	4E5N Prelim Math Paper 2 Marking Scheme	
Qn	**Solution**	**Marks**
1i	<table><tr><td>Ball number</td><td>2</td><td>3</td><td>6</td><td>9</td></tr><tr><td>2</td><td>-</td><td>(2, 3)</td><td>(2, 6)</td><td>(2, 9)</td></tr><tr><td>3</td><td>(3, 2)</td><td>-</td><td>(3, 6)</td><td>(3, 9)</td></tr><tr><td>6</td><td>(6, 2)</td><td>(6, 3)</td><td>-</td><td>(6, 9)</td></tr><tr><td>9</td><td>(9, 2)</td><td>(9, 3)</td><td>(9, 6)</td><td>-</td></tr></table>	B2 Deduct 1m if "–" diagonal is included Deduct 1m for any <u>two</u> mistakes in paired-values
1ii(a)	1/6	B1
1ii(b)	1/6	B1
1ii(c)	5/6	B1
1iii	New probability (with replacement) $=\frac{12}{16}$ $=\frac{3}{4}$ $<\frac{5}{6}$ from 2(ii)(c) Therefore, I **do not agree** as the probability **has decreased**	M1 A1 (must show comparison to 5/6)
2a	$\text{Loan amount} = \frac{70}{100}\times 80000$ $= \$56000$ $\text{Interest earned} = 56000\times\frac{2}{100}\times\frac{72}{12}$ $= \$6720$ $\text{Total Amount} = \$80000 + \$6720$ $= \$86720$ OR $\text{Total Amount} = \frac{30}{100}\times 80000 + \left(1+\frac{72}{12}\left(\frac{2}{100}\right)\right)\times 56000$ $= \$86720$	M1 (70% of 80 000) M1 ($\frac{PRT}{100}$ substituted correctly) A1

2b(i)	Total Amount (Bryan)$= \$80000\left(1+\frac{1.8}{100}\right)^{10}$ $= \$95624.189$ $\text{Difference} = \$95264.189 - \$86720$ $= \$8904.19$	M1 (correct application of formula) M1 (total amount) A1
2b(ii)	$\text{James' monthly instalment} = \frac{56000+6720}{72}$ $= \$871.111$ $\text{Bryan's monthly instalment} = \frac{95624.189}{120}$ $= \$796.868$ $< \$871.111 \text{ (James')}$ Bryan's **monthly instalment is less** than James', hence might be preferred. --- Award 1m for "Bryan's method **does not require a deposit**" (must show calculation of monthly instalment to award another mark)	M1 (use their previous two answers to find monthly instalment) A1 (comparison + explanation)
3ai	Mean score = 48 points	B1
3aii	Standard Deviation = 13.1 points (3sf)	B1
3b	The **mean** of Team *A* scores are **higher** than Team *B*'s, hence Team *A* scored more points (better) on **average (or in general)**. The **standard deviation** of Team *A* scores are **smaller** than Team *B*'s hence Team *A*'s scores are **more consistent (or has smaller spread)** than Team *B*'s. Hence, Team *A* performed better.	B1 B1 (Must answer the question)
3c	P(both scores greater than 55 points) $= \frac{5}{15} \times \frac{4}{14}$ $= \frac{2}{21}$	 M1 A1

4ai	$\angle DAB = 180° - 80°$ (**angles in opposite segments**) $= 100°$	B1
4aii	$\angle FEB = 180° - 90° - 45°$ (**radius $\perp$ tangent**) $= 45°$	B1
4aiii	$\angle CAB = \angle FEB$ (**angles in the same segment**) $= 45°$	B1
4bi	$\angle BCE = 90°$ (angles in semi-circle) $\angle CBE = 180° - 90° - 45°$ (angle sum in triangle) $= 45°$ $= \angle BEC$ $\therefore \Delta BEC$ is an isosceles triangle.	M1 (90^o "angles in semi-circle" seen) *No marks for angle $EBC = 45^o$ only A1 (show base angles equal with conclusion)
4bii	$\angle CEB = \angle BEF$ (common) $\angle ECB = \angle EBF$ $= 90°$ $\angle EBC = \angle EFB$ $= 45°$ Since **3 pairs of corresponding angles are equal**, ΔECB is similiar to ΔEBF.	M2 (any 2 pairs of corr. angles shown) A1
5a	x days for 1 house 1 day for $\frac{1}{x}$ house No. of houses in 15 days $= \frac{15}{x}$	B1
5b	$(x + 2)$ days for 1 house 1 day for $\frac{1}{x+2}$ house No. of houses in 15 days $= \frac{15}{x+2}$	B1

