Qu 1	Scheme	Marks	AO
(a)	**Disadvantage:** e.g. Not random; cannot use (reliably) for inferences	B1 (1)	1.1b
(b) (i) (ii)	[Sight or correct use of] $X \sim B(36, 0.08)$ $\qquad\qquad$ $P(X = 4) = 0.167387\ldots$ $\qquad$ awrt **0.167** $\qquad\qquad$ $[P(X \geqslant 7) = 1 - P(X \leqslant 6) =]$ $0.022233\ldots$ awrt **0.0222**	M1 A1 A1 (3)	3.3 1.1b 1.1b
(c)	P(In dance club and dance tango) $= 0.4 \times 0.08 =$ **0.032** or $\dfrac{4}{125}$ or **3.2%**	B1 (1)	1.1b
(d)	[Let T = those who can dance the Tango. Sight or use of] $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad T \sim B(50, \text{“}0.032\text{”})$ $[P(T < 3) = P(T \leqslant 2) =]$ $0.7850815\ldots$ $\qquad$ awrt **0.785**	M1 A1 (2)	3.3 1.1b
		(7 marks)	

	Notes		
(a)	B1 for a suitable disadvantage:		

Allow (B1)	Do NOT allow (B0)
Not random or less random (o.e.)	Not representative
Cannot use (reliably) for inferences	Less accurate
(More likely to be) biased	Any comment based on time or cost
	Any mention of skew
	Any mention of non-response

(b)	M1 for sight of B(36, 0.08) Allow in words: <u>binomial</u> with <u>$n = 36$</u> and <u>$p = 0.08$</u>
	    may be implied by one correct answer to 2sf <u>or</u> sight of $P(X \leqslant 6) = 0.97776\ldots$ i.e. awrt 0.98
	     Allow for $36C4 \times 0.08^4 \times 0.92^{32}$ as this is "correct use"

(i)	1st A1 for awrt 0.167 NB An answer of just awrt 0.167 scores M1($\Rightarrow$)1st A1
(ii)	2nd A1 for awrt 0.0222
(c)	B1 for 0.032 o.e. (Can allow for sight of 0.4×0.08)
(d)	M1 for sight of B(50, "0.032") ft their answer to (c) provided it is a probability $\neq 0.08$ may be implied by correct answer <u>or</u> sight of $[P(T \leqslant 3)] = 0.924348\ldots$i.e. awrt 0.924 or $P(T \leqslant 2)$ as part of $1 - P(T \leqslant 2)$ calc. A1 for awrt 0.785
MR	Allow MR of 50 (e.g. 30) provided clearly attempting $P(T \leqslant 2)$ and score M1A0

Qu 2	Scheme	Marks	AO
(a)	[Sum of probs = 1 implies] $\quad \log_{36} a + \log_{36} b + \log_{36} c = 1$	M1	3.1a
	$\Rightarrow \log_{36}(abc) = 1$ so $\quad abc = 36$	A1	3.4
	All probabilities greater than 0 implies each of a, b and c > 1	B1	2.2a
	$36 = 2^2 \times 3^2$ (or 3 numbers that multiply to give 36 e.g. 2, 2, 9 etc)	dM1	2.1
	Since a, b and c are distinct must be **2, 3, 6** (**$a = 2, b = 3, c = 6$**)	A1	3.2a
		(5)	
(b)	$\left(\log_{36} a\right)^2 + \left(\log_{36} b\right)^2 + \left(\log_{36} c\right)^2$	M1	3.4
	[= 0.0374137…+ 0.09398737…+0.25]		
	$\qquad\qquad\qquad\qquad = 0.38140…$ awrt **0.381**	A1	1.1b
		(2)	
		(7 marks)	
	Notes		
(a)	1ˢᵗ M1 for a start to the problem using sum of probabilities leading to eq'n in a, b and c		
	1ˢᵗ A1 for reducing to the equation $abc = 36$ [Must follow from their equation.]		
NB	Can go straight from $abc = 36$ to the answer for full marks for part (a).		
	B1 for deducing that each value > 1 (may be implied by 3 integers all > 1 in the next line)		
	2ⁿᵈ dM1 (dep on M1A1) for writing 36 as a product of prime factors or		
	3 values with product = 36 and none = 1		
	2ⁿᵈ A1 for 2, 3 and 6 as a list or $a = 2$, $b = 3$ and $c = 6$		
SC	**M0M0** If no method marks scored but a correct answer given score: M0A0B1M0A1 (2/5)		
Ans only	This gets the SC score of 2/5 [Question says show your working clearly]		
(b)	M1 for a correct expression in terms of a, b and c or values; ft their integers a, b and c		
	Condone invisible brackets if the answer implies they are used.		
	A1 for awrt 0.381		

