NAME: MARKING SCHEME- **INDEX No......................**

SCHOOL:...SIGNATURE.................

ADM. NO............ CLASS...........

121/2
MATHEMATICS
PAPER 2
MARCH 2018
2½ HOURS

MOKASA EXAMINATIONS
(Kenya Certificate of Secondary Education)

121/2
MATHEMATICS
PAPER 2
MARCH 2018

INSTRUCTIONS TO CANDIDATES

- *Write your **name** and **index** number in the spaces provided at the top of this page.*
- *This paper consists of two sections: **Section I** and **Section II**.*
- *Answer **all** questions in section **I** and **only** five questions from Section **II**.*
- *Show all the steps in your calculations, giving your answers at each stage in the spaces below each question.*
- *Marks may be given for correct working even if the answer is wrong.*
- *Non- programmable silent electronic calculators and KNEC Mathematical tables may be used.*

For Examiner's Use Only

SECTION I

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total

SECTION II

17	18	19	20	21	22	23	24	Total

Grand Total

This paper consists of 14 pages. Candidates should check the question paper to ensure that all the pages are printed as indicated and no questions are missing.

Section I(50 marks):Answer all questions in this section.

1. Rationalize and simplify. (3mks)

$$\frac{3}{2\sqrt{7}-4\sqrt{3}}-\frac{3}{2\sqrt{7}+4\sqrt{3}}$$

$$\frac{3(2\sqrt{7}+4\sqrt{3})-3(2\sqrt{7}-4\sqrt{3})}{4.7-16\times 3}$$

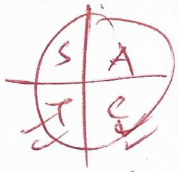
$$\frac{6\sqrt{7}+12\sqrt{3}-6\sqrt{7}+12\sqrt{3}}{28-48}$$

$$\frac{\cancel{24}^{6}\sqrt{3}}{-\cancel{20}_{5}}$$

$$= -\frac{6}{5}\sqrt{3}.$$

2. Solve for x in 2Sin x = - 0.4284 for the range of , $0^0 \le X \le 360^0$ (3mks)

$$\frac{2\sin x}{2} = \frac{-0.4284}{2}$$



$\sin x = -0.2142$

$x = \sin^{-1} 0.2142$

$= 12.37^0$ M1

3rd Quadrant

$x = 180 + \theta$

$= 180 + 12.37$

$= 192.37^0$ A1

4th Quadrant

$x = 360 - \theta$

$= 360 - 12.37$

$= 347.63^0$ A1

3. Make h the subject of the formula: (3mks)

$$E = 1-\pi\sqrt{\frac{h-0.5}{1-h}} \quad (h).$$

~~Exact~~.

$$\left(\pi\sqrt{\frac{h-0.5}{1-h}}\right)^2 = (1-E)^2 \quad M_1 - \text{sq.}$$

$$\pi^2\left(\frac{h-0.5}{1-h}\right) = 1-2E+E^2$$

$$\frac{\pi^2 h - 0.5\pi^2}{1-h} = 1-2E+E^2$$

$$\pi^2 h - 0.5\pi^2 = 1-2E+E^2-h+2hE-hE^2 \quad M_1 - \text{grp } h\text{'s}$$

$$\pi^2 h + h - 2hE + hE^2 = 1-2E+E^2 + 0.5\pi^2$$

$$\frac{h(\pi^2+1-\cancel{2E}+E^2)}{(\pi^2+1-\cancel{2E}+E^2)} = \frac{1-2E+E^2+0.5\pi^2}{\pi^2+1-2E+E^2}$$

$$h = \frac{1-2E+E^2+0.5\pi^2}{\pi^2+1-2E+E^2} \quad A_1$$

4. Given that $2 \leq A \leq 4$ and $0.1 \leq B \leq 0.2$ find the maximum value of $\frac{AB}{A-B}$ (3mks)

Max Quot = $\frac{\text{Max}}{\text{Min}}$

Num = Max x Max = 4 x 0.2 = 0.8 M1

Den = Min − Max

= 2 − 0.2

= 1.8 M1

Max Quot = $\frac{0.8}{1.8}$

= $\frac{8}{18}$

= $\frac{4}{9}$

= $0.\dot{4}$ A1

5. A matrix $\begin{pmatrix} 2 & 2 \\ 4 & 3 \end{pmatrix}$ maps an object to an image of area $30cm^2$. Calculate the area of the image. (3mks)

Det = A.S.F = $\frac{A_i}{A_o}$

= 6 − 8

= 2 M1

$2 = \frac{A_i}{30}$ M1

$A_i = 2 \times 30$

$= 60cm^2$ A1

6. Line PQ is the diameter of a circle. Find the equation of a the circle, given the coordinates of P (0, 2) and Q (6, 2) (3mks)

