1.	$2x^2+5x-12=0$ $\alpha+\beta=\frac{-b}{a}=\frac{-5}{2}$ $\alpha\beta=\frac{c}{a}=\frac{-12}{2}=-6$ $(\alpha-\beta)^2=\alpha^2+\beta^2-2\alpha\beta$ $\left[(\alpha+\beta)^2-2\alpha\beta\right]-2\alpha\beta$ $(\alpha+\beta)^2-4\alpha\beta$ $=\frac{25}{4}+24$ $=\frac{25+96}{4}$ $=\frac{121}{4}$ or 30.25 or $30\frac{1}{4}$	B_1 for both $(\alpha+\beta)$ and $\alpha\beta$ M_1 for expanding B_1 for correct expression M_1 for substitution A_1 for correct value **05**
2.	(i) $2+3\log x=\log 1-\log 10$ $2+3\log x=0-1$ $3\log x=-3$ $\log x=-1$ $x=10^{-1}$ or 0.1 (ii) $(9^x)(3^{x+1})=81$ $\left[(3^2)^x\right]\left[3^{x+1}\right]=3^4$ $\left[3^{2x}\right]\left[3^{x+1}\right]=3^4$ $3^{2x+(x+1)}=3^4$ $3^{3x+1}=3^4$ $=3x+1=4$ $3x=3$ $x=1$	B_1 for both log1 and log 10 B_1 for correct value of x **02** M_1 for expressing as power of 3. M_1 for applying laws of induces A_1 for correct value of x **03**
3.	$5\tan^2 A-5\tan A=2\sec^2 A$ $5\tan^2 A-5\tan A=2(1+\tan^2 A)$ $5\tan^2 A-5\tan A=2+2\tan^2 A$ $3\tan^2 A-5\tan A-2=0$ $(3\tan A+1)(\tan A-2)=0$ $\tan A=\frac{-1}{3}$ or $\tan A=2$ $A=161.57^0,341.57^0$ OR $A=63.43^0,243.43^0$ $A=63.43^0, 161.57^0, 243.43^0, 341.57^0$ If all are Correct (allow 1 or 2 d.p)	B_1 for $\sec^2 A=1+\tan^2 A$ A_1 for quadratic equation formed. M_1 for method. A_1 A_1 for each set of angles. **05**

4.	$\frac{dy}{dx} = \frac{2x-1}{2y}$ $2ydy = (2x-1)dx$ M1 $\int 2ydy = \int 2xdx - \int 1dx$ M1 $\frac{2y^2}{2} = \frac{2x^2}{2} - x + c$ $y^2 = x^2 - x + c$ no marks. $6^2 = 2^2 - 2 + c$ M1 $36 = 4 - 2 + c$ $c = 34$ B1 $\therefore y^2 = x^2 - x + 34$ A1 – correct integral:	M_1 for separately variables M_1 for integration A_1 for correct integrals B_1 for correct value of c A_1 (correct solution) **05**
5.	Mean = $\frac{203+205+203+207+209+208+201+204+208+202}{10}$ M1 $\bar{x} = \frac{2050}{10} = 205$ A1	M_1 A_1 **02**
	(i)	M_1 for $(x-\bar{x})^2$
	$\sigma^2 = \frac{1}{10}(67)$ M1 A1 (atleast 2d.p) $\sigma = 2.59 (2dp)$ 2.6833 (4 d.p)	B_1 for $\sum(x-\bar{x})^2 = 67$ A_1(for standard deviation of ten baking power as population) **03**
6.	For mutually exclusive P(AnB) = 0 B1 (a) P(B) = P(AUB) – P(A) $= \frac{9}{10} - \frac{1}{2}$ M1 $= \frac{18-10}{20}$ $= \frac{8}{20}$	B_1 for conditions M_1 for method getting P(B)

$= \frac{2}{5}$ or 0·4 A1

$P(A' \cap B) = P(B)$

$= \frac{2}{5}$ A1 or 0·4

(ii)

$P(A' \cap B') = 1 - P(A \cup B)$

$1 - \frac{9}{10}$ M1

$= \frac{1}{10}$ A1 or 0·1

A1 for $P(A' \cap B)$ correct value

03

need $P(A') = P(A' \cap B) +$

M1 for substitution $P(A' \cap B')$.

$0.5 = 0.4 + P(A' \cap B')$.

