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Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE/ NATIONAL SENIOR CERTIFICATE

GRADE 12

MATHEMATICS P2

NOVEMBER 2020

MARKS: 150

TIME: 3 hours

PROPOSED MEMORANDUM

PREPARED BY: SAMUEL K.



EMATHP2

[Signature]
17/11/2020.

This question paper consists of 14 pages, 1 information sheet
and an answer book of 24 pages.

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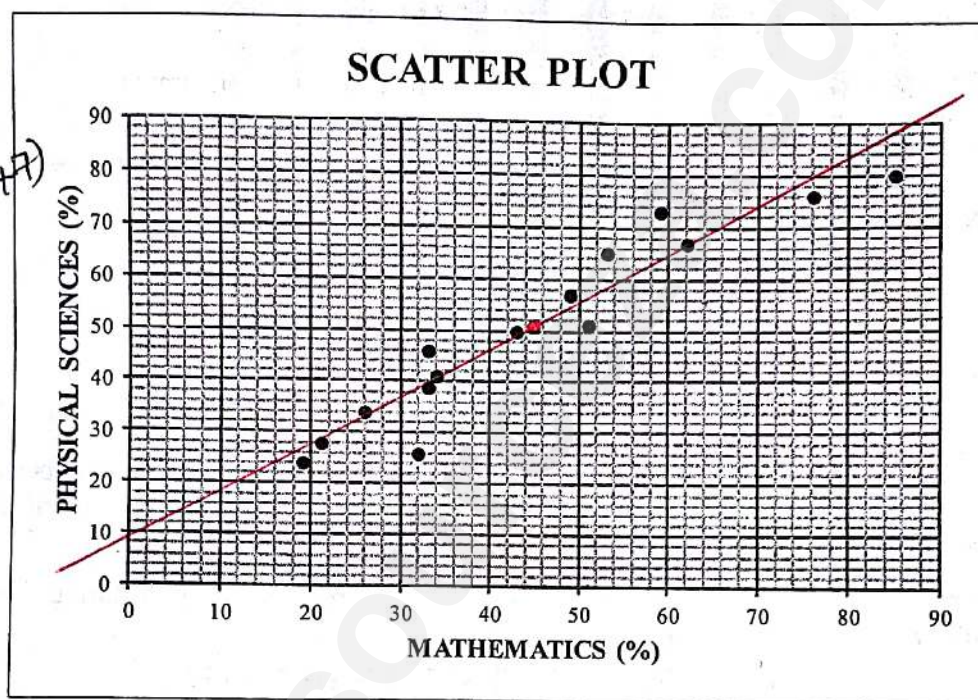
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QUESTION 1

A Mathematics teacher was curious to establish if her learners' Mathematics marks influenced their Physical Sciences marks. In the table below, the Mathematics and Physical Sciences marks of 15 learners in her class are given as percentages (%).

MATHEMATICS (AS %)	26	62	21	33	53	76	32	59	43	33	49	51	19	34	85
PHYSICAL SCIENCES (AS %)	34	67	28	46	65	76	26	73	50	39	57	51	24	41	80

$(\bar{x}, \bar{y})$
 $(45, 07; 59, 47)$



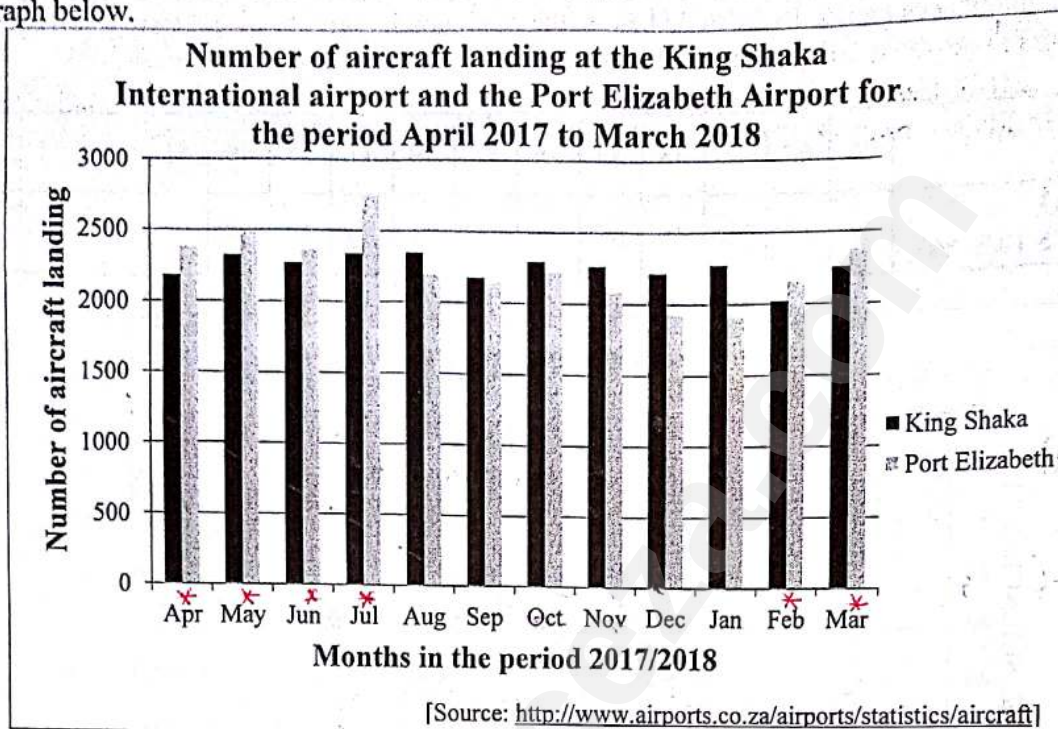
- 1.1 Determine the equation of the least squares regression line for the data. $a = 9,50$ ✓ $b = 0,91$ ✓ eqn: $y = 9,50 + 0,91x$ ✓ (3)
- 1.2 Draw the least squares regression line on the scatter plot provided in the ANSWER BOOK. ✓ passes through $a = 9,50$ ✓ passes through $(\bar{x}, \bar{y})$ (45,07; 59,47). (2)
- 1.3 Predict the Physical Sciences mark of a learner who achieved 69% for Mathematics. $y = 9,50 + 0,91(69) = 72,29\%$ ✓ Accept 1-72% (2)
- 1.4 Write down the correlation coefficient between the Mathematics and Physical Sciences marks for the data. $r = 0,95$ ✓ (1)
- 1.5 Comment on the strength of the correlation between the Mathematics and Physical Sciences marks for the data. It is a very strong positive correlation. ✓ (1)
- 1.6 What trend did the teacher observe between the results of the two subjects? (1)

As the Mathematics marks increase, the Physical Sciences marks increase too. ✓ [10]



QUESTION 2

The number of aircraft landing at the King Shaka International Airport and the Port Elizabeth Airport for the period starting in April 2017 and ending in March 2018, is shown in the double bar graph below.



