IYGB - MMS PAPER S - QUESTION 1

$X \sim B(n, p)$

- $E(X) = \text{MEAN} = 0.95$

  $np = 0.95$

- $Var(X) = (S.D)^2 = 0.95^2$

  $np(1-p) = 0.95^2$

$$0.95 \times (1-p) = 0.95^2$$
$$1 - p = 0.95$$
$$p = 0.05$$

& $np = 0.95$

$n \times 0.05 = 0.95$

$n = 19$

IYGB - MMS PAPER S - QUESTION 2

$$\boxed{\bar{x} = \frac{1}{n}\sum_{r=1}^{n} x_r = 2 \qquad \sigma = \sqrt{\frac{1}{n}\sum_{r=1}^{n}(x_r)^2 - \frac{1}{n^2}\left[\sum_{r=1}^{n} x_r\right]^2} = 3}$$

PROCEED AS FOLLOWS & DROPPING SUBSCRIPTS/SUPERSCRIPTS IN SIGMA

- $\frac{1}{n}\sum x = 2$

  $\sum x = 2n$

- $\sqrt{\frac{1}{n}\sum x^2 - \frac{1}{n^2}\left(\sum x\right)^2} = 3$

  $\frac{1}{n}\sum x^2 - \frac{1}{n^2}\left(\sum x\right)^2 = 9$

  $\frac{1}{n}\sum x^2 - \left(\frac{\sum x}{n}\right)^2 = 9$

  $\frac{1}{n}\sum x^2 - \bar{x}^2 = 9$

  $\frac{1}{n}\sum x^2 - 2^2 = 9$

  $\frac{1}{n}\sum x^2 = 13$

  $\sum x^2 = 13n$

HENCE WE NOW HAVE

$$\sum_{r=1}^{n}(x_r+1)^2 = \sum_{r=1}^{n}\left(x_r^2 + 2x_r + 1\right)$$

$$= \sum_{r=1}^{n}\left(x_r^2\right) + \sum_{r=1}^{n}(2x_r) + \sum_{r=1}^{n} 1$$

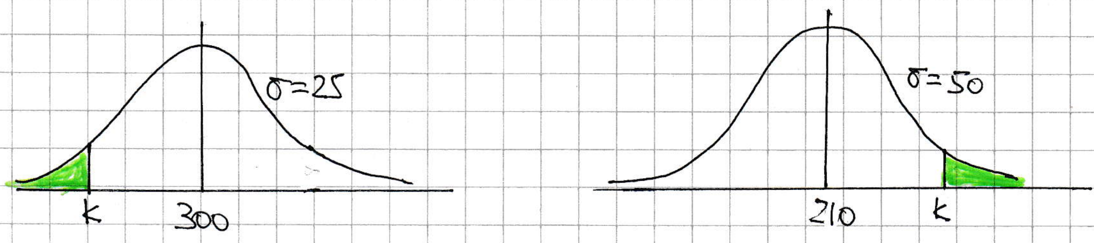
$$= \sum_{r=1}^{n}\left(x_r^2\right) + 2\sum_{r=1}^{n} x + \sum_{r=1}^{n} 1$$

$$= 13n + 2 \times 2n + n$$

$$= 18n$$

IYGB - MMS PAPER S - QUESTION 3

STARTING WITH TWO DIAGRAMS



$$\Rightarrow \quad P(X<k) = P(Y>k)$$
$$\Rightarrow \quad 1-P(X>k) = 1-P(Y<k)$$
$$\Rightarrow \quad P(Y<k) = P(X>k)$$
$$\Rightarrow \quad P\left(Z<\frac{k-300}{25}\right) = P\left(Z>\frac{k-210}{50}\right)$$
$$\Rightarrow \quad \Phi\left(\frac{k-300}{25}\right) = \Phi\left(\frac{k-210}{50}\right)$$

NOW NOTE THE "NEGATIVE INVERSION" IN THE L.H.S

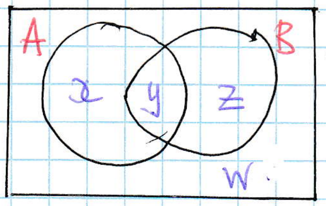
$$\Rightarrow \quad -\frac{k-300}{25} = \frac{k-210}{50}$$
$$\Rightarrow \quad \frac{300-k}{25} = \frac{k-210}{50}$$
$$\Rightarrow \quad 2(300-k) = k-210$$
$$\Rightarrow \quad 600-2k = k-210$$
$$\Rightarrow \quad 810 = 3k$$
$$\Rightarrow \quad k = 270$$

IYGB - MMS PAPER S - QUESTION 4

A = "A" SUCCESSFUL
A' = "A" UNSUCCESSFUL & SIMILARLY FOR B

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

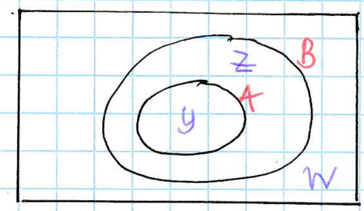
FILL IN A VENN DIAGRAM (PARTLY)



