adamjee maths

A-LEVEL MATHS / EDEXCEL / FREE RESOURCES

Conditional probability

Mark scheme

6 questions

Exam questions and marking instructions remain credited to their board.

Contents

1 June 2025 - Paper 3 Statistics - Q1

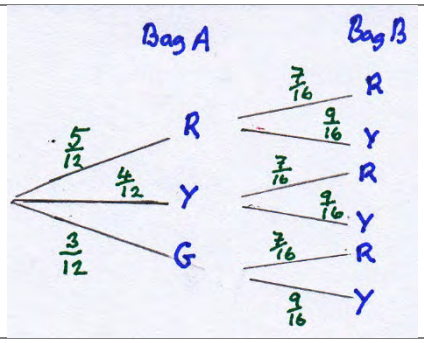
2 June 2025 - Paper 3 Statistics - Q5

3 June 2024 - Paper 3 Statistics - Q6

4 June 2022 - Paper 3 Statistics - Q5

5 October 2021 - Paper 3 Statistics - Q4

6 October 2021 - Paper 3 Statistics - Q5

Question	Scheme	Marks	AOs
1(a)(i)	[Let p = probability of yellow from bag **B**] P(YY) = $\frac{4}{12}\times p$	M1	1.1b
	$\left[\frac{4}{12}\times p=\frac{3}{16}\right]$ so $p=\underline{\underline{\frac{9}{16}}}$ (Allow 0.5625 and condone 0.563)	A1	1.1b
		(2)	
1(a)(ii)		B1	1.1b
		B1ft	1.1b
		(2)	
1(b)	e.g. P(RY) + P(Y) + P(GY) or 1 – P(RR) – P(GR) or P(…Y) + P(YR)	M1	2.1
	$\frac{5}{12}\times\frac{"9"}{"16"}+\frac{4}{12}+\frac{3}{12}\times\frac{"9"}{"16"}$ or $1-\left[\frac{5}{12}\times\frac{"7"}{"16"}+\frac{3}{12}\times\frac{"7"}{"16"}\right]$ or $\frac{"9"}{"16"}+\frac{1}{3}\times\frac{"7"}{"16"}$	A1ft	1.1b
	$=\underline{\underline{\frac{136}{192}}}=\underline{\underline{\frac{17}{24}}}=\underline{\underline{0.708\dot{3}}}$	A1	1.1b
		(3)	
1(c)	$\left[\mathrm{P}(W\mid X)=\right]\frac{\mathrm{P}(W\cap X)}{\mathrm{P}(X)}$ or $\frac{\frac{3}{12}\times\frac{"9"}{"16"}}{"(b)"}$	M1	1.1b
	$=\underline{\underline{\frac{27}{136}}}$	A1	1.1b
		(2)	
			(9 marks)

Notes:

(a)(i)	M1	for a suitable expression (in their p) for the probability both are yellow.
	A1	for correct probability of yellow from **B**. Can be implied by values on tree diagram.
(a)(ii)	B1	for a correct 1st column of tree diagram (probabilities from **A**)
	B1ft	(**dep on M1 in (i)**) for correct 2nd column of tree diagram (ft their $\frac{9}{16}$ and $1-\frac{9}{16}$)
(b)	M1	for selection of <u>all</u> correct cases (including the 1 – if required). Don't need P(… may be implied by correct probability products seen (ft their tree diagram)
	A1ft	for a correct complete probability expression (ft their tree diagram) or awrt 0.708 Must see product pairs (for ft) <u>or</u> implied by correct values e.g. $\frac{15}{64}+\frac{7}{48}+\frac{3}{16}+\frac{9}{64}$ May see $1-\mathrm{P}\left(\overline{Y}\,\overline{Y}\right)$ (M1) and $1-\frac{2}{3}\times\frac{"7"}{"16"}$ (A1ft)
	A1	for an exact answer …fraction needn't be simplified but decimal must have …$\dot{3}$
(c)	M1	for a correct ratio of probabilities expression (in symbols) or ft their values seen
	A1	for an exact answer NB an answer of awrt 0.199 (0.198529411…) implies M1
Acc	**If scored 2nd A0 in (b) for 0.708 (or better) then allow A1 in (c) for awrt 0.199**	

