Question 1

Q4	Model Solution – 30 Marks	Marking Notes
(a) (i)	Centre $= (h, -3)$ Radius $= \sqrt{12}$ *or* $2\sqrt{3}$	**Scale 10C (0, 4, 7, 10)** *Low Partial Credit:* • Work of merit towards finding x-ordinate **or** y-ordinate of the centre *High Partial Credit* • Centre or radius correct
(ii)	$\frac{\lvert h-4(-3)+7\rvert}{\sqrt{(1)^2+(-4)^2}} = 5$ $\lvert h+19\rvert = 5\sqrt{17}$ $h+19 = 5\sqrt{17}$ or $h+19 = -5\sqrt{17}$ $h = 5\sqrt{17}-19$ or $h = -5\sqrt{17}-19$ **OR** $(h+19)^2 = 425$ $h^2+38h-64 = 0$ $h = 5\sqrt{17}-19$ or $h = -5\sqrt{17}-19$	**Scale 15D (0, 4, 8, 12, 15)** **3 steps:** **1.** $\frac{\lvert h-4(-3)+7\rvert}{\sqrt{(1)^2+(-4)^2}}$ **2.** $\frac{\lvert h-4(-3)+7\rvert}{\sqrt{(1)^2+(-4)^2}} = 5$ **3.** Find values of h *Low Partial Credit:* • Work of merit, for example, some substitution into relevant formula, or draws diagram with relevant figures (5, centre marked, and line) *Mid Partial Credit:* • 1 step correct *High Partial Credit:* • 2 steps correct

Q4	Model Solution – 30 Marks	Marking Notes
(b)	Centre $= (h, k)$ $k = \frac{3-5}{2} = -1$ $(x-h)^2+(y+1)^2 = \left(\sqrt{20}\right)^2$ $x^2+y^2-2hx+h^2+2y+1 = 20$ $(8,1)$ is on the circle… $(8)^2+(1)^2-2h(8)+h^2+2(1)+1$ $= 20$ $h^2-16h+48 = 0$ $(h-4)(h-12) = 0$ $h = 4$, ~~$h = 12$~~ s: $(x-4)^2+(y+1)^2 = 20$ **OR** $(a,3)$: $a^2+2ga+6f+c = -9$ $(a,-5)$: $a^2+2ga-10f+c = -25$ So: $f = 1$ $(8,1)$: $16g+2f+c = -65$ So: $16g+c = -67$ … **Eqn A**	**Scale 5D (0, 2, 3, 4, 5)** *Low Partial Credit:* • Some correct substitution of relevant point *Mid Partial Credit* • Finds $k = -1$ • Finds $f = 1$ • 4 independent equations in g, f, c and a *High Partial Credit:* • $k = -1$ and quadratic equation in h • Finds $f = 1$ and quadratic equation in g *Full Credit –1:* • Finds the relevant constants, but equation of circle not stated • Finds equation of circles for both values of *h* but does not select the correct one

	$\sqrt{g^2+f^2-c}=\sqrt{20}$ So: $g^2-c=19$ … **Eqn B** From **A** and **B**: $g^2+16g+48=0$ so $g=-4$ So $c=-3$ And eqn is $x^2+y^2-8x+2y-3=0$	

