

General Certificate of Secondary Education
2011

Additional Mathematics

Paper 2
Mechanics and Statistics

[G0302]



THURSDAY 19 MAY, MORNING

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 approximate 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.



Answer **all twelve** questions.

1 A particle rests in equilibrium at a point O on a smooth horizontal plane.

The particle is acted upon by three horizontal forces of magnitude 6 N, 10 N and P N. The direction of each of these forces relative to the horizontal axes Ox and Oy is shown in **Fig. 1**.

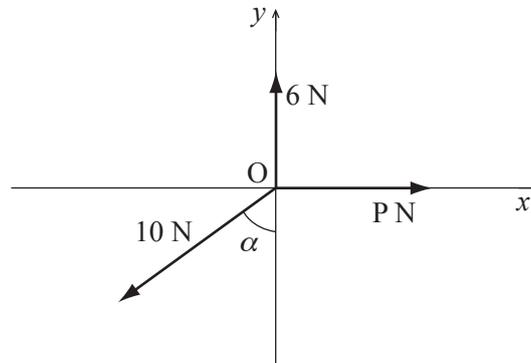


Fig. 1

(i) Show that the angle $\alpha = 53.1^\circ$ correct to 1 decimal place. [2]

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

2 (i) By giving an example, explain what is meant by the statistical terms **population** and **sample**. [2]

Describe a situation where it is

(ii) more appropriate to use a sample, [1]

(iii) necessary to use a sample. [1]

3 A seesaw is made of a uniform plank of wood AB of mass 15 kg and length 6 m.

Jane, whose mass is 26 kg, sits at the end A of the seesaw and her brother Jack, whose mass is 34 kg, sits at the other end B.

The seesaw is supported in a horizontal position by a smooth pivot at a point P as shown in **Fig. 2**.

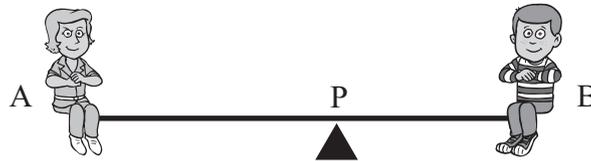


Fig. 2

The seesaw rests in equilibrium in a horizontal position.

(i) Copy **Fig. 2** and mark clearly on your diagram the forces acting on the seesaw. [2]

Calculate

(ii) the reaction at the pivot, [1]

(iii) the distance of the pivot from the end A. [3]

4 The histogram in **Fig. 3** in your Supplementary Answer Booklet shows the distribution of the number of months, to the nearest month, it had taken employees in a taxi firm to pass their driving tests.

(i) Use the information from the histogram to complete **Table 1** in your Supplementary Answer Booklet. [3]

Two new employees join the firm. Both of them took between 13 and 16 months, to the nearest month, to pass their driving tests.

(ii) Use this information to complete the histogram in **Fig. 3** in your Supplementary Answer Booklet. [3]

5 A particle is initially at rest at the origin. It is acted upon by a force \mathbf{F} and it moves with constant acceleration in a straight line in a horizontal plane. After 4 seconds the position vector of the particle is $(-16\mathbf{i} + 24\mathbf{j})$ metres.

(i) Show that the acceleration of the particle is $(-2\mathbf{i} + 3\mathbf{j})\text{m/s}^2$. [2]

(ii) Find in vector form the velocity of the particle after 4 seconds. [2]

The particle is of mass 3 kg. The force \mathbf{F} is the resultant of two forces \mathbf{P} and \mathbf{Q} where $\mathbf{P} = (10\mathbf{i} - 5\mathbf{j})$ N.

(iii) Find the force \mathbf{Q} in vector form. [3]

6 (a) Students were asked how long it had taken them to travel to school. The times were recorded to the nearest minute and are summarised in **Table 2**.

Table 2

Time taken t (min)	$0 < t \leq 10$	$10 < t \leq 20$	$20 < t \leq 30$	$30 < t \leq 40$	$40 < t \leq 60$
Number of students	23	86	122	107	51

Calculate an estimate of the median time. [4]

(b) Luca recorded the number of people in each car passing through the school gates. **Table 3** below summarises his findings.

