

**APPLIED MATH P2**

QTN      SOLUTION

MARK

1       $\begin{pmatrix} -2 \\ -3 \end{pmatrix} + \begin{pmatrix} 7 \\ p \end{pmatrix} + \begin{pmatrix} -1 \\ -1 \end{pmatrix} = \begin{pmatrix} 4 \\ 9 \end{pmatrix}$

M<sub>1</sub>

$-4 + p = 9$

A<sub>1</sub>

$\therefore p = 13$

$$\begin{vmatrix} 2 & 0 \\ -2 & -3 \end{vmatrix} + \begin{vmatrix} 0 & -3 \\ 7 & 13 \end{vmatrix} + \begin{vmatrix} 1 & 1 \\ -1 & -1 \end{vmatrix} = \begin{vmatrix} 3 & q \\ 4 & 9 \end{vmatrix}$$

M<sub>1</sub>

$$-6 - 0 + 0 - 21 + 1 - 1 = 27 - 4q$$

M<sub>1</sub>

$$15 = 27 - 4q$$

A<sub>1</sub>

$$Q = 3$$

05

2

$$P(B^1 \cap A) = P(A) \times P(B^1 / A)$$

B<sub>1</sub>

$$= \frac{2}{5} \times \frac{3}{5}$$

$$= \frac{6}{25}$$

$$P(B \cap A^I) = P(A^I) \times P(B/A^I)$$

$$= \frac{3}{5} \times \frac{1}{3}$$

$$= \frac{1}{5}$$

$$P(B^I) = P(A \cap B^I) + P(A^I \cap B^I)$$

$$= P(A \cap B^I) + P(A^I) - P(A^I \cap B)$$

$$= \frac{6}{25} + \frac{3}{5} - \frac{1}{5}$$

$$= \frac{16}{25}$$

For  $P(A^I \cap B^I)$

$$\begin{cases} \frac{3}{5} \\ \frac{1}{5} \end{cases}$$

B<sub>I</sub> M<sub>I</sub>

A<sub>I</sub>

0.8

3

$$\Delta A = 0.0005$$

$$\Delta B = 0.005$$

B<sub>1</sub>

$$\frac{A}{B} = \frac{2.719}{-3.80} = -\left(\frac{2.719}{3.80}\right)$$

$$Lower\ limit = -\left(\frac{2.7195}{3.795}\right)$$

$$= -0.7166$$

A<sub>1</sub>

$$upper\ limit = -\left(\frac{2.7185}{3.805}\right)$$

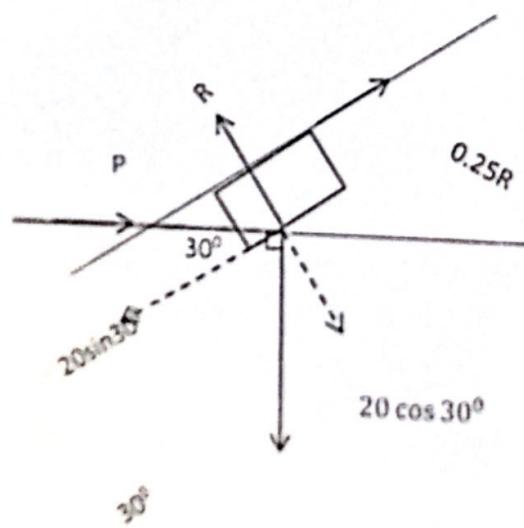
M<sub>1</sub>

$$= -0.7145$$

A<sub>1</sub>

05

4



$$(\nearrow) 0.25 + P \cos 30^\circ - 20 \sin 30^\circ = 0$$

B<sub>1</sub>

$$(\nwarrow) R = P \sin 30^\circ + 20 \cos 30^\circ$$

B<sub>1</sub>

$$0.25 (P \sin 30^\circ + 20 \cos 30^\circ) + P \cos 30^\circ = 20 \sin 30^\circ$$

M<sub>1</sub>

$$P = \frac{20 \sin 30^\circ - 0.25 \times 20 \cos 30^\circ}{0.25 \sin 30^\circ + \cos 30^\circ}$$

