IYGB - MMS PAPER M - QUESTION 1

a)

	2010	2011	2012	2013	2014	2015	2016	2017
x	52	340	511	621	444	700	805	921
y	120	126	134	138	132	146	153	160

USING A STATISTICAL CALCULATOR, WE OBTAIN THE P.M.C.C

$$r_{xy} = 0.969\ldots$$

b) $r_{ac} = 0.969$ I.E UNCHANGED AS THE PMCC IS INDEPENDENT OF SCALING (HERE DIVIDING BY 1000), OR CHOICE OF ORIGIN (HERE SUBTRACTING 7000)

c) STRONG POSITIVE CORRELATION, I.E THE MORE SPEND ON ADVERTISING THE HIGHER THE CAR SALES

IYGB - MMS PAPER M - QUESTION 2

- USING THE CONDITIONAL PROBABILITY FORMULA

$$\Rightarrow P(B|A) = \frac{P(A\cap B)}{P(A)}$$

$$\Rightarrow \frac{1}{6} = \frac{P(A\cap B)}{3/5}$$

$$\Rightarrow P(A\cap B) = \frac{1}{10}$$

- USING THE PROBABILITY FOUND AND THE CONDITIONAL FORMULA AGAIN

$$\Rightarrow P(A|B) = \frac{P(A\cap B)}{P(B)}$$

$$\Rightarrow \frac{3}{13} = \frac{\frac{1}{10}}{P(B)}$$

$$\Rightarrow P(B) = \frac{\frac{1}{10}}{\frac{3}{13}}$$

$$\Rightarrow P(B) = \frac{13}{30}$$

- FINALLY WE HAVE

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

$$\Rightarrow P(A\cup B) = \frac{3}{5} + \frac{13}{30} - \frac{1}{10}$$

$$\Rightarrow P(A\cup B) = \frac{14}{15}$$

- HENCE $P(A'\cap B') = \frac{1}{15}$

IYGB – MMS PAPER M – QUESTION 3

a)

NO OF CHILDREN	0	1	2	3	≥ 4
PERCENTAGE OF HOUSEHOLDS	23%	32%	35.%	7%	3%

I) $\boxed{X = \text{"NO KID" HOUSEHOLD} \quad X \sim B(20, 0.23)}$

$P(X=3) = \binom{20}{3} 0.23^3 \, 0.77^{17}$

$= 0.1631$

II) $\boxed{Y = \text{"AT LEAST 2 KIDS" HOUSEHOLD} \quad Y \sim B(20, 0.45)}$

$P(\text{more than half})$

$= P(Y > 10) = P(Y \geq 11)$

$= 1 - P(Y \leq 10) = \ldots$ tables

$= 1 - 0.7507$

$= 0.2493$

III) $\boxed{W = \text{"AT MOST 2 KIDS" HOUSEHOLD} \quad W \sim B(20, 0.9)}$

MODEL WITH COMPLEMENT

$W' \sim B(20, 0.1)$

W	W'
16	4
17	3
18	2
19	1

$P(15 < W \leq 19)$

$= P(16 \leq W \leq 19)$

$= P(1 \leq W' \leq 4)$

$= P(W' \leq 4) - P(W' \leq 0)$

$= 0.9568 - 0.1216$

$= 0.8352$

IYGB - MMS PAPER N - QUESTION 3

b) V = A FOUR OR MORE KID HOUSEHOLD

$V \sim B(n, 0.03)$

$\Rightarrow P(V \geq 1) > 10\%$

$\Rightarrow P(V \geq 1) > 0.1$

$\Rightarrow 1 - P(V=0) > 0.1$

$\Rightarrow -P(V=0) > -0.9$

$\Rightarrow P(V=0) < 0.9$

$\Rightarrow \binom{n}{0}(0.03)^0(0.97)^n < 0.9$

$\Rightarrow 0.97^n < 0.9$

BY LOGARITHMS

$\Rightarrow \log 0.97^n < \log 0.9$

$\Rightarrow n \log 0.97 < \log 0.9$

$\Rightarrow n > \dfrac{\log 0.9}{\log 0.97}$

$\Rightarrow n > 3.459\ldots$

$\Rightarrow n = 4$

OR TRIAL AND IMPROVEMENT

$n=5 \quad 0.97^5 = 0.858 < 0.9$

$n=4 \quad 0.97^4 = 0.885 < 0.9$

$n=3 \quad 0.97^3 = 0.913 > 0.9$

$\therefore n = 4$

IYGB - MMS PAPER M - QUESTION 4

TIME (NEAREST MIN)	2-6	7-11	12-16	17-31	32-36
	4	9	14	24	34
NO OF PATIENTS	6	15	k	24	12

- FINDING THE MIDPOINTS (ABOVE TABLE IN GREEN)
- THEN SET AN EQUATION FOR THE MEAN, GIVEN TO BE 18.6

$$\Rightarrow \frac{(4\times6)+(9\times15)+(14k)+(24\times24)+(34\times12)}{6+15+k+24+12} = 18.6$$

