

# Pearson Edexcel Level 3

## GCE Mathematics

### Advanced Level

### Paper 3: Statistics & Mechanics

Practice Paper G

Time: 2 hours

Paper Reference(s)

9MA0/03

**You must have:**

**Mathematical Formulae and Statistical Tables, calculator**

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

#### Instructions

- Use black ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – *there may be more space than you need*.
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Inexact answers should be given to three significant figures unless otherwise stated.

#### Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 11 questions in this paper. The total is 100.
- The for each question are shown in brackets – *use this as a guide as to how much time to spend on each question*.

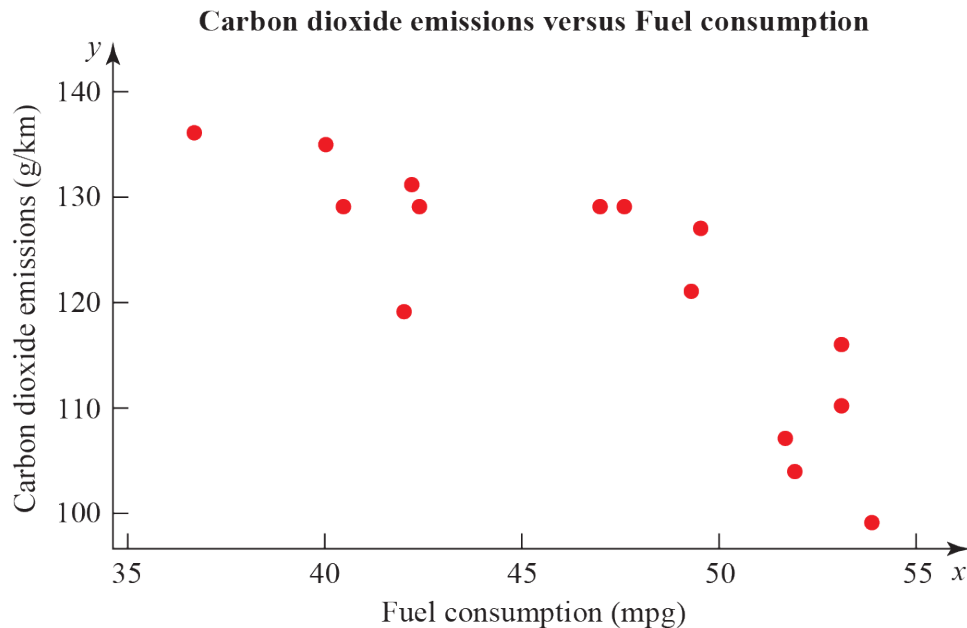
#### Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

**SECTION A: STATISTICS****Answer ALL questions.**

1. An engineer believes that there is a relationship between the CO<sub>2</sub> emissions and fuel consumption for cars.

A random sample of 40 different car models (old and new) was taken and the CO<sub>2</sub> emission figures,  $e$  grams per kilometre, and fuel consumption,  $f$  miles per gallon, were recorded, as shown in Figure 1. The engineer calculates the product moment correlation coefficient for the 40 cars and obtains  $r = -0.803$ .

**Figure 1**

- (a) State what is measured by the product moment correlation coefficient. **(1)**
- (b) State, with a reason, whether a linear regression model based on these data is reliable or not for a car when the fuel consumption is 60 mpg. **(1)**
- (c) For the linear regression model  $e = 198 - 1.71 \times f$  write down the explanatory variable. **(1)**
- (d) State the definition of a hypothesis test. **(1)**
- (e) Test at 1% significance level whether or not the product moment correlation coefficient for CO<sub>2</sub> emissions and fuel consumption is less than zero. State your hypotheses clearly. **(3)**

**(Total 7 marks)**

2. A mechanic carried out a survey on the defects of cars he was servicing. He found that the probability of a car needing a new tyre is 0.33 and that a car needing a new tyre has a probability of 0.7 of needing tracking. A car not needing a new tyre has a probability of 0.04 of needing tracking.

(a) Draw a tree diagram to represent this information.

**(3)**

(b) Find the probability that a randomly chosen car has exactly one of the two defects, needing a new tyre or needing tracking.

**(2)**

The mechanic also finds that cars need new brake pads with probability 0.35 and that this is independent of needing new tyres or tracking. A car is chosen at random.

(c) Find the probability that the car has at least one of these three defects.

