GCE

Mathematics

Advanced GCE

Unit **4732:** Probability and Statistics 1

Mark Scheme for June 2011

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All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

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Note: "(3 sfs)" means "answer which rounds to … to 3 sfs". If correct ans seen to $\geq$ 3sfs, ISW for later rounding
Penalise over-rounding only once in paper.

1ia	$\dfrac{3247-\frac{251\times65}{5}}{\sqrt{(14323-\frac{251^2}{5})(855-\frac{65^2}{5})}}$ or $\dfrac{-16}{\sqrt{1722.8\times10}}$ = –0.1219…	M2 A1 3	M1 for correct subst in any correct *S* formula M2 for correct subst'n in any correct *r* formula Must see at least 4 sfs	or $\dfrac{-80}{\sqrt{8614\times50}}$ Allow –0.1218
b	Poor/no/little/weak/not strong corr'n or rel'nship or link between income & distance oe	B1 1	or slight neg/weak corr'n (oe) between income & distance In context, ie <u>any</u> comment on income & distance, even if incorrect	eg, Poor neg corr'n, so higher distance, lower income No rel'nship. Low income doesn't cause low distance NOT "Not proportional …" NOT "negative corr'n …" No recovery of this mark in (ii)
c	No effect or -0.122 oe	B1 1	eg "Nothing" or "None" oe	Ignore other NOT "Little effect" NOT "Not much effect"
ii	*r* close to 0, or small, or poor corr'n oe or *r* = –0.122 Unreliable	B1 B1dep 2	or Weak/no corr'n or poor rel'nship oe or No evidence to link sales & distance Condone "innacurate"or "incorrect" or "less reliable" or "not that reliable" "The data is unreliable" Must have correct reason	or because small sample Ignore other Allow: "Unreliable because pts do not fit a st line" "Unreliable because pts are scattered" "Unreliable because not strong neg …." "Unreliable because *r* not close to -1" "Unreliable because *r* smaller than (–)0.7" NOT "Unreliable because extrapolated": B0B0 but "Unreliable because extrapolated and poor corr'n": B1B1
Total		**7**		

2	Attempt ranks
	4 1 2 3 or 1 2 3 4 or 1 2 3 4 oe
	2 1 3 4 1 3 4 2 1 4 2 3
	
	Σd^2 attempted (or 6)
	
	$1-\frac{6\Sigma d^2}{4(4^2-1)}$
	
	$=\frac{2}{5}$ oe
		M1
		
		A1
		
		M1
		
		M1
		
		A1 5
			Ignore labels of rows or columns
			
			No ranks seen, d = (0), ±1, ±1, ±2, or
			        d^2 = (0), 1, 1, 4 any order: M1A1
			NOT $(\Sigma d)^2$
				No wking, Σd^2 = 6: M1A1M1
				No wking, Σd^2 = eg 14: M0A0M0, but can gain 3rd M1
				
				No wking, ans $\frac{2}{5}$: Full mks
				Allow both sets of ranks reversed
				
				NB incorrect method:
				2 3 4 1
				2 1 3 4 OR d = (0), ±2, ±1, ±3 any order
				        OR d^2 = (0), 4, 1, 9 any order
				        (leading to Σd^2 = 14 and $r_s = -\frac{2}{5}$):
				                M0A0M1M1A0