$$\Rightarrow \frac{24+135+14k+576+408}{k+57} = \frac{93}{5}$$

$$\Rightarrow \frac{1143+14k}{k+57} = \frac{93}{5}$$

$$\Rightarrow 93k+5301 = 5715+70k$$

$$\Rightarrow 23k = 414$$

$$\Rightarrow k=18$$

- FINALLY GETTING AN EXPRESSION FOR THE STANDARD DEVIATION

$$\Rightarrow \sigma = \sqrt{\frac{\Sigma fx^2}{\Sigma f} - \bar{x}^2} \quad \text{OR} \quad \sigma = \sqrt{\frac{\Sigma x^2}{n} - \bar{x}^2}$$

$$\Rightarrow \sigma = \sqrt{\frac{(4^2\times6)+(9^2\times15)+(14^2\times18)+(24^2\times24)+(34^2\times12)}{6+15+18+24+12} - (18.6)^2}$$

$$\Rightarrow \sigma = \sqrt{\frac{32535}{75} - (18.6)^2}$$

$$\Rightarrow \sigma = \sqrt{87.84} \approx 9.37$$

IYGB - MMS PAPER M - QUESTION 5

a) X = VOLUME OF STILL BOTTLED WATER

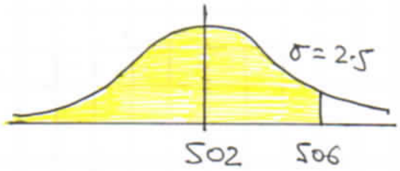
$X \sim N(502, 2.5^2)$

I) $P(X < 506)$

$= P\left(Z < \frac{506-502}{2.5}\right)$

$= \Phi(1.6)$

$= 0.9452$



II) $P(X < 495)$

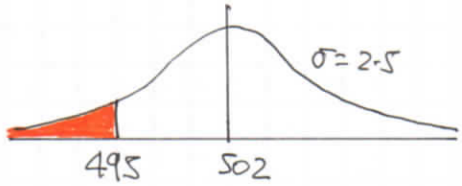
$= 1 - P(X > 495)$

$= 1 - P\left(Z > \frac{495-502}{2.5}\right)$

$= 1 - \Phi(-2.8)$

$= 1 - 0.9974$

$= 0.0026$



III) $P(495 < X < 506) = P(X < 506) - P(X < 495)$

$= 0.9452 - 0.0026$

$= 0.9426$

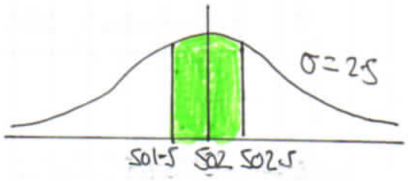
IV) $P(X = 500) = 0$ (CONTINUOUS DATA)

IYGB - MMS PAPER U - QUESTION 5

I) $P(501.5 < X < 502.5)$

$= P(X < 502.5) - P(X < 501.5)$

$= P(X<502.5) - [1 - P(X > 501.5)]$



$= P(X<502.5) + P(X>501.5) - 1$

$= P\left(Z < \frac{502.5-502}{2.5}\right) + P\left(Z > \frac{501.5-502}{2.5}\right) - 1$

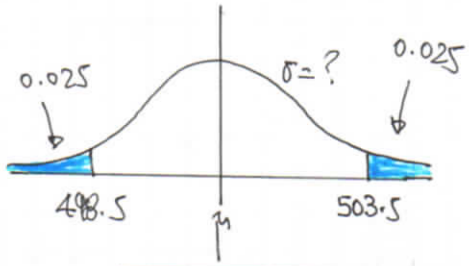
$= \Phi(0.2) + \Phi(-0.2) - 1$

$= 0.5793 + 0.5793 - 1$

$= 0.1586$

b) FIRSTLY BY SYMMETRY, SEE DIAGRAM,

$\mu = \frac{503.5 + 498.5}{2} = 501$



HENCE WE HAVE

$\Rightarrow P(Y > 503.5) = 0.025$

$\Rightarrow P(Y < 503.5) = 0.975$

$\Rightarrow P\left(Z < \frac{503.5 - 501}{\sigma}\right) = 0.975$

INVERTING

$\Rightarrow \frac{2.5}{\sigma} = +\Phi^{-1}(0.975)$

$\Rightarrow \frac{2.5}{\sigma} = 1.96$

$\Rightarrow \sigma \approx 1.28$

Y = VOLUME OF SPARKLING WATER

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

IYGB – MMS PAPER N – QUESTION 6

a) a)

$$\boxed{\begin{array}{l} X = \text{NO OF SUCCESSES} \\ X \sim B(20, 0.35) \end{array}}$$

