

# Practice Paper 1(Applied)

Total: 100 marks

Name: \_\_\_\_\_



**MATHSFLEX  
TUTORING**  
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## Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- Fill in the boxes at the top of this page with your name.
- 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.
- This paper is split into 2 sections (A- statistics, B- mechanics)
- Each section is 50 marks each.
- There are 11 questions in this question paper. The total mark is 100.
- The marks 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.

| Question     | Marks |
|--------------|-------|
| Section A    |       |
| 1            |       |
| 2            |       |
| 3            |       |
| 4            |       |
| 5            |       |
| 6            |       |
| Section B    |       |
| 1            |       |
| 2            |       |
| 3            |       |
| 4            |       |
| 5            |       |
| <b>TOTAL</b> |       |

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**Q1**

Hamza is studying the mean total cloud cover, in oktas, for Cambourne in 1987 using data from the large data set. The daily mean total cloud cover for all 184 days from the large data set is summarised in the table below.

|                                      |   |   |   |    |    |    |    |    |    |
|--------------------------------------|---|---|---|----|----|----|----|----|----|
| Daily mean total cloud cover (oktas) | 0 | 1 | 2 | 3  | 4  | 5  | 6  | 7  | 8  |
| Frequency (number of days)           | 0 | 3 | 7 | 15 | 25 | 20 | 48 | 38 | 28 |

One of the 184 days is selected at random.

- a. Find the probability that it has a daily mean total cloud cover of 5 or greater. **(1 mark)**

Hamza is investigating whether the daily mean total cloud cover can be modelled using a binomial distribution.

He uses the random variable  $X$  to denote the daily mean total cloud cover and believes that  $X \sim B(8, 0.78)$

Using Hamza's model,

- b. i. find  $P(X \geq 5)$  (2 marks)
- ii. find, to 1 decimal place, the expected number of days in a sample of 184 days with a daily mean total cloud cover of 6. (2 marks)
- c. Explain, whether or not your answers to part b support the use of Hamza's model. (1 mark)

[illegible]

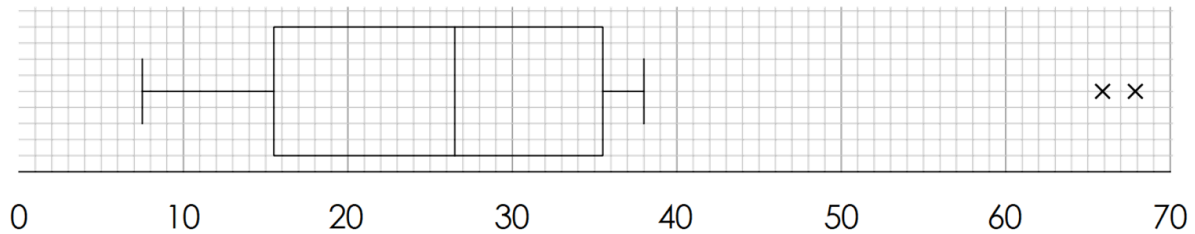


**Q2.**

Each member of a group of 29 people was timed when completing a puzzle.

The time taken,  $x$  minutes, for each member of the group was recorded.

These times are summarised in the following box and whisker plot.



a. Find the range of the times. **(1 mark)**

b. Find the interquartile range of the times **(1 mark)**

For these 29 people  $\Sigma x = 783$  and  $\Sigma x^2 = 27304.25$

c. calculate the mean time taken to complete the puzzle, **(1 mark)**

d. calculate the standard deviation of the times taken to complete the puzzle. **(2 marks)**

Sophie defines an outlier as a value more than 3 standard deviations above the mean.

e. State how many outliers Sophie would say there are in these data, giving a reason for your answer.

