

| Qu | Scheme | Marks | AO |
|--------------|--|-----------|------|
| 1 (a) | $[p = 1 - (0.2 + 0.2 + 0.1 + 0.2)] = \underline{0.3}$ | B1 (1) | 1.1b |
| (b) | A and C are mutually exclusive. [NOT P(A) and P(C)] | B1 (1) | 1.2 |
| | | (2 marks) | |
| Notes | | | |
| (a) | B1 for | | |
| (b) | B1 for A and C [NB $A \cap C$ or $A \cap C = \emptyset$ is B0] If more than one case given they must <u>all</u> be correct e.g. $A \cap B$ and C | | |

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|--------------|---|-----------|------|
| 2 | Must end up with 3 of each colour or 4 of each colour | M1 | 3.1b |
| | <u>n = 2</u> requires 1 st red and 2 nd green <u>or</u> red from A and green from B | M1 | 2.2a |
| | $P(1^{\text{st}} \text{ red and } 2^{\text{nd}} \text{ green}) = \frac{4}{9} \times \frac{1}{10} = \frac{4}{90} \text{ or } \frac{2}{45} \quad p = \frac{2}{\underline{\underline{45}}}$ | A1 | 1.1b |
| | <u>n = 5</u> requires 1 st green and 2 nd yellow <u>or</u> green from A and yellow from B | M1 | 2.2a |
| | $P(1^{\text{st}} \text{ green and } 2^{\text{nd}} \text{ yellow}) = \frac{5}{12} \times \frac{3}{10} = \frac{15}{120} \text{ or } \frac{1}{8} \quad p = \frac{1}{\underline{\underline{8}}}$ | A1 | 1.1b |
| | | (5) | |
| | | (5 marks) | |
| Notes | | | |
| | <p>1st M1 for an overall strategy realising there are 2 options. Award when evidence of both cases (3 of each colour or 4 of each colour) seen.</p> <p>2nd M1 for $n = 2$ <u>and</u> attempt at 1st red and 2nd green May be implied by e.g. $\frac{4}{9} \times \frac{1}{9}$</p> <p>1st A1 for $p = \frac{2}{\underline{\underline{45}}}$ or exact equivalent</p> <p>3rd M1 for $n = 5$ <u>and</u> attempt at 1st green and 2nd yellow May be implied by e.g. $\frac{5}{12} \times \frac{3}{9}$</p> <p>2nd A1 for $p = \frac{1}{\underline{\underline{8}}}$ or exact equivalent</p> <p>NB If both correct values of p are found and then added (get $\frac{61}{360}$), deduct final A1 only (i.e. 4/5)</p> | | |

| Qu | Scheme | Mark | AO |
|---------------|---|-----------|------|
| 3. (a) | [D = number of bags that are damp] $D \sim B(35, 0.08)$ NB $0.08 = \frac{2}{25}$ | M1 | 3.3 |
| (i) | $P(D = 2) = 0.2430497\dots$ awrt 0.243 | A1 | 3.4 |
| (ii) | $P(D > 3) = [1 - P(D \leq 3) = 1 - 0.69397\dots] = 0.30602\dots$ awrt 0.306 | A1 | 1.1b |
| | | (3) | |
| (b) | $H_0 : p = 0.08$ $H_1 : p < 0.08$ | B1 | 2.5 |
| | [$X \sim$] $B(70, 0.08)$ | M1 | 2.1 |
| | $[P(X = 2)] = 0.0739756\dots$ awrt 0.074 | A1 | 1.1b |
| | [$0.074 < 0.10$ so significant, reject H_0 so...] | | |
| | there <u>is</u> evidence to <u>support</u> supplier <u>B's claim</u> (o.e.) | A1 | 2.2b |
| | | (4) | |
| | | (7 marks) | |
| Notes | | | |
| (a) | M1 for selecting a correct model: sight of or use of $B(35, 0.08)$ [Condone $B(0.08, 35)$ May be implied by one correct answer or sight of $P(D \leq 3) =$ awrt 0.694 (or allow 0.693) or seeing $\binom{35}{2} 0.08^2 \times (1 - 0.08)^{35-2}$ Saying $B(35, 8\%)$ without a correct calculation would score M0 | | |
| (i) | 1 st A1 for awrt 0.243 | | |
| (ii) | 2 nd A1 for awrt 0.306 (Condone poor use of notation e.g. $P(D = 3) = 0.306\dots$ i.e. just mark ans) | | |
| NB | $P(D \leq 3) = 0.539$ scores 2 nd A0 but would of course score M1 | | |
| (b) | B1 for both hypotheses correct in terms of p or π [Condone 8% for 0.08] M1 for sight or correct use of $B(70, 0.08)$ [Condone $B(0.08, 70)$ May be implied by prob of 0.074 or better 1 st A1 for final answer awrt 0.074 can condone poor notation e.g. $P(X = 2) =$ awrt 0.074 Can allow this mark for CR of $X = 2$ provided $[P(X = 2)] = 0.074$ (or better) is seen [Can allow 0.07 if $X \sim B(70, 0.08)$ and $P(X = 2)$ are both seen] 2 nd A1 (dep on M1A1 but independent of hypotheses) for a correct inference in context Must mention <u>claim</u> or <u>B and</u> idea of <u>support for</u> ... or <u>proportion/probability</u> (of damp bags) and idea of <u>less</u> than 8% or A 2 nd A0 for contradictory statements e.g. "accept H_0 so evidence to support B's claim" 2 nd A0 if you see $0.0739\dots < 0.08$ so significant/ reject H_0 etc | | |
| MR | 0.8 for 0.08 In (a) allow M1 for $B(35, 0.8)$ then A0A0 In (b) allow B1 for Hypotheses and M1 for $B(70, 0.8)$ seen, then A0A0 | | |

