

MARK SCHEME for the May/June 2011 question paper
for the guidance of teachers

9709 MATHEMATICS

9709/61

Paper 6, maximum raw mark 50

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Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2011	9709	61

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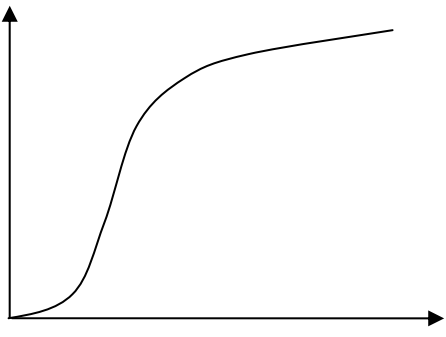
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1 $18p = 2.7$ $p = 0.15$ $P(2, 3, 4) =$ ${}^{18}C_2 \times (0.15)^2 (0.85)^{16} + {}^{18}C_3 (0.15)^3 (0.85)^{15}$ $+ {}^{18}C_4 (0.15)^4 (0.85)^{14}$ $= 0.655$	B1	Correct value for p
	M1	Summing 3 binomial probs o.e
	A1	Correct unsimplified answer
	A1 [4]	Correct answer
2 $P(\text{pencil case} \mid \text{find}) =$ $\frac{P(\text{pencil case and find})}{P(\text{find})} = \frac{0.7 \times 1}{0.7 + 0.3 \times 0.2}$ $= 0.921$	M1	Attempt to use cond prob formula, must be quotient
	A1	Correct num of a fraction
	A1	Correct denominator
	A1 [4]	Correct answer
3 (i) $P(\text{any other number}) = 9/70$ $P(X < 2) = 27/70 + 1/10$ $= 34/70$ (17/35) (0.486)	B1	9/70 Seen
	B1 ft [2]	Ft their probs if < 1
	M1	Valid attempt at $E(X)$ (needn't be accurate)
	M1	Using a variance formula correctly with mean ² subtracted numerically, no extra division
$\text{Var}(X) = ((-2)^2 + \dots + 5^2) \times 9/70 - (54/35)^2$ $= 5.33$	A1 [3]	Correct final answer
(iii) $a = 1$	B1 [1]	
4 (i) Options 5 bat 5 bl 1 Wk in ${}^{10}C_5 \times {}^9C_5 \times {}^2C_1 = 63504$ ways or 5 bat 4 bl 2 Wk in ${}^{10}C_5 \times {}^9C_4 \times {}^2C_2 = 31752$ ways or 6 bat 4 bl 1 Wk in ${}^{10}C_6 \times {}^9C_4 \times {}^2C_1 = 52920$ ways Total = 148176 (148000)	M1	Multiplying three combinations together
	M1	Summing more than one sensible option
	A1	Two options correct unsimplified
	A1 [4]	Correct final answer
(ii) $\frac{11!}{5!4!2!} = 6930$	B1 [1]	Correct answer evaluated
(iii) Omit a pen $\frac{10!}{4!4!2!} = 3150$ Omit a diary $\frac{10!}{5!3!2!} = 2520$ Omit a notebook $\frac{10!}{5!4!} = 1260$ Total = 6930	M1	Summing three options
	B1	One option correct
	A1 [3]	Correct final answer