$H_0 : p = 0.35$

$H_1 : p > 0.35$

WHERE p IS THE PROBABILITY OF WILLIAM HITTING THE TARGET IN GENERAL

- CRITICAL REGION REQUIRED AS CLOSE AS POSSIBLE TO 1%

LOOKING AT BINOMIAL TABLES

$$P(X \geqslant 12) = 1 - P(X \leqslant 11) = 1 - 0.9804 = 0.0196 = 1.96 > 1\%$$

$$P(X \geqslant 13) = 1 - P(X \leqslant 12) = 1 - 0.9940 = 0.0060 = \underbrace{0.60}_{\text{CLOSER}} < 1\%$$

- THE REQUIRED CRITICAL REGION IS $\{13, 14, 15, \ldots, 20\}$

b)

- USING THE SAME HYPOTHESES AS ABOVE WITH $n = 150$

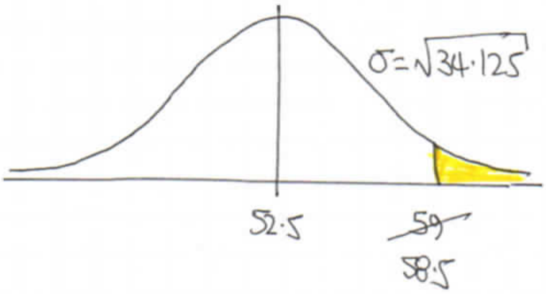
$$X \sim B(150, 0.35)$$

- APPROXIMATE BY

$$Y \sim N(np, np(1-p))$$

$$Y \sim N[150 \times 0.35, 150 \times 0.35 \times 0.65]$$

$$Y \sim N[52.5, 34.125]$$



$$\Rightarrow P(X \geqslant 59) = P(Y > 58.5)$$

$$= 1 - P(Y < 58.5)$$

$$= 1 - P\left(Z < \frac{58.5 - 52.5}{\sqrt{34.125}}\right)$$

$$= 1 - \Phi(1.0271)$$

$$= 1 - 0.8478$$

$$= 0.1522 \leftarrow \text{P VALUE}$$

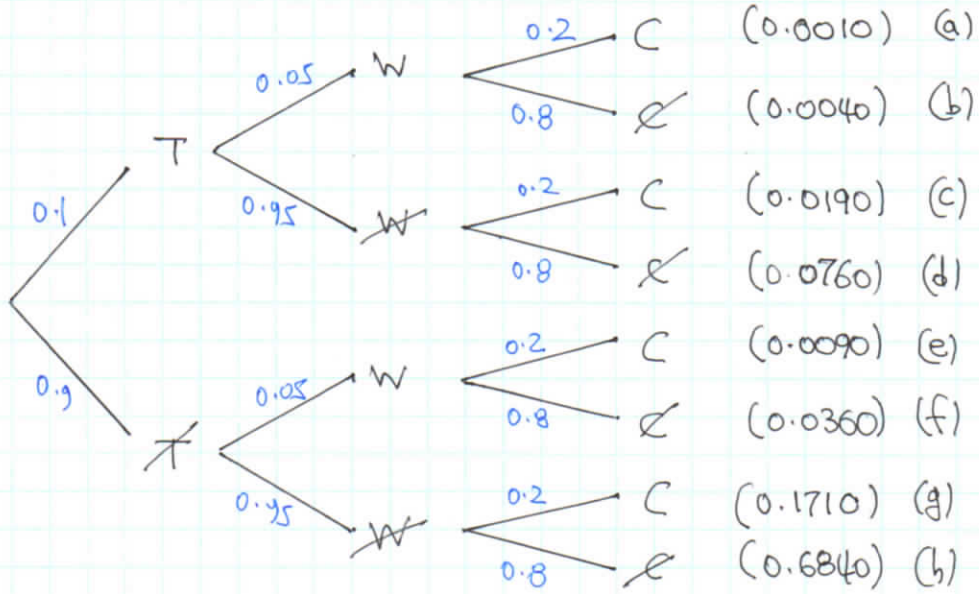
THERE IS NO SIGNIFICANT EVIDENCE THAT THE NEW BOW HAS THE DESIRED EFFECT (COMPARE WITH 5%)

