UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

9709 MATHEMATICS

9709/61 Paper 6, maximum raw mark 50

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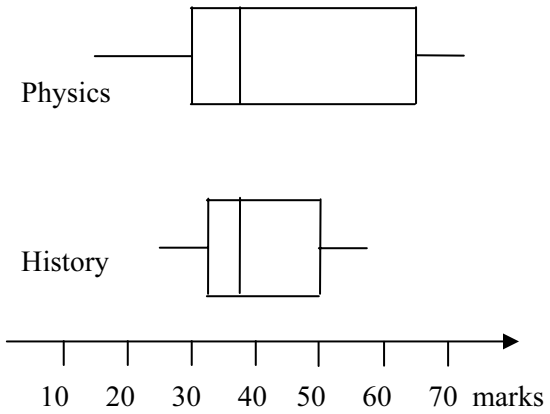
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1	$\mu = 250 \times 0.86 = 215$	B1		250 × 0.86 and 250 × 0.86 × 0.14 seen o.e
	$\sigma^2 = 250 \times 0.86 \times 0.14 = 30.1$	M1		Standardising, with or without cc, must have sq rt in denom
	$P(X > 210) = 1 - \Phi\left(\frac{210.5 - 215}{\sqrt{30.1}}\right)$	M1		Continuity correction 210.5 or 209.5 only
	$= \Phi(0.820)$	M1		Correct region (> 0.5) ft their mean
	$= 0.794$	A1	[5]	Correct answer
2	**(i)** $133/n + 25 = 28.325$	M1		Equation involving 133, 25 and 28.325
	$n = 40$	A1		Correct answer for n
	$3762/40 - 3.325^2 = 82.99$	M1		Using coded mean in variance formula
	standard deviation = 9.11	A1	[4]	Correct answer
	(ii) $82.99 = \Sigma x^2/40 - 28.325^2$	M1		Using uncoded material in variance formula
	$\Sigma x^2 = (82.99 + 28.325^2) \times 40$			
	$= 35412$ (35400)	A1		Correct answer
	OR			
	$\Sigma(x - 25)^2 = \Sigma x^2 - 50\Sigma x + 40 \times 25^2$	M1		Expanding and substituting for Σx
	$\Sigma x^2 = 3762 + 50 \times 1133 + 25000$			
	$= 35412$	A1	[2]	Correct answer
3	**(i)** $P(X = 1) = P(GBBB)\ 4 \times {}_1C_1$	M1		Considering values of X of 1, 2, 3, 4
	$= 5/8 \times 3/7 \times 2/6 \times 1/5 \times 4 = 1/14$	M1		Attempting to find the probability of at least 2 values of X
	$P(X = 2) = P(GGBB) \times {}_4C_2 = 3/7$			
	$P(X = 3) = P(GGGB) \times {}_4C_3 = 3/7$	A1		One correct probability
	$P(X = 4) = P(GGGG) \times {}_4C_4 = 1/14$	A1		All correct
	OR			
	$P(1) = {}_5C_1 / {}_8C_4 = 1/14$	M1		Considering values of X of 1, 2, 3, 4
	$P(2) = {}_3C_2 \times {}_5C_2 / {}_8C_4 = 3/7$	M1		Dividing by ${}_8C_4$
	$P(3) = {}_3C_1 \times {}_5C_3 / {}_8C_4 = 3/7$	A1		One correct probability
	$P(4) = {}_5C_4 / {}_8C_4 = 1/14$	A1	[4]	All correct
	(ii) $\text{Var}(X) = 1/14 + 12/7 + 27/7 + 16/14 - (5/2)^2$	M1		Using a variance formula correctly with mean^2 subtracted numerically, no extra division
	$= 15/28$ (0.536)	A1	[2]	Correct final answer