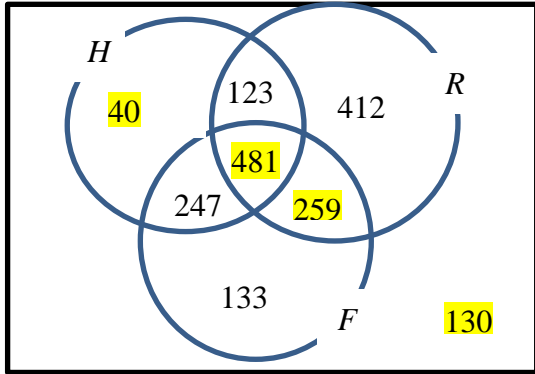
| Qu | Scheme | Mark | AO |
|--------------|---|-----------|------|
| 4. (a)(i) | Require $R = 3$ and $G = 4$ so probability is $\frac{3}{4} \times \frac{1}{3}$ | M1 | 2.1 |
| | $= \frac{1}{4}$ or 0.25 | A1 | 1.1b |
| (ii) | [R must be 2 and $G = 1$ so $\frac{1}{4} \times \frac{2}{3}$] = $\frac{1}{6}$ | A1 | 1.1b |
| (b) | $P(X = 50) = 0.25$ must mean $R = 3$ and $G = 4$ | M1 | 3.1a |
| | so $3m + 4n = 50$ | A1 | 1.1b |
| | $P(X = 20) = \frac{1}{6} \Rightarrow R = 2, G = 1$ so $2m + n = 20$ | A1 | 2.1 |
| | Solving: $3m + 4(20 - 2m) = 50$ (o.e.) | M1 | 1.1b |
| | $m = 6$ and $n = 8$ | A1 | 3.2a |
| | | (5) | |
| | | (8 marks) | |
| Notes | | | |
| (a)(i) | <p>M1 for sight of $\frac{3}{4} \times \frac{1}{3}$ or $\frac{1}{4} \times \frac{2}{3}$ as a single product BUT allow e.g. $\frac{3}{4} \times \frac{1}{3} + \frac{1}{3} \times \frac{3}{4}$ to score M1</p> <p>However if the products are later added e.g. $\frac{3}{4} \times \frac{1}{3} + \frac{1}{4} \times \frac{2}{3}$ it is M0</p> <p>May be implied by one correct answer to (i) or (ii)</p> <p>A1 for $\frac{1}{4}$ or 0.25 or exact equivalent (allow 25%)</p> | | |
| (ii) | <p>A1 for $\frac{1}{6}$ or exact equivalent</p> | | |
| (b) | <p>For the 1st 4 marks condone incorrect labelling e.g. R for m or G for n if intention is clear</p> <p>1st M1 for identifying either set of cases ($R = 2, G = 1, X = 20$) or ($R = 3, G = 4, X = 50$)</p> <p>Allow 1st M1 for $P(X = 20) = \frac{1}{4} \times \frac{2}{3}$ or $P(X = 50) = \frac{3}{4} \times \frac{1}{3}$ NOT just $P(X = 20) = \frac{1}{6}$ etc</p> <p><u>or</u> $\frac{1}{4}m + \frac{2}{3}n = 20$ or $\frac{3}{4}m + \frac{1}{3}n = 50$ and might score 2nd M1 (answer is $m = 64, n = 6$)</p> <p><u>or</u> $\frac{1}{4}m + \frac{2}{3}n = \frac{1}{6}$ or $\frac{3}{4}m + \frac{1}{3}n = \frac{1}{4}$ and might score 2nd M1 (answer is $m = \frac{4}{15}, n = \frac{3}{20}$)</p> <p><u>or</u> $2m + n = \frac{1}{6}$ or $3m + 4n = \frac{1}{4}$ and might score 2nd M1 (answer is $m = \frac{1}{12}, n = 0$)</p> <p><u>or</u> $2m + n = 50$ and $3m + 4n = 20$ and might score 2nd M1 (answer is $m = 36, n = -22$)</p> <p>1st A1 for one correct equation</p> <p>2nd A1 for both correct equations and no incorrect equations, unless they attempt to solve the correct 2 equations only</p> <p>2nd M1 for attempt to solve <u>their</u> two linear equations in m and n (reduce to an equation in one variable, condone one sign error). May be implied by $m = 6$ and $n = 8$.</p> <p>Calc</p> <p>If they use one of the 4 sets of equations for 1st M1 and use a calculator to write down the answer, we will allow this mark for sight of the correct answers to those equations as given above.</p> <p>3rd A1 $m = 6$ and $n = 8$ only (no incorrect labelling here)</p> <p>Correct answer by trial can score 5/5 if no incorrect working seen.</p> | | |