Centre ⇒ Midpoint

$\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$ = Centre

$\left(\frac{0+6}{2}, \frac{2+2}{2}\right)$

(3, 2) ⇒ Centre M1

radius = $\begin{pmatrix} 3 \\ 2 \end{pmatrix} - \begin{pmatrix} 0 \\ 2 \end{pmatrix}$

= $\begin{pmatrix} 3 \\ 0 \end{pmatrix}$

= 3 units M1

$(x-3) + (y-2) = 9$ A1

7. Calculate the rate per annum in which a certain amount of money triples after being invested for a period of 6 years compounded annually. (3mks)

n = 6

A = 3P

P = P

$A = P(1 + r/100)^n$ M1 (Corr sub)

$\frac{3\cancel{P}}{\cancel{P}} = \frac{\cancel{P}(1 + r/100)^6}{\cancel{P}}$

$3^{1/6} = (1 + r/100)^{6 \times 1/6}$ M1 − (root 6)

$1.200936955 = 1 + r/100$

$100 \times 0.200936955 = r/100 \times 100$

∴ r = 20.0937 A1

8. solve for y in $\log_2 y + \log_2 50 - 2 = \log_2 100$ (3mks)

$\log_2 y + \log_2 50 - \log_2 2^2 = \log_2 100$ M1

$\log_2 y = \log_2 100 + \log_2 4 - \log_2 50$

$\log_2 y = \log_2\left(\frac{100 \times 4}{50}\right)$ M1 - combining.

$y = \frac{\cancel{100}^{2} \times 4}{\cancel{50}_{1}}$

$= 8$ A1

9. Determine the amplitude, the period and the phase angle for the curve: $y = 3Sin\left(\frac{1}{4}x - 90\right)$ (3mks)

Amplitude = 3 units. B1

Period = $360 \div \frac{1}{4} = 1440^\circ$ B1

Phase angle = 90° B1

10. Given the vectors A=$4\underset{\sim}{i} - 3\underset{\sim}{j} + 2\underset{\sim}{k}$ and B=$2\underset{\sim}{j} + 4\underset{\sim}{k}$, given that pont C is a midpoint of vector $\overrightarrow{AB}$, find vector C in form of $\underset{\sim}{i}, \underset{\sim}{j}$ and $\underset{\sim}{k}$ and the magnitude of CB, written to 4 s.f.(3mks)

$C = \frac{4+0}{2}i + \frac{-3+2}{2}j + \frac{2+4}{2}k$

$= 2i - 0.5j + 3k$ M1

$CB = B - C$

$= \begin{pmatrix} 0 \\ 2 \\ 4 \end{pmatrix} - \begin{pmatrix} 2 \\ -0.5 \\ 3 \end{pmatrix}$

$= \begin{pmatrix} -2 \\ 2.5 \\ 1 \end{pmatrix}$ M1

$|CB| = \sqrt{-2^2 + 2.5^2 + 1^2}$

$= \sqrt{11.25}$

$= 3.354101966$

$= 3.354$ units A1 (to

11. Expand $(1 + 2x)^6$ upto the term X^3, hence use it to solve $(1.12)^6$ giving your answer to three decimal places. (4mks)

$(1+2x)^6 = 1.1^6(2x)^0 + 6.1^5(2x)^1 + 15.1^4(2x)^2 + 20.1^3(2x)^3 + \dots$

$= 1 + 12x + 60x^2 + 160x^3$ M1

$(1+2x)^6 = (1.12)^6$

$x = 0.06$ M1

$(1.12)^6 = 1 + 12(0.06) + 60(0.06)^2 + 160(0.06$

$= 1.97056$ A1 (to 3 d.p)

12. The data below represents heights in centimeters of ten students.
100, 121, 103, 122, 125, 118, 115, 123, 105, 108
Calculate the mean absolute deviation of their heights. (4mks)

$\bar{x} = \frac{\sum fx}{N}$

$= \frac{1140}{10}$

$= 114$

x	100	121	103	122	125	118	115	123	105	108
$d = x - \bar{x}$	-14	7	-11	8	11	4	1	9	-9	-6
d^2	196	49	121	64	121	16	1	81	81	36

B_1 - for d^2 column.
B_1 - for d column.

Mean abs dev $= \frac{\sum fd^2}{\sum f} = \frac{766}{10}$ M_1 - correct subst.

$= 76.6$. A_1

13. Two variables A and B are such that A varies partly as B and partly as the square root of B. Given that A = 30, when B = 9 and A = 16 when B = 4, find A when B = 36. (4mks)

$A \propto B + \sqrt{B}$

$A = kB + h\sqrt{B}$ M_1

$(30 = 9k + 3h)2$
$(16 = 4k + 2h)3$ M_1 forming simult eqn

$60 = 18k + 6h$
$48 = 12k + 6h$

$\frac{12}{6} = \frac{6k}{6}$ $k = 2$ M_1 - solving k & h.