A1 for $P(A' \cap B')$ correct value. $0.1 = P(A' \cap B')$

02

7. (i)

X	$x\,P(x = x)$
-2	$-2\left(\frac{1}{4}\right) = \frac{-1}{2}$
0	$0\left(\frac{1}{8}\right) = 0$
1	$1\left(\frac{1}{4}\right) = \frac{1}{4}$
2	$2\left(\frac{3}{8}\right) = \frac{3}{4}$

$E(x) = \Sigma x P(x = x)$

$= \frac{-1}{2} + 0 + \frac{1}{4} + \frac{3}{4}$ M1

$= \frac{1}{2}$ or 0·5 A1

x	$P(X=x)$	$xP(X=x)$	x^2	$x^2P(X=x)$
-2	1/4	-1/2	4	1
0	1/8	0	0	0
1	1/4	M1 1/4	1	1/4
2	3/8	3/4	4	3/2
		$\Sigma xP(X=x) = 0.5$		$\Sigma x^2P(X=x)$

(i) $E(X) = \Sigma p(x=x)$ $= 1/2$ A1

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

M1 for method of getting E(x)

$= \Sigma x^2 p(X=x) - [E(x)]^2$

$= 11/4 - 1/4 = 5/2$

7. (ii)

X	$x^2\,P(x = x)$
-2	$4\left(\frac{1}{4}\right) = 1$
0	$0\left(\frac{1}{8}\right) = 0$
1	$1\left(\frac{1}{4}\right) = \frac{1}{4}$
2	$4\left(\frac{3}{8}\right) = \frac{3}{2}$

allow working done in the table

$E(x^2) = \Sigma x^2 P(x = x)$

$= 1 + 0 + \frac{1}{4} + \frac{3}{2}$

$= \frac{11}{4}$ M1

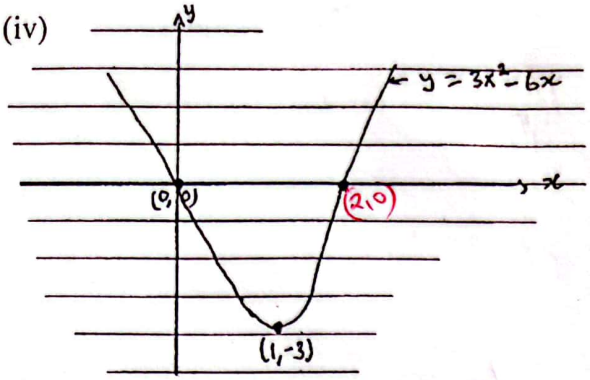
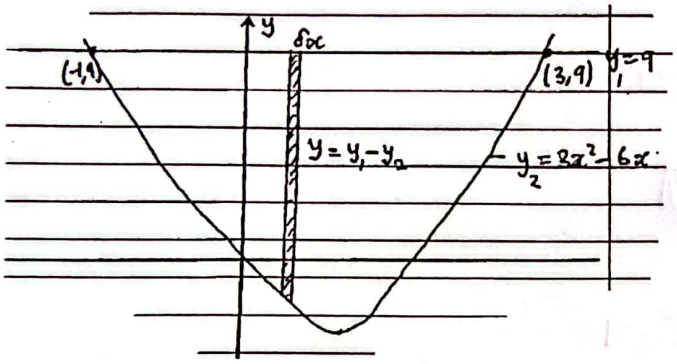
A1 for correct value of expectation of x

