

MARK SCHEME for the May/June 2013 series

9709 MATHEMATICS

9709/61

Paper 6, maximum raw mark 50

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	GCE AS/A LEVEL – May/June 2013	9709	61

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

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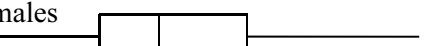
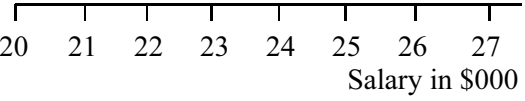
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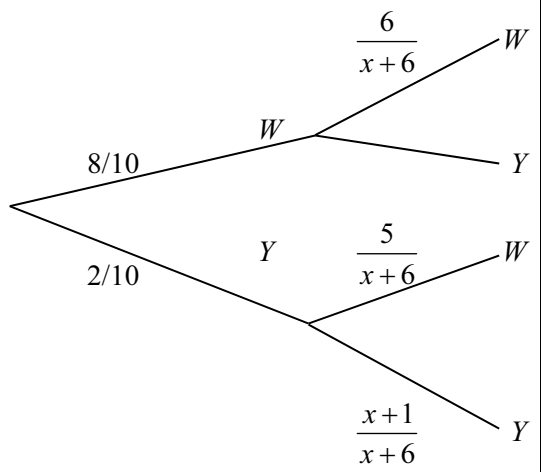
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1	(i)	$sd^2 = 1957.5/30 - (234/30)^2$ $sd = 2.1$	M1 A1	[2]	Subst in formula or expand Accept 2.10
	(ii)	$86 = 234/30 + c$ $c = 78.2$	M1 A1	[2]	234/30 seen
2		$np = 350 \times 1/7 (= 50)$ $npq = 350 \times 1/7 \times 6/7 (= 42.857)$ $P(x = 47) = P\left(z > \frac{46.5 - 50}{\sqrt{42.857}}\right) =$ $P(z > -0.5346)$ $= 0.704$	B1 M1 M1 M1 A1	 [5]	Correct unsimplified np and npq standardising, with or without cc, must have sq rt continuity correction 46.5 or 47.5 correct area ie > 0.5 must be a Φ correct answer
3	(i)	females: med \$22 700 LQ \$21 700 UQ \$24 000	B1 B1	[2]	Any 2 correct All correct
	(ii)	males 	B1		Uniform scale and labels must see Salary, \$000
		females  	B1 B1	 [3]	Correct graph for females ft their quartiles. Line not through box Correct graph for males
4	(a)	$P(y < 0) = P\left(z < \frac{0 - \mu}{\mu/2}\right)$ $= P(z < -2)$ $= 1 - 0.9772 = 0.0228$	M1 A1 A1	 [3]	Standardising containing 0 (can be implied) and μ only $z < -2$ seen Correct answer
(b)		$P(x > 2.1) = 253/8000 = 0.031625$ $P(x < 2.1) = 0.968375 = \Phi(z)$ $z = 1.857 \text{ or } 1.858 \text{ or } 1.859 = \frac{2.1 - 2.04}{\sigma}$ $\sigma = 0.0323$	M1 A1 M1 A1	 [4]	1 – their 253/8000 used to obtain a z-value Rounded to 1.86 seen Solving for σ using their z val must be a z val Correct answer
5	(i)	$X \sim \text{Bin}(12, 0.2)$	B1 B1 B1	[3]	Bin or B 12 0.2 or 1/5
	(ii)	$P(X = 3, 4, 5) = 0.2^3 0.8^9 {}_{12}C_3 + 0.2^4 0.8^8 {}_{12}C_4$ $+ 0.2^5 0.8^7 {}_{12}C_5$ $= 0.23622 + 0.13287 + 0.05315$ $= 0.422$	M1 A1ft A1	 [3]	Bin expression with any p Correct unsimplified expression, their p Correct answer