NOT SUFFICIENT EVIDENCE TO REJECT H_0

IYGB – MMS PAPER M – QUESTION 7

$$P(T) = 0.1 \quad \bullet \quad P(W) = 0.05 \quad \bullet \quad P(C) = 0.2$$

DRAWING A TREE DIAGRAM



a) I) $\underline{P(\text{delay due to 1 reason})} = d + f + h$

$$= 0.0760 + 0.0360 + 0.1710$$

$$= 0.2830$$

II) $\underline{P(\text{delayed})} = 1 - P(\text{not delayed}) = 1 - \text{"}h\text{"} = 1 - 0.6840$

$$= 0.3160$$

b) $\underline{P(\text{one reason only} \mid \text{delayed})} = \dfrac{d + f + h}{a+b+c+d+e+f+g+h}$

$$= \frac{0.2830}{0.3160} = 0.896$$

c) $\underline{P(\text{delayed} \mid T')} = \dfrac{e+f+g}{e+f+g+h} = \dfrac{0.0090 + 0.0360 + 0.1710}{0.0090 + 0.0360 + 0.1710 + 0.6840}$

$$= \frac{0.216}{0.9} = 0.24$$

IYGB - MMS PAPER M - QUESTION 8

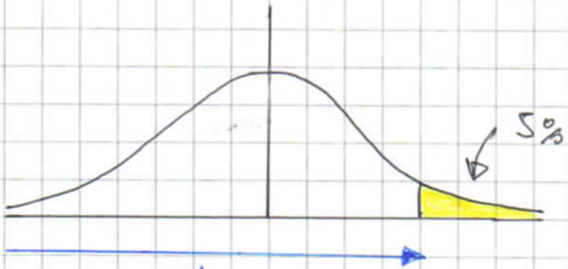
START BY DEFINING VARIABLES

X = HEIGHT OF MALE STUDENT IN THAT COLLEGE

$X \sim N(170, 6^2)$

SETTING HYPOTHESES & COLLECTING ALL AUXILIARIES

$H_0: \mu + 5 = 175$
$H_1: \mu + 5 > 175$
• $\bar{x}_4 = 180$
• $n = 4$
• $\sigma = 6$
TEST 5% SIGNIFICANCE



$\Phi^{-1}(0.95) = +1.6449$

• $\text{Z-STAT} = \dfrac{\bar{x} - (\mu + 5)}{\frac{\sigma}{\sqrt{n}}}$

• $\text{Z-STAT} = \dfrac{180 - (170 + 5)}{6/\sqrt{4}}$

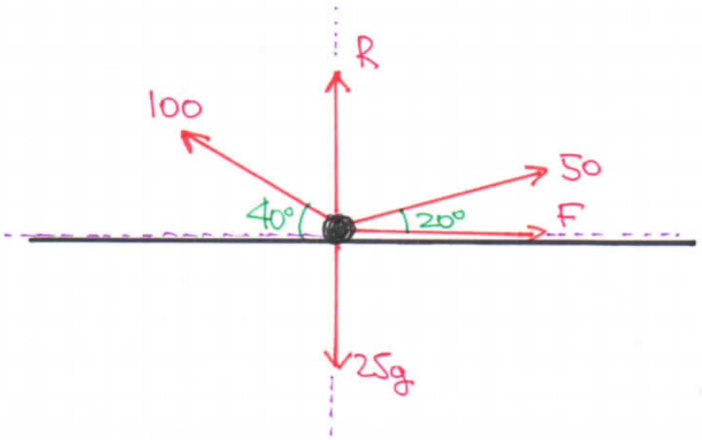
• $\text{Z-STAT} = 1.677\ldots$

AS $1.677 > 1.6449$ THERE IS SIGNIFICANT EVIDENCE THAT THE MEAN HEIGHT OF MALE STUDENTS IN THE COLLEGE IS GREATER THAN 175 cm.

THERE IS SUFFICIENT EVIDENCE TO REJECT H_0

IYGB - MMS PAPER U - QUESTION 9

START WITH A STANDARD DIAGRAM IN ORDER TO RESOLVE FORCES



RESOLVING VERTICALLY TO FIND THE NORMAL REACTION R (EQUILIBRIUM)