Total		**5**		
3ia	$(1 - 0.5565)$ or $12\times0.85^{11}\times(1-0.85) +0.85^{12}$ = 0.4435 or 0.443 or 0.444 (3 sf)	M1 A1 2	or $1 - ((1-0.85)^{12}\ldots.^{12}C_{10}\times0.85^{10}(1-0.85)^2)$ ie 1 – (all 11 correct binomial terms)	or 1 – 0.557 NB 1 – 0.4435 (oe): M0A0
b	$0.5565 - 0.2642$ or $^{12}C_{10}(1-0.85)^2(0.85)^{10}$ = 0.2923 or 0.2924 or 0.292 (3 sf)	M1 A1 2		or 0.557 – 0.264
c	$12 \times 0.85 \times (1-0.85)$ = 1.53 oe	M1 A1 2		
ii	$(\frac{3}{4})^2$ AND $\frac{3}{4}\times\frac{1}{4}$ seen (possibly $\times 2$) $(\frac{3}{4})^2 \times 2 \times\frac{3}{4}\times\frac{1}{4}$ oe or $\frac{27}{128}$ or 0.211 $2 \times (\frac{3}{4})^2 \times 2 \times\frac{3}{4}\times\frac{1}{4}$ oe $=\frac{27}{64}$ or 0.422 (3 sfs)	M1 M1 M1 A1 4	eg $(\frac{3}{4})^2+\frac{3}{4}\times\frac{1}{4}$ or $2\times(\frac{3}{4})^2 + 2\times\frac{3}{4}\times\frac{1}{4}$ or $0.5625 + 0.1875$ or $0.5625 + 0.375$ or eg 0.5625×0.375 Fully correct method	or $\frac{9}{16}$ and $\frac{3}{16}$ or $\frac{9}{16}$ and $\frac{3}{8}$ eg in table or list Allow even if further incorrect wking Ans 0.211: check wking but probably gets M1M1M0A0 Use of 0.85 instead of $\frac{1}{4}$: MR max M1M1M1A0
Total		**10**		

4i	Method is either: Just $4 \div 3$ or $\frac{4}{3}$				
	or: Use of ratio of correct frequencies AND ratio of widths (correct or 4 and 2)				

4i	$5.6 \times \frac{4}{28} \times \frac{5}{3}$ or $0.8 \times \frac{5}{3}$ or $(5.6 \div \frac{28}{5}) \times \frac{4}{3}$ or $\frac{4}{3}$ or $4 \div 3$ oe	M2	M1 for $5.6 \times \frac{4}{28} \times \frac{4}{2}$ or $0.8 \times \frac{4}{2}$ or $(5.6 \div \frac{28}{4}) \times \frac{4}{2}$ or 0.8×2 oe (= 1.6)	Correct calc'n using 5.6, 28, 4, 5, 3 oe: M2 Correct calc'n using 5.6, 28, 4, 4, 2 oe: M1 ie fully correct method: M2 or: incorrect class widths, otherwise correct method: M1
	$= 1\frac{1}{3}$ or $\frac{4}{3}$ or 1.33 (3 sf) oe	A1 3	No wking, ans 1.3: M2A0 Ans 1.6: Check wking but probably M1M0A0	$\frac{4}{3}$ correctly obtained (or no wking) then further incorrect: M1M0A0 Use of ratio of widths OR freqs but not both: M0 eg $5.6 \times \frac{4}{28} (= 0.8)$ or $5.6 \times \frac{3}{5} (= 3.36)$: M0 $\frac{4}{2} = 2$: M0M0A0

ii	25 or 26 or 25.5	B1	or 25 & 26	May be implied, eg by 21 or 22 or 21.5
	Med is 21st (or 22nd or 21.5^{th}) in 31-35 class or "25 – 4" Can be implied by calc'n	B1	or med in last $\approx$ 7 in class or $33 \approx 14^{th}$ in class or $33 \approx 18^{th}$ in whole set Can be implied by diagram	Calc'ns need not be correct but need to contain relevant figures for gaining B1B1
	Med > 33 or "more than"	B1 3	indep	The "$\approx$" sign means $\pm$ 2 <u>Alternative Method</u>: $33 \approx 18^{th}$ value B1 More values above 33 than below oe B1 Med > 33 B1 Ignore comment on skew NB Use EITHER the main method OR the <u>Alternative Method</u> (above), not a mixture of the two. Choose the method that gives most marks.

iii	≥ 3 mid-pts attempted	M1	seen or implied	Not nec'y correct values (29, 33, 40.5, 53)
	$\Sigma fx \div 50$ attempted $\quad (= \frac{1819}{50})$	M1	≥ 3 terms.	Allow on boundaries. Not class widths
	$= 36.38$ or 36.4 (3 sf)	A1	or 36 with correct working	
	Σfx^2 attempted $\quad (= 68055.5)$	M1	≥ 3 terms.	Allow on boundaries. Not class widths (3364, 30492, 22963.5, 11236)
	$\sqrt{\frac{68055.5}{50} - (\frac{1819}{50})^2}$ or $\sqrt{1361.11 - 36.38^2}$ $(= \sqrt{37.6056})$	M1	completely correct method except midpts & ft their mean, dep not $\sqrt{(\text{neg})}$	Allow class widths for this mark only NB mark is not just for "$- \text{mean}^2$", unlike q5(iii) $\Sigma(fx)^2$: M0M0A0
	$= 6.13$ (3 sfs)	A1 6		If no wking for Σfx^2, check using their x and f

