Name: MARKING SCHEME Index No.: ……………
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121/2
MATHEMATICS
Paper 2
September 2021
Time: 2½ Hours

BURAMU 2 JOINT EXAMINATIONS
The Kenya National Examinations Council

121/2
MATHEMATICS PAPER 2
September 2021
Time: 2½ Hours

Instructions to candidates

1. Write your name, admission number and class in the spaces provided above.
2. The paper contains two sections: **Section I** and **Section II**.
3. Answer **ALL** the questions in **Section I** and **ANY FIVE** questions from **Section II**.
4. All working and answers must be written on the question paper in the spaces provided below each question.
5. Marks may be awarded for correct working even if the answer is wrong.
6. Negligent and slovenly work will be penalized.
7. Non-programmable silent electronic calculators and mathematical tables are allowed for use.

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 booklet contains 15 printed pages. Please confirm that all the pages exist and are properly printed before starting the exam.

M1

1. a) Write down the expansion of $\left(1+\frac{1}{4}x\right)^4$ leaving your answer to 3 significant figure (1 marks)

$1.1^4 + 4.1^3(\frac{1}{4}x) + 6.1^2(\frac{1}{4}x)^2 + 4.1^1(\frac{1}{4}x)^3 + 1.1(\frac{1}{4}x)^4$

$1 + x + \frac{3}{8}x^2 + \frac{1}{16}x^3 + \frac{1}{256}x^4$ ✓

B1

b) Use it to find the value of 1.025^4 leaving your answer to 3 significant figure (2 marks)

$x = 0.1$

$1 + 0.1 + \frac{3}{8}(0.1)^2 + \frac{1}{16}(0.1)^3 + \frac{1}{256}(0.1)^4$ ✓ M1

$= 1.10$ ✓ A1

3

2. Solve the equations (4marks)

$x + y = 17$

$xy - 5x = 32$

$y = 17 - x$

$x(17-x) - 5x = 32$

$17x - x^2 - 5x = 32$

$x^2 - 12x + 32 = 0$ ✓ M1 – Quadratic Eqn.

$x^2 - 8x - 4x + 32 = 0$

$x(x-8) - 4(x-8) = 0$ ✓ M1 – Attempt to solve Quadratic equation.

$(x-8)(x-4) = 0$

$x = 8$ or $x = 4$ ✓ A1

If $x = 8$, $y = 9$

$x = 4$, $y = 13$. ✓ B1 – Both pairs Correct.

4

3. Omolo bought a new car for sh. 800 000. After 5 years, he sold the car at sh. 480 000. Calculate the annual rate of depreciation of the car as a percentage (3 marks)

$480{,}000 = 800{,}000\left(1-\frac{r}{100}\right)^5$ ✓ M1 – Sub. in Eqn.

$\left(1-\frac{r}{100}\right)^5 = 0.6$

$1 - \frac{r}{100} = 0.9029$ ✓ M1 – 5th root

$-\frac{r}{100} = -0.0971$

$r = 9.71\%$ ✓ A1

3

4. A box contains 5 red, 3 yellow and 12 blue biro pens. Two biro pens are pick[illegible] at random without replacement. Find the probability that only one of the biro pens picked is blue

(3 marks)

$P(1B) = P(RB) + P(YB)$

$= \frac{5}{20} \times \frac{12}{19} + \frac{3}{20} \times \frac{12}{19}$

$= \frac{24}{95}$

M1 – Identification of Probabilities

M1 – Attempt to find Prob.

A1

3

5. Evaluate $\int_{-2}^{3}(2x-4)dx$ ([illegible] marks)

$(x^2 - 4x)\Big|_{-2}^{3}$

$= (3^2 - 4\times3) - (2^2 + 4\times2)$

$= -15$

M1 – Correct Integration with Limits

M1 – Correct subst.

A1

3

6. A circle which passes through the point (3,-1) has its centre at (5, -1). Determi[illegible] equation of the circle in the form $x^2 + y^2 + ax + by + c = 0$ where a, b and c [illegible] constants ([illegible] marks)

$r^2 = (3-5)^2 + (1--1)^2$

$r^2 = 4$

$(x-3)^2 + (y+1)^2 = 4$

$x^2 - 6x + 9 + y^2 + 2y + 1 = 4$

$x^2 + y^2 - 6x + 2y + 6 = 0$

M1 – r Attempt for radius

A1 – Eqn of a Circle

B1 – r form.

3

7. Two grades of coffee one costing sh. 42 per kilogram and the other costing sh[illegible] kilogram are to be mixed in order to produce a blend worth sh. 46 per kilogra[illegible] in what proportion should they be mixed ([illegible] marks)

Ratio $x:y$

$\frac{42x+47y}{x+y} = 46$

$42x + 47y = 46x + 46y$

$4x = y$

$\frac{x}{y} = \frac{1}{4}$

Ratio = 1:4

M1 – ~~attempt~~ Eqn on cost per kg.