A<sub>1</sub>

$$= 5.7212N$$

05

5

competitor	$r_{j1}$	$r_{j2}$	D	$D^2$
A	2	3	-1	1
B	5	4	1	1
C	3	2	1	1
D	6	8	-2	4
E	1	1	0	0
F	8	5	3	9
G	4	7	-3	9
H	7	6	1	1

$$\varepsilon D^2 = 26$$

$$\rho = 1 - \frac{6 \times 26}{8(8^2 - 1)}$$

$$= 0.6905$$

It is not significant at 5% level

$$6 \quad X \sim B(1000, 0.1) \quad \mu = 1000 \times 0.1 = 100$$

$$\delta = \sqrt{1000 \times 0.1 \times 0.9}$$

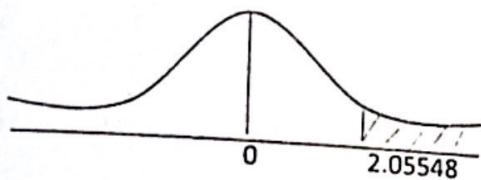
$$= \sqrt{90}$$

$$= 9.4868$$

$$P(X \geq 120) \rightarrow P(X \geq 119.5)$$

$$= P\left(Z > \frac{119.5 - 100}{\sqrt{90}}\right)$$

$$= P(Z > 2.05548)$$



$$= 0.5 - 0.4800$$

$$= 0.02$$

7

30.22

30.24

30.27

3.4085

3.4092

P

05

B<sub>1</sub>

$$\frac{P - 3.4092}{30.27 - 30.24} = \frac{3.4092 - 3.4085}{30.24 - 30.22}$$

$$P = 3.41025$$

30.18

t

30.20

M<sub>1</sub>

3.4072

3.4075

3.4078

$$\frac{t - 30.18}{3.4075 - 3.4072} = \frac{30.20 - 30.18}{3.4078 - 3.4072}$$

A<sub>1</sub>

$$t = 30.19$$

05

8

(a)  $\left(10 \times 3 + \frac{1}{2}a \times 3^2\right) - \left(10 \times 2 + \frac{1}{2}a \times 2^2\right) = 20$

M<sub>1</sub> M<sub>1</sub>

$$30 + 4.5a - 20 - 2a = 20$$

$$2.5a = 10$$

A<sub>1</sub>

$$\therefore a = 4 \text{ ms}^{-2}$$

b)  $S = 10 \times 3 + \frac{1}{2} \times 3^2$

M<sub>1</sub>

$$= 48 \text{ m}$$

05

9

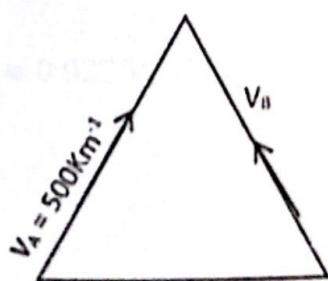
	C.B	<i>f</i>	C	<i>f.d</i>	<i>C.f</i>	
(a)	9.5 -19.5	20	10	2	20	
	19.5 - 24.5	20	5	4	40	M1
	24.5 - 29.5	10	5	5	50	
	29.5 - 30.5	14	1	14	64	A1
	30.5 - 34.5	16	4	4	80	
	34.5 - 39.5	10	5	2	90	
	39.5 - 59.5	10	20	0.5	100	
	B1	$\epsilon d = 100$	B1	B1	B1	

$$\text{Mode} = 29.5 + \left( \frac{12}{12 + 10} \right) \times 1$$

$$= 30.045$$

10

(a)



A 10km B

B1

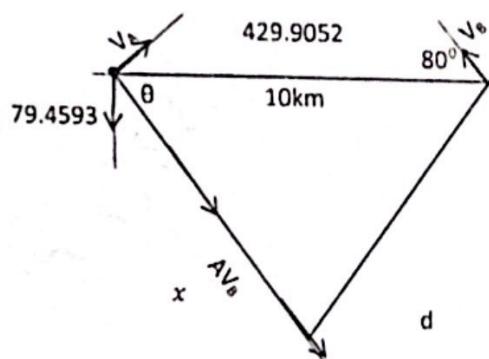
$$\frac{V_B}{\sin 60^\circ} = \frac{500}{\sin 80^\circ}$$

$$V_B = 439.6926 \text{ km}^{-1}$$

80°

M1

(b)



A1

B1 for  $\Delta V_B$   
plus d

$${}_{\text{A}}V_{\text{B}} = \begin{pmatrix} 500 \cos 45^{\circ} \\ 500 \sin 45^{\circ} \end{pmatrix} - \begin{pmatrix} -439.6926 \cos 80^{\circ} \\ 439.6926 \sin 80^{\circ} \end{pmatrix}$$

