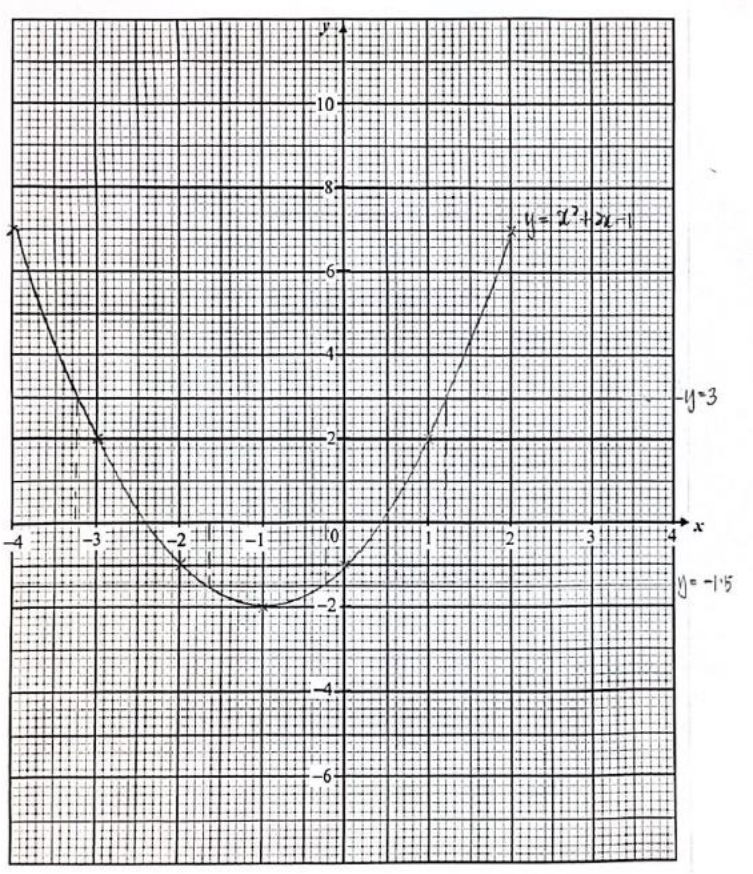
2024 4E/5N EM Prelim Paper 2 Marking Scheme (90 marks)

1a	$\frac{3x+1}{3} < \frac{2-5x}{4}$ $4(3x+1) < 3(2-5x)$ $12x+4 < 6-15x$ $27x < 2$ $x < \frac{2}{27}$	M1 A1
1bi	$a = \frac{2(0.2)-3(-1.5)}{0.2+2(-1.5)}$ $a = -\frac{7}{4} / -1.75$	 B1
1bii	$a = \frac{2b-3c}{b+2c}$ $a(b+2c) = 2b-3c$ $ab+2ac = 2b-3c$ $ab-2b = -3c-2ac$ $b(a-2) = -3c-2ac$ $b = \frac{-3c-2ac}{a-2}$ $b = \frac{3c+2ac}{2-a}$	 M1 M1 Either A1
1c	$\frac{5x}{x-3} - \frac{2}{2x-3} = 1$ $\frac{5x(2x-3)-2(x-3)}{(x-3)(2x-3)} = 1$ $10x^2-15x-2x+6 = 2x^2-3x-6x+9$ $10x^2-17x+6 = 2x^2-9x+9$ $8x^2-8x-3 = 0$ $x = \frac{-(-8) \pm \sqrt{(-8)^2-4(8)(-3)}}{2(8)}$ $x = 1.2906, -0.29057$ $x = 1.291, -0.291\ (3dp)$	 M1 – common denominator M1 – either expansion M1 A1A1