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4	**(i)**	History: lowest 27, highest 57, LQ = 33 med = 39 UQ = 50  	M1 [1]	Attempt to find history quartiles and median by putting in order or stem and leaf (can be implied if the answer is reasonable) Correct history median and quartiles Uniform scale and labels Correct history graph ft their quartiles line not through box Correct physics graph
	(ii)	Physics marks are more spread out than History marks	B1 [1]	Any sensible comment
5	**(i)**	$z = 1.882$ or 1.881	B1	± 1.882 or ± 1.881 seen
		$1.882 = (32 - 20) / \sigma$	M1	Equation using their z (must be a z-value) 32, 20 and s
		$\sigma = 6.38$	A1 [3]	Correct answer
	(ii)	$P(x > 13) = P\left(z > \frac{13-20}{6.376}\right)$	M1	Standardising
		$= P(z > -1.0978)$	M1	Correct area > 0.5
		$= 0.864$	A1 [3]	Correct answer
	(iii)	P(at least 2) = 1 – P(0, 1)	M1	Using 0.03 and 0.97 or 0.06 and 0.94 in a binomial expression powers summing to 7
		$= 1 - (0.97)^7 - (0.03)(0.97)^6{}_7C_1$	M1	Correct unsimplified binomial expansion
		$= 0.0171$	A1 [3]	Correct answer
6	**(a)**	**(i)** $\frac{12!}{2!3!2!} = 19958400$ (20,000,000)	M1 A1 [2]	Dividing by 2! 3! 2! Correct answer
		(ii) $\frac{4!}{2!} \times \frac{9!}{2!3!} = 362880$	B1 B1 B1 [3]	4! seen multiplied 9! or 9 × 8! seen multiplied Correct final answer
	(b)	**(i)** $3876 \times 4!$	M1	Multiplying by 4!
		$= 93024$	A1 [2]	Correct answer
		(ii) $(3!)^4 \times 4!$	M1	3! or 6 or 4! seen
		$= 31104$	A1 [2]	Correct final answer

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7	**(i)** P(2, N2, 2) = 1/4 × 1 × 1/7 = 1/28	M1		Considering at least two options of 2s and 8s
	P(8, 8, N8) = 1/4 × 2/5 × 3/7 = 3/70	M1		Considering three options for the 8s
	P(8, N8, 8) = 1/4 × 3/5 × 4/7 = 3/35	M1		Summing their options if more than 3 in total
	P(N8, 8, 8) = 3/4 × 2/5 × 4/7 = 6/35	B1		One option correct
	Σ = 47/140 (0.336)	A1	[5]	Correct answer
	(ii) P(2, 2 given same) = $\frac{1/28}{47/140}$	M1		1/28 in numerator of a fraction
	= 5/47 (0.106)	A1	[2]	Correct answer
	(iii) P(X) = 47/140	M1		Attempt to compare P(A and B) with P(A) × P(B) or using conditional probabilities
	P(Y) = 1/4			
	P(X and Y) = 1/28 ≠ 47/140 × 1/4	A1		Legitimate correct answer
	Not independent		[2]	