Question 2

Q6	Model Solution – 30 Marks	Marking Notes
(a)	Answer: FALSE Justification: *Describes or draws any situation where two angles are equal in size without being vertically opposite. Eg. equilateral triangle, isosceles triangle, opposite angles in a parallelogram etc.*	**Scale 5B (0, 2, 5)** *Partial Credit:* • Correct answer with no justification • States True and justifies (ignores "and only if
(b) (i)	**1.** $\lvert\angle EHD\rvert=\lvert\angle DBC\rvert=\theta$ … alternate angles $\lvert\angle EFD\rvert=\lvert\angle EHD\rvert$ … both $=\theta$ **2.** $\lvert\angle FED\rvert=\lvert\angle HED\rvert$ …rectangle & straight angle $\lvert\angle FDE\rvert=\lvert\angle HDE\rvert$ … angles in tri. sum to 180** **3.** $\lvert ED\rvert=\lvert ED\rvert$ … common side **Conclusion:** So $FED\equiv HED$ … by ASA $\lvert FE\rvert=\lvert EH\rvert$ **OR** **1.** $\lvert\angle EHD\rvert=\lvert\angle DBC\rvert=\theta$ … alternate angles $\lvert\angle EFD\rvert=\lvert\angle EHD\rvert$ … both $=\theta$ $\lvert FD\rvert=\lvert DH\rvert$ … isosceles triangle **2.** $\lvert\angle FED\rvert=\lvert\angle HED\rvert=90°$ …rectangle & straight angle **3.** $\lvert ED\rvert=\lvert ED\rvert$ … common side **Conclusion:** So $FED\equiv HED$ … by RHS $\lvert FE\rvert=\lvert EH\rvert$ *Or similar*	**Scale 15D (0, 4, 8, 12, 15)** Consider the solution as having 4 elements: 3 steps and a conclusion: **Steps 1, 2 & 3:** 3 correct statements for congruency (with justifications) **and** Conclusion (with reason) Note: To prove by SAS, candidates will have to establish that $\lvert\angle FDE\rvert=\lvert\angle HDE$ *Low Partial Credit:* • Work of merit, for example, $\lvert\angle EHD\rvert=\lvert\angle DBC\rvert$ indicated *Mid Partial Credit:* • 2 correct steps (no justifications) *High Partial Credit:* • 3 correct steps (including one side) with at least one justification • All 3 steps correct and conclusion stated (no justifications) *Full Credit -1*

		• $\|FE\| = \|EH\|$ not stated

Q6	Model Solution – 30 Marks	Marking Notes
(b) (ii)	$\|FE\| = \frac{1}{2}\|AB\| = 10$ $\|FG\| = 40$ $\tan\theta = \frac{\|AG\|}{\|FG\|} = \frac{90}{40}$ $\theta = 66\cdot037..°$ $\theta = 66°$ [nearest degree] **OR** $\|FE\| = \frac{1}{2}\|AB\| = 10$ Triangles FED and BCD are similar So $\|ED\|$ = 90/4 = 22.5 $\tan\theta = \frac{\|ED\|}{\|FE\|} = \frac{22.5}{10}$ $\theta = 66\cdot037..°$ $\theta = 66°$ [nearest degree] **OR** $\|FE\| = \frac{1}{2}\|AB\| = 10$ Triangles FED and BCD are similar So $\|DC\|$ = 90 x $\frac{3}{4} = 67.5$ $\tan\theta = \frac{\|CD\|}{\|BC\|} = \frac{67.5}{30}$ $\theta = 66\cdot037..°$ $\theta = 66°$ [nearest degree]	**Scale 10D (0, 3, 5 , 8, 10)** **4 steps:** **1.** $\|FE\| = \frac{1}{2}\|AB\| = 10$ **2.** Finds 2nd side in a relevant triangle **3.** Trignometric equation set up **4.** Finds θ *Low Partial Credit:* • Work of merit in finding any side of a relevant triangle *Mid Partial Credit* • 2 steps correct *High Partial Credit:* • 3 steps correct *Full Credit -1* • Incorrect rounding or no rounding

Question 3

Q1	Model Solution –30 Marks	Marking Notes
(a)	$P(€6, €9, €6) = \left[\frac{5}{12}\times\frac{3}{12}\times\frac{5}{12}\right]$ $= \frac{75}{1728} = \frac{25}{576} = 0\cdot04340....$ $= 0\cdot0434$ [4 d.p.]	**Scale 10C (0, 4, 7, 10)** *Low Partial Credit:* • Any correct relevant probability stated *High Partial Credit:* • $P(€6) = \frac{5}{12}$ and $P(€9) = \frac{3}{12}$ and some multiplication indicated • $\frac{5}{12}\times\frac{3}{12}\times\frac{5}{12}$ • $\frac{5}{12}\times\frac{3}{11}\times\frac{5}{10}$ and continues *Full Credit -1* • Incorrect rounding or no rounding
(b)	Success = getting a 9 $P(\text{success}) = \frac{1}{4}$ Failure = not getting a 9 $P(\text{failure}) = \frac{3}{4}$ 2 successes in first 7 spins and then success	**Scale 10D (0, 3, 5, 8, 10)** Consider the solution as being the product of four terms: $\binom{7}{2}$, $\left(\frac{1}{4}\right)^2$, $\left(\frac{3}{4}\right)^5$ and $\frac{1}{4}$ *Low Partial Credit:*

$= \binom{7}{2}\left(\frac{1}{4}\right)^2\left(\frac{3}{4}\right)^5 \times \frac{1}{4}$

$= 0 \cdot 07786 \ldots$

$= 0 \cdot 0779$ [4 d.p.]