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2a	$y = 7$	B1
2b		7 points – B2 4 points – B1 Curve – B1
2ci	$-3.25 < x < 1.2$	B1
2cii	$x^2 + 2x + \frac{1}{2} = 0$ $x^2 + 2x + \frac{1}{2} - 1.5 = 0 - 1.5$ $x^2 + 2x - 1 = -1.5$ $y = -1.5$ $x = -1.65 \quad or \quad x = -0.25$	M1 A1A1
2ciii	$x^2 + 2x - 1$ $= \left(x + \frac{2}{2}\right)^2 - \left(\frac{2}{2}\right)^2 - 1$ $= (x+1)^2 - 2$ Therefore, the minimum point is $(-1, -2)$	M1 - either x or y value seen A1 – in the form $(x+p)^2 + q$

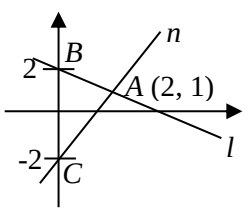
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3a	Vol of hemisphere $= \frac{2}{3} \times \pi \times (3x)^3$ $= 18\pi x^3$ Vol of cone $= \frac{1}{3} \times \pi \times \left(\frac{3}{2}x\right)^2 \times y$ $= \frac{1}{3} \times \pi \times \frac{9}{4}x^2 \times y$ $= \frac{3\pi}{4}x^2 y$ $18\pi x^3 = 3 \times \frac{3\pi}{4}x^2 y$ $18x^3 = \frac{9}{4}x^2 y$ $y = \frac{18x^3 \times 4}{9x^2}$ $y = 8x$ (*shown*)	M1 M1 A1
3b	$l = \sqrt{y^2 + \left(\frac{3}{2}x\right)^2}$ $= \sqrt{(8x)^2 + \left(\frac{3}{2}x\right)^2}$ $= \sqrt{64x^2 + \frac{9}{4}x^2}$ $= \sqrt{\frac{265x^2}{4}}$ $= 8.1394x$ / $\frac{\sqrt{265}}{2}x$ CSA of cone $= \pi\left(\frac{3}{2}x\right) \times l$ $= \pi\left(\frac{3}{2}x\right) \times 8.1394x$ $= 38.356x^2$ CSA of cylinder $= 2\pi \times \left(\frac{3}{2}x\right) \times 3x$ $= 28.274x^2$ CSA of hemisphere $= 2\pi \times (3x)^2$ $= 56.549x^2$ rim area $= \pi(3x)^2 - \pi\left(\frac{3}{2}x\right)^2$ $= 21.206x^2$	M1 4 correct – M3 3 correct – M2 2 correct – M1

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3b	Total SA = 450 $38.356x^2 + 28.274x^2 + 56.549x^2 + 21.206x^2 = 450$ $144.385x^2 = 450$ $x^2 = 3.1167$ $x = 1.7654$ Total ht, $h = y + 3x + 3x$ $h = 8x + 3x + 3x$ $h = 14x$ $h = 14(1.7654)$ $h = 24.7156$ $h = 24.7$ $(3sf)$	M1 M1 A1
4a	$\frac{1}{25}$	B1
4b	$T_n = \frac{16-3n}{5n}$	M1 - $-3n$ M1 – $5n$ A1 - T_n
4c	$T_{n+1} - T_n = \frac{16-3(n+1)}{5(n+1)} - \frac{16-3n}{5n}$ $= \frac{16-3n-3}{5(n+1)} - \frac{16-3n}{5n}$ $= \frac{n(13-3n)-(16-3n)(n+1)}{5n(n+1)}$ $= \frac{13n-3n^2-(16n+16-3n^2-3n)}{5n(n+1)}$ $= \frac{13n-3n^2-16n-16+3n^2+3n}{5n(n+1)}$ $= \frac{-16}{5n(n+1)}$ $(shown)$	M1 M1 A1
4d	For $n > 0$ $5n(n+1) > 0$ $\frac{-16}{5n(n+1)} < 0$ $T_{n+1} - T_n < 0$	B1

