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**General Certificate of Secondary Education
2010**

Additional Mathematics

Paper 2
Mechanics and Statistics

[G0302]

WEDNESDAY 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 m/s^2 when required.

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

A package of mass 4 kg rests in equilibrium on a smooth horizontal plane under the action of three horizontal forces

$$(2\mathbf{i} - 3\mathbf{j}) \text{ N} \qquad (7\mathbf{i} - 5\mathbf{j}) \text{ N} \qquad \text{and} \qquad (a\mathbf{i} + b\mathbf{j}) \text{ N}$$

where *a* and *b* are constants.

(i) Find the values of *a* and *b*. [3]

The three forces are now removed and replaced by a single force (8**i** – 6**j**) N and the package begins to move along the plane.

(ii) Calculate the acceleration of the package in vector form. [1]

2 Ursula recorded the fuel consumption of each of 38 cars taking part in a fixed length test drive. Each recording was rounded to the nearest litre. The results are summarised in **Table 1**.

Table 1

Fuel consumption (litres)	8–9	10–11	12–14	15–17	18–19
Number of cars	6	8	12	9	3

Using **Fig. 1** in your Supplementary Answer Booklet, draw a histogram to represent this information. **Label each axis clearly.** [5]

3 During a school visit to a large fun park, students recorded the waiting times, t mins, for a ride on the Big Wheel.

A summary of the results is given in **Table 2**.

Table 2

Times (t mins)	$0 \le t < 2$	$2 \le t < 4$	$4 \le t < 6$	$6 \le t < 8$	$8 \le t < 12$	$12 \le t < 15$
Number of students	35	36	33	19	6	2

Calculate an estimate of the median waiting time. [5]

4 A block of wood of mass M kg is suspended from the ceiling of a workshop by two light inextensible strings as shown in **Fig. 2**.
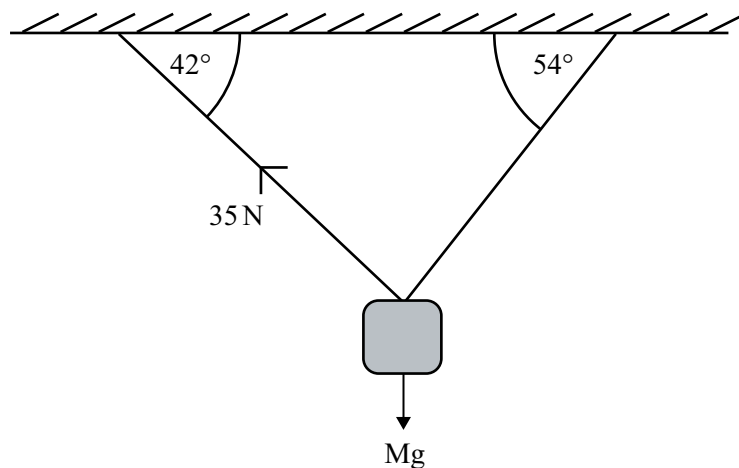

Fig. 2

The block hangs in equilibrium.

One string is inclined at 42° to the horizontal and the tension in this string is 35 N. The second string is inclined at 54° to the horizontal.

Calculate, giving your answers correct to 2 decimal places,

(i) the tension in the second string, [3]

(ii) the mass of the block of wood. [3]

5 **(a)** In a study of a town's leisure facilities for children and young people, the data collected gave a mean of 22.8 and a standard deviation of 4.3

  (i) What is the variance of these data? [1]

  To compare the results of a study with similar data collected in a second town each data item was adjusted by adding 10 and then multiplying by 2.

  (ii) Find the mean and standard deviation of the adjusted data. [3]

(b) Ellen achieved the following percentages in her class tests this term:

$$62, \quad 72, \quad 41, \quad 89, \quad 86, \quad 72, \quad 42, \quad 50$$

Which average (mean, mode or median) should she use to best impress her parents?

Give a reason for your answer and show any calculations used. [3]

6 A boy stands at the edge of a balcony 8 metres above horizontal ground. He throws a ball vertically upwards with a speed of 6 m/s.

  (i) Show that the greatest height above the **ground** reached by the ball is 9.8 m. [2]

  Assume that the ball does not hit the balcony as it descends.

  Find

  (ii) the speed of the ball, in m/s, as it strikes the ground, [2]

  (iii) the time which elapses from the instant the ball is thrown until it strikes the ground. [3]

7 The outside doors in a school security system are protected by a keypad device which is based on a 3 digit number. To open the doors the correct 3 digit number must be entered on the keypad. This number will be in the range 000 to 999

  (i) What is the probability of guessing the correct number at the first attempt? [2]

  The number is changed each week. I cannot remember this week's number but I do know that the three digits are all different.