02

M1 for method of getting $E(x^2)$

	$Var(x) = E(X^2) - (E(X))^2$ $\frac{11}{4} - \left(\frac{1}{2}\right)^2$ m1 $= \frac{11}{4} - \left(\frac{1}{2}\right)^2$ $\frac{10}{4}$ $= \frac{5}{2}$ or 2.5 A1	M_1 for substitution A_1 for correct value of var (x) **03**
8.	(i) Given P = 0.25 Q = 0.75 $^{15}C_6 p^6 q^{15-6}$ $^{15}C_6 (0.25)^6 (0.75)^9$ m1 $= 5005(1.833122224 \times 10^{-5})$ $= 0.09174767$ $\approx 0.09 (2dps)$ A1 (atleast 2d.ps) (ii) ~~$^{15}C_6 (0.25)^6 (0.75)^9$~~ $= {}^{15}C_4 (0.25)^4 (0.75)^{11} + {}^{15}C_5 (0.25)^5 (0.75)^{10}$ m1 $= 1365(1.649810001 \times 10^{-4}) + 3003(5.499366671 \times 10^{-5})$ m1 $= 0.225199065 + 0.165145981$ $\approx 0.39 (2dps)$ A1 (atleast 3d.ps)	M_1 for method. A_1 for correct value of P(x=6) **02** M_1 for method M_1(for adding) A_1 for correct of probability required. **03**
	SECTION B (60 marks)	
9.	(a) $4\begin{pmatrix}0\\5\end{pmatrix} + 3\begin{pmatrix}7\\0\end{pmatrix} - 4\begin{pmatrix}5\\-5\end{pmatrix}$ m1 $\begin{pmatrix}0\\20\end{pmatrix} + \begin{pmatrix}21\\0\end{pmatrix} - \begin{pmatrix}20\\-20\end{pmatrix}$ m1 $= \begin{pmatrix}0+21-20\\20+0+20\end{pmatrix}$ m1 $= \begin{pmatrix}1\\40\end{pmatrix}$ A1 or $\underset{\sim}{i} + 40\underset{\sim}{j}$	M_1(for substitution) M_1(for multiplying by scalar) M_1 (for method of simplifying) A_1 (for correct required vector) **04**
	(b) (i) $\underset{\sim}{PQ} = \underset{\sim}{OQ} - \underset{\sim}{OP}$ $= \begin{pmatrix}7\\0\end{pmatrix} - \begin{pmatrix}0\\5\end{pmatrix}$ m1 $= \begin{pmatrix}7\\-5\end{pmatrix}$ A1 or $7\underset{\sim}{i} - 5\underset{\sim}{j}$	M_1 for substitution A_1 for correct value of PQ

	PR = OR − OP $= \begin{pmatrix} 5 \\ -5 \end{pmatrix} - \begin{pmatrix} 0 \\ 5 \end{pmatrix}$ - M1 $= \begin{pmatrix} 5 \\ -10 \end{pmatrix}$ - A1 $5\underset{\sim}{i} + -10\underset{\sim}{j}$ (ii) PQ. PR = $\begin{pmatrix} 7 \\ -5 \end{pmatrix} \cdot \begin{pmatrix} 5 \\ -10 \end{pmatrix}$ - M1 =35+50 = 85 A1 (iii) $\lvert PQ \rvert = \sqrt{(7)^2 + (-5)^2} = \sqrt{74}$ - B1 (on answers) $\lvert PR \rvert = \sqrt{5^{2+(-10)^2}} = \sqrt{125}$ - B1 allow decimal (2d.p) $\text{Cos } \theta = \frac{PQ.PR}{\lvert PQ \rvert \lvert PR \rvert}$ $= \frac{85}{\sqrt{74}\sqrt{125}}$ - M1 0.8838 B1 $\theta = Cos^{-1}(0.8838)$ $= 27.9^0$ A1 Correct value, atleast 1d.pl. - deny if there are no units	M_1 for substitution A_1 for correct value of PR **04** M_1 for substitution A_1 for correct value of PQ.PR **02** $PQ \cdot PR = \lvert PQ \rvert \lvert PR \rvert \cos\theta$ M_1 for $\lvert PQ \rvert$ M_1 for $\lvert PR \rvert$ θ is angle QPR M_1 (for substitution) A_1 for correct Cos θ B_1 for correct angle **05**
10	(a) (i) When y = 0 $0 = 3x^2 - 6x$ $0 = 3x(x-2)$ } M1 $x = 0$ or 2 when $x = 0$ $y = 3(0)^2 - 6(0) = 0$ ∴ intercepts are (0, 0) and (2, 0). A1 (ii) $\frac{dy}{dx} = 6x - 6$ M1 For turning point $\frac{dy}{dx} = 0$ $\Rightarrow 0 = 6x - 6$ M1 $x = 1$ $\Rightarrow y = 3(1)^2 - 6(1)$ $= -3$ B1 Hence turning point is $(1, -3)$ A1. (iii) $\frac{d^2y}{dx^2} = 6$ M1	M_1 for method A_1 for intercepts **02** M_1 for differentiation A_1 for value of x=1 B for value of y = -3 A_1 for correct turning point **04** M_1 for method