$$\Rightarrow R + 100\sin 40^\circ + 50\sin 20^\circ = 25g$$

$$\Rightarrow R = 163.6202319\ldots N$$

NOW CONSIDER THE MAGNITUDE OF THE HORIZONTAL FORCES

$(\leftarrow)$: $100\cos 40^\circ = 76.604\ldots N$

$(\rightarrow)$: $50\cos 20^\circ = 46.98463\ldots N$

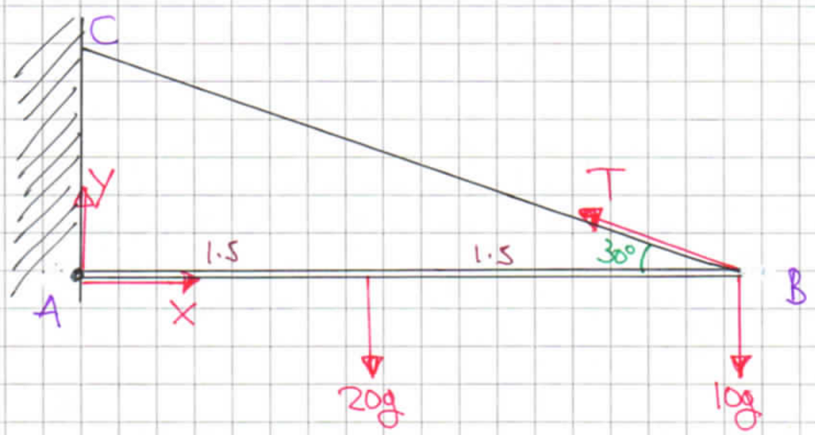
$(\rightarrow)$: MAX FRICTION $= \mu R = 0.2 \times 163.620\ldots = 32.724\ldots N$

$$76.604\ldots < 46.9846\ldots + 32.724\ldots$$

$\therefore$ NO MOTION, IE EQUILIBRIUM

IYGB – MMS PAPER N – QUESTION 10

a) STARTING WITH A GOOD DIAGRAM



FORMING THREE STANDARD EQUATIONS

$(\uparrow): \; Y + T\sin 30° = 20g + 10g$

$(\rightarrow): \; X = T\cos 30°$

$(\curvearrowright A): \; (20g \times 1.5) + (10g \times 3) = T\sin 30 \times 3$

USING THE "MOMENT" EQUATION

$\Rightarrow \; 30g + 30g = \frac{3}{2}T$

$\Rightarrow \; \frac{3}{2}T = 60g$

$\Rightarrow \; T = 40g$

$\Rightarrow \; T = 392 \text{ N}$ //

b) USING THE "VERTICAL & HORIZONTAL" EQUATIONS WITH $T = 392 = 40g$

- $X = T\cos 30$

  $X = 40g \times \frac{\sqrt{3}}{2}$

  $X = 20\sqrt{3}\,g$

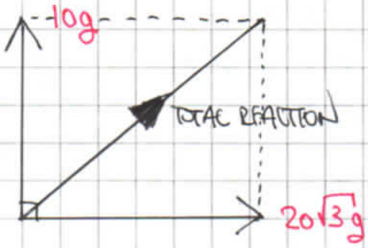
- $Y + T\sin 30 = 30g$

  $Y + 40g \times \frac{1}{2} = 30g$

  $Y = 10g$

IYGB - MMS PAPER N - QUESTION 10

FINALLY THE "NET REACTION"