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(iii)	$P(X = 0) < 0.01$ $0.8^n < 0.01$ $n = 21$	M1 M1 A1	[3]	Statement involving $P(X = 0)$ and 0.01 can be implied Equation involving '0.8', 0.01 or 0.99 Correct answer
6 (i)	$4! \times 3! \times 5! \times 2! \times 4! = 829440$	B1 B1 B1	[3]	4!, 3!, 5!, 2 seen multiplied 1, not in denominator Mult by 4! Correct answer
(ii)	$8! \times 9 \times 8 \times 7 \times 6 \times 5 \times 4$ $= 2438553600 (2.44 \times 10^9)$	B1 B1 B1	[3]	8! seen multiplied 1 Mult by 9P ₆ Correct answer
(iii)	$8C3 \times 5C3 \times 2C2$ $= 560$	B1 B1 B1	[3]	8C3 seen mult 5C3 seen mult Correct answer
7 (i)	number of balls in B is $5 + x + 1 = x + 6$ $P(Y) = x/(x + 6)$ AG	B1	[1]	Sensible reason
(ii)	box A box B 	B1 B1 B1 B1	[4]	both correct for box A 1 correct 1 correct 1 correct
(iii)	$P(W_B) = \frac{6}{x+6} = \frac{1}{3}$ $x = 12$ AG	M1 A1	[2]	their $\frac{6}{x+6} = 1/3$ or $x/x+6 = 2/3$ Verification or solving legit

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(iv)	$P(Y) = \frac{8}{10} \times \frac{12}{18} + \frac{2}{10} \times \frac{13}{18}$	M1		Attempt at P(Y) involving 2 two-factor fractions, seen anywhere.
	$= \frac{61}{90}$	A1		Correct P(Y) seen as num or denom of a fraction
	$P(A B) = \frac{P(A \cap B)}{P(B)}$	B1		$(2/10) \times (13/18)$ seen as num or denom of a fraction
	$= \frac{2}{10} \times \frac{13}{18} / \frac{61}{90}$			
	$= \frac{13}{61} (0.213)$	A1	[4]	Correct answer

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1	$z = 1.452$ $1.452 = \frac{20 - \mu}{\mu/5}$ $\mu = 15.5$	B1 B1 B1	[3]	Rounding to ± 1.45 $\frac{20 - \mu}{\mu/5}$ or $\frac{20 - 5\sigma}{\sigma}$ seen oe rounding to correct answer
2	$\bar{x} = 50 + 81.4/22 = 53.7$ $\text{var} = 671/22 - 3.7^2 = 16.81(16.8)$ $16.81 = \Sigma x^2/22 - 53.7^2$ $= 63811(63800)$ OR $\Sigma x - 22 \times 50 = 81.4$ ($\Sigma x = 1181.4$) $\Sigma x^2 - 100\Sigma x + 22 \times 50^2 = 671$ $\Sigma x^2 = 671 + 118140 - 55000 = 63811$ $\text{Var} = \Sigma x^2/22 - (\Sigma x/22)^2 = 16.81$	M1 A1 M1 A1 M1 M1 A1 A1	[4]	Attempt to find variance using coding in both, correct formula Correct answer using their var and their mean with uncoded formula for both correct answer expanded eqn with 22×50 seen expanded eqn with 2 or 3 terms correct correct answer correct answer
3	(i) $P(x < 440)$ $= P\left(z < \frac{440 - 445}{3.6}\right) = 1 - \Phi(1.389)$ $= 1 - 0.9176$ Ans = 0.0824 (ii) $z = 1.881$ $\frac{c}{3.6} = 1.881$ $c = 6.77$	M1 M1 A1 M1 M1 A1	[3] [3]	Standardising no cc no sq or sq rt Correct area $(1 - \Phi)$ oe (indep) Rounding to correct answer accept 0.0825 ± 1.88 or 1.881 or 1.882 or 1.555 seen $\pm$ Equation with $\pm c/3.6$ or $2c/3.6$ only = z or prob (can be implied) Correct answer accept 6.78
4	(i) $p = 4/9$ or $5/9$ $P(\text{at least } 2) = 1 - P(0, 1)$ $= 1 - (5/9)^5 - (4/9)(5/9)^4 {}_5C_1$ $= 0.735$ (ii) $np = 96$ $npq = 32$ $p = P(\leq k)$ $p = 2/3$ $q = 1/3$ $n = 144$ $k = 6$ $n = 144$	B1 M1 A1 M1 A1 A1ft A1	[3] [4]	Binomial term ${}_5C_x p^x (1-p)^{5-x}$ seen Correct answer Using $np = 96$ $npq = 32$ to obtain eqn in 1 variable 1/3 or 2/3 seen or implied Correct k ft $k = 9p$ correct n

