IYGB - MMS PAPER P - QUESTION 1

a) INPUTING THE FIRST 7 PAIRS OF DATA INTO A STATISTICAL CALCULATOR WE OBTAIN

$$r = 0.792$$

b) AS THE NUMBER OF MATHS TEACHERS INCREASES, SO DO THE NUMBER OF BURGLARIES, IE POSITIVE CORRELATION

c) SETTING HYPOTHESES

$H_0 : \rho = 0$

$H_1 : \rho > 0$, WHERE ρ DENOTES THE P.M.C.C OF ALL, IE THE POPULATION, NOT JUST THE SAMPLE OF 7

THE CRITICAL VALUE FOR $n=7$, AT 5% SIGNIFICANCE IS 0.6694

AS $0.792 > 0.6694$, THERE SUFFICIENT EVIDENCE OF POSITIVE CORRELATION, I.E SUFFICIENT EVIDENCE TO REJECT H_0

d) CORRELATION DOES NOT IMPLY CAUSE, THERE MIGHT BE A CONNECTION TO A THIRD VARIABLE HERE THE TOWNS' POPULATIONS

THE STATEMENT IS NOT LIKELY TO BE TRUE

e) USING A STATISTICAL CALCULATOR TO OBTAIN A REGRESSION LINE

$$y = a + bx$$

$$y = 0.408x + 15.1 \quad (\text{TO } 3 \text{ s.f})$$

WHEN $x = 40$

$$y = 0.408 \times 40 + 15.1 \simeq 31.42\ldots \simeq 31$$

IYGB - MMS PAPER P - QUESTION 2

1, 12, 13, 14, 16, 17, 20, 21, 23, 24, 26, 34, 55

$n = 13$ (ODD)

a) MEDIAN & QUARTILES $(n+1)$ RULE APPLIES

$Q_1 = \frac{1}{4}(13+1) = 3.5$ I.E $3^{RD}/4^{TH}$ OR 4^{TH}

$Q_2 = \frac{1}{2}(13+1) = 7^{th}$ OBS

$Q_3 = \frac{3}{4}(13+1) = 10.5$, I.E $10^{TH}/11^{TH}$ OR 11^{TH} OBS

$\therefore$ $Q_1 = 13.5$, $Q_2 = 20$, $Q_3 = 25$

OR

$Q_1 = 14$, $Q_2 = 20$, $Q_3 = 26$

b) USING CALCULATOR IN STAT MODE WE OBTAIN

$\Sigma x = 281$, $\Sigma x^2 = 8223$

- $\bar{x} = \frac{\Sigma x}{n} = \frac{281}{13} \simeq 21.6$

- $\sigma = \sqrt{\frac{\Sigma x^2}{n} - \bar{x}^2} = \sqrt{\frac{8223}{13} - \left(\frac{281}{13}\right)^2} \approx 12.9$

c) USING THE MOST COMMON CRITERION

- LOWER BOUND $= Q_1 - \frac{3}{2}(IQR) = 14 - \frac{3}{2}(26-14) = -4$
- UPPER BOUND $= Q_3 + \frac{3}{2}(IQR) = 26 + \frac{3}{2}(26-14) = 44$

$\therefore$ 55 IS A OUTLIER

IYGB - MMS PAPER P - QUESTION 2

1, 12, 13, 14, 16, 17, 20, 21, 23, 24, 26, 39, 55

$n = 13$ (ODD)

a) MEDIAN & QUARTILES $(n+1)$ RULE APPLIES

$Q_1 = \frac{1}{4}(13+1) = 3.5$ I.E $3^{RD}/4^{TH}$ OR 4^{TH}

$Q_2 = \frac{1}{2}(13+1) = 7^{th}$ OBS

$Q_3 = \frac{3}{4}(13+1) = 10.5$, I.E $10^{TH}/11^{TH}$ OR 11^{TH} OBS

$\therefore$ $Q_1 = 13.5$, $Q_2 = 20$, $Q_3 = 25$

OR

$Q_1 = 14$, $Q_2 = 20$, $Q_3 = 26$

b) USING CALCULATOR IN STAT MODE WE OBTAIN

$\sum x = 281$, $\sum x^2 = 8223$

- $\bar{x} = \frac{\sum x}{n} = \frac{281}{13} \simeq 21.6$
- $\sigma = \sqrt{\frac{\sum x^2}{n} - \bar{x}^2} = \sqrt{\frac{8223}{13} - \left(\frac{281}{13}\right)^2} \approx 12.9$

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- LOWER BOUND $= Q_1 - \frac{3}{2}(IQR) = 14 - \frac{3}{2}(26-14) = -4$
- UPPER BOUND $= Q_3 + \frac{3}{2}(IQR) = 26 + \frac{3}{2}(26-14) = 44$

$\therefore$ 55 IS A OUTLIER

IYGB - MMS PAPER P - QUESTION 2

ALTERNATIVE METHOD FOR OUTLIERS

LOWER BOUND $= \bar{x} - 2\sigma = 21.6 - 2 \times 12.9 \simeq -4$

UPPER BOUND $= \bar{x} + 2\sigma = 21.6 + 2 \times 12.9 \simeq 47$

$\therefore$ 55 IS AN OUTLIER

d)