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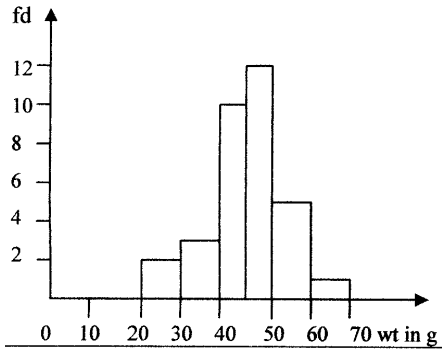
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1	$\bar{x} = 59.4$	B1		
		M1		Correct method (can be implied by correct answer)
	$\sigma = 7.68$	A1	[3]	Correct answer
2	**(i)** each in 2 ways = 2^{12}	M1		2^{12} seen
	= 4096	A1	[2]	Correct answer
	(ii) $\frac{12!}{7!5!}$	B1	[1]	
	= 792			
3	**(a)** *G R L*			
	11 7 7 = 15C11 × 10C7 × 8C7 = 1310400	M1		Multiplying 3 combinations
	13 6 6 = 15C13 × 10C6 × 8C6 = 617400	A1		One of 1310400, 617400, 14112 seen
	15 5 5 = 15C15 × 10C5 × 8C5 = 14112	M1		Adding 3 options
	Total = 1941912 (1940000)	A1	[4]	Correct answer
	(b) e.g. * E * R * E (GG) N * A * E * gives 6 ways for G	B1		7! / 3! Or 7!/3!3! seen oe
	$\frac{7!}{3!} \times 6$ or 8!/3! – 2 × 7!/3!	B1		Multiplying by 6 (gaps) oe
	= 5040 ways.	B1	[3]	Correct final answer
4	**(i)** 45 – 50 g	B1	[1]	
	(ii) LQ in 40 – 45			
	UQ in 50 – 60	M1		Considering groups containing LQ and UQ (can be implied)
	Smallest IQ range could be 5			
	Largest IQ range could be 20	A1	[2]	Correct answer
	(iii) 50	B1	[1]	
	(iv) freqs 0, 20, 30, 50, 60, 50, 10			
	fd 0, 2, 3, 10, 12, 5, 1	M1		Attempt at frequencies and fd
		B1		Correct labels and scales with a histogram-type shape
		B1		Correct bar widths starting at 20
		A1	[4]	Correct heights of bars
5	**(i)** $4p + p + 3p = 1$ so P(blue) = 1/8 AG	B1	[1]	Must show something
	(ii) P(*R*) = ½, P(*B*) = 1/8, P(*G*) = 3/8	M1	[3]	Multiplying P (*R*, *B*, *G*) together
	P(all different) = ½ × 1/8 × 3/8 × 3!	M1		Mult by 3!
	=9/64 (0.141)	A1		Correct answer

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	(iii)	mean = 136 × 1/8 = 17, var = 14.875	B1		Unsimplified mean and variance correct
		$P(<20) = P\left(z < \frac{19.5-17}{\sqrt{14.875}}\right)$	M1		Standardising, need sq rt
			M1		Cont correction 19.5 or 20.5
		$= \Phi(0.648)$	M1		Correct area, > 0.5 legit
		$= 0.742$	A1	[5]	Correct answer
6	**(i)**	P(0, 1, 2)	B1		0.15 and 0.85 seen
		$=(0.85)^6 + (0.15)(0.85)^5{}_6C_1 +$	M1		Any binomial expression Σpowers = 6, Σ p = 1
		$(0.15)^2(0.85)^4{}_6C_2$			
		$= 0.953$	A1	[3]	Correct answer
	(ii)	$P(D) = 0.6 \times 0.1 + 0.4 \times 0.55 = 0.28$	M1		Attempt to find P(*D*)
			A1		0.28 seen
		$P(B\|D) = \frac{P(B \cap D)}{P(D)}$	M1		Using cond prob formula to find P(*B*|*D*)
		$0.06/0.28 = 0.2143$	√A1		Correct unsimplified answer
		$P(> 1) = 1 - P(0)$	M1		Binomial expression 1 –P(0) or 1 –P(0, 1) Σ p = 1
		$= 1 - (0.7857)^5$			
		$= 1 - 0.7078$	A1	[6]	Correct answer accept 0.700
		$= 0.701$			
7	**(i)**	$z_1 = \frac{12-8}{\sqrt{24}} = 0.816$ $\Phi_1(0.816) = 0.7926$	M1		Standardising any one, sq rt, no cc
		$z_2 = \frac{7-8}{\sqrt{24}} = -0.204$ $\Phi_2(-0.204) = 1 - 0.5808$	M1		Correct area $\Phi_1 + \Phi_2 - 1$
		Prob = 0.7926 – (1 – 0.5808) = 0.373	A1	[3]	Correct answer
	(ii)	$z = \frac{0-\mu}{2\mu} = -0.5$	M1		Standardising, no cc no sq rt, one variable
		$P(z < -0.5) = 1 - 0.6915$			
		= 0.309 or 30.9%	A1	[2]	Correct answer oe
	(iii)	$z = \frac{3\mu-\mu}{2\mu} = 1$	M1		Standardising and eliminating μ
		$P(z > 1) = 1 - 0.8413 = 0.1587$	M1		Subt from 1 and multiplying by 70
		$70 \times 0.1587 = 11.1$	A1	[3]	Correct answer accept 11 or 12
	(iv)	$z = 1.45$	B1		± 1.45 seen
		$1.45 = \frac{6-\mu}{2\mu}$	M1		Solving for μ with 6, 2 μ , μ and their z
		$\mu = 1.54$	A1	[3]	Correct answer

