponding y Any of unsimplified 72, 504 or 1680 seen Correct answer

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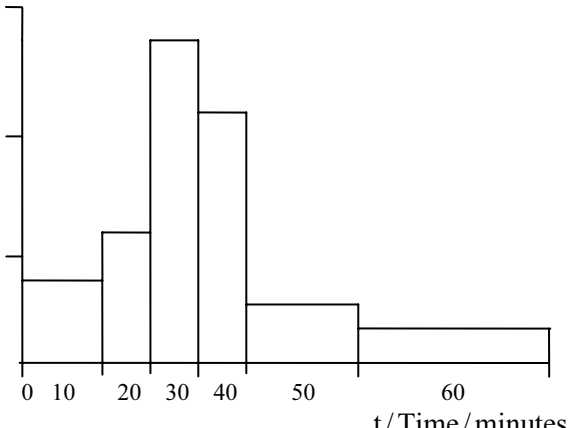
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1	(i) $P(A \text{ Later}) = 0.5 \times 0.2 = 0.1$	B1	[1]	
	(ii) $P(L \text{ given } I) = (0.2 \times 0.1)/(0.5 \times 0.8 + 0.3 \times 0.6 + 0.2 \times 0.1)$ $= 0.02/0.6$ $= 0.0333 \text{ (1/30)}$	B1 M1 A1 A1	 [4]	0.2×0.1 seen on its own as num or denom of a fraction Attempt at $P(I)$ summing 2 or 3 2-factor prods, seen anywhere Correct unsimplified $P(I)$ as num or denom of a fraction Correct answer accept 0.033
2	(i) $z_1 = \frac{12 - 6.4}{5.2} = 1.077$ $z_2 = \frac{10 - 6.4}{5.2} = 0.692$ $\Phi(z_1) - \Phi(z_2) = 0.8593 - 0.7556$ $= 0.104$	M1 M1 A1	 [3]	Standardising, can be all in thousands, no mix, no cc no sq rt no sq $\Phi_2 - \Phi_1$, Φ_2 must be $> \Phi_1$ Correct answer
	(ii) $P(\text{loss}) = P(z < \frac{0 - 6.4}{5.2}) = P(z < -1.231)$ $= 1 - 0.8909$ $= 0.109$ $P(1) = (0.1091)^1(0.8909)^3 \times 4C1$ $= 0.309 \text{ or } 0.308$	M1 A1 M1 A1	 [4]	Standardising using $x = 0$, accept $\frac{0.5 - 6.4}{5.2}$ Correct prob Binomial term ${}_4C_x p^x(1-p)^{4-x}$ any $p \neq 0$ Correct answer
3	(i) median in 15–20 mins, UQ in 25–40 mins	B1 B1	 [2]	
	(ii) fd 1.9, 2.4, 5.6, 4.4, 1.2, 0.65 or Scaled freq 9.5, 12, 28, 22, 6, 3.25 	M1 A1 B1 B1	 [4]	Attempt at fd or scaled freq [f/(attempt at cw)] Correct heights seen on diagram Correct bar widths visually no gaps Labels (time/ mins and fd or freq per 5 min) and correct bar ends

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(iii) $(5 \times 19 + 12.5 \times 12 + 17.5 \times 28 + 22.5 \times 22 + 32.5 \times 18 + 50 \times 13) / 112 = 2465 / 112 = 22.0$ minutes	M1 A1	[2]	Attempt at $\Sigma xf / 112$ using mid-points, NOT classwidths, NOT upper class bounds Correct answer accept 22
4 (i) $z = 1.036$ or 1.037 $1.036 = \frac{5 - 4s}{s}$ $s = 0.993$ $\mu = 3.97$	B1 B1 M1 A1	[4]	± 1.036 or ± 1.037 seen $\frac{5 - 4\sigma}{\sigma}$ seen or $\frac{5 - \mu}{\mu / 4}$ oe One variable and sensible solving attempt z-value not nec Both answers correct
(ii) $p = 0.85$ $\mu = 200 \times 0.85 = 170$, $\text{var} = 200 \times 0.85 \times 0.15 = 25.5$ $P(\text{at least } 160) = P\left(z > \frac{159.5 - 170}{\sqrt{25.5}}\right)$ $= P(z > -2.079)$ $= 0.981$	B1 M1 M1 M1 A1	[5]	200×0.85 (170) and $200 \times 0.85 \times 0.15$ (25.5) seen Standardising, sq rt and must have used 200 continuity correction 159.5 or 160.5 correct area (> 0.5) must have used 200 correct value
5(a) Boys in: $10C1 \times 9C3 = 840$ ways Boys out: $10C3 \times 9C3 = 10080$ ways Total = 10920 ways (10900)	M1 B1 A1	[3]	summing two 2-factor products, C or P Any correct option unsimplified Correct final answer
(b)(i) ${}_{12}P_8 = 19,958,400$	B1	[1]	or 20,000,000
(ii) together: ${}_{11}P_7 = 1663200 \times 2 = 3326400$ Not tog: $19958400 - 3326400 = 16,632,000$ (16,600,000) OR M at end then not F in $10 \times 10P6 \times 2 = 3024000$ ways not at end in $10 \times 9 \times 10P6 = 13608000$ ways Total = 16,632,000 ways	B1 M1 A1 M1 B1 A1	[3]	${}_{11}P_7$ seen 19958400 or their (i) – their together (must be > 0) correct final answer summing options for M at end and M not at end one correct option correct final answer
(iii) $8! \times 5 = 201600$ ways	B1 M1 A1	[3]	$8!$ seen mult by equivalent of integer ≥ 1 Mult by 5 Correct answer SR $8! \times 5! = 4838400$ B2