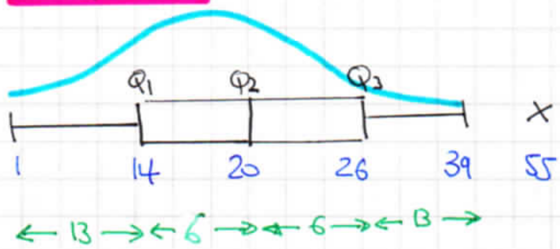
METHOD A

(MODE) < MEDIAN < MEAN

20   21.6

$\therefore$ POSITIVE SKEW

METHOD B



$Q_2 - Q_1 = Q_3 - Q_2$

$\therefore$ SYMMETRICAL (NO SKEW)

THE TWO METHODS HERE DISAGREE (SOMETIMES THIS HAPPENS)
THIS IS DUE TO THE OUTLIER AT 55.

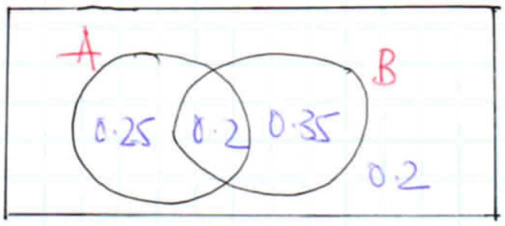
IF THE OUTLIER IS CONSIDERED THERE IS SMALL POSITIVE SKEW; NOTE THAT MEAN & MEDIAN ARE STILL CLOSE.

IF THE OUTLIER IS NOT CONSIDERED THE DISTRIBUTION IS VERY SYMMETRICAL

IYGB - MMS PAPER P - QUESTION 3

$P(A) = 0.45 \qquad P(A \cap B') = 0.25 \qquad P(A \cup B) = 0.8$

a) FILL IN A DIAGRAM



b) USING CONDITIONAL PROBABILITY FORMULA

I) $P(A|B') = \dfrac{P(A \cap B')}{P(B')} = \dfrac{0.25}{0.45} = \dfrac{25}{45} = \dfrac{5}{9}$

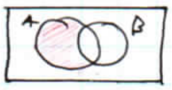
II) $P(B'|A') = \dfrac{P(B' \cap A')}{P(A')} = \dfrac{0.2}{0.55} = \dfrac{20}{55} = \dfrac{4}{11}$

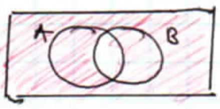
c) START BY OBTAINING THE VALUE OF $P(A' \cup B')$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$
$$P(A' \cup B') = P(A') + P(B') - P(A' \cap B')$$
$$P(A' \cup B') = 0.55 + 0.45 - 0.2$$
$$P(A' \cup B') = 0.8$$

WITHOUT USING A FORMULA

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





$= \dfrac{0.25}{0.8} = \dfrac{25}{80} = \dfrac{5}{16}$

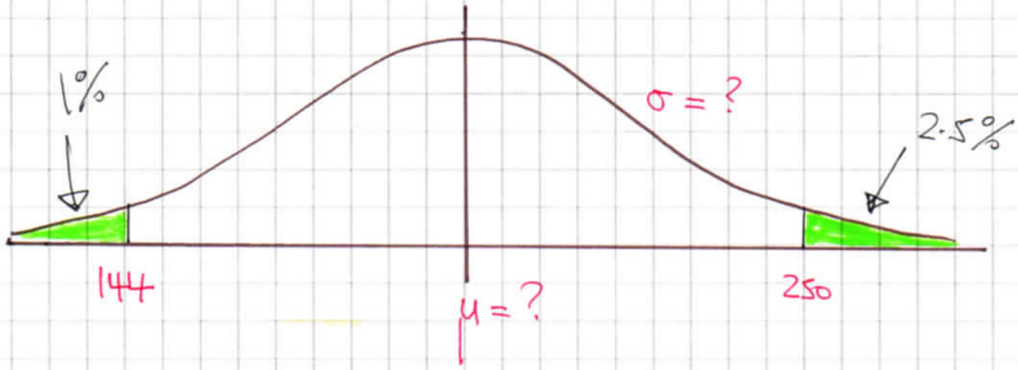
PICK THIS   OUT OF THIS

IYGB – MMS PAPER P – QUESTION 4

a)

W = weight of a baking apple

$W \sim N(\mu, \sigma^2)$



- $P(W<144) = 0.01$

$\Rightarrow P(W>144) = 0.99$

$\Rightarrow P\left(Z > \frac{144-\mu}{\sigma}\right) = 0.99$

NEGATIVE INVERSION!