| Que. | Scheme | Marks | AOs | |
|------------------|--|---|------|------|
| 5(a) | $45 - 25 = 20$ or e.g. '25 ,, 13 + 12 + y ,, 45' | M1 | 2.1 | |
| | 12 ,, x ,, 32 | A1 | 1.1b | |
| | | (2) | | |
| (b) | To be independent $P(A) \times P(M) = P(A \text{ and } M)$ | M1 | 1.1a | |
| | $P(M) = \frac{P(A \text{ and } M)}{P(A)} = \frac{\frac{12}{45}}{\frac{25}{45}} = \frac{12}{25}$ or $\frac{25}{45} \times P(M) = \frac{12}{45}$ | A1 | 2.1 | |
| | or $\frac{25}{45} \times \frac{x}{45} = \frac{12}{45}$ or $\frac{25}{45} \times \frac{12+y}{45} = \frac{12}{45}$ | | | |
| | The number of students taking part in music would be $\frac{12}{25} \times 45 = 21.6$ | The number of students taking part in music but not art would be $y = 9.6$ | A1 | 1.1b |
| | ...so it is not possible for A and M to be independent (since it must be a whole number). | | A1 | 2.2a |
| | | (4) | | |
| (6 marks) | | | | |
| Notes | | | | |
| (a) | <p>M1: for attempting to find range for x or attempt to find the largest/smallest number of students that could study Music only May be implied by one correct end point. Also may be implied with 20 given as an end point</p> <p>A1: oe allow $12 - 32$ or $x \dots 12$ and $x ,, 32$ $12 < x < 32$ or $x \dots 12$ or $x ,, 32$ or $x \dots 12, x ,, 32$ all score M1A0</p> | | | |
| (b) | <p>M1: writing the definition of independence, must use A and M Allow any rearrangement Allow all three probabilities labelled followed by a correct equation/definition</p> <p>$P(A) = \frac{25}{45}$, $P(A \text{ and } M) = \frac{12}{45}$, $P(M) = \frac{x}{45}$ or $\frac{12+y}{45}$</p> <p>A1: $P(M) = 0.48$ oe or correct equation for P(M), or x or y (allow any letter for y) Do not award this mark if working with numbers e.g. $P(A \text{ and } M) = 12$ A1: (dependent on M1 only and does not imply first A1)</p> <p>21.6 oe (also allow $\frac{21.6}{45}$) or 9.6 oe</p> <p>A1: (dependent on all previous marks being scored) correct deduction from correct working. Ignore any reference to the range of values found in part (a).</p> | | | |
| SC: | If M0 scored, allow access to 1 st and 2 nd A1 (to score maximum M0A1A1A0) | | | |

