

General Certificate of Secondary Education
2013

Additional Mathematics

Paper 2
Mechanics and Statistics

[G0302]



FRIDAY 24 MAY, AFTERNOON

TIME

2 hours.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number on the Answer Booklet and the Supplementary Answer Booklet provided.

Answer **all twelve** questions.

At the conclusion of the examination attach the Supplementary Answer Booklet to your Answer Booklet using the treasury tag supplied.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

You may use your calculator.

A copy of the formulae list is provided.

Take $g = 10 \text{ m/s}^2$ when required.



- 1 Micah recorded the volumes of liquid produced in an experiment carried out by his class. The mean volume was calculated to be 77 ml and the standard deviation 8.1 ml.

To compare these volumes with results recorded under different conditions, each volume had to be multiplied by 0.69

- (i) Calculate the mean and standard deviation of the adjusted volumes. [2]

The **original** volumes were each rescaled by adding 0.2 and then multiplying by 0.98

- (ii) Calculate the mean and standard deviation of these rescaled volumes. [3]

- 2 (Throughout this question **i** and **j** denote unit vectors parallel to a set of standard x - y axes.)

A body of mass 8 kg, initially at the origin O, accelerates uniformly from a velocity of $(4\mathbf{i} - 2\mathbf{j})$ m/s to a velocity of $(3\mathbf{i} + 9\mathbf{j})$ m/s in 6 seconds.

- (i) Find its displacement from O after 6 seconds. [2]

A force **P** is then applied to the body causing it to come to rest in a further 12 seconds.

- (ii) Find the acceleration of the body. [1]

- (iii) Hence find the force **P** in component form. [1]

- (iv) Find the magnitude of **P**. [1]

3 The mass of fruit picked by each of 100 workers was recorded and is partially summarised in **Table 1** in your Supplementary Answer Booklet.

(i) Complete **Table 1** in your Supplementary Answer Booklet. [3]

(ii) Using **Fig. 1** in your Supplementary Answer Booklet draw a histogram to represent this information. **Label each axis clearly.** [3]

4 A body of mass 12 kg is resting on a smooth horizontal surface AB. It is acted upon by a horizontal force of 125 newtons and by another force Q newtons, where Q is inclined at an angle of 33° to the horizontal, as shown in **Fig. 2**.

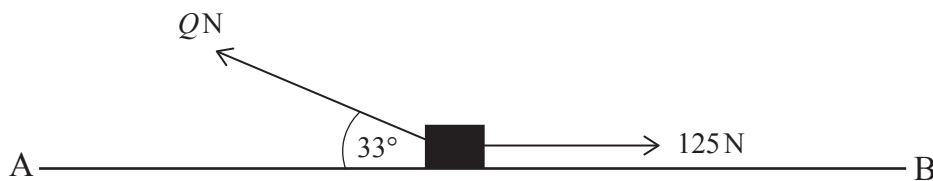


Fig. 2

The body remains in equilibrium.

Find

(i) the value of Q ; [2]

(ii) the normal reaction between the surface and the body. [3]

The force Q newtons is now replaced by a horizontal force P newtons, as shown in **Fig. 3**.



Fig. 3

The body begins to move in the direction of B with a uniform acceleration of 1.5 m/s^2 .

(iii) Find the value of P . [2]

5 (a) (i) Give an example of a discrete variable. [1]

(ii) Give an example of a continuous variable. [1]

(b) At a local community festival one of the attractions was a Wellie Wanging competition to see how far competitors could throw a Wellington boot. The results are summarised in Table 2.

Table 2

Distance d (m)	$0 < d \leq 5$	$5 < d \leq 15$	$15 < d \leq 25$	$25 < d \leq 35$	$d > 35$
Number of competitors	8	47	33	5	2

(i) What is the **upper** limit of the modal class? [1]

(ii) Calculate an estimate of the median distance thrown. [4]

6 A particle moves with constant acceleration from point A to point B to point C along a straight line.

The initial velocity of the particle is 4.5 m/s. It takes 6 seconds to move from A to B, where $AB = 70.2$ m.