$\Rightarrow \frac{144-\mu}{\sigma} = -\Phi^{-1}(0.99)$

$\Rightarrow \frac{144-\mu}{\sigma} = -2.3263$

$\Rightarrow 144 - \mu = -2.3263\sigma$

$\Rightarrow 144 + 2.3263\sigma = \mu$

- $P(W>250) = 0.025$

$\Rightarrow P(W<250) = 0.975$

$\Rightarrow P\left(Z < \frac{250-\mu}{\sigma}\right) = 0.975$

POSITIVE INVERSION

$\Rightarrow \frac{250-\mu}{\sigma} = \Phi^{-1}(0.975)$

$\Rightarrow \frac{250-\mu}{\sigma} = 1.9600$

$\Rightarrow 250 - \mu = 1.96\sigma$

$\Rightarrow 250 - 1.96\sigma = \mu$

IYGB - MMS PAPER P - QUESTION 4

SOLVING SIMULTANEOUSLY

$$\left.\begin{array}{l}\mu = 144 + 2.3263\sigma \\ \mu = 250 - 1.96\sigma\end{array}\right\} \Rightarrow 144 + 2.3263\sigma = 250 - 1.96\sigma$$

$$\Rightarrow 4.2863\sigma = 106$$

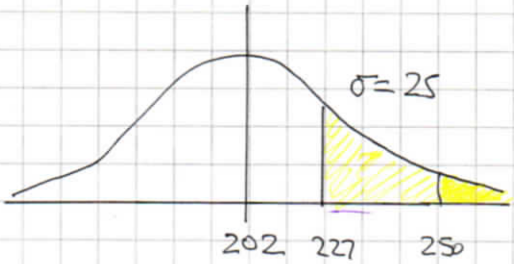
$$\Rightarrow \sigma \simeq 24.72995\ldots$$

$$\Rightarrow \sigma \approx 25$$

& HENCE $\mu \simeq 201.529\ldots$

$\mu \simeq 202$

b) WE ARE REQUIRED TO FIND $P(W>250 \mid W>227)$



$$P(W>227) = 1 - P(W<227)$$

$$= 1 - P\left(Z < \frac{227-202}{25}\right)$$

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

$$= 1 - 0.84134$$

$$= 0.15866$$

$\therefore$ REQUIRED PROBABILITY IS $= \dfrac{0.025}{0.15866} \simeq 0.157569\ldots$

$\simeq 0.158$

IYGB – MMS PAPER P – QUESTION 5

X = NUMBER OF "PEOPLE" WITH SATELLITE SUBSCRIPTIONS

$X \sim B(25, 0.35)$

a) I) $P(X=12) = \binom{25}{12}(0.35)^{12}(0.65)^{13} = 0.064971\ldots \approx 0.0650$

II) $P(X>12) = P(X \geqslant 13) = 1 - P(X \leqslant 12)$

tables or calculator

$= 1 - 0.9396$

$= 0.0604$

b) START BY FINDING THE EXPECTATION & VARIANCE

$E(X) = np = 25 \times 0.35 = 8.75$

$Var(X) = np(1-p) = 8.75 \times 0.65 = 5.6875$

HENCE WE OBTAIN

$P\left[E(X) - \sqrt{Var(X)} < X < E(X) + \sqrt{Var(X)}\right]$

$= P\left[8.75 - 2.3848\ldots < X < 8.75 + 2.3848\ldots\right]$

$= P(6.365\ldots < X < 11.135\ldots)$

$= P(7 \leqslant X \leqslant 11)$

$= P(X \leqslant 11) - P(X \leqslant 6)$

tables (or calculator)

$= 0.8746 - 0.1734$

$= 0.7012$

IYGB - MMS PAPER P - QUESTION 5

c) LET THE REQUIRED SAMPLE BE N

$$\Rightarrow P(X \geq 1) > 99\%$$
$$\Rightarrow P(X = 0) < 1\%$$
$$\Rightarrow \binom{N}{0}(0.35)^0(0.65)^N < 0.01$$
$$\Rightarrow 1 \times 1 \times 0.65^N < 0.01$$

BY LOGS (OR TRIAL & IMPROVEMENT)

$$\Rightarrow 0.65^N < 0.01$$
$$\Rightarrow \log(0.65^N) < \log(0.01)$$
$$\Rightarrow N\log(0.65) < \log(0.01)$$
$$\Rightarrow N > \frac{\log(0.01)}{\log(0.65)}$$

$\log(0.65)$ IS NEGATIVE SO THE INEQUALITY REVERSES

$$\Rightarrow N > 10.6902...$$

$\therefore N = 11$

d) SETTING UP HYPOTHESES

- $H_0 : p = 0.35$
- $H_1 : p > 0.35$, WHERE p REPRESENTS THE PROPORTION OF HOUSEHOLDS WITH SATELLITE TV IN THE POPULATION (NOT THE SAMPLE)