| Que. | Scheme | Marks | AOs | | | | | | | | |
|------------------|--|-----------------|----------------|---|---|------------|----------------|-----------------|----------------|----|------|
| 6(a) | $X = 0, 1, 2$ only | B1 | 3.1b | | | | | | | | |
| | $[P(X = 0) =] \frac{6}{8} \times \frac{5}{7} \times \frac{4}{6}$ | M1 | 1.1b | | | | | | | | |
| | $[P(X = 1) =] 3 \times \frac{2}{8} \times \frac{6}{7} \times \frac{5}{6}$ or $[P(X = 2) =] 3 \times \frac{2}{8} \times \frac{1}{7} \times \frac{6}{6}$ | M1 | 2.1 | | | | | | | | |
| | | A1 | 1.1b | | | | | | | | |
| | <table border="1"> <tr> <td>x</td> <td>0</td> <td>1</td> <td>2</td> </tr> <tr> <td>$P(X = x)$</td> <td>$\frac{5}{14}$</td> <td>$\frac{15}{28}$</td> <td>$\frac{3}{28}$</td> </tr> </table> | x | 0 | 1 | 2 | $P(X = x)$ | $\frac{5}{14}$ | $\frac{15}{28}$ | $\frac{3}{28}$ | A1 | 1.1b |
| | x | 0 | 1 | 2 | | | | | | | |
| $P(X = x)$ | $\frac{5}{14}$ | $\frac{15}{28}$ | $\frac{3}{28}$ | | | | | | | | |
| | (5) | | | | | | | | | | |
| (b) | $J \sim B(10, \frac{1}{9})$ | M1 | 3.1b | | | | | | | | |
| | $P(J \leq 4) = 1 - P(J \geq 3)$ or $P(J \leq 4) = P(J = 4) + P(J = 5) + \dots + P(J = 10)$ or $1 - 0.981(57\dots)$ | M1 | 3.4 | | | | | | | | |
| | $=$ awrt 0.0184 | A1 | 1.1b | | | | | | | | |
| | | (3) | | | | | | | | | |
| (8 marks) | | | | | | | | | | | |
| Notes | | | | | | | | | | | |
| (a) | <p>B1: identifying that X can only take on the values 0, 1 and 2 (may be seen at end of tree diagram). If other values stated, they must be associated with a probability of 0.</p> <p>M1: correct expression for $P(X = 0)$</p> <p>M1: correct expression for either $P(X = 1)$ or $P(X = 2)$</p> <p>A1: one correct probability</p> <p>Watch out for $\frac{6}{8} \times \frac{5}{7} = \frac{15}{28}$ which is an incorrect attempt at $P(X = 0)$ and scores M0A0</p> <p>A1: complete probability distribution, need not be in a table, but each value of x must be associated with its probability.</p> <p>Allow awrt 0.357, awrt 0.536, awrt 0.107</p> | | | | | | | | | | |
| (b) | <p>M1: identifying that the B(inomial) distribution with $n = 10$ is appropriate here.</p> <p>If distribution not stated, may be implied by use of $(10Cr)p^r(1-p)^{10-r}$ or 0.981(57...)</p> <p>M1: writing or using a correct probability statement</p> <p>A1: awrt 0.0184</p> <p>Correct answer scores 3 out of 3</p> | | | | | | | | | | |