5c	$\frac{15}{x}-\frac{15}{x+2}=2$ $15(x+2)-15x=2x(x+2)$ $2x^2+4x-30=0$ $x^2+2x-15=0$	M1 (formulating eqn) M1 (removing denominator) A1 (algebraic manipulation and simplifying)
5d	$(x+5)(x-3)=0$ $x=-5$ or $x=3$ No. of houses $=\frac{15}{3}$ $=5$	M1 (factorizing or using quadratic formula) M1 (show both solutions) A1
6a	$\mathbf{A}=\begin{pmatrix}100 & 80 & 120 & 180\\ 90 & 80 & 70 & 150\end{pmatrix}$	B1
6b	$\mathbf{B}=\begin{pmatrix}300\\280\\230\\200\end{pmatrix}$	B1
6c	$\mathbf{P}=\begin{pmatrix}100 & 80 & 120 & 180\\ 90 & 80 & 70 & 150\end{pmatrix}\begin{pmatrix}300\\280\\230\\200\end{pmatrix}$ $=\begin{pmatrix}30000+22400+27600+36000\\27000+22400+16100+30000\end{pmatrix}$ $=\begin{pmatrix}116000\\95500\end{pmatrix}$	 M1 (soi) A1

6d	$\mathbf{D} = \begin{pmatrix} 100 & 80 & 120 & 180 \\ 90 & 80 & 70 & 150 \end{pmatrix} \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \end{pmatrix}$ $= \begin{pmatrix} 100+80+120+180 \\ 90+80+70+150 \end{pmatrix}$ $= \begin{pmatrix} 480 \\ 390 \end{pmatrix}$ Elements of **D** represent the **total number** of tickets sold for **Saturday and Sunday respectively** for that weekend.	B1 B1
6ei	$\mathbf{E} = \begin{pmatrix} 1 & 1 \end{pmatrix}$	B1
6eii	$\mathbf{ED} = \begin{pmatrix} 1 & 1 \end{pmatrix} \begin{pmatrix} 480 \\ 390 \end{pmatrix}$ $= \begin{pmatrix} 480+390 \end{pmatrix}$ $= \begin{pmatrix} 870 \end{pmatrix}$	B1
6f	$x = 0.95$ $y = 1.25$	B1 B1
7ai	Volume of 6 balls $= 6 \times \frac{4}{3}\pi(3)^3$ $= 678.5840$ $= 679 \text{ cm}^3$	M1 ($\frac{4}{3}\pi(3)^3$ seen) A1
7aii	**<u>Method 1 (Trigonometric formula)</u>** Base area $= \frac{1}{2} \times 22.4 \times 22.4 \times \sin 60°$ $= 217.268$ **<u>Method 2 (Pythagoras' Theorem)</u>** Base area $= \frac{1}{2} \times 22.4 \times \sqrt{22.4^2 - 11.2^2}$ $= 217.268$ Volume of triangular prism $= 217.268 \times 6$ $= 1303.61 \text{ cm}^3$	M1 ($\frac{1}{2}ab\sin C$ seen, correct substitution) **OR** M1 (1/2 base x height seen using Pythogoras) M1 (their base area x height)

	Volume of unoccupied space $= 1303.61 - 678.5840$ $= 625.026$ $= 625 \text{ cm}^3$	A1
7bi	Total surface area of bowl $= 2\pi(10)^2 + 2\pi(12)^2 + [\pi(12)^2 - \pi(10)^2]$ $= 1671.327$ $= 1670 \text{ cm}^2$	M1 ($\pi(12)^2 - \pi(10)^2$ seen) M1($2\pi(10)^2$ and $2\pi(12)^2$ seen) A1
7bii	Volume of bowl $= \frac{2}{3}\pi(12^3) - \frac{2}{3}\pi(10^3)$ $= \frac{1456}{3}\pi \text{ cm}^3$ Volume of each cube $= 2.5^3$ $= 15.625 \text{ cm}^3$ Number of cubes $= \frac{1456}{3}\pi \div 2.5^3$ $= 97.58$ ≈ 97 cubes Maximum number of cubes = 97	M1 (vol. of bowl) M1 (vol. of bowl divide by vol. of cube) A1 (rounded down)
8ai	$x = \frac{y-x}{2y} + 6$ $x = \frac{y-x+12y}{2y}$ or $x - 6 = \frac{y-x}{2y}$ $2xy = y - x + 12y$ or $2xy - 12y = y - x$ $2xy + x = 13y$ $x(2y+1) = 13y$ $x = \frac{13y}{2y+1}$	M1 (remove denominator) M1 (factorise) A1
8aii	Sub $y = 2$, $x = \frac{13(2)}{2(2)+1}$ $= 5.2$ or $5\frac{1}{5}$	B1

8bi	$(a-b)^2 = a^2 - 2ab + b^2$ $8 = a^2 + b^2 - 2(-3)$ $a^2 + b^2 = 2$	B1
8bii	$\left(\frac{a+b}{2}\right)^2 = \frac{a^2+2ab+b^2}{4}$ $= \frac{2+2(-3)}{4}$ $= -1$	B1
8c	$\frac{2x^2-12x+18}{x^2-9} = \frac{2(x-3)(x-3)}{(x+3)(x-3)}$ $= \frac{2(x-3)}{x+3}$ or $\frac{2x-6}{x+3}$	M2 (1m for each complete factorization) A1
8d	$y = 14 - 6x + x^2$ $= (x^2 - 6x + 9) - 9 + 14$ $= (x-3)^2 + 5$ *must use $\left(-\frac{6}{2}\right)^2$ or $(-3)^2$ as part of correct step Therefore coordinates of turning point are **(3, 5)**	M1 ($(x-3)^2$ seen) M1 (+5 seen) Deduct 1m for any incorrect step A1
9a	See attached	B1 (all construction lines shown + accuracy) B1 (labelling of *S* and all lengths accurately)
9b	See attached	B2 (all construction lines must be shown + accuracy)
9c	Bearing = 097.5°	B1 (accept $\pm 1.5°$)
9di	Actual distance = 6.4×10 = 64 m	B1 (accept ± 1)
9dii	**<u>Method 1 (using trigonometry formula)</u>** **Using** $\frac{1}{2}ac\sin C$ **formula.** Measure or use ***BR*** **as** ***a***, ***RS*** **as** ***b***, and **angle** ***BRS*** **as** ***C***.	