Table 3

Number of people	1	2	3	4	5	6	7
Number of cars	18	46	71	85	x	10	2

If the mean number of people per car is 3.5 find x . [4]

- 7 A package of mass 4 kg is held at rest on the surface of a rough plane which is inclined at 22° to the horizontal as shown in **Fig. 4**.

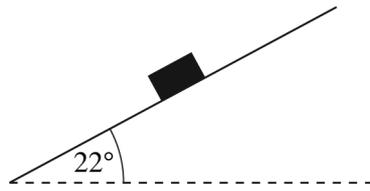


Fig. 4

The package is released from rest and begins to slide down the plane.

The coefficient of friction between the package and the plane is 0.3

- (i) Copy **Fig. 4** and mark clearly on your diagram all the forces acting on the package as it slides down the plane. [1]

Giving your answers correct to 2 decimal places,

- (ii) calculate the normal reaction of the plane on the package, [1]

- (iii) show that the magnitude of the force due to friction acting on the package is 11.13 N, [2]

- (iv) find the acceleration of the package as it slides down the plane, [3]

- (v) find the speed of the package when it has travelled 1.4 m down the plane. [2]

8 **Table 4** shows the probabilities of scores, apart from 6, from a single throw of a **biased die**.

Table 4

Score	1	2	3	4	5	6
Probability	0.14	0.17	0.16	0.15	0.17	

This die is rolled once.

(i) What is the probability of getting a 6? [1]

(ii) What is the probability of getting a square number? [2]

This **biased die** is rolled twice and the scores added.

(iii) What is the probability of the total being a square number? [3]

(iv) Given that the total is a square number what is the probability that it is an even number? [3]

- 9 An express train normally travels at a uniform speed of 45 m/s. However, maintenance work is in operation on part of a straight stretch of track ABCD as shown in Fig. 5.

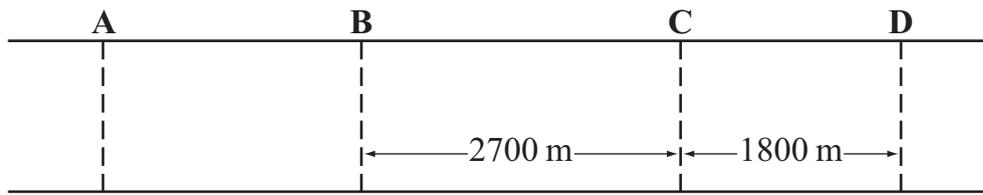


Fig. 5

The repairs are in operation for 2700 m between B and C and the speed of the train has to be reduced to 15 m/s on this stretch. To ensure that the speed is 15 m/s when the train arrives at B the brakes are applied when the train is at A.

The uniform retardation produced by the brakes is 0.4 m/s^2 .

Calculate

(i) the time during which the brakes are applied, [2]

(ii) the distance AB. [2]

The train maintains this uniform speed of 15 m/s between B and C. When it passes C the train accelerates uniformly until it reaches its normal speed of 45 m/s at D. The distance from C to D is 1800 m.

(iii) Calculate the time during which the train accelerates. [3]

If the maintenance work had not been in operation the train would have travelled from A to D at the uniform speed of 45 m/s.

(iv) Calculate the total time lost because of the speed restriction. [4]

- 10** Beth recorded how much money had been spent on stationery over the past 3 years in the office where she worked. The amount of money spent each quarter was rounded to the nearest pound and the results are summarised in **Table 5**.

Table 5

Quarter	1	2	3	4
2008	229	229	218	236
2009	252	256	244	262
2010	280	282	272	289

These data have been plotted on the graph given in **Fig. 6** in your Supplementary Answer Booklet.

- (i)** Calculate appropriate moving averages to smooth the data. [2]
- (ii)** Plot these averages on the graph and draw the trend line. [3]
- (iii)** Showing clearly where any reading is taken, use your trend line to calculate an estimate of how much will be spent on stationery during the first quarter of 2011. [4]
- (iv)** Beth decided to do a more detailed analysis of the **monthly** stationery costs, rather than quarterly costs, by calculating 12 point moving averages over the same 3 year period. How many moving average points will this give her? [2]

11 Mal recorded the number of press-ups and the number of sit-ups each team member could do in one minute. **Table 6** shows the results of the first 10 players.