- 2.1 The number of aircraft landing at the Port Elizabeth Airport exceeds the number of aircraft landing at the King Shaka International Airport during some months of the given period. During which month is this difference the greatest? **July** ✓ (1)
- 2.2 The number of aircraft landing at the King Shaka International Airport during these months are:

2 182	2 323	2 267	2 334	2 346	2 175
2 293	2 263	2 215	2 271	2 018	2 254

✓ Full mks for Answer only

- Calculate the mean for the data. $\bar{x} = \frac{26941}{12} = 2245,08$ ✓ (2)
- 2.3 Calculate the standard deviation for the number of aircraft landing at the King Shaka International Airport for the given period. $\sigma = 86,3$ ✓ (2)
- 2.4 Determine the number of months in which the number of aircraft landing at the King Shaka International Airport were within one standard deviation of the mean. ✓ (3)
- 2.5 Which ONE of the following statements is CORRECT? **9 months** ✓ (3)
- A. During December and January, there were more landings at the Port Elizabeth Airport than at the King Shaka International Airport.
- B. There was a greater variation in the number of aircraft landing at the King Shaka International Airport than at the Port Elizabeth Airport for the given period.
- C. ✓ The standard deviation of the number of landings at the Port Elizabeth Airport will be higher than the standard deviation of the number of landings at the King Shaka International Airport.

Since the variation in number of landings at P.E is bigger compared to King Shaka International Airport.

QUESTION 3

$\triangle TSK$ is drawn. The equation of ST is $y = \frac{1}{2}x + 6$ and ST cuts the x -axis at M . $W(-4; 4)$ lies on ST and R lies on SK such that WR is parallel to the y -axis. WK cuts the x -axis at V and the y -axis at $P(0; -4)$. KS produced cuts the x -axis at N . $\angle TSK = \theta$.

3.3: $ST: y = \frac{1}{2}x + 6$ --- (1)

$SK: y = -\frac{2}{5}x - 6$

$y = -\frac{2}{5}x - 12$ --- (2)