  (ii) What is the probability that I can guess this week's number correctly at the first attempt? [2]

  (iii) **Hence**, what is the probability that I fail to get it correct at my first attempt? [1]

  (iv) What is the probability that I fail to get it correct at my first attempt but get it correct at my second attempt? [4]

5494

8 A uniform plank AB of length 5 metres lies on the horizontal flat roof of a sports hall with 1.6 m projecting over the edge of the roof as shown in **Fig. 3**.
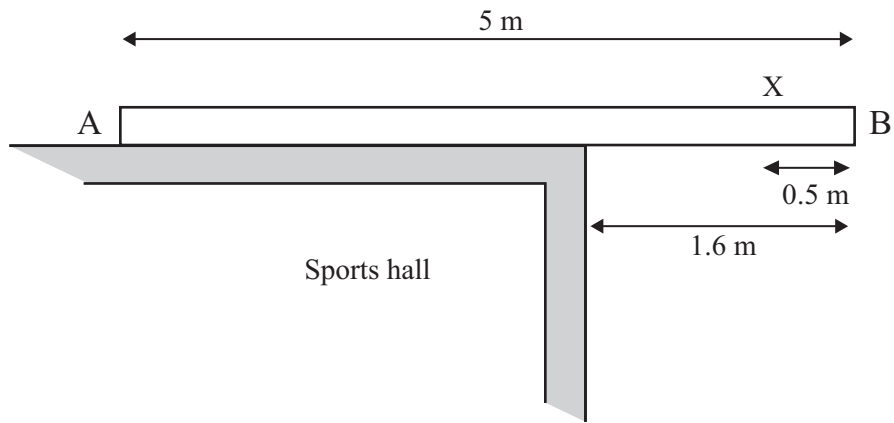

Fig. 3

A girl of mass 54 kg walks along the plank from the end A.

When she reaches the point X on the plank, 0.5 m from B, the plank is on the point of tilting about the edge of the roof.

(i) State the reaction at A when the plank is on the point of tilting. [1]

(ii) Find the mass of the plank. [3]

A box of mass M kg is placed at the end A of the plank. The girl can now continue to walk along the plank towards B. When she reaches B the plank is again on the point of tilting.

(iii) Find the value of M. Give your answer correct to 1 decimal place. [5]

[Turn over

9 Owen organises cycle tours at an outward pursuit centre on four days of each week. The numbers of people taking part in these tours in July 2009 are summarised in **Table 3**.

Table 3

	Thursday	Friday	Saturday	Sunday
Week 1	240	237	270	297
Week 2	212	208	221	263
Week 3	172	168	202	241
Week 4	157	148	179	

These data have been plotted in **Fig. 4** in your Supplementary Answer Booklet.

(i) Calculate appropriate moving averages to smooth the data. [3]

(ii) Plot these averages in **Fig. 4** and draw the trend line. [3]

(iii) Showing clearly where any reading is taken, use the trend line to calculate an estimate of the number of people taking a cycle tour on Sunday in week 4. [4]

(iv) With which characteristic movement of a time series do you associate these data? [1]

5494

10 A box of mass 6 kg rests on the surface of a rough plane inclined at 25° to the horizontal as shown in **Fig. 5**.
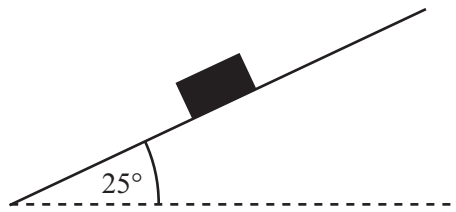

Fig. 5

The box is just on the point of sliding down the plane.

(i) Copy **Fig. 5** and mark clearly on your diagram **all** the forces acting on the box. [2]

(ii) Calculate the normal reaction of the plane on the box. [1]

(iii) Show that the coefficient of friction between the box and the plane is 0.47, correct to 2 decimal places. [2]

The box is now pulled up the plane by a light inextensible string which is held parallel to the line of greatest slope of the plane. It exerts a force of P newtons on the box, as shown in **Fig. 6**. The box moves up the plane with constant velocity.
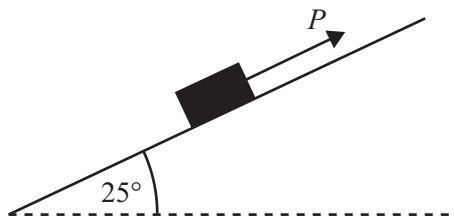

Fig. 6

(iv) Copy **Fig. 6** and mark clearly on your diagram all of the forces now acting on the box. [1]

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

The force P is increased in magnitude and the box now moves up the plane with an acceleration of $3.5\,\text{m/s}^2$.