**(1 mark)**

Areeb and Bonnie also completed the puzzle in  $a$  minutes and  $b$  minutes respectively, where

$$a > b.$$

When their times are included with the data of the other 29 people

- the median time increases
- the mean time does not change

f. Suggest a possible value for  $a$  and a possible value for  $b$ , explaining how your values satisfy the above conditions. **(3 marks)**

g. Without carrying out any further calculations, explain why the standard deviation of all 31 times will be lower than your answer to part d. **(1 mark)**

[illegible]

[illegible]

### Q3

Kirstie owns a small clothes shop in a seaside town. She records the weekly sales figures,  $\pounds w$ , and the average weekly temperature,  $t^{\circ}\text{C}$ , for 8 weeks during the summer.

The product moment correlation coefficient for these data is -0.525.

- a. Stating your hypothesis clearly and using a 5% level of significance, test whether or not the correlation between sales figures and average weekly temperature is negative. **(3 marks)**
- b. Suggest a possible reason for this correlation. **(1 mark)**

Kirstie suggests that a linear regression model could be used to model these data.

- c. State, giving a reason, whether or not the correlation coefficient is consistent with Kirstie's suggestion. **(1 mark)**
- d. State, giving a reason, which variable would be the explanatory variable. **(1 mark)**

Kirstie calculated the linear regression equation as  $w = 12855 - 103t$

- e. Give an interpretation of the gradient of this regression equation. **(1 mark)**

[illegible]

[illegible]

**Q4**

A machine puts liquid into bottles of perfume. The amount of liquid put into each bottle,  $D$ ml, follows a normal distribution with mean 45ml.

Given that 17% of bottles contain less than 43.21ml

- a. find, to 2 decimal places, the value of  $k$  such that  $P(43.21 < D < k) = 0.35$  **(5 marks)**

A random sample of 100 bottles is taken.

- b. Using a normal approximation, find the probability that fewer than half of these bottles contain between 43.21ml and kml (3 marks)

The machine is adjusted so that the standard deviation of the liquid put in each bottle is now 1.14ml

Following the adjustments, Sally believes that the mean amount of liquid put in each bottle is less than 45ml

She takes a random sample of 40 bottles and finds the mean amount of liquid to be 44.67ml

- c. Test Sally's belief at the 5% level of significance.

You should state your hypotheses clearly. **(5 marks)**

[illegible]

[illegible]

**Q5**

Three bags,  $A$ ,  $B$  and  $C$ , each contain 1 red marble and some green marbles.

Bag  $A$  contains 1 red marble and 11 green marbles only

Bag  $B$  contains 1 red marble and 7 green marbles only

Bag  $C$  contains 1 red marble and 5 green marbles only.

John selects at random one marble from bag  $A$ .

If he selects a red marble, he stops selecting.

If the marble is green, he continues by selecting at random one marble from bag  $B$ .

If he selects a red marble, he stops selecting.

If the marble is green, he continues by selecting at random one marble from bag  $C$ .

- a. Draw a tree diagram to represent this information. **(2 marks)**
- b. Find the probability that John selects 3 green marbles. **(2 marks)**
- c. Find the probability that John selects at least 1 marble of each colour. **(2 marks)**
- d. Given that John selects a red marble, find the probability that he selects it from bag  $B$ . **(2 marks)**

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[illegible]

**END OF SECTION A**

## SECTION B- MECHANICS

**Q1**

[In this question position vectors are given relative to a fixed origin O]

At time  $t$  seconds, where  $t \geq 0$ , a particle,  $P$ , moves so that its velocity  $\mathbf{v}$  ms<sup>-1</sup> is given by

$$\mathbf{v} = 4t\mathbf{i} - 7t^{\frac{5}{2}}\mathbf{j}$$

When  $t = 0$ , the position vector of P is  $(-30\mathbf{i} + 20\mathbf{j})\text{m}$ .