(1) = (2) $\frac{1}{2}x + 6 = -\frac{2}{5}x - 12$

$5x + 60 = -4x - 120$

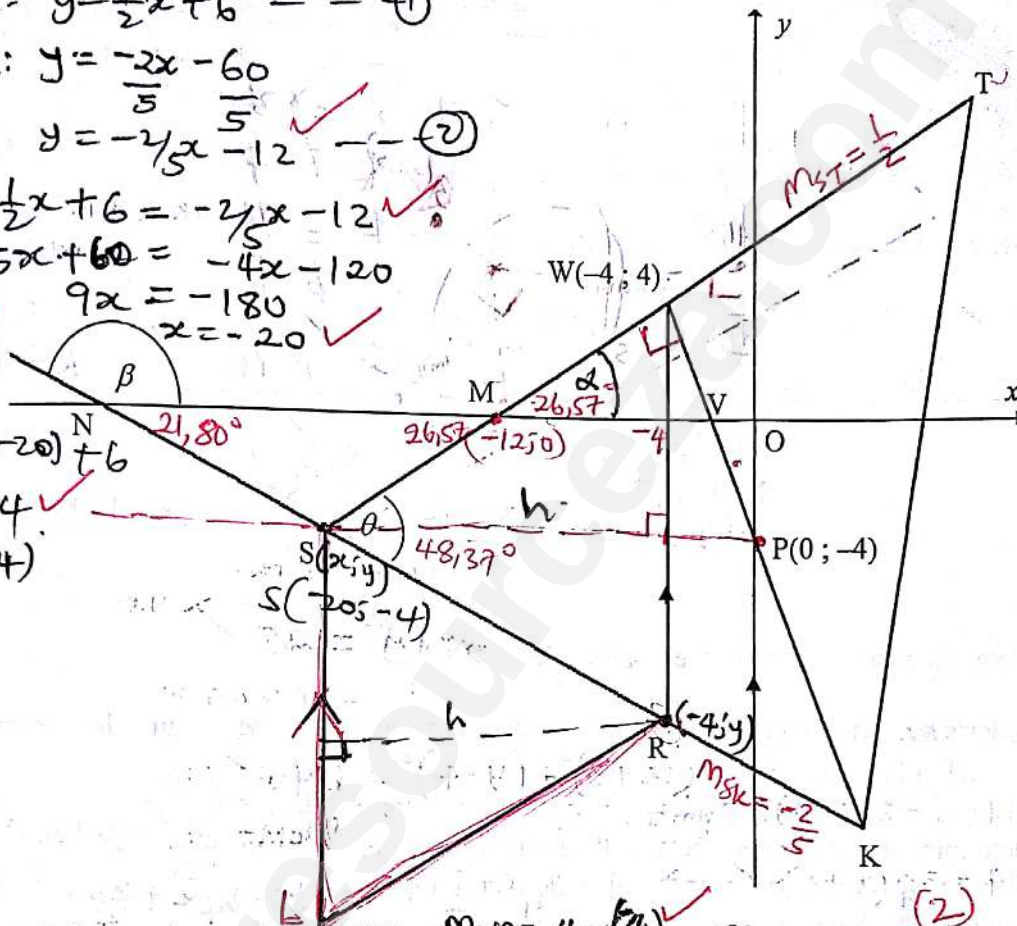
$9x = -180$

$x = -20$

$y = \frac{1}{2}(-20) + 6$

$y = -4$

$S(-20; -4)$



3.1 Calculate the gradient of WP . $m_{WP} = \frac{4 - (-4)}{-4 - 0} = \frac{8}{-4} = -2$ (2)

3.2 Show that $WP \perp ST$. $m_{WP} \times m_{ST} = -2 \times \frac{1}{2} = -1$ (2)

3.3 If the equation of SK is given as $5y + 2x + 60 = 0$, calculate the coordinates of S . (4)

3.4 Calculate the length of WR . $R(-4; y)$; $y = -\frac{2}{5}(-4) - 12 = -10.4$ (4)

3.5 Calculate the size of θ . $WR = y_W - y_R = 4 - (-10.4) = 14.4$ (5)

3.6 Let L be a point in the third quadrant such that $SWRL$, in that order, forms a parallelogram. Calculate the area of $SWRL$. (4)

$\tan \beta = m_{SK}$ $\tan \alpha = m_{ST}$ $\text{Area} = \text{base} \times \text{height}$ (21)

$\tan \beta = -\frac{2}{5}$ $\tan \alpha = \frac{1}{2}$ $= WR \times \text{height}$

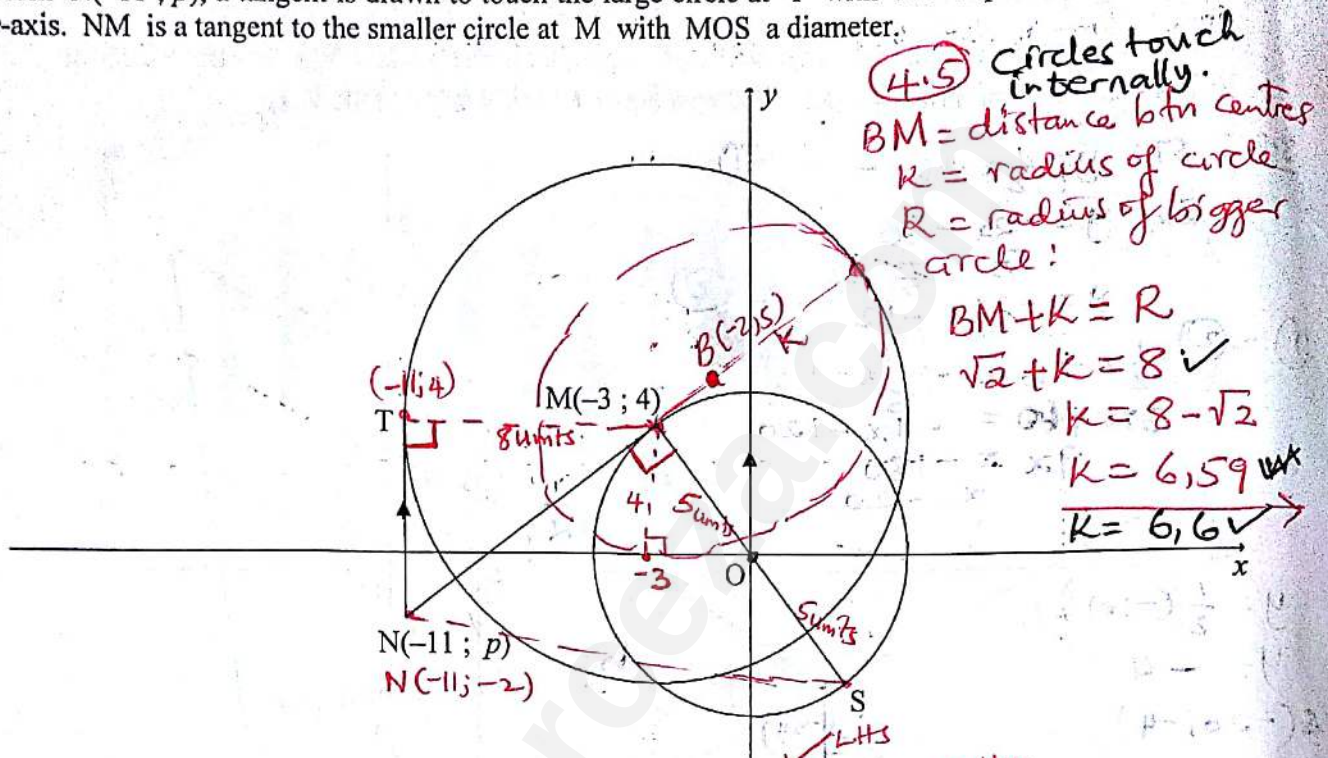
$\beta = -21.80^\circ + 180^\circ$ $\alpha = 26.57^\circ$ $= 14.4 \times 16$

$\beta = 158.20^\circ$ $\alpha = 26.57^\circ$ $= 230.4 \text{ units}^2$

$\angle SNM = 21.8^\circ$ $\angle TSK = 48.37^\circ$

QUESTION 4

M(-3; 4) is the centre of the large circle and a point on the small circle having centre O(0; 0). From N(-11; p), a tangent is drawn to touch the large circle at T with NT is parallel to the y-axis. NM is a tangent to the smaller circle at M with MOS a diameter.