$$= \begin{pmatrix} 429.9052 \\ 79.4593 \end{pmatrix}$$

$$|{}_{\text{A}}V_{\text{B}}| = \sqrt{429.9052^2 + 79.4593^2}$$

B1 for  $V_{\text{A}}$   
OR  $V_{\text{B}}$

$$= 437.1868$$

B1

$$\theta = \tan^{-1} \left( \frac{79.4593}{429.9052} \right) = 10.47^{\circ}$$

B1

$$\sin 10.47^{\circ} = \frac{d}{429.9052}$$

$$d = 78.1227 \text{ km}$$

B1

M1

$$T_s = \frac{x}{AVB} = \left( \frac{10 \cos 10.47^{\circ}}{437.1868} \right)$$

A1

$$= 0.0225 \text{ h } OR 1.35 \text{ min } OR 81 \text{ s}$$

A1

12

11       $h = \frac{\pi - 0}{6} \quad B1 = \frac{\pi}{6}$

B1	x	$y_0, y_6$	$y_1, y_2, y_3, y_4, y_5$	
	0	1		
	$\pi/6$		1.70841	
	$2\pi/6$		1.96302	
	$3\pi/6$	B1	2.11934	B1
	$4\pi/6$		2.21325	
	$5\pi/6$		2.26081	
	$\pi$	2.27245		
	<b>SUM</b>	. 27245	<b>10.26483</b>	$\geq 5 \text{ dps}$

$$\int_0^\pi (\sqrt{x} + \cos \frac{x}{3}) dx \approx \frac{1}{2} \times \frac{\pi}{6} [3.27245 + 2 \times 10.26483]$$

M1

$$\approx 6.2314$$

A1 (4dps)

$$\int_0^\pi (x^{\frac{1}{2}} + \cos \frac{x}{3}) dx = \left[ \frac{2}{3} x^{\frac{3}{2}} + 3 \sin \frac{x}{3} \right]$$

M1

(b)

$$\left( \frac{2}{3} (\pi)^{\frac{3}{2}} + 3 \sin \frac{\pi}{3} \right) - (0 + \sin 0)$$

M1

$$= 6.3103$$

A1 4dps

$$\text{Error} = |6.3103 - 6.2314|$$

M1

(C)

