IYGB - MMS PAPER O - QUESTION 1

USING A CALCULATOR IN STATS MODE TO OBTAIN THE P.M.C.C

(x) GEOGRAPHY %	80	29	56	56	58	45	67	72
(y) HISTORY %	78	49	65	50	75	50	60	47

$r = 0.4896746... \simeq 0.4897$

NEXT SETTING HYPOTHESES

- $H_0: \rho = 0$
- $H_1: \rho > 0$, WHERE ρ IS THE P.M.C.C OF THE ENTIRE POPULATION, NOT THAT OF THE SAMPLE OF 8

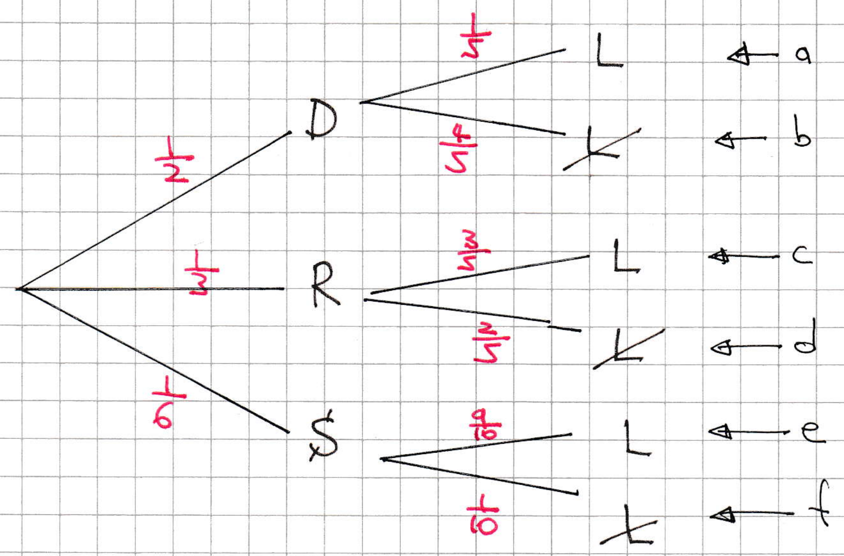
THE CRITICAL VALUE FOR $n=8$, AT 10% SIGNIFICANCE IS 0.5067

AS $0.4897 < 0.5067$ THERE IS NO SIGNIFICANT EVIDENCE OF POSITIVE CORRELATION BETWEEN THE PERCENTAGE MARKS IN GEOGRAPHY & HISTORY.

THERE IS NO SUFFICIENT EVIDENCE TO REJECT H_0

IYGB - MMS PAPER O - QUESTION 2

DRAWING A TREE DIAGRAM



a) $P(L) = a + c + e$

$= \left(\frac{1}{2} \times \frac{1}{5}\right) + \left(\frac{1}{3} \times \frac{3}{5}\right) + \left(\frac{1}{6} \times \frac{9}{10}\right)$

$= \frac{1}{10} + \frac{1}{5} + \frac{3}{20}$

$= \frac{9}{20} = 0.45$

b) $P(R|L) = \frac{P(R \cap L)}{P(L)} = \frac{\frac{1}{3} \times \frac{3}{5}}{\frac{9}{20}} = \frac{\frac{1}{5}}{\frac{9}{20}} = \frac{4}{9}$

