Practice Paper G
Paper 3 Statistics and Mechanics

1/ a/ The pmcc measures the strength of the linear relationship between the CO_2 emissions and fuel consumption

b/ 60 mpg is outside the data range and so may be unreliable

c/ The explanatory variable is the one that affects the other, so it is the fuel consumption

d/ A hypothesis test is a statistical test used to determine whether a hypothesis assumed for a sample of data is true for an entire population

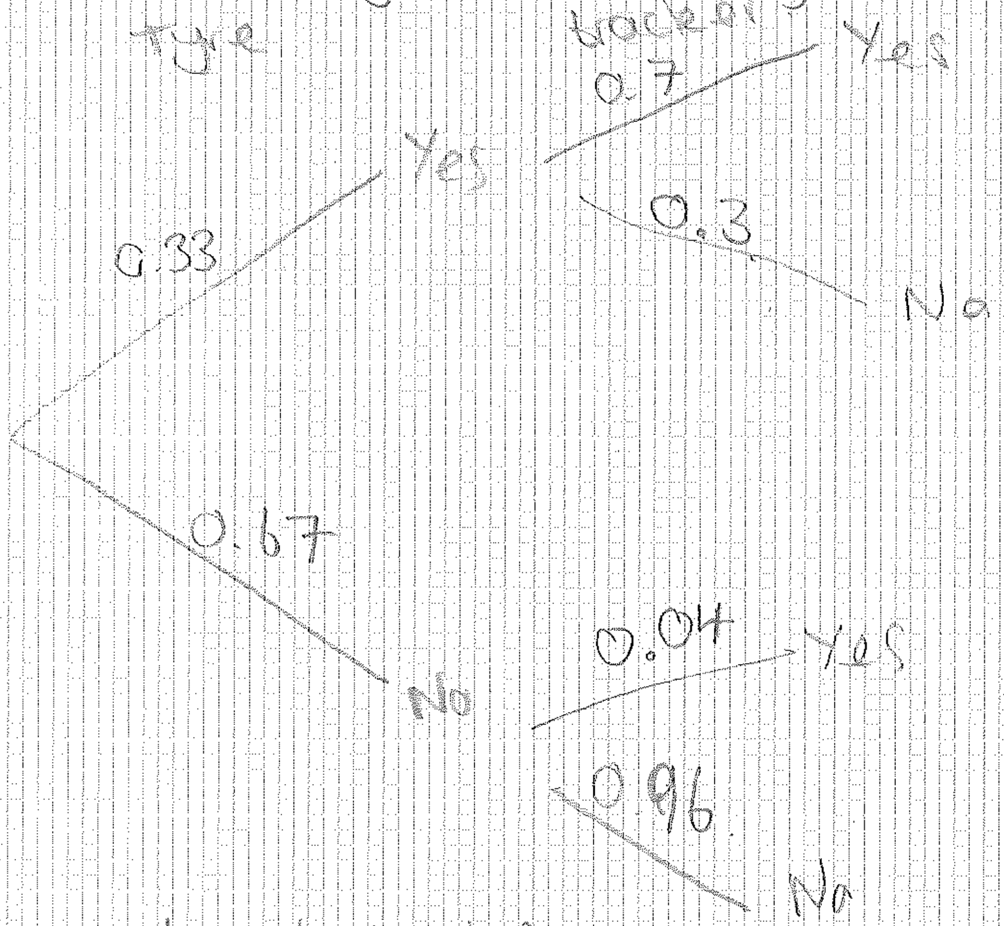
e/ H_0 $\rho = 0$ H_1 $\rho < 0$
this must be a 1 tailed test since says "less than zero"
$\therefore$ $r = -0.803$ $n = 40$
Using the statistical table for critical values, critical value is 0.3665
$-0.3665 > -0.803$
$\therefore$ there is evidence that we can reject the null hypothesis and that the pmcc for

CO_2 emissions and fuel consumption is less than zero.