A1 –

B1 – Follow through.

3

8. Solve for n in the equation (marks)

$\frac{2}{3}\log x^4 - 2\log\sqrt[3]{x} = n\log x$

M1 – Writing both sides under one log.

$\log x^{8/3} - \log x^{2/3} = \log x^n$

M1 – Dropping logs

$\log \frac{x^{8/3}}{x^{2/3}} = \log x^n$ ✓

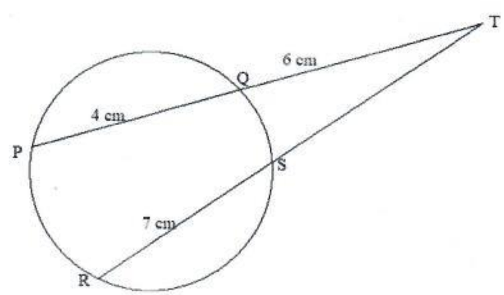
$x^2 = x^n$ ✓

A1

$n = 2$ ✓

3

9. In the figure below, chords PQ and RS intersect externally at T



Given that $PQ = 4\ cm$, $QT = 6cm$ and RS=7cm, find RT (marks)

M1 – Attempt to form the Eqn

$6 \times 10 = x(x+7)$ ✓

$x^2 + 7x - 60 = 0$

M1 ✓ attempt to solve eqn by any ✓ method

$x^2 + 12x - 5x - 60 = 0$

$x(x+12) - 5(x+12) = 0$ ✓

A1 → x

$(x+12)(x-5) = 0$

B1

$x = -12$ or $x = 5$

$\therefore x = 5$ ✓

$RT = 7 + 5$

$= 12$ ✓

4

10. A pyramid block has a square base whose side is exactly 7.5 cm. Its height m to the nearest millimetre is 3.5 cm. find the percentage error in calculating it correct to 3 decimal places (marks)

Min	Act	Max
7.5	7.5	7.5
3.45	3.5	3.55

B1 – Identification of Max and min

$Max = \frac{1}{3} \times 7.5^2 \times 3.55$

$Min = \frac{1}{3} \times 7.5^2 \times 3.45$

$Act = \frac{1}{3} \times 7.5 \times 3.5$

$AE = 9.375 \times 0.1$

$= 0.9375$ ✓

M1 – ✓ attempt to find AE.

$\%\ Error = \frac{0.9375}{8.75} \times 100$

A1

$= 10.7\%$ ✓

3

11. Solve without using tables or calculators, (3 marks)

$$\frac{sin480^0 - tan225^0}{\tan 45^0 - cos(-330)^0}$$

$= \dfrac{\frac{\sqrt{3}}{2} - 1}{1 - \frac{\sqrt{3}}{2}}$ ✓

$= \dfrac{\sqrt{3} - 2}{2 - \sqrt{3}}$

$\dfrac{(\sqrt{3} - 2)(2 + \sqrt{3})}{(2 - \sqrt{3})(2 + \sqrt{3})}$

$\dfrac{2\sqrt{3} + 3 - 4 - 2\sqrt{3}}{4 - 3}$ ✓

$= -1$

B1 - Trig ratios into surd form
M1 - Use of Conjugate
A1
3

12. Make m the subject the subject of the formula (3 marks)

$$V = \sqrt{\frac{a^2 - t^2}{\frac{1}{m^2} + k}}$$

$V^2 = \dfrac{a^2 - t^2}{1/m^2 + k}$ ✓

$\dfrac{V^2}{m^2} + V^2k = a^2 - t^2$

$\dfrac{V^2}{m^2} = a^2 - t^2 - V^2t$

$m^2 = \dfrac{V^2}{a^2 - t^2 - V^2t}$ ✓

$M = \pm\sqrt{\dfrac{V^2}{a^2 - t^2 - V^2t}}$ ✓

~~B1~~ M1 - Square on both sides
M1 - On One Side
A1 CAO
3

13. Object A of the area 10cm^2 is mapped onto its image B of area 60cm^2 by a transformation whose matrix is given by $P = \begin{pmatrix} x & 4 \\ 3 & x+3 \end{pmatrix}$. Find the possible values of x (4 marks)

$\dfrac{60}{10} = x^2 + 3x - 12$ ✓

$x^2 + 3x - 18 = 0$ ✓

$x^2 + 6x - 3x - 18 = 0$

$x(x+6) - 3(x+6) = 0$ ✓

$(x+6)(x-3) = 0$

$x = -6$ or $x = 3$ ✓

M1 - Eqn.
M1 - Q.E
M1 - Attempt to Solve
A1

14. Solve $2\sin(2x - 10)^0 = \sqrt{3}$ for $0^0 \leq x \leq 360^0$ (3 marks)

$2\sin(2x-10) = \sqrt{3}$

$\sin(2x-10) = \frac{\sqrt{3}}{2}$

$\sin w = \frac{\sqrt{3}}{2}$

$w = 60°$ ✓

$2x-10 = 60°, 120°, 420°, 480°$ ✓

$2x = 70°, 130°, 430°, 490°$

$x = 35°, 65°, 215°, 245°$ ✓

B1 - Acute Angle

B1 - Angles → 2x-10

B1 → All x.