$30 = 9k + 3h$

$30 = 18 + 3h$

$\frac{12}{3} = \frac{3h}{3}$

$h = 4$

$\therefore A = 2B + 4\sqrt{B}$

$A = 2(36) + 4\sqrt{36}$

$= 72 + 24$

$= 96$ A_1

14. The first, the third and the seventh terms of an increasing arithmetic progression are three consecutive terms of a geometric progression. If the first term of the arithmetic progression is 10, find the common difference of the arithmetic progression. (3mks)

AP G.P

$1^{st} = 10$ n^{th}

$3^{rd} = 10 + 2d$ $(n+1)^{th}$ M_1

$7^{th} = 10 + 6d$ $(n+2)^{th}$

$r = \frac{10 + 6d}{10 + 2d} = \frac{10 + 2d}{10}$ M_1 - (for r)

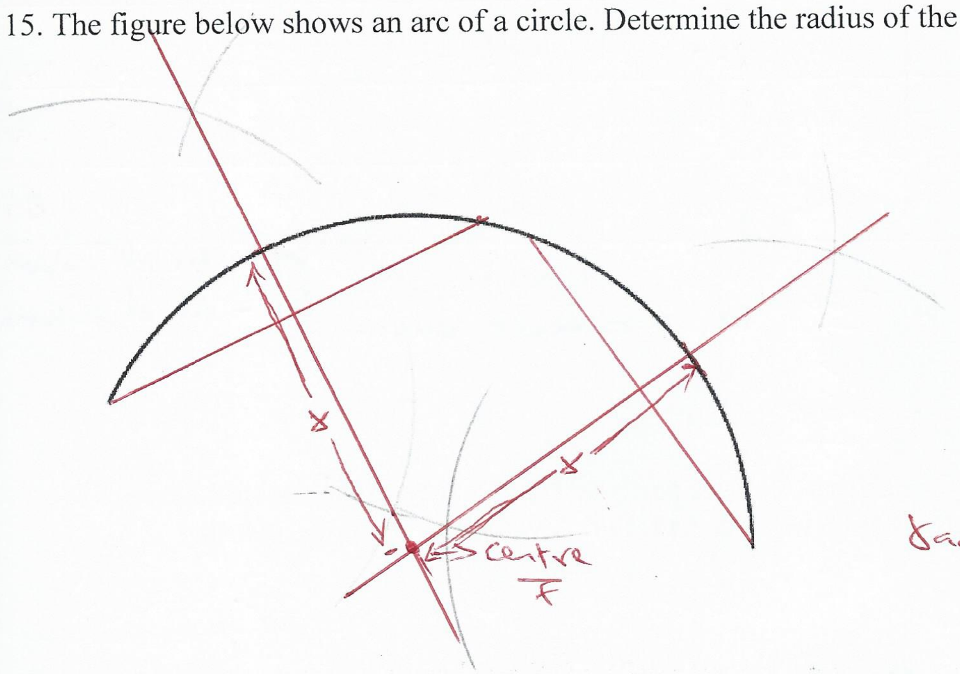
$100 + 40d + 4d^2 = 100 + 60d$

$\frac{4d^2}{4d} = \frac{20d}{4d}$

$d = 20/4$

$= 5$ A_1

15. The figure below shows an arc of a circle. Determine the radius of the circle. (3mks)



B_1 – chord & ⊥ bisector

B_1 – //

B_1 – radius.

radius = 4.4 cm.

16. Lynn mixes rice worth Kshs.47 and Kshs.55 per kg, how many kilograms of each should she use to obtain 24kg of the mixture worth Kshs.52 per kg. (3mks)

47   55

52

3 : 5 M_1

M_1 – to be awarded if long method used.

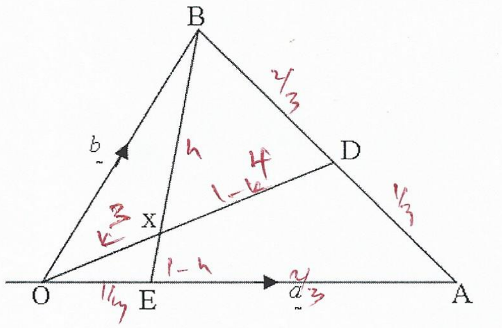
$\frac{3}{8} \times 24 = 9$ kg.

$\frac{5}{8} \times 24 = 15$ kg

A1 (for both)

Section II(50 marks):Answer ***only five*** questions in this section

17. The figure below shows triangle **OAB** in which **OA** is vector $\underset{\sim}{a}$ and **OB** is vector $\underset{\sim}{b}$. Points **D** and **E** are such that **AD** = $\frac{1}{3}$**AB** and **OE** = $\frac{1}{3}$**OA**.