- $P(\text{success}) = \frac{1}{4}$
- $P(\text{failure}) = \frac{3}{4}$
- $\binom{7}{2}$
- $\frac{1}{4}$ for the last day
- $\binom{8}{3}$

Mid Partial Credit:

- Product of two correct terms evaluated
- Product of three correct terms

High Partial Credit:

- $\binom{7}{2}\left(\frac{1}{4}\right)^2\left(\frac{3}{4}\right)^5 \times \frac{1}{4}$

Full Credit -1

- Incorrect rounding or no rounding

Q1	Model Solution –30 Marks	Marking Notes
(c)	Will get less than €16 unless 9, 9, so: $1 - P(9,9) = 1 - \frac{1}{4} \times \frac{1}{4} = \frac{135}{144}$ **or** $\frac{15}{16}$ $= 0 \cdot 9375$ **OR** $P(0,0)$ $\frac{4}{12} \times \frac{4}{12}$ | $P(0 \text{ first})$ $\frac{4}{12}$ $P(0,6)$ $\frac{4}{12} \times \frac{5}{12}$ $P(0,9)$ $\frac{4}{12} \times \frac{3}{12}$ $P(6,0)$ $\frac{5}{12} \times \frac{4}{12}$ | $P(6 \text{ first})$ $\frac{5}{12}$ $P(6,6)$ $\frac{5}{12} \times \frac{5}{12}$ $P(6,9)$ $\frac{5}{12} \times \frac{3}{12}$ $P(9,0)$ $\frac{3}{12} \times \frac{4}{12}$ | $P(9,0)$ $\frac{1}{12}$ $P(9,6)$ $\frac{3}{12} \times \frac{5}{12}$ | $P(9,6)$ $\frac{5}{48}$ **TOTAL** $= \frac{15}{16}$ | $= \frac{15}{16}$ $= 0 \cdot 9375$	**Scale 10D (0, 3, 5, 8, 10)** **Note:** *Low Partial Credit:* • Relevant probability • Relevant work on establishing the condition, for example, indicates $P(9,9)$, or lists three that are in line with the condition (e.g.,$(0,0)$, $(0,6)$, $(0,9)$) *Mid Partial Credit:* • $\frac{1}{4} \times \frac{1}{4}$ indicated • Probability calculated correctly for three pairs on the table *High Partial Credit:* • $\frac{1}{16}$ or equivalent • Probability calculated correctly for six pairs on the table *Full Credit -1* • No rounding or incorrect rounding

Question 4

Q2	Model Solution – 30 Marks	Marking Notes
(a)	$C = \left(\frac{1(8)+4(-1)}{4+1}, \frac{1(-4)+4(3)}{4+1}\right)$ $C = \left(\frac{4}{5}, \frac{8}{5}\right)$ **OR** x: 9 steps back [8 to -1] So $x_C = 8 - \frac{4}{5}(9) = \frac{4}{5}$ y: 7 steps up [-4 to 3] So $y_C = -4 + \frac{4}{5}(7) = \frac{8}{5}$	**Scale 10C (0,3,7,10)** *Low Partial Credit* • Correct formula with some substitution • Value from formula explicitly identified $(a, b, x_1, y_1, x_2, y_2)$ • Recognises 9 steps for x or 7 steps for y • Plots both points on a set of axes

