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Rewarding Learning

General Certificate of Secondary Education
2012

Additional Mathematics

Paper 2
Mechanics and Statistics

[G0302]

G0302

FRIDAY 1 JUNE, AFTERNOON

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.

7184

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 **four** horizontal forces of magnitude 6 N, 10 N, R N and S 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 $R = 11$ [2]

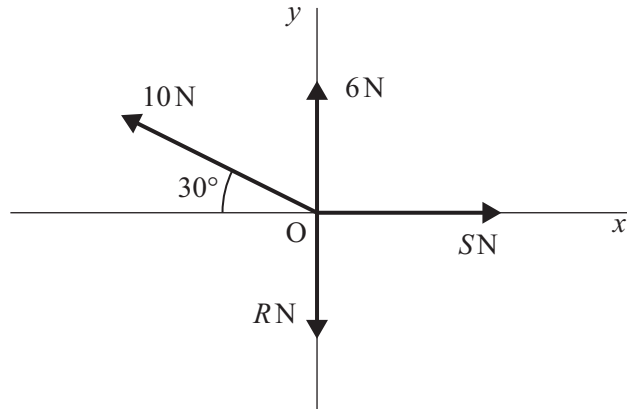   **(ii)** Find the value of S.   [2]

2   Carole recorded, to the nearest minute, how long it took her to complete each puzzle in her Sudoku book. Her results are summarised in **Table 1** below.

Table 1

Time (minutes)	1–5	6–10	11–13	14–17	18–20	21–30
Number of puzzles	1	11	10	24	36	27

Calculate an estimate of the median time Carole took to complete a Sudoku puzzle.   [5]

3   A stone of mass 0.45 kg is released from rest on the surface of the water in a pond.

The water exerts a constant resistance of 3 N.

(i)   Show that the acceleration of the stone is $\frac{10}{3}$ m/s². [3]

The stone takes 1.5 seconds to reach the bottom of the pond.

Calculate

(ii) the speed with which the stone hits the bottom of the pond, [2]

(iii) the depth of the pond. [1]

4   **(i)** What is the difference in the way frequency is represented when drawing a bar chart and drawing a histogram? [1]

(ii) Students in a statistics class measured the lengths of the pencils in their pencil cases. The results are summarised in **Table 2** below.

Table 2

Length x (cm)	$5 \leqslant x < 8$	$8 \leqslant x < 11$	$11 \leqslant x < 13$	$13 \leqslant x < 15$	$15 \leqslant x < 16$
Number of pencils	12	21	22	19	14

Using **Fig. 2** in your Supplementary Answer Booklet draw a histogram to represent this information. **Label each axis clearly**. [5]

[Turn over

5 Jordan recorded the number of points scored in each match by Jumpers basketball team throughout the season.

The mean number of points scored for all 30 games was 36 and the standard deviation was 8.2

The mean number of points scored for the 14 home games was 40 and the standard deviation was 7.8

Calculate

(i) the mean number of points scored for the 16 away games, [3]

(ii) the standard deviation for these 16 away games. [4]

6 A **uniform** plank AB of mass 40 kg and length 8 m rests horizontally on two supports, one at C and the other at D, where AC = 2 m and CD = 3.5 m, as shown in **Fig. 3**.
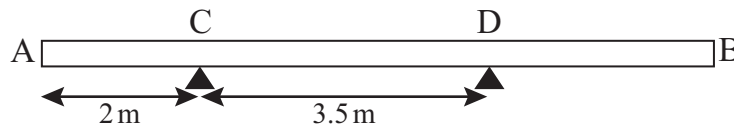

C   D
A [_____] B
   ←——→ ←——————————→
    2 m   3.5 m

Fig. 3

A child of mass 30 kg stands at the centre of the plank.

(i) Copy **Fig. 3** and show on your diagram all the forces acting on the plank. [1]

(ii) Find in Newtons the reactions at C and D. [3]

The child now moves towards the end B until the plank is on the point of tilting about the support D.