Table 6

Number of press-ups	48	50	42	45	38	46	31	41	40	43
Number of sit-ups	38	39	36	38	31	40	29	38	37	35

- (i) Find the rank orders for the numbers of press-ups and the numbers of sit-ups. [2]
- (ii) Calculate Spearman's coefficient of rank correlation. [3]
- (iii) What significance, if any, do you attach to the value you obtained in (ii)? [1]

The data from **Table 6** are plotted on the graph given in **Fig. 7** in your Supplementary Answer Booklet.

- (iv) Calculate the mean number of press-ups and the mean number of sit-ups. [1]
- (v) Draw your line of best fit on the graph in the Supplementary Answer Booklet. [2]
- (vi) Determine the equation of the line of best fit which you have drawn. [3]

- 12 A car of mass 1050 kg pulls a trailer of mass 750 kg along a straight horizontal road by means of a light inextensible horizontal towbar as shown in Fig. 8.



Fig. 8

The car and trailer accelerate uniformly from rest with an acceleration of 1.2 m/s^2 .

The car's engine exerts a tractive force of 3450 N and the resistance to the motion of the car is 0.8 N/kg .

(i) Calculate the resistance to the motion of the car. [1]

(ii) Show that the total resistance to the motion of the car and trailer is 1290 N. [3]

Calculate

(iii) the resistance to the motion of the trailer, [2]

(iv) the tension in the towbar. [2]

At the instant when the speed of the car and trailer is 12 m/s the coupling in the towbar snaps.

Assume that the resistance to the motion of the trailer remains the same.

Find

(v) the time taken by the trailer in coming to rest after the towbar snaps, [3]

(vi) the distance the trailer travels in this time. [2]

