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NATIONAL SENIOR CERTIFICATE EXAMINATION
MAY 2023

MATHEMATICS: PAPER II

MARKING GUIDELINES

Time: 3 hours | 150 marks

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NOTE:

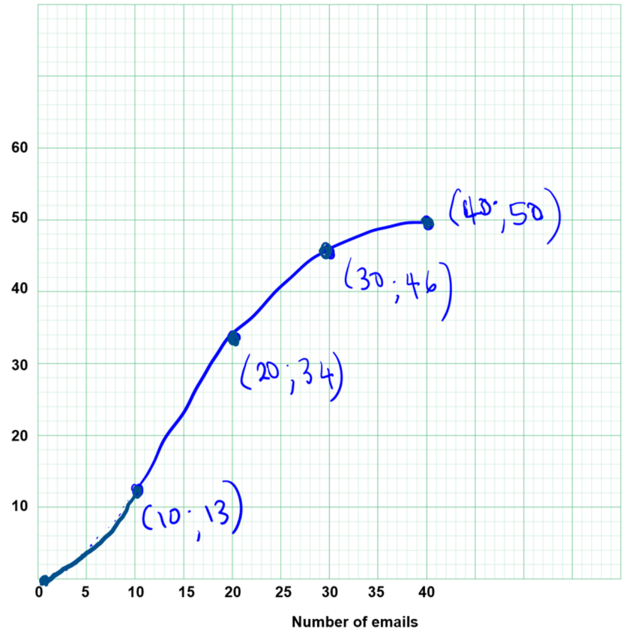
- If a candidate answers a question more than once, only mark the FIRST attempt.
- Consistent Accuracy applies in all aspects of the marking memorandum.

SECTION A

QUESTION 1

(a)	$A = 14{,}533$ $B = 0{,}863$ $y = 14{,}533 + 0{,}863x$	$A = 14{,}533$ $B = 0{,}863$ $y = 14{,}533 + 0{,}863x$
(b)(1)	$r = 0{,}979\ldots$ $r \approx 1$	$r \approx 1$
(b)(2)	There is a very strong positive correlation.	strong positive correlation
(c)	$y = 14{,}533 + 0{,}863(70)$ $y = 74{,}9$ **Alternate:** Using calculator: $y = 74{,}9$	$y = 14{,}533 + 0{,}863(70)$ $y = 74{,}9$
(d)	Interpolation usually results in a fairly reliable prediction. **Alternate:** $r \approx 1$, hence strong correlation and reliable prediction. **Alternate:** 70 is not an outlier, hence a reliable prediction.	fairly reliable interpolation

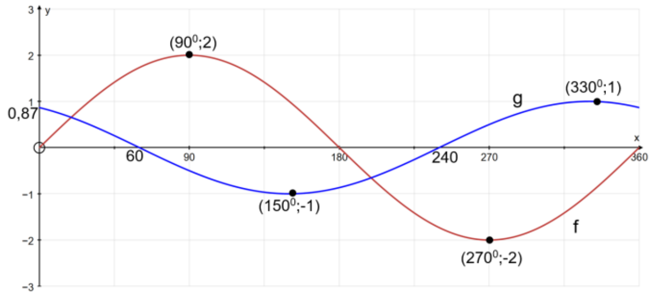
QUESTION 2

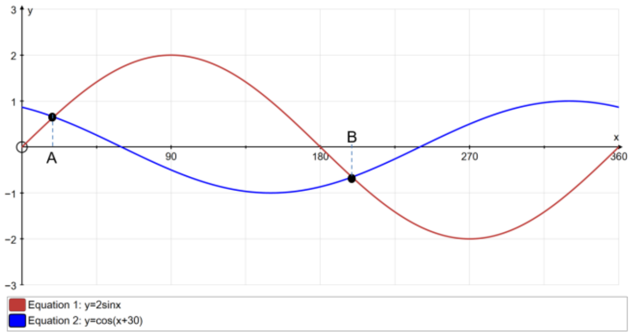
(a)	$\bar{x} = \dfrac{(5\times13)+(15\times21)+(25\times12)+(35\times4)}{50}$ $\bar{x} = 16,4$	$(5\times13)+(15\times21)+$ $(25\times12)+(35\times4)$ 50 $\bar{x} = 16,4$
(b)		Shape Interval endpoints as x-coordinates Cumulative frequency as y-coordinates Co-ordinate endpoint Co-ordinate endpoint
(c)	Median lies in the interval $10 < x \leq 20$ so calculated as 15 (or read off the ogive curve). Mean is calculated as 16,4 in (a). Since mean > median, the data is positively skewed.	median: 15 Mean>median Positively skewed.