(i) Find the acceleration of the particle. [2]

(ii) Find the velocity of the particle when it is at B. [2]

The particle has a velocity of 23.7 m/s when it reaches C.

(iii) Find the distance BC. [2]

(iv) Find the time taken for the particle to travel from B to C. [1]

- 7 Ellen recorded how many minutes she spent on revision each evening for the first three weeks in April. Her results are shown in **Table 3** below.

Table 3

	Sun	Mon	Tue	Wed	Thu
Week 1	104	82	110	124	150
Week 2	121	99	128	148	165
Week 3	135	129	141	164	185

These data have been plotted on the graph given in **Fig. 4** in your Supplementary Answer Booklet.

- (i) Calculate appropriate moving averages to smooth the data. [2]
- (ii) Plot these averages on **Fig. 4** and draw the trend line. [3]
- (iii) Showing clearly where any reading is taken, use your trend line to calculate an estimate of how long she will spend on revision on Sunday of the fourth week in April. [4]

- 8 A uniform rod AB, of mass 0.81 kg and length 4 m, rests horizontally in equilibrium on two supports. One support is at the end A and the other support is at C, where $AC = 3.6$ m, as shown in Fig. 5.

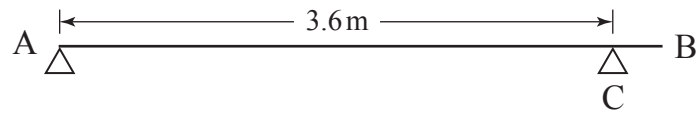


Fig. 5

- (i) Copy the diagram and mark clearly **all** the forces acting on the rod, showing clearly the points at which they act on the rod. [2]

- (ii) Calculate the reactions at the supports. [3]

A mass of 0.75 kg is placed at a point X on the rod such that the reaction at A is now twice the reaction at C.

- (iii) Find the reaction at C. [2]

- (iv) Hence find the distance AX. [2]

- 9** Hannah travels to school either by train or by bus. On any given day the probability that she will travel to school by train is 0.8

If she travels to school by train the probability that she will be late is 0.05

If she travels to school by bus the probability that she will be late is 0.13

Using a tree diagram or otherwise,

- (i)** calculate the probability that Hannah will be late for school on Monday; [3]
- (ii)** calculate the probability that she will be late for school on Monday and Tuesday. [2]
- (iii)** There are 13 full weeks in the next school term. Calculate how many days Hannah would be expected to be late next term. [2]
- (iv)** Given that Hannah was late for school last Wednesday, what is the probability that she travelled to school by train that day? [3]

- 10 A box of mass 5.2 kg is pulled **up** a rough plane which is inclined at 35° to the horizontal by a string acting parallel to the plane, as shown in **Fig. 6**.

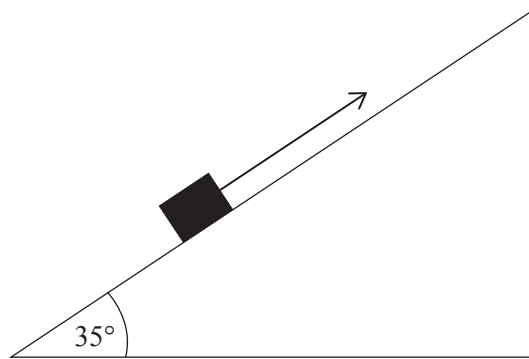


Fig. 6

The string exerts a force of 40 N on the box, which moves at a **constant** speed of 2.5 m/s.

- (i) Copy **Fig. 6** and mark clearly on your diagram **all** the forces acting on the box. [2]
- (ii) Find the coefficient of friction between the box and the plane, correct to 3 decimal places. [4]

The string is removed and the box continues for a further x metres up the plane before coming to rest.

