OCR
Oxford Cambridge and RSA

GCE

Mathematics

Unit **4732**: Probability and Statistics 1

Advanced Subsidiary GCE

Mark Scheme for June 2015

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

S1 June 2015 Final mark scheme

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding
Penalise over-rounding only once in paper. "oe" means "or equivalent"

Question			Answer	Marks	Guidance	
1	(i)		$S_{xx} = 200.39 - \frac{33.7^2}{6}$		or 11.108 or 11.1 or $\frac{1333}{120}$	
			$S_{yy} = 28314 - \frac{410^2}{6}$		or 297.333 or 297 or $\frac{892}{3}$	
			$S_{xy} = 2313.9 - \frac{33.7\times410}{6}$	M1	or 11.067 or 11.1 or $\frac{166}{15}$	Correct sub in a correct *S* formula or correct value of one *S* seen
			$r = \frac{"11.067"}{\sqrt{"11.108"\times"297.333"}}$	M1		Correct sub in 3 correct *S* formulae and a correct *r* formula
			= 0.193 (3 sf)	A1		No working: 0.193 M1M1A1
				[3]		Ignore comment about $0 < r < 0.2$
1	(ii)		(For these 6 clubs)		Allow without "For these 6 clubs" & "top"	Allow "Salary has little effect on points"
			No/little/poor/weak oe			
			relationship/corr'n/link oe		or "no strong corr'n between etc"	Ignore all else including "positive"
			between (top) salaries and no. of points	B1	In context.	NOT if use "goals" instead of "points"
				[1]		
1	(iii)		Extrapolation oe		Outside range of values. Salary is less than the others.	NOT "Corr'n does not imply causation"
			Corr'n poor/weak or no rel'nship/link oe		*r* small or *r* close to 0 or *r* not close to 1	NOT "Could be other factors"
			or Points not close to line		or Results do not correlate well	NOT if use "goals" instead of "points"
			Small sample or only (top) 6 clubs oe	B1 B1	Any two; allow without context	
				[2]		
2	(i)		35	B1	Allow 30 to 40 inclusive	
				[1]		
2	(ii)		$\frac{50\pm2}{400} \times 100$ oe	M1	NOT $\frac{50\pm2}{450} \times 100$	NOT $\frac{100\pm2}{400 \text{or} 450} \times 100$
			= 12% to 13%	A1		NOT $\frac{350\pm2}{400} \times 100$ (unless sub from 100)
				[2]		
2	(iii)		eg 7.5, 87.5 or 5, 90 or 5-10, 85-90	B1	or any values in intervals 5 - 10 & 85 - 90	NOT "Because it's cumulative frequency"
			"Classes" or "intervals" or "groups" or "mid-points" or "bounds" seen	B1	No raw data given. Not have each data value	NOT "Because it's a line of best fit"
					Exact values not given or can't be read off oe	NOT "Because graph is difficult to read"
			Data lost oe			NOT "because graph is a curve"
				[2]	Ignore all else for 2nd B1, **not 1st B1**	NOT "Cont data has no exact data pts"

Question			Answer	Marks	Guidance	
2	(iv)		Median = 39 ± 1 drawn Quartiles = 25 ± 1, 55 ± 1 drawn Ends in ranges 5 - 10 & 85 - 90 drawn Correct B&W plot ± 1 drawn	B1 B1 B1f B1f **[4]**	or stated or stated or ft (iii) or ft (iii) mark intention (allow unruled lines)	Mark diagram even if contradicts statements of values in (iv) or (iii) If no diagram, award max B1B1B1 for statements of med, quartiles & ends
2	(v)		Stretched out at top end oe Not symmetrical More concentrated towards lower end More values (or data) in lower half of range Median closer to lowest value Average towards lower end More plums have lower masses Majority of distribution towards lower end More below 50 (or 45) Upper whisker longer than lower whisker	B1 **[1]**	Positive skew, Skewed to right (or to higher values) Larger skewness at top Larger plums more spread than smaller ones Ignore all else No need for context	**NOT** any of below: more large extremes than small extremes IQR is towards the lower end skewed to the left (or to lower values) majority below 39 distribution towards lower end
3	(i)		Year 80 81 82 83 84 85 86 87 88 Age 1 2 3 4 5 6 7 8 9 Quality 1 3 4 2 5 6 8 7 9 Attempt ranks Correct ranks Attempt Σd^2 (= 8) $1 - \frac{6\times"8"}{9\times(81-1)}$ $= \frac{14}{15}$ or $0.9\dot{3}$ or 0.933 (3 sf)	 M1 A1 M1 M1 A1 **[5]**	Y 80 83 81 82 84 85 87 86 88 Q 1 2 3 4 5 6 7 8 9 A 1 4 2 3 5 6 8 7 9 Allow both sets of ranks reversed NB $0.9\dot{3}$ is correct	One set reversed, max 4 mks, eg Y 80 81 82 83 84 85 86 87 88 A 9 8 7 6 5 4 3 2 1 Q 1 3 4 2 5 6 8 7 9 or similar Attempt ranks M1 Incorrect ranks A0 Attempt Σd^2 (= 232) M1 $1 - \frac{6\times"232"}{9\times(81-1)}$ M1 $-\frac{14}{15}$ or $-0.9\dot{3}$ or –0.933 (3 sf) A1
3	(ii)		Older is better oe or newer is worse oe As age increases, quality increases Must imply older is better oe, ie "good (or positive) corr'n between age and quality" is not enough	B1 **[1]**	No ft from (i) -0.933 in (i) leads to same conclusion as +0.933 in (ii) Nothing contradictory seen, **ie NOT ignore all else** In context; no need to include "rank"	 NOT as year increases quality increases NOT High/strong/good corr'n/agreement/ rel'nship between age and quality oe