(a) Express in terms of $\underset{\sim}{a}$ and $\underset{\sim}{b}$

(i) $\overline{OD}$ $= a + \frac{1}{3}(b - a)$ (1mk)

$= a + \frac{1}{3}b - \frac{1}{3}a = \frac{2}{3}a + \frac{1}{3}b$. B1

(ii) $\overline{BE}$ $= -b + \frac{1}{3}a$ (1mk)

$= \frac{1}{3}a - b$ B1

(b) If $\overline{OX} = \mathbf{k}\overline{OD}$ and $\overline{BX} = \mathbf{h}\overline{BE}$, where **k** and **h** are constants, express OX in terms in two ways hence, find the values of **h** and **k**. (6mks)

$OX = kOD$

$= k\left(\frac{2}{3}a + \frac{1}{3}b\right)$

$= \frac{2}{3}ka + \frac{1}{3}kb$ M1

$OX = OB + BX$

$= b + h\left(\frac{1}{3}a - b\right)$

$= b + \frac{1}{3}ha - hb$ M1 - correct expansion.

$= \frac{1}{3}ha + (1-h)b$ M1

Comparing Coefficients

a: $\frac{2}{3}k = \frac{1}{3}h$

b: $\frac{1}{3}k = 1 - h$ M1.

Solving Simultaneous Equ

$3 \times \frac{2}{3}k = \frac{1}{3}h \times 3$

$h = 2k$

$\frac{1}{3}k = 1 - 2k$

$1 = 2\frac{1}{3}k$

$\frac{3}{7} \times 1 = \frac{7}{3}k \times \frac{3}{7}$

$k = \frac{3}{7}$ A1

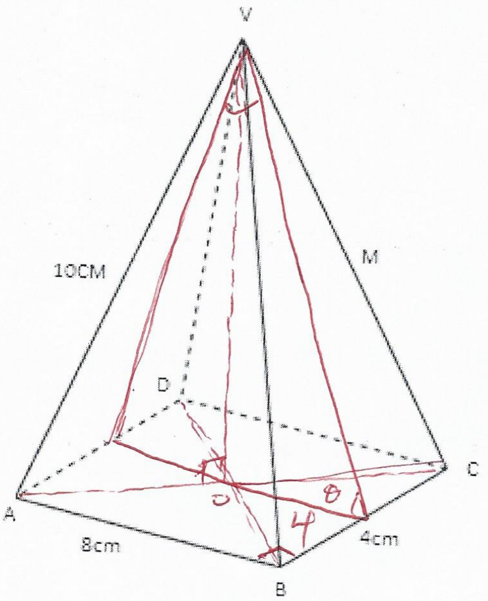
Ans $= 2\left(\frac{3}{7}\right) = \frac{6}{7}$

(c) Find the ratio in which D divides OX. (2mk)

OD : DX.

$7 : -4$ or $-7 : 4$ B1 B1

18. The figure below shows a right pyramid with the vertex V and edges VA, VB, VC, CD each 10cm long. The base ABCD is a rectangle of length 8cm and width 4cm and M is the mid-point of CV.



Calculate:

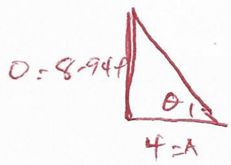
a. the vertical height of the pyramid (2mks)

$AC = \sqrt{8^2+4^2}$ $\quad AO = \frac{1}{2} \times 8.944$ $\quad OC = \sqrt{10^2 - 4.472^2}$

$= \sqrt{80}$ $\quad = 4.472$ $\quad = 8.944$ cm A1

$= 8.944$ M1

b. the angle between the planes VBC and the base ABCD. (2mks)

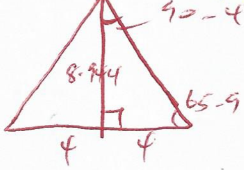


$\tan\theta = \frac{8.944}{4}$ M1

$\theta = \tan^{-1} 2.236$

$= 65.90°$ A1

c. the angle between the planes VBC and VAD. (3mks)



$90 - 45.9 = 24.1$ M1 $\times 2$ M1 $= 48.2°$ A1

Alternative Methods Allowed.

d. the length of the projection of CM on the base ABCD. (3mks)

