Name: ....Class: .... Adm.No........

School: .... Date: ....

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121/2
MATHEMATICS
PAPER 2
TIME: 2 ½ HOURS

SUKELLEMO PRE-MOCK E X A M I N A T I O N - JUNE 2022
Kenya Certificate to Secondary Education
MATHEMATICS (PAPER 2)
TIME: 2 ½ HOURS

Instructions

- *Write your name, class, admission number, school, date and signature in spaces provided above.*
- *The paper contains **two** sections **I** and **II.***
- *Answer **all** questions in section **I** and **any five** questions from section **11** in the spaces provided below each question.*
- *Show all the steps in your calculations giving your answers at each stage in the spaces below each question.*
- *Non-programmable silent electronic calculator and mathematical tables may be used except where stated otherwise.*

For Examiner's Use Only

SECTION A

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

SECTION B

17	18	19	20	21	22	23	24	TOTAL

PERCENTAGE

SCORE

SECTION I (50 MARKS)

*Answer **all** the questions from this section*

1. The expression $(1 + \frac{x}{2})$ is taken as an approximation for $\sqrt{1+x}$. Find the percentage error in doing so if x = 0.44. (Give answer correct to 2 d.p) (3 Marks)

$1 + \frac{0.44}{2}$

$1 + 0.22 = 1.22$

$\sqrt{1 + 0.44}$

$= 1.2$ M1

Error $= 1.22 - 1.2$ M1

$= 0.02$

$\frac{0.02}{1.2} \times 100$

$= 1.67\%$ A1

2. Express the following in surd form and simplify by rationalizing the denominator. (3 Marks)

$\frac{1}{\cos 60^\circ - \sin 45^\circ}$

$\frac{1}{\frac{1}{2} - \frac{1}{\sqrt{2}}}$ B1

$\frac{1}{\frac{\sqrt{2}-2}{2\sqrt{2}}} = \frac{2\sqrt{2}}{\sqrt{2}-2}$

$\frac{2\sqrt{2}}{\sqrt{2}-2} \times \frac{\sqrt{2}+2}{\sqrt{2}+2}$ M1

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

$= -2 - 2\sqrt{2}$ A1

3. Make q the subject of the formula (3 Marks)

$P = \sqrt[3]{\frac{nq-m}{q}}$

$p^3 = \frac{nq-M}{q}$ M1

$p^3q = nq - M$

$p^3q - nq = -M$ M1

$\frac{q(p^3-n)}{p^3-n} = \frac{-M}{p^3-n}$

$q = \frac{-M}{p^3-n}$ A1

4. The data below shows the age of 10 pupils picked at random in a primary school 6, 11, 13, 14, 8, 7, 12, 20, P and 9 if $\sum fx^2 = 1360$. Determine the value of P hence, find the standard Deviation to 3d.p (4 Marks)

$36+49+64+81+100+121+144+169+196+400+p^2$

$1260+p^2=1360$ M1

$p^2=100$

$P=10$ M1

$S.d = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$

$= \sqrt{\frac{1360}{10} - \left(\frac{110}{10}\right)^2}$ M1

$= \sqrt{136-121}$

$= \sqrt{15}$

$= 3.873$ A1

5. The volume, V of a cylinder varies jointly as its height, (h) and the square of its radius, (r), Calculate the percentage increase in its volume (V), when radius increases by 5% and height, h increases by 10%. (3 Marks)

$V \propto \pi r^2 h$

$V = \pi r^2 h$

$V_1 = \pi r_1^2 h_1$

$V_1 = \pi (1.05)^2 \times 1.1 r^2 h$ M1

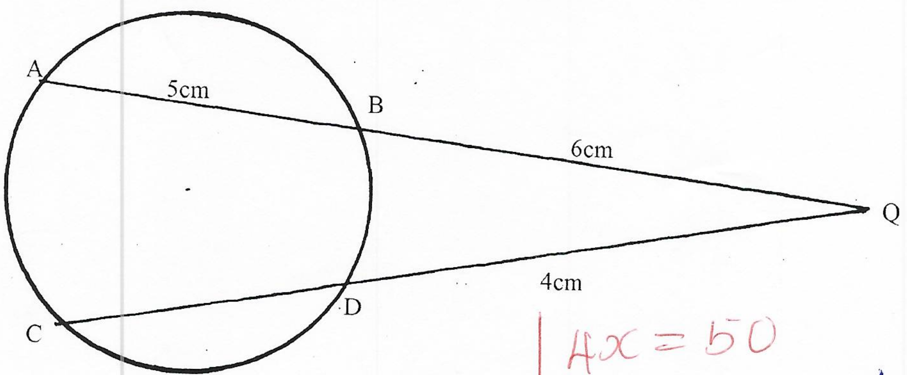
$V_1 = 1.1025 \times 1.1 \pi r^2 h$

$= 1.21275V$

$= \frac{1.21275V - V}{V}$ M1

$= 21.275\%$ A1

6. Chords AB and CD in the figure below intersect externally at Q. if AB = 5cm BQ = 6cm and DQ = 4cm, calculate the length of chord CD. (2 Marks)