QUESTION 3

(a)	$\sin[(85°+\theta)-(25°+\theta)]$ $\sin(60°)$ $=\dfrac{\sqrt{3}}{2}$	$\sin[(85°+\theta)-(25°+\theta)]$ $=\dfrac{\sqrt{3}}{2}$
(b)	$-\tan(\theta).\cos(\theta)+\dfrac{2\sin\theta.\cos\theta}{2\cos(\theta)}$ $-\dfrac{\sin\theta}{\cos\theta}.\cos\theta+\dfrac{2\sin\theta.\cos\theta}{2\cos\theta}$ $-\sin\theta+\sin\theta$ $=0$	$-\tan\theta$ $\cos\theta$ $2\sin\theta.\cos\theta$ $2\cos\theta$ $-\sin\theta+\sin\theta$ $=0$
(c)(1)	$y^2=1^2-p^2$ $=\sqrt{1-p^2}$	$y^2=1^2-p^2$ $=\sqrt{1-p^2}$
(c)(2)	$=2\cos^2 x-1$ $=2p^2-1$	$=2\cos^2 x-1$ $=2p^2-1$
(d)	$\dfrac{\sin(x-30°)}{\cos(x-30°)}=\dfrac{1}{2}$ $\tan(x-30°)=\dfrac{1}{2}$ $x-30°\approx 26{,}6°+k180°;\quad k\in Z$ $x\approx 56{,}6°+k180°\quad ;\quad k\in Z$	$\tan(x-30°)=\dfrac{1}{2}$ Ref angle: 26,6º $x\approx 56{,}6°+k180°;\ k\in Z$

QUESTION 4

<table>
<tr><td>(a)</td><td>
</td><td>x-intercepts
TP
endpoints

x-intercepts
TP
endpoints</td></tr>
<tr><td>(b)</td><td>$g(x) = \cos x.\cos 30° - \sin x.\sin 30°$
$g(x) = \frac{\sqrt{3}}{2}\cos x - \frac{1}{2}\sin x$
$g(x) = \frac{1}{2}\left(\sqrt{3}\cos x - \sin x\right)$</td><td>$\cos x.\cos 30° - \sin x.\sin 30°$
$\frac{\sqrt{3}}{2}\cos x - \frac{1}{2}\sin x$</td></tr>
<tr><td>(c)</td><td>At the points A and B

</td><td>Indicating points of intersection
Showing the point on the x-axis.</td></tr>
</table>