**(2)**

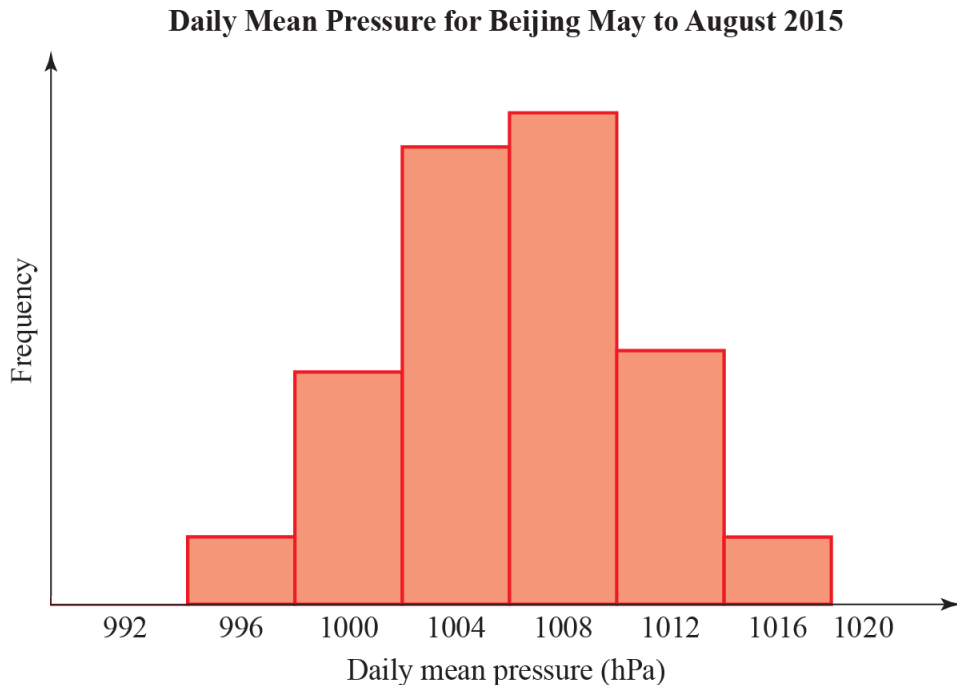
(d) What advice would you give to motorists?

**(1)**

**(Total 8 marks)**

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3. The summary statistics and histogram (Figure 2) are an extract from statistical software output for the distribution of the daily mean pressure for Beijing, May to August (inclusive) 2015.



**Figure 2**

Variable	<i>N</i>	Mean	Standard deviation	$Q_1$	$Q_2$	$Q_3$
Daily Mean Pressure	123	1006	4.4	1003	1006	1010

- (a) Explain why it is reasonable to model the daily mean pressure for Beijing, during May to August using a normal distribution.

(1)

The distribution for the daily mean pressure for Beijing, May to August 2015,  $X$ , can be modelled by a normal distribution.

Daily mean pressure (hPa)	Suggests
Above 1013	Good weather
Between 1013 and 1000	Fair weather
Less than 1000	Poor or bad weather
Less than 980	Hurricane

- (b) Based on the statistical output and the information in the table above, what is the chance of poor or bad weather in Beijing during May to August?

(2)

- (c) Although very unlikely, based on the model in part **a**, give a reason why we cannot say there is no chance of a hurricane in Beijing during May to August. **(1)**

The distribution for daily mean pressure for Jacksonville during May to August can also be considered normally distributed with mean 1017 hPa and standard deviation 3.26 hPa. A student claims that you can depend on better weather in Jacksonville than in Beijing during May to August.

- (d) State, giving reasons, whether the information in this question supports this claim. **(4)**