$OC = \frac{1}{2} AC$ M1

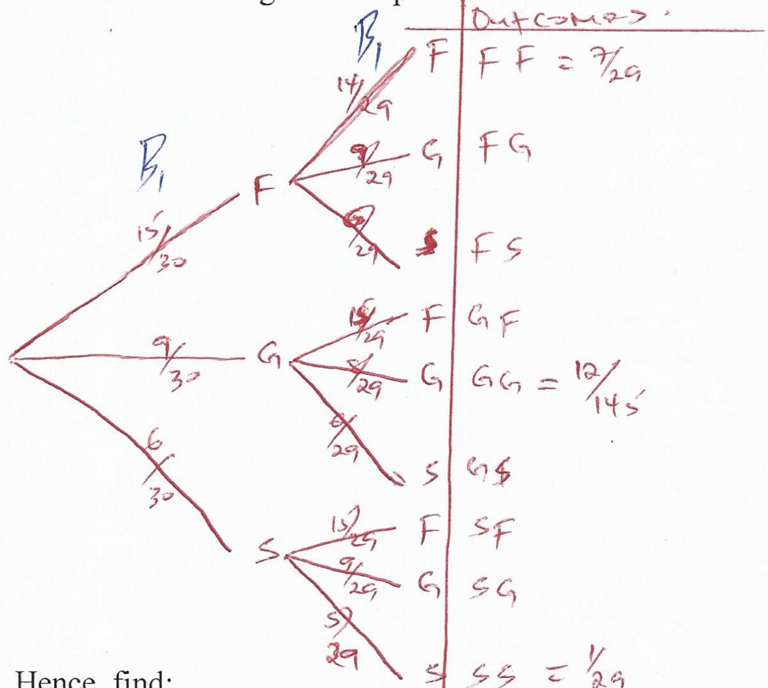
$= \frac{1}{2} \times 8.944$ M1

$= 4.472$ cm A1

Alternative Methods Allowed

19. Each member of a class take one and only one of the three foreign languages: French, Germany and Spanish. 15 pupils take French, 9 take Germany and 6 take Spanish. If Two students are chosen at random. from the class.

i. Draw a tree diagram to represent the above information. (2mks)



$\frac{9}{30} \times \frac{8}{29}$

Hence, find:

ii. The probability that both students take French. (2mks)

$P(FF) = \frac{15}{30} \times \frac{14}{29}$ M1

$= \frac{7}{29}$ A1

iii. The probability that both students take same subject. (3mks)

$= P(FF)$ or $P(GG)$ or $P(SS)$ M1

$= \frac{7}{29} + \frac{12}{145} + \frac{1}{29}$ M1

$= \frac{52}{145}$ A1

iv. The probability that both pupils take different subject. (3mks)

$= 1 - \frac{52}{145}$ M1 M1

$= \frac{93}{145}$ A1

or

$= P(FG)$ or $P(FS)$ or $P(GF)$ or $P(GS)$ or $P(SF)$ or $P(SG)$ M1

$= \frac{93}{145}$

$= \frac{135}{870} + \frac{90}{870} + \frac{135}{870} + \frac{54}{870} + \frac{54}{870} + \frac{54}{870}$ M1