$AQ \cdot QB = CQ \cdot QD$

$11 \times 6 = (x+4)4$ M1

$66 = 4x+16$

$4x = 50$

$x = 12.5$ A1

7. Jane can do a piece of job in 4 days while Mary can do the same piece of work in 7 days. Mary and Jane did the job together for two days before Jane fell sick. Mary was left to complete the job. How long did it take to do the job? (3 Marks)

$\left(\frac{1}{4}+\frac{1}{7}\right)2$

$\frac{11}{28}\times 2$

$=\frac{11}{14}$ work done M1

Rem $=\frac{3}{14}$

1 day $\Rightarrow \frac{1}{7}$

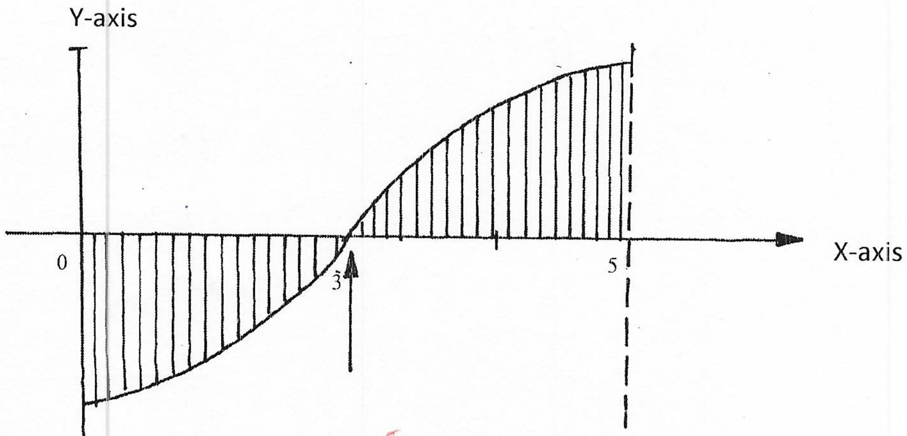
$\frac{3}{14}$

$=\frac{3}{14}\times\frac{7}{1} = 1\frac{1}{2}$ M1

$1\frac{1}{2}+2$

$=3\frac{1}{2}$ days A1

8. The sketch below represents the graph of $y=x^2-x-6$. Find the area bounded by the curve, x-axis, y-axis and the line x=5. (3 Marks)



$A = \int_0^3 (x^2-x-6)dx + \int_3^5 x^2-x-6$

$=\left[\frac{x^3}{3}-\frac{x^2}{2}-6x\right]_0^3 + \left[\frac{x^3}{3}-\frac{x^2}{2}-6x\right]_3^5$ M1

$\left(\frac{27}{3}-\frac{9}{2}-18\right)-(0)+\left(\frac{125}{3}-\frac{25}{2}-30\right)-\left(\frac{27}{3}-\frac{9}{2}-18\right)$ M1

$(-13.5)+-\frac{5}{6}+13\frac{1}{2}$

$=13\frac{1}{2}+12\frac{2}{3}$

$=26\frac{1}{6}$ sq units A1

9. Use matrix method to determine the co-ordinates of the point of intersection of the two lines. 3x-2y=13, 2y+x+1=0 (3 Marks)

$3x-2y=13$
$x+2y=-1$

$\begin{pmatrix}3 & -2\\ 1 & 2\end{pmatrix}\begin{pmatrix}x\\ y\end{pmatrix}=\begin{pmatrix}13\\ -1\end{pmatrix}$ M1

Det $=8$

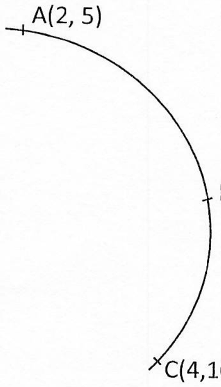
$\begin{pmatrix}\frac{1}{4} & \frac{1}{4}\\ -\frac{1}{8} & \frac{3}{8}\end{pmatrix}\begin{pmatrix}3 & -2\\ 1 & 2\end{pmatrix}\begin{pmatrix}x\\ y\end{pmatrix}=\begin{pmatrix}\frac{1}{4} & \frac{1}{4}\\ -\frac{1}{8} & \frac{3}{8}\end{pmatrix}\begin{pmatrix}13\\ -1\end{pmatrix}$ M1

$\begin{pmatrix}1 & 0\\ 0 & 1\end{pmatrix}\begin{pmatrix}x\\ y\end{pmatrix}=\begin{pmatrix}\frac{13}{4}-\frac{1}{4}\\ -\frac{13}{8}-\frac{3}{8}\end{pmatrix}$

$\begin{pmatrix}x\\ y\end{pmatrix}=\begin{pmatrix}3\\ -2\end{pmatrix}$

$x=3$
$y=-2$ A1

10. The figure **below** shows an arc of a circle through three points A, B and C.



Calculate the co-ordinates of the centre of the circle. (4 Marks)