QUESTION 5

(a)	$\hat{A}_1 = A\hat{D}O$ (Radii/$\angle$s opp. = sides) $\therefore \hat{A}_1 = \frac{180° - 40°}{2}$ (int. $\angle$s of Δ) $\therefore \hat{A}_1 = 70°$	$\hat{A}_1 = A\hat{D}O$ (Radii/$\angle$s opp. = sides) $\therefore \hat{A}_1 = 70°$ (int. $\angle$s of Δ)
(b)	$\hat{E} = 110°$ (Opp. $\angle$s of cyclic quad.) **Alternate** $\hat{O}_2 = 180° - 40°$ (Adj. $\angle$s on str line) $\hat{O}_2 = 140°$ $\therefore \hat{C}_2 = 70°$ ($\angle$ at centre $= 2 \times \angle$ at circumf.) $\hat{E} = 110°$ (Opp. $\angle$s of cyclic quad.) **Alternate:** Reflex. $D\hat{O}B = (\hat{O}_1 + 180°)$ (adj. $\angle$ on str. line) Reflex. $D\hat{O}B = 220°$ $\hat{E} = 110°$ ($\angle$ at centre $= 2 \times \angle$ at circumf.)	$\hat{E} = 110°$ (Opp. $\angle$s of cyclic quad.) $\hat{O}_2 = 140°$ $\therefore \hat{C}_2 = 70°$ ($\angle$ at centre $= 2 \times \angle$ at circumf.) $\hat{E} = 110°$ (Opp. $\angle$s of cyclic quad.) Reflex. $D\hat{O}B = 220°$ $\hat{E} = 110°$ ($\angle$ at centre $= 2 \times \angle$ at circumf.)
(c)	$\hat{C}_1 = 20°$ ($\angle$ at centre $= 2 \times \angle$ at circumf.) **Alternate:** $\hat{C}_1 + \hat{C}_2 = 90°$ ($\angle$ in semi-circle) and $\therefore \hat{C}_2 = 70°$ (proven) $\therefore \hat{C}_1 = 20°$	$\hat{C}_1 = 20°$ ($\angle$ at centre $= 2 \times \angle$ at circumf.)
(d)	$\hat{B}_1 = 40°$ (corresp $\angle$s DO//EB)	$\hat{B}_1 = 40°$ (corresp $\angle$s DO//EB)

(e)	$AF = FE$ (line from midpoint // to one side) $DO \perp AE$ (line from centre to midpoint of chord) In ΔAOF: $\sin 40° = \frac{AF}{4\frac{1}{2}}$ $AF \approx 2{,}9$ units $\therefore FE \approx 2{,}9$ units $\therefore AE \approx 5{,}8$ units **Alternate:** In In ΔABE: $\hat{E} = 90°$ ($\angle$ in semi-circle) Hence: $\sin 40° = \frac{AE}{9}$ $\therefore AE \approx 5{,}8$ units	$AF = FE$ (line from midpoint // to one side) $DO \perp AE$ (line from centre to midpoint of chord) In ΔAOF: $\sin 40° = \frac{AF}{4\frac{1}{2}}$ $AF \approx 2{,}9$ units $\therefore FE \approx 2{,}9$ units $\therefore AE \approx 5{,}8$ units

QUESTION 6

(a)	$\hat{A} = x$ (tan/chord theorem)	$\hat{A} = x$ (tan/chord theorem)
(b)	In ΔCBD and ΔACD: $\hat{B}_2 = 90°$ (adj. $\angle$s on str line) $A\hat{C}D = 90°$ (tan $\perp$ rad) $\hat{C}_2 = \hat{A}$ (tan/chord theorem) $\hat{D}$ is common $\therefore \Delta CBD \mathbin{///} \Delta ACD$ ($\angle\angle\angle$)	$\hat{C}_2 = \hat{A}$ (tan/chord theorem) $\hat{D}$ is common $\therefore \Delta CBD \mathbin{///} \Delta ACD$ ($\angle\angle\angle$)
(c)	$\frac{CD}{BD} = \frac{AD}{CD}$ (/// Δs - side in prop) $CD^2 = 9 \times 4$ $\therefore CD = 6$ units	$\frac{CD}{BD} = \frac{AD}{CD}$ (/// Δs - side in prop) $CD^2 = 9 \times 4$ $\therefore CD = 6$

QUESTION 7

(a)	$\hat{B} = 90^\circ$ ($\angle$ in semi $\odot$) $\hat{C}_1 = 45^\circ$ (given) $\therefore \hat{A}_1 = 180^\circ - (90^\circ + 45^\circ)$ (int. $\angle$s of Δ) $\therefore \hat{A}_1 = 45^\circ$ (isosceles Δ / sides opp $= \angle$s)	$\hat{B} = 90^\circ$ ($\angle$ in semi $\odot$) $\therefore \hat{A}_1 = 180^\circ - (90^\circ + 45^\circ)$ (int. $\angle$s of Δ) $\therefore \hat{A}_1 = 45^\circ$ (isos Δ / sides opp $= \angle$s)
(b)	$\hat{B}_2 = 90^\circ - 67{,}5^\circ$ ($\angle$ in semi $\odot$) $\hat{B}_2 = 22{,}5^\circ$ $\therefore \hat{A}_2 = 22{,}5^\circ$ ($\angle$ in same seg) $\hat{A}_1 = 45^\circ$ (shown) $\therefore \hat{A}_1 = 2 \times \hat{A}_2$	$\hat{B}_2 = 90^\circ - 67{,}5^\circ$ ($\angle$ in semi $\odot$) $\therefore \hat{A}_2 = 22{,}5^\circ$ ($\angle$ in same seg) $\hat{A}_1 = 45^\circ$ (shown)