Question	Scheme	Marks	AOs

		(2)	
5(b)	[Let F be the height of a women from the club] P(F < 170) = 0.40 $\Rightarrow \frac{170-\mu}{\sigma} = -0.2533$ [calc gives – 0.253347…]	M1	3.1b
	P(F > 175) = 0.15 $\Rightarrow \frac{175-\mu}{\sigma} = 1.0364$ [calc gives 1.036433…]	M1	3.4
	Solving: $5 = \sigma(1.0364 + 0.2533)$	M1	1.1b
	σ = 3.87687… awrt **3.88**	A1	1.1b
	μ = 170.9820… awrt **171**	A1	3.2b
		(5)	
5(c)	[P(170 < F < 175) =] 1 – (0.40 + 0.15) = 0.45 (allow awrt 0.45) [P(170 < M < 175) =] 0.047282… = (allow awrt 0.047)	M1	3.4
	[P(170 < F < 175) × P(170 < M < 175) =] "0.45"×"0.047" or 0.021…	A1ft	1.1b
	So P(both) = 0.021277… awrt **0.021**	A1	1.1b
		(3)	
			(10 marks)

Notes:

(a)(i)	B1	for awrt 0.270 (accept just 0.27)
(ii)	B1	for awrt 0.607
(b)	M1	for standardising 170 with μ and σ and set equal to a z value $0 < \|z\| < 0.3$
	M1	for standardising 175 with μ and σ and set equal to a z value $1 < \|z\| < 2$
	M1	for solving their 2 linear equations, reducing to a linear equation in one variable This can be implied by two answers that are correct to 2sf.
	To award the A marks they must have scored 1st M1 and 2nd M1	
	A1	for = σ awrt 3.88
	A1	for = μ awrt 171 (Must not be from incorrect working e.g. $\sigma < 0$)
	Ans only	We need to see the linear equations in μ and σ to start awarding marks. If 1st M1 and 2nd M1 are scored and correct answers are seen we can award 5 marks.
	MR	**(15% as 0.015)** 2nd M1 for z = 2.17…, 3rd M1 implied by σ = 2.06… and μ = 170.5 … i.e. Maximum M1M1M1A0A0
(c)	M1	for correct probability for women or correct probability for men or clear intention to multiply P(170 < F < 175) by P(170 < M < 175)
	A1ft	for using P(170 < F < 175) × P(170 < M < 175) with one probability correct to 2sf
	A1	for awrt 0.021. Correct answer only is 3 marks.
	MR	**(if used in (b))** P(170< F < 175) = 0.585 (or awrt 0.58 or 0.59) answer awrt 0.027 or 0.028 All 3 marks can be scored here.

Qu 6	Scheme	Marks	AO
(a)	A, C <u>or</u> A, D <u>or</u> B, D [Allow things like $A \cap D$]	B1 **(1)**	1.2
(b)	$\mathrm{P}(C) = 0.6$ <u>and</u> $\mathrm{P}(B) = p + 0.32$ <u>and</u> $\mathrm{P}(B \cap C) = 0.27$		
	<u>or</u> $(0.08 + 0.25 + 0.27) \times (0.27 + 0.05 + p) = 0.27$ <u>or</u> $0.27 + 0.05 + p = \frac{0.27}{0.6} = 0.45$	M1	1.1b
	[$p + 0.32 = 0.45$ so] $p =$ **<u>0.13</u>**	A1 **(2)**	2.2a
(c)	$\left[\mathrm{P}(A \mid B')\right] = \frac{q}{q + r + 0.25 + 0.08}$ <u>or</u> $\frac{q}{1 - (0.05 + "0.13" + 0.27)}$ <u>or</u> $\frac{q}{0.55}$	M1	2.1
	$q + r = 1 - 0.65 -$ "0.13" [= 0.22]	M1	1.1b
	Since r …0 the greatest value of q is "0.22" so $\mathrm{P}(A \mid B')$,, **<u>0.4</u>** or $\frac{2}{5}$	A1 **(3)**	2.2a
(d)	$\left[\mathrm{P}(B \mid A') =\right] \frac{0.27 + "0.13"}{0.6 + "0.13" + r} = 0.5$ or $\frac{0.27 + "0.13"}{1 - (q + 0.05)} = 0.5$	M1	1.1b
	$r =$ **<u>0.07</u>** ,	A1	1.1b
	$q =$ **<u>0.15</u>**	A1ft **(3)**	1.1b
(e)	$\left\lfloor \mathrm{P}\left(\left[A \cup B\right]' \cap C \right) = \right\rfloor \left[0.25 + 0.08\right] =$ **<u>0.33</u>**	B1 **(1)**	1.1b
(f)	e.g. $B \cap \left[A \cup C\right]'$ <u>or</u> $B \cap A' \cap C'$ <u>or</u> $(B \cap A') \cap (B \cap C')$ o.e.	B1 **(1)**	1.1b
		(11 marks)	