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5	(i)	Stem leaf 0 1 4 6 8 1 0 3 4 4 4 5 5 5 6 6 6 6 7 8 8 2 0 1 5 7 8 3 1 4 5 5 7 Key 1 4 represents \$140	B1		Correct stem condone a space under the 1
			B1		Correct leaves must be single digits and one line for each stem value or 2 lines each stem value
			B1ft	[3]	Correct key must have \$, ft 2 special cases
	(ii)	Median = 160 LQ = 140 UQ = 210 IQ range = UQ - LQ = 70	B1		
			M1		Subt their LQ from their UQ
			A1	[3]	Correct answer cwo
	(iii)	$1.5 \times \text{IQ range} = 105$ Lower outlier is below 35 Upper outlier is above 315 Outliers 10, 450, 570	M1		Mult their IQ range by 1.5 can be implied
			A1ft		Correct limits ft their IQ range and quartiles
6			A1	[3]	Correct outliers
	(i)	H J O 1. 28 2 = $4C2 \times 9C8 \times 2C2 = 54$ 3 7 2 = $4C3 \times 9C7 \times 2C2 = 144$ 4 6 2 = $4C4 \times 9C6 \times 2C2 = 84$ Total = 282 ways	M1		Mult 3 combs, $2C2$ may be implied
			M1		$4C_x \times 9C_y \times 2C_z$
			A1		Summing 2 or 3 three-factor options
			A1	[4]	2 options correct unsimplified
			A1	[4]	Correct answer
	(ii)	$4! \times 6! \times 2! \times 3!$ = 207360 (207000)	M1		$4! \times 6! \times 2!$ oe seen multiplied by int ≥ 1
			M1		$3!$ seen mult by int ≥ 1
			A1	[3]	Correct answer
	(iii)	8 J and O trees in $8! = 40320$ ways 9 gaps $\times 8 \times 7 \times 6$ = 121,927,680 (122,000,000)	B1		$8!$ seen mult by int ≥ 1 no division
			M1		$9P_4$ oe or $7P_4$ or $8P_4$ seen mult by int ≥ 1 no division
			A1	[3]	Correct answer
	(i)	SR $4C2 \times 9C2 \times 2C2 \times 9C6$	M1		
	(ii)	SR $\frac{4! \times 6! \times 2!}{4! \times 6! \times 2!}$ or $3!$ or both M1	M1		

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	(iii)	SR1 $12! - 9! 4!$	M1										
		SR2 $\frac{9P4}{4!}$ or $\frac{8!}{6! 2!}$ or both	M1										
7	(i)	$P(T,B) = \frac{5}{12} \times \frac{2}{10} = \frac{1}{12} (0.0833)$	M1 A1	[2]	Mult their $P(T)$ by 2/9 or 2/10 only Correct answer								
	(ii)	$P(C_S \cap C_A) = \frac{7}{12} \times \frac{4}{10} = \frac{28}{120} (0.2333)$	M1		Mult their $P(C_S)$ by 3/9 or 4/10 seen as num or denom of a fraction								
		$P(C_A) = \frac{7}{12} \times \frac{4}{10} + \frac{5}{12} \times \frac{3}{10} = \frac{43}{120} (0.3583)$	M1		Summing 2 two-factor products to find $P(C_A)$ seen anywhere								
		$P(C_S C_A) = \frac{P(C \cap C)}{P(C_A)} = \frac{28/120}{43/120}$	A1		Correct unsimplified $P(C_A)$ seen as num or denom of a fraction								
		$= \frac{28}{43} (0.651)$	A1	[4]	Correct answer								
	(iii)	<table border="1"><tr><td>x</td><td>0</td><td>1</td><td>2</td></tr><tr><td>Prob</td><td>7/24</td><td>19/40</td><td>7/30</td></tr></table>	x	0	1	2	Prob	7/24	19/40	7/30	B1		$x = 0, 1, 2$, can be implied from table or working
x	0	1	2										
Prob	7/24	19/40	7/30										
		$P(X = 0) = P(T, B) + P(T, T)$	M1		1 or 2 two-factor products, denoms 12 and 10 or 12 and 9, implied if ans is correct								
		$= \frac{5}{12} \times \frac{2}{10} + \frac{5}{12} \times \frac{5}{10} = \frac{7}{24} (0.292)$	A1		One correct unsimplified								
		$P(X = 2) = P(C, C) = \frac{7}{12} \times \frac{4}{10} = \frac{28}{120} (0.233)$	B1		One other correct unsimplified								
		$P(X = 1) = 1 - 7/24 - 28/120 = \frac{19}{40} (0.475)$	B1ft	[5]	Third correct ft $1 - P(2 \text{ of their probs})$								