Question			Answer	Marks	Guidance	
4	(i)		$S_{xx} = 481.13 - \frac{60.5^2}{8}$ or 23.59875 or 23.6 or $\frac{18879}{800}$ $S_{xy} = 334.65 - \frac{60.5\times44.9}{8}$ or –4.90625 or -4.91 or $-\frac{157}{32}$ $b = \frac{334.65-\frac{60.5\times44.9}{8}}{481.13-\frac{60.5^2}{8}}$ oe or –0.20790 or –0.208 or $-\frac{3925}{18879}$ $y - \frac{44.9}{8} =$ "–0.20790"$(x - \frac{60.5}{8})$ y = -0.208x + 7.18 (or + 7.19) (3 sf)	M1 M1 M1 A1 **[4]**	Correct sub in any correct S_{xx} or S_{xy} formula or correct value of either S Correct sub in both Ss and in a correct b formula or $a = \frac{44.9}{8} -$ "–0.20790" $\times \frac{60.5}{8}$ or $y = -\frac{3925}{18879}x$ + 7.18/9 Must include "y =" Allow y = -0.21x + 7.2 (awrt 2 sf)	Alternative method: 44.9 = 8a + 60.5b M1 334.65 = 60.5a + 481.13b M1 hence a = 7.18 or b = -0.208 A1 y = –0.208x + 7.18 A1 no wking, correct ans M1M1M1A1 If find x on y line, can score first M1 only or ans x = 31 -4.2y seen first M1 only
4	(ii)		"–0.208" × 9.2 + "7.18" = 5.27 or 5.28 (km/l) (3 sf)	M1 A1ft **[2]**	ft their equn from (i)	but no ft from x on y line
4	(iii)		(7.56, 5.61) (3 sf) or $(\frac{121}{16}, \frac{449}{80})$ oe	B1 **[1]**	Ignore calc'n of reg line, if done	NOT $(\frac{60.5}{8}, \frac{44.9}{8})$
4	(iv)		Use reg line of x on y (either equn or line) Sub y = 5.8 or fuel = 5.8 or km/l = 5.8	M1 A1 **[2]**	Must specify or imply x on y, otherwise M0A0 NOT "Use either x on y or y on x" NOT "and read off **y** coord"	If calc x on y reg line (allow errors)M1 Subst 5.8 into their x on y line A1 Ignore all else
5	(i)	(a)	$(1 - 0.27)^7 \times 0.27$ = 0 0298 (3 sf)	M1 A1 **[2]**	alone	