	Alt for variance:
	$\Sigma f(x - \bar{x})^2 \ (= 1880.28) \qquad$ M1
	$\sqrt{\frac{1880.28}{50}} \qquad\qquad\qquad$ M1
	$= 6.13$ (3 sf) $\qquad\qquad\qquad$ A1
				If no wking or unclear wking:
				     full mks for each correct ans
				     for incorrect ans:
				         $35.8 \leq \mu \leq 36.9$ M0M1A0
				         $6.0 \leq \text{sd} \leq 6.25$ M1M0A0

iv	(a) Decrease (b) Increase (c) Same (d) Same	B1B1 B1B1 4	Ignore other, eg "slightly" or "probably"	Ignore any comments or reasons, even if incorrect
Total		**16**		
5	If done with replacement, no marks in any part of this question.			
5i	All correct probs correctly placed, matching labels, if any	B2 2	B1 for 4 correct probs anywhere	Allow B2 with missing labels but only if probs consistently placed, ie R above B throughout

ii	$\frac{4}{10} \times \frac{6}{9} + \frac{6}{10} \times \frac{4}{9} \times \frac{5}{8} + \frac{6}{10} \times \frac{5}{9} \times \frac{4}{8}$
	
	or $\frac{4}{15} + \frac{1}{6} + \frac{1}{6}$
	
	$(= \frac{3}{5}$ **AG**$)$
		B2 2	B1: two of these products (or their results) added
			                             (not multiplied)
			
			or $1 - (\frac{6}{10} \times \frac{5}{9} \times \frac{4}{8} + \frac{6}{10} \times \frac{4}{9} \times \frac{3}{8} + \frac{4}{10} \times \frac{3}{9})$
			
			or $1 - (\frac{1}{6} + \frac{1}{10} + \frac{2}{15})$
				B1: 1 – two of these products (or results) added
				                             (not multiplied)
				
				NB incorrect methods can lead to correct ans
				AG so no wking no mks
				
				No ft from tree in (i)

iii	Σxp attempted $= \frac{16}{15}$ oe or 1.07 (3 sfs)	M1 A1	Both non-zero terms $\quad\div 3$ etc or $\frac{1}{\Sigma xp}$: M0	
	$\Sigma x^2 p$ attempted $\quad(= \frac{23}{15}$ or 1.53) $- $ " $\frac{16}{15}$ "^{2} $= \frac{89}{225}$ oe or $0.39\dot{5}$ or 0.396 (3 sfs)	M1 M1 A1 5	Both non-zero terms $\quad\div 3$ etc: or $\frac{1}{\Sigma x^2 p}$: M0 indep but dep +ve result Ans 0.388: check wking but probably comes from $\mu = 1.07$; premature rounding: M1M1A0	Not Σxp^2 NB easier to gain than equiv mark in qu 4(iii) not 0.395, but check for dot over 5 for recurring
	Alt for Var(X): $\Sigma (x-\bar{x})^2 p$ M2		$\frac{1}{6} \times \frac{16}{15}^2 + \frac{3}{5} \times \frac{1}{15}^2 + \frac{7}{30} \times \frac{14}{15}^2$ all correct M2, 2 terms correct M1	
Total		**9**		
6ia	5040	B1 1		
b	6! or 5!×6 or 720 $\div$ 7! or $\div$ "5040" or 1440 or (5! or 6!) × 2 $= {}^2/_7$ oe or 0.286 (3 sf)	M1 M1 A1 3	Any $\div$ 7! or "5040" but NOT any × 2 | $^1/_7 \times {}^1/_6$ M1* | × 6 or × 2 M1 dep*	NOT 6! in denom eg ${}^{6!}/_{5040}$ or $^1/_7$ or 0.143 or $^1/_{21}$ (3 sfs): M1M1A0
iia	$3! \times 4!$ alone or 144 ($\div$ 7! or "5040") $= {}^1/_{35}$ oe or 0.0286 (3sf)	M1 A1 2	${}^4/_7 \times {}^3/_6 \times {}^3/_5 \times {}^2/_4 \times {}^2/_3 \times {}^1/_2$ oe or $\overline{7C3\mathrm{or}7C4}^{\,1}$	Not $3! \times 4! \times...$ (eg not $3! \times 4! \times 5$) not $\frac{1}{3! \times 4!}$, not $\frac{1}{144}$ NB no mark for $\div$ 7! or "5040" in this part
b	5 seen or 5! seen $3! \times 4! \times 5$ or $5! \times 3!$ or 720 or 5×144 ($\div$ 7! or "5040") $= {}^1/_7$ oe or 0.143 (3 sf)	M1 M1 A1 3	or $5 \times {}^3/_7 \times {}^2/_6 \times {}^1/_5 ({\times}^4/_4 \times {}^3/_3 \times {}^2/_2)$ oe: M2 or $5 \times \overline{7C3\mathrm{or}7C4}^{\,1}$: M2 or $5 \times$ "(iia)": M2	or GGGBBBB, BGGGBBB, BBGGGBB, BBBGGGB, BBBBGGG NB no mark for $\div$ 7! or "5040" in this part
Total		**9**		