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6	(i) $P(9) = P(1,4,4) \times 3 + P(2,3,4) \times 6 + P(3,3,3)$ $= 10/64 (5/32) (0.156) \text{ AG}$	M1 M1 A1	[3]	Listing at least 2 different options Multiplying $P(4,3,2)$ by 6 or $P(1,4,4)$ by 3 Correct answer must see numerical justification
	(ii) probs $1/64, 3/64, 6/64, 10/64, 12/64, 12/64, 10/64, 6/64, 3/64, 1/64$.	B1 B1 B1	[3]	3 or more additional correct probs 5 or more correct All correct
	(iii) $P(S) = 6/64 (3/32)$ $P(R \cap S) = 3/64, \neq 15/1024 \text{ ie } P(R) \times P(S)$ OR $P(R S) = \frac{3/64}{6/64} = 1/2, \neq 10/64 \text{ ie } P(R)$ Not independent	M1 A1 B1 M1 A1ft	[5]	An attempt at $P(S)$ 4,4,1 or 4,2,2 Correct $P(S)$ Correct $P(R \cap S)$ in either intersection or cond prob cases comparing their $P(R \cap S)$ with their $P(R) \times P(S)$ or their $P(R S)$ with their $P(R)$ need numerical vals correct conclusion ft wrong $P(S)$ or $P(R \cap S)$ only

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		A1 3	Correct final answer
2	$-3p + 2r + 4 \times 0.4 = 2.3$ $(-3)^2p + 2^2r + 4^2 \times 0.4 - 2.3^2 = 3.01$ $p + q + r + 0.4 = 1$ $-3p + 2r = 0.7$ $9p + 4r = 1.9$ so $-9p + 6r = 2.1$ or $-6p + 4r = 1.4$ $4r + 6r = 1.9 + 2.1$ or $9p + 6p = 1.9 - 1.4$ $r = \frac{2}{5} (0.4), p = \frac{1}{30} (0.0333)$ $q = 0.6 - 0.4 - 0.0333 = \frac{1}{6} (0.167)$	B1 B1 B1	Correct unsimplified equation, oe Correct unsimplified equation, oe Correct equation, oe
		M1	Obtain an equation in 1 unknown
		A1	One correct answer
		A1 6	Remaining two answers correct
3	(i) $\frac{74}{170} \left(\frac{37}{85} \right) (0.435)$	B1 1	Correct answer
	(ii) $\frac{38}{96} \left(\frac{19}{49} \right) (0.396)$	B1	Correct unsimplified numerator or denominator
	(iii) P(high GDP and high birth rate) = 0 So they are exclusive	B1 2	Correct answer
		B1* B1dep* 2	Correct reason Correct answer, CWO
4	(iv) $\frac{42}{74} \times \frac{41}{54}$ $= \frac{1722}{3996} \left(\frac{287}{666} \right) (0.431)$	M1	Multiplying 2 probabilities with different numerators and denominators, only
		B1	One correct probability seen
		A1 3	Correct answer
4	(i) $(3 \times 59 + 8 \times 67 + 15.5 \times 38 + 25.5 \times 18 + 40.5 \times 11) / 193$ $= 11.4$ $\sigma^2 = (3^2 \times 59 + 8^2 \times 67 + \dots) / 193 - (11.43..)^2$ $\sigma = 9.78 \text{ or } 9.79$	M1	Attempt to calculate the mean using midpoints not ends, with frequencies, can be implied
		A1	Correct mean
		M1	Using $\Sigma x^2 f$ with mean ² subtracted numerically, can be implied
		A1 4	Correct answer, method marks can be implied