Question			Answer	Marks	Guidance	
5	(i)	(b)	$(1 - 0.27)^8$	M1	alone or 1 - P(X = 1,2,3,4,5,6,7,8) all terms correct (= 1 - 0.91935)	NOT $(1 - 0.27)^8 \times \ldots$ NOT 1- $(1-0.27)^8$
			= 0.0806 (3 sf) or 0.08065	A1 **[2]**		
5	(ii)		Bin stated ${}^8C_2 \times (1 - 0.27)^6 \times 0.27^2$ 0.309 (3 sf)	B1 B1 B1 **[3]**	or implied by ${}^8C_2$ or ${}^8C_6$ or $(1–0.27)^a \times 0.27^b$ ($a+b=8$) NOTE. Must see sub in formula for this B1	or by ans 0.309. Allow "Bio" Allow correct + ... Correct ans, no working: B1B0B1
5	(iii)		Their (ii) × 0.27 seen together Their (ii) × 0.27 × $(1 - 0.27)^2$ × 0.27 ie wholly correct method ft(ii) = 0.0120 (3 sf)	M1 M1 A1ft **[3]**	or $({}^8C_2 \times (1 - 0.27)^6 \times 0.27^2) \times 0.27$ seen together or ${}^8C_2 \times (1 - 0.27)^6 \times 0.27^2 \times 0.27 \times (1 - 0.27)^2 \times 0.27$ ie wholly correct method Allow 0.012; ft their **(ii)** only	or ${}^8C_2 \times (1 - 0.27)^8 \times 0.27^4$ SC: $(1 - 0.27)^8 \times 0.27^4$ oe alone M0M1A0
6	(i)		7! or 5040 or ${}^7P_7$ seen $1 \div \frac{7!}{2}$ or $\frac{2}{7!}$ = $\frac{1}{2520}$ or 0.000397 (3 sf)	M1 M1 A1 **[3]**	or $5! \times ({}^6C_2 + 6)$ NOT $5! \times {}^6C_2$ $\frac{1}{5! \times (6C2 + 6)}$ or $\frac{2}{5040}$ oe	or $\frac{2}{7} \times \frac{1}{6} \times \frac{1}{5} \times \frac{1}{4} \times \frac{1}{3} \times \frac{1}{2}$ alone M2 or $\geq$ 5 correct fracs mult: or 6 correct fracts mult × M1
6	(ii)	(a)	5	B1 **[1]**	Ignore any working seen	
6	(ii)	(b)	${}^5C_2$ alone (or × ${}^2C_2$) or ${}^6C_3 \div 2$(!) or $\frac{2}{7} \times {}^7C_3$ or ${}^5P_2 \div 2$ = 10	M1 A1 **[2]**	alone, eg NOT ${}^5C_2 \times \ldots$ or ${}^5C_2 + \ldots$	But allow ${}^5C_2$ as denom of prob M1A0
6	(ii)	(c)	"5" + "10" + ${}^5C_3$ = 25	M1 A1f **[2]**	or ${}^6C_3$ + "5" or ${}^7C_3$ - "10" or ${}^7C_3 - {}^5C_2$ ft (a) &/or (b) only if working seen	Allow as denom of a prob M1A0

Question			Answer	Marks	Guidance	
7	(i)	(a)	Binomial seen or implied $0.7759 - 0.5256$ or ${}^{10}C_3 \times (1 - 0.25)^7 \times 0.25^3$ $= 0.250$ (3 sf)	B1 M1 A1 **[3]**	by tables or ${}^{10}C_3$ or ${}^{10}C_7$ Allow 0.25	or by $0.25^a \times 0.75^b$ ($a + b = 10$)
7	(i)	(b)	$1 - 0.5256$ or $1 - ((1 - 0.25)^{10} + 10(1 - 0.25)^9 \times 0.25$ $+ {}^{10}C_2(1 - 0.25)^8 \times 0.25^2)$ $= 0.4744$ or 0.474 (3 sf)	M1 A1 **[2]**	or P(X = 3,4,5,6,7,8,9,10) all correct terms Allow ${}^{10}C_8$ instead of ${}^{10}C_2$	NOT 1 - 0.7759 (P(X >3) from table)
7	(ii)		0.4744 or 0.474) or 0.5256 or 0.526 seen $1 - (1 - \text{“}0.4744\text{”})^6$ oe $= 0.979$ (3 sf)	M1 M1 A1f **[3]**	Their (i)(b) seen, or result of 1-(i)(b) seen or P(X = 1,2,3,4,5,6) all correct terms seen ft from **(i)(b)**	eg B(6, 0.474) or P($X \geq 3$) = 0.474
8	If 0.3 and 0.6 or 0.3 and 0.7 or similar used, can score (i) B1B0(ii) M1A0 (iii) M1M1M1A0 (iv) B1					
	(i)		Correct structure with no extra branches Probs and R and B all correct	B1 B1dep **[2]**	Allow extra branches with correct 0 & 1 Ignore other probs	ignore probs and R & B
8	(ii)		$\frac{2}{3} \times \frac{2}{3} \times \frac{2}{3}$ $= \frac{8}{27}$ or 0.296 (3 sf)	M1 A1 **[2]**	or $\frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{1}{3} + \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3}$ NOT $\frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3}$ No ft from tree for A1	ft their tree, eg "without replacement" gives $\frac{2}{3} \times \frac{3}{5} \times \frac{2}{4}$ ($=\frac{1}{5}$) M1A0