Question	Scheme	Marks	AOs
3(a)	$\dfrac{365}{1825}$ or $\dfrac{1}{5}$ or 0.2 oe	B1	1.1b
		(1)	
(b)	$\dfrac{170}{1825}$ or $\dfrac{34}{365}$ or awrt 0.093	B1	1.1b
		(1)	
(c)	$90 \times 0.4 + 80 \times 0.05 [= 40]$ or $90 \times 0.6 + 80 \times 0.95 [= 130]$ or $740 \times 0.65 [= 481]$ or $740 \times 0.35 [= 259]$	M1	3.1b
		B1 B1 A1	1.1b 1.1b 1.1b
		(4)	
(d)	$P(R' \cap F) = \dfrac{380}{1825} \left[= \dfrac{76}{365} = 0.208... \right]$ oe awrt 0.208	B1	1.1b
		(1)	
(e)	$\left[\dfrac{133 + "130"}{1825} = \right] \dfrac{"263"}{1825}$ awrt 0.144	B1ft	1.1b
		(1)	
(f)	$\dfrac{247 + "481"}{247 + "481" + 123 + "40"}$	M1	3.4
	$= \dfrac{728}{891}$ 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 481 or 259 Implied by 40, 481, 259 or 130 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**	380/1825 oe 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	
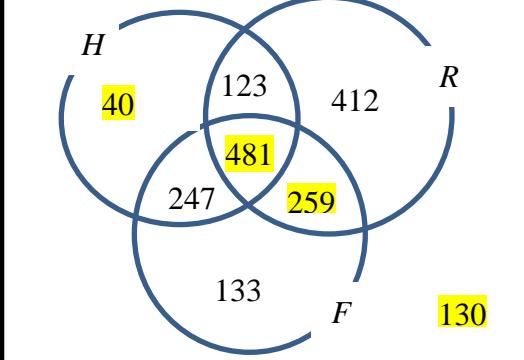
Note: In the Venn diagram (part c), the following values are shown: H region contains 40 (highlighted), 123, 481 (highlighted), 247; R region contains 412, 259 (highlighted); F region contains 133; outside 130 (highlighted).

Qu 4	Scheme	Marks	AO
(a)	$[0.13 + 0.25 =]$ **0.38**	B1 **(1)**	1.1b
(b)	Independence implies: e.g. $\left[\mathrm{P}(B \cap C) = \mathrm{P}(B) \times \mathrm{P}(C) \Rightarrow \right] \quad 0.3 = (0.3 + 0.05 + 0.25) \times (0.3 + p)$	M1	1.1b
	$\text{So} \quad p = \underline{\mathbf{0.2}}$	A1	1.1b
	[Sum of probabilities = 1 gives] $\qquad q = \underline{\mathbf{0.07}}$	B1ft **(3)**	1.1b
(c)	$\left[\mathrm{P}(A \mid B') = \right] \dfrac{\mathrm{P}(A \cap B')}{\mathrm{P}(B')} \quad \text{or} \quad \dfrac{0.13}{(1-0.6) \ \text{or} \ (0.13 + "0.2" + "0.07")}$	M1	1.1b
	$= \dfrac{13}{40} \ \text{or} \ \underline{\mathbf{0.325}}$	A1 **(2)**	1.1b
		(6 marks)	

	Notes
(a)	B1 for 0.38 (or exact equivalent) **If answers are given on Venn Diagram <u>and</u> in the script then the script takes precedence.**

(b)	M1 for a correct equation in p or $\mathrm{P}(C)$ only.
	       May be implied by an answer of $p = 0.2$ **provided** this does not come from incorrect working.
	       Condone missing brackets if they get 0.2
	       Other rules for independence will give simple rearrangements of this equation.

Beware	If $p = 0.2$ comes from incorrect working, we've seen $p = \dfrac{0.6}{0.3} = 0.2$, score M0A0
	A1 for $p = 0.2$ (or exact equivalent) B1ft for $q = 0.07$ (or exact equivalent) ft their p i.e. $q = 0.27 - "0.2"$ where $0 \leqslant p \leqslant 0.27$
(c)	M1 for a correct ratio of probability expressions <u>or</u> a correct ratio of probabilities ft their values of p and q (provided both probabilities) <u>or</u> letters p and q A1 for 0.325 or exact equivalent. Correct answer only will score 2/2 **NB on epen this is labelled M1 but treat it as A1**

Qu 5	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)	$P(C) = 0.6$ <u>and</u> $P(B) = p + 0.32$ <u>and</u> $P(B \cap C) = 0.27$ <u>or</u> $(0.08 + 0.25 + 0.27) \times (0.27 + 0.05 + p) = 0.27$ <u>or</u> $0.27 + 0.05 + p = \frac{0.27}{0.6} = 0.45$ $[p + 0.32 = 0.45$ so$]$ $p = \underline{\mathbf{0.13}}$	M1 A1 **(2)**	1.1b 2.2a
(c)	$\left[P(A \mid B') \right] = \dfrac{q}{q + r + 0.25 + 0.08}$ or $\dfrac{q}{1 - (0.05 + "0.13" + 0.27)}$ or $\dfrac{q}{0.55}$ $q + r = 1 - 0.65 -$ "0.13" $[= 0.22]$ Since $r \ldots 0$ the greatest value of q is "0.22" so $P(A \mid B')$ „ $\underline{\mathbf{0.4}}$ or $\underline{\frac{2}{5}}$	M1 M1 A1 **(3)**	2.1 1.1b 2.2a
(d)	$\left[P(B \mid A') = \right] \dfrac{0.27 + "0.13"}{0.6 + "0.13" + r} = 0.5$ or $\dfrac{0.27 + "0.13"}{1 - (q + 0.05)} = 0.5$ $r = \underline{\mathbf{0.07}}$, $q = \underline{\mathbf{0.15}}$	M1 A1 A1ft **(3)**	1.1b 1.1b 1.1b
(e)	$\left[P\left([A \cup B]' \cap C \right) = \right] [0.25 + 0.08] = \underline{\mathbf{0.33}}$	B1 **(1)**	1.1b
(f)	e.g. $B \cap [A \cup C]'$ <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 $P(A \cap C) = 0$ 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 $P(A \mid B')$ in q (and r) ft their p. May be done in stages
	      e.g. find correct expression for $P(B')$, 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 $P(A \mid B')$. Allow „ 0.4 or $P(A \mid B') = 0.4$
	      Can award 3/3 for $P(A \mid B') = 0.4$ but not 0.4 alone as it can come from e.g $P(C')$

(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 $P(A') = 0.27 + 0.25 + 0.08 + p + r$ 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(…