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(ii) fd = 11.8, 13.4, 3.8, 1.8, 0.55	M1	Attempt at frequency density or scaling
	A1	Correct heights seen on graph
	B1	Bar lines correctly located at 5.5, 10.5, 20.5 and 30.5, no gaps, their scale which may be non-linear
	B1	correct widths of bars, independent of bar lines
	B1 5	Both axes uniform, from at least 0 to 14 if fd and 0.5 to 50.5, and labelled (fd or freq per 5% and % meat or % or meat)
5 (i) $\Phi\left(\frac{84.5-82}{\sqrt{126}}\right) - \Phi\left(\frac{83.5-82}{\sqrt{126}}\right)$ $= \Phi(0.2227) - \Phi(0.1336)$ $= 0.5883 - 0.5533$ $= 0.0350$	M1	Standardising using 83.5 or 84.5, must have square root
	M1	Subtracting two probabilities, both > 0.5 or both < 0.5
	A1 3	Correct answer
(ii) $P(x > 87) = 1 - \Phi\left(\frac{87-82}{\sqrt{126}}\right) = 1 - \Phi(0.445)$ $= 1 - 0.6718 = 0.3282$ $P(0, 1) = (0.6718)^5 + {}_5C_1(0.3282)(0.6718)^4$ $= 0.471$	M1	Standardising, no cc, must have square root
	A1	Correct probability
	M1	Any binomial term of form ${}_nC_x p^x (1-p)^{n-x}, x \neq 0$
	A1 4	Correct answer
(iii) $P(x < 87) = 0.6718$ $P(x < k) = 0.9718$ $z = 1.908$ or 1.909 $1.909 = \pm \frac{k-82}{\sqrt{126}}$ $k = 103$	M1	Finding $P(x < 87)$, value > 0.5
	M1	Adding 0.3 to their 0.6718 or equivalent
	A1	Correct z
	M1	Equation with k , 82 or 81.5 or 82.5, $\sqrt{126}$, and a z-value
	A1 5	Correct answer rounding to 103
6 (a) twins in: ${}_6C_2$ twins out: ${}_5C_2 \times {}_6C_2$ Total = $15 + 150$ $= 165$ OR all: ${}_7C_2 \times {}_6C_2$ one twin: $2 \times {}_5C_1 \times {}_6C_2$ Total = $315 - 150$ $= 165$	B1	${}_6C_2$ alone or ${}_5C_2$ multiplied seen or implied
	M1	Summing two cases
	A1 3	Correct final answer
	B1	${}_7C_2 \times {}_6C_2$ alone or ${}_5C_1$ multiplied seen or implied
	M1	$2 \times {}_5C_1 \times {}_6C_2$ seen, subtracted
	A1	Correct final answer

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(b) (i) ends in 2, 6 or 8: $6!/2!$ (= 360) ways ends in 4: $6!$ (= 720) ways Total = $3 \times 360 + 720$ = 1800 ways OR₁ all: $7!/2!$ (= 2520) ways ends in 1 or 7: $6!/2!$ (= 360) ways Total = $2520 - 2 \times 360$ = 1800 OR₂ (4_A, 4_B) final digit: 5 ways other digits: $6!$ ways and $\div$ by $2!$ Total = 5×360 = 1800	B1 B1 M1 A1 4 B1 B1 M1 A1 B1 B1 M1 A1	Correct option for ending with 2 or 6 or 8. $6!/2!$ seen anywhere, not multiplied Correct option for ending in 4 Summing 3 or 4 even options Correct final answer $7!/2!$ seen anywhere, not multiplied $6!/2!$ seen, subtracted Subtract 2 odd options from total options Correct final answer 5 seen, multiplied $6!$ seen and divide by $2!$ at some stage Multiplying their two numbers Correct final answer
(ii) $5 \times 4 \times 3 \times 2$ or ${}_5P_4$ or ${}_5C_4 \times 4!$ or $5!$ or ${}_5P_5$ or ${}_6P_5 \div 6$ = 120 ways	M1 A1 2	One of these oe Correct final answer
(c) $\left(\frac{2}{3}\right)^7$ = $\frac{128}{2187}$ (0.0585)	M1 M1 A1 3	$2/3$ seen multiplied 7 probabilities multiplied together Correct final answer