- $x + y + z + w = 1$
- $w = x + w$

$x = 0$

REDRAWING THE VENN



$$\therefore \quad P(A \cap B) = y = P(A)$$

IYGB – MMS PAPER S – QUESTION 5

START BY WRITING THE DISTRIBUTIONS EXPLICITLY

x	1	2	3	4	5	6	7
$P(X=x)$	$\frac{1}{7}$	$\frac{1}{7}$	$\frac{1}{7}$	$\frac{1}{7}$	$\frac{1}{7}$	$\frac{1}{7}$	$\frac{1}{7}$

y	2	3	6
$P(Y=y)$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{6}$

NOW $X_1 + X_2 \geqslant 9 + Y_1$

LET $Y_1 = 2$	LET $Y_1 = 3$	LET $Y_1 = 6$
$X_1 + X_2 \geqslant 11$	$X_1 + X_2 \geqslant 12$	$X_1 + X_2 \geqslant 15$

LET SMALLEST $X_1 = \ldots$ FIRST OF THESE X OBSERVATIONS

$\left.\begin{matrix} 4,7 \\ 5,6 \\ 5,7 \\ 6,6 \\ 6,7 \\ 7,7 \end{matrix}\right\}$ 2 WAYS EXCEPT 6,6 7,7	$\left.\begin{matrix} 5,7 \\ 6,6 \\ 6,7 \\ 7,7 \end{matrix}\right\}$ TWO WAYS EXCEPT 6,6 7,7	NOT POSSIBLE

NOW THE PROBABILITIES

$\left(\underset{X_1}{\frac{1}{7}} \times \underset{X_2}{\frac{1}{7}} \times \underset{\text{WAYS}}{10}\right) \times \underset{Y_1=2}{\frac{1}{2}}$	$\left(\underset{X_1}{\frac{1}{7}} \times \underset{X_2}{\frac{1}{7}} \times \underset{\text{WAYS}}{6}\right) \times \underset{Y_1=3}{\frac{1}{3}}$	0
$\frac{5}{49}$	$\frac{2}{49}$	

$\therefore$ REQUIRED PROBABILITY IS $\frac{5}{49} + \frac{2}{49} = \frac{7}{49} = \frac{1}{7}$

IYGB - MMS PAPER S - QUESTION 6

PROCEED AS FOLLOWS FROM $X \sim B(n,p)$

$$\Rightarrow P(X=2) = P(X=3)$$

$$\Rightarrow \binom{n}{2} p^2 (1-p)^{n-2} = \binom{n}{3} p^3 (1-p)^{n-3}$$

$$\Rightarrow \frac{n(n-1)}{1 \times 2} p^2 (1-p)^{n-2} = \frac{n(n-1)(n-2)}{1 \times 2 \times 3} p^3 (1-p)^{n-3}$$

DIVIDE BOTH SIDES BY n, $n-1$, p^2, $(1-p)^{n-3}$ WHICH ARE ALL NON ZERO

$$\Rightarrow \frac{1}{2}(1-p) = \frac{1}{6}(n-2)p$$

$$\Rightarrow 3(1-p) = (n-2)p$$

$$\Rightarrow 3 - 3p = np - 2p$$

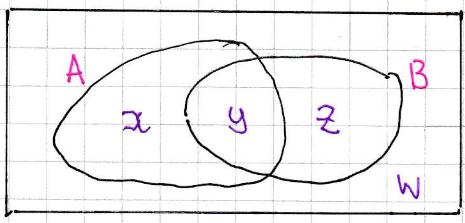
$$\Rightarrow 3 - p = np$$

$$\therefore \quad np = E(X) = \text{MEAN} = 3 - p$$

AS REQUIRED

IYGB - MMS PAPER S - QUESTION 7

BEST APPROACH IS TO USE ALGEBRA WITH A SUITABLY LABELLED VENN



- $P(A \cup B') = 0.92$

  $x + y + w = 0.92 \quad -\text{I}$

- $P(A' \cup B) = 0.5$

  $z + w + y = 0.5 \quad -\text{II}$

- $P(A' \cup B') = 0.88$

  $z + w + x = 0.88 \quad -\text{III}$

- $x + y + z + w = 1 \quad -\text{IIII}$

MAKE (II) WITH "w" THE SUBJECT AND SUBSTITUTE INTO THE OTHER 3

$$(\text{II}) \quad w = 0.5 - z - y \quad \Rightarrow \begin{cases} x + \cancel{y} + (0.5 - z - \cancel{y}) = 0.92 \\ \cancel{z} + (0.5 - \cancel{z} - y) + x = 0.88 \\ x + \cancel{y} + \cancel{z} + (0.5 - \cancel{z} - \cancel{y}) = 1 \end{cases}$$

$$\Rightarrow \begin{cases} x - z = 0.42 \\ x - y = 0.38 \\ x = 0.5 \end{cases}$$