TESTING AT 5% SIGNIFICANCE ON THE BASIS THAT $x = 13$

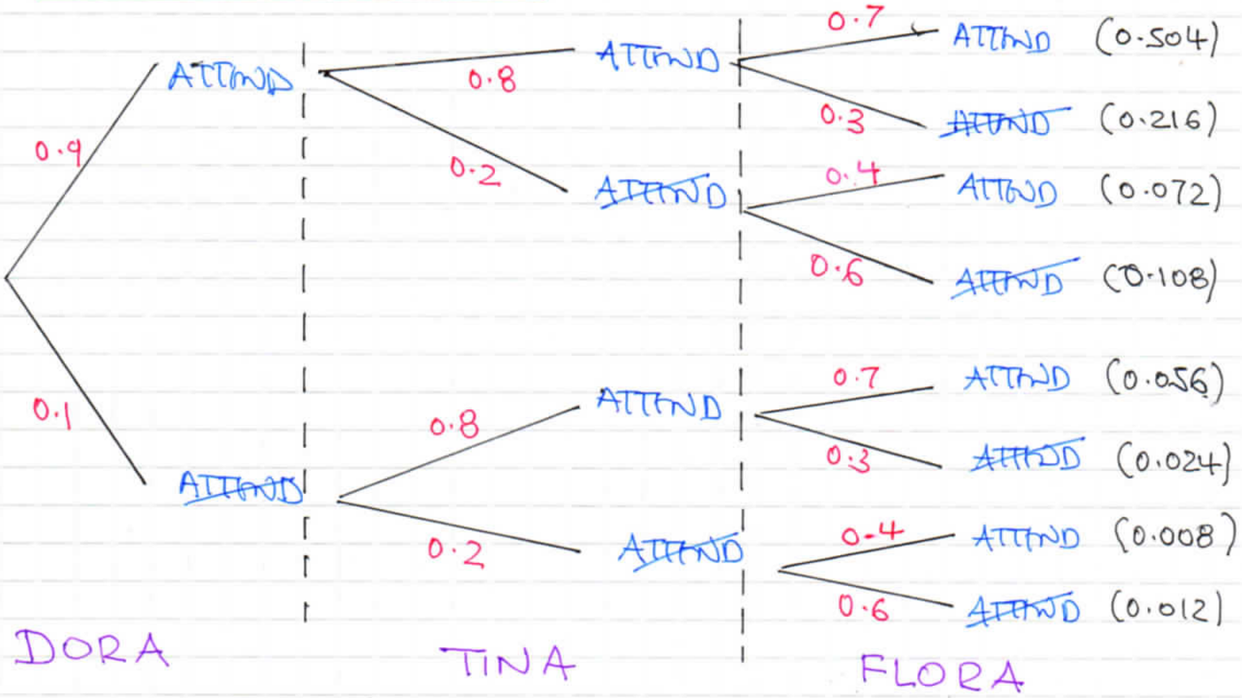
$$P(X \geq 13) = 1 - P(X \leq 12) = 1 - 0.9396 = 0.0604$$
$$= 6.04\% > 5\%$$

THERE IS NO SIGNIFICANT EVIDENCE THAT THE PROPORTION OF HOUSEHOLDS WITH SATELLITE T.V IS HIGHER THAN 35%

THERE IS NO SUFFICIENT EVIDENCE TO REJECT H_0

IYGB - MMS PAPER P - QUESTION 6

USING A TREE DIAGRAM



a) LOOKING AT THE DIAGRAM & THE PROBABILITIES CALCULATED AT THE END OF THE 8 BRANCHES

I) $P(\text{All } 3) = 0.504$

II) $P(\text{EXACTLY } 2) = 0.216 + 0.072 + 0.056 = 0.344$

b) I) $P(\text{DORA} \cap \text{TINA} \mid \text{FLORA}) = \dfrac{P(\text{DORA} \cap \text{TINA} \cap \text{FLORA})}{P(\text{FLORA})}$

$$= \frac{0.504}{0.504 + 0.072 + 0.056 + 0.008}$$

$$= \frac{0.504}{0.640}$$

$$= \frac{63}{80} = 0.7875$$

IYGB - MMS PAPER P - QUESTION 6

II) $$P(\text{FLORA} \mid \text{DORA} \cap \text{TINA}) = \frac{P(\text{FLORA} \cap \text{DORA} \cap \text{TINA})}{P(\text{DORA} \cap \text{TINA})}$$

$$= \frac{0.504}{0.9 \times 0.8}$$

$$= \frac{0.504}{0.720}$$

$$= \frac{7}{10} = 0.7$$

III) $$P(\text{DORA} \cap \text{FLORA} \mid \text{TINA}) = \frac{P(\text{DORA} \cap \text{FLORA} \cap \text{TINA})}{P(\text{TINA})}$$

$$= \frac{0.504}{(0.9 \times 0.8) + (0.1 \times 0.8)}$$

$$= \frac{0.504}{0.800}$$

$$= \frac{63}{100} = 0.63$$

IV) $$P(\text{DORA} \mid \text{TINA} \cap \text{FLORA}) = \frac{P(\text{DORA} \cap \text{TINA} \cap \text{FLORA})}{P(\text{TINA} \cap \text{FLORA}}$$