When the plank is on the point of tilting,

(iii) state the value of the reaction at C, [1]

(iv) calculate the distance of the child from the end B. [3]

7 There are 24 books on a bookshelf, 16 of which are poetry books and the rest are drama books.

Eighteen of the books on the shelf are paperback and 12 of these are poetry books.

The rest of the books on the shelf are hardback.

(i) Complete **Table 3** in your Supplementary Answer Booklet to show the number of poetry books and the number of drama books on this shelf. [1]

Two students each take a book at random from this shelf.

Calculate the probability that

(ii) they both take hardback books, [2]

(iii) they both take hardback poetry books. [2]

(iv) Given that the first student selected a hardback poetry book, what is the probability that the second student did not select a hardback poetry book? [3]

8 A box of mass 8 kg, initially at rest, is pulled in a straight line along a rough horizontal plane by a light inextensible rope which is held parallel to the plane. The box moves with constant acceleration.

After travelling 18 m along the plane the box is moving with velocity 3 m/s.

(i) Show that the acceleration of the box is $0.25 \, \text{m/s}^2$. [1]
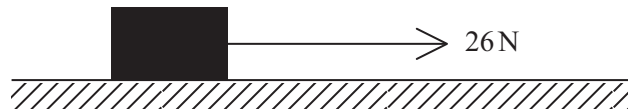
The tension in the rope is 26 N, as shown in **Fig. 4**.

Fig. 4

(ii) Calculate the force due to friction opposing the motion of the box. [2]

(iii) Calculate the coefficient of friction between the box and the plane. [2]

The box is now stopped and the rope is removed. A chain, inclined at an angle of 25° to the horizontal, is attached to the box. This chain exerts a force of PN on the box, as shown in **Fig. 5**.
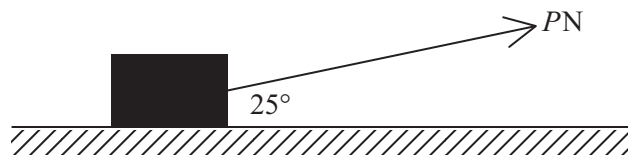

Fig. 5

(iv) Copy **Fig. 5** and mark on your diagram all the forces acting on the box. [1]

(v) Find the least value of P required to move the box. [4]

9 Benedict has a part-time job where he works the first weekend in each month. He recorded how much he earned in tips each night, correct to the nearest pound. His results are summarised in **Table 4** below.

Table 4

	Friday	Saturday	Sunday
August	17	42	25
September	18	46	29
October	20	49	32
November	22	52	33

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. [3]

(ii) Plot these averages in **Fig. 6** 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 Benedict will earn in tips on the first Friday in December. [4]

(iv) What assumption is made when calculating your answer to part **(iii)**? [1]

[Turn over

10 Two packages A and B of masses $5\,\text{kg}$ and $m\,\text{kg}$ respectively, where $m < 5$, are connected by a light inextensible string which passes over a smooth pulley fixed to the ceiling of a store, as shown in **Fig. 7**.
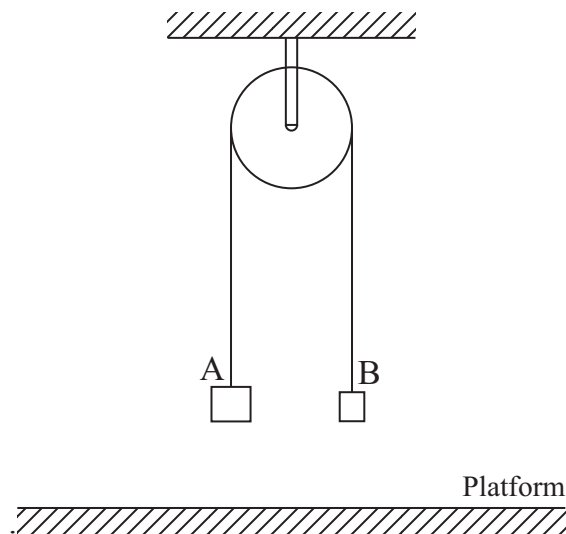

Fig. 7

The packages are held so that both parts of the string are hanging vertically with the string taut. The system is released from rest and the magnitude of the acceleration of each package during the subsequent motion is $2.5\ \text{m/s}^2$.