3

15. Machine A can do a piece of work in 6 hours while machine B can do the same work in 9 hours. The machines started working together at the same time and after 3 hours machine A broke down and machine B did the rest of the work. Find how long machine B took to do the rest of the work (4 marks)

Fraction done In 1 hr

$A = \frac{1}{6}$

$B = \frac{1}{9}$ ✓

Fraction in 3hrs $= \left(\frac{1}{6} + \frac{1}{9}\right)3 = \frac{5}{6}$

Time by $B = \frac{1}{6} \times 9$ ✓

$= 1\frac{1}{2}$ ✓

B1 - Fraction in 1 hr (Both

M1 - Expression for 3 hrs.

M1 - Expr for B

A1

4

16. The following is the weight of some form one students in a school

30, 35, 48, 39, 41, 45, 42, 43, 49, 47

Find

a) Mean

$\frac{419}{10} = 41.9$

B1

b) the quartile deviation (3 marks)

30, 35, 39, 41, 42, 43, 45, 47, 48, 49

$Q_1 = 39$ ✓

$Q_3 = 47$ ✓

$Q.D = \frac{47-39}{2}$

$= 4$ ✓

B1

B1

B1

4

17. Three quantities R, S and T are such that R varies directly as S and inversely as the square root of T.

a) Given that $R = 480$ when $S = 150$ and $T = 25$, write the equation connecting R, S and T (4 marks)

$R \propto \frac{S}{\sqrt{T}}$ ✓

$R = \frac{kS}{\sqrt{T}}$

$480 = \frac{150k}{\sqrt{25}}$ ✓

$k = \frac{480 \times 5}{150}$

$k = 16$ ✓

$R = \frac{16s}{\sqrt{T}}$ ✓

B1 – ✓ relation

M1 – ✓ Subst

A1

B1

b) Find;

i) The value of R when $S = 360$ and $T = 2.25$ (2 marks)

$R = \frac{16 \times 360}{\sqrt{2.25}}$ ✓

$= 3,840$ ✓

M1

A1

ii) The percentage change in R if S is increased by 5% and T decreased by 15.36% (4 marks)

$R_1 = \frac{kS}{\sqrt{T}}$

$R_2 = \frac{1.05Sk}{\sqrt{84.64T}}$ ✓

$\% \Delta = \frac{\left(1 - \frac{1.05S}{\sqrt{84.64}}\right)\cancel{\frac{kS}{\sqrt{T}}}}{\cancel{\frac{kS}{\sqrt{T}}}} \times 100$ ✓

$\frac{163}{184} \times 100 = 88.59\%$ Decrease. ✓

or

$88\frac{27}{46}\%$.

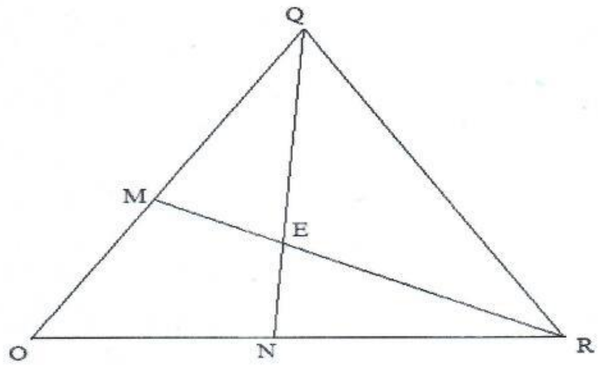
M1 – Exp. for New R

M1 – Exp. for Δ

M1 – Exp. for % Δ

A1 – Must have "Decrease"

18. In the figure below $\boldsymbol{OQ} = \boldsymbol{q}$ and $\boldsymbol{OR} = \boldsymbol{r}$. point M divides **OQ** in the ration 1:[illegible] N divides **OR** in the ratio 3:4. Lines **MR** and **NQ** intersect at E



a) Express in terms of **q** and **r**

i) **MR** (1 mark)

$-\frac{1}{3}\underset{\sim}{q} + \underset{\sim}{r}$

B1

ii) **NQ** (1 mark)

$-\frac{3}{7}\underset{\sim}{r} + \underset{\sim}{q}$

B1

b) If **ME** = s **MR** and **NE** = t **NQ** , express **OE** in terms of;

i) **r, q** and s (1 mark)