$\left(\frac{2+3}{2}, \frac{5+8}{2}\right)=(2.5, 6.5)$

$\left(\frac{3+4}{2}, \frac{8+10}{2}\right)=(3.5, 9)$

gradient AB $=\frac{8-5}{3-2}=3$

$\frac{y-6.5}{x-2.5}=-\frac{1}{3}$

$3y-19.5=-x+2.5$
$3y+x=22$ M1

gradient BC $=\frac{10-8}{4-3}=2$

$\frac{y-9}{x-3.5}=-\frac{1}{2}$

$2y-18=-x+3.5$
$2y+x=21.5$ M1

$3y+x=22$ −
$2y+x=21.5$ M1
$y=0.5$

$2(0.5)+x=21.5$
$1+x=21.5$
$x=20.5$

C $(20.5, 0.5)$ A1

11. A bag contains 4 white balls and 5 Red balls of similar shape and size. Two balls are picked at random without replacement. Find the probability that both balls are:

a) White (1 Mark)

$\frac{4}{9} \times \frac{3}{8} = \frac{1}{6}$ B1

b) Of different colour (2 Marks)

$\left(\frac{4}{9} \times \frac{5}{8}\right) + \left(\frac{5}{9} \times \frac{4}{8}\right)$ M1 $= \frac{5}{9}$ A1

$= \frac{5}{18} + \frac{5}{18}$

12. A point $P(2,-3)$ undergoes transformation represented by the matrix $\begin{pmatrix} 3 & 0 \\ 0 & 1 \end{pmatrix}$. **Find** the Co-ordinate of the image of P. (2 Marks)

$\begin{pmatrix} 3 & 0 \\ 0 & 1 \end{pmatrix} \overset{P}{\begin{pmatrix} 2 \\ -3 \end{pmatrix}} = \overset{P'}{\begin{pmatrix} 6 \\ -3 \end{pmatrix}}$ M1

$P'(6,-3)$ A1

13. Expand $(2+x)^6$ up to the fourth term. (2 Marks)

$2^6 + 6(2^5)x + 15(2)^4x^2 + 20(2)^3x^3$ B1

$= 64 + 192x + 240x^2 + 160x^3$ B1

Hence use the above expansion to evaluate $(1.96)^6$ correct to 4 d.p. (2 Marks)

$(2+x)^6 = (2-0.04)^6$

$x = -0.04$

$64 + 192(-0.04) + 240(-0.04)^2 + 160(-0.04)^3$ M1

$64 - 7.68 + 0.384 - 0.01024$

$= 56.6938$ A1

14. Find the value of x in the equation $10\sin^2 x - 7\cos x + 2 = 0$ for the range $270^\circ \leq x \leq 360^\circ$

(3 Marks)

$10(1-\cos^2 x) - 7\cos x + 2 = 0$

$10 - 10\cos^2 x - 7\cos x + 2 = 0$

$10\cos^2 x + 7\cos x - 12 = 0$ M1

$10y^2 + 7y - 12 = 0$

$10y^2 + 15y - 8y - 12 = 0$

$5y(2y+3) - 4(2y+3) = 0$

$(5y-4)(2y+3) = 0$ M1

$y = \frac{4}{5}$ or $2y = -3$

$y = 0.8$ or $y = -1.5$ ignore

$\cos x = 0.8$

$x = 36.87$

$360 - 36.87$

$= 323.13^\circ$ A1

15. Find the value of x in

(3 Marks)

Log(x-2) + log (x+1) = 1 + log 4

$\log x-2 + \log x+1 = \log 10 + \log 4$ M1

$\log((x-2)(x-1)) = \log(10 \times 4)$

$(x-2)(x-1) = 40$

$x^2 - x - 42 = 0$ M1

$x(x-7) + 6(x-7) = 0$

$x = -6$ or 7 A1

ignore

Alternatively

$\log(x-2) + \log(x+1) - \log 4 = 1$

$\log\left(\frac{(x-2)(x+1)}{4}\right) = 1$ M1

$\frac{(x-2)(x+1)}{4} = 10$

$(x-2)(x+1) = 40$

$x^2 - x - 42 = 0$ M1

$x = -6$ or $x = 7$ A1

ignore

16. The sum of two numbers is 9. The sum of the square of the number is 41. Find the numbers

(4 Marks)

$\left.\begin{array}{l} x + y = 9 \\ x^2 + y^2 = 41 \end{array}\right\}$ M1

$y = 9 - x$

$x^2 + (9-x)^2 = 41$

$x^2 - 9x + 20 = 0$ M1

$x(x-5) - 4(x-5) = 0$

$(x-4)(x-5) = 0$

$x = 4$ or $x = 5$ A1

$\left.\begin{array}{l} \text{when } x = 4 \\ \quad y = 5 \\ \text{when } x = 5 \\ \quad y = 4 \end{array}\right\}$ B1