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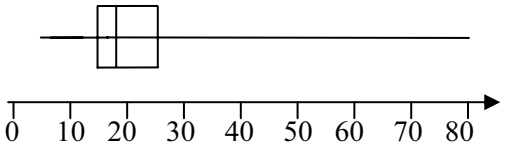
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1	**(i)**	$z = 0.38$	B1	$\pm 0.38\,(0)$ seen or implied
		$\pm\dfrac{25-\mu}{\mu/3} = 0.38$	M1	Standardising attempt resulting in z = some μ/σ/both, no continuity correction
			M1	Substituting to eliminate μ or σ and attempt to solve linear equation
		$\mu = 22.2,\ \sigma = 7.40$	A1 [4]	Both correct
	(ii)	$P(4) = {}^6C_4(0.352)^4(0.648)^2$	M1	${}^6C_r \times (p)^r \times (1-p)^{6-r}$, $r = 2$ or 4
		$= 0.0967$	A1 [2]	Correct answer
2	**(i)**	$P(F) = \dfrac{12}{30}$ (0.4)	B1	$\dfrac{12}{30}$ or $\dfrac{16}{30}$ or $\dfrac{5}{30}$ seen
		or $P(W) = \dfrac{16}{30}$ (0.533)	M1	Valid attempt to find P(F or W)
		or $P(M \cap W') = \dfrac{5}{30}$ (0.167)		
		$(F \text{ or } W) = \dfrac{13}{30}+\dfrac{3}{30}+\dfrac{9}{30}$	A1	Correct unsimplified expression
		or $1 - \dfrac{5}{30}$ or $\dfrac{12}{30}+\dfrac{16}{30}-\dfrac{3}{30}$		
		$= \dfrac{5}{6}$ (0.833)	A1 [4]	Correct answer
	(ii)	$P(M) = 18/30$ (0.6), $P(W) = 16/30$ (0.533), $P(M) \times P(W) = 8/25$ (0.32)	M1	Valid attempt to find P(M), P(W) and P(M) × P(W)
		P(M and W) = 13/30 (0.433) $\neq$ 8/25 (0.32)	A1	P(M and W) = 13/30 $\neq$ 8/25 and correct conclusion
		not independent		
		OR		
		$P(M \mid W) = \dfrac{P(M \text{ and } W)}{P(W)} = \dfrac{13/30}{16/30} = \dfrac{13}{16}$ (0.813)	M1	Valid attempt to find P(M and W), P(W) and P(M and W) ÷ P(W)
		$\neq \dfrac{18}{30} = P(M)$,	A1	$\dfrac{13}{16} \neq \dfrac{18}{30} = P(M)$
		not independent		
		OR		
		$P(W \mid M) = \dfrac{P(M \text{ and } W)}{P(W)} = \dfrac{13/30}{18/30} = \dfrac{13}{18}$	M1	Valid attempt to find P(M and W), P(M) and P(M and W) ÷ P(M)
		$\neq \dfrac{16}{30} = P(W)$,	A1	$\dfrac{13}{16} \neq \dfrac{18}{30} = P(M)$
		not independent	[2]	