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	$P(Q \cap S) = \frac{2}{36}$ or $P(S Q) = \frac{1}{2}$ or	B1	oe
	$P(Q S) = \frac{2}{18}$		
	$P(Q \cap S) = P(Q) \times P(S)$ or $P(S Q) = P(S)$ or $P(Q S) = P(Q)$	M1	Comparing correct pair of terms $0 \leq$ all probabilities < 1
	Independent	A1	[4] Correct conclusion must have all probs correct
2	$P(\text{at least } 2) = P(2, 3) \text{ or } 1 - P(0, 1)$	M1	Summing, or 1–, two different three-factor prob expressions, ${}_3C_2$ not needed
	$= \frac{5}{12} \times \frac{4}{11} \times \frac{7}{10} \times {}_3C_2 + \frac{5}{12} \times \frac{4}{11} \times \frac{3}{10}$	M1	12, 11, 10 seen or implied in denominator
	$= \frac{4}{11} (0.364)$	M1	Mult a prob by ${}_3C_2$ or ${}_3C_1$ oe
	OR $\frac{{}_5C_3 + ({}_5C_2 \times {}_7C_1)}{{}_{12}C_3}$	A1	[4] Correct answer
		M1	${}_5C_3$ seen added in numerator
		M1	${}_5C_2$ seen mult alone or in numerator
		M1	${}_{12}C_3$ seen in denom
		A1	Correct answer
3 (i)	$P(\text{tall}) = P\left(z > \frac{70-50}{16}\right) = P(z > 1.25)$	M1	+ve/-ve Standardising no cc no sq rt no sq
	$= 1 - 0.8944$		
	$= 0.106$	A1	[2] Correct answer
	(ii) $P(\text{short}) = (1 - 0.1056)/3$	M1	Subt their (i) from 1 or their (i) and multiplying by $\frac{1}{3}$ or $\frac{2}{3}$
	$= 0.2981$	A1 ft	Rounding to 0.298, only ft for $\frac{(1-(i))}{3}$
	$z = -0.53$	A1	$\pm$ z-value rounding to 0.53, condone ± 0.24
	$-0.53 = \frac{x-50}{16}$	M1	Standardising with their z value (not a probability), no cc sq rt etc.
	$x = 41.5$	A1	[5] Correct answer