- (iii) Find the acceleration of the box after the string is removed. [3]
- (iv) Find the value of x . [2]

- 11 A van of mass M kg tows a trailer of mass 480 kg by means of a light horizontal tow bar along a straight horizontal road.

The tractive force produced by the engine in the van is 3450 N, as shown in Fig. 7.

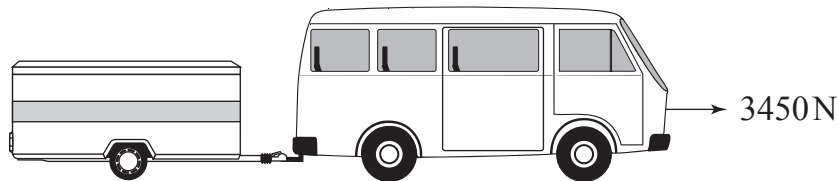


Fig. 7

The van and trailer accelerate uniformly from rest to a speed of 10 m/s while travelling a distance of 125 m.

- (i) Find the acceleration of the van and trailer. [1]

The resistance to motion of the van is 1180 N.

The tension in the tow bar is 1806 N.

- (ii) Find the value of M . [3]

- (iii) Find the resistance to motion of the trailer. [2]

The tractive force is increased so that the van and trailer travel the next 125 m in 10 seconds with uniform acceleration.

- (iv) Calculate the acceleration of the van and trailer while travelling the second 125 m. [1]

Assuming the resistances to motion remain the same, calculate

- (v) the new tension in the tow bar; [2]

- (vi) the amount by which the tractive force was increased. [2]

- 12 As part of the driving test candidates are required to pass a Hazard Perception Test and a Theory Test. **Table 4** shows the scores achieved by eight candidates in these tests.

Table 4

Hazard Perception Test	59	75	40	63	67	35	44	51
Theory Test	45	46	37	47	49	44	43	47

(i) Find the rank orders for the scores in each of these tests. [2]

(ii) Calculate Spearman's coefficient of rank correlation. [4]

(iii) What significance, if any, do you attach to the value you obtained in (ii)? [1]

The data from **Table 4** are plotted on the graph given in **Fig. 8** in your Supplementary Answer Booklet.

(iv) Calculate the mean score in each test. [1]

(v) Draw your line of best fit on the graph in your Supplementary Answer Booklet. [2]

(vi) Determine the equation of the line of best fit which you have drawn. [3]

THIS IS THE END OF THE QUESTION PAPER

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SUPPLEMENTARY ANSWER BOOKLET

3 (i) Complete **Table 1**.

Table 1

Mass (kg)	Number of workers	Frequency density
3–10	16	2
11–20		2.9
21–25		
26–40		1.8

(ii) Using **Fig. 1** draw a histogram to represent the information from **Table 1**.
Label each axis clearly.



Fig. 1

7 (ii) Plot the moving averages in **Fig. 4** and draw the trend line.