$\underset{\sim}{OE} = \frac{1}{3}\underset{\sim}{q} + s(-\frac{1}{3}\underset{\sim}{q} + \underset{\sim}{r})$

$\underset{\sim}{OE} = \underset{\sim}{q}(\frac{1}{3} - \frac{1}{3}s) + \underset{\sim}{r}\, s.$ ✓

B1 or at Earliest stage

ii) **r, q** and t (1 mark)

$\underset{\sim}{OE} = \frac{3}{7}\underset{\sim}{r} + t(-\frac{3}{7}\underset{\sim}{r} + \underset{\sim}{q})$

$= \underset{\sim}{r}(\frac{3}{7} - \frac{3}{7}t) + \underset{\sim}{q}t.$ ✓

B1 or at Earliest stage

c) find the value of s and t using the results in b) above (4 marks)

$\frac{1}{3} - \frac{1}{3}s = t$

$3t + s = 1$ *

$\frac{3}{7} - \frac{3}{7}t = s$

$3t + 7s = 3$ *

$3t + s = 1$

$3t + 7s = 3$

$6s = 2$

$s = \frac{1}{3}$

$3t + \frac{1}{3} = 1$

$t = \frac{2}{9}$

B1 – Both pairs

M1 – Attempt to solve One Unknown.

A1

B1

d) show that M, E and R are collinear (2 marks)

$\underset{\sim}{ME} = \frac{1}{3}MR$ ✓

ME // MR and M is a Common point ✓

B1

B1

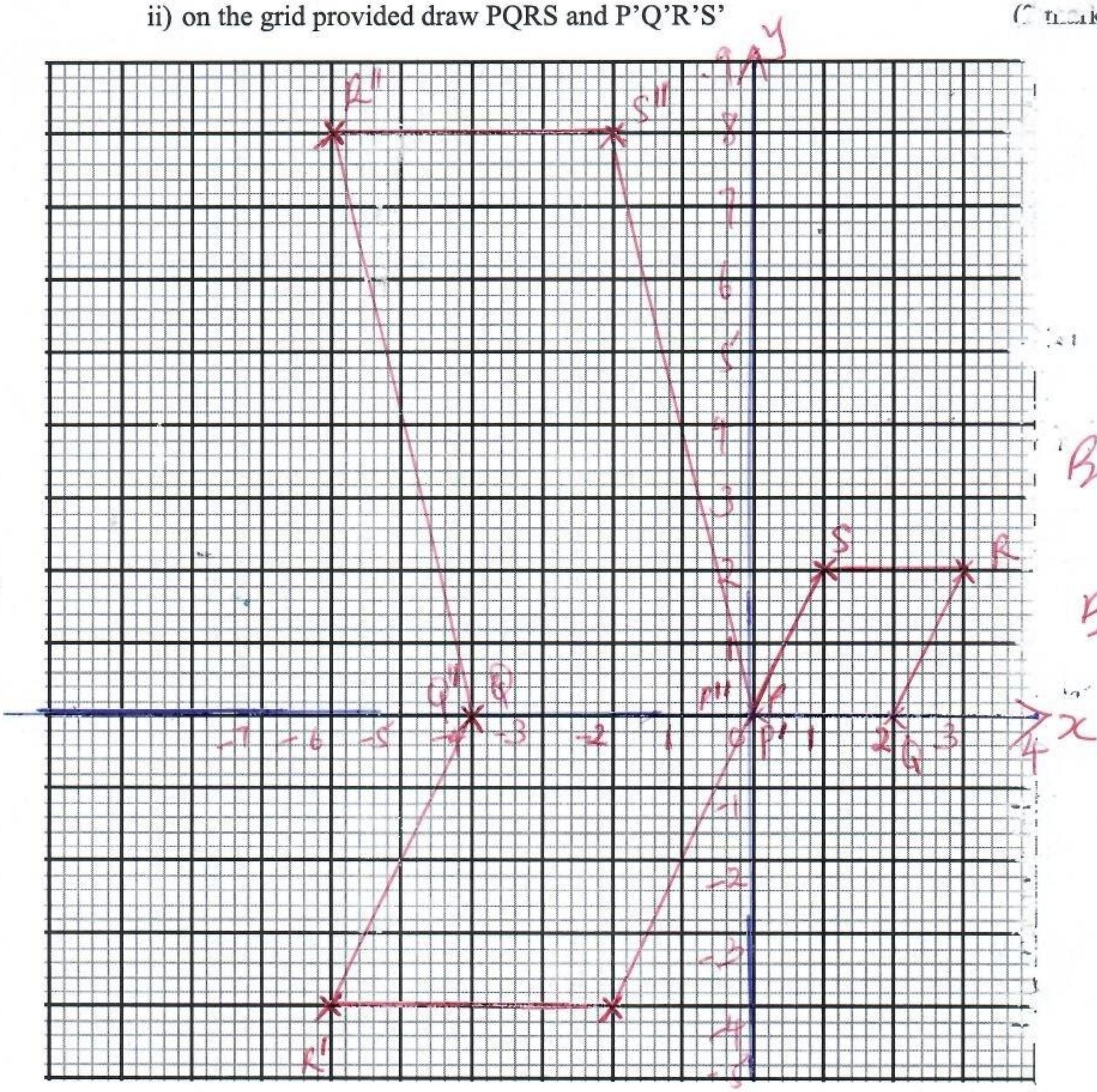
19. PQRS is a rectangle with vertices P(0,0), Q(2,0), R(3,2) and S(1,2). P'Q'R'S' is the image of PQRS under transformation $\begin{pmatrix} -2 & 0 \\ 0 & -2 \end{pmatrix}$