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5 (a) $z > \frac{2\mu - \mu}{\sigma} = \frac{\mu}{\sigma} = \frac{7\sigma^2}{3\sigma}$ $\frac{7\sigma}{3} = 1.272$ $\sigma = 0.545$ $\mu = 0.693$	M1 M1 B1 A1 [4]	Standardising attempt resulting in $z > \text{some } \mu/\sigma$ Substituting to eliminate μ or σ 1.272 seen Both answers correct
(b) $P(X < a + 33) = 0.75$ $z = 0.674$ $\frac{a + 33 - 33}{\sqrt{21}} = 0.674$ $a = 3.09$	M1 A1 M1 A1 [4]	Using 0.75 oe ± 0.674 seen Standardising, no cc, must have sq rt Correct answer
6 (i)  Median 270	M1 M1 (Indpt) A1 [3]	Sensible attempt at graph using u.c.b. 2500 seen in median attempt on a CF graph Can be implied Correct answer + or – 5
(ii) 20% less than 160	M1 A1 [2]	Using 20% Correct answer + or – 5
(iii) $2100 - 1600 = 500$	B1 [1]	
(iv) $(50.5 \times 200 + 125.5 \times 600 + 175.5 \times 800 + 225.5 \times 500 + 300.5 \times 2000 + 400.5 \times 600 + 525.5 \times 300) / 5000$ $= 268$	M1 M1 A1 A1 [4]	Using an attempt at mid-points Using an attempt at frequencies Correct mid-points or frequencies Correct answer only
7 (a) (i) $P(\text{at least one 3}) = 1 - P(\text{no 3s})$ $= 1 - (5/6)^9$ $= 0.806$	M1 A1 [2]	Using $1 - \text{none}$ Correct answer
(ii) $P(\text{at least 1 three}) = 1 - (5/6)^n$ $1 - (5/6)^n > 0.9$ $n > 12.6$ $n = 13$	B1 M1 M1 A1 [4]	Equation or inequality involving n and 0.9 Solving attempt of sensible equation, can be trial Correct answer
(b) $P(\text{R wins his 1st ball}) = P(\text{GY})$ $= 15/56$ (0.268) $P(\text{R wins 2nd ball}) = P(\text{GGGY}) = 3/28$ $P(\text{R wins 3rd ball}) = P(\text{GGGGGY})$ $\frac{5}{8} \times \frac{4}{7} \times \frac{3}{6} \times \frac{2}{5} \times \frac{1}{4} \times \frac{3}{3} = 1/56$ $P(\text{R wins}) = 11/28$ (0.393)	M1 M1 M1 A1 [4]	Using $P(\text{GY})$ Attempt to find $P(\text{GGGY})$ or $P(\text{GGGGGY})$ Adding three options Correct answer

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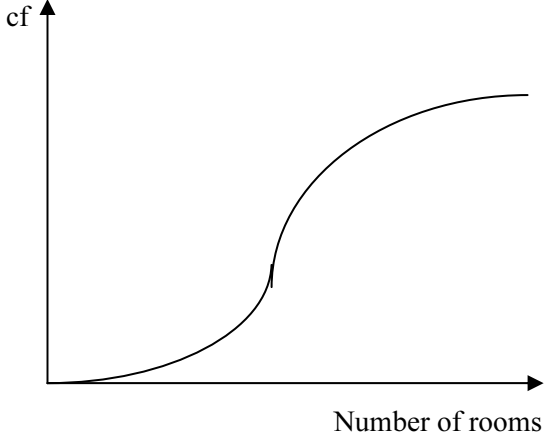
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1 $20p = 4.8$ $p = 0.24$ or $4.8/20$ $P(0, 1, 2) = (0.76)^{20} + {}^{20}C_1(0.24)^1(0.76)^{19}$ $+ {}^{20}C_2(0.25)^2(0.76)^{18}$ $= 0.109$ SR max 3 out of 4	B1 M1 A1 A1 [4] B1 M1 A1	Correct value for p Summing 2 or 3 binomial probs o.e., any $p, n = 5$ or 20 Correct unsimplified answer Correct answer As above Using $N(4.8, 3.648)$ with cc 2.5 or 3.5 0.114 seen
2 (i) $np = 24, npq = 4.8$ $z = \pm \left(\frac{24.5 - 24}{\sqrt{4.8}} \right) = 0.228$ Prob = 0.590	B1 M1 M1 A1 [4]	24 and 4.8 or $\sqrt{4.8}$ seen can be unsimplified Standardising, need sq rt, cc not necessary Continuity correction 24.5 or 25.5 used Correct answer must be from 24.5
(ii) np and nq both > 5.	B1 [1]	Need both
3 (i) Mean = $45 - 148/36 = 40.9$ or $1472/36$ <i>EITHER</i> Var = $3089/36 - (-148/36)^2 = 68.9$ sd = 8.30 <i>OR</i> $\Sigma x^2 = 3089 - 36 \times 45^2 + 90 \times 1472 = 62669$ Var = $\left(\frac{62669}{36} - \left(\frac{1472}{36} \right)^2 \right)$ sd = 8.30	B1 M1 A1 [3] M1 A1	Correct answer $3089/36 - (\pm \text{their coded mean})^2$ Correct answer Expanding $\Sigma(x - 45)^2$ with at least 2 terms correct and solving, then substituting their Σx^2 in correct variance formula with their mean² sub^t numerically Correct answer
(ii) New $\Sigma(x - 45) = -148 - 16 = -164$ New $\Sigma(x - 45)^2 = 3089 + 16^2 = 3345$ New sd = $\sqrt{3345/37 - (-164/37)^2}$ = 8.41 <i>OR</i> $\Sigma x = 36 \times 45 - 148 = 1472$ New $\Sigma x = 1472 + 29 = 1501$ $\Sigma x^2 = 3089 - 36 \times 45^2 + 90 \times 1472 = 62669$ New $\Sigma x^2 = 62669 + 29^2 (= 63510)$ New sd = $\sqrt{63510/37 - (1501/37)^2}$ = 8.41	M1 M1 M1 A1 [4] M1 M1 M1 A1	Adding their coded new value to -148 Adding their (coded value)² to 3089 Subst in coded var formula, can have one of 29 and one of -16 here Correct answer Finding Σx and adding 29 Finding Σx^2 and adding 29^2, at least 2 terms of $3089, 36 \times 45^2, 90 \times 1472$ Subst their values in correct var formula Correct answer