4.1 Determine the equation of the small circle. $x^2 + y^2 = 25$ ✓ R.H.S. (2)

4.2 Determine the equation of the circle centred at M in the form $(x-a)^2 + (y-b)^2 = r^2$ $(x+3)^2 + (y-4)^2 = 64$ ✓ (3)

4.3 Determine the equation of NM in the form $y = mx + c$ $m_{OM} = \frac{4}{-3} \Rightarrow m_{NM} = \frac{3}{4}$ (Tan ⊥ rad) (4)

4.4 Calculate the length of SN. $y - 4 = \frac{3}{4}(x + 3) \Rightarrow y = \frac{3}{4}x + \frac{9}{4} + 4 \Rightarrow y = \frac{3}{4}x + \frac{25}{4}$ ✓ (5)

at N(-11; p) $y = p = \frac{3}{4}(-11) + \frac{25}{4} = -2$ ✓ N(-11; -2)
4.5 If another circle with centre B(-2; 5) and radius k, touches the circle centred at M, determine the value(s) of k, correct to ONE decimal place. (5)

$$MS = 2OM = 2 \times 5 = 10 \text{ units} \quad \checkmark$$

$$NM^2 = (-11+3)^2 + (-2-4)^2 \quad (5)$$

$$= 64 + 36$$

$$NM^2 = 100 \quad \checkmark$$

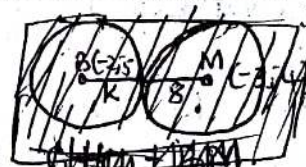
$$\therefore \angle NMS = 90^\circ \text{ (Tan } \perp \text{ diameter)}.$$

$$\therefore SN^2 = NM^2 + MS^2 \text{ (Pythagoras)} \Rightarrow k + 8 = \sqrt{2} \quad \checkmark$$

$$= 100 + 10$$

$$SN^2 = 200$$

$$SN = 10\sqrt{2} \text{ units} \quad \checkmark$$



$$BM + k = R.$$

$$\sqrt{2} + k = 8$$

$$k = 8 - \sqrt{2} = 6.59 \quad \checkmark$$

$$\text{but } BM = \sqrt{(-3+2)^2 + (4-5)^2} = \sqrt{2} \quad \checkmark$$

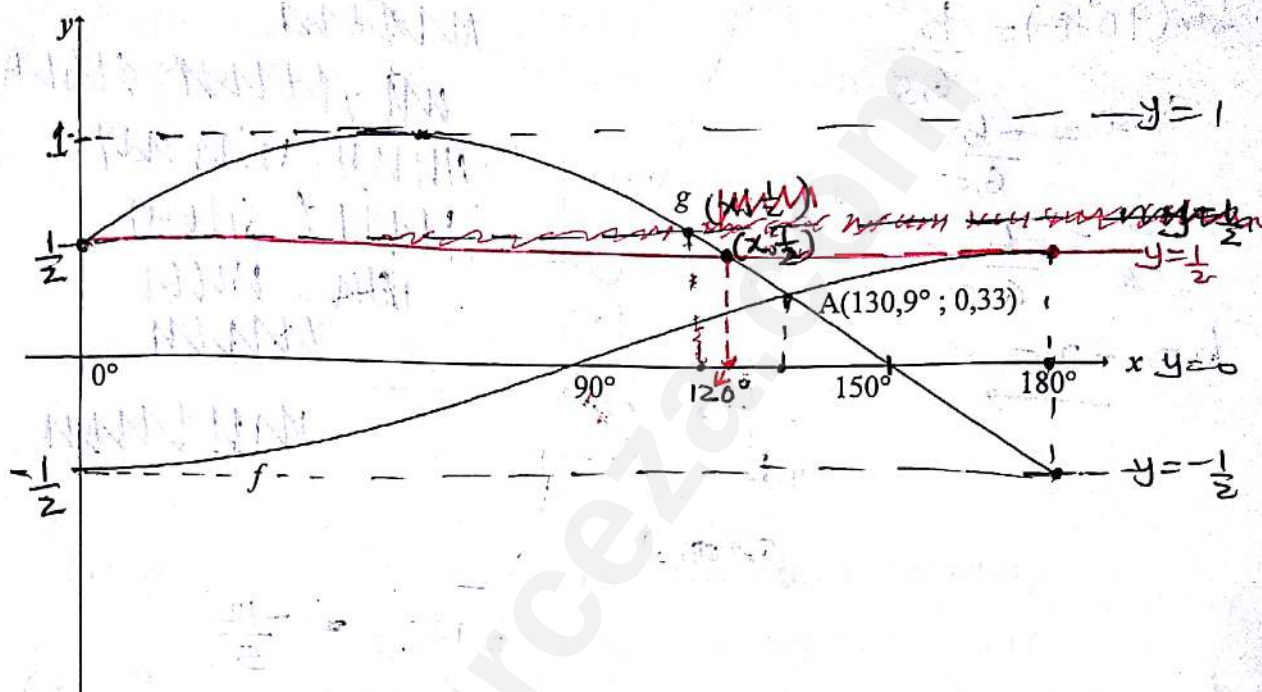
$$k = -\sqrt{2} + 8 \quad (5)$$

$$k = +6.59 \quad \checkmark \text{ (WHAN)}$$

Circles touch each internally

QUESTION 5

The graphs of $f(x) = -\frac{1}{2}\cos x$ and $g(x) = \sin(x+30^\circ)$, for the interval $x \in [0^\circ; 180^\circ]$, are drawn below. $A(130,9^\circ; 0,33)$ is the approximate point of intersection of the two graphs.



5.1 Write down the period of g . $= 360^\circ$ ✓ (1)

5.2 Write down the amplitude of f . $= \frac{1}{2}$ ✓ (1)

5.3 Determine the value of $f(180^\circ) - g(180^\circ)$. $\frac{1}{2} - (-\frac{1}{2}) = 1$ ✓ (1)

5.4 Use the graphs to determine the values of x , in the interval $x \in [0^\circ; 180^\circ]$, for which:

5.4.1 $f(x-10^\circ) = g(x-10^\circ)$: $130,9^\circ + 10^\circ = 140,9^\circ$ ✓ (1)

5.4.2 $\sqrt{3}\sin x + \cos x \geq 1$ (4)

[8]

Divide by 2:

$$\frac{\sqrt{3}}{2}\sin x + \frac{1}{2}\cos x \geq \frac{1}{2}$$

$$\cos 30^\circ \sin x + \sin 30^\circ \cos x \geq \frac{1}{2}$$

$$\sin(x+30^\circ) \geq \frac{1}{2} \quad (4)$$

$$g(x) \geq \frac{1}{2}$$

$\therefore x \in [0^\circ; 120^\circ]$ ✓ End Pts ✓ correct

$\sin(x+30^\circ) = \frac{1}{2}$
 $x+30^\circ = 30^\circ$
 $x = 0^\circ$
 or $x+30^\circ = 180^\circ - 30^\circ$
 $x+30^\circ = 150^\circ$
 $x = 120^\circ$