	At $\frac{d^2y}{dx^2} = +ve$ (indicates minimum) A1 $\therefore (1,-3)$ is minimum turning point. (iv)  	value of x: L | 1 | R Sign of dy/dx: - | 0 | + minimum A_1 for minimum point B_1 for labeling the axes and showing origin and turning point and intercept B_1 for shape - No mark for shape if the axes are not labelled **02**
10	(b)  Area $= \int_{-1}^{3}[(9)-(3x^2-6x)]dx$ $\int_{-1}^{3}(9+6x-3x^2)dx$ $[9x+3x^2-x^3]_{-1}^{3}$ $[9(3)+3(3)^2-(3)^3]-[9(-1)+3(-1)^2-(-1)^3]$ $(27+27+-27)-(-9+3+1)$ 27 + 27- 27+ 9 - 3 -1 = 32 square units. A1 deny the A1 if there are no square units	B_1 for limits $x = -1$ $x = 3$ M_1 for integrating A_1 for integral M_1 for substitution of limits A_1 for correct value of area enclosed **05**
11.	(a) Repeated letters and number times they are repeated letter times. R 2 E 3 S 2 Total letters, n = 8 Arrangement = $\frac{n!}{r!p!q!}$	B_1 for repeated letters and their number of times, and total number of letters

$$\frac{8!}{2!3!2!}$$ M1

$= 1680$ A1

(b)

Chocies or selection	Number available
4	6

Number of sets $= {}^{6}C_{4}$ M1

$= 15$ A1

There are 15 sets of four questions

M1 for substitution

A1 for required arrangement

03

M1 for method
A1 for correct set
~~B1 for conclusion~~

03

(c) $\begin{pmatrix} x & -2 \\ -1 & y \end{pmatrix}\begin{pmatrix} 5 & 2 \\ 1 & 4 \end{pmatrix} = \begin{pmatrix} 18 & 0 \\ 0 & 18 \end{pmatrix}$

$\begin{pmatrix} 5x & -2 & 2x & -8 \\ -5 & +y & -2 & +4y \end{pmatrix} = \begin{pmatrix} 18 & 0 \\ 0 & 18 \end{pmatrix}$ M1

$5x-2=18 \Rightarrow 5x=20 \Rightarrow x=4$
$-5+y=0 \Rightarrow y=5$
$2x-8=0 \Rightarrow 2x=8 \Rightarrow x=4$
$-2+4y=18 \Rightarrow 4y=20 \Rightarrow y=5$
$\therefore x=4$ and $y=5$ B1

M1

~~M1 A1 for 4 equations and 4 values of x and y~~

B1 for concluding $x=4$ and $y=5$

04

(d) $8x-2y=28$
$5x+3y=9$

$\begin{pmatrix} 8 & -2 \\ 5 & 3 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 28 \\ 9 \end{pmatrix}$ B1 M1

$\begin{pmatrix} 3 & 2 \\ -5 & 8 \end{pmatrix}\begin{pmatrix} 8 & -2 \\ 5 & 3 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 3 & 2 \\ -5 & 8 \end{pmatrix}\begin{pmatrix} 28 \\ 9 \end{pmatrix}$ M1

$\begin{pmatrix} 24+10 & -6+6 \\ -40+40 & 10+24 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 84+18 \\ -140+72 \end{pmatrix}$

$\begin{pmatrix} 34 & 0 \\ 0 & 34 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 102 \\ -68 \end{pmatrix}$ M1

$\frac{1}{34}\begin{pmatrix} 34 & 0 \\ 0 & 34 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} = \frac{1}{34}\begin{pmatrix} 102 \\ -68 \end{pmatrix}$

$\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 3 \\ -2 \end{pmatrix}$ Or $\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 3 \\ -2 \end{pmatrix}$

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

M1 for pre-multiplying by $\begin{pmatrix} 3 & 2 \\ -5 & 8 \end{pmatrix}$

M1 for pre-multiplying by $\frac{1}{34}$

~~A1 for x and y still in matrix form~~

~~B1 for both values of $\frac{1}{34}$~~

~~A1 for x and y still in matrix form.~~

~~B1 for both value of x = 3 and y = -2~~

05

12

(a) $x \geq 0$ _____(i)

$y \geq 0$ _____(ii)

$16x + 30y > 120$

$8x + 15y > 60$ _____(iii)

$240{,}000\ x + 300{,}000y \leq 2{,}400{,}000$

$4x + 5y \leq 40$ _____(iv)

$x \leq y + 2$ _____(v)

B1

B1

B1

03

(b) Changing inequalities to equation to in order to get boundary lines.

$x = 0$

$y = 0$

$8x + 15y = 60$

x	0	7.5
y	4	0

hence (0,4) and (7.5,0) lie on the line $8x + 15y = 60$ M1

$5y + 4x = 40$

x	0	10
y	8	0

hence (0,8) and (10,0) lie on the line $4x + 5y = 40$ M1

$x = y + 2$, hence (2,0), (3,1),(4,2), (5,3) and (6,4) lie on the line $x = y + 2$.