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4 (i) 90720 (ii) 3 vowels together $= 3! \times 7!/2!2! = 7560$ $\text{Prob(not together)} = \frac{90720 - 7560}{90720} = \frac{83160}{90720}$ $= 0.917 (=11/12)$ (iii) One S in ${}^5C_3$ ways = 10 SS in ${}^5C_2$ ways = 10 Total = 20 OR ${}^6C_3$ = 20	B1 [1]	Not 9!/2!2!
	B1 B1 M1	3! oe seen multiplied by integer oe 7 or 6! seen multiplied as a num Subt from their (i) or dividing by their (i) or 1 – prob
	A1 [4]	Correct answer from correct working
	M1 M1 A1 [3] M1 M1 A1	${}^5C_3$ seen added ${}^5C_2$ seen added Correct answer ${}^6C_3 \times 2$ or $\div 2$ or $\times 1$ seen ${}^6C_3$ only Correct answer
5 (i)  (ii) Line on graph up from 30 $200 - 20 = 180$ OR using lin int $10 + \frac{(30 - 20.5)}{20} \times 32 = 25.2$ $= 174.8$ (iii) Line on graph across from 150 59 rooms OR lin int $50.5 + 46/50 \times 10$ $= 59$ or 60	M1 M1 M1 A1 [4]	Attempt at cf table (up to 200) Linear scale minimum 0 to 200 and 20 to 80, and labels Attempt to plot points at (20.5, 10), (40.5, 42), (50.5, 104), (60.5, 154), (70.5, 182), (90.5, 200), accept (20, 10), (40, 42) or (21, 10), (41, 42) etc All points correct and joined up, allow (0, 0) or (0.5, 0)
	M1 A1 [2] M1 A1	Line or mark seen, can be implied if matches graph and in range Accept 174 – 180 if reading from graph Can have 20 or 20.5 Accept decimals, 174 – 175 if using lin int
	M1 A1 [2] M1 A1	Line or mark seen, can be implied if matches graph and in range. 150 seen and line between 140 and 160 Accept 58 – 60 Can have 50 or 50.5 Must be integer