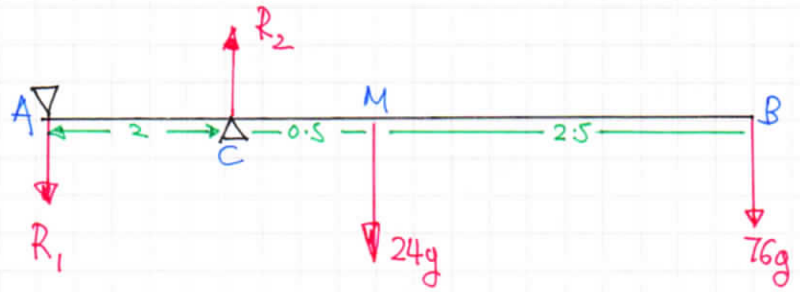
$$= \frac{0.504}{0.504 + 0.056}$$

$$= \frac{0.504}{0.560}$$

$$= \frac{9}{10} = 0.9$$

IYGB – MMS PAPER P – QUESTION 7

STARTING WITH A DIAGRAM & NOTING THAT THE ROD IS UNIFORM



RESOLVING VERTICALLY

$$R_2 = R_1 + 24g + 76g$$
$$R_2 = R_1 + 100g$$

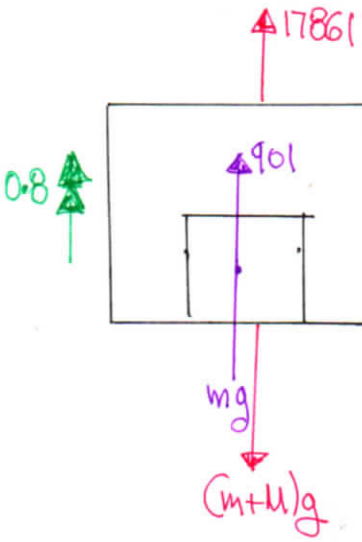
TAKING MOMENTS ABOUT C

$$R_1 \times 2 = 24g \times 0.5 + 76g \times 3$$
$$2R_1 = 12g + 228g$$
$$2R_1 = 240g$$
$$R_1 = 120g$$
$$R_1 = 1176\text{ N}$$ (REACTION AT A)

HENCE THE R_2

$$R_2 = R_1 + 100g$$
$$R_2 = 120g + 100g$$
$$R_2 = 220g$$
$$R_2 = 2156\text{ N}$$ (REACTION AT C)

IYGB – MMS PAPER P – QUESTION 8



- **WHEN THE LIFT IS ACCELERATING UPWARDS**

- **LOOKING AT THE MAN**

$\Rightarrow$ "$F = ma$"

$\Rightarrow 901 - mg = ma$

$\Rightarrow 901 - mg = 0.8m$

$\Rightarrow 901 = 0.8m + 9.8m$

$\Rightarrow 901 = 10.6m$

$\Rightarrow m = 85 \text{ kg}$

- **LOOKING AT THE LIFT + MAN AS A SYSTEM**

$\Rightarrow$ "$F = ma$"

$\Rightarrow 17861 - (m+M)g = (m+M) \times 0.8$

$\Rightarrow 17861 = (m+M)(g+0.8)$

$\Rightarrow 17861 = (85+M)(9.8+0.8)$

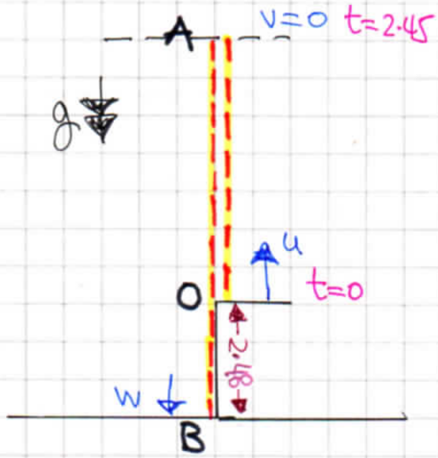
$\Rightarrow 17861 = (8.5+M) \times 10.6$

$\Rightarrow 1685 = 85+M$

$\Rightarrow M = 1600 \text{ kg}$

IYGB - MMS PAPER P - QUESTION 9

LOOKING AT THE JOURNEY "UP" (O TO A)



$u = ?$
$a = -9.8\ ms^{-2}$
$s =$
$t = 2.45\ s$
$v = 0$

- $v = u + at$
  $0 = u - 9.8 \times 2.45$
  $u = 24.01\ ms^{-1}$

THE PARTICLE ON ITS WAY DOWN WILL HAVE THE SAME SPEED, SO LOOKING AT THE JOURNEY FROM O TO B (DOWNWARDS)

$u = 24.01\ ms^{-1}$
$a = 9.8\ ms^{-2}$
$s = 2.48\ m$
$v = ?$

- $v^2 = u^2 + 2as$
  $v^2 = (24.01)^2 + 2(9.8)(2.48)$
  $v^2 = 625.0881$
  $|v| = 25.00176...$
  $|v| \simeq 25.0\ ms^{-1}$

ALTERNATIVE / VARIATION

FROM THE UPWARD JOURNEY O TO A, FIND u & s

$u = (24.01)$
$a = -9.8\ ms^{-2}$
$s = ?$
$t = 2.45\ s$
$v = 0$

$v^2 = u^2 + 2as$
$0 = 24.01^2 + 2(-9.8)s$
$19.6s = 576.4801$
$s = 29.41225 \longleftarrow |OA|$

IYGB − MMS PAPER P − QUESTION 9

NOW LOOKING AT THE JOURNEY FROM A TO B DOWNWARDS

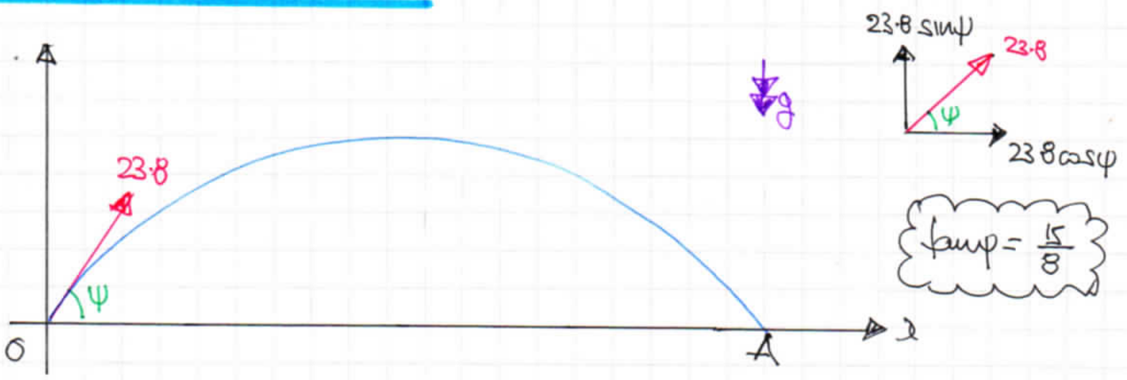
$u = 0$
$a = 9.8 \text{ ms}^{-2}$
$s = 29.41225 + 2.48 = 31.89225$
$t =$
$v = ?$