2/ a/ P(new tyre) = 0.33

P(new tracking given new tyre) = 0.7

P(not new tyre but needing tracke) = 0.04.



b/ P(tyre but not tracke) = 0.33 × 0.3 = 0.099

P(tracke but not tyre) = 0.67 × 0.04 = 0.0268.

0.099 + 0.0268 = 0.1258.

c/ P(at least 1 defect)

= 1 − P(no defects)

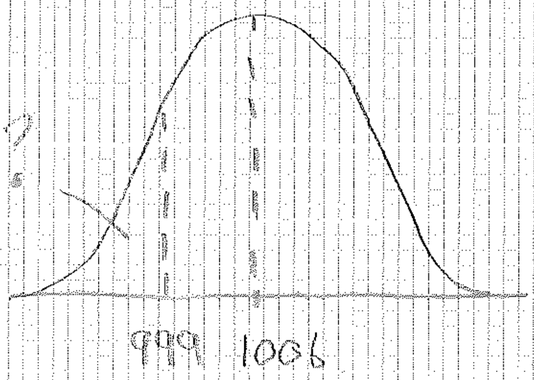
= 0.67 × 0.96 × (1 − 0.35) = 0.418

1 − 0.418 = 0.582

d/ The advice would be to get cars regularly serviced as there is over 50% chance something is defective.

3/ a/ It is reasonable as the distribution has the bell shape of the normal distribution

b/ Poor or bad weather; less than 1000



$X \sim N(1006, 4.4^2)$

$P(X < 1000)$

using classwiz, normal CD,

lower = -10,000

upper = 1000

= $\underline{0.0863}$

c/ Hurricane could still happen as there could be extreme circumstances in reality, despite the model

d/ $X \sim N(1017, 3.26^2)$

$P(X<1000) = P(~~0~~\ 9.20459 \times 10^{-8})$

it is very very unlikely that is poor weather the mean is higher suggesting better weather also, and the standard deviation is smaller showing there is less variation ~~is~~ in the weather.

Therefore, the information supports his claim.

4/ a/ The pmcc measures the strength of the linear correlation between the 2 variables b/ The pmcc of -0.477 shows there is some negative correlation between mean windspeed and mean pressure.

c/ This means that as the pressure increases the daily mean windspeed in Hurn decreases.

d/ H_0: $\rho = 0$ H_1: $\rho < 0$

pmcc = -0.477

p-value < 0.001

as this is less than 0.1%,

it is less than the 5% significance level, there is evidence to reject H_0 and there is evidence that there is a negative correlation between mean pressure and mean wind speed.

e/ If we use the regression model,

km = 180 - 0.1694 × hPa

= [illegible]

f/ the gradient tells us that every time the mean pressure increases by 1, the speed descreases by 0.1694 km.

g/ This is near the bottom of the range so may not be very accurate.

5/ $P(E) = 0.25 \quad P(F) = 0.4$

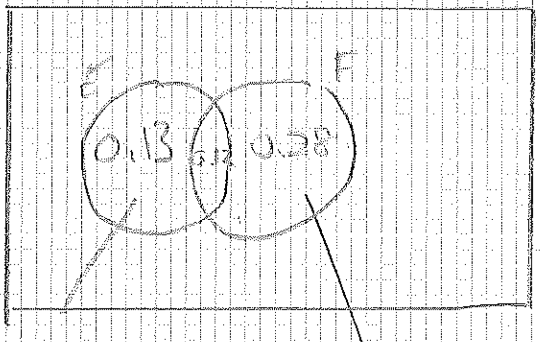
$P(E \cap F) = 0.12$

a/ $P(E' \mid F')$

using the rule for conditional probability;

$$P(B \mid A) = \frac{P(A \cap B)}{P(B)}$$ or

venn diagram;