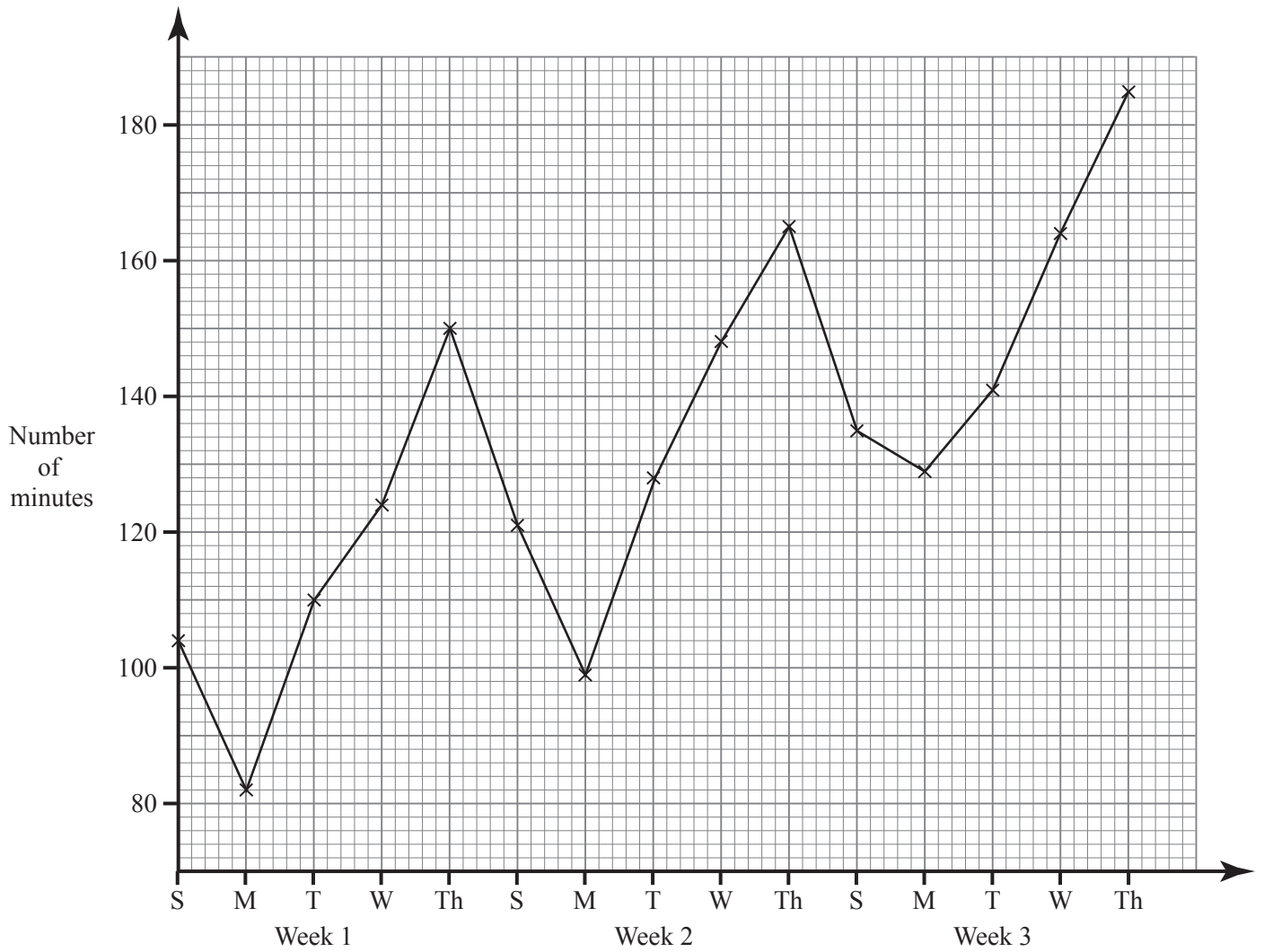


Fig. 4

12 (v) Draw your line of best fit through the data points shown in Fig. 8.