SECTION II (50 MARKS)

*Answer **FIVE** questions **ONLY** from this section*

17. The table below shows the taxation rates for income earned.

Income in ksh pm	Tax rates (%)
1 – 9680	10
9681 – 18800	15
18801 – 27920	20
27921 – 37040	25
Excess over 37041	30

In that year, Mr. Hamisi paid a net tax of KSh. 5,512 per month. He gets a house allowance of KShs. 10,000, medical allowance of KShs. 2400 and acting allowance of KShs. 2820 per month. He was entitled to a monthly personal relief of KShs. 162. He has a life insurance policy for which he pays a monthly premium of KSh. 1,500 and claims a relief at a rate of 10% of the premium paid per month. The following deductions also made every month.

(i) N.H.I.F. KSh. 320

(ii) Co-operative society shares KSh. 6000

(iii) Union dues KSh. 200

(a) Calculate Mr. Hamisi's monthly basic salary in KSh. (7 Marks)

Gross tax = 5512+162+150 M1

= 5824

9680 x 0.1 = 968

9120 x 0.15 = 1368 M1

9120 x 0.2 = 1824 M1

y x 0.25 = 1664

y = 6656 M1

27920 + 6656 M1

= 34576

34576 − (10000+2400+2820) M1

= 19356. A1

(b) Calculate his net monthly salary. (3 Marks)

34576 − (5512 + 320 + 6000 + 200 + 1500) M1

= 34576 − 13532 M1

= 21,044 A1

18. A jet leaves town P(30°S, 26°W) at 2.00 p.m on Monday and flew due \north to town Q(50°N,26°W).

a) Calculate the distance covered by the jet in Km. (take $\prod = {}^{22}/_{7}$ and R=6370) (3 Marks)

Angle diff $= 30+50 = 80^0$ B1

$PQ = \frac{80}{360} \times 2 \times \frac{22}{7} \times 6370$ M1

$= 8898$ KM. A1

b) After 35 min stoppage at town Q the jet flew due East to town R a distance of 2500 nautical miles from town Q.

Find i) the position of town R (3 Marks)

$\alpha \times 60 \cos 50 = 2500$ M1

$\alpha = \frac{2500}{60 \cos 50}$

$= 64.82^0$ A1

$64.82^0 - 26^0 = 38.82$.

$R(50^0N, 38.82^0E)$. B1

ii) The local time the jet landed at R if its average speed for the whole journey is 1000km/h.

(Take 1nm=1.853km) (4 Marks)

Total distance $= (8898 + (2500 \times 1.853))$ M1

$= 13530.5$ KM.

Time taken $= \frac{13530.5}{1000}$ M1

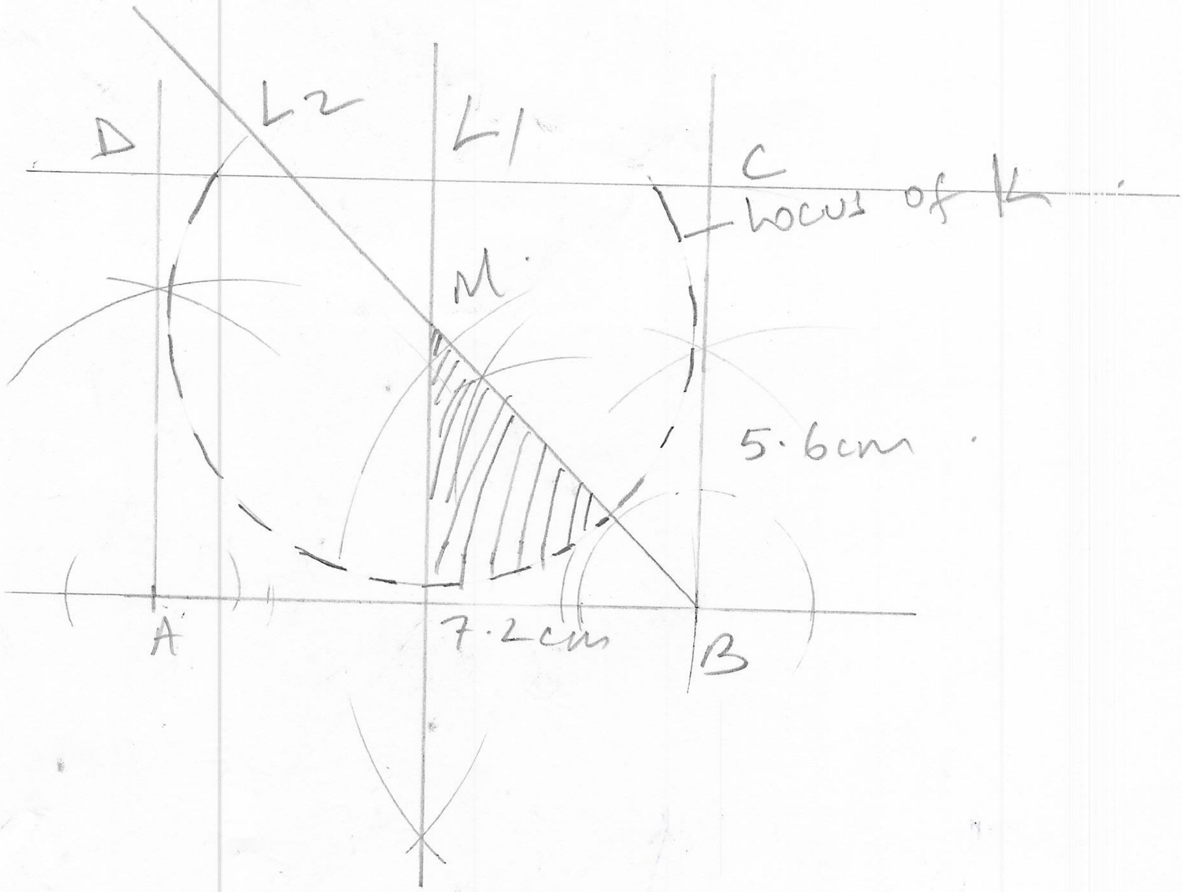
$= 13.5305$ hrs.