OR

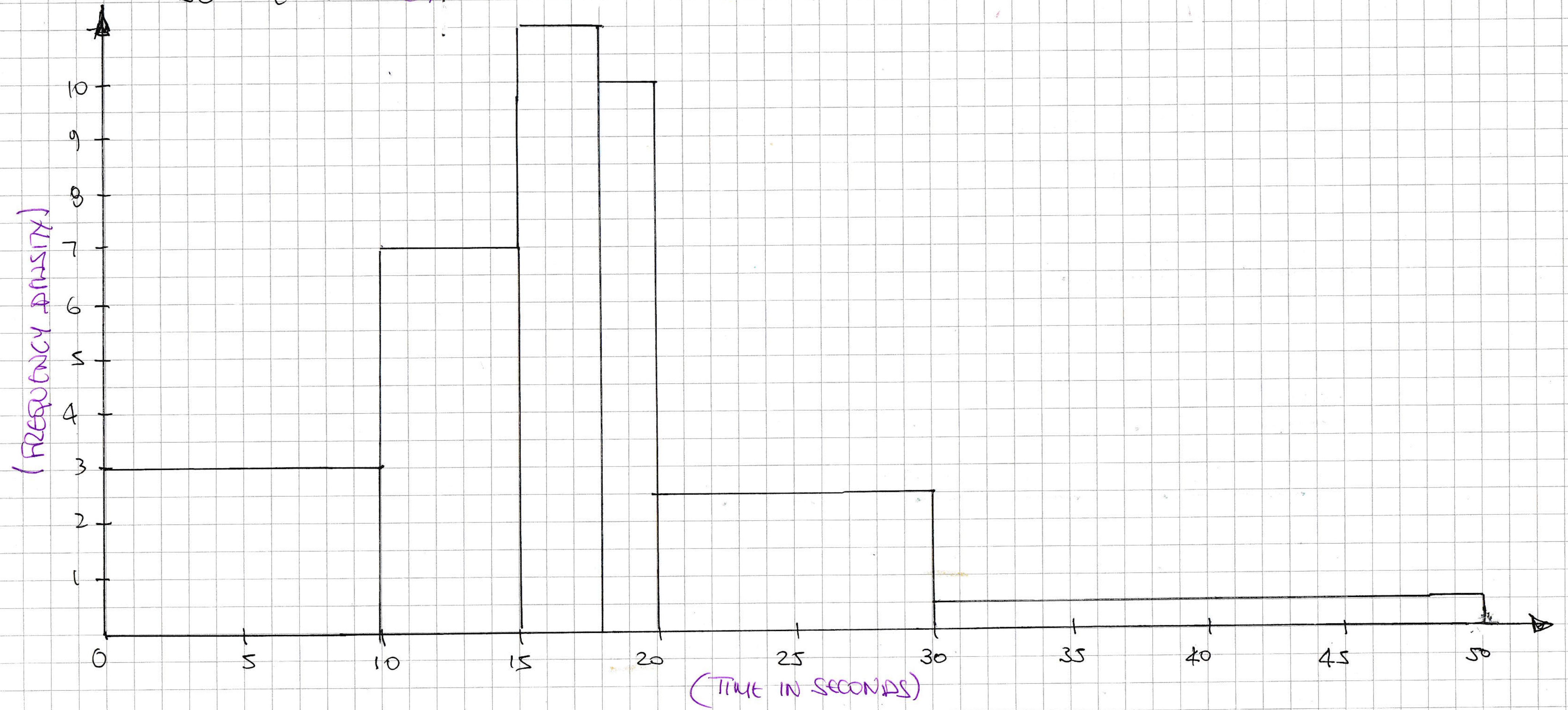
$$\boxed{\frac{c}{a + c + e}}$$

IYGB - MMS PAPER O - QUESTION 3

a)

TIME (IN SECONDS)	FREQUENCY	FREQUENCY DENSITY
$0 < t \leqslant 10$ (10)	30	$30 \div 10 = 3$
$10 < t \leqslant 15$ (5)	35	$35 \div 5 = 7$
$15 < t \leqslant 18$ (3)	33	$33 \div 3 = 11$
$18 < t \leqslant 20$ (2)	20	$20 \div 2 = 10$
$20 < t \leqslant 30$ (10)	25	$25 \div 10 = 2.5$
$30 < t \leqslant 50$ (20)	10	$10 \div 20 = 0.5$

$$\boxed{\text{FREQUENCY DENSITY} = \frac{\text{FREQUENCY}}{\text{CLASS WIDTH}}}$$



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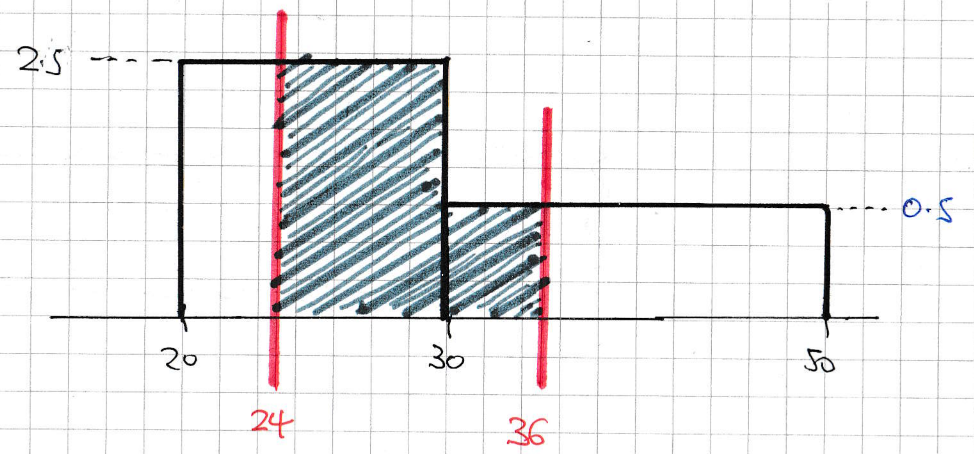
b)



APPROXIMATELY $\approx (6 \times 2.5) + (6 \times 0.5) \approx$ 18 PATIENTS

c)

USING THE MIDPOINTS :

m	5	12.5	16.5	19	25	40
f	30	35	33	20	25	10

FROM CALCULATOR

$\sum x = 2537$ $\quad \sum x^2 = 54048$ $\quad n = 153$

- $\bar{x} = \frac{\sum x}{n} = \frac{2537}{153} \approx 16.6$

- $\sigma = \sqrt{\frac{\sum x^2}{n} - \bar{x}^2} = \sqrt{\frac{54048}{153} - 16.581...^2} \approx 8.85$

IYGB - MMS PAPER O - QUESTION 4

LOOKING AT THE CODED SUMMARY STATISTICS

$$\sum_{n=1}^{40}(x_n-50) = 140 \qquad \sum_{n=1}^{40}(x_n-50)^2 = 4490$$

LET $y = x-50$

$$\sum y = 140 \qquad \sum y^2 = 4490 \qquad n = 40$$

CALCULATE THE MEAN & STANDARD DEVIATION IN y

$$\bar{y} = \frac{\sum y}{n} = \frac{140}{40} = 3.5$$

$$\sigma_y = \sqrt{\frac{\sum y^2}{n} - \bar{y}^2} = \sqrt{\frac{4490}{40} - 3.5^2} = 10$$

UNCODE BACK INTO x

- $\bar{x} = \bar{y} + 50$

  $\bar{x} = 3.5 + 50$

  $\bar{x} = 53.5$

- $\sigma_x = \sigma_y$

  $\sigma_x = 10$

  (STANDARD DEVIATION DOES NOT GET AFFECTED BY ADDITION/SUBTRACTION)

IYGB - MMS PAPER O - QUESTION 5

a) X = NUMBER OF PINS WITH FLAWS

$X \sim B(20, 0.1)$

I) $P(X=3) = \binom{20}{3}(0.1)^3(0.9)^{17} \simeq \underline{\underline{0.1901}}$