SECTION B

QUESTION 8

(a)	**Construction:** Join AO and BO In ΔAOC and ΔBOC OC is a common side $AO = BO$ (radii) $\hat{C}_1 = \hat{C}_2 = 90°$ (given) $\therefore \Delta AOC \equiv \Delta BOC$ (R;H;S) Hence $AC = CB$	Join AO and BO OC is a common side $AO = BO$ (radii) $\hat{C}_1 = \hat{C}_2 = 90°$ (given) $\therefore \Delta AOC \equiv \Delta BOC$ (R;H;S)
(b)	Let: line perp to AB meet AB at M $\therefore$ CM goes through the centre $BM = MA = 4$ units (line from centre perp to chord) In ΔAOM: Let $OM = x$ $\therefore$ radius $CO = 8 - x$ $\therefore (8 - x)^2 = x^2 + 4^2$ (pythag) $16x = 48$ $x = 3$ $\therefore$ radius is 5 units **Alternate:** Let the radius be r In ΔAOM: $OM = 8 - r$ $\therefore r^2 = (8 - r)^2 + 4^2$ $\therefore 16r = 80$ Hence $r = 5$	$BM = MA = 4$ units (line from centre perp to chord) $\therefore$ radius $CO = 8 - x$ $\therefore (8 - x)^2 = x^2 + 4^2$ (pythag) $x = 3$ $\therefore$ radius is 5 units

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QUESTION 9

(a)	In ΔACG: $\frac{\text{AE}}{\text{EC}} = \frac{\text{AF}}{\text{FG}}$ (line $\parallel$ one side of Δ) $\frac{3p}{2p} = \frac{2k}{\text{FG}}$ $\therefore \text{FG} = \frac{4}{3}k$ In ΔBFD: $\frac{\text{BG}}{\text{GF}} = \frac{\text{BC}}{\text{CD}}$ (line $\parallel$ one side of Δ) $\frac{\frac{11}{3}k}{\frac{4}{3}k} = \frac{\text{BC}}{\text{CD}}$ $\frac{\text{BC}}{\text{CD}} = \frac{11}{4}$	$\frac{\text{AE}}{\text{EC}} = \frac{\text{AF}}{\text{FG}}$ (line $\parallel$ one side of Δ) $\therefore \text{FG} = \frac{4}{3}k$ $\frac{\frac{11}{3}k}{\frac{4}{3}k} = \frac{\text{BC}}{\text{CD}}$ (line $\parallel$ one side of Δ) $\frac{\text{BC}}{\text{CD}} = \frac{11}{4}$