$$\Rightarrow \quad z = 0.08, \; y = 0.12, \; w = 0.3$$

FINALLY WE HAVE

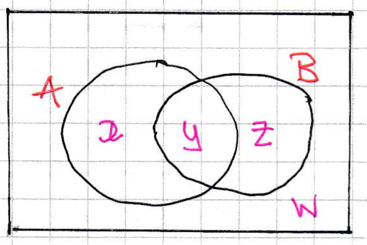
$$P(A' \cap B') = w = 0.3$$

P.T.O

IYGB - MMS PAPER S - QUESTION 7

ALTERNATIVE

LOOKING AT THE SAME VENN DIAGRAM



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

$$0.92 = (\cancel{x}+y) + (x+w) - \cancel{x}$$

$$0.92 = x + y + w$$

$\therefore z = 0.08$

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

$$0.5 = (z+w) + (y+\cancel{z}) - \cancel{z}$$

$$0.5 = w + y + z$$

$\therefore x = 0.5$

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

$$0.88 = (z+w) + (x+\cancel{w}) - \cancel{w}$$

$$0.88 = x + z + w$$

$$0.88 = 0.5 + 0.08 + w$$

$$w = 0.3$$

$\therefore P(A' \cap B') = w = 0.3$

AS BEFORE

IYGB - MMS PAPER S - QUESTION 8

a) SORTING OUT THE OUTCOMES

$$P(\text{SUM OF TWO IS EVEN}) = P(\text{EVEN},\text{EVEN}) + P(\text{ODD},\text{ODD})$$
$$= \left(\tfrac{1}{2}\times\tfrac{1}{2}\right) + \left(\tfrac{1}{2}\times\tfrac{1}{2}\right)$$
$$= \frac{1}{2}$$

b) LISTING THE DESIRED OUTCOMES

$$P(2^{ND} > 1^{ST}) = P(6, 1 \text{ to } 5) + P(5, 1 \text{ to } 4) + P(4, 1 \text{ to } 3)$$
$$P(3, 1 \text{ or } 2) + P(2,1)$$
$$= \left(\tfrac{1}{4}\times\tfrac{3}{4}\right) + \left(\tfrac{1}{8}\times\tfrac{5}{8}\right) + \left(\tfrac{1}{8}\times\tfrac{1}{2}\right) + \left(\tfrac{1}{8}\times\tfrac{3}{8}\right) + \left(\tfrac{1}{8}\times\tfrac{1}{4}\right)$$
$$= \frac{13}{32}$$

ALTERNATIVE FOR THIS PART

$$P(\text{"SAME"}) = P(1,1) + \underbrace{P(2,2) + P(3,3) + P(4,4) + P(5,5)}_{\frac{1}{8}\times\frac{1}{8}\times 4 \text{ WAYS}} + P(6,6)$$
$$\left(\tfrac{1}{4}\times\tfrac{1}{4}\right)\times 2 \text{ WAYS}$$
$$= \frac{1}{\text{[illegible]}} + \frac{1}{16}$$
$$= \frac{\text{[illegible]}}{\text{[illegible]}}$$

BY SYMMETRY AS $P(2^{ND} > 1^{ST}) = P(1^{ST} > 2^{ND})$ THE REQUIRED ANSWER WILL BE

$$\frac{1}{2}\left(1 - \frac{3}{16}\right) = \frac{13}{32}$$ AS BEFORE

c) SENSIBLE TO LIST AGAIN

$$P(\text{SUM IS EVEN \& HIGHER ON THE } 2^{ND}) = P(1,3) + P(1,5) + P(2,4) + P(2,6)$$
$$P(3,5) + P(4,6)$$
$$= \frac{(2\times1) + (2\times1) + (1\times1) + (1\times2) + (1\times1) + (1\times2)}{8\times8}$$

IYGB - MMS PAPER S - QUESTION 8

$$= \frac{2+2+1+2+1+2}{64} = \frac{10}{64} = \frac{5}{32}$$

d) P(DIFFERENT TUBES) $= \frac{8}{8} \times \frac{7}{8} \times \frac{6}{8} = \frac{42}{64} = \frac{21}{32}$

CHOICES OUT 8 | CHOICES OUT OF 8 | CHOICES OUT OF 8

e) ORGANISED OUTCOMES AGAIN - BEST TO WORK WITH COMPLEMENT

1,1 WITH 2,3,4,5 $\quad \left(\frac{2}{8} \times \frac{2}{8} \times \frac{1}{8} \times 3\text{ WAYS}\right) \times 4 = \frac{48}{512}$

2,2 WITH 3,4,5
3,3 WITH 2,4,5
4,4 WITH 2,3,5
5,5 WITH 2,3,4 $\quad \left[\left(\frac{1}{8} \times \frac{1}{8} \times \frac{1}{8} \times 3\text{ WAYS}\right) \times 3\right] \times 4 = \frac{36}{512}$

6,6 WITH 2,3,4,5 $\quad \left(\frac{2}{8} \times \frac{2}{8} \times \frac{1}{8} \times 3\text{ WAYS}\right) \times 4 = \frac{48}{512}$

6,6,1 OR 6,1,1 $\quad \left(\frac{2}{8} \times \frac{2}{8} \times \frac{2}{8} \times 3\text{ WAYS}\right) \times 2 = \frac{48}{512}$

2,2, WITH 1 OR 6
3,3 WITH 1 OR 6
4,4 WITH 1 OR 6
5,5 WITH 1 OR 6 $\quad \frac{1}{8} \times \frac{1}{8} \times \frac{2}{8} \times 3\text{ WAYS}) \times 2 \times 4 = \frac{48}{512}$

THE ABOVE OUTCOMES ARE "TWO THE SAME" - WE ALSO HAVE ALL 3 THE SAME

1,1,1 OR 6,6,6 $\quad \frac{2}{8} \times \frac{2}{8} \times \frac{2}{8} \times 2 = \frac{16}{512}$