| Qu 7 | Scheme | Marks | AO |
|------------------|--|-----------------------------------|-------------|
| (a) | Disadvantage: e.g. Not random; cannot use (reliably) for inferences | B1 | 1.1b |
| (b) | [Sight or correct use of] $X \sim B(36, 0.08)$ | M1 | 3.3 |
| (i) | $P(X = 4) = 0.167387\dots$ awrt 0.167 | A1 | 1.1b |
| (ii) | $[P(X \geq 7) = 1 - P(X \leq 6) =]$ 0.022233... awrt 0.0222 | A1 | 1.1b |
| (c) | $P(\text{In dance club and dance tango}) = 0.4 \times 0.08 = \underline{\underline{0.032}}$ or $\frac{4}{125}$ or 3.2% | B1 | 1.1b |
| (d) | [Let T = those who can dance the Tango. Sight or use of] $T \sim B(50, "0.032")$ $[P(T < 3) = P(T \leq 2) =]$ 0.7850815... awrt 0.785 | M1 A1 | 3.3 1.1b |
| | | (1) (3) (1) (2) | |
| (7 marks) | | | |
| Notes | | | |
| (a) | B1 for a suitable disadvantage: | | |
| | Allow (B1) | Do NOT allow (B0) | |
| | Not random <u>or</u> 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 $n = 36$ and $p = 0.08$ may be implied by one correct answer to 2sf <u>or</u> sight of $P(X \leq 6) = 0.97776\dots$ i.e. awrt 0.98 Allow for $36C4 \times 0.08^4 \times 0.92^{32}$ as this is "correct use" | | |
| (i) | 1 st A1 for awrt 0.167 NB An answer of just awrt 0.167 scores M1(\Rightarrow)1 st A1 | | |
| (ii) | 2 nd 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 $[P(T \leq 3)] = 0.924348\dots$ i.e. awrt 0.924 or $P(T \leq 2)$ as part of $1 - P(T \leq 2)$ calc. A1 for awrt 0.785 | | |
| MR | Allow MR of 50 (e.g. 30) provided clearly attempting $P(T \leq 2)$ and score M1A0 | | |

| Qu 8 | Scheme | Marks | AO |
|--------------|--|---|------------------------------------|
| (a) | [Sum of probs = 1 implies] $\log_{36} a + \log_{36} b + \log_{36} c = 1$ $\Rightarrow \log_{36}(abc) = 1$ so $abc = 36$ All probabilities greater than 0 implies each of a , b and $c > 1$ $36 = 2^2 \times 3^2$ (or 3 numbers that multiply to give 36 e.g. 2, 2, 9 etc) Since a , b and c are distinct must be <u>2, 3, 6</u> (<u>$a = 2, b = 3, c = 6$</u>) | M1 A1 B1 dM1 A1 (5) | 3.1a 3.4 2.2a 2.1 3.2a |
| | (b) | $(\log_{36} a)^2 + (\log_{36} b)^2 + (\log_{36} c)^2$ $[= 0.0374137\dots + 0.09398737\dots + 0.25]$ $= 0.38140\dots$ awrt <u>0.381</u> | M1 A1 (2) |
| Notes | | | |
| (a) | 1 st M1 for a start to the problem using sum of probabilities leading to eq'n in a , b and c 1 st 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) 2 nd dM1 (dep on M1A1) for writing 36 as a product of prime factors <u>or</u> 3 values with product = 36 and none = 1 2 nd 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 | |
|--------------------------|---|--|----------------------|------|
| 9(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) | $90 \times 0.4 + 80 \times 0.05 [= 40]$ 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) | $P(R' \cap F) = \frac{380}{1825} \left[= \frac{76}{365} = 0.208... \right]$ 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 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 | | |

| Qu 10 | Scheme | Marks | AO |
|---------------|---|-------------------------|----------------------|
| (a) | $[0.13 + 0.25 =]$ <u>0.38</u> | B1 (1) | 1.1b |
| (b) | Independence implies: e.g. $[P(B \cap C) = P(B) \times P(C) \Rightarrow] 0.3 = (0.3 + 0.05 + 0.25) \times (0.3 + p)$ So $p = \underline{0.2}$ [Sum of probabilities = 1 gives] $q = \underline{0.07}$ | M1 A1 B1ft (3) | 1.1b 1.1b 1.1b |
| (c) | $[P(A B') =] \frac{P(A \cap B')}{P(B')}$ or $\frac{0.13}{(1-0.6)}$ or $\frac{0.13}{(0.13 + "0.2" + "0.07")}$ $= \frac{13}{40}$ or <u>0.325</u> | M1 A1 (2) | 1.1b 1.1b |
| 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 $P(C)$ 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 $p = \frac{0.6}{0.3} = 0.2$, 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 $0 \leq p \leq 0.27$ | | |
| (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 open this is labelled M1 but treat it as A1 | | |