(i) Copy **Fig. 7** and mark on your diagram the forces acting on the packages. [1]

By forming an equation of motion for each package, find

(ii) the tension in the string, [2]

(iii) the value of m, [2]

(iv) the force exerted by the string on the pulley when the packages are in motion. [1]

When the packages have been in motion for 1.5 seconds, A strikes a fixed platform. The string becomes slack and B initially continues to rise.

Assuming that B does not reach the pulley, calculate

(v) the speed of the packages at the moment when A strikes the platform, [1]

(vi) the **additional** distance through which B rises after A strikes the platform, [2]

(vii) the time which elapses between A striking the platform and the string becoming taut again. [2]

11 A car and a motorcycle are travelling in the same direction along a dual carriageway. **At the same instant** they pass a sign warning them of a checkpoint ahead.

The car passes the warning sign at a speed of 20 m/s, continues at this speed for 1 minute and then decelerates uniformly to rest at the checkpoint.

The motorcyclist passes the warning sign at a speed of 26 m/s and continues at this speed for T seconds. He then decelerates uniformly to rest at the checkpoint.

They both arrive at the checkpoint at the same instant.

(i) Using **Fig. 8** in your Supplementary Answer Booklet, sketch the speed/time graphs for both vehicles as they travel from the warning sign to the checkpoint. [2]

The distance from the warning sign to the checkpoint is 1.3 km.

Calculate

(ii) the distance travelled by the car in the first minute, [1]

(iii) the deceleration of the car, [2]

(iv) the time for which the car was decelerating, [1]

(v) the total time for the journey between the warning sign and the checkpoint, [1]

(vi) the value of T. [4]

[Turn over

12 The total number of hours of sunshine and the total amount of rainfall, in mm, were recorded in different areas of the United Kingdom last year. The results are given in **Table 5**.

Table 5

Sunshine (hours)	1364	1478	1644	1450	1364	1412	1538	1670
Rainfall (mm)	1260	1005	806	1244	1314	1056	780	599

(i) Find the rank orders for the numbers of hours of sunshine and the amounts of rainfall. [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 5** are plotted on the graph given in **Fig. 9** in your Supplementary Answer Booklet.

(iv) Calculate the mean number of hours of sunshine and the mean rainfall. [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]

THIS IS THE END OF THE QUESTION PAPER

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SUPPLEMENTARY ANSWER BOOKLET