2,2,2 TO 5,5,5 $\quad \frac{1}{8} \times \frac{1}{8} \times \frac{1}{8} \times 4 = \frac{4}{512}$

IYGB - MMS PAPER S - QUESTION 8

ADDING ALL THE PROBABILITIES FOUND

$$\frac{48+36+48+48+48+16+4}{512} = \frac{248}{512}$$

HENCE WE HAVE

$$P(\text{ALL 3 DIFFERENT SCORES}) = 1 - \frac{248}{512}$$

$$= \frac{264}{512}$$

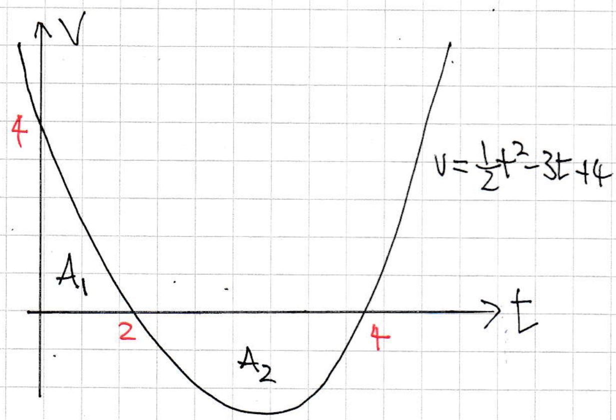
$$= \frac{33}{64}$$

IYGB - MMS PAPER S - QUESTION 9

NEED TO SKETCH A VELOCITY-TIME GRAPH HERE (BEST APPROACH)

$$V = 0 \implies \frac{1}{2}t^2 - 3t + 4 = 0$$
$$t^2 - 6t + 8 = 0$$
$$(t-2)(t-4) = 0$$
$$t = \begin{cases} 2 \\ 4 \end{cases}$$

DRAWING THE QUADRATIC



- $A_1 = \int_0^2 \frac{1}{2}t^2 - 3t + 4 \, dt$

$A_1 = \left[\frac{1}{6}t^3 - \frac{3}{2}t^2 + 4t\right]_0^2$

$A_1 = \frac{4}{3} - 6 + 8$

$A_1 = \frac{10}{3}$ ← DISTANCE/DISPLACEMENT

- $A_2 = \int_2^4 \frac{1}{2}t^2 - 3t + 4 \, dt = \left[\frac{1}{6}t^3 - \frac{3}{2}t^2 + 4t\right]_2^4$

$= \left(\frac{32}{3} - 24 + 16\right) - \left(\frac{4}{3} - 6 + 8\right) = \frac{8}{3} - \frac{10}{3} = -\frac{2}{3}$

$\therefore$ DISPLACEMENT $= -\frac{2}{3}$

$\therefore$ DISTANCE $= +\frac{2}{3}$

TOTAL DISTANCE FOR $0 \le t \le 4$ IS $\frac{10}{3} + \frac{2}{3} = 4$

NEED $13 - 4 = 9$. EXTRA METRES AFTER $t = 4$

WHEN THE DISTANCE IS 13 THE DISPLACEMENT MUST BE 9 (FOR $t \ge 4$)

TOTAL DISPLACEMENT REQUIRED $= \frac{10}{3} - \frac{2}{3} + 9 = \frac{35}{3}$

IYGB - MMS PAPER S - QUESTION 10

USING $\underline{v} = \underline{u} + \underline{a}t$

$$22\underline{i} + 22\underline{j} = 10\underline{i} - 13\underline{j} + (p\underline{i} + q\underline{j})t$$

$$12\underline{i} + 35\underline{j} = pt\underline{i} + qt\underline{j}$$

$pt = 12$

$qt = 35$

ACCELERATION MAGNITUDE IS 3.7

$$\Rightarrow |\underline{a}| = |p\underline{i} + q\underline{j}| = 3.7$$

$$\Rightarrow \sqrt{p^2 + q^2} = 3.7$$

$$\Rightarrow p^2 + q^2 = 13.69$$

SOLVING AS FOLLOWS

$$\left.\begin{array}{l} p^2t^2 = 144 \\ q^2t^2 = 1225 \end{array}\right\} \Rightarrow p^2t^2 + q^2t^2 = 1369$$

$$\Rightarrow t^2(p^2 + q^2) = 1369$$

$$\Rightarrow 13.69t^2 = 1369$$

$$\Rightarrow t^2 = 100$$

$$\Rightarrow t = 10$$

FINALLY

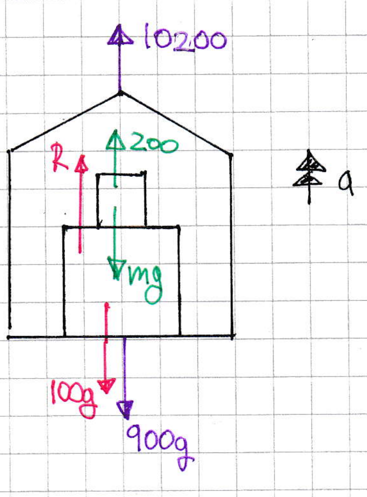
$pt = 12$ & $qt = 35$

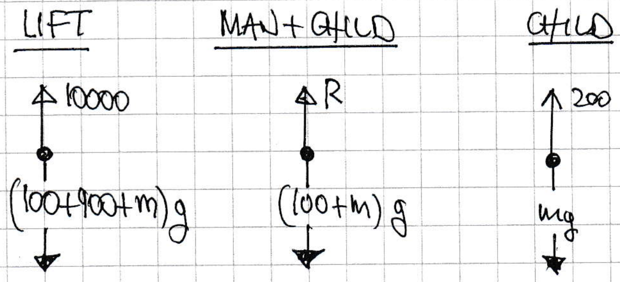
$10p = 12$ $10q = 35$

$p = 1.2$ $q = 3.5$

IYGB - MMS PAPER S - QUESTION 14

START WITH A DIAGRAM — MARK THE ACCELARATION UPWARDS





"F=ma" ON THE CHILD

$$200 - mg = ma$$

"F=ma" ON THE "ENTIRE SYSTEM"