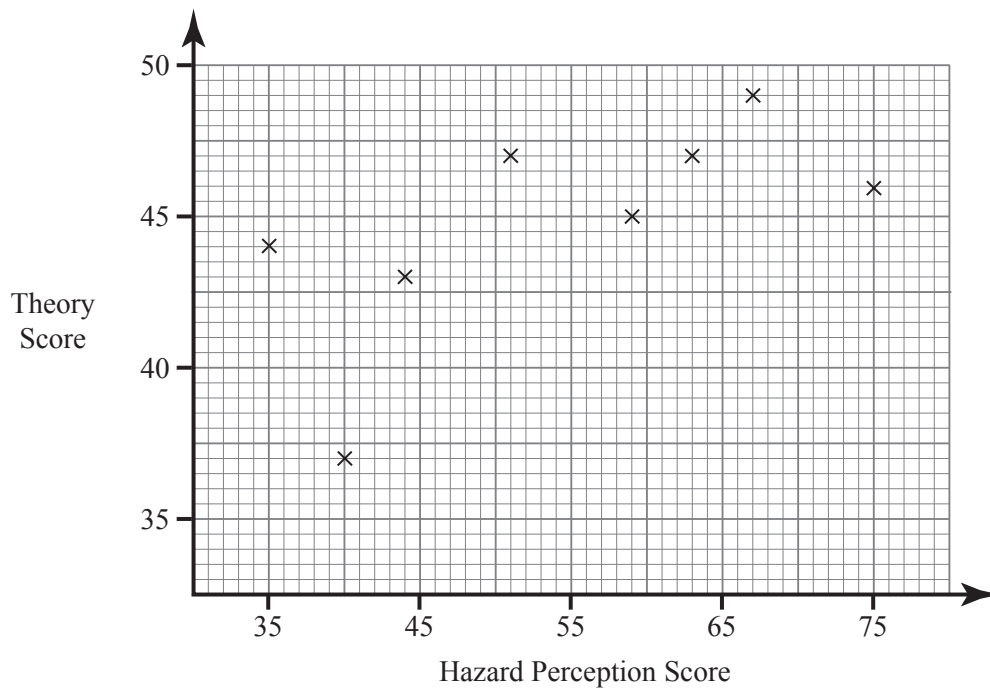


Fig. 8



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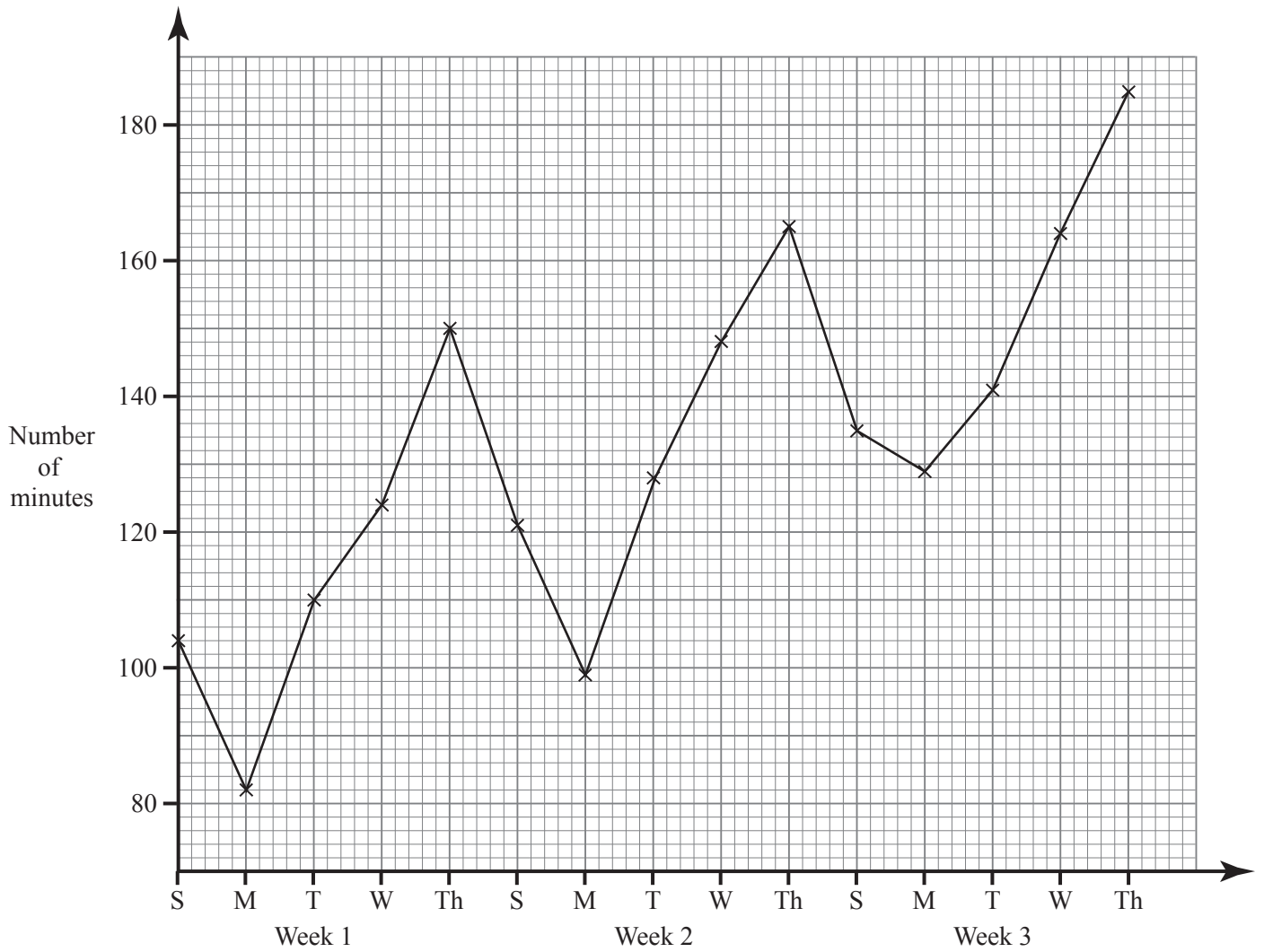