Notation Please turn over



QUESTION 6

6.1 In the diagram, $P(-5; 12)$ and T lies on the positive x -axis. $\hat{POT} = \theta$

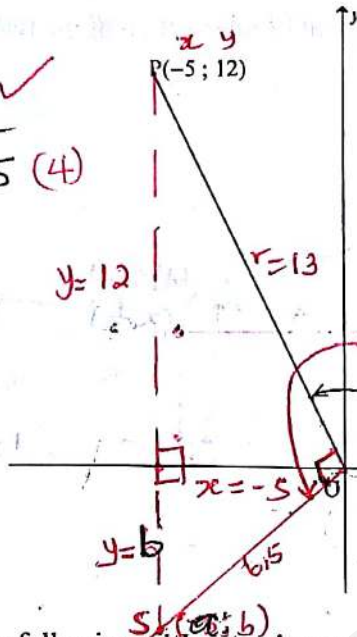
Method 1:

$$\sin(90^\circ + \theta) = \frac{b}{6,5} \quad (4)$$

$$\cos \theta = \frac{+b}{6,5}$$

$$\frac{-5}{13} = \frac{+b}{6,5}$$

$$b = -2,5$$



Method 2: $\frac{OR}{OP} = \frac{a}{6,5}$

$$-\sin \theta = \frac{a}{6,5}$$

$$-\left(\frac{12}{13}\right) = \frac{a}{6,5}$$

$$a = -6$$

$$b^2 = 6,5^2 - (6)^2$$

$$b^2 = 6,25 \quad (4)$$

$$b = \pm 2,5$$

$$b = -2,5$$

Method 2: $\frac{OR}{OP} = \frac{a}{6,5}$

$\hat{POT} = \theta$

$(\cos \theta) = \frac{OR}{OP}$

$(\cos \theta) = \frac{OR}{6,5}$

$\cos \theta = \frac{OR}{6,5}$

$\cos \theta = \frac{OR}{6,5}$

$\cos \theta = \frac{OR}{6,5}$

Answer the following without using a calculator:

6.1.1 Write down the value of $\tan \theta = \frac{12}{-5} = -\frac{12}{5} \quad (1)$

6.1.2 Calculate the value of $\cos \theta = \frac{-5}{13} \quad (r^2 = (-5)^2 + (12)^2)$
 $r = 13 \quad (3)$

6.1.3 $S(a; b)$ is a point in the third quadrant such that $\hat{TOS} = \theta + 90^\circ$ and $OS = 6,5$ units. Calculate the value of b . (4)

6.2 Determine, without using a calculator, the value of the following trigonometric expression:

$$\frac{\sin 2x \cdot \cos(-x) + \cos 2x \cdot \sin(360^\circ - x)}{\sin(180^\circ + x)} = \frac{2 \sin x \cos x \cdot \cos x + (2 \cos^2 x - 1)(-\sin x)}{-1} = -1 \quad (5)$$

6.3 Determine the general solution of the following equation:

$$6 \sin^2 x + 7 \cos x - 3 = 0$$

$$6(1 - \cos^2 x) + 7 \cos x - 3 = 0$$

$$6 - 6 \cos^2 x + 7 \cos x - 3 = 0$$

$$-6 \cos^2 x + 7 \cos x + 3 = 0$$

$$6 \cos^2 x - 7 \cos x - 3 = 0$$

$$(3 \cos x + 1)(2 \cos x - 3) = 0$$

$$\cos x = -\frac{1}{3} \text{ or } \cos x = \frac{3}{2} \quad (6)$$

6.4 Given: $x + \frac{1}{x} = 3 \cos A$ and $x^2 + \frac{1}{x^2} = 2$

$$\left(x + \frac{1}{x}\right)^2 = x^2 + \frac{1}{x^2} + 2$$

$$(3 \cos A)^2 = 2 + 2$$

$$9 \cos^2 A = 4$$

$$\cos^2 A = \frac{4}{9}$$

$$2 \cos^2 A = \frac{4}{9} \times 2$$

$$2 \cos^2 A - 1 = \frac{8}{9} - 1$$

$$\cos 2A = -\frac{1}{9}$$

Determine the value of $\cos 2A$ without using a calculator. $\cos x = -\frac{1}{3}$ or $\cos x = \frac{3}{2}$ (N/A)

$$\text{Ref } x = 70,53^\circ$$

$$x = 109,47^\circ + k \cdot 360^\circ; k \in \mathbb{Z}$$

$$\text{or } x = 250,53^\circ + k \cdot 360^\circ; k \in \mathbb{Z}$$



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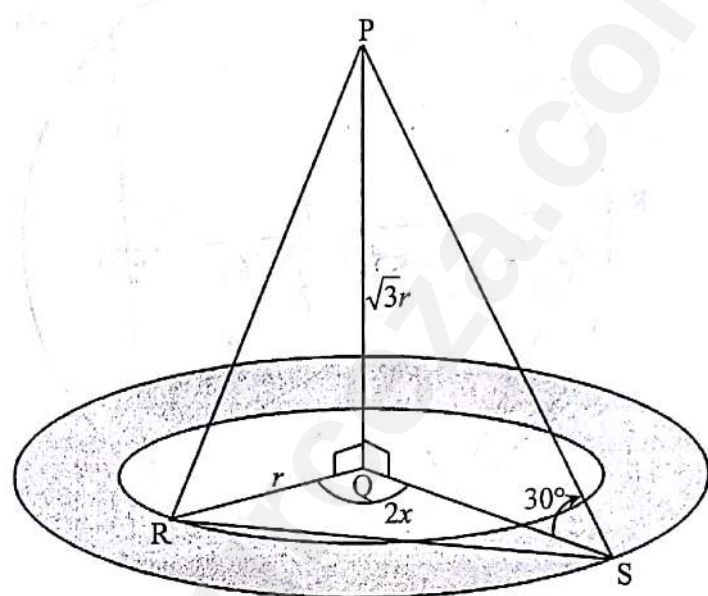
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$$= \frac{\sin 2x \cdot \cos x + \cos 2x \cdot (-\sin x)}{-\sin x} = \frac{\sin 2x}{-\sin x} = -\sin 2x \quad (5)$$

QUESTION 7 = $\frac{\sin(2x - x)}{-\sin x} = -1$

A landscape artist plans to plant flowers within two concentric circles around a vertical light pole PQ. R is a point on the inner circle and S is a point on the outer circle. R, Q and S lie in the same horizontal plane. RS is a pipe used for the irrigation system in the garden.