Local time at R. $= 2.00 + \underset{hrs}{13.5305} + \underset{Min}{35} + \left(\frac{4 \times 64.82}{60}\right)$ M1

8.26 a.m. Tuesday. A1

19. Use a ruler and a pair of compasses only in all constructions in this question.

(a) Construct the rectangle ABCD such that AB = 7.2cm and BC = 5.6cm. (3 Marks)



b) Constructs on the same diagram the locus L_1 of points equidistant from A and B to meet with another locus L_2 of points equidistant from AB and BC at M. Measure the acute angle formed at M by L_1 and L_2. 45^0 (3 Marks)

c) Construct on the same diagram the locus of point K inside the rectangle such that K is less than 3.5cm from point M. Given that point K is nearer to B than A and also nearer to BA than BC, shade the possible region where K lies. Hence calculate the area of this region. Correct to one decimal place. (4 marks)

$\frac{45}{360} \times \frac{22}{7} \times 3.5^2 = 4.8125 \text{ cm}^2.$

20. (a) The first term of a geometric progression is 36.the sum of the first three terms is 27.

Calculate the common ratio and the value of the second term (4 Marks)

$a + ar + ar^2 = 27$

$36 + 36r + 36r^2 = 27$ M1

$36r^2 + 36r + 9 = 0$ M1

$4r^2 + 4r + 1 = 0$

$2r + 1 = 0$

$r = -\frac{1}{2}$ A1

2nd term $= -\frac{1}{2} \times 36$

$= -18$ B1

(b)The first term of an AP is 2.the first term of a geometric sequence is also 2 and its common ratio equals the common difference of the arithmetic sequence. The square of the fifth term of arithmetic sequence exceeds the third term of the geometric sequence by 2. Find the common difference and the sum of the first 50 terms of an AP. (6 Marks)