$$= 0.0789$$

A1

By increasing number of sub-intervals

B1

12

9

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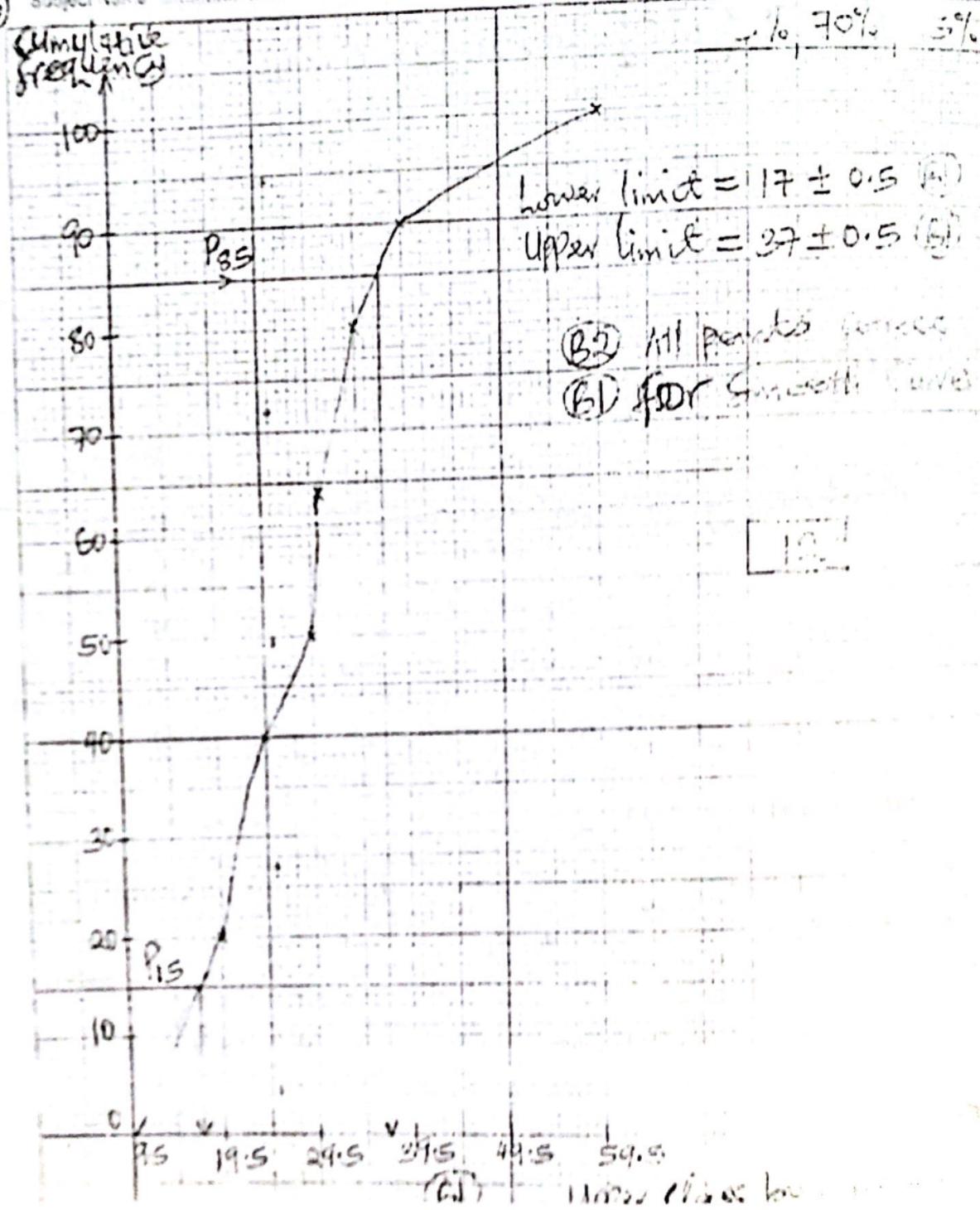
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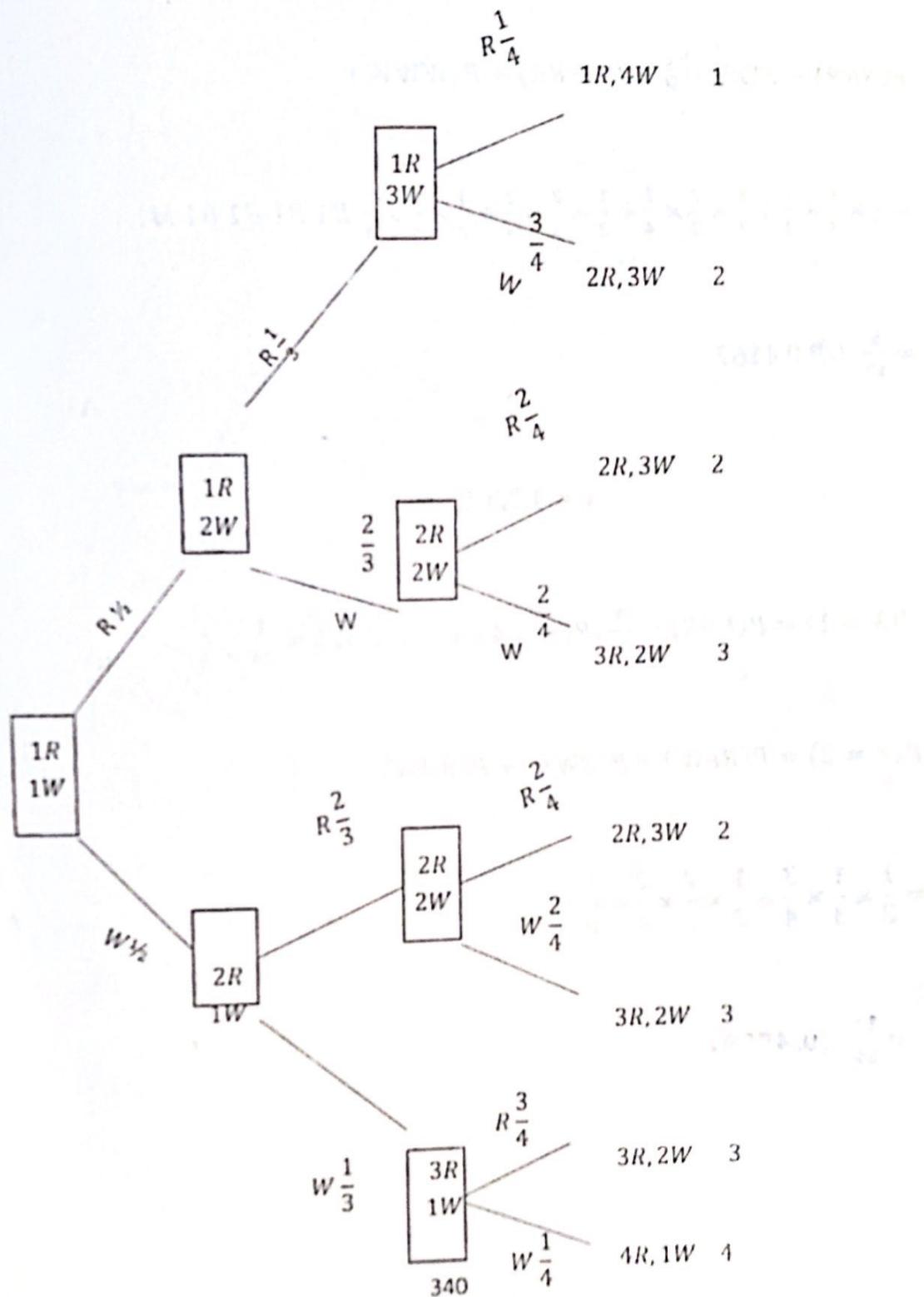
(b)