- The radius of the inner circle is r units and the radius of the outer circle is QS .
- The angle of elevation from S to P is 30° .
- $\angle RQS = 2x$ and $PQ = \sqrt{3}r$



7.1 Show that $QS = 3r$ $\Rightarrow QS = \frac{\sqrt{3}r}{\frac{1}{\sqrt{3}}}$ (3) $\Rightarrow QS = \sqrt{3}r \cdot \sqrt{3} = 3r$ (simplifying)

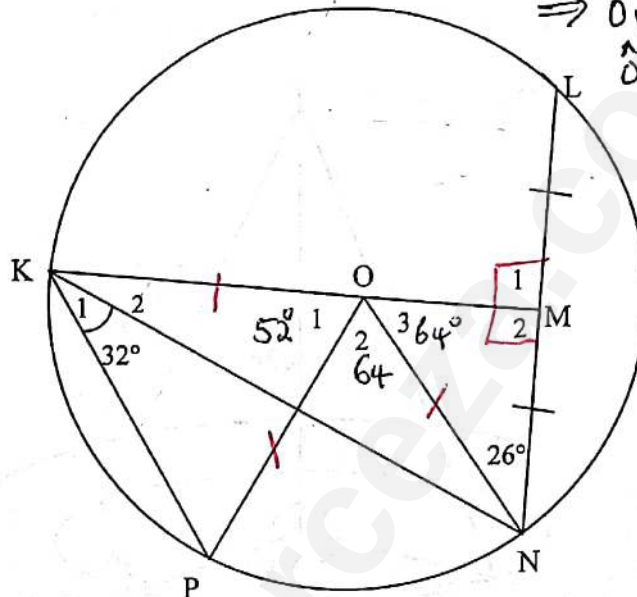
7.2 Determine, in terms of r , the area of the flower garden.
 $A = \pi r^2 + \pi(3r)^2 = 10\pi r^2$ (Area of outer circle - Area of inner circle) (2)

7.3 Show that $RS = r\sqrt{10 - 6\cos 2x}$
 $RS^2 = r^2 + (3r)^2 - 2(r)(3r)\cos 2x$ (3)
 $RS^2 = 10r^2 - 6r^2\cos 2x$ (2)
 $RS = \sqrt{r^2(10 - 6\cos 2x)}$ [10]
 $RS = r\sqrt{10 - 6\cos 2x}$

7.4 If $r = 10$ metres and $x = 56^\circ$, calculate RS.
 $RS = 10\sqrt{10 - 6\cos 2(56)}$ (subst) (2)
 $= 10\sqrt{10 - 6\cos 112^\circ}$
 $RS = 35.0$ (A)
 3499662728

QUESTION 8

- 8.1 O is the centre of the circle. KOM bisects chord LN and $\hat{MNO} = 26^\circ$. K and P are points on the circle with $\hat{NKP} = 32^\circ$. OP is drawn.



8.1.1.b) $\hat{M}_2 = 90^\circ$ (line from centre to mid pt of chord) ✓S
 $\Rightarrow \hat{O}_1 + \hat{O}_2 = 26^\circ + \hat{M}_2$ (Ext of Δ) ✓S
 $\hat{O}_1 + 64^\circ = 26^\circ + 90^\circ$ ✓S
 $\hat{O}_1 = 52^\circ$ ✓A (4)

- 8.1.1 Determine, giving reasons, the size of:

(a) $\hat{O}_2 = 64^\circ$ (Lat centre = $2 \times$ Lat circumference) ✓R (2)
 $\hat{M}_2 = 90^\circ$ (line from centre to mid pt of chord) ✓S
 (b) $\hat{O}_1 = 52^\circ$ (sum in Δ) ✓S (4)
 $\hat{O}_1 = 52^\circ$ (Ls on str. line) ✓A (4)

- 8.1.2 Prove, giving reasons, that KN bisects $\hat{OKP}$. (3)

In ΔKON

$\hat{K}_2 + \hat{ONK} = \hat{O}_3$ (Ext $\angle$ of Δ) ✓S/R

but $\hat{K}_2 = \hat{ONK}$ (Ls opp equal sides) ✓S/R.

$\Rightarrow 2\hat{K}_2 = 64^\circ$

$\hat{K}_2 = 32^\circ$ ✓S

$\therefore$ KN bisects $\hat{OKP}$ ($\hat{K}_1 = \hat{K}_2 = 32^\circ$). (3)

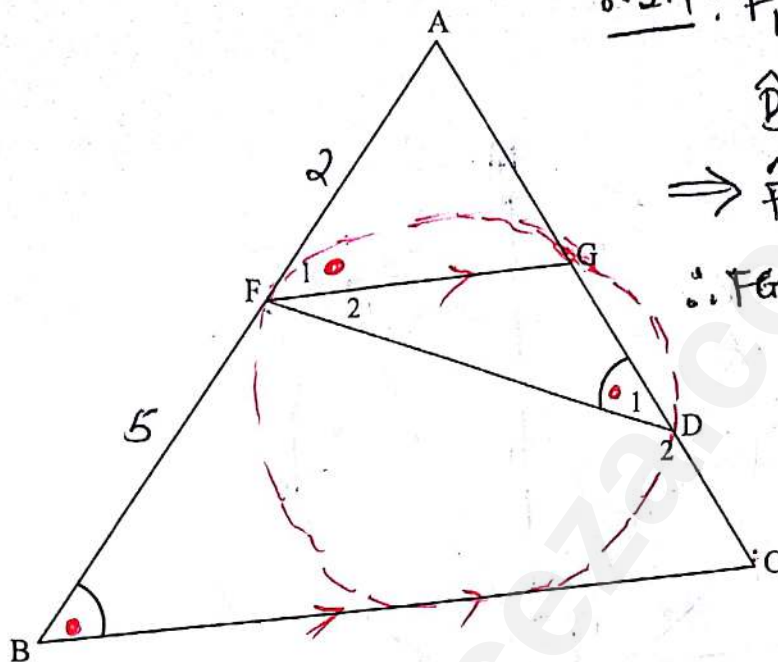
OR: In ΔKOP :