Question	Answer	Marks	Guidance
8 (iii)	There are basically 6 cases, as in LH column. Some group these into 3 cases, as in middle column. Others use 9 cases - treat these as grouped into the 6 cases below and mark accordingly. Must decide which case a candidates is using, and use the corresponding scheme. NB. Listing Adnan and Beryl separately gains no marks. They must be combined into cases. For example $(\frac{2}{3})^3 \times \frac{1}{3} = \frac{8}{81}$ is correct for P(Adnan 4 throws and Beryl 1throw), but it could also come from P(Adnan gets RRRB) which scores no marks by itself. If correct 6 (or 3) cases, or equiv, are given, but extra cases also given, award 1st M1, and possibly 2nd M1, but no more. No ft from tree, but if clearly state cases may score 1st M1 only.		
	All six cases seen or implied: 2&1; 3&2, 3&1; 4&3, 4&2, 4&1 or 2&1; 3 & (< 3); 4& (< 4)	M1	All three cases soi: R & B; RR & RB; RRR & RRB M1 or R & B; RR & RB; RRRR & RRB; RRRB & RRB ie 3 cases: (≥2 & 1) (≥3 & 2) (4 & 3)
	$P(2\&1) = \frac{2}{3} \times \frac{1}{3} \times \frac{1}{3}$ or $\frac{2}{27}$		$P(R \& B) = \frac{2}{3} \times \frac{1}{3}$ or $\frac{2}{9}$ M1
	$P(3\&2) = (\frac{2}{3})^2 \times \frac{1}{3} \times \frac{2}{3} \times \frac{1}{3}$ or $\frac{8}{243}$		**NB Must be clearly part of 3-case method**
	$P(3\&1) = (\frac{2}{3})^2 \times \frac{1}{3} \times \frac{1}{3}$ or $\frac{4}{81}$		$P(RR \& RB) = (\frac{2}{3})^2 \times \frac{2}{3} \times \frac{1}{3}$ or $\frac{8}{81}$
	$P(4\&3) = (\frac{2}{3})^3 \times (\frac{2}{3})^2 \times \frac{1}{3}$ or $(\frac{2}{3})^4 \times (\frac{2}{3})^2 \times \frac{1}{3} + (\frac{2}{3})^3 \times \frac{1}{3} \times (\frac{2}{3})^2 \times \frac{1}{3}$ or $\frac{32}{729}$		$P(RRR \& RRB) = (\frac{2}{3})^3 \times (\frac{2}{3})^2 \times \frac{1}{3}$ or $\frac{32}{729}$ Both these correct expressions or results and add all 3 cases oe ie completely correct method M1 $\frac{266}{729}$ or 0.365 (3 sf) A1
	$P(4\&2) = (\frac{2}{3})^3 \times \frac{2}{3} \times \frac{1}{3}$ or $(\frac{2}{3})^4 \times \frac{2}{3} \times \frac{1}{3} + (\frac{2}{3})^3 \times \frac{1}{3} \times \frac{2}{3} \times \frac{1}{3}$ or $\frac{16}{243}$		
	$P(4\&1) = (\frac{2}{3})^3 \times \frac{1}{3}$ or $(\frac{2}{3})^4 \times \frac{1}{3} + (\frac{2}{3})^3 \times (\frac{1}{3})^2$ or $\frac{8}{81}$		May see other groupings of 6 cases into 3 cases eg 4&(1or2or3) 3&(1or2) 2&1 M1
	Correct expressions (or results) for 3 of these 6 probs	M1	$\frac{8}{27} \times \frac{19}{27}$ oe or $\frac{152}{729}$ M1
	Correct expressions (or results) for the other 3 of these 6 probs & no extra cases, and add all 6 cases ie completely correct method	M1	$\frac{4}{27} \times \frac{5}{9} + \frac{2}{9} \times \frac{1}{3}$ oe or $\frac{20}{243} + \frac{2}{27}$ or $\frac{38}{243}$ ie completely correct method M1
	$\frac{266}{729}$ or 0.365 (3 sf)	A1	$\frac{266}{729}$ or 0.365 (3 sf) A1
	See next page for more	**[4]**	