5

Mark Scheme

7i	x	B1	1	Ignore explanations. "Neither" or "Both": B0	
ii	Diag showing vertical differences only	B1		Allow description instead of diag: "Distances from pts to line // to y-axis" oe	Allow $\geq$ one line, from a point to the line
	State that sum of squares of these is min oe	B1	2	dep vert or horiz lines (not both) drawn or described	Must have Min, Squares, Distances & Sum
iii	-1 Ranks opposite or reversed or <u>perfect</u> neg corr'n between <u>ranks</u> oe	B1 B1dep 2		Not approx -1 As x increases, y decreases	Allow eg: -1 because neg corr'n so ranks must be reversed Ignore other NOT neg corr'n or strong neg rel'nship oe NOT comment about "disagreement" or "agreement"
iv	"Negative" or "Not -1"	 B1	 1	eg "Strong neg" or any negative value > -1 or "Close to -1"	Any implication of Negative, except NOT "Negative gradient" and NOT "-1" given as the value of r
Total		**6**			
8	Incorrect p (eg "cubical die means 18 sides hence $p = \frac{1}{18}$"): can gain all B & M marks.				
8i	$^{25}/_{216}$ oe or 0.116 (3 sfs)	B1	1		
ii	$(^5/_6)^7 \times {}^1/_6$ alone $= 0.0465$ (3 sfs) or $\frac{78125}{1679616}$	M2 A1	 3	M1 for $(^5/_6)^8 \times {}^1/_6$ alone	
iii	$(^5/_6)^8$ oe alone $= 0.233$ (3 sfs) or $\frac{390625}{1679616}$	M1 A1	 2	$1 - P(X \leq 8)$, with exactly 8 correct terms	NOT $1 - (\frac{5}{6})^8$, NOT $(\frac{5}{6})^8 \times \ldots$
iv	NB If more than 5 products are added (eg $P(1 \leq X \leq 12)$): no marks				

	$(^5/_6)^9 \times {}^1/_6 + (^5/_6)^{10} \times {}^1/_6 + (^5/_6)^{11} \times {}^1/_6 + (^5/_6)^{12} \times {}^1/_6$
	$(= 0.0323 + 0.0268 + 0.0224 + 0.0187)$
	
	$= 0.100$ (3 sfs)
		M3
		
		A1
			
			4
				M3 for all correct
				
				or M2 for 3 of these added or these 4 plus 1
				    extra or 0.0817 or 0.0680 or 0.139 or 0.116
				
				or M1 for $\geq$ 1 of these terms or values seen;
				                                      ignore incorrect
				Allow 0.1 with wking
					$(^5/_6)^9 - (^5/_6)^{13}$ or $1 - (^5/_6)^{13} - [1 - (^5/_6)^9]$ M3
					or $(^5/_6)^{8, 9 \text{ or } 10} - (^5/_6)^{12, 13 \text{ or } 14}$
					or $1 - (^5/_6)^{12, 13 \text{ or } 14} - [(1 - (^5/_6)^{8, 9 \text{ or } 10}]$ M2
					
					or $\pm[(^5/_6)^9 - (1 - (^5/_6)^{13})]$ or $\pm [1 - (^5/_6)^9 - (^5/_6)^{13}]$ M1

Total		**10**			

Total 72 marks

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