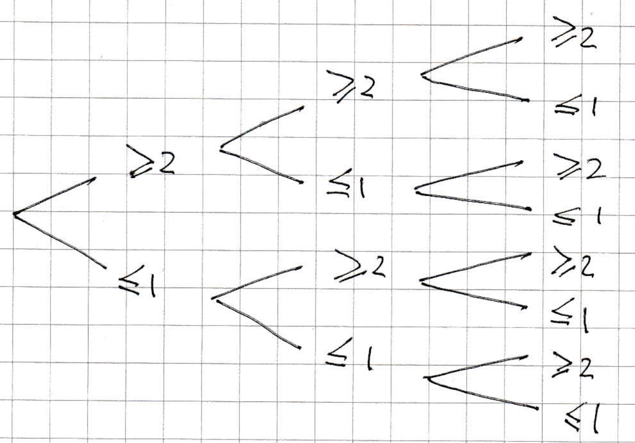
II) $P(X \geq 2) = 1 - P(X \leq 1)$ ... tables

$= 1 - 0.3917$

$= \underline{\underline{0.6083}}$

b) USING ALL THE OUTCOMES OR BY SETTING ANOTHER DISTRIBUTION OR A TREE DIAGRAM

$\boxed{P(X \geq 2) = 0.6083}$ & $\boxed{P(X \leq 1) = 0.3917}$



THE REQUIRED PROBABILITY IS GIVEN BY ALL THE BRANCHES ABOVE EXCEPT THE BOTTOM ONE

OR $1 - [P(X \leq 1)]^3 = 1 - 0.3917^3 = \underline{\underline{0.9399}}$

IYGB - MMS PAPER O - QUESTION 5

c) SETTING UP HYPOTHESES

- $H_0 : p = 0.1$
- $H_1 : p > 0.1$
- WHERE p REPRESENTS THE PROPORTION OF PINS WITH FLAWS IN THE ENTIRE POPULATION & NOT IN THE SAMPLE

TESTING AT 5% SIGNIFICANCE ON THE BASIS THAT $X=5$

$$P(X \geq 5) = 1 - P(X \leq 4)$$

... tables ...

$$= 1 - 0.9568$$

$$= 0.0432$$

$$= 4.32\%$$

$$< 5\%$$

THERE IS SIGNIFICANT EVIDENCE AT 5% THAT THE PROPORTION OF PINS WITH FLAWS IS HIGHER THAN 10%

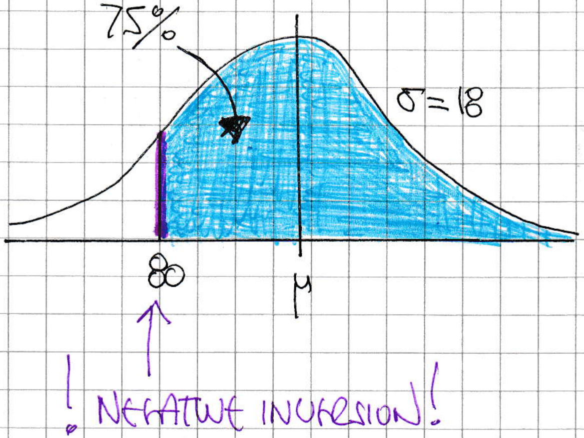
WE DO NOT HAVE ENOUGH EVIDENCE TO REJECT H_1

IYGB - MMS PAPER O - QUESTION 6

a)

X = Paul's training time

$X \sim N(\mu, 18^2)$



$\Rightarrow P(X > 80) = 0.75$

$\Rightarrow P\left(Z > \frac{80-\mu}{18}\right) = 0.75$

INVERSION

$\Rightarrow \frac{80-\mu}{18} = -\Phi^{-1}(0.75)$

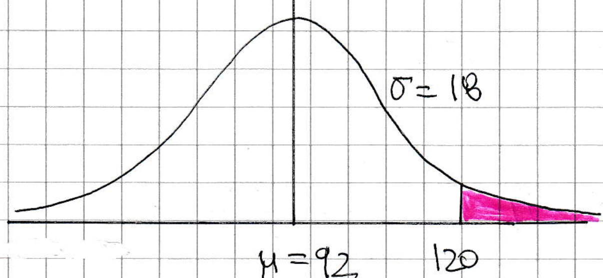
$\Rightarrow \frac{80-\mu}{18} = -0.674$

$\Rightarrow 80-\mu = -12.132$

$\Rightarrow \mu = 92.132$

$\therefore$ 92 MINUTES

b)



$P(X > 120)$

$= 1 - P(X < 120)$

$= 1 - P\left(Z < \frac{120-92}{18}\right)$

$= 1 - \Phi(1.555\ldots)$

$= 1 - 0.94009$

$\simeq 0.05999$

IYGB - MMS PAPER O - QUESTION 6

c) WE ARE REQUIRED TO FIND $P(X<135 \mid X>120)$

$$= \frac{P(X<135 \cap X>120)}{P(X>120)}$$

$$= \frac{P(120<X<135)}{P(X>120)}$$

- $P(120<X<135) = P(X<135) - P(X<120)$

$$= P\left(Z<\frac{135-92}{18}\right) - P\left(Z<\frac{120-92}{18}\right)$$

$$= \Phi(2.3888\ldots) - \Phi(1.555\ldots)$$

$$= 0.99155 - 0.94009$$

$$= 0.05146$$

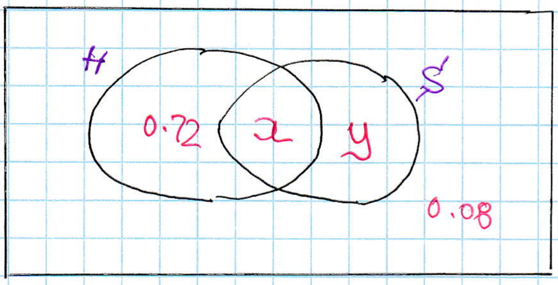
- THE REQUIRED PROBABILITY IS $\frac{0.05146}{0.05999} \approx 0.8578$