$$10200 - (100+900+m)g = (100+900+m)a$$

$$10200 - 100g - 900g - mg = 100a + 900a + ma$$

$$10200 - 980 - 8820 - mg = 1000a + ma$$

$$400 - mg = 1000a + ma$$

$$400 - \cancel{mg} = 1000a + (200 - \cancel{mg})$$

$$200 = 1000a$$

$$a = 0.2$$ (INDEED UPWARDS)

$$\Rightarrow 200 - mg = m \times 0.2$$

$$\Rightarrow 200 = mg + 0.2m$$

$$\Rightarrow 200 = 10m$$

$$\Rightarrow m = 20 \text{ kg}$$

FINALLY "F=ma" ON MAN + CHILD

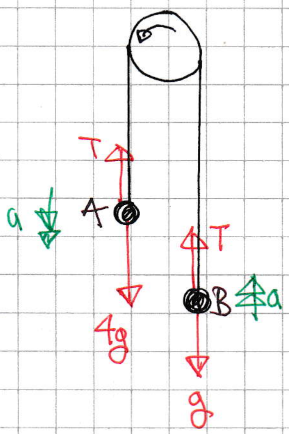
$$\Rightarrow R - (100+m)g = (100+m)a$$

$$\Rightarrow R - 120g = 120 \times 0.2$$

$$\Rightarrow R = 1200 \text{ N}$$

IYGB - MMS PAPER S - QUESTION 12

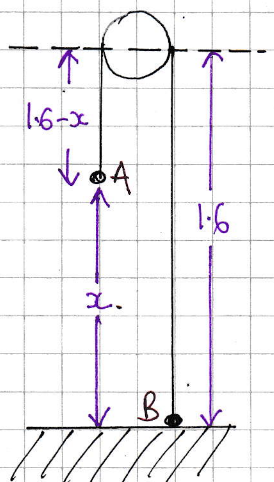
START BY OBTAINING THE ACCELERATION OF THE SYSTEM, WHEN IN MOTION



$$\left.\begin{array}{l}(A): 4g - T = 4a \\ (B): T - g = 1a\end{array}\right\} \quad 5a = 3g$$

$$a = \frac{3}{5}g = 5.88 \text{ ms}^{-2}$$

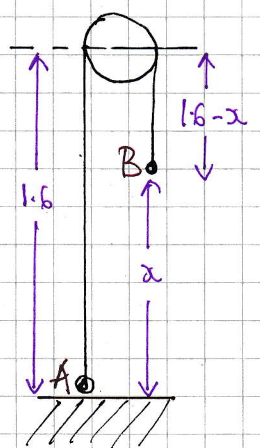
NOW ANOTHER DIAGRAM - SUPPOSE THAT A IS x ABOVE THE FLOOR (ON RELEASE)



KINEMATICS FOR A

$u = 0$
$a = \frac{3}{5}g$
$s = x$
$t =$
$v = ?$

$$v^2 = \cancel{u^2} + 2as$$
$$v^2 = 2\left(\tfrac{3}{5}g\right)x$$
$$v^2 = \frac{6}{5}gx$$
$$v = \sqrt{\frac{6}{5}gx}$$



KINEMATICS FOR B (UNDER GRAVITY)

$u = \sqrt{\frac{6}{5}gx}$
$a = -g$
$s = 1.6 - x$
$t =$
$v = 0$

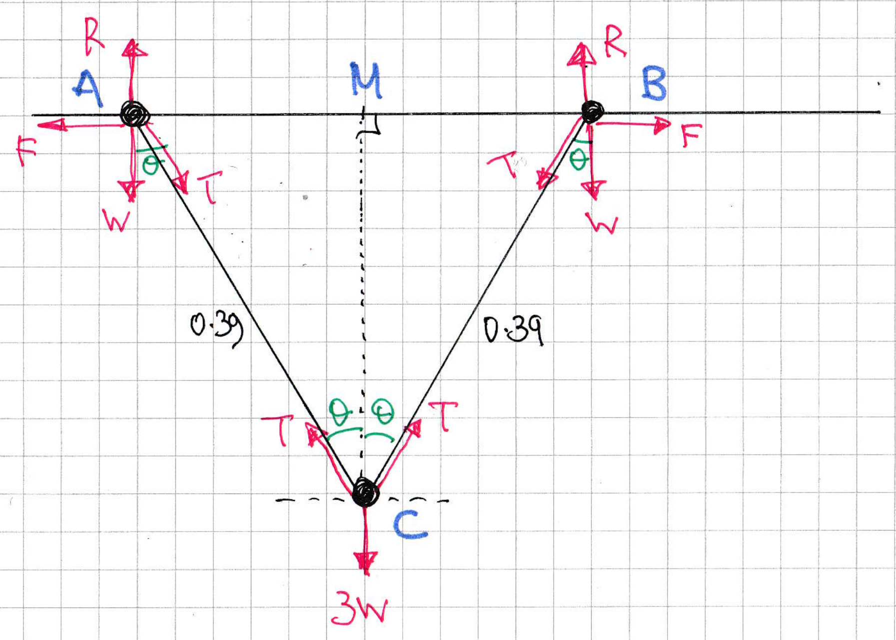
$$v^2 = u^2 + 2as$$
$$0 = \frac{6}{5}gx + 2(-g)(1.6 - x)$$
$$0 = \frac{6}{5}gx - 2g(1.6 - x)$$
$$0 = \frac{6}{5}gx + 2g(x - 1.6)$$
$$0 = 1.2x + 2(x - 1.6)$$
$$0 = 1.2x + 2x - 3.2$$
$$x = 1$$