$0.25 - 0.12 = 0.13$ $\quad$ $0.4 - 0.12 = 0.28$

$P(F') = 0.6$

$$P(E' \mid F') = \frac{0.47}{0.6} = 0.783$$

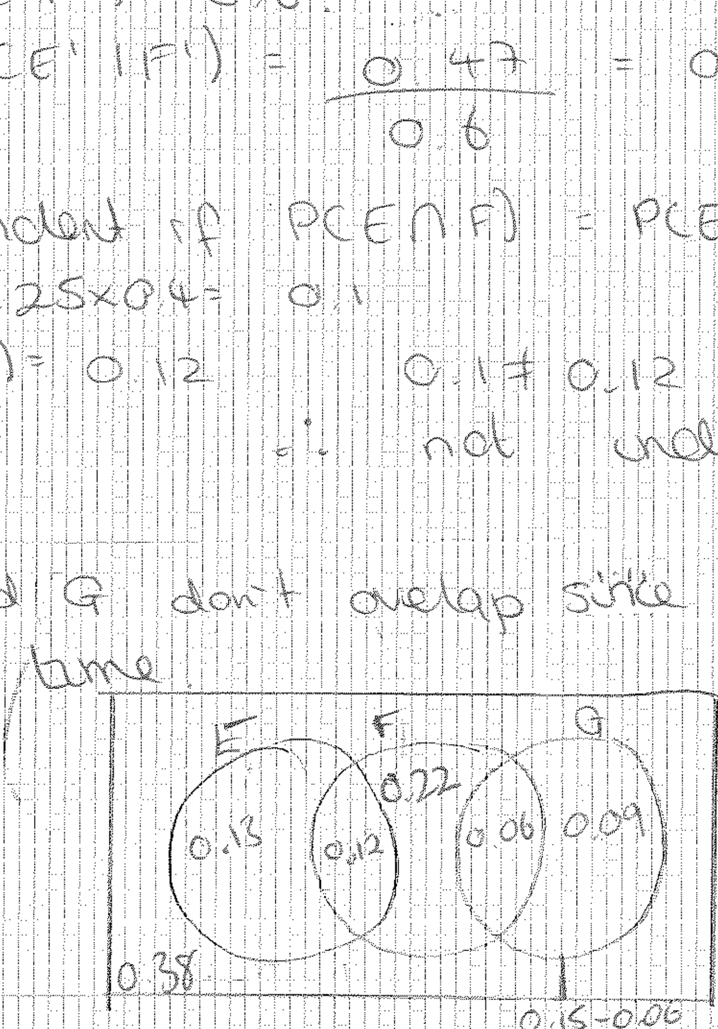
b/ Independent if $P(E \cap F) = P(E) \times P(F)$

$P(E) \times P(F) \quad 0.25 \times 0.4 = 0.1$

$P(E \cap F) = 0.12 \qquad 0.1 \neq 0.12$

$\therefore$ not independent

c/ E and G don't overlap since can't happen at same time



$0.15 - 0.06$

F and G independent, so $P(F \cap G) = 0.15 \times 0.4 = 0.06$

d) $p((F \cup G)')$

$= 0.38 + 0.13$

$= 0.51$

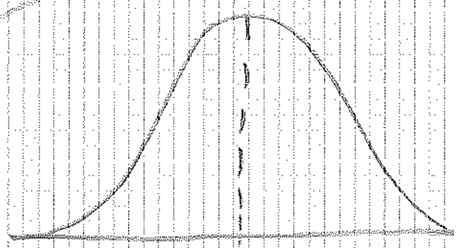
6) 54% female 46% male

$n = 200$

Binomial.