$= \frac{93}{145}$ A1

$-1-3+4$ $\quad 1-3+4 \quad 8-12+4$

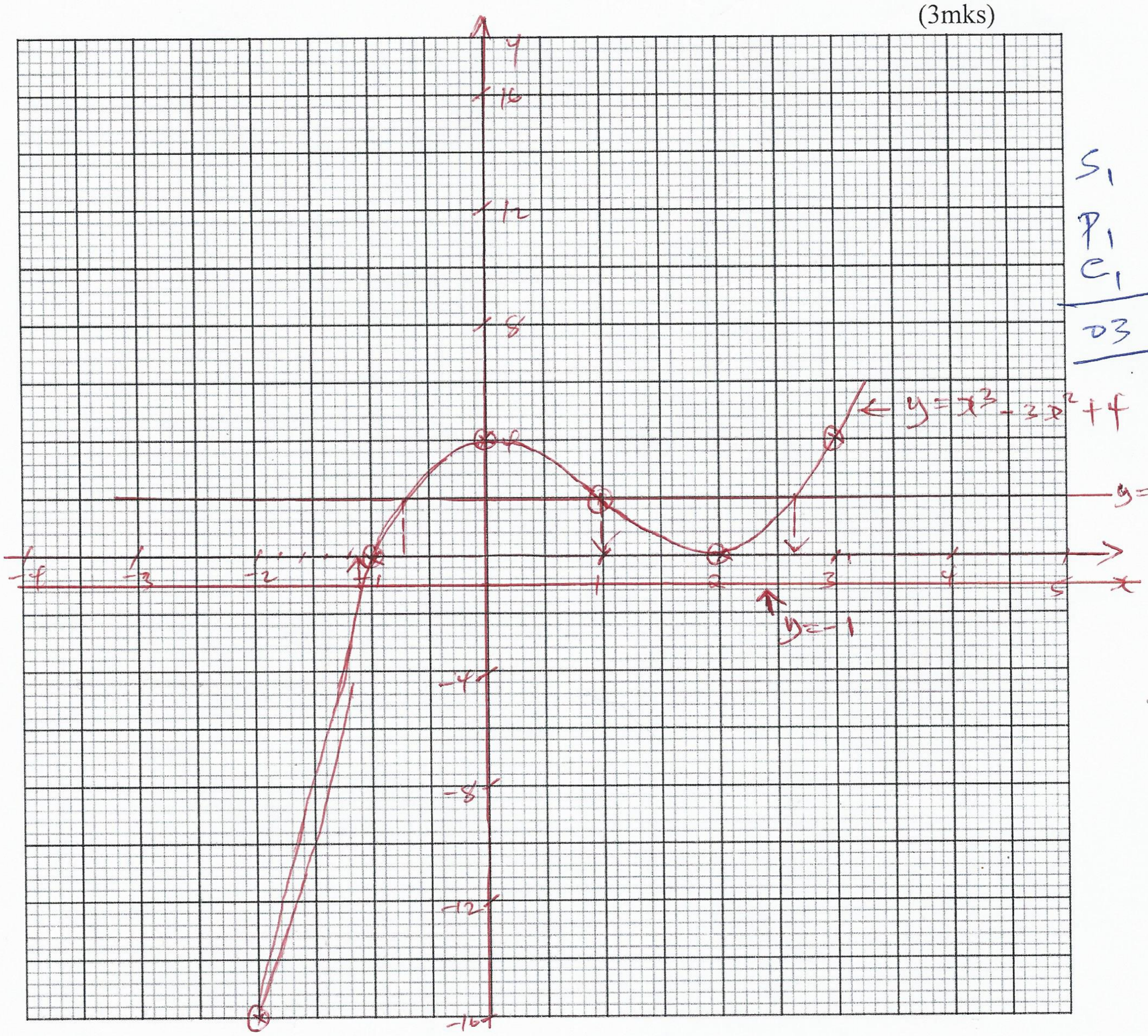
$-1-3+4$

20. (a) Complete the table for the function $y = x^3 - 3x^2 + 4$ for $-2 \le x \le 3$. (2mks)

X	-2	-1	0	1	2	3
Y	-16	0	4	2	0	4

$B_1\ B_1$ – 1Mk @ 2 correct

Draw the curve of function $y = x^3 - 3x^2 + 4$ in the range $-2 \le x \le 3$ on a grid provided below. (3mks)



S_1
P_1
C_1
03

Use your graph to solve

(i) $x^3 - 3x^2 + 4 = 0$ (1mks)

$y = x^3 - 3x^2 + 4$
$\underline{0 = x^3 - 3x^2 + 4}$
$y = 0$

$x_1 = -1$, $x_2 = 2$ A_1 for both

(ii) $x^3 - 3x^2 + 2 = 0$ (2mks)

$y = x^3 - 3x^2 + 4$
$\underline{0 = x^3 - 3x^2 + 2}$ M_1
$y = 2$

$x_1 = -0.7$, $x_2 = 1$, $x_3 = 2.7$ A_1 for all

(iii) $\frac{3x^3}{3} - \frac{9x^2}{3} + \frac{15}{3} = \frac{0}{3}$ (2mks)

$x^3 - 3x^2 + 5 = 0 \Rightarrow$
$y = x^3 - 3x^2 + 4$
$\underline{0 = x^3 - 3x^2 + 5}$
$y = -1$ M_1

$x = -1.2$ A_1

21. Mokaya has 20 acres of land on which to grow maize and beans. For maize he has to employ one worker per acre and for beans he employs two workers per acre. The number of workers must not exceed 30. The total cost of growing beans is ksh 600 per acre and ksh 1000 per acre for maize. He cannot spend more than ksh 15000 altogether. He approximates the profit of maize to be ksh 4000 per acre and ksh 6000 per acre of beans.

(a) Form all the inequalities to represent the information above. Take x to represent acres for maize `and y beans. (4mks)

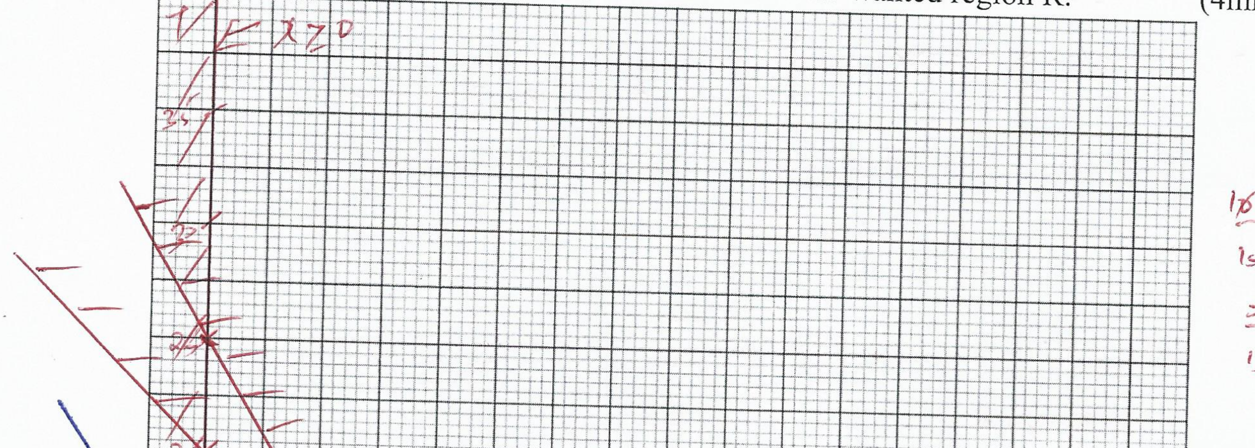
i). $x + y \leq 20$ B1

ii). $x + 2y \leq 30$ B1

iii). $1000x + 600y \leq 15000$ B1

iv) $x \geq 0$
v) $y \geq 0$ } B1 for both.