Notes

(a) B1 for a correct pair. If more than one pair is given then all must be correct.
P(A) and P(C) etc is B0 $\mathrm{P}(A \cap C) = 0$ is B0 **but** condone things like $A \cap C = \varnothing$

In parts (b) – (d) we will condone poor notation and mark equations/expressions

(b) M1 for all relevant labelled probabilities listed <u>or</u> a correct equation/expression for p
A1 for $p = 0.13$

In parts (c) and (d) they can use letter p or we ft their value for p provided a probability

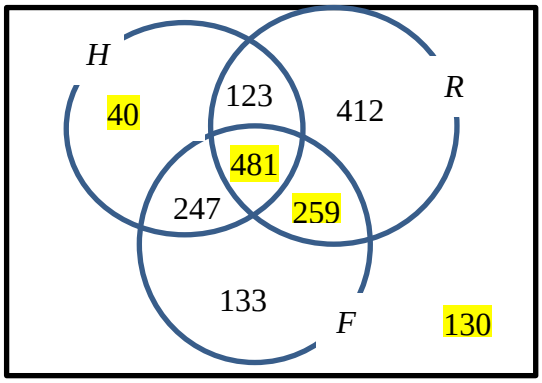
(c) 1st M1 for a correct method for $\mathrm{P}(A \mid B')$ in q (and r) ft their p. May be done in stages
e.g. find correct expression for $\mathrm{P}(B')$, simplify incorrectly then use q over this
2nd M1 for a correct equation for $q + r$ (o.e.)(ft their p) Can accept $r = 0$ and $q = 0.22$
NB sight of $\frac{0.22}{0.55}$ will score M1M1
A1 for 0.4 i.e. deducing the maximum value of $\mathrm{P}(A \mid B')$. Allow ,, 0.4 or $\mathrm{P}(A \mid B') = 0.4$
Can award 3/3 for $\mathrm{P}(A \mid B') = 0.4$ but not 0.4 alone as it can come from e.g $\mathrm{P}(C')$

(d) M1 for a correct equation for r (or q) only can have p or ft their value for p.
May be in stages
e.g. find $\mathrm{P}(A') = 0.27 + 0.25 + 0.08 + p + r$ but make a slip in getting 0.6 then use this.
1st A1 for $r = 0.07$ <u>or</u> $q = 0.15$
2nd A1ft for $r = 0.07$ <u>and</u> $q = 0.15$ <u>or</u> values giving $q + r = 0.22$ provided both q and r are probabilities. Obviously, 2nd A1ft is dependent on the M1

(e) B1 for 0.33

(f) B1 for any correct expression. Do **not** condone P(…

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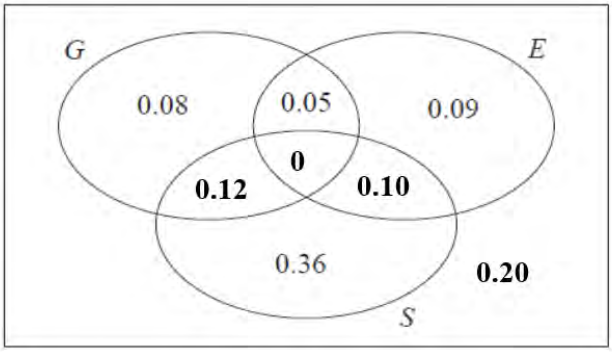
Question	Scheme	Marks	AOs
5(a)	$\frac{365}{1825}$ or $\frac{1}{5}$ or 0.2 oe	B1	1.1b
		(1)	
(b)	$\frac{170}{1825}$ or $\frac{34}{365}$ or awrt 0.093	B1	1.1b
		(1)	
(c)	$90\times0.4+80\times0.05[=40]$ or $90\times0.6+80\times0.95[=130]$ or $740\times0.65[=481]$ or $740\times0.35[=259]$ 	M1 B1 B1 A1	3.1b 1.1b 1.1b 1.1b
		(4)	
(d)	$P(R'\cap F)=\frac{380}{1825}\left[=\frac{76}{365}=0.208...\right]$ oe awrt 0.208	B1	1.1b
		(1)	
(e)	$\left[\frac{133\ +\ "130"}{1825}=\right]\frac{"263"}{1825}$ awrt 0.144	B1ft	1.1b
		(1)	
(f)	$\frac{247+"481"}{247+"481"+123+"40"}$	M1	3.4
	$=\frac{728}{891}$ awrt 0.817	A1	1.1b
		(2)	