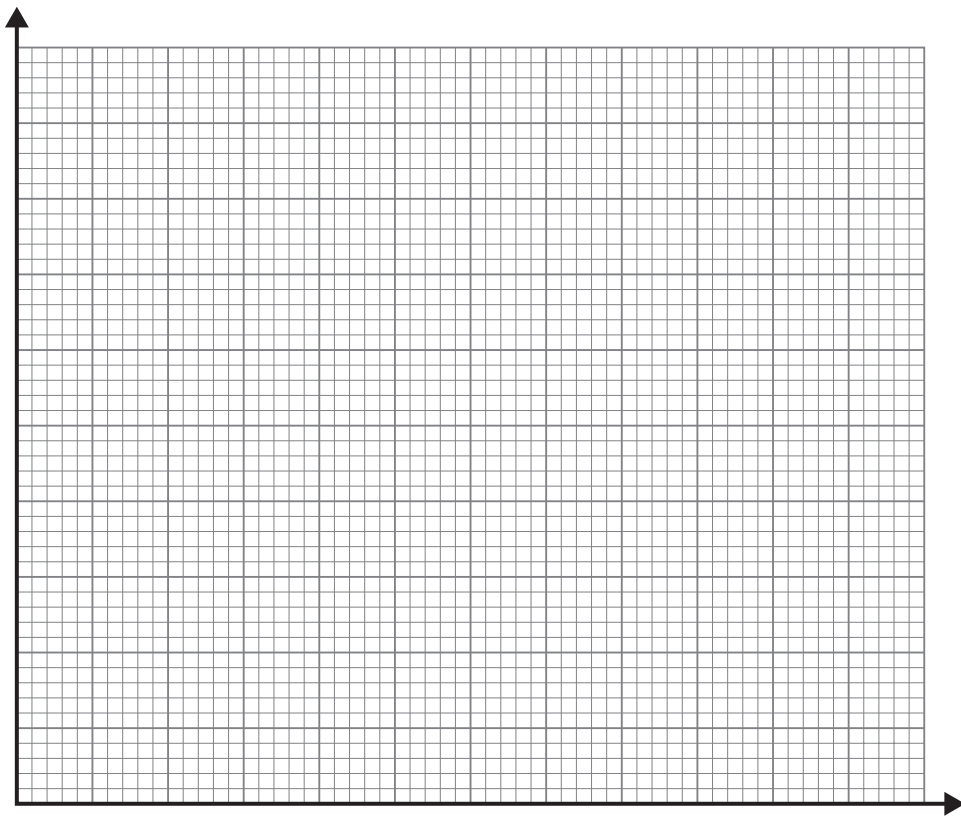**4** **(ii)** Using the information from **Table 2**, draw a histogram in **Fig. 2**. **Label each axis clearly**.

Fig. 2

7 (i) Complete **Table 3** below to show the number of poetry books and the number of drama books on the shelf.

Table 3

	Poetry	Drama
Hardback		
Paperback		

[Turn over

9 (ii) Plot the moving averages in **Fig. 6** and draw the trend line.
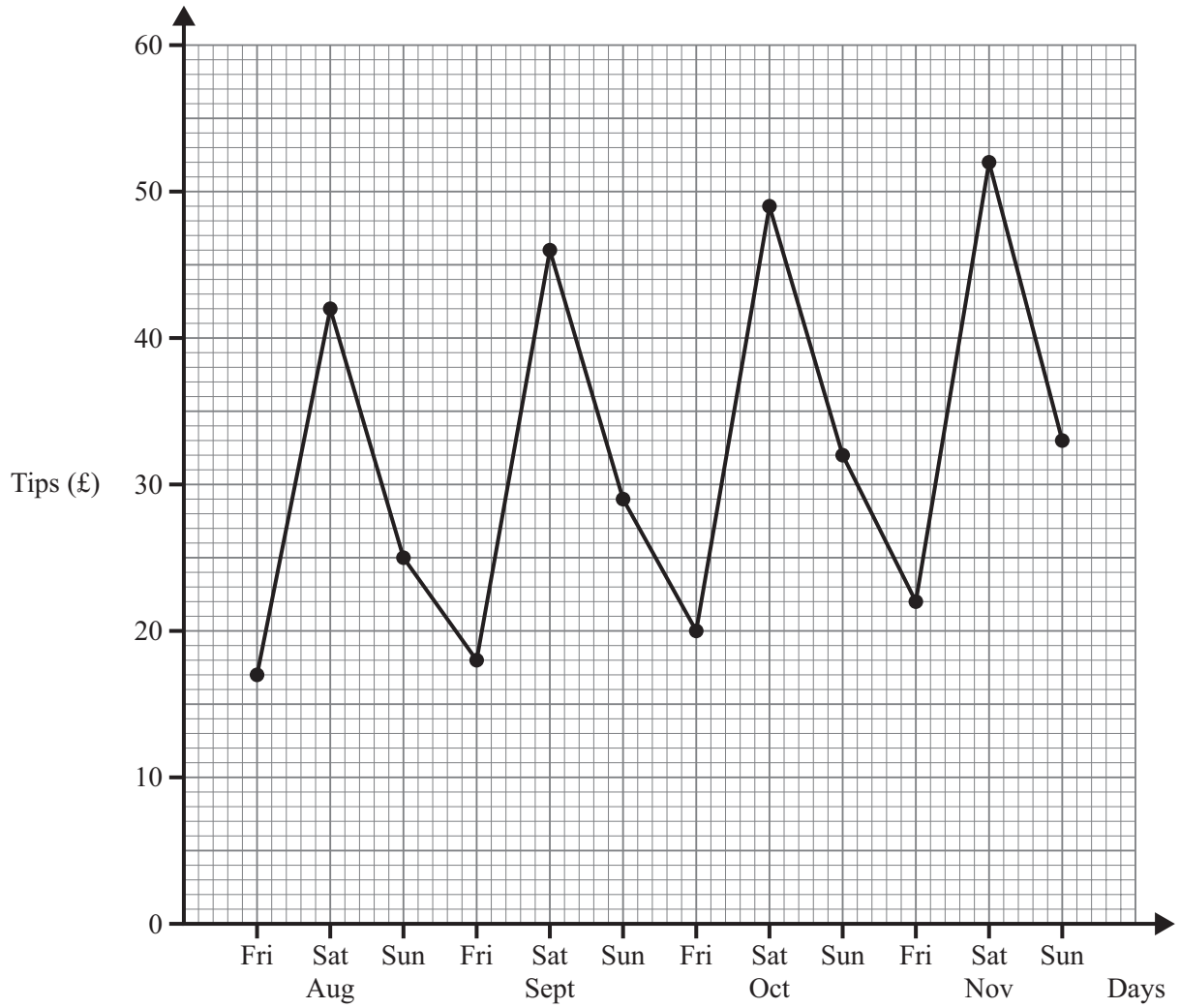
Fig. 6