$\therefore$ LENGTH $= 2 \times 1.6 - x = 2.2$

$L = 2.2$

IYGB - MMS PAPER $ - QUESTION 13

STARTING WITH A DETAILED DIAGRAM



LOOKING AT "C" VERTICALLY

$$2T\cos\theta = 3W$$

$$T = \frac{3W}{2\cos\theta}$$

LOOKING AT ONE OF THE RINGS, SAY "A"

$$\left.\begin{array}{l}(\uparrow): \quad R = W + T\cos\theta \\ (\rightarrow): \quad F = T\sin\theta\end{array}\right\} \Rightarrow$$

$$\left.\begin{array}{l}R = W + \left(\frac{3W}{2\cancel{\cos\theta}}\right)\cancel{\cos\theta} \\ F = \left(\frac{3W}{2\cos\theta}\right)\sin\theta\end{array}\right\} \Rightarrow$$

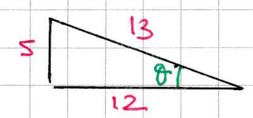
$$R = \frac{5}{2}W$$

$$F = \frac{3}{2}\tan\theta\, W$$

BUT $F \leq \mu R$

$$\Rightarrow \frac{3}{2}\cancel{W}\tan\theta \leq \frac{1}{4}\left(\frac{5}{2}\cancel{W}\right)$$

$$\Rightarrow \tan\theta \leq \frac{5}{12}$$



$$\Rightarrow \sin\theta \leq \frac{5}{13}$$

$$\sin\theta = \frac{5}{13}$$

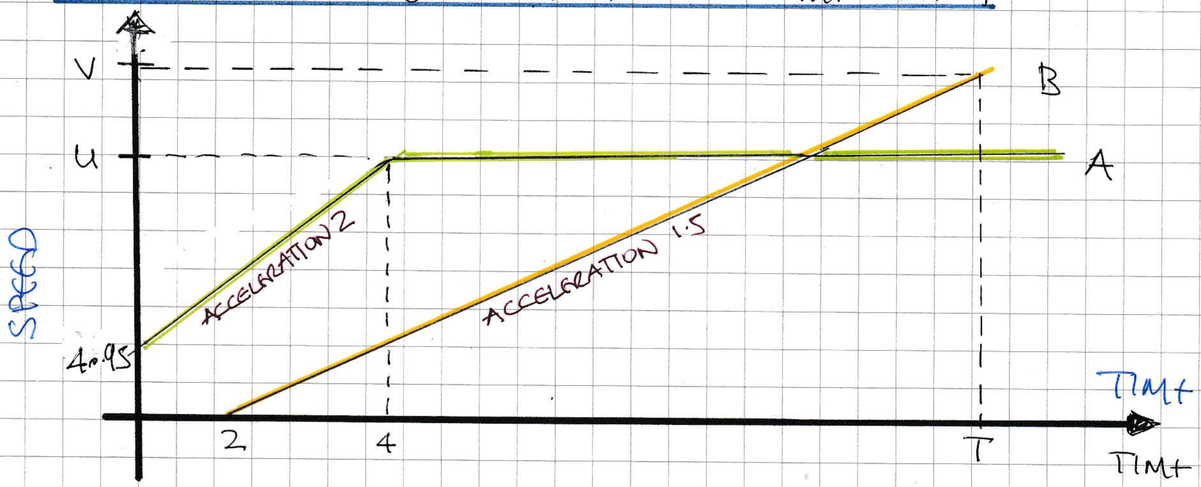
$$\Rightarrow 0.39\sin\theta \leq \frac{5}{13} \times 0.39$$

$$\Rightarrow |AM| \leq 0.15$$

$$\Rightarrow |AB| \leq 0.30$$

IYGB - MMS PAPER S - QUESTION 14

ATTEMPTING A SOLUTION BY A SPEED TIME GRAPH



LET THE MAXIMUM SPEEDS OF A & B BE u & V RESPECTIVELY

THEN FOR A "$v = u + at$"

$\Rightarrow u = 4.95 + 2 \times 4$

$\Rightarrow u = 12.95$

AND FOR B "$v = u + at$"