$a = 2 \quad r = d$

$(a + 4d)^2 = 2r^2 + 2$

$(2 + 4d)^2 = 2d^2 + 2$ M1

$4 + 16d + 16d^2 = 2d^2 + 2$ M1

$14d^2 + 16d + 2 = 0$

$7d^2 + 8d + 1 = 0$ M1

$7d^2 + 7d + d + 1 = 0$

$7d(d+1) + 1(d+1) = 0$

$(7d + 1)(d + 1) = 0$

$d = -\frac{1}{7}$ or $d = -1$ A1

$S_{50} = \frac{50}{2}\{4 + (50-1) - 1\}$

$= 25(4 - 49)$

$= -1125$ B1

or

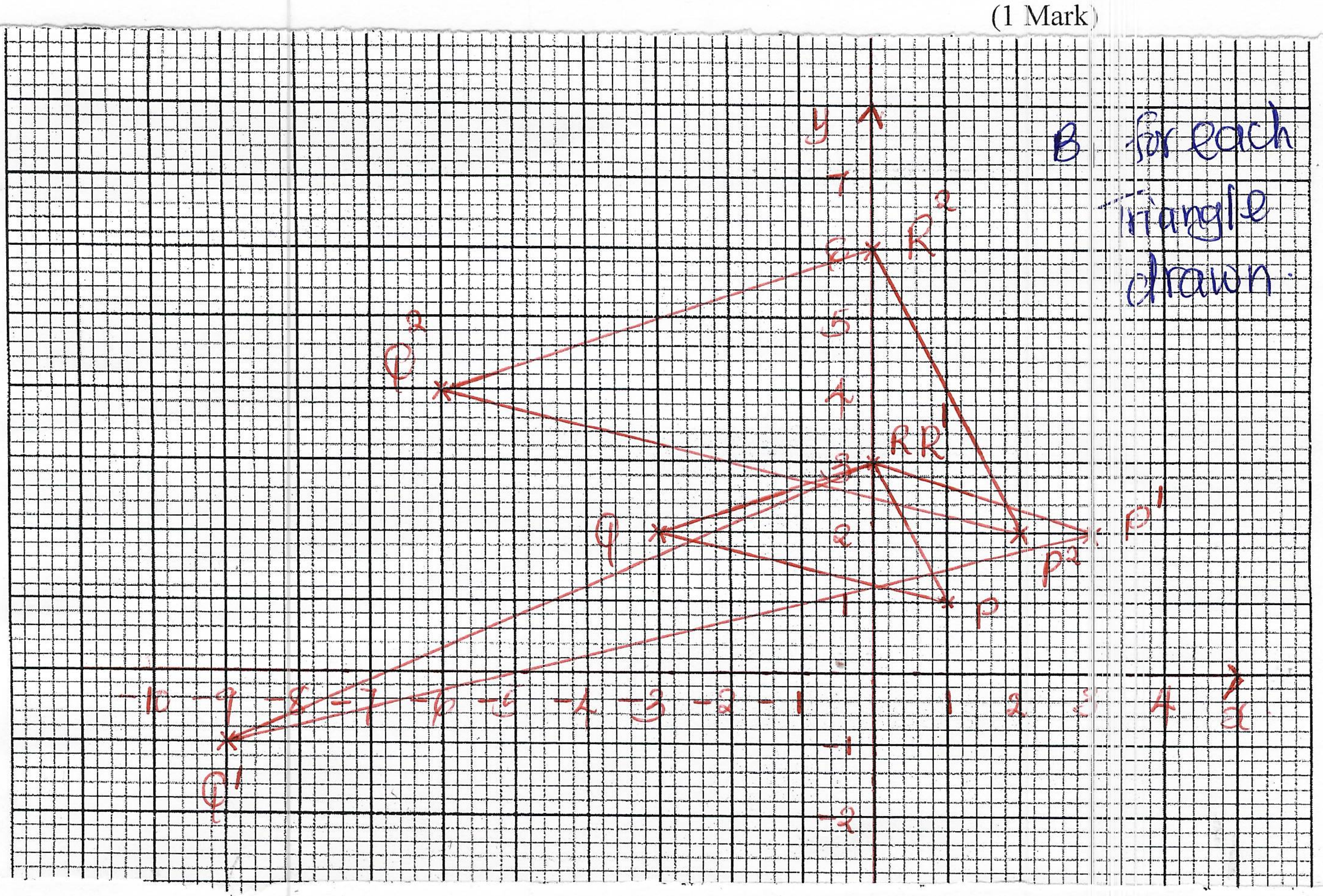
$\frac{50}{2}\{4 + (50-1) - \frac{1}{7}\}$

$= 25(-3)$

$= -75$ B1

21. a) Draw triangle PQR whose vertices are P(1,1) Q(-3,2) and R(0,3) on the grid provided.

(1 Mark)



b) Find the coordinates of triangle $P_1Q_1R_1$ the image of triangle PQR under the transformation whose matrix is $\begin{pmatrix} 3 & 0 \\ 1 & 1 \end{pmatrix}$. Draw triangle $P_1Q_1R_1$. (3 Marks)

$$\begin{pmatrix} 3 & 0 \\ 1 & 1 \end{pmatrix}\begin{array}{c} \begin{array}{ccc} P & Q & R \end{array} \\ \begin{pmatrix} 1 & -3 & 0 \\ 1 & 2 & 3 \end{pmatrix} \end{array} = \begin{array}{c} \begin{array}{ccc} P' & Q' & R' \end{array} \\ \begin{pmatrix} 3 & -9 & 0 \\ 2 & -1 & 3 \end{pmatrix} \end{array} \quad M1$$

$P'(3,2)$

$Q(-9-1)$ A1

$R(0,3)$

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c) $P_1Q_1R_1$ is then transformed onto $P_2Q_2R_2$ by the transformation with matrix $\begin{pmatrix} \frac{2}{3} & 0 \\ \frac{-2}{3} & 2 \end{pmatrix}$

Find the coordinates of $P_2Q_2R_2$ and draw triangle $P_2Q_2R_2$ (3 Marks)

$$\begin{pmatrix} \frac{2}{3} & 0 \\ -\frac{2}{3} & 2 \end{pmatrix}\begin{array}{c} \begin{array}{ccc} P^1 & Q^1 & R^1 \end{array} \\ \begin{pmatrix} 3 & -9 & 0 \\ 2 & -1 & 3 \end{pmatrix} \end{array} \text{M1} = \begin{array}{c} \begin{array}{ccc} P^2 & Q^2 & R^2 \end{array} \\ \begin{pmatrix} 2 & -6 & 0 \\ 2 & 4 & 6 \end{pmatrix} \end{array}$$