- a. Find the acceleration of  $P$  when  $t = 4$  **(3 marks)**
- b. Find the position vector of  $P$  when  $t = 4$  **(3 marks)**

[illegible]

## Q2

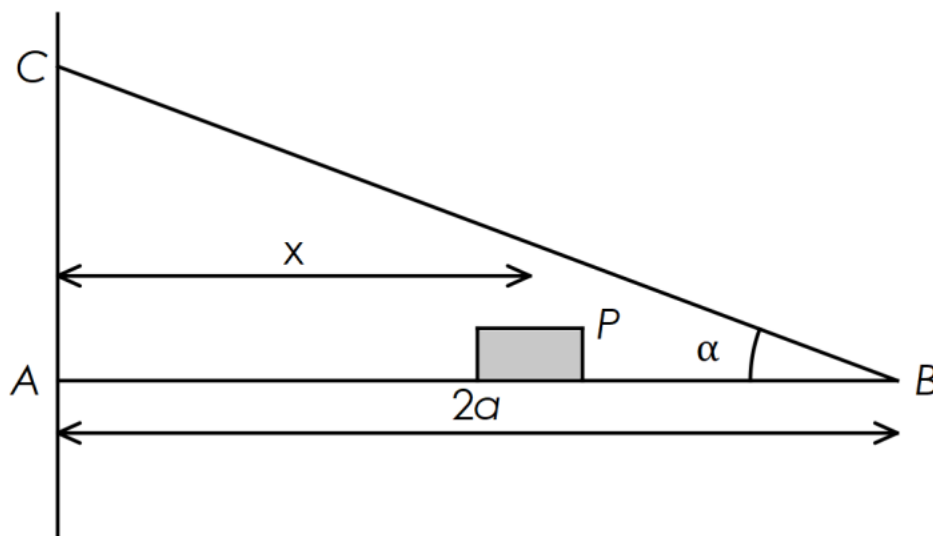


Figure 1

A plank,  $AB$ , of mass  $M$  and length  $2a$ , rests with its end  $A$  against a rough vertical wall. The plank is held in a horizontal position by a rope. One end of the rope is attached to the plank at  $B$  and the other end is attached to the wall at the point  $C$ , which is vertically above  $A$ .

A small block of mass  $4M$  is placed on the plank at the point  $P$ , where  $AP = x$ . The plank is in equilibrium in a vertical plane which is perpendicular to the wall.

The angle between the rope and the plank is  $\alpha$ , where  $\tan \alpha = \frac{4}{3}$ , as shown in Figure 2.

The plank is modelled as a uniform rod, the block is modelled as a particle and the rope is modelled as a light inextensible string.

- a. Using the model, show that the tension in the rope is  $\frac{5Mg(a+4x)}{8a}$  (3 marks)

The magnitude of the horizontal component of force exerted on the plank at  $A$  by the wall is  $3Mg$ .

- b. Find  $x$  in terms of  $a$ . (2 marks)

The force exerted on the plank at  $A$  by the wall acts in a direction which makes an angle  $\beta$  with the horizontal.

- c. Find the value of  $\tan \beta$  (5 marks)

The rope will break if the tension in it exceeds  $5Mg$ .

- d. Explain how this will restrict the possible position of  $P$ . You must justify your answer carefully. (3 marks)

[illegible]

[illegible]

Q3

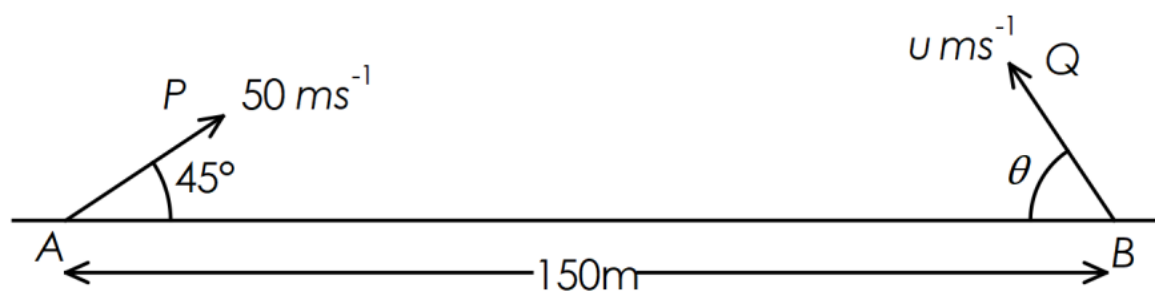


Figure 2

The points  $A$  and  $B$  lie 150m apart on horizontal ground.