IYGB - MMS PAPER O - QUESTION 7

H = having a haircut
S = having a shave

a) $P(H \cap S') = 0.72$, $P(S|H) = 0.2$, $P(S' \cap H') = 0.08$

FILL IN A VENN DIAGRAM



- $x + y + 0.72 + 0.08 = 1$

  $x + y = 0.2$

- $P(S|H) = \dfrac{P(S \cap H)}{P(H)}$

  $\Rightarrow 0.2 = \dfrac{x}{x + 0.72}$

  $\Rightarrow 0.2(x + 0.72) = x$

  $\Rightarrow 0.2x + 0.144 = x$

  $\Rightarrow 0.144 = 0.8x$

  $\Rightarrow x = 0.18$

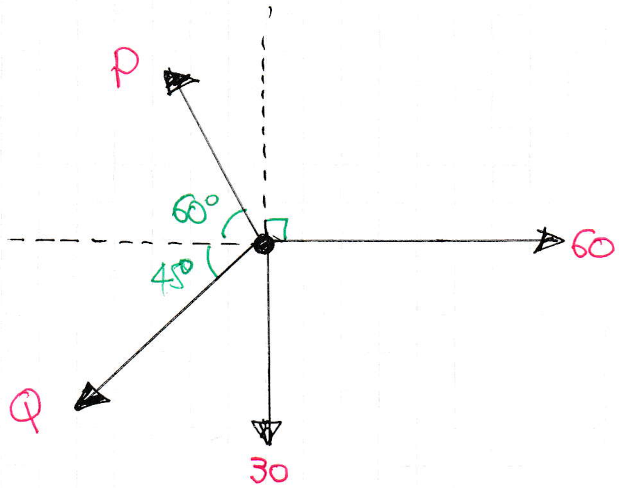
  & HENCE $y = 0.02$

$\therefore P(S \cap H) = x = 0.18$

b) $P(S|H) = 0.2 = P(S) \leftarrow x + y = 0.2$

$\therefore$ EVENTS ARE INDEPENDENT

IYGB - MMS PAPER O - QUESTION 8



- RESOLVING VERTICALLY AND HORIZONTALLY, WE OBTAIN

$(\uparrow): P\sin 60 = Q\sin 45 + 30$

$(\rightarrow): P\cos 60 + Q\cos 45 = 60$

- TIDYING UP THE ABOVE EQUATIONS

$$\left.\begin{aligned} \frac{\sqrt{3}}{2}P &= \frac{\sqrt{2}}{2}Q + 30 \\ \frac{1}{2}P + \frac{\sqrt{2}}{2}Q &= 60 \end{aligned}\right\} \Rightarrow \left.\begin{aligned} \sqrt{3}P &= \sqrt{2}Q + 60 \\ P + \sqrt{2}Q &= 120 \end{aligned}\right\} \Rightarrow$$

$$\left.\begin{aligned} \sqrt{3}P &= \sqrt{2}Q + 60 \\ P &= 120 - \sqrt{2}Q \end{aligned}\right\} \Rightarrow \text{ADDING} \Rightarrow (\sqrt{3}+1)P = 180$$

$$\Rightarrow P = \frac{180}{\sqrt{3}+1}$$

$$\Rightarrow P = \frac{180(\sqrt{3}-1)}{(\sqrt{3}+1)(\sqrt{3}-1)}$$

$$\Rightarrow P = \frac{180(\sqrt{3}-1)}{2}$$

$$\Rightarrow P = 90(\sqrt{3}-1)$$

- FINALLY TO FIND Q WE HAVE

$$P + \sqrt{2}Q = 120$$

$$\sqrt{2}P + 2Q = 120\sqrt{2}$$

$$\sqrt{2}\left[90(\sqrt{3}-1)\right] + 2Q = 120\sqrt{2}$$

$$45\sqrt{2}(\sqrt{3}-1) + Q = 60\sqrt{2}$$

$$45\sqrt{6} - 45\sqrt{2} + Q = 60\sqrt{2}$$

$$Q = 105\sqrt{2} - 45\sqrt{6}$$

$$\therefore Q = 15\left[7\sqrt{2} - 3\sqrt{6}\right]$$

IYGB - MMS PAPER O - QUESTION 9

a) LOOKING AT THE FIRST JOURNEY (UP TO HALF A SECOND AFTER PROJECTION)

$u = 14 \text{ ms}^{-1}$
$a = -9.8 \text{ ms}^{-2}$
$s = ?$
$t = 0.5 \text{ s}$
$v = ?$

- $v = u + at$

$\Rightarrow v = 14 - 9.8 \times 0.5$

$\Rightarrow v = 9.1 \text{ ms}^{-1}$

- $s = \frac{1}{2}(u+v)t$

$\Rightarrow s = \frac{1}{2}(14 + 9.1) \times 0.5$

$\Rightarrow s = 5.775 \text{ m}$

b) METHOD A

LOOKING AT THE JOURNEY UP

$u = 14 \text{ ms}^{-1}$
$a = -9.8 \text{ ms}^{-2}$
$s = ?$
$t = ?$
$v = 0$

- $v = u + at$

$\Rightarrow 0 = 14 - 9.8t$

$\Rightarrow 9.8t = 14$

$\Rightarrow t = \frac{10}{7}$

- $v^2 = u^2 + 2as$

$\Rightarrow 0 = 14^2 + 2(-9.8)s$

$\Rightarrow 19.6s = 196$

$\Rightarrow s = 10$

LOOKING AT THE JOURNEY DOWN

$u = 0 \text{ ms}^{-1}$
$a = +9.8 \text{ ms}^{-2}$
$s = ?$
$t = 2 - \frac{10}{7} = \frac{4}{7}$
$v =$