a) i) Find the coordinates of P'Q'R'S' (2 marks)

$$\begin{pmatrix} -2 & 0 \\ 0 & -2 \end{pmatrix}\begin{array}{cccc} P & Q & R & S \\ \end{array}\begin{pmatrix} 0 & 2 & 3 & 1 \\ 0 & 0 & 2 & 2 \end{pmatrix} = \begin{array}{cccc} P' & Q' & R' & S' \\ \end{array}\begin{pmatrix} 0 & -4 & -6 & -2 \\ 0 & 0 & -4 & -4 \end{pmatrix} \checkmark \quad B1$$

P'(0,0), Q'(-4,0), R'(-6,-4), S'(-2,-4). ✓ B1

ii) on the grid provided draw PQRS and P'Q'R'S' (2 marks)



B1

B1

b) i) Find P''Q''R''S'' the image of P'Q'R'S' under the transformation matrix $\begin{pmatrix}1 & 0\\0 & -2\end{pmatrix}$. (… marks)

$$\begin{pmatrix}1 & 0\\0 & -2\end{pmatrix}\begin{array}{cccc} P' & Q' & R' & S' \\ \end{array}\begin{pmatrix}0 & -4 & -6 & -2\\0 & 0 & -4 & -4\end{pmatrix} = \begin{array}{cccc} P'' & Q'' & R'' & S'' \\ \end{array}\begin{pmatrix}0 & -4 & -6 & -2\\0 & 0 & 8 & 8\end{pmatrix}$$

M1

A1

ii) on the same grid draw P''Q''R''S'' (… mark)

B1

c) find the single transformation that maps P''Q''R''S'' onto PQRS (3 marks)

$$\begin{pmatrix}1 & 0\\0 & -2\end{pmatrix}\begin{pmatrix}-2 & 0\\0 & -2\end{pmatrix} = \begin{pmatrix}-2 & 0\\0 & 4\end{pmatrix}$$ ✓

B1

Inverse $\Rightarrow -\frac{1}{8}\begin{pmatrix}4 & 0\\0 & -2\end{pmatrix}$ ✓

B1

$$= \begin{pmatrix}-\frac{1}{2} & 0\\0 & \frac{1}{4}\end{pmatrix}$$ ✓

B1

10

20. The product of the first three terms of a geometric progression is 64. If the first term is a and the common ration is r

a) Express r in term of a (3 marks)

a, ar, ar^2

$a^3r^3 = 64$ ✓

$ar = 4$ ✓

$r = \frac{4}{a}$ ✓

M1 –

M1 – Cube root

A1

b) Given that the sum of the three terms is 14;

i) Find the values of a and r hence write down two possible sequences each upto 4th term (5 marks)

$a, 4, \frac{16}{a}$

$a + 4 + \frac{16}{a} = 14$ M1

$a^2 - 10a + 16 = 0$ ✓

$a^2 - 8a - 2a + 16 = 0$

$a(a-8) - 2(a-8) = 0$ ✓

$(a-8)(a-2) = 0$

$a = 8$ or $a = 2$ ✓

If $a = 8$, $r = \frac{1}{2}$

If $a = 2$, $r = 2$ ✓

i) $8, 8\times\frac{1}{2}, 8\times\left(\frac{1}{2}\right)^2, 8\times\left(\frac{1}{2}\right)^3$

$8, 4, 2, 1$ ✓

ii) $2, 2\times2, 2\times2^2, 2\times2^3$

$2, 4, 8, 16$ ✓

M1 – Formation of Q.E

M1 – Attempt to Solve Q.E

A1 – Both a

B1 – Both pairs

B1 – Both

ii) Find the product of the 50th terms of the two sequences (2 marks)