$$\text{TOTAL REACTION} = \sqrt{(10g)^2 + (20\sqrt{3}g)^2}$$

$$= \sqrt{100g^2 + 400 \times 3 \times g^2}$$

$$= \sqrt{1300g^2}$$

$$= \sqrt{100g^2}\sqrt{13}$$

$$= 10g\sqrt{13}$$

$$= 98\sqrt{13}$$

// AS REQUIRED

IYGB - MMS PAPER M - QUESTION 11

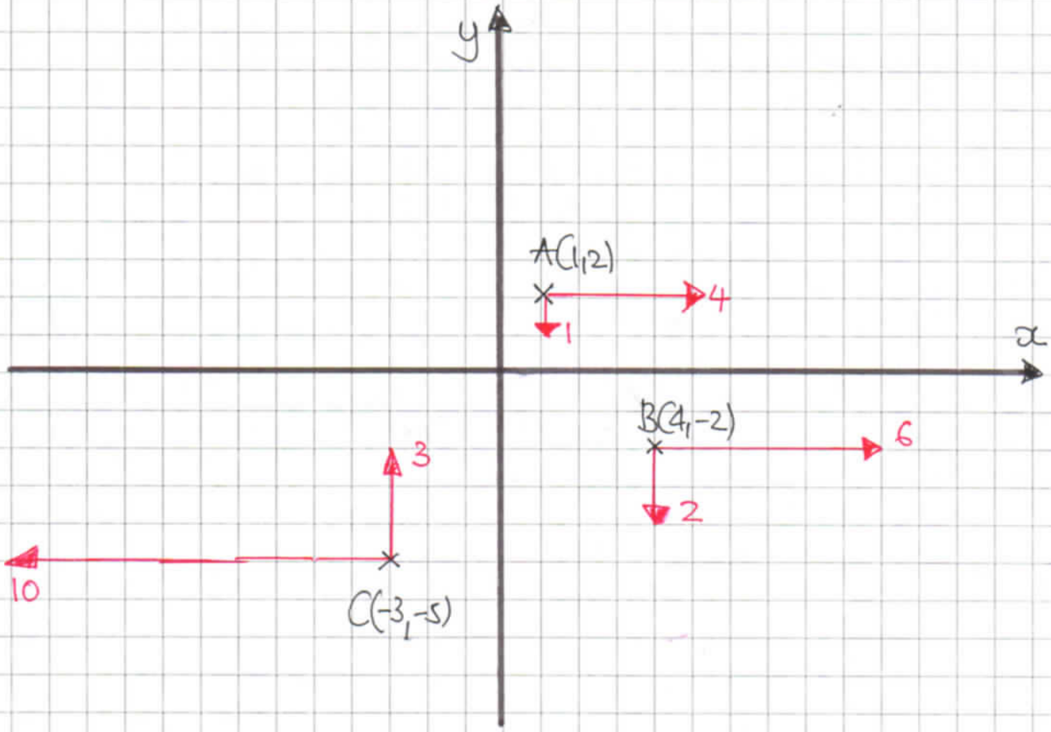
a) FIRSTLY THE RESULTANT FORCE IS ZERO

$$(4\underline{i} + b\underline{j}) + (3a\underline{i} + 2b\underline{j}) + (10b\underline{i} + 3\underline{j}) = \underline{0}$$
$$(4 + 3a + 10b)\underline{i} + (3b+3)\underline{j} = \underline{0}$$

- $3b + 3 = 0$
  $3b = -3$
  $\underline{b = -1}$

- $4 + 3a + 10b = 0$
  $4 + 3a - 10 = 0$
  $3a = 6$
  $\underline{a = 2}$

NEXT DRAW A DIAGRAM - TAKE MOMENTS ABOUT O



USING CONVENTION POSITIVE IS ANTICLOCKWISE

$$\left.\begin{array}{ll}
\underline{F}_1 \text{ ACTING AT } A & \left\{\begin{array}{l} -(4\times 2) = -8 \\ -(1\times 1) = -1 \end{array}\right. \\
\underline{F}_2 \text{ ACTING AT } B & \left\{\begin{array}{l} +(6\times 2) = 12 \\ -(2\times 4) = -8 \end{array}\right. \\
\underline{F}_3 \text{ ACTING AT } C & \left\{\begin{array}{l} -(3\times 3) = -9 \\ -(10\times 5) = -50 \end{array}\right.
\end{array}\right\} \text{ ADDING GIVES } -64$$

$\therefore$ 64 Nm CLOCKWISE

IYGB – MMS PAPER M – QUESTION 11

b) MOMENTS ABOUT C NOW – NOTING THAT $\underline{F}_3$ HAS ZERO MOMENT

$\underline{F}_1$ ACTING AT A $\begin{cases} -(1\times4) = -4 \\ -(4\times7) = -28 \end{cases}$

$\underline{F}_2$ ACTING AT B $\begin{cases} -(6\times3) = -18 \\ -(2\times7) = -14 \end{cases}$

ADDING THESE COMPONENTS OF MOMENTS GIVES -64

$\therefore$ MOMENT ABOUT C IS ALSO 64 Nm CLOCKWISE

IYGB - MMS PAPER M - QUESTION 12

a) THE VELOCITY OF Q IS $(8\underline{i} - 6\underline{j})\ \text{km h}^{-1}$

$\therefore$ SPEED $= |\text{VELOCITY}| = |8\underline{i} - 6\underline{j}| = \sqrt{8^2 + (-6)^2} = 10\ \text{km h}^{-1}$

b) USING $\underline{r} = \underline{r}_0 + \underline{v}t$ FOR EACH

$$\underline{p} = (6\underline{i} - 2\underline{j}) + (0\underline{i} + 12\underline{j})t$$
$$\underline{q} = (-5\underline{i} + 0\underline{j}) + (8\underline{i} - 6\underline{j})t$$

$\Longrightarrow$

$$\underline{p} = 6\underline{i} + (12t - 2)\underline{j}$$
$$\underline{q} = (8t - 5)\underline{i} - 6t\underline{j}$$

c) WHEN $t = 2$

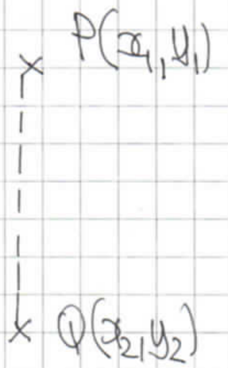
$\underline{p} = 6\underline{i} + (12\times2 - 2)\underline{j} = 6\underline{i} + 22\underline{j}$ IE $P_2(6, 22)$

$\underline{q} = (8\times2 - 5) - (6\times2)\underline{j} = 11\underline{i} - 12\underline{j}$ IE $Q_2(11, -12)$