Cumulative  
frequency

Paper code \_\_\_\_\_

70%, 30%, 3%





(a)

$$P(RRR) + P(RWW) + P(WRR) + P(WWW)$$

$$= \frac{1}{2} \times \frac{1}{3} \times \frac{1}{4} + \frac{1}{2} \times \frac{2}{3} \times \frac{2}{4} + \frac{1}{2} \times \frac{2}{3} \times \frac{2}{4} + \frac{1}{2} \times \frac{1}{3} \times \frac{1}{4} \quad B1 \ B1 \ B1 \ B1 \ M1$$

$$= \frac{5}{12} \text{ OR } 0.4167$$

A1

b(i)

$$x = 1, 2, 3, 4$$

$$P(X = 1) = P(RRR) = \frac{1}{24}, P(X = 4) = P(WWW) = \frac{1}{24}$$

B1

$$P(X = 2) = P(RRW) + P(RWR) + P(WRR)$$

$$= \frac{1}{2} \times \frac{1}{3} \times \frac{3}{4} + \frac{1}{2} \times \frac{2}{3} \times \frac{2}{4} + \frac{1}{6}$$

$$= \frac{11}{24} \quad (0.4583)$$

$$P(X = 3) = 1 - \left(\frac{1}{24} + \frac{1}{24} + \frac{11}{24}\right) = \frac{11}{24}$$

B1

Probability distribution

$x$	1	2	3	4	B1
$P(X = x)$	$\frac{1}{24}$	$\frac{11}{24}$	$\frac{11}{24}$	$\frac{1}{24}$	

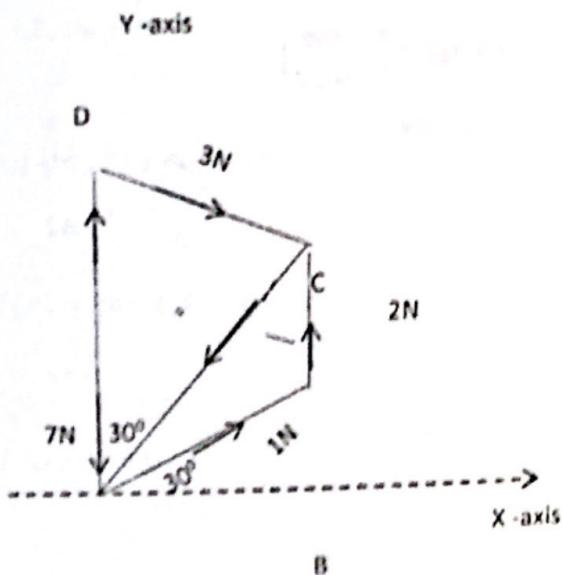
$$E(x) = 1 \times \frac{1}{24} + 2 \times \frac{11}{24} + 3 \times \frac{11}{24} + 4 \times \frac{1}{24}$$

$$(ii) -2.5 \quad M1$$

$$\quad \quad \quad A1$$

$$\quad \quad \quad 12$$

13a)



30

A

$$|\underline{R}| = \begin{pmatrix} 4 \cos 30^\circ \\ 4 \sin 30^\circ \end{pmatrix} + \begin{pmatrix} 2 \\ 2 \end{pmatrix} + \begin{pmatrix} 3 \sin 60^\circ \\ 3 \cos 60^\circ \end{pmatrix} + \begin{pmatrix} 0 \\ -7 \end{pmatrix} + \begin{pmatrix} -1 \cos 60^\circ \\ -1 \sin 60^\circ \end{pmatrix}$$

M1  
M1  
B1  
B1

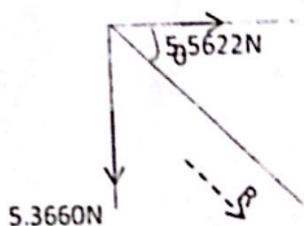
$$= \begin{pmatrix} 5.5622 \\ -5.3660 \end{pmatrix} N$$

$$R = \sqrt{5.5622^2 + -5.3660^2}$$

M1

$$= 7.7286 N$$

A1



$$\theta = \tan^{-1} \left( \frac{5.366}{5.5622} \right)$$

M1

$$= 43.97^\circ$$

A1

b)