$\hat{K}_2 + \hat{K}_1 + \hat{P} + \hat{O}_1 = 180^\circ$ (sum in Δ) ✓S

but $\hat{K}_2 + \hat{K}_1 = \hat{P}$ (Ls opp equal sides) ✓S (3)

$\hat{K}_2 + 32^\circ = 180^\circ - 52^\circ$
 $\hat{K}_2 = 96^\circ - 32^\circ = 64^\circ$
 $\hat{K}_2 = 32^\circ$ ✓S

- 8.2 In $\triangle ABC$, F and G are points on sides AB and AC respectively. D is a point on GC such that $\hat{D}_1 = \hat{B}$.



8.2.1: $\hat{F}_1 = \hat{D}_1$ (tan chord theorem) ✓
 $\hat{B} = \hat{D}_1$ (Given) ✓
 $\Rightarrow \hat{F}_1 = \hat{B}$ (both = $\hat{D}_1$) ✓
 $\therefore FG \parallel BC$ (Corresp $\angle$ s =) ✓

- 8.2.1 If AF is a tangent to the circle passing through points F, G and D, then prove, giving reasons, that $FG \parallel BC$. (4)

- 8.2.2 If it is further given that $\frac{AF}{FB} = \frac{2}{5}$, $AC = 2x - 6$ and $GC = x + 9$, then calculate the value of x. (4)

$\frac{AC}{GC} = \frac{AB}{FB}$ (Prop Theorem; $FG \parallel BC$) ✓
 [17]

$\frac{2x-6}{x+9} = \frac{7}{5}$ ✓ substitution

$10x - 30 = 7x + 63$ ✓ simplification

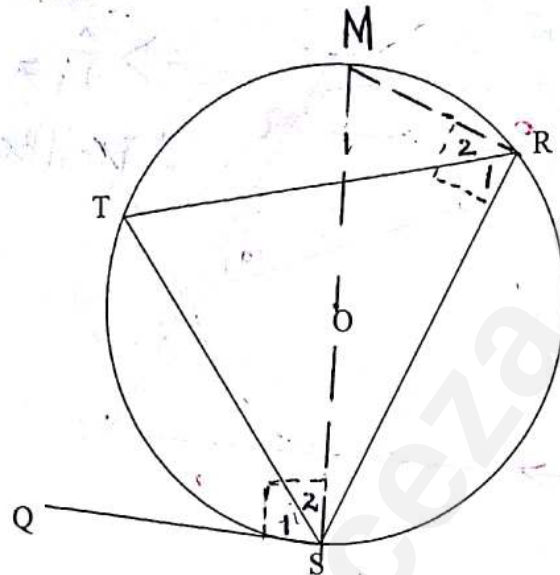
$3x = 93$

$x = 31$ ✓ A



QUESTION 9

- 9.1 In the diagram, O is the centre of the circle. Points S, T and R lie on the circle. Chords ST, SR and TR are drawn in the circle. QS is a tangent to the circle at S.



Use the diagram to prove the theorem which states that $\angle QST = \angle TRS$.

(5)

Construction:

Draw diameter SM and join MR. ✓ C

$\hat{S}_1 + \hat{S}_2 = 90^\circ$ (Tan $\perp$ diameter) ✓ R

$\hat{R}_1 + \hat{R}_2 = 90^\circ$ (Ls in semi circle) ✓ S/R

$\hat{S}_1 + \hat{S}_2 = \hat{R}_1 + \hat{R}_2$ (both = 90°)

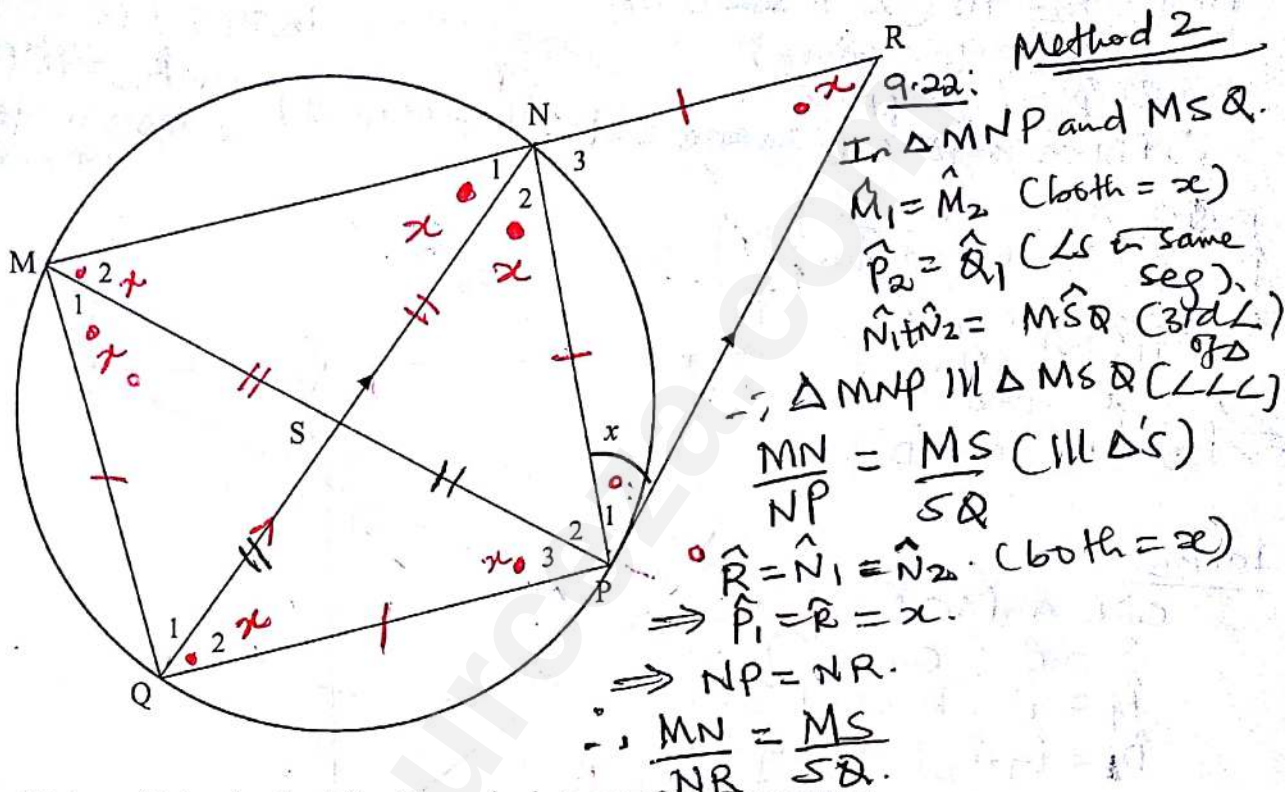
but $\hat{S}_2 = \hat{R}_2$ (Ls in same seg) ✓ (5)