- $s = \cancel{ut +} \frac{1}{2}at^2$

$\Rightarrow s = \frac{1}{2}(9.8)\left(\frac{4}{7}\right)^2$

METHOD B

LOOKING AT THE JOURNEY UP

$u = 14 \text{ ms}^{-1}$
$a = -9.8$
$s = ?$
$t =$
$v = 0$

- $v^2 = u^2 + 2as$

$\Rightarrow 0 = 14^2 + 2(-9.8)s$

$\Rightarrow 19.6s = 196$

$\Rightarrow s = 10$

NOW LOOKING AT THE ENTIRE JOURNEY

$u = 14 \text{ ms}^{-1}$
$a = -9.8 \text{ ms}^{-2}$
$s = ?$
$t = 2$
$v =$

- $s = ut + \frac{1}{2}at^2$

$\Rightarrow s = 14 \times 2 + \frac{1}{2}(-9.8) \times 2^2$

IYGB - MMS PAPER O - QUESTION 9

$\Rightarrow \underline{s = 1.6\text{ m}}$

$\therefore$ TOTAL DISTANCE COVERED IS

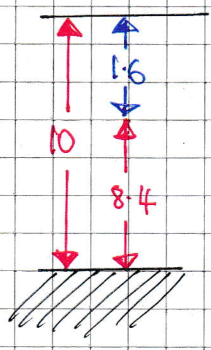
$10 + 1.6 = 11.6\text{ m}$

$\Rightarrow s = 28 - 19.6$

$\Rightarrow \underline{s = 8.4\text{ m}}$

LOOKING AT THE DIAGRAM THE REQUIRED DISTANCE IS

$2 \times 10 - 8.4 = 11.6\text{ m}$



METHOD C

LOOKING AT THE JOURNEY TO THE HIGHEST POINT

$$\boxed{\begin{aligned} u &= 14\text{ ms}^{-1} \\ a &= -9.8\text{ ms}^{-2} \\ s &= \\ t &= ? \\ v &= 0\text{ ms}^{-1} \end{aligned}}$$

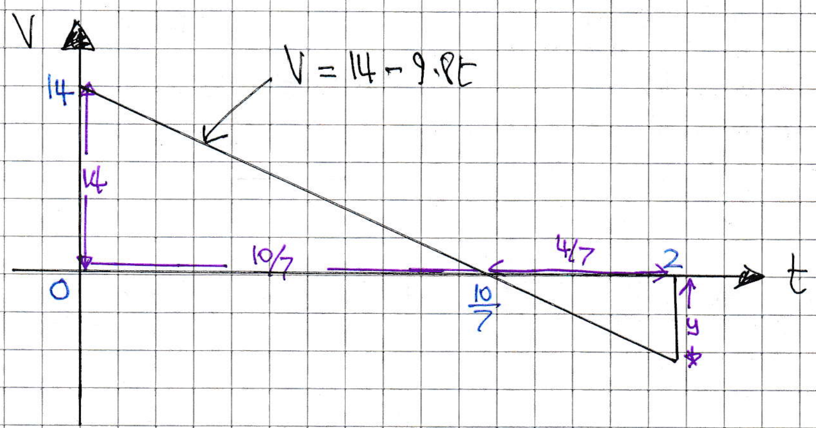
- $v = u + at$

$\Rightarrow 0 = 14 - 9.8t$

$\Rightarrow 9.8t = 14$

$\Rightarrow t = \frac{10}{7}$

NOW BY A VELOCITY TIME GRAPH



BY SIMILAR TRIANGLES

$$\frac{y}{\frac{4}{7}} = \frac{14}{\frac{10}{7}}$$

$$\frac{10}{7}y = 8$$

$$y = \underline{5.6\text{ ms}^{-1}}$$

OR $\underline{v = u + at}$

$v = 14 - 9.8 \times 2$

$v = -5.6$

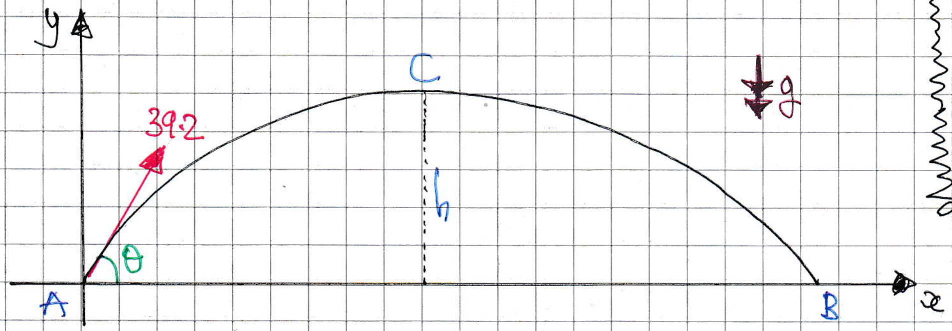
$\therefore$ TOTAL DISTANCE $= \left(\frac{1}{2} \times 14 \times \frac{10}{7}\right) + \left(\frac{1}{2} \times \frac{4}{7} \times y\right)$