	$C = \left(\frac{4}{5}, \frac{8}{5}\right)$	*High Partial Credit* • Fully correct substitution into formula • $8 + \frac{4}{5}(-1-8)$ **and** $-4 + \frac{4}{5}\big(3-(-4)\big)$, or equivalent
(b)	From y-intercept to (q, r): Run $= q$, so rise $= qm$, so y-value $= r - qm$ Answer: $(0, r-qm)$ **OR** $y = mx + c$ So $r = mq + c$ So $c = r - mq$ Answer: $(0, -mq + r)$ **OR** $y - y_1 = m(x - x_1)$ $y - r = m(x - q)$ $y - r = mx - mq$ $y = mx - mq + r$ $x = 0$, so $y = -mq + r$ Answer: $(0, -mq + r)$	**Scale 5C (0,2,3,5)** *Low Partial Credit* • Work of merit, for example, equation of line formula (accept m as substitution), or indicates distance q or r correctly on diagram, or indicates $x = 0$ *High Partial Credit* • States $x = 0$ **and** work of merit towards finding y • Correct y-value found *Full Credit –1* • Correct values for x and y, but not given as co-ordinates of a point

Q2	Model Solution – 30 Marks	Marking Notes
(c)	$\tan 30° = \frac{-2-m_2}{1+(-2)m_2}$ So $\frac{1}{\sqrt{3}} = \frac{-2-m_2}{1-2m_2}$ $1 - 2m_2 = -2\sqrt{3} - \sqrt{3}m_2$ $m_2 = \frac{1+2\sqrt{3}}{2-\sqrt{3}}$ $m_2 = \frac{1+2\sqrt{3}}{2-\sqrt{3}} \times \frac{2+\sqrt{3}}{2+\sqrt{3}}$ $m_2 = 8 + 5\sqrt{3}$ **OR** $\frac{1}{\sqrt{3}} = \frac{-(-2-m_2)}{1+(-2)m_2}$ $1 - 2m_2 = 2\sqrt{3} + \sqrt{3}m_2$ $m_2 = \frac{1-2\sqrt{3}}{2+\sqrt{3}}$ $m_2 = \frac{1-2\sqrt{3}}{2+\sqrt{3}} \times \frac{2-\sqrt{3}}{2-\sqrt{3}}$ $m_2 = 8 - 5\sqrt{3}$	**Scale 15D (0,4,8,12,15)** **1.** Subs in 30 or -2 **2.** Fully substituted formula (30 and -2) **3.** Eliminate fractions and expands **4.** Find slope Note: A solution based on $tan^{-1}(-2) = 116{\cdot}5\ldots°$ is awarded at most *Low Partial Credit* *Low Partial Credit* • Work of merit, for example, formula for $\tan\theta$ with substitution for given slope, or $\tan 30°$ indicated • Indicates $\tan^{-1}(-2)$ or $116{\cdot}5\ldots°$ *Mid Partial Credit* • 2 steps correct • Sets $30 = \frac{-2-m_2}{1-2m_2}$ and finishes correctly *High Partial Credit* • 3 steps correct *Full Credit –1* • Correct value for slope, but not in required form

Question 5

Q1	Model Solution – 30 Marks	Marking Notes
(a) (i)	<table><tr><th></th><th colspan="2">Age (years)</th><th rowspan="2">Total</th></tr><tr><th></th><th>≤ 23</th><th>≥ 24</th></tr><tr><td>Under.</td><td>12 785</td><td>2922</td><td>15 707</td></tr><tr><td>Post.</td><td>1353</td><td>5654</td><td>7007</td></tr><tr><td>Total</td><td>14 138</td><td>8576</td><td>22 714</td></tr></table>	**Scale 5C (0, 2, 3, 5)** Accept correct answers without supporting work *Low Partial Credit* • 1 value correct *High Partial Credit* • 2 values correct