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6 (i) $z = -1.282$ $P(x < 20) = P\left(z < \frac{20 - \mu}{0.8}\right)$ $-1.282 = \frac{20 - \mu}{0.8}$ $\mu = 21.0 \text{ cm (21.0256)}$	B1 M1 A1 [3]	± 1.282 or ± 1.281 seen Standardising, no cc, must have 0.8, must be a z-value Correct answer																
(ii) $P(21.5 < x < 22.5)$ $= P\left(\frac{21.5 - 21.03}{0.8} < z < \frac{22.5 - 21.03}{0.8}\right)$ $= \Phi(1.8375) - \Phi(0.5875)$ $= 0.9670 - 0.7217$ $= 0.2453$ $P(< 2) = P(0) + P(1)$ $= (0.7547)^4 + (0.2453)^1(0.7547)^3 {}^4C_1$ $= 0.746$	M1 M1 A1 M1 M1 A1 [6]	2 attempts at standardising with their mean, must have 0.8 oe Subtracting 2 Φ s ft their mean Needn't be entirely accurate, rounding to 0.24 or 0.25 Binomial term with ${}^4C_r p^r (1 - p)^{4-r}$ seen $r \neq 0$, any $p < 1$ Bin expression for $P(0) + P(1)$, any $p < 1$ Accept 3sf rounding to 0.75																
7 (i) $P(6) = P(3, 9) + P(9, 3) = 2/25 = 0.08$ AG	B1 [1]	Accept 2/25 seen																
(ii) <table border="1"><tr><td>x</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>Prob</td><td>0.2</td><td>0.24</td><td>0.08</td><td>0.08</td><td>0.16</td><td>0.16</td><td>0.08</td></tr></table>	x	0	1	2	3	4	5	6	Prob	0.2	0.24	0.08	0.08	0.16	0.16	0.08	M1 A1 [2]	Values 0 – 6 seen could be in list All correct
x	0	1	2	3	4	5	6											
Prob	0.2	0.24	0.08	0.08	0.16	0.16	0.08											
(iii) Mean = $\Sigma xp = 2.56$ (64/25)	B1 [1]																	
(iv) $P(4, 5, 6) = 0.4(10/25)$ or $0.16 + 0.16 + 0.08$ $= P(\text{draw}) \times 0.4$ $= 0.2 \times 0.4 = 0.08$ (2/25)	B1 ft M1 A1 ft [3]	ft their $P(4, 5, 6)$ providing $p < 1$ Multiplying by their $P(\text{draw})$ providing $p < 1$ Correct answer																
(v) $P(\text{J wins on } n\text{th go})$ $= (0.2)^{n-1} \times 0.4$ oe	M1 A1 ft [2]	Mult by any p^n or p^{n-1} , $p < 1$ ft their probs																

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(ii) $\frac{\Sigma x_A^2}{9} - 3.6^2 = 1.925^2$ $\Sigma x_A^2 = 150$ $\frac{150.0 + 352}{24} - 4.017^2 = 4.780$ $sd = 2.19$	M1 A1 M1 A1 [4]	Attempt to find Σx_A^2 using correct variance formula Correct Σx_A^2 Using 352 + their 150 in correct variance formula Correct answer
2 (i) $4 \times 3 \times 7$ $= 84$	B1 [1]	Correct answer
(ii) $10! - 9! \times 2$ $= 2903040$ (2900000) <i>OR</i> $8! \times 9 \times 8$ $= 2903040$ (2900000)	B1 B1 [2] B1 B1	$10! - k \times 9!$ seen oe Correct answer $8! \times 9 \times l$ seen oe Correct answer
(iii) ${}^9C_1 + {}^9C_2 + \dots + {}^9C_9$ $= 511$ <i>OR</i> $2^9 - 1$ $= 511$	M1 M1 A1 [3] M1 M1 A1	Using combinations Adding 9 combinations Correct answer 2^9 seen Subtracting 1 Correct answer
3 (i) $median_A < 35$ or $20 \leq median_A < 35$ or $median_A = 33.0/33.1/33.5/33.6$ or $median_B \geq 50$ or $50 \leq median_B < 70$ or $median_B = 51.7/51.9/52.2/52.4$ $median_B > median_A$ <i>OR</i> A has 66 and $50 < \text{mark} < 100$, so $med_A < 50$ or B has 156 and $50 < \text{mark} < 100$, so $med_B > 50$ $median_B > median_A$	B1 B1 [2] B1 B1	Correct numerical statement re $median_A$ or $median_B$ Correct numerical statement re other median and a conclusion As before As before
(ii) $159 - 68 = 91$	B1 [1]	Correct final answer
(iii) $\text{mean} = \left(\frac{4.5 \times 25 + 14.5 \times 43 + 27 \times 91}{+ \dots + 84.5 \times 40} \right) / 300$ $= 11270 / 300 = 37.6$	M1 M1 M1 A1 [4]	Using an attempt at mid-points, not end points or class widths Using an attempt at frequencies, not cum freqs Sum of 6 prods, correct freqs, divided by 300 Correct answer