$v^2 = \cancel{u^2} + 2as$
$v^2 = 2 \times 9.8 \times 31.89225$
$v^2 = 625.0881$
$|v| \simeq 25.0 \text{ ms}^{-1}$

AS BEFORE

IYGB – MMS PAPER P – QUESTION 10

a) STARTING WITH A DIAGRAM



$\tan\psi = \frac{15}{8}$

LOOKING AT THE VERTICAL MOTION, USING "$s = ut + \frac{1}{2}at^2$"

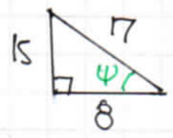
$\Rightarrow 0 = (23.8\sin\psi)t - \frac{1}{2}gt^2$

$\Rightarrow 0 = 23.8 \times \frac{15}{17}t - \frac{1}{2}(9.8)t^2$

$\Rightarrow 0 = 21t - 4.9t^2$

$\Rightarrow 0 = t(21 - 4.9t)$

$\Rightarrow t = \cancel{0}$ or $\frac{21}{4.9} = \frac{30}{7}$ ← FLIGHT TIME



$\tan\psi = \frac{15}{8}$

$\sin\psi = \frac{15}{17}$

$\cos\psi = \frac{8}{17}$

NOW HORIZONTALLY, AS THERE IS NO ACCELERATION, "DISTANCE = SPEED × TIME"

$\Rightarrow |OA| = (23.8\cos\psi) \times \frac{30}{7}$

$\Rightarrow |OA| = 23.8 \times \frac{8}{17} \times \frac{30}{7}$

$\Rightarrow |OA| = 48\text{ m}$

b) LOOKING AT THE VERTICAL MOTION WITH "$v^2 = u^2 + 2as$", FROM THE MOMENT OF PROJECTION UNTIL IT REACHES THE HIGHEST POINT

$\Rightarrow 0^2 = (23.8\sin\psi)^2 + 2(-9.8)s$

$\Rightarrow 0 = 21^2 - 19.6s$

$\Rightarrow 19.6s = 441$

$\Rightarrow s = 22.5\text{ m}$

I.E. $H = 22.5\text{ m}$

IYGB - MMS PAPER P - QUESTION 10

ALTERNATIVE TO PART (b) - USING "TIME SYMMETRY"

AS THE FLIGHT TIME IS $\frac{30}{7}$s, IT WILL TAKE $\frac{15}{7}$s TO REACH THE HIGHEST POINT

USING VERTICALLY "$s = ut + \frac{1}{2}at^2$" $\Rightarrow s = (23.8\sin\psi)\times\frac{15}{7} + \frac{1}{2}(-9.8)\left(\frac{15}{7}\right)^2$

$\Rightarrow s = 21\times\frac{15}{7} - \frac{45}{2}$

$\Rightarrow s = 22.5$ m

c) WITHOUT USING ENERGIES - LOOK AT THE VERTICAL MOTION

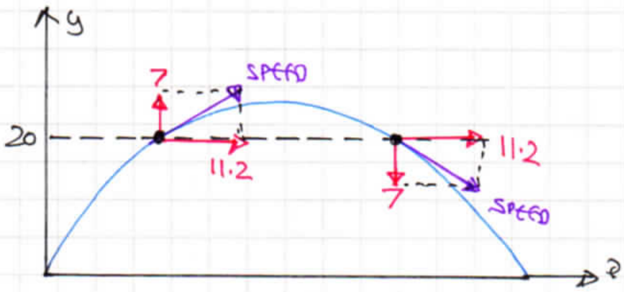
$\Rightarrow$ "$v^2 = u^2 + 2as$"

$\Rightarrow v^2 = (23.8\sin\psi)^2 + 2(-9.8)\times 20$

$\Rightarrow v^2 = 21^2 - 392$

$\Rightarrow v^2 = 49$

$\Rightarrow v = \pm 7$



HORIZONTAL SPEED IS CONSTANT AT $23.8\cos\psi = 11.2$ ms^{-1}

EITHER WAY IN THE DIAGRAM, BY PYTHAGORAS

$|\text{speed}| = \sqrt{7^2 + 11.2^2} = 13.2$ ms^{-1} 3 s.f.