(vi) Find the new value of P. [3]

[Turn over

11 **Table 4** shows the scores eight golfers recorded over a 2-day competition.

Table 4

Round 1	88	80	87	88	85	84	79	86
Round 2	86	83	85	87	86	82	81	84

    (i) Find the rank orders for the scores for each round. [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 in **Fig. 7** in your Supplementary Answer Booklet.

    (iv) Draw the line of best fit. [3]

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

12 A cyclist is travelling along a straight horizontal road with a constant speed of 12 m/s. Just as he passes a filling station S a van begins to move off from the station in the same direction as the cyclist and along the same road.

The van moves from rest with a constant acceleration of 3 m/s² until it reaches its maximum speed of 18 m/s. It then continues to travel at this speed.

(i) Find the time taken by the van to reach its maximum speed. [2]

(ii) Find the distance it travels in this time. [2]

(iii) Show that the van does not overtake the cyclist before it reaches its maximum speed. [2]

The van overtakes the cyclist as they both pass a telephone box T.

(iv) Using **Fig. 8** in your Supplementary Answer Booklet, sketch on the same axes the speed–time graphs for the van and the cyclist as they travel from S to T. [2]

Let t seconds be the time taken to travel from S to T.

(v) Write down in terms of t an expression for the distance from S to T travelled by

    (a) the van,

    (b) the cyclist. [3]

(vi) Hence or otherwise find the distance ST. [2]

THIS IS THE END OF THE QUESTION PAPER

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SUPPLEMENTARY
ANSWER BOOKLET