USING THE DISTANCE FORMULA FROM THE CO-ORDINATE GEOMETRY

$$d = \sqrt{(y_2 - y_1)^2 + (x_2 - x_1)^2} = \sqrt{(-12 - 22)^2 + (11 - 6)^2} = \sqrt{1156 + 25}$$
$$= \sqrt{1181} \simeq 34.4\ \text{km}$$

d) LOOKING AT THE DIAGRAM



- When P is north of Q, their x coordinate must be the same, IE $x_1 = x_2$ & $y_1 > y_2$
- $6 = 8t - 5$ ($\underline{i}$)

  $13 = 8t$

  $t = \frac{11}{8}$ HOURS

  $t = 82.5$ MINUTES

CHECK THE $\underline{j}$

- $12t - 2 = 12\times\frac{11}{8} - 2$
  $= 14.5$
- $-6t = -6\times\frac{11}{8} = -8.25$

$y_1 > y_2$

IYGB - MMS PAPER M - QUESTION 13

a) LOOKING AT THE JOURNEY FROM O TO B

$u = ?$
$a = ?$
$s = 6\text{ m}$
$t = 4\text{ s}$
$v = 7\text{ ms}^{-1}$

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

$6 = \frac{1}{2}(u+7)\times 4$

$6 = 2(u+7)$

$3 = u+7$

$u = -4\text{ ms}^{-1}$

$\therefore$ 4 ms^{-1} TO THE "LEFT"

- $v = u+at$

$7 = -4+a\times 4$

$11 = 4a$

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

$a = 2.75\text{ ms}^{-2}$

b) NOW LOOKING AT THE JOURNEY FROM O TOWARDS A

- EITHER

$u = -4\text{ ms}^{-1}$
$a = 2.75\text{ ms}^{-2}$
$s = ?$
$t = —$
$v = 0\text{ ms}^{-1}$

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

$0^2 = (-4)^2 + 2\times 2.75\times s$

$5.5s = -16$

$s = -2.909\ldots > -3$

$\therefore$ IT NEVER REACHES A

- OR

$u = -4\text{ ms}^{-1}$
$a = 2.75\text{ ms}^{-2}$
$s = -3$
$t = ?$
$v = —$

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

$-3 = -4t + \frac{1}{2}(2.75)t^2$

$-3 = -4t + \frac{11}{8}t^2$

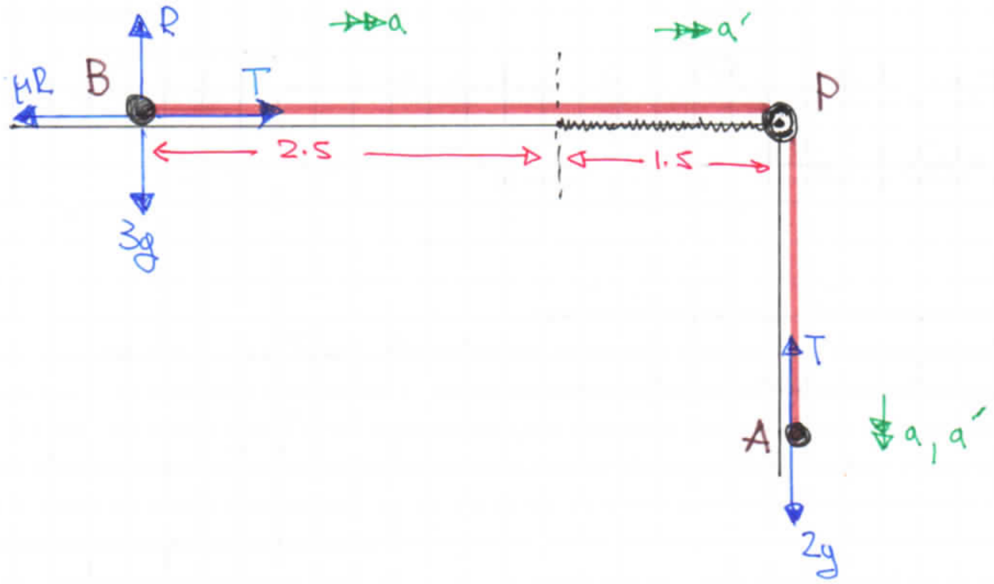
$-24 = -32t + 11t^2$

$0 = 11t^2 - 32t + 24$

$b^2 - 4ac = (-32)^2 - 4\times 11\times 24$
$= 1024 - 1056$
$= -32 < 0$

NO SUCH TIME, SO IT NEVER REACHES A

IYGB – MMS PAPER M – QUESTION 14



LOOKING AT THE EQUATIONS OF MOTION FOR THE BOX AND THE PARTICLE FOR THE FIRST 2.5 m OF THE MOTION

[BOX]: $T = 3a$ (NO FRICTION)
[PARTICLE]: $2g - T = 2a$

ADDING GIVES
$5a = 2g$
$a = \frac{2}{5}g$

FIND THE COMMON SPEED AT THE END OF THE FIRST 2.5 m

$$\boxed{\begin{aligned} u &= 0 \\ a &= \tfrac{2}{5}g \text{ ms}^{-2} \\ s &= 2.5 \text{ m} \\ t &= \\ v &= ? \end{aligned}}$$