$\Rightarrow V = 0 + 1.5(T-2)$

$\Rightarrow V = \frac{3}{2}(T-2)$

WHEN B DRAWS LEVEL THE DISTANCES WOULD BE IDENTICAL

$\Rightarrow$ 

$\Rightarrow \frac{u+4.95}{2} \times 4 + u(T-4) = \frac{1}{2}V(T-2)$

$\Rightarrow \frac{12.95+4.95}{2} \times 4 + 12.95(T-4) = \frac{1}{2} \times \frac{3}{2}(T-2) \times (T-2)$

$\Rightarrow 35.8 + 12.95(T-4) = \frac{3}{4}(T-2)^2$

$\Rightarrow 716 + 259(T-4) = \frac{3}{4}(T-2)^2$ $\quad \times 20$

$\Rightarrow 716 + 259T - 1036 = 15(T^2 - 4T + 4)$

IYGB - MMS PAPER S - QUESTION 14

$$\Rightarrow -320 + 259T = 15T^2 - 60T + 60$$

$$\Rightarrow 0 = 15T^2 - 319T + 380$$

BY THE QUADRATIC FORMULA

$$T = \frac{319 \pm \sqrt{(-319)^2 - 4 \times 15 \times 380}}{2 \times 15} = \frac{319 \pm 281}{30}$$

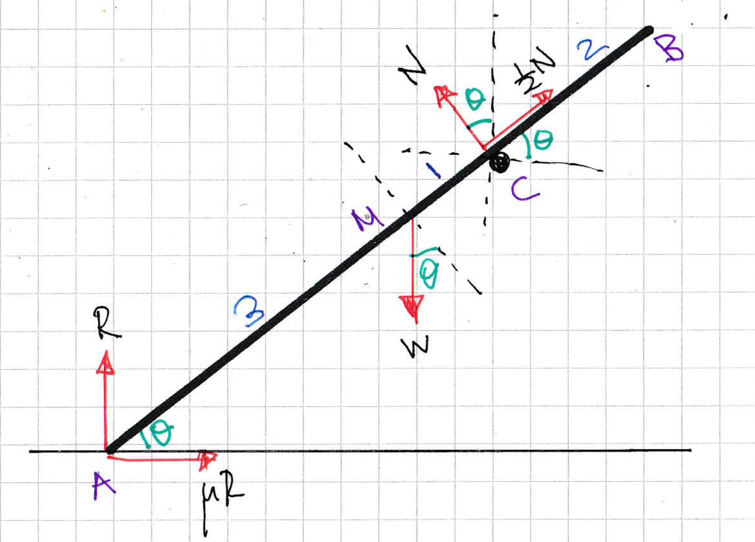
$$T = \begin{cases} 20 \\ \frac{19}{15} \simeq \cancel{1.267} \quad (T > 4) \end{cases}$$

HENCE THE REQUIRED "AREA" IS $\frac{3}{4}(T-2)^2$ WITH $T = 20$

$\therefore$ DISTANCE COVERED $= \frac{3}{4} \times 18^2 = 243 \text{ m}$

IYGB - MMS PAPER S - QUESTION 15

STARTING WITH A DETAILED DIAGRAM



RESOLVING AND TAKING MOMENTS ABOUT "A"

$\overset{\curvearrowleft}{A}$: $W\cos\theta \times 3 = N \times 4$

$$\boxed{N = \frac{3}{4}W\cos\theta}$$

$(\uparrow)$: $R + N\cos\theta + \frac{1}{2}N\sin\theta = W$

$R = W - N\cos\theta - \frac{1}{2}N\sin\theta$

$R = W - \left(\frac{3}{4}W\cos\theta\right)\cos\theta - \frac{1}{2}\left(\frac{3}{4}W\cos\theta\right)\sin\theta$

$$\boxed{R = W - \frac{3}{4}W\cos^2\theta - \frac{3}{8}W\cos\theta\sin\theta}$$

$(\rightarrow)$: $\mu R + \frac{1}{2}N\cos\theta = N\sin\theta$

$\mu R = N\sin\theta - \frac{1}{2}N\cos\theta$

$\mu = \dfrac{N\sin\theta - \frac{1}{2}N\cos\theta}{R}$

$\mu = \dfrac{\left(\frac{3}{4}\cancel{W}\cos\theta\right)\sin\theta - \frac{1}{2}\left(\frac{3}{4}\cancel{W}\cos\theta\right)\cos\theta}{\cancel{W} - \frac{3}{4}\cancel{W}\cos^2\theta - \frac{3}{8}\cancel{W}\cos\theta\sin\theta}$

$\mu = \dfrac{\frac{3}{4}\cos\theta\sin\theta - \frac{3}{8}\cos^2\theta}{1 - \frac{3}{4}\cos^2\theta - \frac{3}{8}\cos\theta\sin\theta}$ MULTIPLY "TOP BOTTOM" BY 8

$\mu = \dfrac{6\cos\theta\sin\theta - 3\cos^2\theta}{8 - 6\cos^2\theta - 3\cos\theta\sin\theta}$