$$\text{Ans } G = 2 \times a \cos 30^\circ - 3 \sin 60^\circ \times 2a$$

$$= 2\sqrt{3}a$$

$$\begin{vmatrix} 0 & y \\ 5.5622 & -5.3660 \end{vmatrix} = -2\sqrt{3}a$$

M1

$$0 - 5.5622y = -2\sqrt{3}a$$

M1

$$y = +0.6228a$$

$$0.6228a \text{ from A}$$

A1

$$\text{OR } 1.3772a \text{ from D}$$

12

14       $f(x) = \ln x + x - 2$

B1

$$f'(x) = \frac{1}{x} + 1$$

M1

$$x_{n+1} = x_n - \frac{(\ln x_n + x_n - 2)}{\frac{1}{x_n} + 1}$$

$$= \frac{x_n(3 - \ln x_n)}{1 + x_n} ; n = 0, 1, 2, \dots$$

$$x_0 = 1.56$$

B1

$$x_1 = \frac{1.56(3 - \ln 1.56)}{1 + 1.56} = 1.5571$$

M1

$$x_2 = \frac{1.5571(3 - \ln 1.5571)}{1 + 1.5571} = 1.5571$$

M1

$$\therefore |x_2 - x_1| = 1.5571 - 1.5571$$

$$\therefore \text{Root} = 1.557$$

A1

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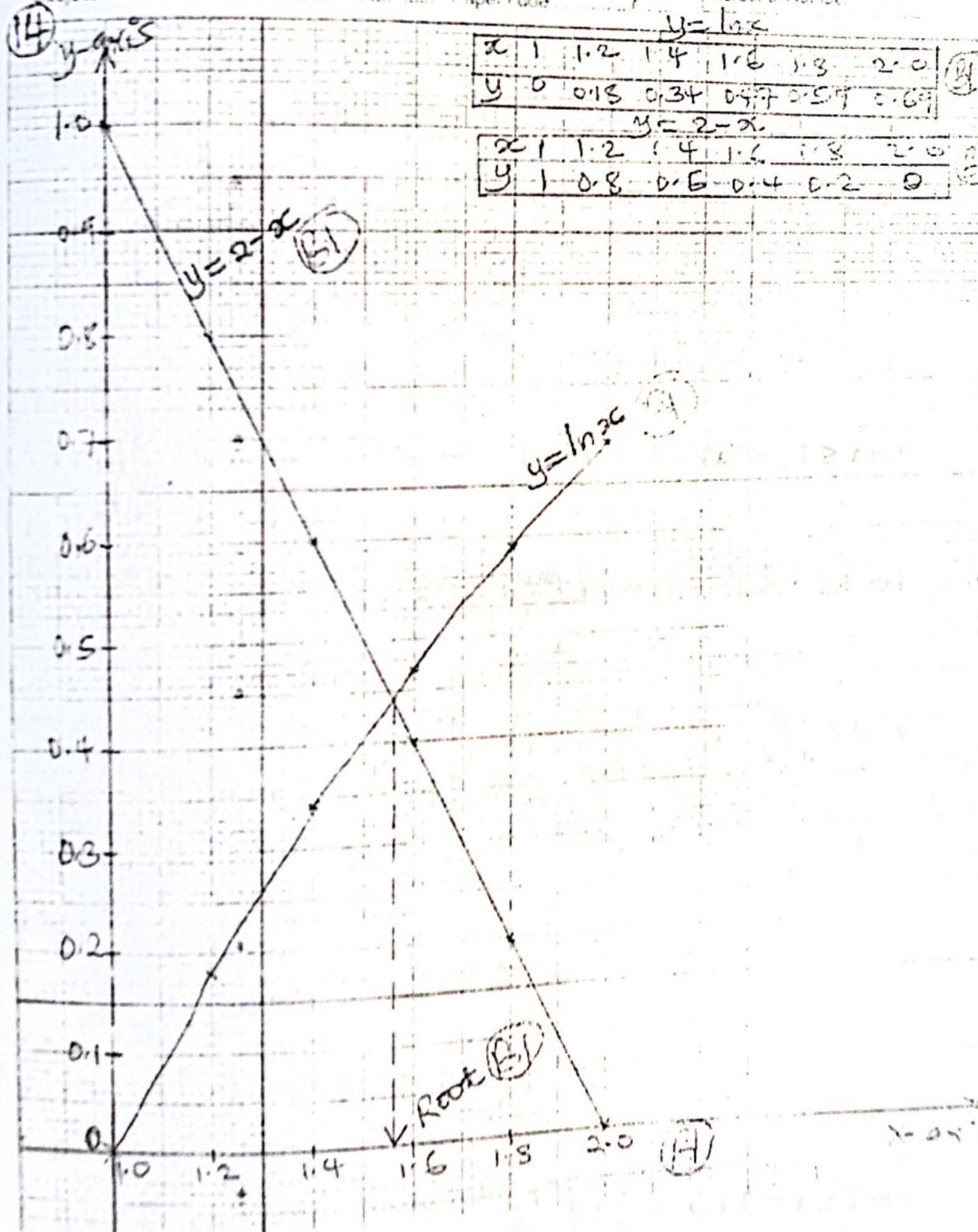
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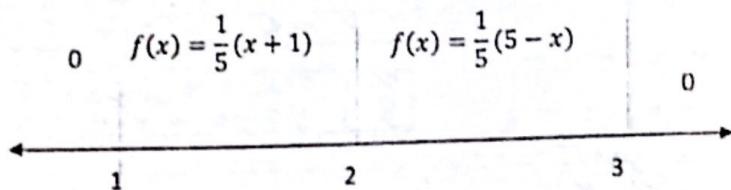
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15a)