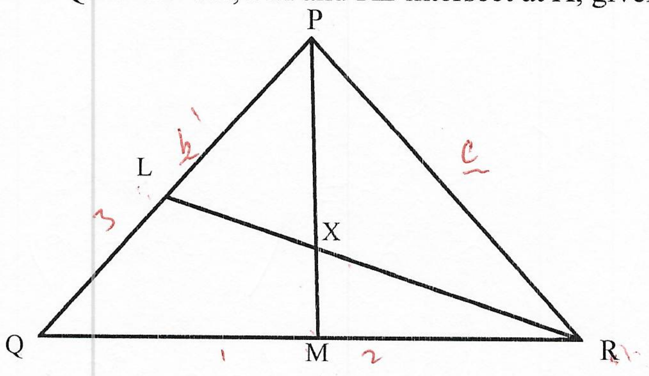
$P^2(2\ 2)$ $Q^2(-6, 4)$ $R^2(0, 6)$ A1

d) Describe fully a single transformation which maps PQR onto $P_2Q_2R_2$. Find the matrix of this transformation (3 Marks)

Enlargement, centre $(0,0)$, scale factor 2 B1

$$\begin{pmatrix} \frac{2}{3} & 0 \\ -\frac{2}{3} & 2 \end{pmatrix}\begin{pmatrix} 3 & 0 \\ 1 & 1 \end{pmatrix} \text{M1} = \begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix} \text{A1}$$

22. In the triangle PQR below L and M are points on PQ and QR respectively such that PL: LQ=1:3 and QM:MR=1:2, PM and RL intersect at X, given that PQ = **b** and PR = **c**,



(a) Express the following vectors in terms of **b** and **c**

(i) **QR** (1mark)

$-\underset{\sim}{b} + \underset{\sim}{c}$ B1

(ii) **PM** (1mark)

$\underset{\sim}{b} + \frac{1}{3}(-\underset{\sim}{b} + \underset{\sim}{c})$ B1

$= \frac{2}{3}\underset{\sim}{b} + \frac{1}{3}\underset{\sim}{c}$

(iii) **RL** (1mark)

$\underset{\sim}{b} - \underset{\sim}{c} - \frac{3}{4}\underset{\sim}{b}$

$= \frac{1}{4}\underset{\sim}{b} - \underset{\sim}{c}$ B1

(b) By taking **PX** = h**PM** and **RX** = k**RL** where h and k are constants find two expressions of **PX** in terms of h, k, **b** and **c**. Hence determine the values of the constant h and k. (6marks)

$\vec{PX} = h(\frac{2}{3}\underset{\sim}{b} + \frac{1}{3}\underset{\sim}{c})$

$= \frac{2}{3}h\underset{\sim}{b} + \frac{1}{3}h\underset{\sim}{c}$ M

$\vec{PX} = \underset{\sim}{c} + k(\frac{1}{4}\underset{\sim}{b} - \underset{\sim}{c})$

$= (1-k)\underset{\sim}{c} + \frac{1}{4}k\underset{\sim}{b}$ M1

$\frac{2}{3}h\underset{\sim}{b} + \frac{1}{3}h\underset{\sim}{c} = (1-k)\underset{\sim}{c} + \frac{1}{4}k\underset{\sim}{b}$ M1

$\frac{2}{3}h = \frac{1}{4}k \Rightarrow k = \frac{8}{3}h$

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

$\frac{1}{3}h = 1 - \frac{8}{3}h$ M1

$\frac{9h}{3} = \frac{1}{3}$

$h = \frac{1}{3}$ A1

$k = \frac{8}{9}$ B

(c) Determine the ratio LX: XR (1mark)