All four cases soi:
B&B; RB & RB; RRB & RRB; RRRX & RRRX ie 1&1 or 2&2 or 3&3 or 4&4 M1
$(\frac{1}{3})^2 + (\frac{2}{3} \times \frac{1}{3})^2 + (\frac{2}{3} \times \frac{2}{3} \times \frac{1}{3})^2 + (\frac{2}{3} \times \frac{2}{3} \times \frac{2}{3})^2$ or $\frac{1}{9} + \frac{4}{81} + \frac{16}{729} + \frac{64}{729}$ or $\frac{197}{729}$ all correct M1
$\frac{1}{2}(1 - \text{'}\frac{197}{729}\text{'})$ M1
$\frac{266}{729}$ or 0.365 (3 sf) A1
NB $\frac{2}{3} \times \frac{1}{3} = \frac{2}{9}$ often seen, usually scores 0. Must be clearly part of 3-case method to score.

Question			Answer	Marks	Guidance	
8	(iii)	cont	4 COMMON INCORRECT METHODS: All six cases seen or implied: M1 $\frac{2}{27}+\frac{8}{243}+\frac{4}{81}+\frac{32}{2187}+\frac{16}{729}+\frac{8}{243}$ oe M1M0 $=\frac{494}{2187}$ or 0.226 A0 $\frac{2}{3}\times\frac{1}{3}+(\frac{2}{3})^2\times\frac{1}{3}+(\frac{2}{3})^3\times\frac{1}{3}+(\frac{2}{3})^4$ or $\frac{2}{3}\times\frac{1}{3}+(\frac{2}{3})^2\times\frac{1}{3}+(\frac{2}{3})^3\times\frac{1}{3}$ M0M0M0M0 P(2&1) + P(3&2) + P(4&3) $=\frac{2}{3}\times\frac{1}{3}\times\frac{1}{3}+(\frac{2}{3})^2\times\frac{1}{3}\times\frac{2}{3}\times\frac{1}{3}$ + $(\frac{2}{3})^4\times(\frac{2}{3})^2\times\frac{1}{3}+(\frac{2}{3})^3\times\frac{1}{3}\times(\frac{2}{3})^2\times\frac{1}{3}$ M0M1M0A0		ANOTHER EXAMPLE $\frac{RB}{B}$ $\frac{RRB}{B+RB}$ $\frac{RRRB}{B+RB+RRB}$ $\frac{RRRR}{B+RB+RRB}$ ie 2&1 3&(1or2) 4&(1or2or3) This scores the 1st M1 for all 3 cases soi (The last two "fractions" together make the 3rd case)	ANOTHER INCORRECT METHOD $(\frac{2}{3})^3\times\frac{1}{3}+(\frac{2}{3})^2\times\frac{1}{3}+\frac{2}{3}\times\frac{1}{3}$ $(\frac{2}{3})^2\times\frac{1}{3}\times\frac{2}{3}+(\frac{2}{3})^3\times\frac{1}{3}\times\frac{2}{3}$ $+(\frac{2}{3})^3\times\frac{1}{3}\times(\frac{2}{3})^2$ ie attempt 4&1, 3&1, 2&1; 3&2, 4&2; 4&3 Some of these overlap, but 1st, 5th, 6th correct. Overall M1M1M0A0
8	(iv)		Unlimited number of throws oe Not stop at 4 throws oe	B1 **[1]**	Not fixed number of throws Turn continues until blue obtained	Allow Throw die until blue obtained NOT Continue until 1st success NOT "Not stop at 4 throws or when blue obtained" Ignore all else
9	(i)		$a + b$, $a + 2b$, $a + 3b$ $a + b + a + 2b + a + 3b = 1$ oe ($3a + 6b = 1$ **AG**)	B1 B1dep **[2]**	All three seen Must see this line oe before final answer or "Probabilities add up to 1" oe stated	Must include "= 1"
9	(ii)		$a + b + 2(a + 2b) + 3(a + 3b) = \frac{5}{3}$ $6a + 14b = \frac{5}{3}$ or $18a + 42b = 5$ eg $6\times\frac{1-6b}{3}+14b=\frac{5}{3}$ or $2b=-\frac{1}{3}$ or $6a+14\times\frac{1-3a}{6}=\frac{5}{3}$ or $3a=2$ $a=\frac{2}{3}$, $b=-\frac{1}{6}$	M1 A1f A1 A1 **[4]**	ft their probs or any correct three term equn, ft their probs or any correct equn in a or b only. cao cao	

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

OCR Customer Contact Centre

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Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

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