(b) On the grid provided, draw the inequalities to show the wanted region R. (4mks)



$\frac{10x}{15} + \frac{6y}{15} = \frac{150}{15}$

$\frac{x}{15} + \frac{y}{25} = 1$

B1 B1 B1 B1

Awarded as in (a) above.

(c) Use your graph in (b) above to determine the number of acre of maize and beans he has to plant in order to maximize the profit and find the profit. (2mks)

$4000x + 6000y = K$

$K = 20{,}000 + 30{,}000$

$= 50{,}000$

$\frac{4x}{50} + \frac{6y}{50} = \frac{50}{50}$

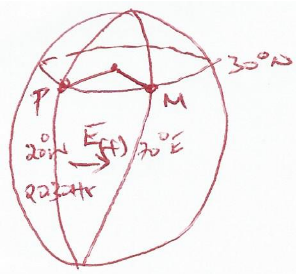
$\frac{x}{12.5} + \frac{y}{8.3} = 1$

Max profit $\Rightarrow (8.5, 10.5)$ M1

$= 4000(8.5) + 6000(10.5)$

$= 34{,}000 + 63{,}000$

$=$ Sh. 97,000 A1



22. A pilot starts flying from city M to city P. Given that M (30°N, 70°E) and P (30°N, 20°W) taking $\pi = \frac{22}{7}$ and radius of the earth $R = 6370km$, Calculate:

(a) the distance between city M and city P along the parallel of latitude.

(i) in km θ diff $= 70 + 20 = 90°$ M1 (2mks)

$D = \frac{\theta}{360} \times 2 \times \pi R \cos\theta = \frac{90}{360} \times 2 \times \frac{22}{7} \times 6370 \cos 30$

$= 8{,}668.914$ km A1

(ii) in nm (1mk)

$= 90 \times 60 \cos 30$

$= 4{,}676.537$ nm A1 OR $= \frac{8668.914}{1.853}$

$= 4{,}678.313$ nm A1

(b) The local time at city M if the local time at city P is 2030 hours. (2mks)

$1° = 4$ Min

$90° = ??$

$= \frac{90 \times 4}{1}$

$= 360$ Min

$= 6$ hrs M1

2030
600 +
2630
2400
02.30

0230 Hrs the next day or 2.30 A.M A1

(c) The position of city A if A is 5,700nm south of P(Give your answer to the nearest whole number). (2mks)

$\frac{\theta \times 60}{60} = \frac{5700}{60}$

$\theta = 95°$

$95 - 30° = 65°$ M1

A(65°S, 20°W) A1

(d) The ~~shortest~~ distance between A and K in nm given the position of K (65°S, 20°E). (3mks)

long diff $= 20 + 20$

$= 40°$ M1

distance $= 40 \times 60 \cos 65$ M1

$= 1{,}014.284$ nm A1

23. Using a ruler and a pair of compass only, construct triangle PQR such that PQ=8cm, QR=7cm and <PQR=120^0.

i. measure PQ. B1 – Correct △ B1 = Correct PQ = 12.9 ± 0.1cm (2mks)