$8\times\left(\frac{1}{2}\right)^{49} \times 2\times(2)^{49}$ ✓

$= 16.$ ✓

M1

A1

21. Owiti makes two types of dresses; A and B. He takes 3 hours to make one pair of type A dress and 4 hours to make one pair of type B dress. He works for a maximum of 120 hours to make x pairs of Type A and y pairs of type B. it costs him sh. 400 to make a pair of type A and sh. 150 to make a pair of type B. His total cost does not exceed sh. 9000. He must make atleast 8 pairs of type A and more than 12 pairs of type B

a) Write down four inequalities representing the above information (4 marks)

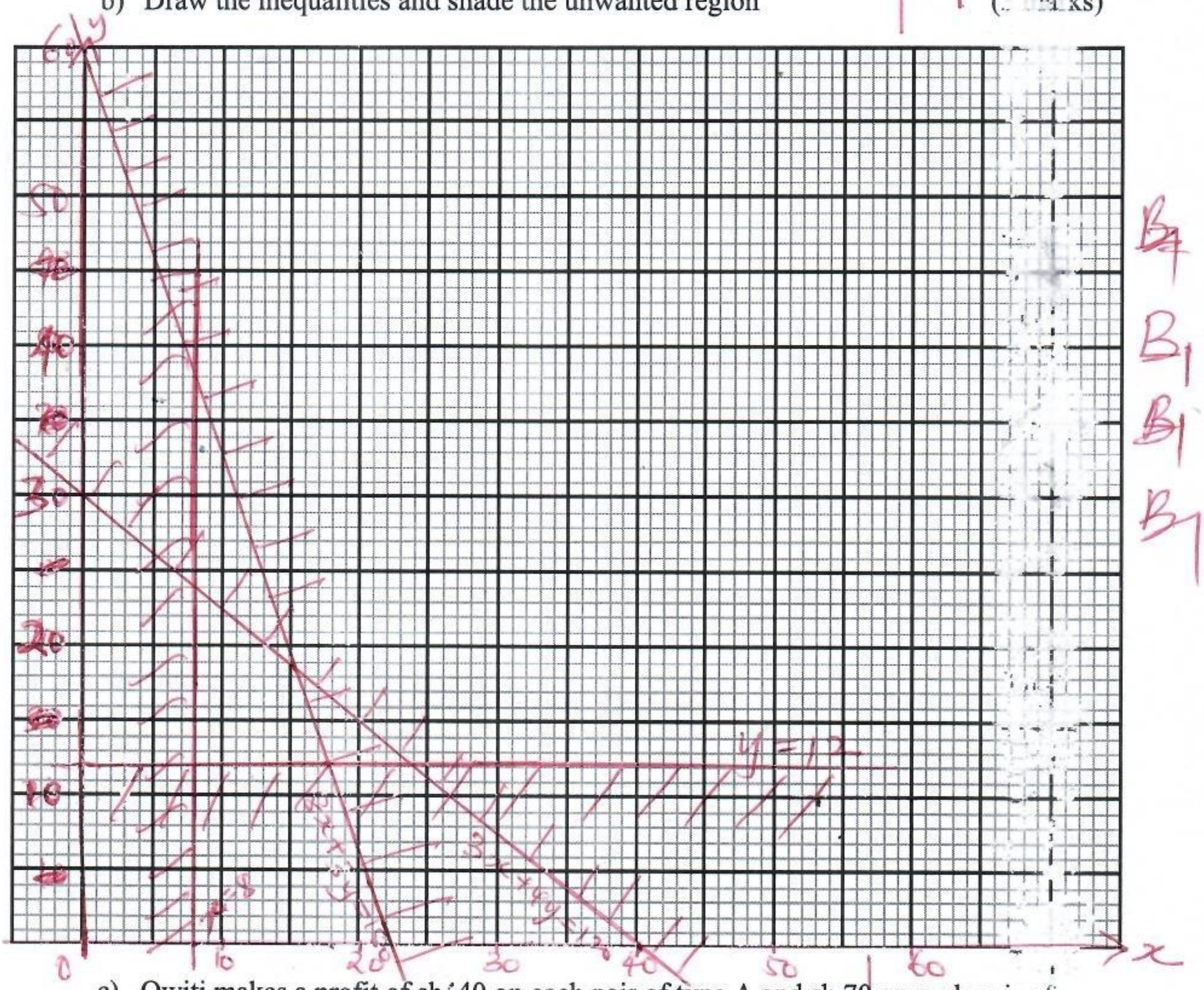
$3x + 4y \leq 120$ ✓ B1

$8x + 3y \leq 180$ ✓ or $400x + 150y \leq 9000$ B1

$x \geq 8$ ✓ B1

$y \geq 12$ ✓ B1

b) Draw the inequalities and shade the unwanted region (… marks)



c) Owiti makes a profit of sh. 40 on each pair of type A and sh.70 on each pair of type B dresses. Use the graph in part (b) above to determine the maximum possible profit he makes (… marks)