	*must relate sides and angle used to formula **can use other sides and angle, as long as angle is included angle **<u>Method 2 (using shortest distance)</u>** Using **area of triangle formula** $\frac{1}{2}\times \text{base}\times \text{height}$ Measure or use **the perpendicular/shortest distance from *B* to *RS* as height**, and ***RS* as the base** (or vice versa). *must relate the sides used to formula **can use other base / height pairing	B2 (correct formula used, with sides and angle clearly stated) B2 (correct formula used, with sides clearly stated) *student must state perpendicular or shortest distance, not just *B* to *RS*
9diii	Actual distance $= 4\times 10$ = 40 m OR Student can calculate area of triangle *RBS* using their measurements (about 1380 m^2). Then letting distance be *h*, equate $\frac{1}{2}\times 70\times h = 1400$ to find *h*. Value of *h* must be within 40 m (± 1 m)	B1 (accept ± 1 m) B1
9div	Let the greatest angle of elevation be θ. $\tan\theta = \frac{80}{40}$ $\theta = \tan^{-1} 2$ $= 63.4°$	M1 (correct trigo ratio formed using their **d(iii)**) A1 *62.9° if 41m; 64.0° if 39m)
10a	$p = 2(2) + \frac{30}{2} - 16$ $= 3$	B1
10b	See attached graph	B1 – **all** points plotted accurately B1 – axes, scale & label

		B1 – smooth curve passing through **all** points
10c	Draw tangent at $x = 6$ $\text{gradient} = \dfrac{2.5-0}{7.4-5.2}$ $= 1.14$	B1 (accurate at (6, 1)) B1 (accept 0.97 to 1.37)
10di	$2.1 < x < 7.2$	B1 (accept ± 0.1 for each end)
10dii	$2x + \dfrac{30}{x} = 18$ $2x + \dfrac{30}{x} - 18 = 0$ $2x + \dfrac{30}{x} - 16 = 2$ Draw $y = 2$ to find intersection points. $x = 2.2$ (± 0.1) or 6.8 (± 0.1)	 M1 (draw $y = 2$) A1
11ai	$\dfrac{92592}{287379} \times 360° = 115.99°$ $= 116.0°$ (1 dp)	M1 A1
11aii	$\text{Percentage of deaths} = \dfrac{2}{432} \times 100\%$ $= 0.463\%$ (3 sf) or $\dfrac{25}{34}\%$	M1 A1
11b	Without Social Distancing, $a = 0.1$ $N_1 = 1$ $N_2 = 1 + 0.1(1) = 1.1$ $N_3 = 1.1 + 0.1(1.1) = (1.1)(1+0.1) = (1.1)^2$ $N_4 = (1.1)^2 + 0.1(1.1)^2 = (1.1)^2(1+0.1) = (1.1)^3$ $\vdots$ $N_{100} = (1.1)^{99} = 12527.8294$ With Social Distancing, $a = 0.09$	 M1 (for N_{100} without social distancing) M1 (formulating the pattern for a=0.09)

	$N_1 = 1$ $N_2 = 1 + 0.09(1) = 1.09$ $N_3 = 1.09 + 0.09(1.09) = (1.09)(1 + 0.09) = (1.09)^2$ $N_4 = (1.09)^2 + 0.09(1.09)^2 = (1.09)^2(1 + 0.09) = (1.09)^3$ $\vdots$ $N_{100} = (1.09)^{99} = 5072.5144$	S.O.I M1 (for N_{100} with social distancing)
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	Percentage Decrease $= \frac{12527.8294 - 5078.5144}{12527.8294} \times 100\%$ $= 59.5\%$ (3 sf) I **agree** with Alex's claim as the percentage decrease is 59.5% which is **more than 55%.**	M1 (% decrease formula using their N_{100} values) M1 (correct % decrease) A1 (with comparison)
	OR Number of new infections $= \frac{1.09^{99}}{1.1^{99}} \times 100\%$ $= 40.5\%$ (3 sf) Percentage Decrease $= 100\% - 40.5\%$ $= 59.5\%$ (3 sf) I **agree** with Alex's claim as the percentage decrease is 59.5% which is **more than 55%.**	M1 (fraction of their N_{100} values seen, **correctly labelled)** M1 (correct % decrease) A1 (with comparison)

