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RECOGNISING ACHIEVEMENT

GCE

Mathematics

Advanced GCE **4735**

Mark Scheme for June 2010

Oxford Cambridge and RSA Examinations

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1(i)	Var(2*A* – 3*B*) = 4Var(*A*) + 9Var(*B*) – 12Cov(*A*,*B*) $\Rightarrow$ 18 = 36 + 54 – 12Cov(*A*,*B*) $\Rightarrow$ Cov(*A* ,*B*) = 6	M1 A1 A1 **3**	Correct formula. Allow one error Substitute relevant values CAO
(ii)	Since Cov(*A*, *B*) ≠ 0, *A* and *B* are not independent	B1 ft **1** **(4)**	Must have a reason. ft Cov≠ 0
2(i)	G′(*t*) = $8te^{4t^2} / e^4$ E(*X*) = G′(1) = 8	M1A1 A1 **3**	M1 for ct^2/e^4
(ii)	EITHER: $G(t) = e^{-4}(1 + 4t^2 + \ldots)$ P(*X*=2) = coefficient of $t^2 = 4e^{-4}$ or $4/e^4$ or 0.0733 OR G″(*t*) = $(8+64t^2)e^{4t^2-4}$ P(*X*=2) = $\frac{1}{2}$G″(0) = $4e^{-4}$ or $4/e^4$ or 0.0733	M1A1 A1 **3** M1A1 A1 **(6)**	Expand in powers of *t* M1 for reasonable attempt at M″(*t*)
3(i)	Number of different rankings $^{11}C_5$ =462 For *R* ≤ 17: 1+2+3+4+5 = 15 1+2+3+4+6=16 1+2+3+5+6=17 1+2+3+4+7=17 P(*R* ≤ 17) = 4/462 = 2/231 AG	M1 A1 B2 A1 **5**	Number of selections of 5 from 11 B1 for 2 or 3 correct
(ii)	*W* = 17 P(*W* ≤ 17) = $\frac{2}{231}$ Smallest SL = $\frac{400}{231}$ %	M1 A1ft **2** **(7)**	 Allow $\frac{4}{231}$; ft $\frac{2}{231}$, but must be exact
4(i)	EITHER: (α) M′(*t*) = $n(1 – 2t)^{-½n – 1}$ E(*Y*) = M′(0)=*n* M″(*t*) = $n(n+2)(1 – 2t)^{-½n – 2}$ Var(*Y*) = $n(n+2) – n^2 = 2n$ OR: M(*t*) = 1 + *nt* + $\frac{1}{2}n(n+2)t^2$ E(*Y*) = *n* Var(*Y*) = $n(n+2) – n^2 = 2n$	M1 A1 A1 M1 A1 **5** M1A1A1 A1 A1 **5**	Correct form for M1 Ft similar M′(*t*) M″(0) – (M′(0))^2
(ii)	MGF = $(1 – 2t)^{-30}$ χ^2 distribution with 60 d.f.	B1 B1 **2**	From $[(1 – 2t)^{-1/2}]^{60}$
(iii)	E(*S*) = 60, Var(*S*) = 120 Using CLT, Probability =1 – Φ(10/√120) = 0.181	B1ft M1 A1 **3** **(10)**	From **(i)** Correct tail: allow cc

5(i)	Assumes salaries symmetrically distributed H_0: m(edian) = 19.5, H_1: m(edian)≠ 19.5 P = 867 (or 408) Using normal approximation μ = ¼ ×50×51 (= 637.5) σ^2 = 50×51×101/24 (= 10731.25) $z = (a - 637.5)/\sqrt{10731.25}$ Use a = 866.5 = 2.211, or 2.215 or 2.220 (– from 408) Compare their z with 1.96 and reject H_0 There is sufficient evidence at the 5% SL that the median salary differs from £19 500	B1 B1 M1 A1 A1 M1 A1 A1 M1 A1 ft **10**	In context For both ; not μ ; accept words a=866.5, 867, 867.5 (or 408.5, 408, 407.5) Or p-value rounding to 0.026 or 0.027 Compare with 0.05 or equivalent ft z Or find critical region
(ii)	Use sign test when salary distribution is skewed	B1 **1** **(11)**	
6(i)	N 0 1 2 0 0 c $2c$ R 1 $2c$ $3c$ $4c$ 2 $4c$ $5c$ $6c$ Total $27c$ = 1 $c = \frac{1}{27}$	B1 M1 A1 **3**	Calculate 9 probs in terms of c
(ii)	$9c/27c$ $= \frac{1}{3}$	M1 A1 ft **2**	Marginal probability AEF; ft c
(iii)	P(N + R > 2) = $15c/27c = \frac{5}{9}$	M1 A1 ft **2**	AEF; ft c
(iv)	P(R=2) = $\frac{15}{27}$ P(N | R=2): $p_0 = \frac{4}{15}$, $p_1 = \frac{1}{3}$, $p_2 = \frac{2}{5}$ E(N |R=2)= $1\times\frac{1}{3}+2\times\frac{2}{5}$ $= \frac{17}{15}$	M1 A1 ft A1 ft A1 **4**	Using conditional probabilities One value; ft values in **(i)** All values Or 1.13
(v)	Eg P(N = 0 and R = 0) = 0 P(N=0)×P(R=0) = $\frac{6}{27}\times\frac{3}{27} \neq 0$ So N and R are not independent	M1 A1 **2** **(13)**	Or from conditional probs M0 from N=1 with R=1 or 2 All correct

7(i)	$\int_0^{2\theta} \frac{x^{n+1}}{2\theta^2}\,dx = \left[\frac{x^{n+2}}{2(n+2)\theta^2}\right]$ $= 2^{n+1}\theta^n/(n+2)$ $E(X) = 4\theta/3$ ----------	M1 A1 B1 ft **3** ----------	Correct integral AEF B0 if not 'deduced' ----------
(ii)	$Var(X) = 2\theta^2 - (4\theta/3)^2 = 2\theta^2/9$ $Var(X^2) = E(X^4) - (E(X))^2$ $= 16\theta^4/3 - 4\theta^4 = 4\theta^4/3$ ----------	M1A1ft M1A1ft **4** ----------	-- ft **(i)** with no n ft **(i)** with no n ----------
(iii)	$E(\sum X_i) = 3\times 4\theta/3$ $= 4\theta$ $T_1 = \frac{1}{4}\Sigma X_i$ $E(\sum X_i^2) = 3\times 2\theta^2$ $=6\theta^2$ $T_2 = (\sum X_i^2)/27$ ----------	M1 A1 ft A1 ft M1 A1 ft A1 ft **6** ----------	--- ft with no n ft with no n or θ ft with no n ft with no n or θ
(iv)	$Var(T_2) = 1/27^2 \times 3 \times Var(X^2)$ $= 4\theta^4/729$	M1 A1 **2** **(15)**	---------- --- CAO
8(i)	$P(L\cap M) = P(L\mid M)P(M) = 0.12$ and $P(L) = P(M\cap L)/P(M\mid L)$ = 0.12/0.4 = 0.3 $P(L'\cup M') = P\left[(L\cap M)'\right]$ $= 1 - P(L\cap M)$ = 1 – 0.2 × 0.6 = 0.88 ----------	*M1* A1 B1 **3** ----------	----------
(ii)	- $P(N\mid L\cap M) = 0.3$ $\Rightarrow P(N\cap L\cap M) = 0.3\times 0.12$ =0.036 $P(L'\cup M'\cup N') = 1 - 0.036 = 0.964$	M1 A1 A1 **3** **[6]**	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)
Telephone: 01223 553998
Facsimile: 01223 552627
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