$40x + 70y = z$

(15, 19), (8, 30). ✓

(18, 12)

$40 \times 8 + 70 \times 30$ ✓

$= 2,420$

B1 atleast 3 points

M1

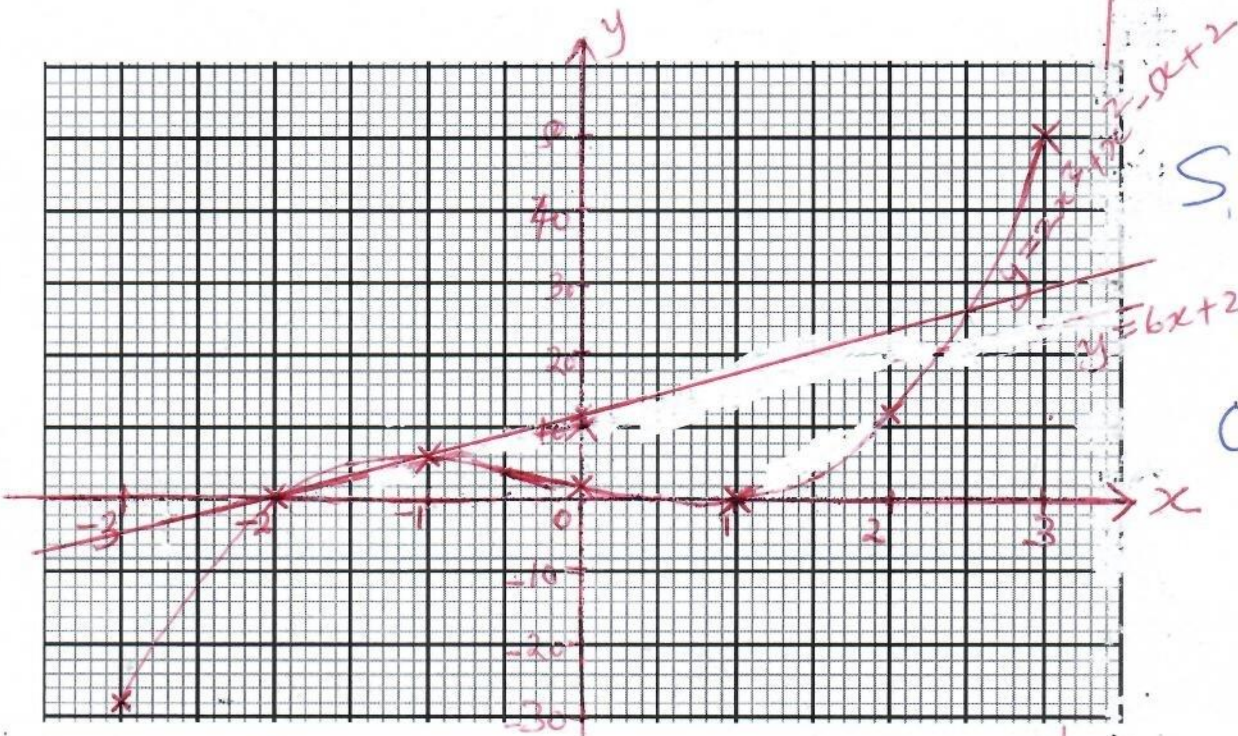
A1

22. Fill the table below for the graph of $y = 2x^3 + x^2 - 5x + 2$ (2 marks)

x	-3	-2	-1	0	1	2	3
y	-28	0	6	2	0	12	50

B1 → $4 \leq y \leq 6$
B2 all correct.

a) Draw the graph of $y = 2x^3 + x^2 - 5x + 2$ for the interval $-3 \leq x \leq 3$ on the grid provided below (scale y –axis: 1 cm rep 10 units, x-axis: 1 cm rep 0.5 units) (3 marks)



S1
P1
C1

b) Use your graph to solve the equations

i) $2x^3 + x^2 - 5x + 2 = 0$ (1 mark)

$x = -2,\ x = 0.5,\ x = 1.$

B1

ii) $2x^3 + x^2 - 11x - 10 = 0$ (3 marks)