2 Using the information from **Table 1**, draw a histogram in **Fig. 1**. Label each axis clearly.

Fig. 1
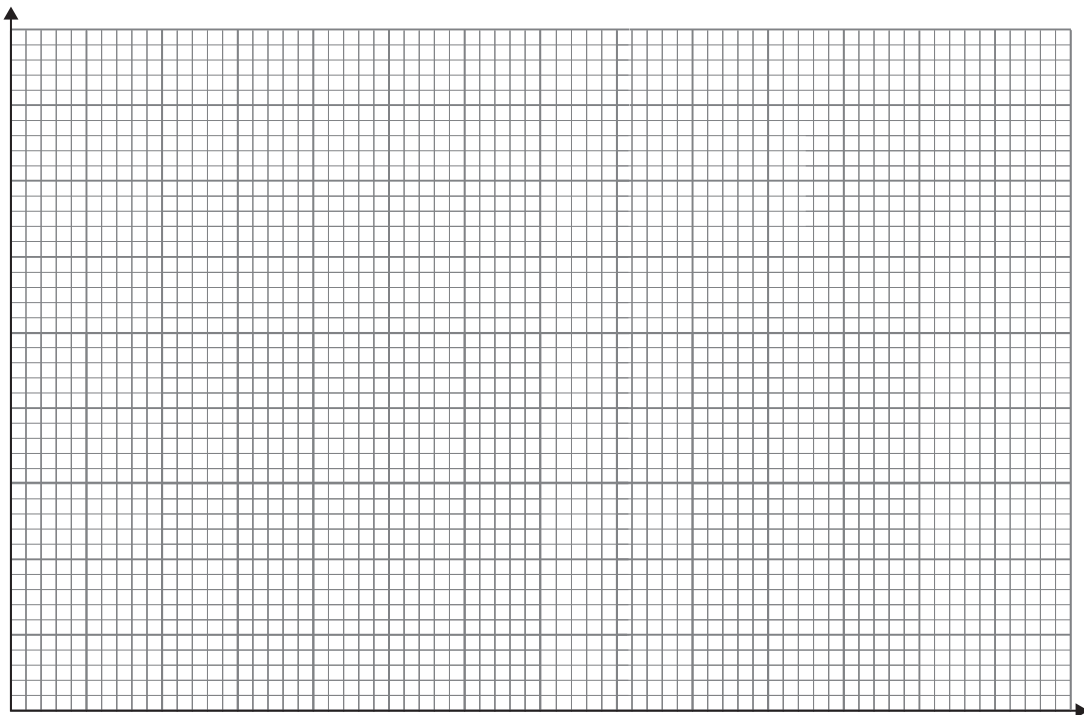
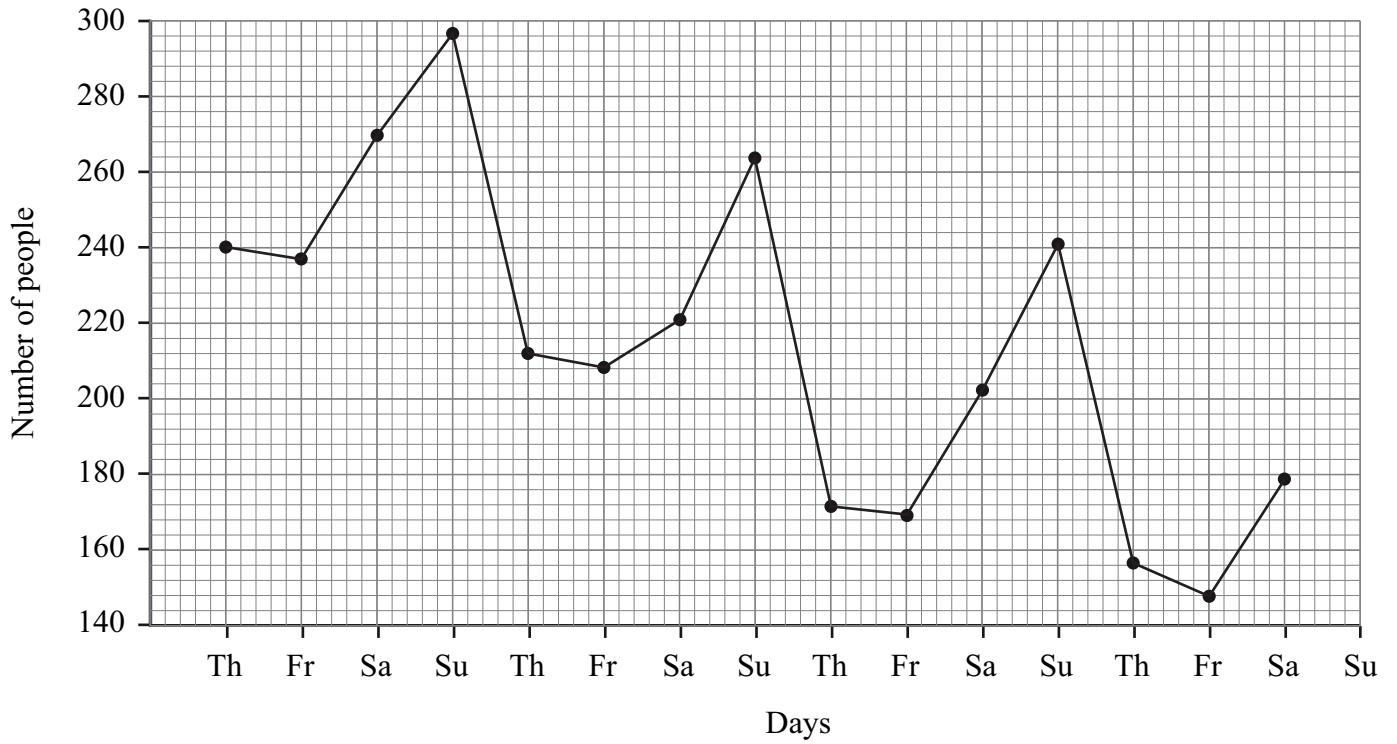**9** Plot the moving averages in **Fig. 4** and draw the trend line.