Q1	Model Solution – 30 Marks	Marking Notes
(a) (ii)	**Conclusion**: They are **not** independent **Justification**: *Based on independent iff* $P(O).P(U) = P(O \cap U)$: $P(O) = \frac{8576}{22714}$ or $\frac{4288}{11357}$ or $0{\cdot}377..$ $P(U) = \frac{15707}{22714} = 0{\cdot}6915..$ $P(O) \times P(U) = 0{\cdot}261\ldots$ $P(O \cap U) = \frac{2922}{22714} = 0{\cdot}1286 \neq P(O).P(U)$ **OR** *Based on independent iff* $P(O) = P(O\|U)$: $P(O) = \frac{8576}{22714}$ or $\frac{4288}{11357}$ or $0{\cdot}377..$ $P(O\|U) = \frac{2922}{15707} = 0 \cdot 186..$ **OR** *Based on independent iff* $P(U) = P(U\|O)$: $P(U) = \frac{15707}{22714} = 0{\cdot}691$ $P(U\|O) = \frac{2922}{8576} = 0{\cdot}3407$ **OR** Relatively few of the undergraduates are 24 or older, compared to the university overall. **OR** Over half the students in the university are undergraduates, but only about one third of students aged 24 or older are undergrads	**Scale 10D (0,3,5,8,10)** Accept without "$\neq P(O).P(U)$" or similar, if conclusion is correct Note: calculations that do not involve probabilities are not awarded credit *Low Partial Credit* • Work of merit, for example, correct conclusion, or makes a relevant statement, or finds a relevant probability *Mid Partial Credit* • Finds two of $P(O)$, $P(U)$, $P(O) \times P(U)$, or $P(O \cap U)$ • Finds $P(O\|U)$ or $P(U\|O)$ *High Partial Credit* • Enough calculations to support a correct conclusion, but no conclusion • Correct conclusion **and** finds $P(O) \times P(U)$ • Correct conclusion **and** finds $P(O)$, $P(U)$, and $P(O \cap U)$ • Correct conclusion **and** finds $P(O\|U)$ or $P(U\|O)$
(b)	$\frac{1}{7} \times \frac{1}{7}$ or $\frac{7}{7} \times \frac{1}{7} \times \frac{1}{7} = \frac{1}{49}$ or $7 \times \left(\frac{1}{7} \times \frac{1}{7} \times \frac{1}{7}\right) = \frac{1}{49}$	**Scale 5C (0,2,3,5)** Accept correct answer without supporting work *Low Partial Credit* • Work of merit, for example, one correct probability

		High Partial Credit • $\frac{1}{7}\times\frac{1}{7}\times\frac{1}{7}$ or $\frac{1}{343}$

Q1	Model Solution – 30 Marks	Marking Notes
(c)	$\frac{g}{b+g}=\frac{3}{5} \Rightarrow 3b-2g=0$ or $b=\frac{2}{3}g$ $\frac{g+4}{b+g+8}=\frac{4}{7} \Rightarrow -4b+3g=4$ $9b-6g=0$ $-8b+6g=8$ $b=8$ $3b=2g \Rightarrow 2g=24 \Rightarrow g=12$ **OR** x students in class : $\frac{g}{x}=\frac{3}{5}$ so $g=\frac{3}{5}x$ $x+8$ in class: $\frac{g+4}{x+8}=\frac{4}{7}$ so $7g+28=4x+32$ Sub 1st into 2nd: $7\left(\frac{3}{5}x\right)+28=4x+32$ Solve: $x=20$, so $g=12$ and $b=8$ **OR** *Trial and Improvement*: 2 boys and 3 girls becomes 6 boys and 7 girls, so $P=\frac{7}{13}$ (not correct) 4,6 becomes 8, 10, so $P=\frac{10}{18}$ (not correct) 8,12 becomes 12, 16, so $P=\frac{16}{28}=\frac{4}{7}$ So $b=8, g=12$	**Scale 10D (0,3,5,8,10)** **1.** Initial equation in b and g **2.** Subsequent equation in b and g **3.** Finds b **4.** Finds g Accept verified correct answer (gives b and g, finds $b+4$ and $g+4$, and verifies that probability is correct) *Low Partial Credit* • Work of merit, for example, indicates $\frac{2}{5}$, or indicates $b+g$, or some part of fraction involving b and g correct, or indicates use of additional 4 boys or girls or total of 8 in a relevant probability *Mid Partial Credit* • 1 step correct • 2 or more incorrect possibilities for b and g tested (by adding 4 to each and finding resulting probability) *High Partial Credit* • 2 steps correct • 2 correct linear equations in 2 unknowns • Correct answer without supporting work or verification *Full Credit –1* • Finds one variable (b or g)