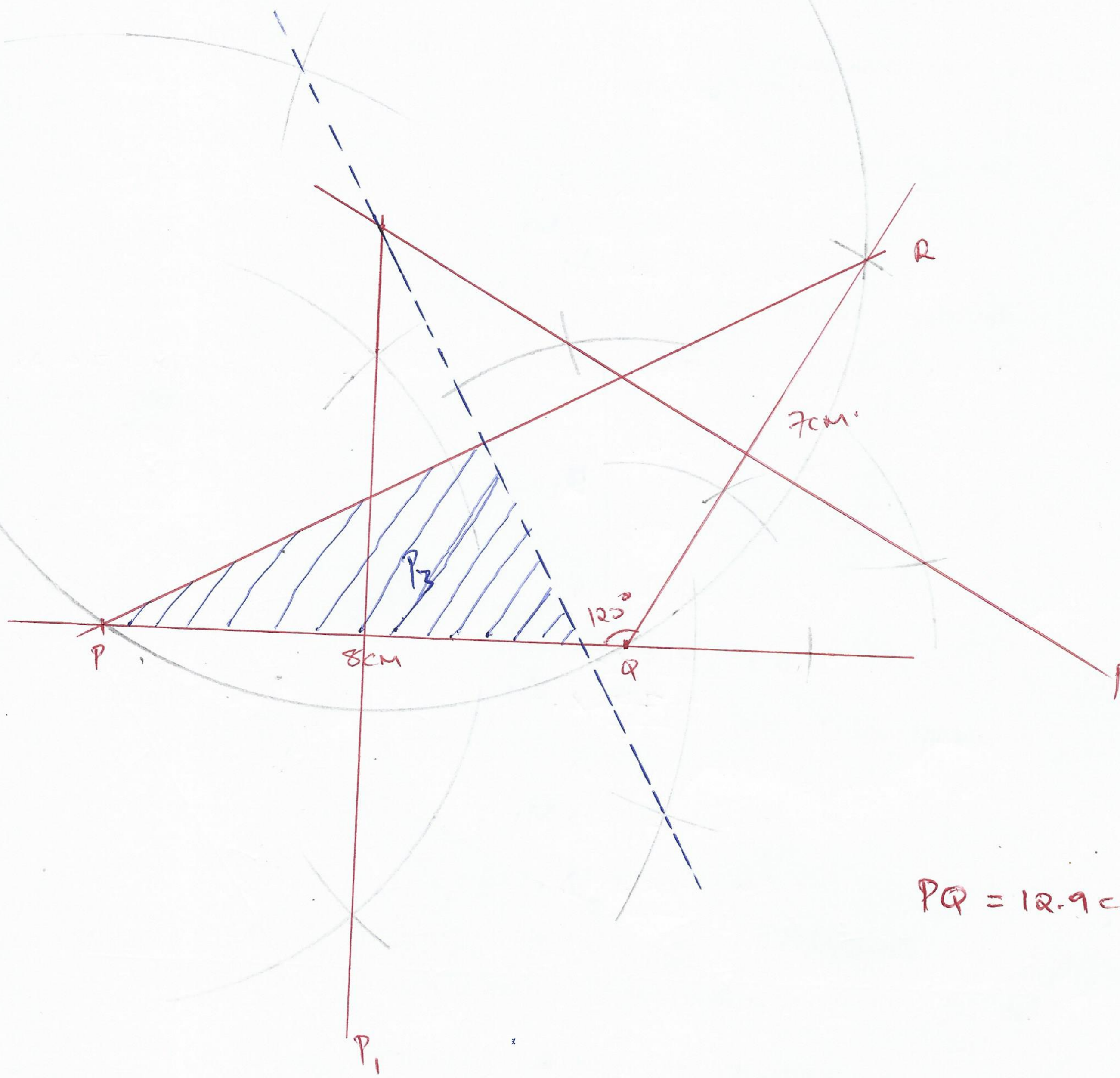
ii. Locate a locus p_1 equidistant from point P and Q. B1 B1 (1mk)

iii. Locate locus p_2 equidistant from point Q and R. B1, B1 (2mks)

iv. Draw a circle touching the vertices P, Q and R. B1 (2mks)

v. Locate by shading locus p_3 which is within the triangle PQR, such that p_3 is closer to P than R. B1 – ⊥ bisector of line PR (1mk)

B1 – correct shading. (2mks)



PQ = 12.9cm ± 0.1

24. In a certain year income tax for all the income earned was charged at the rate shown below

Monthly taxable pay in Ksh	Rate of tax % in each Ksh
1 - 9680	10
9681 - 18800	15
18801 – 27920	20
17921 – 37040	25
Excess over Ksh 37040	30

MrJuma earned a basic salary of Ksh 32000 and a house allowance of Ksh 10000 per month. He claimed a tax relief of Ksh 1400 per month.

a) Calculate:

i. his taxable income. (2mks)

T.I = B.S + Allowances
= 32,000 + 10,000 M1
= Ksh. 42,000. A1

ii. tax payable without relief. (3mks)

$9680 \times \frac{10}{100} = 968$
$9120 \times \frac{15}{100} = 1368$
$9120 \times \frac{20}{100} = 1824$ B1
$9120 \times \frac{25}{100} = 2280$
$4960 \times \frac{30}{100} = 1488$ B1
Sh. 7928. A1

Gross tax = Sh 7928.

iii. the tax paid after relief. (2mks)

Net tax = G.T − Relief
= 7928 − 1400 M1
= Sh. 6,528 A1

b) Other than tax, the following deductions are made: a service charge of sh 100, sacco loan of sh 3200, health insurance fund of sh 500 and burial benevolent fund of sh 300.
Calculate:

i. the total monthly deductions made from his income. (1mk)

= 100 + 3200 + 500 + 300 + 6528
= Sh. 10,628 A1

ii. his net income from his employement. (2mks)

Net pay = (B.S + Allowances) − All deduction
= 42,000 − 10,628 M1
= Sh. 31,372. A1