Fig. 4

[Turn over

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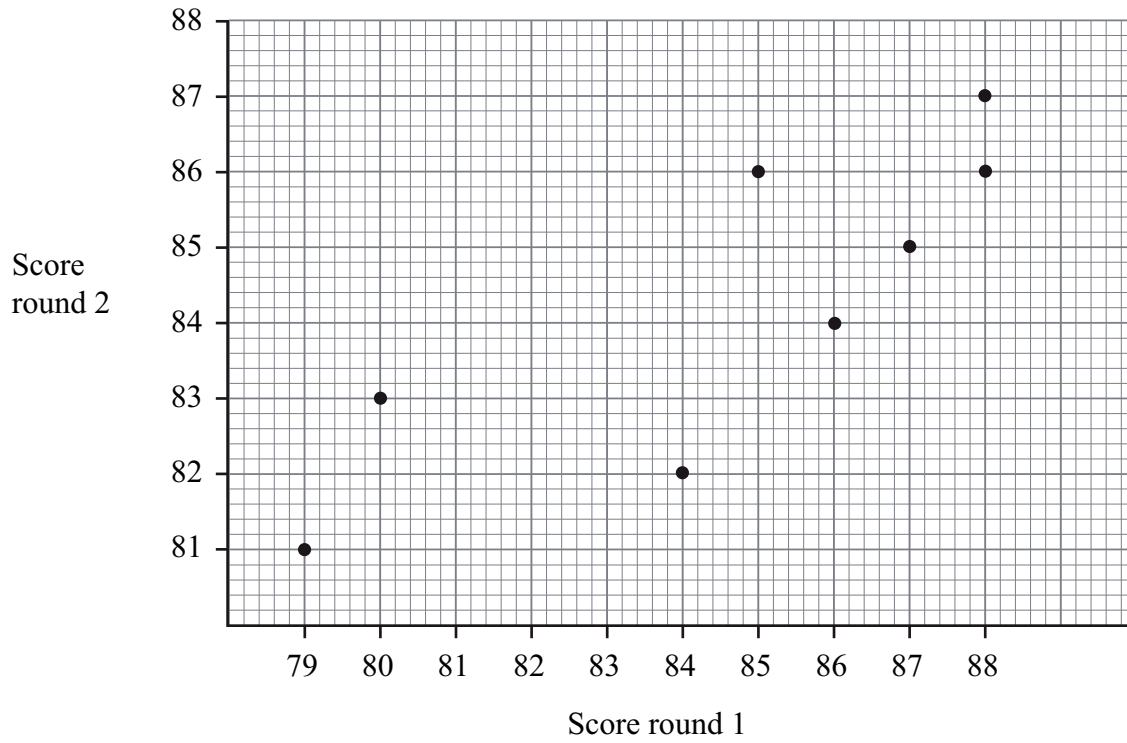

Fig. 7

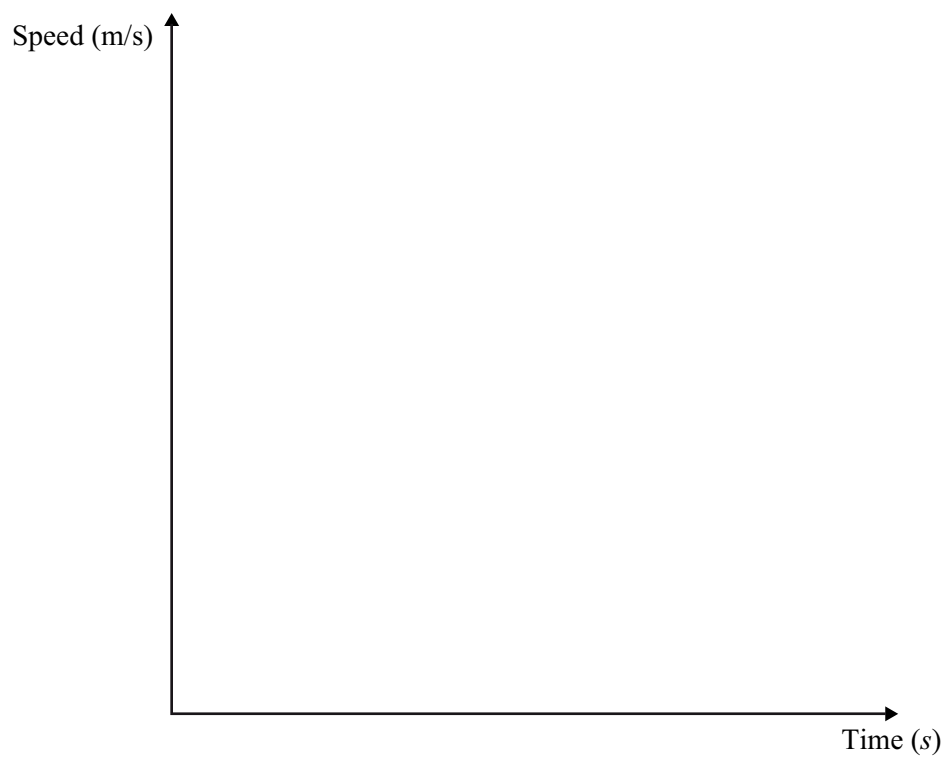**12 (iv)** Sketch the speed–time graphs for the van and the cyclist in **Fig. 8**.

Speed (m/s)

Time (*s*)

Fig. 8

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