$y = 2x^3 + x^2 - 5x + 2$
$0 = 2x^3 + x^2 - 11x - 10$
$y = 6x + 12$ ✓

x	0	-2
y	12	0

$x = -2,\ x = -1$
$x = 2.5$

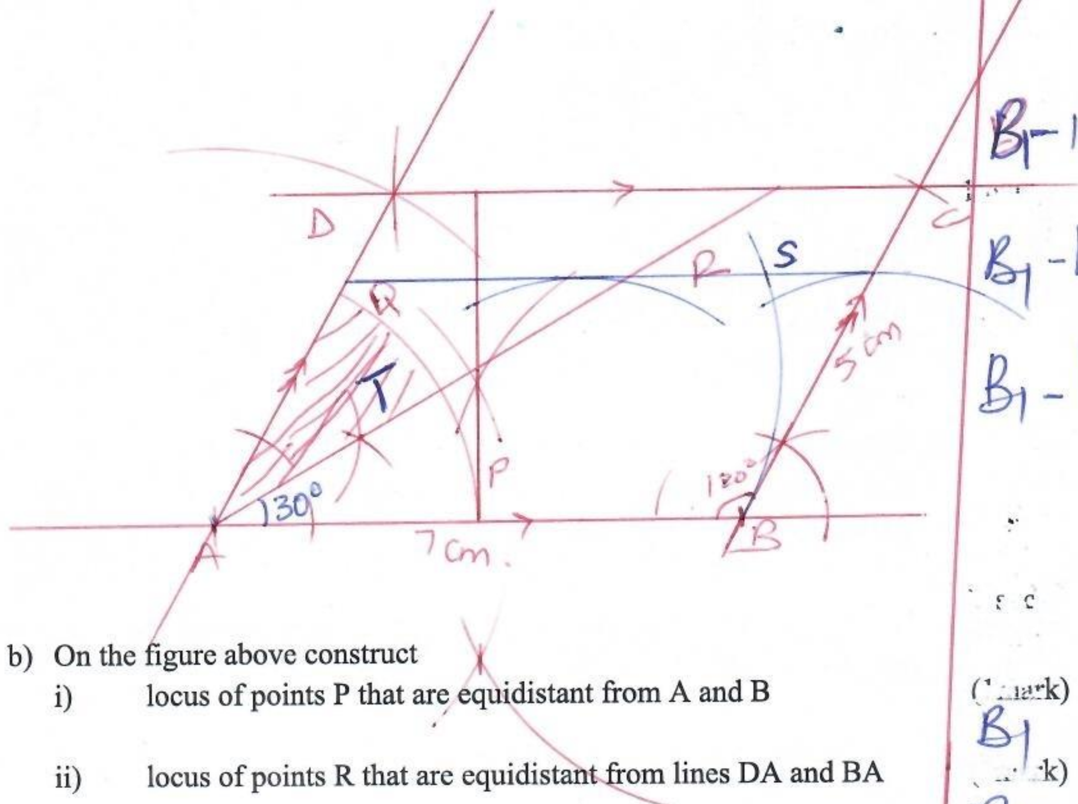
B1 → $y = 6x + 12$
L1 →
B1

c) Calculate the acute angle the line in b ii) above makes with the y-axis (1 mark)

~~Tan~~ $m = 6.$
$\tan \theta = 1/6$
$\theta = 9.462°.$

B1

23. a) Using a ruler and a pair of compasses only, construct a parallelogram ABCD such that AB= 7cm, BC= 5cm and angle ABC =120^0 (3marks)



B1 – 120° Constr.

B1 - Location of C

B1 - location D.

b) On the figure above construct

i) locus of points P that are equidistant from A and B (1 mark)

B1

ii) locus of points R that are equidistant from lines DA and BA (1 mark)

B1

iii) locus of point Q such that AQ = 3.5 cm (1 mark)

B1

c) Locate and shade a region T inside the parallelogram such that AT≤ BT, angle DAT≤ $angle\ BAT$ and AT ≥ 3.5 cm (1 mark)

B1

d) locate a point S above AB such that angle ASB =60^0 and S is always 3.2 cm from line AB (3 marks)

B1 – Parallel.

B1 – Location of Centre.

B1-Location of S

24. An aircraft leaves town P(30^0S,17^0E) and moves directly northwards to Q(60^0N,17^0E). It then moved at an average speed of 300 knots for 8 hours wes[illegible]ds to town R.

Determine;

a) The distance PQ in nautical miles (2 marks)

$PQ = 90 \times 60$

$= 5400$

B1

M1

A1

b) The position of town R (3marks)

Distance $= 300 \times 8 = 2400$

$2400 = \theta 60 \cos 60$

$\theta = \frac{2400}{60 \cos 60}$

$\theta = 80^\circ$

$R(60^\circ N, 63^\circ W)$

M1 – Eqn for distance

A1 – θ

B1 – R

c) The local time at R if the local time at Q is 3:12pm (2 marks)

Time difference $= \frac{80 \times 4}{60} = 5$ hrs 20min

B1 – Time diff.

$$\begin{array}{r} 15\,12 \\ -\ 5\,20 \\ \hline 9\,52 \end{array}$$

9.52am Same day.

B1

d) The total distance moved from P to R in kilometres. Take 1 nm= 1.853km (2 marks)

$(5400 + 2400)1.853$

$= 7800 \times 1.853$

$= 14,453.4.$

M1

A1

16