Question 6

Q8	Model Solution – 50 Marks	Marking Notes
(a) (i) (ii)	**(i)** ***G*** *and* ***H*** *plotted and labelled correctly* **(ii)** *Reasonable line of best fit drawn*	**Scale 10C (0,3,7,10)** In **(i)**, accept x_H plotted between 15 and 20 In **(ii)**, accept line of best fit with some values on each side and with reasonable slope *Low Partial Credit*

		• Work of merit in plotting **G** or **H**, for example, one ordinate correct *High Partial Credit* • (i) or (ii) correct *Full Credit –1* • Points and line correctly plotted, but no or incorrect labels on points
(a) **(iii)** **(iv)**	**(iii)** *Answers consistent with candidate's line of best fit* **(iv)** Answer: **K** Reason: **L** is well beyond all of the given data points	**Scale 5C (0,2,3,5)** *Low Partial Credit* • Work of merit, for example, in (iii): relevant work on the graph, or in (iv): gives **K**, or reason shows some relevant knowledge *High Partial Credit* • One part correct • Work of merit in both parts *Full Credit –1* • Correct answers and reason, but without supporting work on the graph for (iii)
Q8	**Model Solution – 50 Marks**	**Marking Notes**
(a) **(v)** **(b)**	**(a)(v)** $0{\cdot}9659\ldots = 0{\cdot}966$ [3 D.P.] **(b)** *Any valid reason, for example:* Correlation is related to linear relationships, and this is quadratic The line of best fit is close to horizontal The data is symmetrical: it is decreasing first, and then increasing in a symmetrical way	**Scale 5B (0,2,5)** In (a)(v), accept correct answer without supporting work *Partial Credit* • Work of merit, for example, in (a)(v), fully substituted correct formula; or, in (b), draws axis of symmetry or line of best fit *Full Credit –1* • (b) correct and $0{\cdot}965$ or $0{\cdot}96$ or $0{\cdot}97$ given in (a)(v)
(c)	Mean $= \frac{534 + S + M}{13} = 52$ $534 + S + M = 676$ $S + M = 142$ Median $= 54$, so the least value S could be is 55 Greatest value of $S = 142 - 55 = 87$	**Scale 10D (0,3,5,8,10)** *Low Partial Credit* • Work of merit, for example, finds total of the scores (including or excluding S and/or M), or work towards finding the median (for example, rewriting the values in ascending order) *Mid Partial Credit* • Correct equation in S and M • Least value $= 55$ *High Partial Credit* • Correct equation in S and M **and** indicates effort to find values greater than 54

		• Finds answers of 54 and 88, 56 and 86, etc. (that is, $S + M = 142$ and incorrect values, both ≥ 54, found) • Correct answers (55 and 87) with insufficient supporting work

Question 7

Q9	Model Solution – 50 Marks	Marking Notes
(a) (i)	$(x-1)^2 + (y-17)^2 = 144$	**Scale 5B (0, 2, 5)** *Partial Credit:* • Work of merit, for example, some correct substitution into equation of circle; or indication of radius on the diagram
(a)(ii)	$(a-1)^2 + (8-17)^2 = 144$ $(a-1)^2 = 63$ $a - 1 = \sqrt{63}$ (as $a > 0$) $= 1 + \sqrt{63}$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Work of merit, for example, some correct substitution into equation *High Partial Credit:* • $a^2 - 2a - 62 = 0$ • $(a-1)^2 = 63$ *Full Credit-1* • Apply a * if $1 - \sqrt{63}$ is also presented as a solution
(a)(iii)	$\lvert PC\rvert = \sqrt{(10-1)^2 + (6-17)^2} = \sqrt{202}$ $\lvert PC\rvert$ −radius $= \sqrt{202} - 12 = 2{\cdot}2126\ldots$ Shortest distance$= 2{\cdot}2126\ldots \times 100$ $= 221{\cdot}26\ldots$ $= 221$ [m] [nearest m]	**Scale 10C (0, 4, 6, 10)** *Low Partial Credit:* • Work of merit, for example, some correct substitution into distance/perpendicular distance formula; finds slope of CP; *High Partial Credit:* • $\lvert PC\rvert$ −radius $= \sqrt{202} - 12$ or equivalent *Full Credit* −1 • Apply a * for no rounding or incorrect rounding
(b)	$x = 13$	**Scale 5B (0, 2, 5)** *Partial Credit:* • Work of merit, for example, some indication that equation is of form $x =$ constant, or draws in relevant tangent or normal