At time  $t = 0$  two small balls,  $P$  and  $Q$ , are projected in the vertical plane containing  $AB$ .

Ball  $P$  is projected from  $A$  with speed  $50 \text{ ms}^{-1}$  at  $45^\circ$  to  $AB$ .

Ball  $Q$  is projected from  $B$  with speed  $u \text{ ms}^{-1}$  at angle  $\theta$  to  $BA$ , as shown in Figure 2.

At time  $t = 4$  seconds,  $P$  and  $Q$  collide.

Until they collide, the balls are modelled as particles moving freely under gravity.

a. Find the velocity of  $P$  at the instant before it collides with  $Q$ . (6 marks)

b. Find:

- i. the size of angle  $\theta$
- ii. the value of  $u$  (6 marks)

c. State one limitation of the model, other than air resistance that could affect the accuracy of your answers. (1 mark)

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[illegible]





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Q5

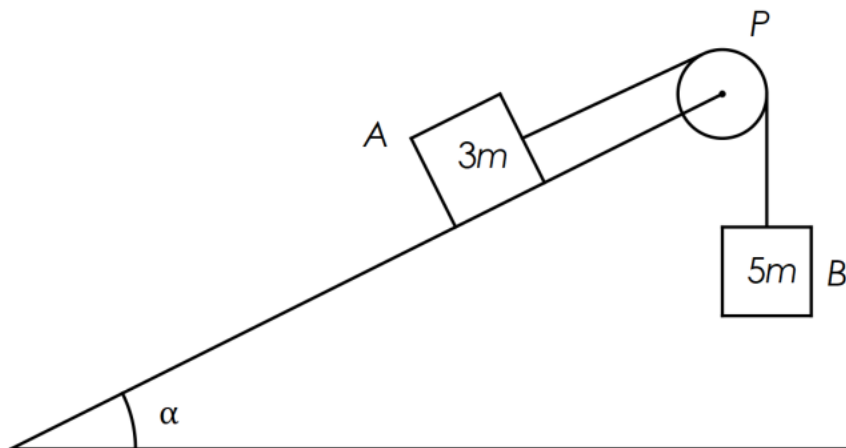


Figure 3

Two blocks,  $A$  and  $B$ , of masses  $3m$  and  $5m$  respectively, are attached to the ends of a light string.

Initially  $A$  is held at rest on a fixed rough plane.

The plane is inclined at an angle  $\alpha$  to the horizontal ground, where  $\tan \alpha = \frac{3}{4}$ .

The string passes over a small smooth pulley,  $P$ , fixed at the top of the plane.

The part of the string from  $A$  to  $P$  is parallel to a line of greatest slope of the plane.

Block  $B$  hangs freely below  $P$ , as shown in Figure 3.

The coefficient of friction between  $A$  and the plane is  $\frac{1}{2}$ .

The blocks are released from rest with the string taut and  $A$  moves up the plane.

The tension in the string immediately after the blocks are released is  $T$ .

The blocks are modelled as particles and the string is modelled as being inextensible.

a. Show that  $T = \frac{15mg}{4}$

**( 8 marks)**

After  $B$  reaches the ground,  $A$  continues to move up the plane until it comes to rest just before reaching  $P$ .

b. Determine whether  $A$  will remain at rest, carefully justifying your answer.

**(2 marks)**

[illegible]

[illegible]

**END OF SECTION B**