**(Total 8 marks)**

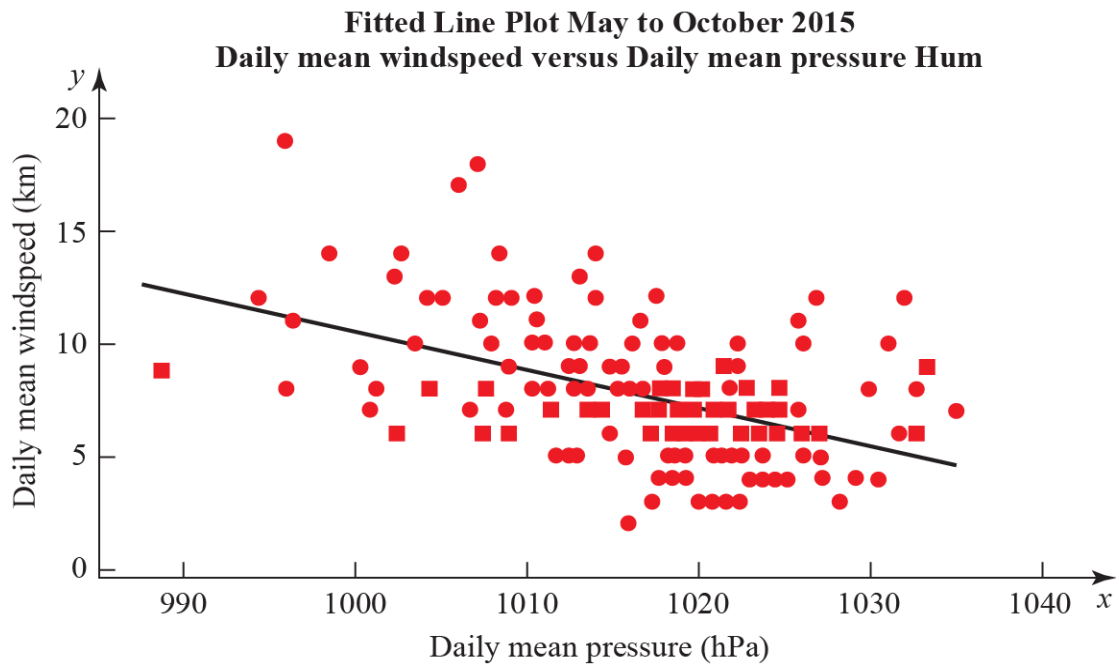
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4. To investigate if there is a correlation between daily mean pressure (hPa) and daily mean wind speed (kn) the location Hurn 2015 was randomly selected from:

Camborne 2015	Camborne 1987
Hurn 2015	Hurn 1987
Leuchars 2015	Leuchars 1987
Leeming 2015	Leeming 1987
Heathrow 2015	Heathrow 1987.

(Source: Pearson Edexcel GCE AS and A Level Mathematics data set.)

The statistical software output for these data is shown in Figure 3 below.



**Figure 3**

Correlation coefficient.

Daily mean winds and Daily mean pressure =  $-0.477$   $p$ -value  $< 0.001$ .

Regression summary output for daily mean wind speed versus daily mean pressure.

	Coefficients	Lower 95%	Upper 95%
<b>Intercept</b>	180.00	133.5424	226.4128
<b>Daily Mean Pressure (hPa) Gradient</b>	-0.1694	-0.21512	-0.12377

- (a) State what is measured by the product moment correlation coefficient.

**(1)**

- (b) Comment on the correlation between the two variables.

**(1)**

- (c) Give an interpretation of the correlation between the two variables. (1)
- (d) Test at 5% significance level whether or not the product moment correlation coefficient for the population is less than zero. State your hypotheses clearly. (3)
- (e) Write down the regression model for daily mean wind speed versus daily mean pressure. (2)
- (f) Interpret the gradient of the line of regression stated in part e. (1)
- (g) The regression model (equation of regression) was used to predict the daily mean wind speed of 11.15 knots for a daily mean pressure of 995 hPa. Comment on the accuracy of this prediction. (1)
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5.  $P(E) = 0.25$ ,  $P(F) = 0.4$  and  $P(E \cap F) = 0.12$
- (a) Find  $P(E' | F')$  (2)
- (b) Explain, showing your working, whether or not  $E$  and  $F$  are statistically independent. Give reasons for your answer. (2)
- The event  $G$  has  $P(G) = 0.15$ .
- The events  $E$  and  $G$  are mutually exclusive and the events  $F$  and  $G$  are independent.
- (c) Draw a Venn diagram to illustrate the events  $E$ ,  $F$  and  $G$ , giving the probabilities for each region. (5)
- (d) Find  $P([F \cup G]')$  (2)
- (Total 11 marks)**
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6. In a town, 54% of the residents are female and 46% are male. A random sample of 200 residents is chosen from the town. Using a suitable approximation, find the probability that more than half the sample are female. (Total 6 marks)
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## SECTION B: MECHANICS

Answer ALL questions.