THIS IS THE END OF THE QUESTION PAPER

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Rewarding Learning

Centre Number

71

Candidate Number

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G0302SAB

**SUPPLEMENTARY
ANSWER BOOKLET**

4 Use the information from the histogram in **Fig. 3** to complete **Table 1**.

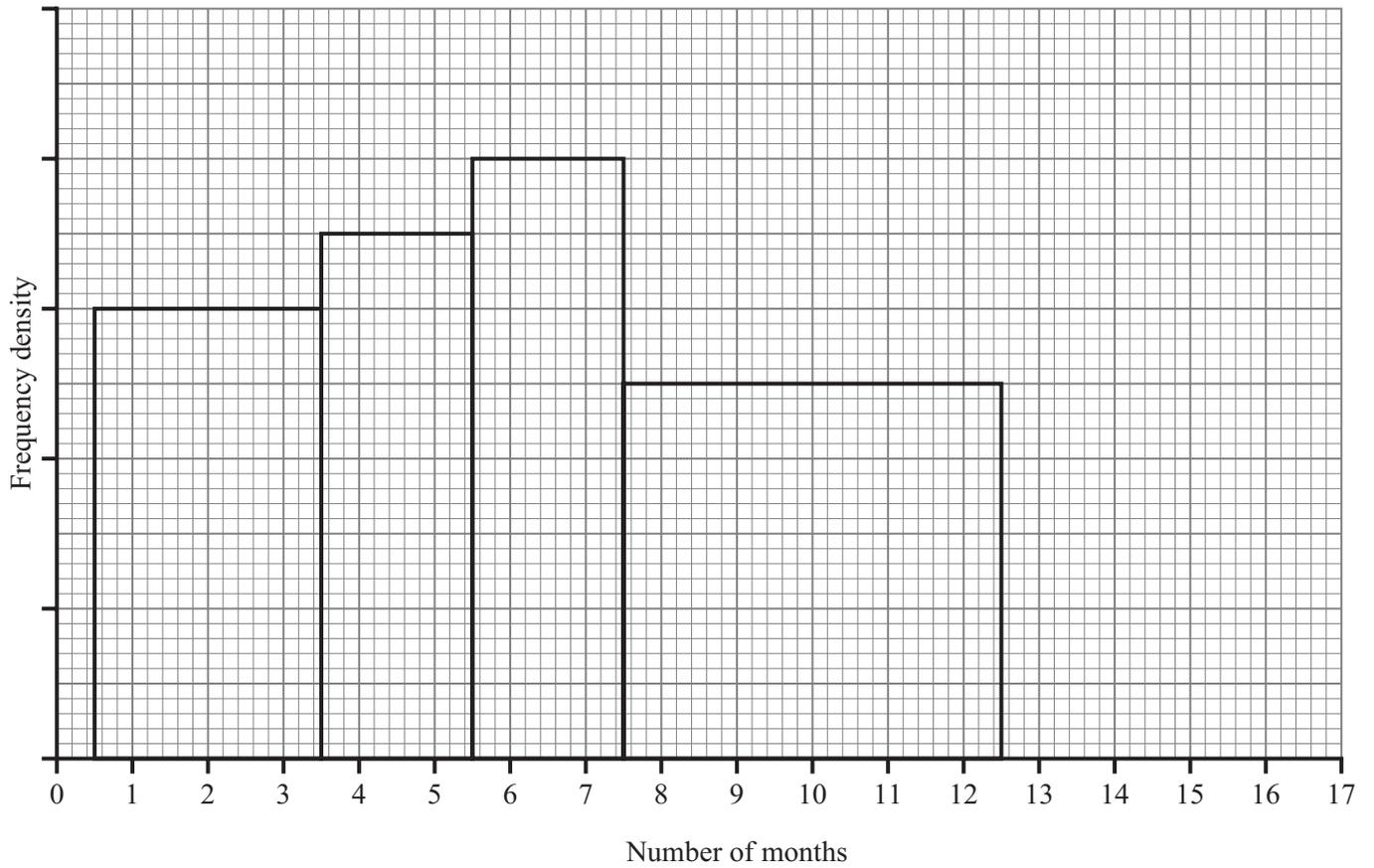


Fig. 3

Table 1

Number of Months	1–3	4–5	6–7	8–12
Frequency	18			

10 Plot the moving averages in Fig. 6 and draw the trend line.

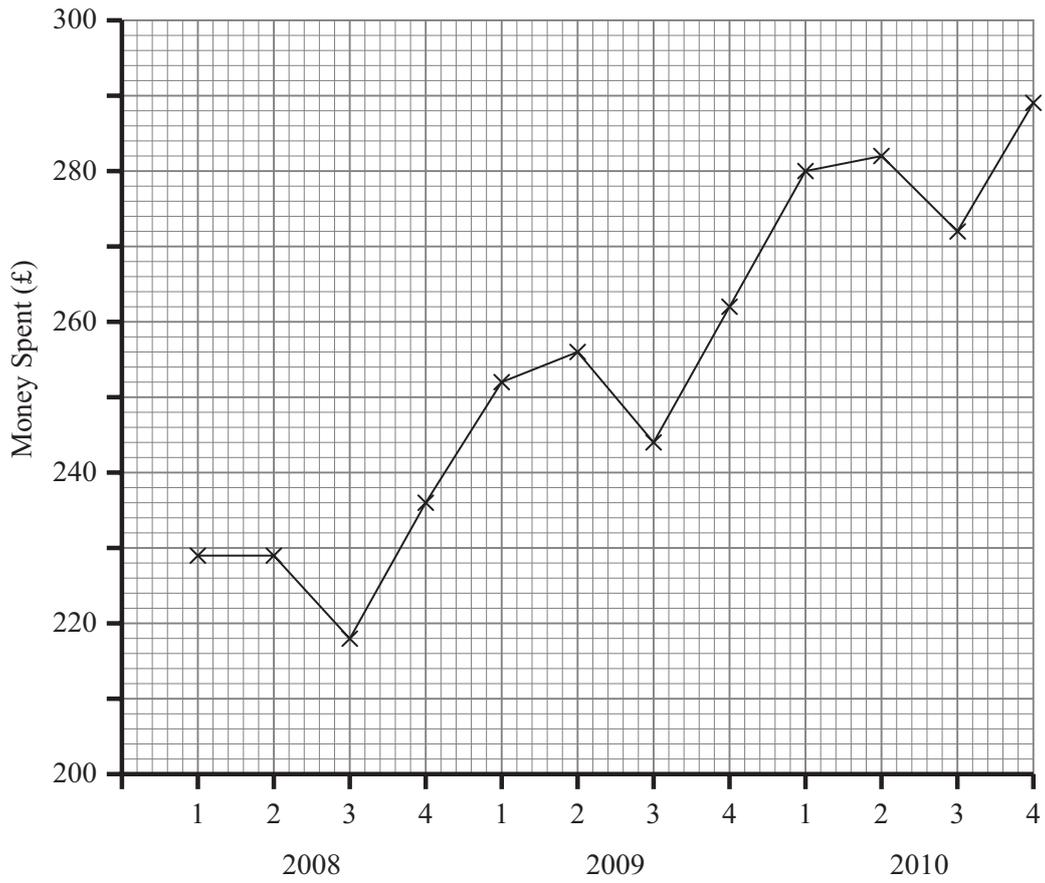


Fig. 6

11 Draw the line of best fit through the data points shown in **Fig. 7**.

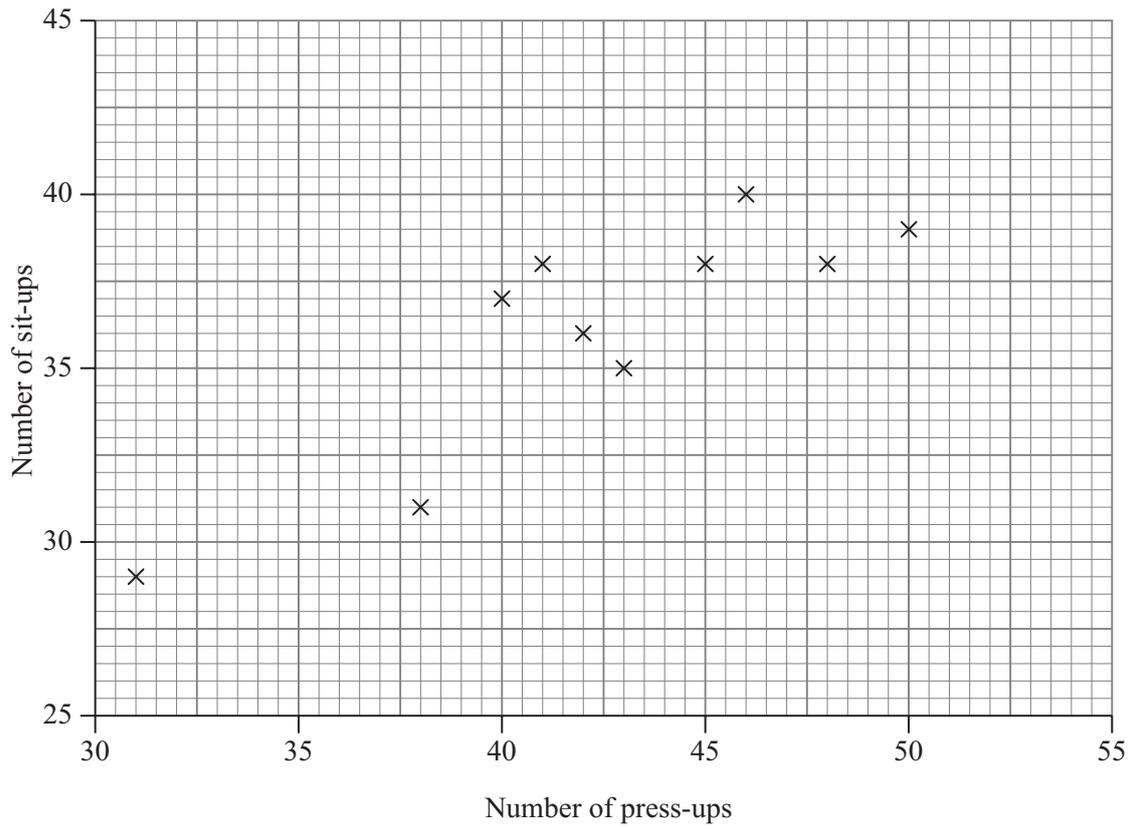


Fig. 7