DIVIDE "TOP/BOTTOM" BY $\cos^2\theta$

$\mu = \dfrac{6\tan\theta - 3}{8\sec^2\theta - 6 - 3\tan\theta}$

$\mu = \dfrac{6\tan\theta - 3}{8(1+\tan^2\theta) - 6 - 3\tan\theta}$

$\mu = \dfrac{6\tan\theta - 3}{8\tan^2\theta - 3\tan\theta + 2}$

AS REQUIRED

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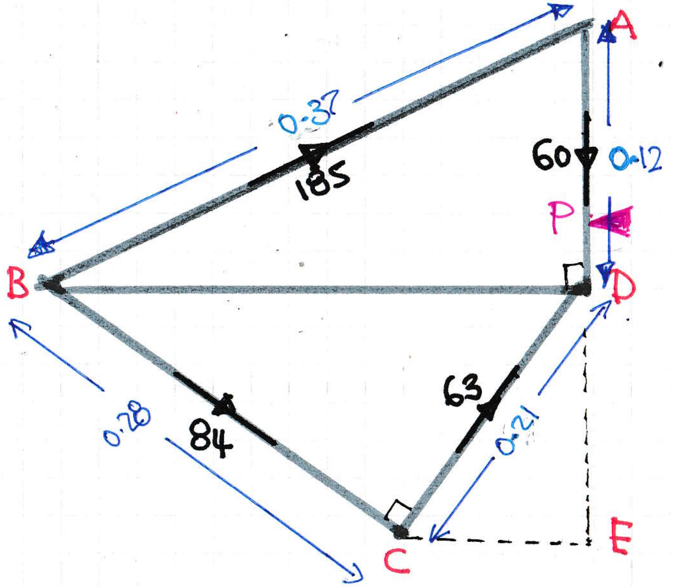
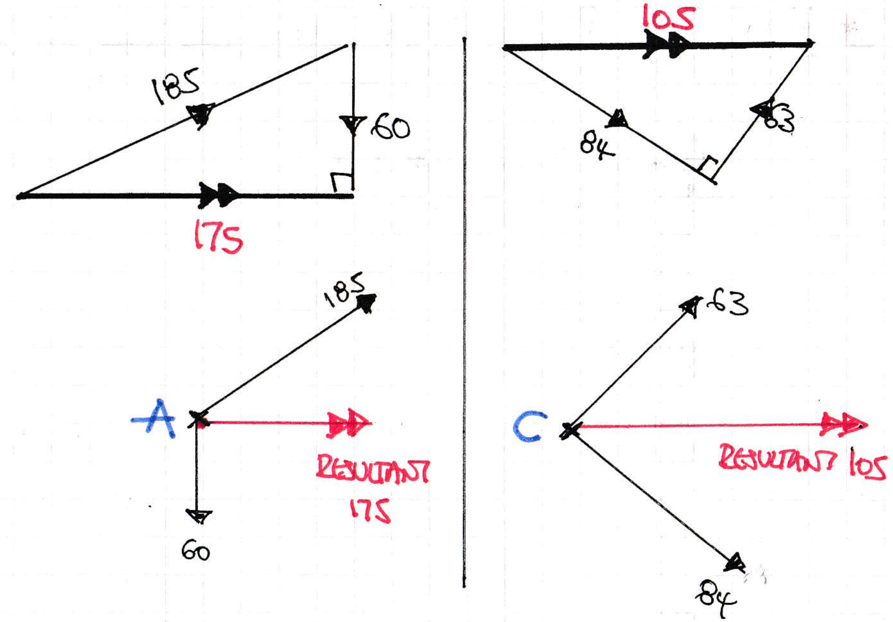
- START WITH A GOOD DIAGRAM



- FIRSTLY LET US NOTE THAT

$$|BD| = \sqrt{0.37^2 - 0.12^2} = \sqrt{0.28^2 + 0.21^2} = 0.35$$

- ON THE "TOP HALF" OF THE FRAMEWORK THE FORCES ARE IN PROPORTION TO THE PYTHAGOREAN TRIPLE OF THE LENGTHS BY A SCALE FACTOR OF 500
- SIMILARLY IN THE BOTTOM HALF, THE SCALE FACTOR IS 300



- NEXT WE NEED TO FIND $|DE|$ (USING AREAS)

$$\cancel{\tfrac{1}{2}}|BC||CD| = \cancel{\tfrac{1}{2}}|BD||DE|$$

$$0.28 \times 0.21 = 0.35|DE|$$

$$|DE| = 0.168$$

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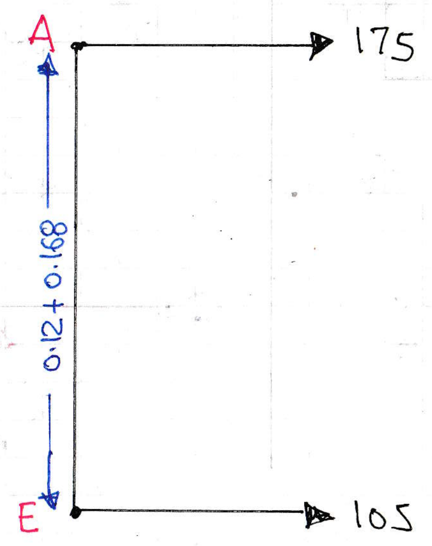
- HENCE THE PROBLEM HAS BEEN REDUCED TO THE FOLLOWING



- THUS BY INSPECTION (RATIO)

$$175 : 105$$
$$5 : 3$$

HENCE

$$|AP| = \frac{3}{8} \times (0.12 + 0.168)$$

$$|AP| = 0.108$$