ALTERNATIVE BY ENERGY CONSIDERATIONS TAKING THE GROUND LEVEL AS THE ZERO POTENTIAL LEVEL

$$KE_0 + \cancel{PE_0} = KE_{(20m)} + PE_{(20m)}$$

$$\frac{1}{2}m(23.8)^2 = \frac{1}{2}mv^2 + mg(20)$$

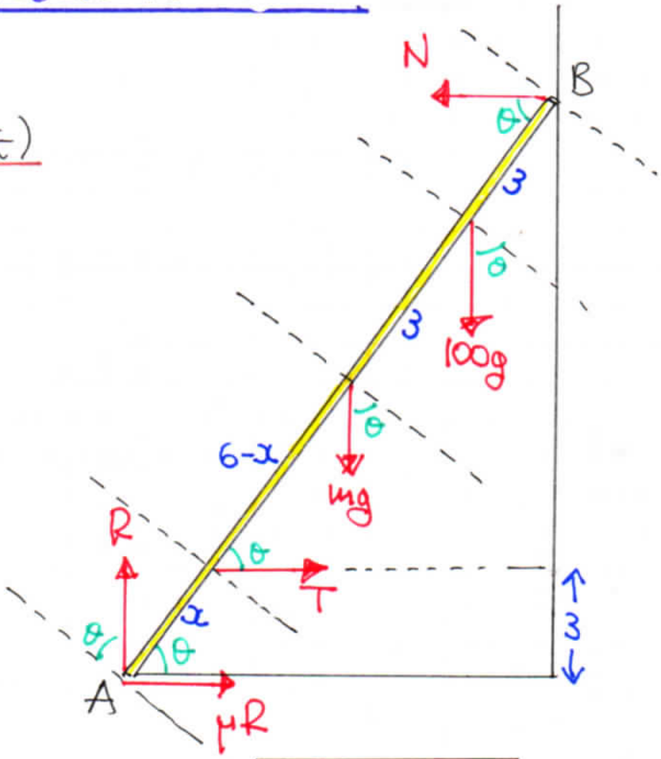
$$23.8^2 = v^2 + 40g$$

$$v^2 = 23.8^2 - 40g$$

$$v^2 = 174.44$$

$$|v| = 13.2 \text{ ms}^{-1}$$ AS ABOVE

IYGB – MMS PAPER P – QUESTION 11



- START WITH A DIAGRAM (OPPOSITE)

WHERE $\mu = \frac{1}{4}$, $T = 490$

ALSO $\tan\theta = \frac{4}{3}$

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

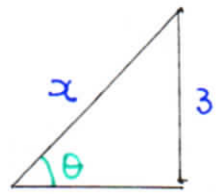
$\sin\theta = \frac{4}{5}$

- RESOLVING & TAKING MOMENTS

$(\uparrow)\ R = mg + 100g$

$(\rightarrow)\ N = T + \mu R$

$(A \circlearrowleft)\ (T\sin\theta)x + (mg\cos\theta)\times 6 + (100g\cos\theta)\times 9 = (N\sin\theta)\times 12$



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

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

$x = \frac{3}{\frac{4}{5}}$

$x = \frac{15}{4}$

- TIDYING UP

$\Rightarrow Tx\tan\theta + 6mg + 900g = 12N\tan\theta$

$\Rightarrow \frac{4}{3}Tx + 6mg + 900g = 12N \times \frac{4}{3}$

$\Rightarrow \frac{4}{3}T\left(\frac{15}{4}\right) + 6mg + 900g = 16N$

$\Rightarrow 5T + 6mg + 900g = 16N$

$\Rightarrow (5\times 490) + 6mg + 900g = 16(T + \mu R)$

$\Rightarrow 2450 + 6mg + 900g = 16T + 16\mu R$

$\Rightarrow 2450 + 6mg + 8820 = 16\times 490 + 16\times\frac{1}{4}(mg + 100g)$

IYGB - MMS PAPER P - QUESTION 11

$$\Rightarrow 11270 + 6mg = 7840 + 4mg + 400g$$

$$\Rightarrow 11270 + 6mg = 7840 + 4mg + 3920$$

$$\Rightarrow \quad 2mg = 490$$

$$19.6m = 490$$

$$m = 25 \text{ kg}$$

IYGB - MMS PAPER P - QUESTION 12

a) USING $\underline{r} = \underline{r}_0 + \underline{v}t$

$$\Rightarrow (13\underline{i} - 7\underline{j}) = (-2\underline{i} + 3\underline{j}) + \underline{v} \times 5$$

$$\Rightarrow 15\underline{i} - 10\underline{j} = 5\underline{v}$$

$$\Rightarrow \underline{v} = 3\underline{i} - 2\underline{j}$$

HENCE A GENERAL EXPRESSION WILL BE

$$\Rightarrow \underline{r} = (-2\underline{i} + 3\underline{j}) + (3\underline{i} - 2\underline{j})t$$