$\hat{S}_1 = \hat{R}_1$

$\therefore \angle QST = \angle TRS$



- 9.2 Chord QN bisects $\widehat{MNP}$ and intersects chord MP at S. The tangent at P meets MN produced at R such that $QN \parallel PR$. Let $\hat{P}_1 = x$.



- 9.2.1 Determine the following angles in terms of x . Give reasons

- (a) $\hat{N}_2 = \hat{P}_1 = x$ (alt $\angle$ s; $QN \parallel PR$) (2)
- (b) $\hat{Q}_2 = \hat{P}_1 = x$ (tan chord Theorem) (2)

- 9.2.2 Prove, giving reasons, that $\frac{MN}{NR} = \frac{MS}{SQ}$

Method 1
 $\frac{MN}{NR} = \frac{MS}{SQ}$ (Prop Theorem; $SN \parallel PR$)

but $\hat{N}_2 = x$ and $\hat{Q}_2 = x$ (Proven).
 $\hat{N}_1 = \hat{N}_2 = x$ (QN bisects $\widehat{MNP}$)
 $\hat{P}_3 = \hat{N}_1 = x$ ($\angle$ s in the same seg.)
 $\Rightarrow \hat{P}_3 = \hat{Q}_2$ (both = x)
 $\Rightarrow SP = SQ$ (sides opp equal $\angle$ s).

$\therefore \frac{MN}{NR} = \frac{MS}{SQ}$

QUESTION 10

In the diagram, a circle passes through D, B and E. Diameter ED of the circle is produced to C and AC is a tangent to the circle at B. M is a point on DE such that $AM \perp DE$. AM and chord BE intersect at F.

10.1.1: $\hat{B}_2 = 90^\circ$ (Ls in semi circle) ✓S/R

$\hat{M}_2 = 90^\circ$ (Given) ✓S

$\Rightarrow \hat{B}_2 = \hat{M}_2 = 90^\circ$ ✓S (3)

$\therefore$ FBDM is cyclic (Converse of cyc quadr) ✓R

OR: $\hat{M}_1 = \hat{M}_2 = 90^\circ$ (Ls on str line) ✓S/R

$\hat{B}_2 = 90^\circ$ (Ls in semi circle) (3) ✓S/R

$\hat{M}_1 + \hat{B}_2 = 90^\circ + 90^\circ = 180^\circ$
 $\therefore$ FBDM is cyclic (Converse of cyc quadr) ✓R

10.1.2: $\hat{B}_3 = \hat{D}_2$ (Tan chord Thm) ✓S (4)

$\hat{D}_2 = \hat{F}_1$ (Ext L of cyc quadr) ✓S

$\Rightarrow \hat{B}_3 = \hat{F}_1$ (both = $\hat{D}_2$) ✓S

10.1.3:

In $\triangle CDB$ and $\triangle CBE$ ✓S/R

$\hat{C} = \hat{C}$ (Common) ✓S

$\hat{B}_1 = \hat{E}$ (Tan chord Thm) ✓S (3)

$\hat{D}_1 = \hat{B}_1 + \hat{B}_2$ (3rd L of $\triangle$) ✓R

$\therefore \triangle CDB \parallel \triangle CBE$ (LL) ✓R

10.2: $\frac{CD}{CB} = \frac{CB}{CE}$ (|| $\triangle$'s) ✓
 $\Rightarrow CB^2 = CD \cdot CE$
 $CB^2 = 2 \times 8 = 16$ (3)
 $CB = 4$ units ✓

10.1 Prove, giving reasons, that:

10.1.1 FBDM is a cyclic quadrilateral (3)

10.1.2 $\hat{B}_3 = \hat{F}_1$ (4)

10.1.3 $\triangle CDB \parallel \triangle CBE$ (3)

10.2 If it is further given that $CD = 2$ units and $DE = 6$ units, calculate the length of:

10.2.1 BC

10.2.2 DB

From 10.1.3: $\frac{CD}{CB} = \frac{CB}{CE}$ (|| $\triangle$'s) ✓S

$BE \cdot CD = CB \cdot DB$ (1) ✓S/R

but $BE^2 = DE^2 - DB^2$ (Pythagoras) (2) ✓S/R

Eqn (1): $BE^2 \cdot CD = CB^2 \cdot DB^2$ (3)

$DE^2 \cdot CD^2 = DB^2 (CB^2 + CD^2)$ (3)

$(6)^2 \cdot (2)^2 = DB^2 (4^2 + 2^2)$ (4)

$144 = DB^2 (20)$ (4) [17]

$DB^2 = 7.2$ TOTAL: 150

$DB = 2.68$ units ✓

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Sub (3) into (2) $(DE^2 - DB^2) CD^2 = CB^2 \cdot DB^2$

$DE^2 \cdot CD^2 - DB^2 \cdot CD^2 = CB^2 \cdot DB^2$