QUESTION 10

(a)(1)	$\frac{\sin\theta.\cos 2\theta}{2\sin\theta\cos\theta} \div \left(\frac{\sin\theta}{\cos\theta} - \frac{\cos\theta}{\sin\theta}\right)$ $= \frac{\sin\theta.\cos 2\theta}{2\sin\theta\cos\theta} \div \left(\frac{\sin^2\theta - \cos^2\theta}{\sin\theta\cos\theta}\right)$ $= \frac{\sin\theta.\cos 2\theta}{2\sin\theta\cos\theta} \times \left(\frac{\sin\theta\cos\theta}{-\cos 2\theta}\right)$ a $f(\theta) = -\frac{1}{2}\sin\theta$	$2\sin\theta\cos\theta$ $\frac{\sin\theta}{\cos\theta}$ $\left(\frac{\sin^2\theta - \cos^2\theta}{\sin\theta\cos\theta}\right)$ for LCD $-\cos 2\theta$ $= -\frac{1}{2}\sin\theta$
(a)(2)	Values of $\theta \in [0°;360°]$ for which the identity is not valid: $\tan\theta$ is undefined for: $\{90°;270°\}$ $\sin 2\theta = 0$ undefined for: $\{0°;180°;360°\}$ $\tan\theta - \frac{1}{\tan\theta} = 0$ undefined for: $\{45°;135°;225°;315°\}$	$\{90°;270°\}$ $\sin 2\theta = 0$ $\{0°;180°;360°\}$ $\tan\theta - \frac{1}{\tan\theta} = 0$ $\{45°;135°;225°;315°\}$
(b)	$A\hat{D}C = 180° - (\alpha + \beta)$ (int. $\angle$s of Δ) $\frac{AC}{\sin A\hat{D}C} = \frac{AD}{\sin\beta}$ **(sine rule)** $\frac{120}{\sin[180° - (\alpha+\beta)]} = \frac{AD}{\sin\beta}$ $\therefore AD = \frac{120\sin\beta}{\sin(\alpha+\beta)}$ In ΔABD: $\tan\theta = \frac{BD}{AD}$ $BD = AD\tan\theta$ $\therefore BD = \frac{120\sin\beta.\tan\theta}{\sin\alpha.\cos\beta + \cos\alpha.\sin\beta}$	$A\hat{D}C = 180° - (\alpha + \beta)$ $\frac{120}{\sin[180° - (\alpha+\beta)]} = \frac{AD}{\sin\beta}$ $\therefore AD = \frac{120\sin\beta}{\sin(\alpha+\beta)}$ In ΔABD: $\tan\theta = \frac{BD}{AD}$ $BD = AD\tan\theta$

QUESTION 11

(a)	$(x+4)^2+(y-5)^2=r^2$ $F\left(\frac{-4-2}{2};\frac{5-1}{2}\right)$ $\therefore F(-3;2)$ sub. in eq of $\odot$ $(-3+4)^2+(2-5)^2=r^2$ $r^2=10$ Eq.: $(x+4)^2+(y-5)^2=10$	$(x+4)^2+(y-5)^2=r^2$ $F\left(\frac{-4-2}{2};\frac{5-1}{2}\right)$ $(-3+4)^2+(2-5)^2=r^2$ $r^2=10$ $(x+4)^2+(y-5)^2=10$
(b)	$m_{AB}=-\frac{1}{2}$ $m_{BC}=2$ Eq. BC: $y=2x+c$ sub. $(-10;3)$ $\therefore c=23$ Eq. BC: $y=2x+23$ $m_{AC}=-3$ Eq. AC: $y=-3x+c$ sub. $(-2;-1)$ $\therefore c=-7$ Eq. AC: $y=-3x-7$ For C: $-3x-7=2x+23$ $x=-6$ $\therefore y=11$ $C(-6;11)$	$m_{AB}=-\frac{1}{2}$ $m_{BC}=2$ $\therefore c=23$ $m_{AC}=-3$ $\therefore c=-7$ For C: $-3x-7=2x+23$ $x=-6$ $\therefore y=11$ $C(-6;11)$
(c)	In $\triangle$CDE: DE $\perp$ CE (tan $\perp$ rad) $DE=\sqrt{10}$ $CD=\sqrt{(-4+6)^2+(5-11)^2}$ $CD=2\sqrt{10}$ $CE^2=(2\sqrt{10})^2-(\sqrt{10})^2$ (pythag) $CE=\sqrt{30}$	DE $\perp$ CE (tan $\perp$ rad) $CD=2\sqrt{10}$ $CE^2=(2\sqrt{10})^2-(\sqrt{10})^2$ $CE=\sqrt{30}$