Q9	Model Solution – 50 Marks	Marking Notes
(c)	**Step 1**: Slope of $w = \frac{1}{3}$ **Step 2**: $\perp$ slope $= -3$ **Step 3**: $y - 6 = -3(x - 10)$ **Step 4**: $3x + y = 36$ $3x + y = 36 \quad (\times 3)$ $\underline{x - 3y = 9}$ $9x + 3y = 108$ $\underline{x - 3y = 9}$ $10x = 117$ $x = 11{\cdot}7$ **Step 5**: $11{\cdot}7 - 3y = 9$ $y = 0{\cdot}9$ $(11{\cdot}7, 0{\cdot}9)$	**Scale 10D (0, 3, 5, 7, 10)** Consider the solution involving 5 steps: **1.** Find the slope of $\boldsymbol{w}$ **2.** Find the perpendicular slope **3.** Find the equation of the line through $\boldsymbol{P}$ that is perpendicular to $\boldsymbol{w}$ **4.** Find one co-ordinate of the point of intersection of the two lines **5.** Find the other co-ordinate of the point of intersection of the two lines **Note**: $w: x - 3y = 9$, therefore eq. of $\perp$ $line\ is\ 3x + y + c = 0$ (Step 1 & Step 2) *Low Partial Credit:* • Work of merit, for example, $-3y = -x + 9$ *Mid Partial Credit* • 2 steps correct and work of merit in another step *High Partial Credit* • 4 steps correct

Q9	Model Solution – 50 Marks	Marking Notes
(d)	$y^2 + (3y)^2 = (12)^2$ $10y^2 = 144$ $y = \sqrt{14{\cdot}4} = 3{\cdot}8\ldots$ $x = 9 + 3\sqrt{14{\cdot}4} = 20{\cdot}4\ldots$ $(20{\cdot}4, 3{\cdot}8)$ [1 DP] **OR** $x^2 = 3^2 + 1^2$ $x^2 = 10$ $x = \sqrt{10}$ $1200\text{m} = 12$ units Factor increase $= \frac{12}{\sqrt{10}} = 3 \cdot 794..$ $x = 3 \times 3 \cdot 794 + 9 = 20.38..$ $y = 3.794..$ $(20{\cdot}4, 3{\cdot}8)$ [1 DP] **OR** Slope of line $w = \frac{1}{3}$ Angle between line w and the $x - axis =$	**Scale 15D (0, 4, 6, 8, 15)** *Low Partial Credit:* • Work of merit in identifying inputs for Pythagoras; slope of $w = \frac{1}{3}$; $1200\text{m} = 12$ units *Mid Partial Credit:* • $y^2 + (3y)^2 = (12)^2$ or equivalent • Finds angle between line w and the positive direction of the $x - axis$ *High Partial Credit* • Finds x or y value *Full Credit-1* • Apply a * for no rounding or incorrect rounding, once only

	$\tan^{-1}\frac{1}{3} = 18.435$ Then, $\sin 18.435 = \frac{y}{12}$ $y = 3.794 \ldots$ $x = 3.794 \times 3 + 9 = 20.384 \ldots.$ $(20{\cdot}4, 3{\cdot}8)$ [1 DP]	