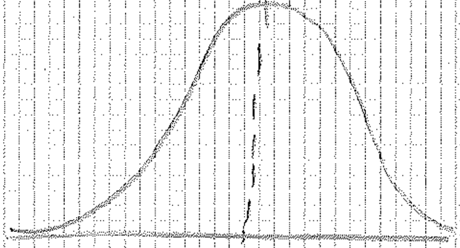
$X \sim B(200, 0.54)$

Binomial



μ

Normal



$\mu = 0$ s.d $= 1$

$X \sim B(n, p)$

$\mu = np$

$\sigma^2 = n \times p \times (1-p)$

$\mu = 200 \times 0.54$

$= 108$

$\sigma^2 = 200 \times 0.54 \times 0.46$

$= 49.68$

using calculator

B $Z \sim N(\mu, \sigma^2)$

$\sigma^2 = npq$

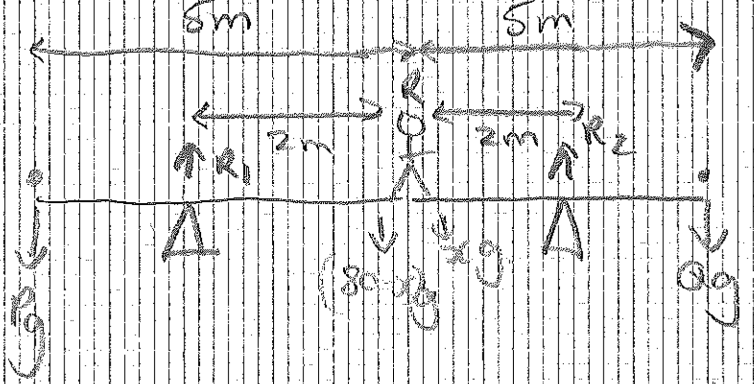
$= np(1-p)$

$P(X > 101) = P(X > 100.5)$

for normal since continuous

using calc $= 0.856$

7/



2 see-saws not joined just touching!

Moments around R_1

clockwise	anti
$(80-x)g$	$Pg \times 3$

$2(80-x)g = Pg \times 3$

(1) $160g - 2xg = 3Pg$

Moments around R_2

clockwise	anti
$Qg \times 3$	$x \times 2$

$2xg = 3Qg$

(2) $2xg = 3Qg$

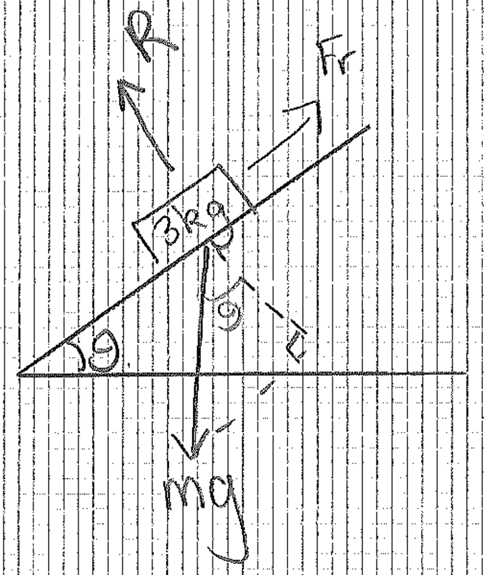
Sub (2) into (1) $160g - 3Qg = 3Pg$

$160g = 3Qg + 3Pg$

$160 = 3Q + 3P$

$Q + P = 53.$

8/ a/



R is the normal reaction from the slope
Fr is the friction
mg is the weight of the object where m = 3