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5a	grad of line l $= \dfrac{-2-4}{8-(-4)}$ $= -\dfrac{1}{2}$ $y = -\dfrac{1}{2}x + c$ *subst* $(-4, 4)$ into $y = -\dfrac{1}{2}x + c$ $4 = -\dfrac{1}{2}(-4) + c$ $c = 2$ $y = -\dfrac{1}{2}x + 2$	M1 A1
5b	Line m $6y = 18 - 3x$ $y = -\dfrac{1}{2}x + 3$ The gradient of line l and line m are equal (gradient = $-\dfrac{1}{2}$) and the y-intercept not equal. Line l and line m are parallel. Therefore, line m does not intersect the line l.	M1 – gradient value A1 – parallel
5c	$y = -\dfrac{1}{2}x + 2$ -------(1) $\quad 2y = 3x - 4$ --------(2) *Subst* (1) *into* (2) $2\left(-\dfrac{1}{2}x + 2\right) = 3x - 4$ $-x + 4 = 3x - 4$ $4x = 8$ $x = 2$ *Subst* $x = 2$ *into* (1) $y = -\dfrac{1}{2}x + 2$ $y = -\dfrac{1}{2}(2) + 2$ $y = 1$ $A(2,1)$	M1 M1 – either x or y coordinate A1
5d	*Area of* ΔABC $= \dfrac{1}{2} \times 4 \times 2$ $= 4\ units^2$  	M1 – BC = 4 units M1 – height of 2 units A1

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6a	$\angle OPV = \angle ORV = 90^\circ$ (tan ⊥ rad) $\angle POR = 360 - 90 - 90 - 40$ (sum of quad) $= 140$ *reflex* $\angle POR = 360 - 140$ ($\angle$ at a pt.) $= 220$ $\angle PQR = \frac{220}{2}$ ($\angle$ at ctr = 2× $\angle$ at circum) $= 110$	M1 M1 A1
6b	$\angle OPR = \frac{180 - 140}{2}$ (sum of isos Δ) $= 20$ $\angle SPR = \angle STR$ ($\angle$ in same seg) $= 43$ $\angle OPU = 43 - 20$ $= 23$ $\angle POU = 180 - 140$ ($\angle$ on str. line) $= 40$ $\angle TUP = \angle OPU + \angle POU$ (ext. $\angle$ of Δ) $= 23 + 40$ $= 63^\circ$	M1 M1 A1
6c	$\angle SOR = 2 \times \angle STR$ ($\angle$ at ctr = 2× $\angle$ at circum) $= 2 \times 43$ $= 86$ reflex $\angle SOR = 360 - 86$ $= 274$ area of minor sector $= \frac{86}{274} \times$ area of major sector $= 0.31387 \times$ area of major sector No because the area of the minor sector is 0.314 of the area of major sector, which is less than $\frac{1}{3}$ (0.333)	M1 M1 A1

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7ai	$\begin{pmatrix} 8 \\ -4 \end{pmatrix} + \begin{pmatrix} u \\ v \end{pmatrix} = \begin{pmatrix} 6 \\ 4 \end{pmatrix}$ $\begin{pmatrix} u \\ v \end{pmatrix} = \begin{pmatrix} 6 \\ 4 \end{pmatrix} - \begin{pmatrix} 8 \\ -4 \end{pmatrix}$ $= \begin{pmatrix} -2 \\ 8 \end{pmatrix}$	B1
7aii	$\overrightarrow{XY} = \begin{pmatrix} -2 \\ 8 \end{pmatrix}$ $\left\|\overrightarrow{XY}\right\| = \sqrt{(-2)^2 + (8)^2}$ $= 8.2462$ $= 8.25 \text{ units}^2$	M1 A1
7aiii	Grad of ZY = Grad of XY $\frac{k-4}{-1-6} = \frac{8}{-2}$ $\frac{k-4}{-7} = -4$ $k = 32$ $\overrightarrow{OZ} = \begin{pmatrix} -1 \\ 32 \end{pmatrix}$	M1 A1
7bi	ΔABD, $\overrightarrow{AB} + \overrightarrow{BD} = \overrightarrow{AD}$ $\overrightarrow{BD} = 8\mathbf{b} - 4\mathbf{a}$ 4 *units*, $\overrightarrow{BD} - 8\mathbf{b} - 4\mathbf{a}$ 3 *units*, $\overrightarrow{BE} - \frac{3}{4}(8\mathbf{b} - 4\mathbf{a})$ $= 6\mathbf{b} - 3\mathbf{a}$	M1 A1
7bii	ΔBEF, $\overrightarrow{BE} + \overrightarrow{EF} = \overrightarrow{BF}$ $\overrightarrow{BF} = 6\mathbf{b} - 3\mathbf{a} + 2\mathbf{a} - 2\mathbf{b}$ $= 4\mathbf{b} - \mathbf{a}$ $\overrightarrow{BC} = 2 \times \overrightarrow{BF}$ $= 8\mathbf{b} - 2\mathbf{a}$	M1 A1
7biii	ΔBCD, $\overrightarrow{BD} + \overrightarrow{DC} = \overrightarrow{BC}$ $\overrightarrow{DC} = \overrightarrow{BC} - \overrightarrow{BD}$ $= 8\mathbf{b} - 2\mathbf{a} - (8\mathbf{b} - 4\mathbf{a})$ $= 2\mathbf{a}$ $\overrightarrow{AB} = 2(2\mathbf{a})$ $\overrightarrow{AB} = 2\overrightarrow{DC}$ *ABCD* is a trapezium because $\overrightarrow{AB} = 2\overrightarrow{DC}$, *AB* is parallel to *DC* 1 pair of opposite side parallel.	M1 M1 - $\overrightarrow{AB} = 2\overrightarrow{DC}$, *AB* is parallel to *DC* A1 – awarded for 'trapezium' only if M1 awarded