7. Two identical 5 m light see-saws are joined at their ends. Robert, who weighs 80 kg, stands on top of the joint. The distance between Robert and each of the pivots is 2 m. Poppy and Quentin stand on the two remaining ends of the see-saws, as shown in Figure 4. Poppy weighs  $p$  kg and Quentin weighs  $q$  kg. The system is in equilibrium.

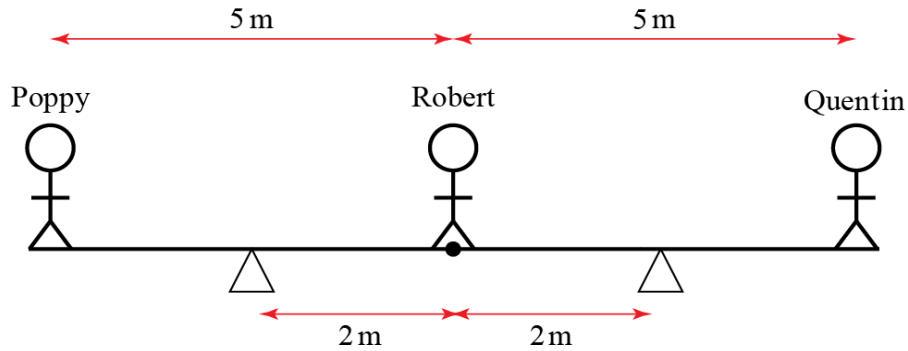


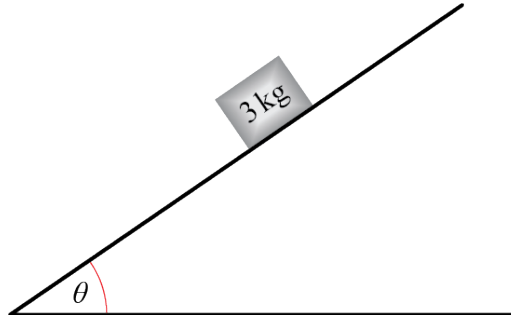
Figure 4

Show that, to the nearest whole number,  $p + q = 53$ .

(Total 8 marks)



8. Figure 5 shows an object of 3 kg sitting on a plane inclined at an angle  $\theta$  to the horizontal. The coefficient of friction between the object and the plane is  $\mu$ . The system is in limiting equilibrium.



**Figure 5**

- (a) Draw a diagram showing all the forces acting on the object. Describe the origin of each force using words. (3)
- (b) By resolving forces in two perpendicular directions, show that  $\mu = \tan \theta$ . (6)
- (c) Hence, determine whether or not the object slips if  $\mu = 0.3$  and  $\theta = 30^\circ$ . (4)
- (d) As  $\theta$  approaches  $90^\circ$ , state whether an object of any mass could remain in equilibrium. Explain your answer. (2)

**(Total 15 marks)**

9. A projectile is launched at  $8 \text{ m s}^{-1}$  from the origin at a  $60^\circ$  angle to the horizontal. Find the length of time for which the particle is at least 2 m above its launch point.

(In this question, take  $g = 9.8 \text{ m s}^{-2}$ .)

**(Total 8 marks)**

10. A 0.5 kg particle experiences two forces,  $\mathbf{A} = (2\mathbf{i} - \mathbf{j})$  N and  $\mathbf{B} = \mathbf{i}$  N. Initially, the particle is at rest and has position vector  $(3\mathbf{i} + 4\mathbf{j})$  m.

(a) Find the  $x$  and  $y$  coordinates of the particle  $t$  seconds later. (9)

(b) Explain why the particle never returns to its starting point. (2)

(c) Describe a physical situation which this mathematical model could represent and give physical meanings to  $\mathbf{A}$  and  $\mathbf{B}$ . (2)

(Total 13 marks)

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11. The position,  $\mathbf{r}$ , of a planet orbiting a star at time  $t$  is given by  $\mathbf{r} = \begin{pmatrix} \cos 2t \\ \sin 2t \end{pmatrix}$ .

(a) Find the velocity  $\mathbf{v}$  and acceleration  $\mathbf{a}$  of the planet in terms of  $t$ . (3)

(b) Show that  $\mathbf{a} = -4\mathbf{r}$ . (1)

(c) Sketch the trajectory of the particle and draw arrows showing its velocity and acceleration when  $t = 0$ . (2)

(Total 6 marks)

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TOTAL FOR PAPER IS 100