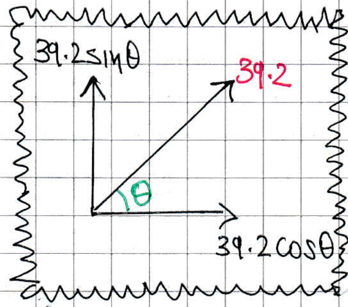
$= 10 + 1.6$

$= 11.6\text{ m}$

IYGB - MMS PAPER O - QUESTION 10

START WITH A PROJECTILE DIAGRAM





LOOKING AT THE VERTICAL MOTION FROM A TO C

$u = 39.2\sin\theta \text{ ms}^{-1}$

$a = -9.8 \text{ ms}^{-2}$

$s = ?$

$t = 3 \text{ s}$

$v = 0 \text{ ms}^{-1}$

a) $v = u + at$

$\Rightarrow 0 = 39.2\sin\theta - 9.8\times 3$

$\Rightarrow 29.4 = 39.2\sin\theta$

$\Rightarrow \sin\theta = \frac{3}{4}$ // AS REQUIRED

b) $s = ut + \frac{1}{2}at^2$

$\Rightarrow s = (39.2\sin\theta)\times 3 + \frac{1}{2}(-9.8)\times 3^2$

$\Rightarrow s = \left(39.2\times\frac{3}{4}\times 3\right) - (4.9\times 9)$

$\Rightarrow s = 88.2 - 44.1$

$\Rightarrow s = 44.1 \text{ m}$ //

c) BY SYMMETRY THE TOTAL FLIGHT TIME WILL BE $2\times 3 = 6$ SECONDS

LOOKING AT THE HORIZONTAL DISPLACEMENT

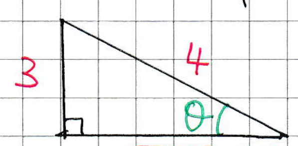
DISTANCE = CONSTANT SPEED × TIME

DISTANCE $= 39.2\cos\theta \times 6$

DISTANCE $= 39.2 \times \frac{\sqrt{7}}{4} \times 6$

DISTANCE $\simeq 155.57$ m //

$\sin\theta = \frac{3}{4}$



$\sqrt{4^2-3^2} = \sqrt{7}$

$\therefore \cos\theta = \frac{\sqrt{7}}{4}$

IYGB - MMS PAPER O - QUESTION 10

d) LEAST SPEED OCCURS AT THE HIGHEST POINT OF THE PATH, POINT C

AT THAT POINT (C) THERE IS ONLY HORIZONTAL VELOCITY

$$\therefore \text{ LEAST SPEED} = 39.2\cos\theta$$
$$= 39.2 \times \frac{\sqrt{7}}{4}$$
$$\approx 25.93 \text{ ms}^{-1}$$

IYGB – MMS PAPER O – QUESTION 11

USING THE EQUATION $\underline{r} = \underline{r}_0 + \underline{u}t + \frac{1}{2}\underline{a}t^2$ FOR EACH PARTICLE.

$$\underline{r}_A = \begin{pmatrix} 7 \\ -2 \end{pmatrix} + \begin{pmatrix} 2 \\ 3 \end{pmatrix}t + \frac{1}{2}\begin{pmatrix} 0.1 \\ 0.2 \end{pmatrix}t^2$$

$$\underline{r}_B = \underline{r}_0 + \begin{pmatrix} 3 \\ 5 \end{pmatrix}t + \frac{1}{2}\begin{pmatrix} -0.2 \\ 0.3 \end{pmatrix}t^2$$

IT IS GIVEN THAT $\underline{r}_A = \underline{r}_B$ WHEN $t = 10$

$$\begin{pmatrix} 7 \\ -2 \end{pmatrix} + 10\begin{pmatrix} 2 \\ 3 \end{pmatrix} + \frac{1}{2}\times 100\begin{pmatrix} 0.1 \\ 0.2 \end{pmatrix} = \underline{r}_0 + 10\begin{pmatrix} 3 \\ 5 \end{pmatrix} + \frac{1}{2}\times 100\begin{pmatrix} -0.2 \\ 0.3 \end{pmatrix}$$

$$\begin{pmatrix} 7 \\ -2 \end{pmatrix} + \begin{pmatrix} 20 \\ 30 \end{pmatrix} + \begin{pmatrix} 5 \\ 10 \end{pmatrix} = \underline{r}_0 + \begin{pmatrix} 30 \\ 50 \end{pmatrix} + \begin{pmatrix} -10 \\ 15 \end{pmatrix}$$

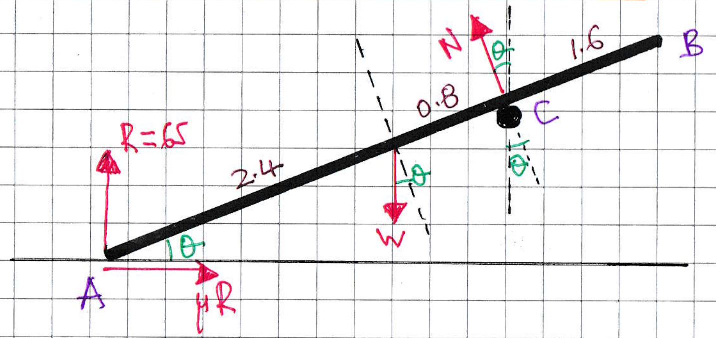
$$\begin{pmatrix} 32 \\ 38 \end{pmatrix} = \underline{r}_0 + \begin{pmatrix} 20 \\ 65 \end{pmatrix}$$

$$\underline{r}_0 = \begin{pmatrix} 12 \\ -27 \end{pmatrix}$$

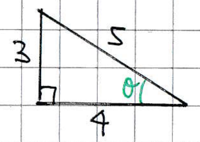
$\therefore$ IT STARTS FROM $12\underline{i} - 27\underline{j}$

IYGB - MMS PAPER O - QUESTION 12

START WITH A DETAILED DIAGRAM



- $\tan\theta = \frac{3}{4}$
- $\mu = \frac{9}{13}$
- $R = 65$



$\sin\theta = \frac{3}{5}$

$\cos\theta = \frac{4}{5}$

FORM 3 EQUATIONS BY RESOLVING & TAKING MOMENTS

$(\uparrow)$: $R + N\cos\theta = W$ (I)

$(\rightarrow)$: $\mu R = N\sin\theta$ (II)