(i)

For  $x \leq 1$   $F(x) = 0$ ;  $F(1) = 0$ 

B1

For  $1 \leq X \leq 2$   $F(x) = 0 + \int_1^x \frac{1}{5}(t+1) dt$ 

$$F(x) = \frac{1}{5} \left[ \frac{t^2}{2} + t \right]_1^x = \frac{1}{5} \left[ \left( \frac{x^2}{2} + x \right) - \left( \frac{1}{2} + 1 \right) \right]$$

$$= \frac{1}{10}x^2 + \frac{1}{5}x - \frac{3}{10}$$

B1

$$F(2) = \frac{1}{10}(2)^2 + \frac{1}{5}(2) - \frac{3}{10} = \frac{1}{2}$$

$$\text{For } 2 \leq x < 3 \quad F(x) = \frac{1}{2} + \int_2^x \frac{1}{5}(5-t) dt$$

$$F(x) = \frac{1}{2} + \frac{1}{5} \left[ 5t - \frac{t^2}{2} \right] 2$$

$$= \frac{1}{2} + \frac{1}{5} \left[ \left( 5x - \frac{x^2}{2} \right) - \left( 10 - \frac{4}{2} \right) \right]$$

B1

$$= \frac{-1}{10}x^2 + x - \frac{11}{10}$$

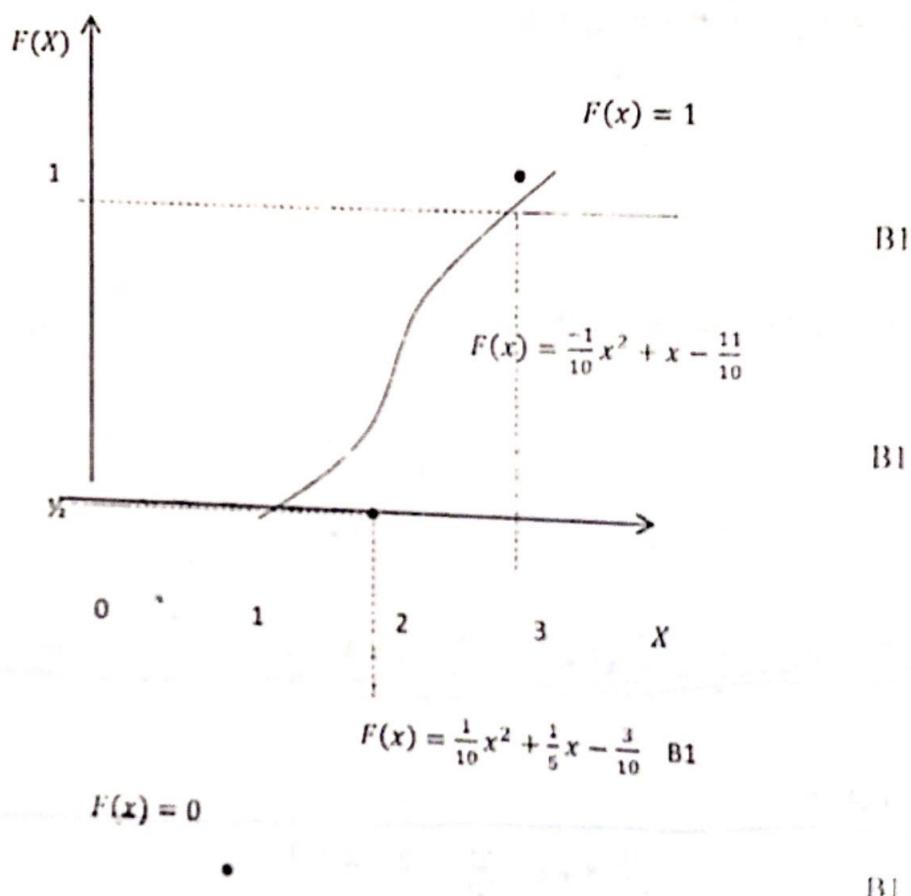
$$F(3) = \frac{-1}{10}(3)^2 + 3 - \frac{11}{10} = 1$$