Question 8

(a) (i)	$P(2 \text{ from the 1st 9 are O}^{-}) \times P(10\text{th is O}^{-})$ $= \binom{9}{2}\left(\frac{8}{100}\right)^2\left(\frac{92}{100}\right)^7 \times \frac{8}{100}$ $= 0{\cdot}01028 \ldots = 0{\cdot}0103$ [4 D.P.]	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • $\frac{8}{100}$ or $\frac{92}{100}$ or $\binom{9}{2}$ • First line of solution indicated (accept with "and" instead of ×) *Mid Partial Credit:* • $\binom{9}{2}\left(\frac{8}{100}\right)^2\left(\frac{92}{100}\right)^7$ • $\binom{10}{3}\left(\frac{8}{100}\right)^3\left(\frac{92}{100}\right)^7$ evaluated *High Partial Credit:* • $\binom{9}{2}\left(\frac{8}{100}\right)^2\left(\frac{92}{100}\right)^7\frac{8}{100}$ • $\binom{10}{3}\left(\frac{8}{100}\right)^3\left(\frac{92}{100}\right)^7\frac{8}{100}$ evaluated
(a) (ii)	$1 - P(\text{none are O}^{-})$ $= 1 - \left(\frac{92}{100}\right)^5$ $= 0{\cdot}34091 \ldots = 0{\cdot}3409$ [4 D.P.] **OR** $P(1 \text{ or } 2 \text{ or } 3 \text{ or } 4 \text{ or } 5 \text{ are O}^{-})$ $= \binom{5}{1}\left(\frac{8}{100}\right)^1\left(\frac{92}{100}\right)^4 + \binom{5}{2}\left(\frac{8}{100}\right)^2\left(\frac{92}{100}\right)^3$ $+\binom{5}{3}\left(\frac{8}{100}\right)^3\left(\frac{92}{100}\right)^2 + \binom{5}{4}\left(\frac{8}{100}\right)^4\left(\frac{92}{100}\right)^1$ $+\left(\frac{8}{100}\right)^5$ $= 0{\cdot}34091 \ldots = 0{\cdot}3409$ [4 D.P.]	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • $\left(\frac{92}{100}\right)^a$ where $0 < a < 5$ • First line of either solution *High Partial Credit:* • $\left(\frac{92}{100}\right)^5$ • Three terms in second solution
(a) (iii)	$1 - 0{\cdot}92^k > 0{\cdot}97$ so $0{\cdot}92^k < 0{\cdot}03$ Find where $0{\cdot}92^k = 0{\cdot}03$ i.e. $k(\ln(0{\cdot}92)) = \ln(0{\cdot}03)$ so $k = \frac{\ln(0{\cdot}03)}{\ln(0{\cdot}92)} = 42{\cdot}05 \ldots$ so least $k = 43$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • $0{\cdot}92^k$ • $0{\cdot}03$ *Mid Partial Credit:* • $1 - 0{\cdot}92^k > 0{\cdot}97$ or $= 0{\cdot}97$ • $k(\ln(0{\cdot}92))$ *High Partial Credit:*

		• Equation in k without indices (logs handled correctly)
(b)	**Interpretation 1:** **initial €70 charged regardless** $0{\cdot}8(70) + 0{\cdot}2(70 + 150 + 80)$ $= 0{\cdot}8(70) + 0{\cdot}2(300) = €116$ **Interpretation 2:** **initial €70 not charged if not successful** $0{\cdot}8(70) + 0{\cdot}2(150 + 80)$ $= 0{\cdot}8(70) + 0{\cdot}2(230) = €102$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • A correct calculation, for example, $0{\cdot}8(70)$ or 300 or 230 *High Partial Credit:* • $0{\cdot}8(70)$ and $0{\cdot}2(300)$ **or** $0{\cdot}8(70)$ and $0{\cdot}2(230)$
(c)	Average pay-out per customer: $120\,000(0{\cdot}0001) + 40\,000(0{\cdot}002)$ $= €92$ Target profit per customer: $\frac{900\,000}{18\,000} = €50$ Required premium: $50 + 92 = €142$ **OR** Average pay-out per customer: $120\,000(0{\cdot}0001) + 40\,000(0{\cdot}002)$ $= €92$ Total expected payout: $€92 \times 18\,000 = €1\,656\,000$ Total revenue required: $€1\,656\,000 + €900\,000 = €2\,556\,000$ Required premium: $€2\,556\,000 \div 18\,000 = €142$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • One relevant calculation, for example, $120\,000(0{\cdot}0001)$ or $\frac{900\,000}{18\,000}$ *Mid Partial Credit:* • Finds €92 (average payout per person) *High Partial Credit:* • Finds €2 556 000 (total revenue) • Finds €92 and €50