$\Rightarrow v^2 = u^2 + 2as$
$\Rightarrow v^2 = 0 + 2\left(\frac{2}{5}g\right) \times 2.5$
$\Rightarrow v^2 = 2g$
$\Rightarrow v^2 = 19.6$
$\Rightarrow v \simeq 4.42718\ldots$

IYGB - MMS PAPER M - QUESTION 14

NEXT OBTAIN THE EQUATION OF MOTION FOR THE BOX & PARTICLE FOR THE ROUGH SECTION OF 1.5 m

$$\left.\begin{array}{ll} [\text{BOX}] : & T - \mu R = 3a' \\ [\text{PARTICLE}] : & 2g - T = 2a' \end{array}\right\} \Rightarrow \text{ADDING GIVES}$$

$$\Rightarrow 5a' = 2g - \mu R$$

$$\Rightarrow 5a' = 2g - \tfrac{3}{4}(3g)$$

$$\Rightarrow 5a' = -\tfrac{1}{4}g$$

$$\Rightarrow a' = -\tfrac{1}{20}g$$

(DECELERATION)

LOOKING AT THE KINEMATICS OF THE LAST SECTION

u	$= \sqrt{2g}$
a	$= -\frac{1}{20}g$
s	$= 1.5$
t	$=$
v	$= ?$

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

$$v^2 = 2g + 2\left(-\tfrac{1}{20}g\right)(1.5)$$

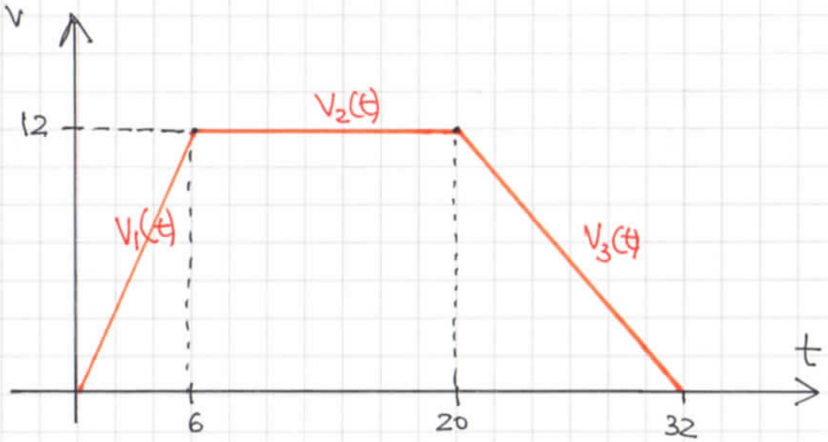
$$v^2 = 2g - \tfrac{3}{30}g$$

$$v^2 = 18.13$$

$$v \simeq 4.26 \text{ ms}^{-1}$$

(3 sf)

IYGB – MMS PAPER M – QUESTION 15



LOOKING AT THE GRAPH OPPOSITE

- GRAD $V_1 = \frac{12}{6} = 2$

  $V_1(t) = 2t$

- GRAD $V_2 = 0$

  $V_2 = 12$

- GRAD $V_3 = -\frac{12}{12} = -1$

  $V_3 - 0 = -1(t-32)$

  $V_3 = 32 - t$

NOW WE CAN TREAT THIS AS FOLLOWS

- $S_1(t) = \int_0^t 2t \, dt = \left[t^2\right]_0^t = t^2 - 0 = t^2.$

- $S_1(6) = 6^2 = 36$

- $S_2(t) = 36 + \int_6^t 12 \, dt = 36 + \left[12t\right]_6^t = 36 + (12t - 72) = 12t - 36$

- $S_2(20) = 12 \times 20 - 36 = 204$

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$$\dot{s}_3(t) = 204 + \int_{20}^{t} 32 - t \, dt = 204 + \left[32t - \frac{1}{2}t^2\right]_{20}^{t}$$

$$= 204 + \left[\left(32t - \frac{1}{2}t^2\right) - (640 - 200)\right]$$

$$= -\frac{1}{2}t^2 + 32t - 236$$

HENCE WE FINALLY OBTAIN

$$\dot{s}(t) = \begin{cases} t^2 & 0 \leq t < 6 \\ 12t - 36 & 6 \leq t \leq 20 \\ -\frac{1}{2}t^2 + 32t - 236 & 20 < t \leq 34 \end{cases}$$