Notes: **(10 marks)**

		Look out for answers given in the question. If you see answers in the question and in the answer space those in the answer space take precedence.
(a)	**B1**	Allow equivalent
(b)	**B1**	Allow equivalent
(c)	**M1**	Correct method to find one of the values 40 or 130 or 481or 259 Implied by 40, 481, 259 or130 seen in correct place on diagram
	B1	One of the highlighted correct
	B1	A second value highlighted correct or their $("259"+"\ 481")=740$ or their $("40"+"\ 481")=521$ or their $("40"+"130")=170$
	A1	Fully correct
(d)	**B1**	380/1825oe or awrt 0.208
(e)	**B1ft**	Correct answer or Ft their 130 (> 0) do not allow if blank Allow ft correct to 3 sf.
(f)	**M1**	For a single fraction with the numerator < denominator and *n* is an integer we will award for *n*/ 891 **or** *n*/(sum of their 4 values in *H*, each > 0) or awrt 0.817
	A1	728/891 oe or awrt 0.817

Qu 4	Scheme	Marks	AO
(a)	$0.08 + 0.09 + 0.36 = \underline{\mathbf{0.53}}$	B1	1.1b
		(1)	
(b)(i)	$\left[\mathrm{P}(G \cap E \cap S) = 0 \ \Rightarrow\right]$ $\underline{\boldsymbol{p = 0}}$	B1	1.1b
(ii)	$[\mathrm{P}(G) = 0.25 \Rightarrow] \ 0.08 + 0.05 + q + "p" = 0.25$	M1	1.1b
	$\underline{\boldsymbol{q = 0.12}}$	A1	1.1b
		(3)	
(c)(i)	$\left[\mathrm{P}(S \mid E) = \frac{5}{12} \ \Rightarrow\right] \frac{r + "p"}{r + "p" + 0.09 + 0.05} = \frac{5}{12}$	M1	3.1a
		A1ft	1.1b
	$[12r = 5r + 5 \times 0.14 \ \Rightarrow]$ $\underline{\boldsymbol{r = 0.10}}$	A1	1.1b
(ii)	$[0.08 + 0.05 + "0.12" + "0" + 0.09 + "0.10" + 0.36 + t = 1 \ \Rightarrow]$ $\underline{\boldsymbol{t = 0.20}}$	B1ft	1.1b
		(4)	
(d)	$\mathrm{P}(S \cap E')$ = 0.36 + "q" [= 0.48]	B1ft	1.1b
	$\mathrm{P}\left(\left[(S \cap E')\right] \cap G\right) = "q"$ [=0.12] **and** P(G) = 0.25 **and**	M1	2.1
	$\mathrm{P}(S \cap E') \times \mathrm{P}(G) = "0.48" \times \frac{1}{4}$ or 0.12		
	$\mathrm{P}(S \cap E') \times \mathrm{P}(G) = 0.12 = \mathrm{P}\left(\left[(S \cap E')\right] \cap G\right)$ so **are independent**	A1	2.2a
		(3)	
		(11 marks)	

	Notes
(a)	B1 for 0.53 (or exact equivalent) [Allow 53%]
(b)(i)	B1 for $p = 0$ (may be placed in Venn diagram)
(ii)	M1 for a linear equation for q (ft letter "p" or their value if $0 \leqslant p \leqslant 0.12$) $\Rightarrow$ by $p + q = 0.12$
	A1 for $q = 0.12$ (may be placed in Venn diagram)
(c)(i)	M1 for a ratio of probabilities (r on num and den) (on LHS) with num < den **and** num <u>or</u> den correct ft. Allow ft of letter "p" <u>or</u> their p where $0 \leqslant p < 0.86$ but "+ 0" is not required.
	1st A1ft for a correct ratio of probabilities (on LHS) allowing ft of their p where $0 \leqslant p < 0.86$
	2nd A1 for $r = 0.1(0)$ or exact equivalent (may be in Venn diagram) **Ans only** 3/3
(ii)	B1ft for $t = 0.2(0)$ (o.e.) <u>or</u> correct ft i.e. $0.42 - (p + q + r)$ where p, q, r and t are all probs
(d)	B1ft for $\mathrm{P}(S \cap E') = 0.48$ (with label) (ft letter "q" or their value if $0 \leqslant q \leqslant 0.12$)
	M1 for attempting all required probs (labelled) <u>and</u> using them in a correct test (allow ft of q)
	A1 for **all probs correct** and a correct deduction (no ft deduction here)
SC	**No "P"** If correct argument seen apart from P for probability for all 3 marks, award (B0M1A1)
	If unsure about an attempt using conditional probabilities, please send to review.