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QUESTION 12

(a)	$(x-7)^2+(y-1)^2=-46+49+1$ $(x-7)^2+(y-1)^2=4$ Centre: $(7;1)$ Radius: 2 units	$(x-7)^2+(y-1)^2=$ $-46+49+1$ Centre: $(7;1)$ Radius: 2 units
(b)	$m_{PA}=-\sqrt{3}$ $\therefore m_{\tan}=\frac{1}{\sqrt{3}}$ $y=\frac{1}{\sqrt{3}}x+c$ sub $(6;\sqrt{3}+1)$ $c=1-\sqrt{3}$ $y=\frac{1}{\sqrt{3}}x+1-\sqrt{3}$	$m_{PA}=-\sqrt{3}$ $\therefore m_{\tan}=\frac{1}{\sqrt{3}}$ $c=1-\sqrt{3}$ $y=\frac{1}{\sqrt{3}}x+1-\sqrt{3}$
(c)(1)	$(x-7)^2+(y-1)^2=4$ $\text{LHS}=(x-7)^2+(y-1)^2$ sub $(8;-\sqrt{3}+1)$ $\text{LHS}=(8-7)^2+(-\sqrt{3}+1-1)^2$ $\text{LHS}=4$ $\text{LHS}=\text{RHS}$ $\therefore$ point lies on the circle	$\text{LHS}=(x-7)^2+(y-1)^2$ sub $(8;-\sqrt{3}+1)$ $\text{LHS}=(8-7)^2+(-\sqrt{3}+1-1)^2$ $\text{LHS}=4$ $\text{LHS}=\text{RHS}$ $\therefore$ point lies on the circle
(c)(2)	Dist AB $=\sqrt{(8-6)^2+(-\sqrt{3}+1-\sqrt{3}-1)^2}$ Dist AB $=4$ This is twice the radius, therefore AB is a diameter.	Dist AB $=$ $\sqrt{(8-6)^2+(-\sqrt{3}+1-\sqrt{3}-1)^2}$ Dist AB $=4$ This is twice the radius, therefore AB is a diameter.

QUESTION 13

(a)	$\Delta BEM \equiv \Delta CEM$ (R;H;S) $\therefore BM = MC = 4$ cm $\tan \hat{E}_1 = \frac{4}{6}$ $\hat{E}_1 = 33,7°$ $\therefore B\hat{E}C = 67,4°$ Snow will build up on the roof. **Alternate:** In ΔBCE: $BE^2 = 4^2 + 6^2$ (pythag) $BE = 2\sqrt{13}$ Cosine Rule: $\hat{A} = \cos^{-1}\left(\frac{8^2 - \left(2\sqrt{13}\right)^2 - \left(2\sqrt{13}\right)^2}{-2\left(2\sqrt{13}\right)\left(2\sqrt{13}\right)}\right)$ $\hat{A} = 67,4°$	$\tan \hat{E}_1 = \frac{4}{6}$ $\hat{E}_1 = 33,7°$ $\therefore B\hat{E}C = 67,4°$
(b)	$DM^2 = 12^2 + 4^2$ (pythag) $DM = 4\sqrt{10}$ In ΔEDM: $DE^2 = 6^2 + \left(4\sqrt{10}\right)^2$ $DE = 14$ cm $\sin D\hat{E}C = \frac{12}{14}$ $D\hat{E}C = 59°$ **Alternate:** In ΔMEC: $CE^2 = 4^2 + 6^2$ (pythag) $CE = 2\sqrt{13}$ DC = 12 cm $DE^2 = 12^2 + \left(2\sqrt{13}\right)^2$ $DE = 14$ cm $\sin D\hat{E}C = \frac{12}{14}$ $D\hat{E}C = 59°$	$DM = 4\sqrt{10}$ ΔEDM: $DE^2 = 6^2 + \left(4\sqrt{10}\right)^2$ $DE = 14$ cm $\sin D\hat{E}C = \frac{12}{14}$ $D\hat{E}C = 59°$