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2011	9709	63

4 (i) (a) $P(\text{final score is } 12) = P(6, 6) = 1/36$ (b) $P[(1,5) + (1,4) + (2,3) + (3,2) + (4,1)]$ $= 5/36$	B1 [1] Correct answer
	M1 Considering $P(1, 5)$ M1 Considering $P[(1,4) + (2,3) + (3,2) + (4,1)]$ A1 [3] Correct answer
(ii) $P(A) = 1/6$ $P(B) = P[(1,5) + (2,4) + (3,3) + (4, 2) + (5,1)]$ $= 5/36$ $P(C) = 1 - P(O, O) = 3/4$ $P(A \text{ and } B) = P(1 \text{ and } 5) = 1/36$ $\neq P(A) \times P(B)$ $P(A \text{ and } C) = P[(2,5) + (4,5) + (6,5)] = 3/36$ $\neq P(A) \times P(C)$ $P(B \text{ and } C) = P[(2,4) + (4,2)] = 2/36$ $\neq P(B) \times P(C)$ None are independent.	B1 B1 Any two of $P(A)$, $P(B)$ and $P(C)$ correct Third probability correct M1 Numerical attempt to compare $P(X \text{ and } Y)$ with $P(X) \times P(Y)$, must be three positive probs A1√ One correct comparison and conclusion, ft their probabilities A1 [5] Correct conclusion(s) following legitimate working
5 (i) $z = \pm 1.751$ $\pm \frac{20 - \mu}{\mu/4} = 1.751$ $\mu = 13.9$	B1 Correct z M1 Standardising no cc, no sqrt, must be a z -value A1 [3] Correct answer
(ii) $P(X < 10) = P(z < \pm \frac{10 - 13.91}{13.91/4})$ $= P(z < -1.124)$ $= 1 - 0.8694$ $= 0.131$ $P(10 < X < 20) = 0.96 - 0.131$ $= 0.829 \text{ or } 0.830$	M1 Standardising attempt with 10, their μ and their $\mu/4$, no cc, no sqrt M1 " $\Phi_1 + \Phi_2 - 1$ ", ft their mean A1 [3] Correct answer
(iii) $\mu = 250 \times 0.96 = 240$ $\sigma^2 = 250 \times 0.96 \times 0.04 = 9.6$ $P(\geq 235) = 1 - \Phi\left(\pm \frac{234.5 - 240}{\sqrt{9.6}}\right)$ $= \Phi(1.775)$ $= 0.962$	B1 240 and 9.6 or sq rt 9.6 seen unsimplified M1 Standardising, with or without cc, must have sq rt in denom M1 Continuity correction 234.5 or 235.5 only M1 Correct region > 0.5 , ft their mean A1 [5] Correct answer

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2011	9709	63

6 (i) $(0.75)^n < 0.06$ $n > 9.78$ $n = 10$	M1*	Equation or inequality with 0.75^n and 0.06 or 0.94 seen
	M1dep*	Attempt at solving by trial and error (can be implied) or using logarithms correctly
	A1 [3]	Correct answer
(ii) $E(X) = 14 \times 0.75$ or 10.5 Try $P(10) = {}^{14}C_{10}(0.75)^{10}(0.25)^4 = 0.220$ $P(11) = {}^{14}C_{11}(0.75)^{11}(0.25)^3 = 0.240$ (mode is) 11 OR	M1	Evaluating binomial probability for an integer value directly above or below their mean
	M1	Evaluating the other binomial probability
	A1 [3]	Correct answer
(iii) $P(> 11)$ $= {}^{14}C_{12}(0.75)^{12}(0.25)^2 + {}^{14}C_{13}(0.75)^{13}(0.25)^1 + (0.75)^{14}$ $= 0.281$ $P(3) = {}^5C_3 (0.2811)^3(0.7189)^2$ $= 0.115$	M1	A binomial term of the form ${}^{14}C_n p^n (1-p)^{14-n}$ seen, $n \neq 0$ or 14
	M1	Summing binomial $P(12, 13, 14)$ or $P(11, 12, 13, 14,)$
	A1	Correct answer 0.280 – 0.282
	M1	A binomial term of the form ${}^5C_3 p^3 (1-p)^2$ seen, any p
	A1 [5]	Correct answer