Fig. 4

12 (v) Draw your line of best fit through the data points shown in Fig. 8.

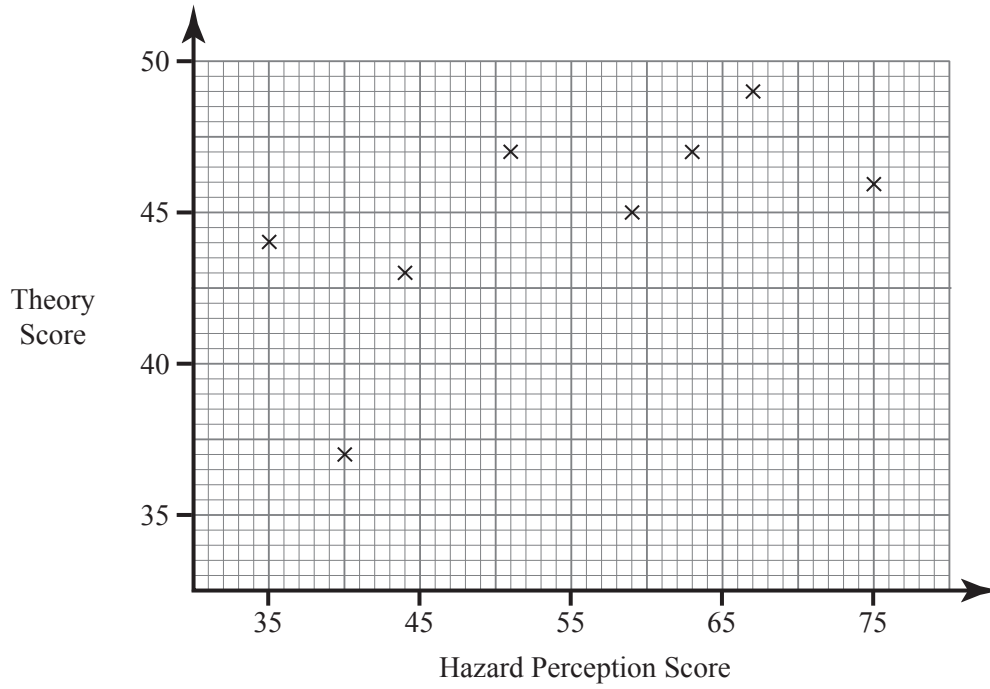


Fig. 8