M1 give max of 02

(c) On the graph ***(at the back)***

(d) Set of number of trips = (x, y);(2,3),(3,3)

(3,4),(4,2),(4,3),(5,2),(5,3),(5,4),

(6,2),(6,3),(7,1),(7,2),(8,1),(10,0),(0,8),(4,2)

(e) 4 – 7 points B_1

8-11 points

12 – 14 including 2 points use (e)B_3

03

(f) Number of supporters in order to used all money is either (16 x 5) + (30 x 4) =200 or (16 x 10) +30(0) =160. Hence the greatest number of supporters that was transported is 200.

M1

A1

02

— Give 3– equations

— Give 2 B1 marks if a student does not give the first two inequalities.

eqns (5 — 3), (4, 3 — 2), (2, 1 — 1)

* on the graph, each line well shaded to show the wanted region, gets 1 mark

* deny marks if the lines are not labelled.

— Deny marks, if there is a point in unwanted region in main, allow B_3 for these points even when they are only 2.

— In case one lists only one from the main 2, and any other points in wanted region, qualifies for 2 marks

Give 1 mark if the list other points but not the main one

(2,4) (2,5), (2,6), (3,5), (4,4) (0,8), (5,4)

M_1 → Testing both 2 points

Conclusion – A_1

13 (a)

Day	Sales	(i) M.T	(ii) M.A
1	10		
2	9		
3	6	~~41~~ 50	~~8.2~~ 10
4	11	49	9.8
5	14	48	9.6
6	9	~~48~~ 50	~~9.6~~ 10
7	8	~~50~~ 52	10.4
8	6	~~48~~ 50	~~9.6~~ 10
9	13		
10	12		

All correct B_3
4 to 5 correct B_2
2to3 correct B_1
03

All correct B_3
4 to 5 correct B_2
2 to3 correct B_1
03

Alt: One may use the averages not in a table.

$M_1 = \frac{10+9+6+11+14}{5} = 10$

$M_2 = \frac{9+6+11+14+9}{5} = 9.8$

B1

Deny a mark for Candidates that write averages in time

Allow a students who only writes the moving averages

Correct labelling axes B1 B1

plotting and joining Correctly the (1) sales (1)

plotting & joining the averages, each all averages, will plotted

(2 marks)

(b) On graph paper *(at the back)*

(c) Let the sales be a.

$\frac{8+8+13+12+a}{5} = 9.2$ 9.6 M_1

$a = 7$ A_1

The graph must indicate the 7th moving average.

M_1 for method

A_1 for correct value of the sales.

1 mark on showing the next moving average.

02

14 (a) Price index $= \frac{P_1}{P_0} \times 100$

Milk:

$\frac{1500}{1200} \times 100$

125

B_1 correct output

Eggs: $\frac{10000}{8000} \times 100$ 1500 = 18.75

~~125~~

B_1 correct output

Sugar: $\frac{5000}{4500} \times 100$

111.11

B_1 correct output

Rice: $\frac{4000}{3500} \times 100$

114.29

Deny marks for the % sign

B_1 correct output

(b) Simple aggregate price index

$$\frac{\Sigma p_1}{\Sigma p_0} \times 100$$

$$\left(\frac{1500+10{,}000+5000+4000}{1200+8000+4500+3500}\right)\times 100$$

$$\frac{20{,}500\times 100}{17200}$$

119.17

B_1 B_1 B_1
- Summer
- Dividing
- Multiplier by 100

M_1 M_1 correct output top and bottom.

A_1 correct output

(c) Weighted aggregated price index.

$$\left[\frac{\sum\left(\frac{p_1}{p_0}\right)w}{\sum w}\right]\times 100$$

$$=\left[\frac{125\times 20+125\times 3+111.11\times 2+114.29\times 4}{20+3+2+4}\right]\times 100$$

$= 122.56$ A_1

Comment: An increment of 22.56% B_1

M_1 M_1 M_1
- Addition
- Multiplication
- Division

Correct output

B_1 correct difference

15 marks

15. Let x be the period.

(a) (i) $P(x=9)$

Standardizing

$$P\left(z=\frac{9-8}{3}\right)$$

$$P(Z=0.333)$$

$$=0.6304$$

B_1 for interpretation of exact

M_1 for standardizing

A_1 for correct read value.

(ii) $P(x<8.5)$

Standardizing

$$P\left(Z<\frac{8.5-8}{3}\right)$$

$$P(Z<0.167)$$

$$=0.5663$$

M_1 for standardizing

B_1 value of Z

A_1 for correct read value.