Qu 5	Scheme	Marks	AO
(a)	$\left[\text{Let } F \sim \text{N}\left(166.5, 6.1^2\right)\right]$ $\text{P}(F < k) = 0.01 \Rightarrow \dfrac{k-166.5}{6.1} = -2.3263$	M1	3.4
	$k = 152.309\ldots$ **<u>152</u>** or awrt **<u>152.3</u>**	A1 **(2)**	1.1b
(b)	[P($150 < F < 175$) =] 0.914840… awrt **<u>0.915</u>**	B1 **(1)**	1.1b
(c)	P($F > 160 \mid 150 < F < 175$)	M1	3.1b
	$= \dfrac{\text{P}(160 < F < 175)}{\text{P}(150 < F < 175)}$ or $\dfrac{\text{P}(160 < F < 175)}{\text{"(b)"}}$	M1	1.1b
	$= \dfrac{0.7749487...}{\text{"0.91484..."}}$	A1ft	1.1b
	= 0.84708… awrt **<u>0.847</u>**	A1 **(4)**	1.1b
(d)	$\text{H}_0 : \mu = 166.5$ $\text{H}_1 : \mu < 166.5$	B1	2.5
	[Let X = height of female from 2nd country] $\bar{X} \sim \text{N}\left(166.5, \left(\dfrac{7.4}{\sqrt{50}}\right)^2\right)$	M1	3.3
	$\text{P}\left(\bar{X} < 164.6\right) = 0.03472...$	A1	3.4
	[0.0347… < 0.05 so significant <u>or</u> reject H_0] There is evidence to support Mia's belief	dA1 **(4)**	2.2b
		(11 marks)	

	Notes
(a)	M1 for standardising (allow <u>+</u>) with k, 166.5 and 6.1 and set equal to a z value $2.3 < \lvert z \rvert < 2.4$ A1 for 152 or awrt 152.3 **Ans only** 2/2 [Condone poor use of notation e.g. $\text{P}(\frac{k-166.5}{6.1}) = -2.3263$] **Allow percentages instead of probabilities throughout.**
(b)	B1 for awrt 0.915
(c)	1st M1 for interpreting demand as an appropriate conditional probability ($\Rightarrow$ by 2nd M1) 2nd M1 for correct ratio of expressions (can ft their (b) on denominator) ($\Rightarrow$ by 1st A1ft) 1st A1ft for a correct ratio of probs (can ft their "0.9148…" to 3sf from (b) if > 0.775) 2nd A1 for awrt 0.847
(d)	B1 for both correct hypotheses in terms of μ 1st M1 for selecting the correct model (needn't use $\bar{X}$ $\Rightarrow$ by standardisation or 1st A1) 1st A1 for correct use of the correct model i.e. awrt 0.035 (allow 0.04 if $\text{P}\left(\text{"}\bar{X}\text{"} < 164.6\right)$ seen) Condone $\text{P}(\text{"}\bar{X}\text{"} > 164.6) = 0.9652$ or awrt 0.97 <u>only if</u> comparison with 0.95 is made
ALT	**Use of *z* value:** Need to see $Z = -1.8(15\ldots)$ **and** cv of <u>+</u> 1.6449 (allow 1.64 or better) for 1st A1
ALT	**Use of CR or CV for $\bar{X}$:** Need to see "$\bar{X}$"< 164.7786… or CV = … (awrt 164.8) for 1st A1 Condone truncation i.e 164.7 or better 2nd dA1 (**dep on M1A1** only) for a correct inference in context. Must mention <u>Mia's belief</u> **or** <u>mean height of females/women</u> Do NOT award if contradictory statements about hypotheses made e.g. "not sig"
SC	**M0 for** $\bar{X}$ ~N(**164.6**, …) If they achieve p = awrt 0.035 (o.e. with z-value or CV of 166.3) **and** a correct conclusion in context is given score M0A0A1 [and SC for awrt 0.97 > 0.95 case]