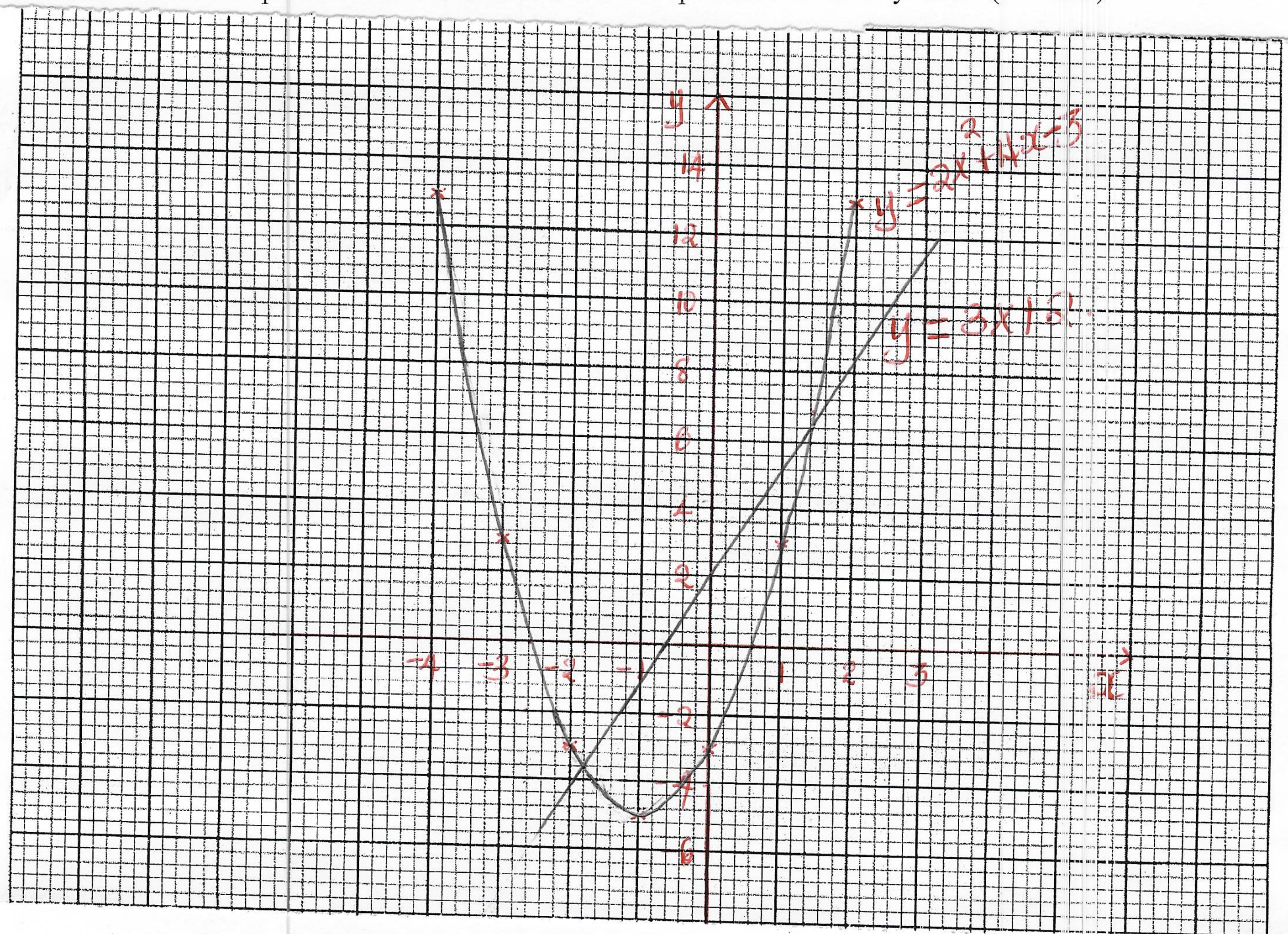
1 : 8 B1

23. a) Complete the table below for the function $y=2x^2 + 4x -3$ (2 Marks)

x	-4	-3	-2	-1	0	1	2
y	13	3	-3	-5	-3	3	13

B_2 for all values
B_1 for 4 or more correct.

b) On the grid provided, draw the graph of the function $y=2x^2 + 4x -3$ for $-4 \leq x \leq 2$ using the scale of 1cm to represent 1 unit on axis and 1cm to represent 2 units on y-axis. (3 Marks)



c) Use the graph above to:

i) Determine the roots of the equation $2x^2 + 4x -3=0$ (2 Marks)

$x = -2.6$

$x = 0.6$

ii) Solve the equation $2x^2 +x -5 =0$ (3 Marks)

$$y = 2x^2+4x-3$$
$$0 = 2x^2+x-5$$
$$y = 3x+2.$$

$x = -1.8$

$x = 1.4.$

24. The acceleration of particle t seconds after passing a fixed point P is given by $a = 3t - 3$.

Given that the velocity of the particle when $t = 2$ is 5m/s, find;

a) Its velocity when $t = 4$ seconds (3 Marks)

$a = 3t - 3$

$V = \frac{3t^2}{2} - 3t + C$

$5 = \frac{3}{2}(2)^2 - 3(2) + C$

$C = 5$

$V = \frac{3}{2}t^2 - 3t + 5$

$V = \frac{3}{2}(4)^2 - 3(4) + 5$

$= 24 - 12 + 5$

$= 17 M/S$

b) Its displacement at the time in (a) above (3 Marks)

$S = \frac{t^3}{2} - \frac{3}{2}t^2 + 5t + C$

$S = 0 \quad t = 0$

$C = 0$

$S = \frac{t^3}{2} - \frac{3}{2}t^2 + 5t$

$\frac{4^3}{2} - \frac{3}{2}(4)^2 + 5(4)$

$= 32 - 24 + 20$

$= 28M$

c) The displacement during the third second (4 Marks)

$\left[\frac{t^3}{2} - \frac{3}{2}t^2 + 5t\right]_2^3$

$\left(\frac{3^3}{2} - \frac{3}{2}(3)^2 + 5(3)\right) - \left(\frac{2^2}{2} - \frac{3}{2}(2)^2 + 5(2)\right)$

$= \left(\frac{27}{2} - \frac{27}{2} + 15\right) - (2 - 6 + 10)$

$= 15 - 6$

$= 9M$