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8ai	$\frac{50}{100}\times 80 = 40$ Median = \$550	 B1
8aii	$\frac{25}{100}\times 80 = 20 \Longrightarrow LQ = \$420$ $\frac{75}{100}\times 80 = 60 \Longrightarrow UQ = \$680$ $IQR = 680 - 420$ $= \$260$	 M1 A1
8b	No of workers $(\leq \$540) = 38$ No of workers $(> \$540) = 80 - 38$ $= 42$ % of workers $(> \$540) = \frac{42}{80}\times 100\%$ $= 52.5\%$	 M1 A1
8c	No of workers $(\leq \$460) = 26$ No of workers $(\leq \$800) = 73$ No of workers btw \$460 and \$800 $= 73 - 26$ $= 47$	M1 - either A1
8d	Let the additional no of workers be x. No of workers now $(\leq \$650) = 56$ $\frac{56+x}{80+x} = \frac{11}{15}$ $840 + 15x = 880 + 11x$ $4x = 40$ $x = 10$	 M1 M1 A1
9a	Total amt $= 90 + 3\times 150$ $= \$540$	 B1
9b	Size of hall required $= (300\times 15)\times 1.65$ $= 7425\ \text{m}^2$ Hall C and Hall E (total area = 7600 m^2) daily rental $= \$8000 + \$5400$ $= \$13400$	M1 A1

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9c	Cost for 1. hall rental = $\$13400 \times 4$ $= \$53600$ 2. long tables $= 300 \times \$2 \times 4$ $= \$2400$ 3. square tables $= \frac{600}{100} \times \$30 \times 4$ $= \$720$ 4. round tables $= \frac{75}{5} \times \$20 \times 4$ $= \$1200$ 5. chairs $= \frac{1500}{50} \times \$10 \times 4$ no of chairs needed = $300 \times 4 + 300$ $= \$1200$ $= 1500$ 6. security guard = $2 \times \$10 \times 12 \times 3$ $= \$720$ 7. part-timers $= 4 \times \$8 \times 12 \times 3$ $= \$1152$ Total cost $= 53600 + 2400 + 720 + 1200 + 1200 + 720 + 1152$ $= \$60992$ Total amt collected for 3 days $= 300 \times \$540$ $= \$162000$ Total entrance fee collected $= 35000 \times 6$ $= 210000$ Profit $= 162000 + 210000 - 60992$ $= \$311008$ The profit of \$311008 is more than the minimum target of \$300000. ∴ The event organiser is correct.	5 items – M3 4 items – M2 2 items – M1 M1 – either item 6 or 7 M1 M1 A1- comparison made

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