(iii) $P(8<x<10)$

Standardizing

$$P\left(\frac{8-8}{3}<Z<\frac{10.8}{3}\right)$$

M_1 M_1 for standardizing each

	$P(0 < Z < 0.667)$ $= 0.7478 - 0.5000$ $= 0.2478$ (b) $P(x > 11)$ $P\left(Z > \frac{11-8}{3}\right)$ $P(Z > 1)$ $= 0.1587$ The number = 0.1587 x 150 $= 23.805 \approx 24$ cows.	B_1M_1 for correct values and subtraction A_1 for correct value read M_1 standardizing A_1 for correct value read M_1 for multiply. A_1 Prob. and total number of cows for required no. of cow.
16.	(a) (i) refer to graph (ii) refer to graph (iii) refer to graph ***(at the back page)*** (b)	

	x_r	y_r	d	d^2
A	8	7	1	1.00
B	5.5	6	-0.5	0.25
C	3.5	4.5	-1.0	1.00
D	1	1	0	0.00
E	3.5	2	1.5	2.25
F	9	9	0	0.00
G	10	10	0	0.00
H	2	3	-1	1.00
I	7	4.5	2.5	6.25
J	5.5	8	-2.5	6.25
Sum				18

B_1 for rank in x

B_1 for rank in y

B_1 for d^2

B_1 for sum d^2

$$= 1 - \frac{6\Sigma d^2}{n(n^2-1)}$$

$$= 1 - \frac{6(18)}{10(99)}$$

$$= 0.89$$

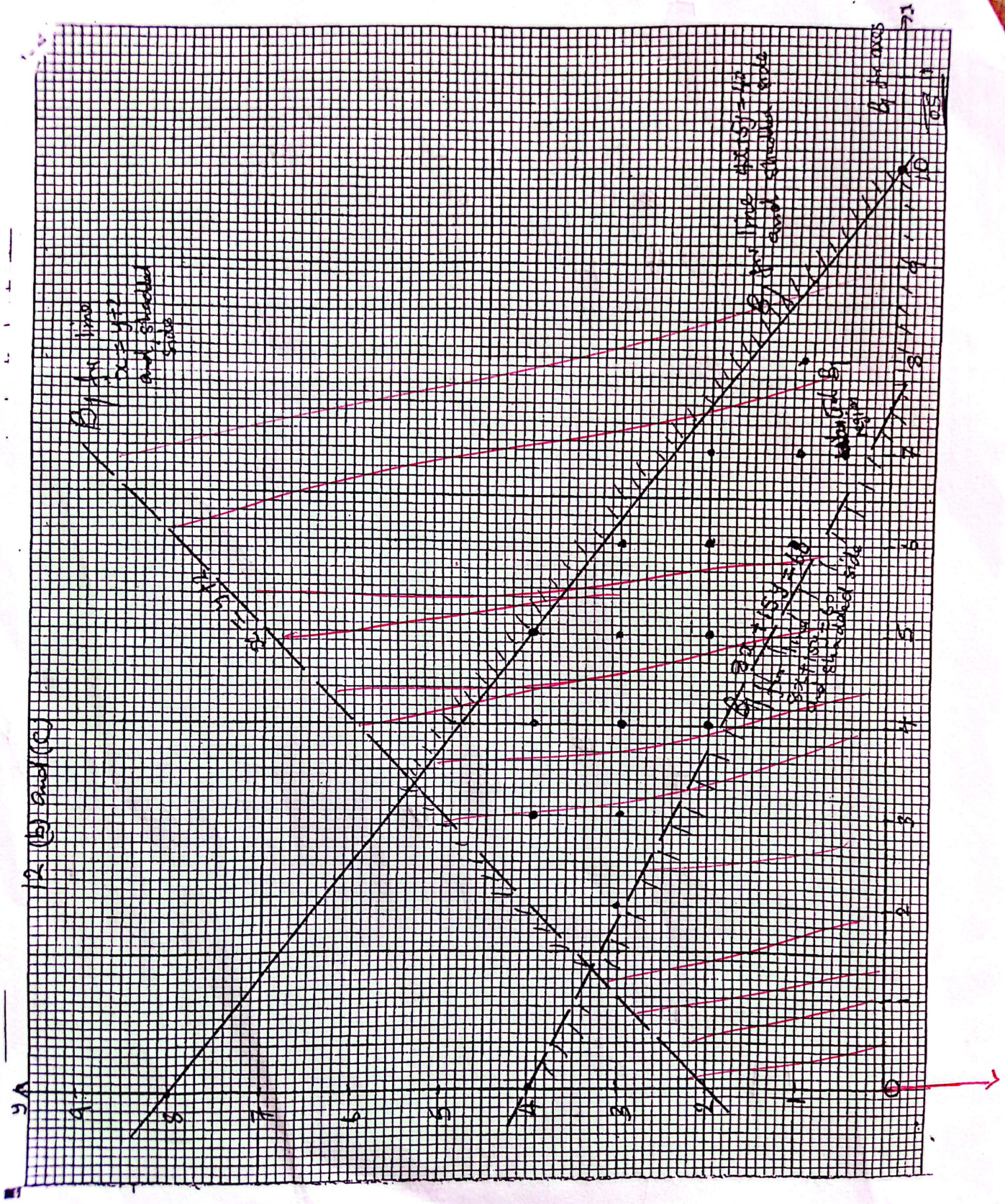
M_1 for substitution

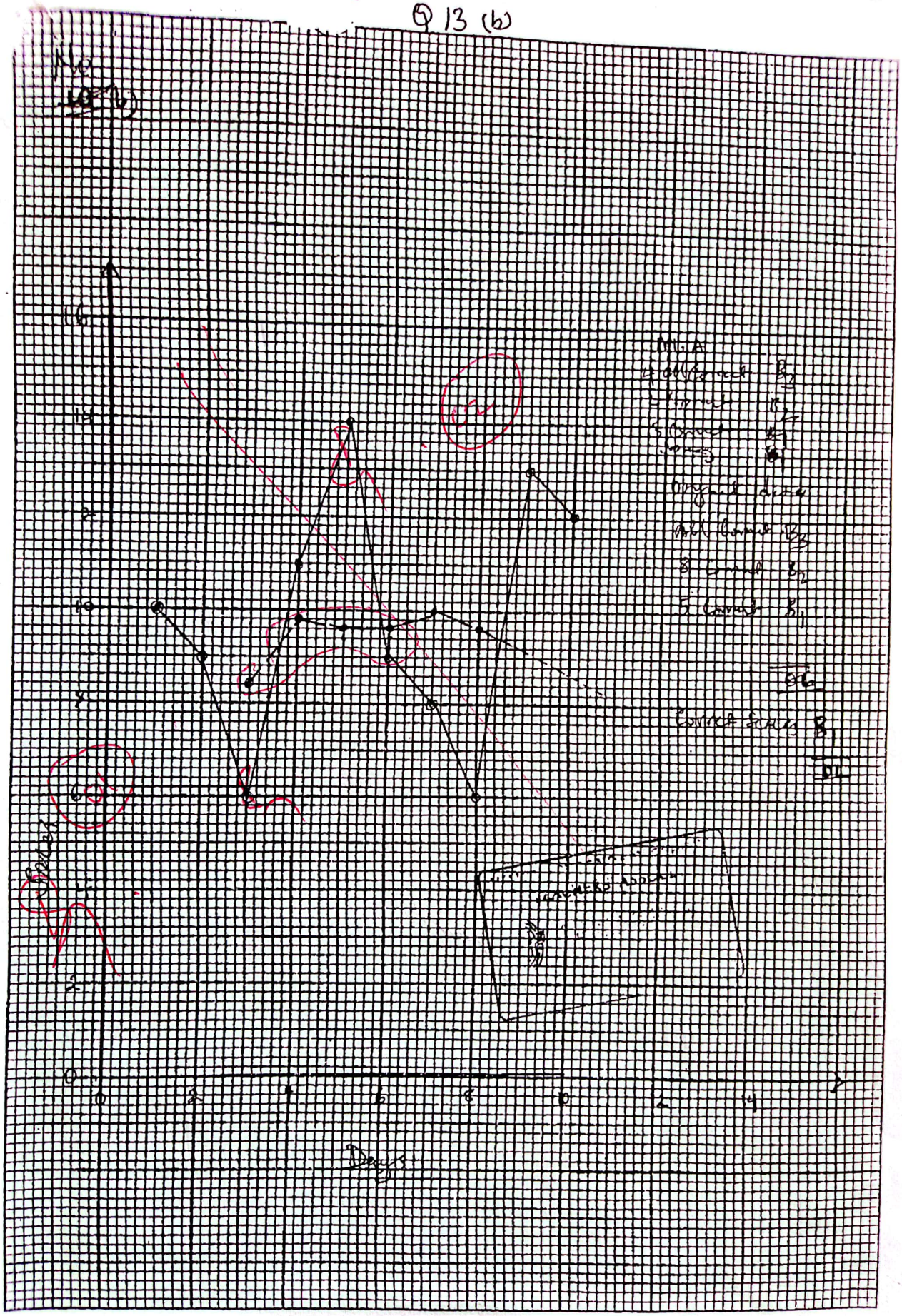
A_1 for correct rank correction coefficient

The highly positive correlated.