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QUESTION 14

(a)	$B(x;-2x)$ $\text{Dist OB} = \sqrt{(x-0)^2+(-2x-0)^2}$ $\sqrt{(x-0)^2+(-2x-0)^2} = \sqrt{125}$ $5x^2 = 125$ $x = \pm 5$ $B(-5;y)$ sub $x=-5$ in $f(x)$ $\therefore B(-5;10)$	$B(x;-2x)$ $\sqrt{(x-0)^2+(-2x-0)^2} = \sqrt{125}$ $x = \pm 5$ $\therefore B(-5;10)$
(b)	$m_{OB} = -2$ $\therefore m_{BE} = \frac{1}{2}$ Eq BE: $y = \frac{1}{2}x + c$ sub $(-5;10)$ $c = \frac{25}{2}$ $\therefore E\left(0;12\frac{1}{2}\right)$ $m_{EC} = -2$ (// lines) Eq EC: $y = -2x + \frac{25}{2}$ For C: $-2x + \frac{25}{2} = 2x$ $x = \frac{25}{8}$ $\therefore y = \frac{25}{4}$ $C\left(\frac{25}{8};\frac{25}{4}\right)$ $\text{Dist EC} = \sqrt{\left(\frac{25}{8}-0\right)^2+\left(\frac{25}{4}-\frac{25}{2}\right)^2}$ $\text{Dist EC} = \frac{25\sqrt{5}}{8}$ $\text{Dist BE} = \sqrt{(-5-0)^2+\left(10-\frac{25}{2}\right)^2}$ $\text{Dist BE} = \frac{5\sqrt{5}}{2}$	$m_{OB} = -2$ $\therefore m_{BE} = \frac{1}{2}$ $c = \frac{25}{2}$ $x = \frac{25}{8}$ $\therefore y = \frac{25}{4}$ $\text{Dist EC} = \frac{25\sqrt{5}}{8}$ $\text{Dist BE} = \frac{5\sqrt{5}}{2}$ $= \frac{1}{2} \times \left(\sqrt{125} + \frac{25\sqrt{5}}{8}\right) \times \frac{5\sqrt{5}}{2}$ $\approx 50{,}8 \text{ units}^2$

	Area of Trap $= \frac{1}{2} \times \left(\sqrt{125} + \frac{25\sqrt{5}}{8} \right) \times \frac{5\sqrt{5}}{2}$ Area of Trap $= \frac{1625}{32}$ $\approx 50,8$ units^2 **Alternate:** In ΔBOE: $m_{OB} = -2$ $\therefore \tan\theta = 2 \quad \therefore \theta = 63,4°$ $\therefore B\hat{O}E = 90° - 63,4°$ $\therefore B\hat{O}E = 26,6°$ Eq BE: $y = \frac{1}{2}x + c$ sub $(-5;10)$ $c = \frac{25}{2}$ $\therefore E\left(0;12\frac{1}{2}\right)$ $\therefore EO = 12\frac{1}{2}$ units and $OB = \sqrt{125}$ Area $\Delta BOE = \frac{1}{2}\left(12\frac{1}{2}\right)\left(\sqrt{125}\right)\sin 26,6°$ Area $\Delta BOE = 31,2881$ units^2 In ΔEOC: $C\hat{E}O = 26,6°$ (alt. $\angle$s, BO//EC) $m_{EC} = -2$ (// lines) Eq EC: $y = -2x + \frac{25}{2}$ For C: $-2x + \frac{25}{2} = 2x$ $x = \frac{25}{8}$ $\therefore y = \frac{25}{4}$ $C\left(\frac{25}{8};\frac{25}{4}\right)$	

	$\text{Dist EC} = \sqrt{\left(\frac{25}{8} - 0\right)^2 + \left(\frac{25}{4} - \frac{25}{2}\right)^2}$ $\text{Dist EC} = \frac{25\sqrt{5}}{8}$ $\text{Area } \Delta\text{EOC} = \frac{1}{2}\left(12\frac{1}{2}\right)\left(\frac{25\sqrt{5}}{8}\right)\sin 26{,}6^\circ$ $\text{Area } \Delta\text{EOC} = 19{,}555$ $\text{Area of Trap } = 31{,}2881 + 19{,}555$ $\approx 50{,}8 \text{ units}^2$	

Total: 150 mark

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