$$\Rightarrow \underline{r} = (3t-2)\underline{i} + (3-2t)\underline{j}$$

b) FIRSTLY LOOKING AT THE POSITION VECTOR OF SHIP A, WHEN $t=30$

$$\underline{r} = (3\times30-2)\underline{i} + (3-2\times30)\underline{j}$$

$$\underline{r} = 88\underline{i} - 57\underline{j}$$

NOW FORMING AN EQUATION FOR THE MOTION OF B

$$\Rightarrow \text{"}\underline{r} = \underline{r}_0 + \underline{v}t\text{"}$$

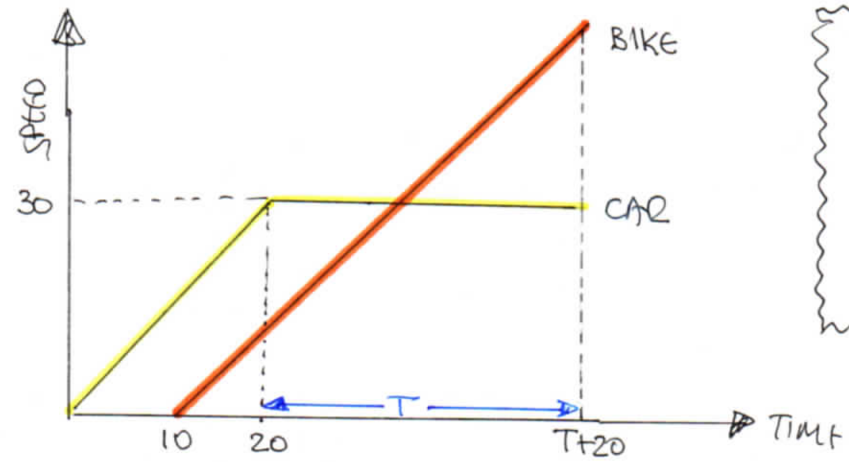
$$\Rightarrow \underbrace{(88\underline{i} - 57\underline{j})}_{\substack{\text{COLLISION AT THIS} \\ \text{POINT WHEN } t=30}} = \underbrace{(8\underline{i} + 3\underline{j})}_{\substack{\text{POSITION OF B} \\ \text{WHEN } t=10}} + \underbrace{\underline{V} \times 20}_{\substack{\text{MOTION FOR ANOTHER 20s} \\ \text{TO REACH } t=30}}$$

$$\Rightarrow 80\underline{i} - 60\underline{j} = 20\underline{V}$$

$$\Rightarrow \underline{V} = 4\underline{i} - 3\underline{j}$$

IYGB - MMS PAPER P - QUESTION 13

- START BY FILLING A SPEED TIME GRAPH



FOR THE CAR

"$V = u + at$"

$V = 0 + (1.5) \times 20$

$V = 30$

- FIND THE "EQUATION OF THE LINE" OF THE BIKE

$\Longrightarrow$ GRADIENT $= 2$ & PASSES THROUGH $(10,0)$

$\Longrightarrow \; V - 0 = 2(t - 10)$

$\Longrightarrow \; V = 2t - 20$

- FORM AN EQUATION SINCE AT THE INSTANT OF OVERTAKING BOTH CAR & BIKE WOULD HAVE COVERED THE SAME DISTANCE.

$$\Longrightarrow \left(\frac{1}{2} \times 20 \times 30\right) + (30T) = \frac{1}{2}(T+10)(2T+0)$$

$V = 2t - 20$

$V = 2(T+20) - 20$

$V = 2T + 20$

$\Longrightarrow \; 300 + 30T = (T+10)(T+10)$

$\Longrightarrow \; 300 + 30T = T^2 + 20T + 100$

$\Longrightarrow \; 0 = T^2 - 10T - 200$

$\Longrightarrow \; 0 = (T - 20)(T + 10)$

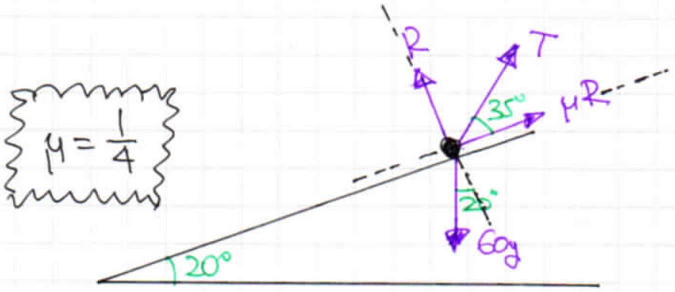
$\Longrightarrow \; T = \cancel{-10}$ or 20

$\therefore \; V = 2 \times 20 + 20$

$V = 60 \text{ ms}^{-1}$

IYGB – MMS PAPER P – QUESTION 14

IF WE REQUIRE THE LEAST TENSION IN THE ROPE, THE BOX WILL BE ON LIMITING EQUILIBRIUM & ABOUT TO SLIP DOWN THE PLANE – DRAW DIAGRAM



RESOLVING PARALLEL & PERPENDICULAR TO THE PLANE

$$(\parallel) \quad 60g\sin 20° = T\cos 35 + \mu R \quad \text{— (I)}$$
$$(\perp) \quad R + T\sin 35° = 60g\cos 20° \quad \text{— (II)}$$

REARRANGE (II) FOR R, AND SUBSTITUTE INTO (I)

$$\Rightarrow R = 60g\cos 20° - T\sin 35°$$

THUS

$$60g\sin 20° = T\cos 35 + \mu\left(60g\cos 20° - T\sin 35°\right)$$
$$60g\sin 20° = T\cos 35 + 60\mu g\cos 20° - \mu T\sin 35°$$
$$60g\sin 20° - 60\mu g\cos 20° = T(\cos 35° - \mu\sin 35°)$$
$$\frac{60g(\sin 20 - \mu\cos 20°)}{(\cos 35° - \mu\sin 35°)} = T$$

$$T = 93.18873\ldots$$

$$T \simeq 93.2\,\text{N}$$