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3	**(i)** P(3m) = 4/5 (0.8) P(5m) = 1/5 (0.2)	B1		P(3m) = 4/5 or P(5m) = 1/5 seen or implied
	E(X) = 17/5 (3.4)	B1		Correct E(X)
		M1		Subtract their mean^2 numerically from Σx^2p, no extra dividing
	Var(X) = 16/25 (0.64)	A1	[4]	Correct answer
	(ii) P(3, 5) + P(5, 3) = 0.8 × 0.2 +0.2 × 0.8	M1		Summing two 2-factor terms
	= 8/25 (0.32)	A1√	[2]	Correct answer, ft on 2 × p × (1 − p), their p
	(iii) P(11) = P(3, 3, 5) + P(3, 5, 3) + P(5, 3, 3)	M1		Mult 2 probs for 3 with 1 prob for 5
	= (4/5 × 4/5 × 1/5) × 3	M1		Multiplying probs for 11 by 3 or summing 3 options
	= 48/125 (0.384)	A1	[3]	Correct final answer
4	**(i)** 3! × 4! × 8! × 3!	M1		Multiplying 3 factorials together
		M1		Multiplying by 3!
	= 34 836 480 (34 800 000)	A1	[3]	Correct answer
	(ii) $^3C_2 \times {}^4C_2 \times {}^8C_2$	M1		Multiplying (only) 3 combinations together
	= 504	A1	[2]	Correct answer
	(iii) Fr Fa H			
	3 1 2 = $^8C_3 \times {}^3C_1 \times {}^4C_2 = 1008$	M1		Multiplying 3 combinations, only
	3 2 1 = $^8C_3 \times {}^3C_2 \times {}^4C_1 = 672$	M1		Summing 3 options
	4 1 1 = $^8C_4 \times {}^3C_1 \times {}^4C_1 = 840$	A1		3 correct combination answers
	total ways = 2520	A1	[4]	Correct answer
5	**(i)** LQ = 15, Median = 18, UQ = 26	B1		LQ = 15, Median = 18, and UQ = 26
		B1		Linear scale and labels
		B1√		Quartiles and median box, ft on their values, but M − LQ < UQ − M
		B1√		Whiskers from 5 to LQ and UQ to 80, ft on their values
			[4]	
	(ii) most (3/4) are earning less than 26K, not many earning high salaries, etc	B1	[1]	Any sensible answer
	(iii) **(a)** IQ range = 11	B1		IQR = 11
	high outlier is above 26 + 1.5 × 11	M1		Their UQ + 1.5 × their IQ range
	= 42500 euros	A1	[3]	Correct answer
	(b) Low outlier is below 15 – 1.5 × 11 = –1.5	B1√	[1]	Correct reason, must involve subtraction, ft on their LQ and 1.5 × their IQR

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6	**(i)**	$P(O \text{ given } +) = \frac{0.37}{0.83}(0.4458)$	B1 A1 M1	0.83 seen or implied Attempt to find P(O given +) using conditional probability fraction Binomial term ${}^9C_r p^r(1-p)^{9-r}$, $r \neq 0$ or 9
		$P(0, 1, 2) = (0.4458)^0(0.5542)^9 + {}^9C_1(0.4458)^1(0.5542)^8 + {}^9C_2(0.4458)^2(0.5542)^7$	M1 A1	Binomial expression P(0, 1, 2) or P(0, 1, 2, 3) powers summing to 9 any $0 < p < 1$ Correct unsimplified expression
		$= 0.156$	A1 [6]	Correct final answer
	(ii)	$\mu = 150 \times 0.35 = 52.5,$	B1	150×0.35 (52.5) and $150 \times 0.35 \times 0.65$ (34.125) seen
		$\sigma^2 = 150 \times 0.35 \times 0.65 = 34.125$	M1 M1	Standardising, using sd not variance Using continuity correction, 59.5 or 60.5
		$P(> 60.5) = P\left(z > \pm \frac{60.5 - 52.5}{\sqrt{34.125}}\right)$	M1	correct area (< 0.5, for mean < their 60)
		$= 1 - \Phi(1.369)$		
		$= 0.0854$ or 0.0855	A1 [5]	correct value

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