B1

$$\text{For } X \geq 3; F(x) = F(3) + 0 = 1$$

B1

$$F(X) = \begin{cases} 0 & x \leq 1 \\ \frac{1}{10}x^2 + \frac{1}{5}x - \frac{3}{10} & 1 \leq X \leq 2 \\ \frac{-1}{10}x^2 + x - \frac{11}{10} & 2 \leq X \leq 3 \\ 1 & X \geq 3 \end{cases}$$



b)  $P(X < 2/X > 1.5) = \frac{P(1.5 < X < 2)}{P(X > 1.5)}$

B1

$$= \frac{F(2) - F(1.5)}{1 - P(1 < X < 1.5)}$$

$$F(1.5) = \frac{1}{10}(1.5)^2 + \frac{1}{5}(1.5) - \frac{3}{10}$$

$$= \frac{9}{40} \text{ OR } 0.225$$

B1

$$\therefore P(X < 2/X > 1.5) = \frac{\frac{1}{2} - \frac{9}{40}}{1 - \frac{9}{40}}$$

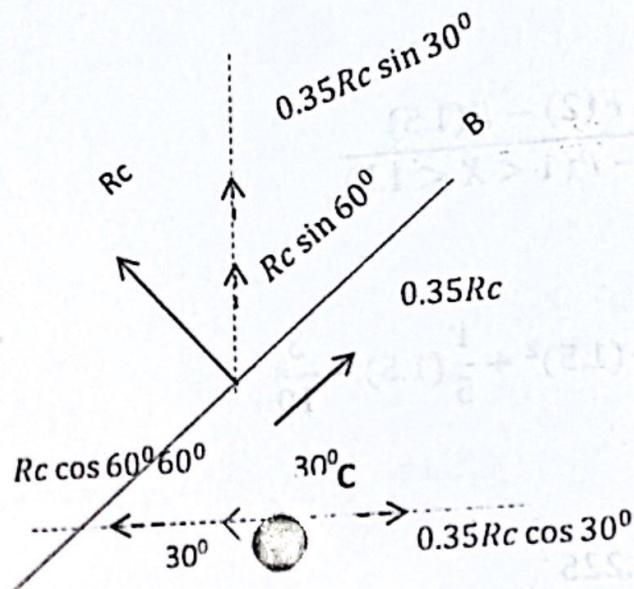
M1

$$= \frac{11}{31} \text{ OR } 0.3548$$

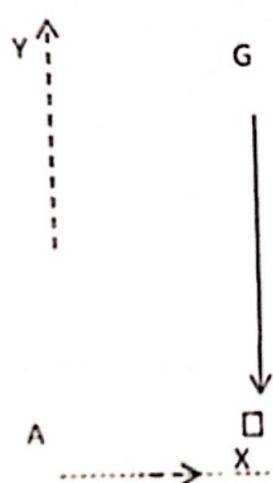
A1

L2

16



B1



$$\Delta C = \frac{3}{4} \Delta B$$

12N

A  $R_c \cdot \frac{3}{4} \Delta B = 12 \times \frac{1}{2} \Delta B$

$$\therefore R_c = \frac{6 \times 4}{3} = 8\text{N}$$

ANSWERS

$$(\rightarrow) X + 0.35 \times 8 \cos 30^\circ - 8 \cos 60^\circ = 0$$



ANSWER

$$\therefore X = 1.5751\text{N}$$

(ii)

$$(\uparrow) Y + 0.35 \times 8 \sin 30^\circ + 8 \sin 60^\circ - 12 = 0$$

ANSWER

$$\therefore Y = 3.6718\text{N}$$

$$R_F = \sqrt{1.5751^2 + 3.6718^2}$$

(iii)

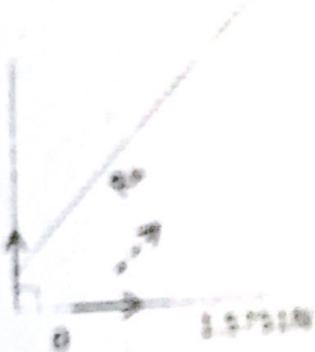
$$\approx 4.1153\text{N}$$

$$\theta = \tan^{-1} \left( \frac{3.6718}{1.5751} \right)$$

ANSWER

$$\approx 66.79^\circ \text{ (to the horizontal)}$$

(iv)



(v)

(vi)

(vii)

(viii)