b/ Resolve ⊥ to slope

① $mg\cos\theta = R$

Resolve ∥ to slope

$mg\sin\alpha = Fr$

limiting equilibrium ∴ $Fr = \mu R$

② $mg\sin\alpha = \mu R$

sub ① into ②

$mg\sin\alpha = \mu(mg\cos\alpha)$

$\frac{mg\sin\alpha}{mg\cos\alpha} = \mu$

$\tan\alpha = \mu$

c/ If $\mu = 0.3$ and $\theta = 30°$

$mg\cos\theta = R$

$3g \times \cos 30 = R$

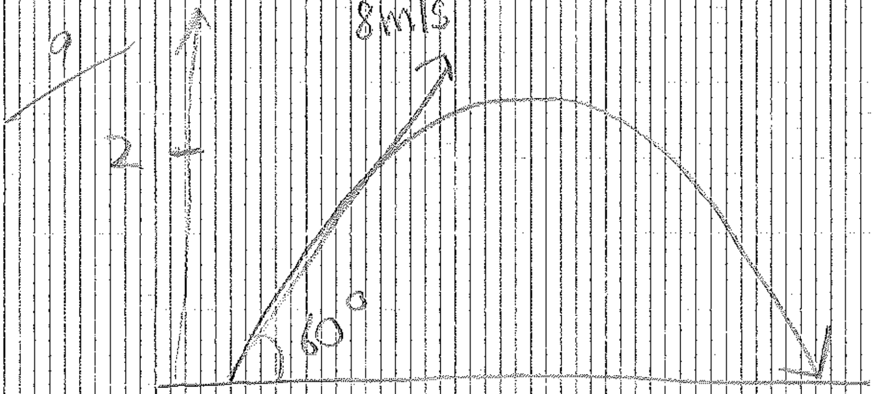
$R = 25.46$

$\mu R = 0.3 \times 25.46 = 7.64$

$mg\sin\alpha = mg\sin 30 = 14.7$

8/ no object remains in equilibrium as the normal reaction is $mg\cos\theta$
so if $\theta = 90$, $mg\cos\theta = 0$
no normal reaction

9/

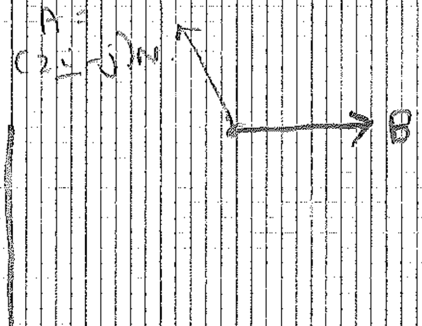


resolve ↑

$s = 2$
$u = 8\sin 60$
$v =$
$a = -9.8$
$t = ?$

$s = ut + \frac{1}{2}at^2$
$2 = 8\sin 60 t - 4.9t^2$
$4.9t^2 - 8\sin 60 t + 2 = 0$
$t = 0.4043$ and 1.0097s
$1.0097 - 0.4043$
$= 0.605$s

10/ $A = (2i - j)$N $B = i$ N



Resultant force
$= A + B =$
$2i - j + i = (3i - j)$N
$F = ma$
$\begin{pmatrix} 3 \\ -1 \end{pmatrix} = 0.5a$
$a = \begin{pmatrix} 6 \\ -2 \end{pmatrix}$

$\underline{a} = 6\underline{i} - 2\underline{j}$

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

$u = 0$ $\quad s = 0 + \frac{1}{2} \times (6\underline{i} - 2\underline{j})t^2$

$v =$ $\quad s = (3\underline{i} - \underline{j})t^2$

$a = 6\underline{i} - 2\underline{j}$ $\quad s = (3\underline{i} - \underline{j})t^2 + (3\underline{i} + 4\underline{j})$

$t = t$

x co-ordinate

$= 3\underline{i}t^2 + 3\underline{i} = 3t^2 + 3$

y co-ordinate

$-\underline{j}t^2 + 4\underline{j} = -t^2 + 4$

b) the particle never returns to its starting point since the x-co-ordinate will be always be greate than 3 since always $3t^2 > 0$

c) An object with 2 forces acting on it e.g. A wind and B a current

11) $\underline{r} = \begin{pmatrix} \cos 2t \\ \sin 2t \end{pmatrix}$ differentiate position for velocity

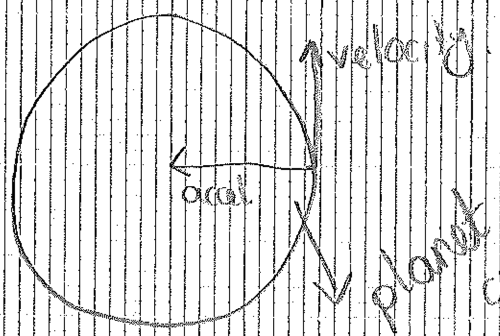
$\underline{v} = \begin{pmatrix} -2\sin 2t \\ 2\cos 2t \end{pmatrix}$ differentiate again for acceleration.

$\underline{a} = \begin{pmatrix} -4\cos 2t \\ -4\sin 2t \end{pmatrix}$

b) $r = \begin{pmatrix} \cos 2t \\ \sin 2t \end{pmatrix}$

$a = -4\begin{pmatrix} \cos 2t \\ \sin 2t \end{pmatrix} = -4\underline{r}$

c



planet will be
orbiting, there will
be a force pulling
it to the centre