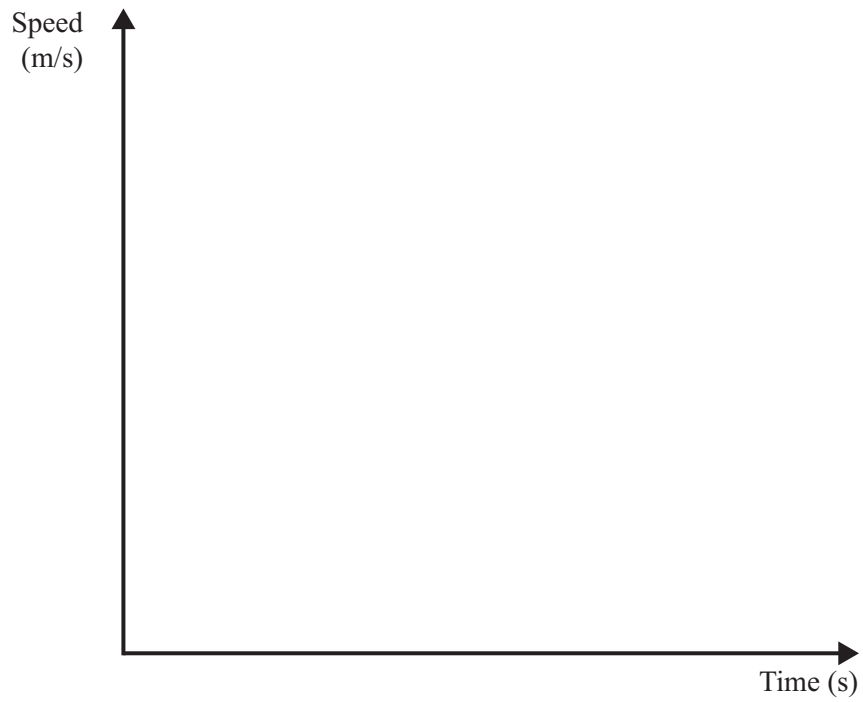**11 (i)** Sketch the speed/time graphs for the car and motorcyclist in **Fig. 8**.

Speed
(m/s)

Time (s)

Fig. 8

[Turn over

12 (v) Draw your line of best fit through the data points shown in **Fig. 9**.

Fig. 9

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