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4 (i) $(0.8)^n < 0.001$ $n > 30.9$ $n = 31$ (ii) $\mu = 120 \times 0.2 = 24$ $\sigma^2 = 120 \times 0.2 \times 0.8 = 19.2$ $P(x < 33) = P\left(z < \frac{32.5 - 24}{\sqrt{19.2}}\right)$ $= P(z < 1.9398)$ $= 0.974$	M1 M1 A1 [3] B1 M1 M1 A1 [4]	Eqn or inequ involving 0.8^n or 0.2^n and 0.001 or 0.999 Trial and error or logs (can be implied) Correct answer MR 0.01, max available M1M1A0 24 and 19.2 or $\sqrt{19.2}$ seen Standardising with or without cc, must have sq rt in denom Continuity correction 32.5 or 33.5 Correct answer
5 (a) $P(W_2) = P(W_1 W_2) + P(L_1 W_2)$ $= 0.3 \times 0.6 + 0.7 \times 0.15$ $= 0.285$ $P(W_1 W_2) = \frac{P(W_1 \cap W_2)}{P(W_2)} = \frac{0.18}{0.285}$ $= 0.632, \frac{12}{19}$ (b) $x + 4$ oe seen $\frac{10}{15} \times \frac{7}{x+4} = \frac{7}{18}$ $x = 8$	B1 M1 A1 A1 [4] B1 M1 A1 A1 [4]	0.3×0.6 alone as num or denom of a fraction Attempt at $P(W_2)$ as sum of two 2-factor options seen anywhere Correct unsimplified $P(W_2)$ as num or denom of a fraction Correct answer Seen anywhere Mult two probabilities, one containing x and equating to $\frac{7}{18}$ Correct unsimplified equation Correct answer
6 (i) (40, 0), (50, 12) etc. up to (90, 144) cf points (ii) 80 weigh less than 67.2 kg $c = 67.2$	B1 B1 [2] M1 A1 ft [2]	Axes, (cf) and labels (kg), uniform scales from at least 0–140 and 40.5–69.5 either way round All points correct, sensible scale (not 12), polygon or smooth curve Subt 64 from 144 Accept anything between 67 and 68 ft from incorrect graph

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(iii) freqs 12, 22, 30, 28, 52 mean wt = $(45 \times 12 + 55 \times 22 + 62.5 \times 30 + 67.5 \times 28 + 80 \times 52) / 144$ = 9675 / 144 = 67.2 kg Var $(45^2 \times 12 + 55^2 \times 22 + 62.5^2 \times 30 + 67.5^2 \times 28 + 80^2 \times 52) / 144$ – $(9675/144)^2 = 127.59$ sd = 11.3, allow 11.2	M1 A1 M1 A1 M1 A1 [6]	frequencies attempt not cf Correct freqs Using mid points attempt, i.e. 44.5, 45, 45.5, in correct mean formula, unsimplified, no cfs, condone 1 error. Correct mean Substituting their mid-pts squared (may be class widths, lower or upper bound) in correct var formula even with cfs with their mean² Correct answer
7 (i) S(10) R(14) P(6) 1 2 4 = $10C1 \times 14C2 \times 6C4 = 13650$ 1 3 3 = $10C1 \times 14C3 \times 6C3 = 72800$ 2 2 3 = $10C2 \times 14C2 \times 6C3 = 81900$ Total = 168350 or 168000 (ii) $2! \times 2! \times 5!$ = 480 If M0 earned $\frac{2! \times 2!}{2! \times 2!}$ or $\frac{5!}{3!}$ or both, seen mult by an integer ≥ 1 Or $2! \times 2! \times 5!$ divided by a value (iii) spaniels and retrievers in 4! ways gaps in $5P3$ or $5 \times 4 \times 3$ ways = 1440 If M0 earned $\frac{4!}{2! \times 2!}$ or $\frac{{}_5P_3}{3!}$ or both, seen multiplied by an integer > 1 or $7! - 5! \times 3!$ – $\{(4! \times 2 \times 4 \times 3!) + (4! \times 3 \times 4 \times 3!)\}$ = 1440 If M0 earned $3! \times 2! \times 2!$ used as a denominator in all 4 terms	M1 M1 B1 A1 [4] M1 M1 A1 [3] SCM1 M1 M1 A1 [3] SCM1 M1 M1 A1 SCM1	Summing 2 or more 3-factor options perms or combs Mult 3 combs or 4 combs with $\Sigma r=7$ 2 options correct, unsimplified Correct answer $2! \times 2!$ oe, seen mult by an integer ≥ 1, no division Mult by $5!$, or $5!$ alone, seen mult by an integer ≥ 1 no division Correct answer $4!$ seen multiplied by an integer > 1 Mult by $5P3$ oe Correct answer ${}_5C_3$ oe oe oe, e.g. $6 \times 5 \times 4 \times 4!$ Marks cannot be earned from both methods.