B_1 for comment

No. 12(b) and (c)





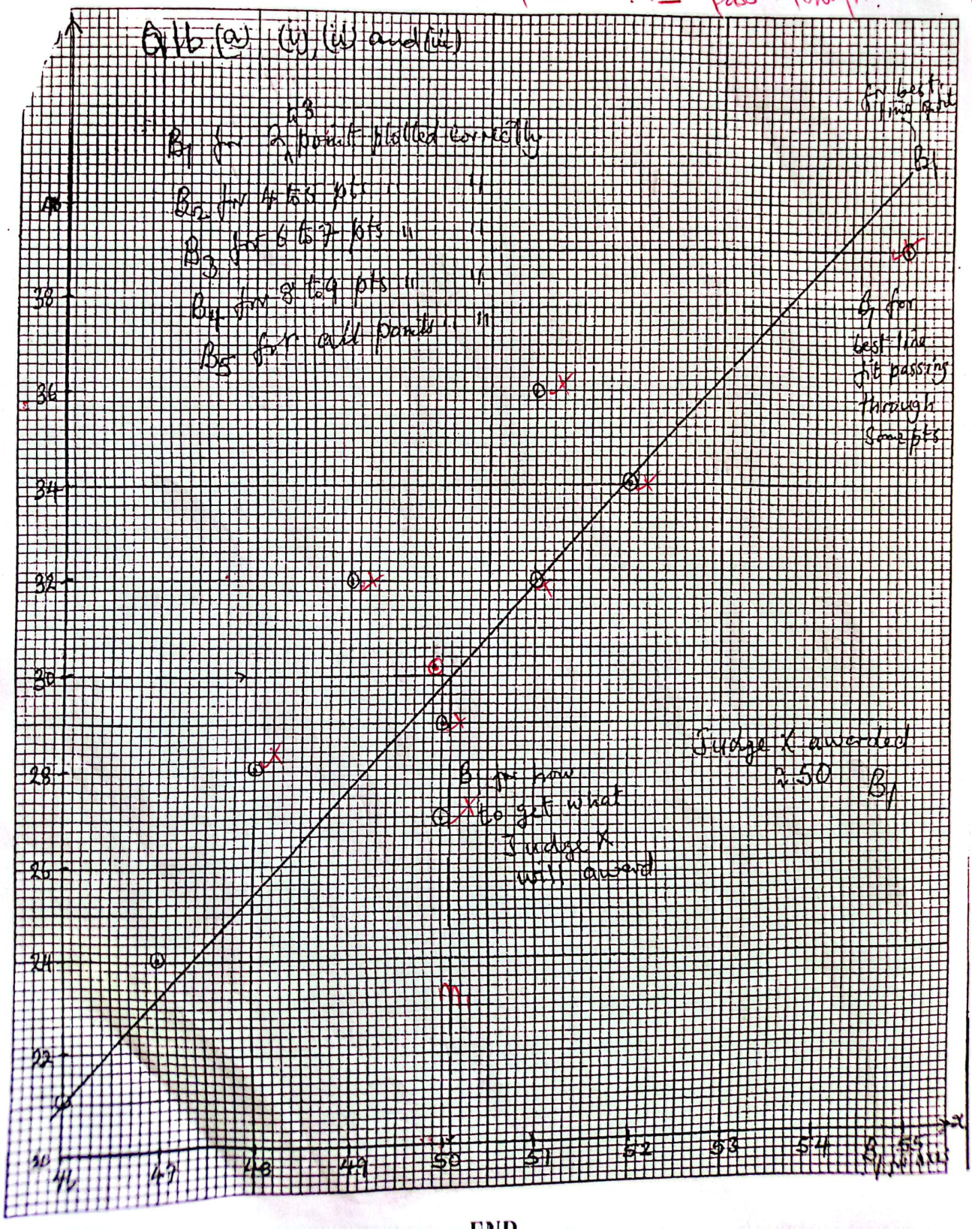
(iv) – Indicating m_1 on graph B1
– stating a right value. B1

B1 – for both well labelled axes

B1 – 1 mark for each two well plotted points

(iii) – allow Centre value # leaves almost equal points up and down. B1
or Inspector – pass through some points B1

No. 16 (a) (i), (ii) and (iii)



END