A: $W\cos\theta \times 2.4 = N \times 3.2$ (III)

b) FROM EQUATION (II) DIRECTLY

$\Rightarrow \mu R = N\sin\theta$

$\Rightarrow \frac{9}{13} \times 65 = N \times \frac{3}{5}$

$\Rightarrow 45 = \frac{3}{5}N$

$\Rightarrow N = 75$

a) EITHER USING (I) OR (III) GIVES

$R + N\cos\theta = W$

$\Rightarrow 65 + 75 \times \frac{4}{5} = W$

$\Rightarrow 65 + 60 = W$

$\Rightarrow W = 125$

OR

$\Rightarrow W\cos\theta \times 2.4 = N \times 3.2$

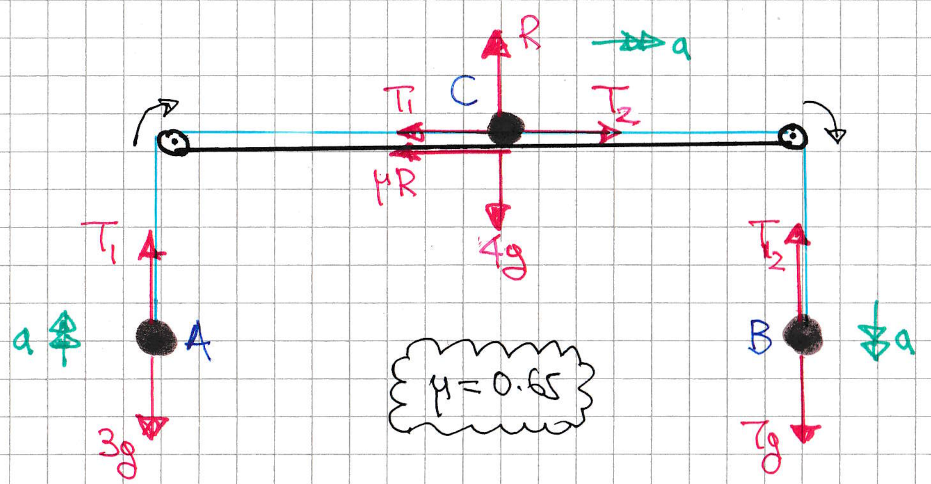
$\Rightarrow W \times \frac{4}{5} \times 2.4 = 75 \times 3.2$

$\Rightarrow 1.92W = 240$

$\Rightarrow W = 125$

IYGB – MMS PAPER O – QUESTION 13

START WITH A DIAGRAM



LOOKING AT THE EQUATION OF MOTION FOR EACH PARTICLE

$$\left.\begin{aligned} (A)&: T_1 - 3g = 3a \\ (B)&: 7g - T_2 = 7a \\ (C)&: T_2 - T_1 - \mu R = 4a \end{aligned}\right\} \Rightarrow \boxed{T_1 = 3a + 3g}$$

$$\left.\begin{aligned} (B)&: 7g - T_2 = 7a \\ (C)&: T_2 - (3a+3g) - \mu(4g) = 4a \end{aligned}\right\} \Rightarrow$$

$$\left.\begin{aligned} (B)&: -T_2 + 7g = 7a \\ (C)&: T_2 - 3a - 3g - \tfrac{13}{5}g = 4a \end{aligned}\right\} \text{ADDING}$$

$\Rightarrow \frac{7}{5}g - 3a = 11a$

$\Rightarrow 14a = \frac{7}{5}g$

$\Rightarrow a = \frac{1}{10}g = 0.98 \text{ ms}^{-2}$

FINALLY WE HAVE

(A): $T_1 = 3a + 3g$

$T_1 = 3(0.98) + 3g$

$T_1 = 32.34 \text{ N}$

(B) $T_2 = 7g - 7a$

$T_2 = 7g - 7(0.98)$

$T_2 = 61.74$

IYGB - MMS PAPER O - QUESTION 14

$v = t^2 - 2t - 24 \quad , \quad t \geq 0 \qquad$ SUBJECT TO $t=3, x=0$

a) OBTAIN THE ACCELERATION BY DIFFERENTIATING THE VELOCITY

$$a = \frac{dv}{dt} = \frac{d}{dt}\left(t^2 - 2t - 24\right)$$

$$a = 2t - 2$$

$$a\Big|_{t=3} = 2 \times 3 - 2$$

$$a\Big|_{t=3} = 4 \text{ ms}^{-2}$$

b) FIND THE TIMES WHEN $v=0$

$$\Rightarrow 0 = t^2 - 2t - 24$$

$$\Rightarrow 0 = (t+4)(t-6)$$

$$\Rightarrow t = \begin{cases} \cancel{-4 \text{ s}} \\ 6 \text{ s} \end{cases}$$

USING INTEGRATION TO OBTAIN AN EXPRESSION FOR THE DISPLACEMENT x

$$\Rightarrow x = \int v \, dt = \int t^2 - 2t - 24 \, dt$$

$$\Rightarrow x = \frac{1}{3}t^3 - t^2 - 24t + C$$

APPLY CONDITION $t=3, x=0$

$$\Rightarrow 0 = \frac{1}{3} \times 3^3 - 3^2 - 24 \times 3 + C$$

$$\Rightarrow 0 = 9 - 9 - 72 + C$$

$$\Rightarrow C = 72$$

$$\Rightarrow x = \frac{1}{3}t^3 - t^2 - 24t + 72$$

IYGB - MMS PAPER O - QUESTION 14

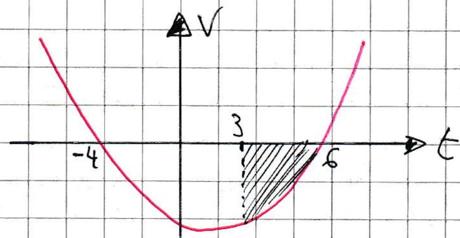
FINALLY WITH $t=6$

$$x(6) = \frac{1}{3}\times 6^3 - 6^2 - 24\times 6 + 72$$
$$= 72 - 36 - 144 + 72$$
$$= -36$$

$\therefore$ A DISTANCE OF 36 m FROM O

ALTERNATIVE FOR PART (b) USING VELOCITY TIME GRAPH

$$v = t^2 - 2t - 24$$
$$v = (t+4)(t-6)$$



$$\text{DISPLACEMENT} = \int_3^6 t^2 - 2t - 24 \, dt$$
$$= \left[\frac{1}{3}t^3 - t^2 - 24t\right]_3^6$$
$$= (72 - 36 - 144) - (9 - 9 - 72)$$
$$= -36 \quad \text{AS BEFORE}$$

c) USING $x = \frac{1}{3}t^3 - t^2 - 24t + 72$ WITH $x=0$ & NOTING $t=3$ IS A KNOWN SOLUTION (GIVEN AS CONDITION)

$$\Rightarrow \frac{1}{3}t^3 - t^2 - 24t + 72 = 0$$
$$\Rightarrow t^3 - 3t^2 - 72t + 216 = 0$$
$$\Rightarrow t^2(t-3) - 72(t-3) = 0 \qquad \text{(OR USE ALGEBRAIC DIVISION)}$$
$$\Rightarrow (t-3)(t^2 - 72)$$
$$\Rightarrow t = 3 \quad \text{OR} \quad t^2 = 72$$

$$\therefore t = +\sqrt{72} \approx 8.49 \text{ s}$$

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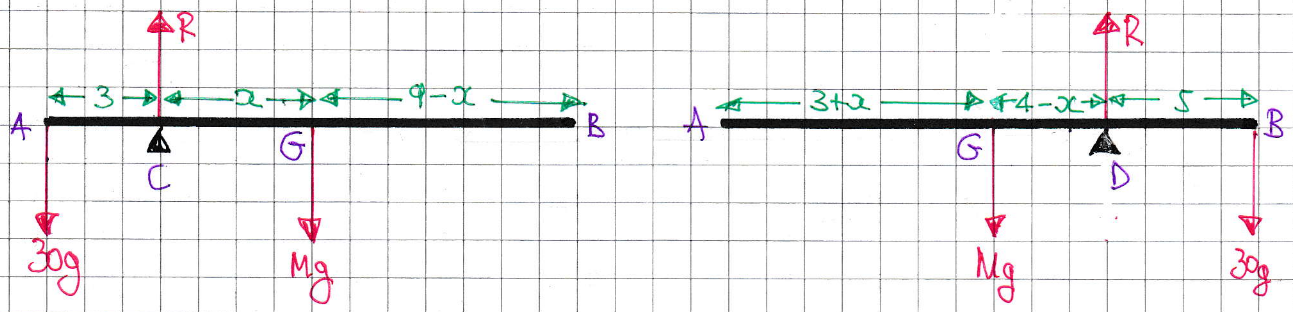
(a)/(b) START WITH TWO SEPARATE DIAGRAMS SHOWING EACH OF THE TWO CASES



NOTE THAT $R = 30g + Mg$ IN BOTH CASES AND $|AG| = 3 + x$

TAKING MOMENTS ABOUT C & ABOUT D IN EACH CASE TO ELIMINATE R

$\circlearrowright C: \; 30g \times 3 = Mgx$

$Mx = 90$

$\circlearrowright D: \; Mg(4-x) = 30g \times 5$

$M(4-x) = 150$

$4M - Mx = 150$

$\Rightarrow 4M - 90 = 150$

$\Rightarrow 4M = 240$

$\Rightarrow M = 60$

NOW WE CAN FIND THE VALUE OF x & SUBSEQUENTLY THE DISTANCE $|AG|$

$\Rightarrow Mx = 90$

$\Rightarrow 60x = 90$

$\Rightarrow x = 1.5$

$\therefore |AG| = 3 + x$

$|AG| = 4.5 \text{ m}$

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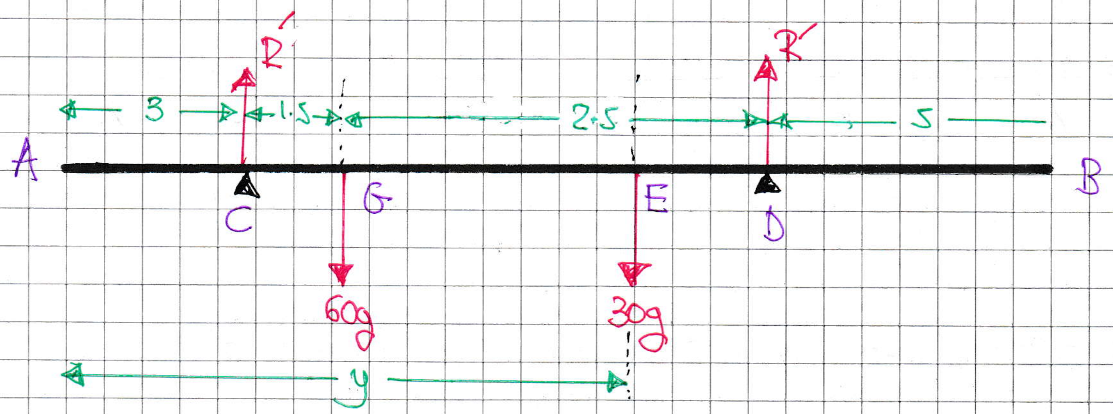
c) START WITH A NEW DIAGRAM



- $2R' = 60g + 30g$

  $2R' = 90g$

  $R' = 45g$

- $\overset{\curvearrowright}{A}$: $(60g \times 4.5) + (30g \times y) = (R' \times 3) + (R' \times 7)$

$$270g + 30gy = 3R' + 7R'$$

$$270g + 30gy = 10R'$$

$$270\cancel{g} + 30\cancel{g}y = 10 \times 45\cancel{g}$$

$$270 + 30y = 450$$

$$27 + 3y = 45 \quad \div 10$$

$$9 + y = 15 \quad \div 3$$

$$y = 6 \text{ m}$$