

Question 1

4. At time $t = 0$, a particle is projected vertically upwards with speed u from a point A . The particle moves freely under gravity. At time T the particle is at its maximum height H above A .

(a) Find T in terms of u and g .

(2)

(b) Show that $H = \frac{u^2}{2g}$

(2)

The point A is at a height $3H$ above the ground.

(c) Find, in terms of T , the total time from the instant of projection to the instant when the particle hits the ground.

(4)

Question 4 continued

Question 4 continued

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(Total 8 marks)	

Question 2

2.

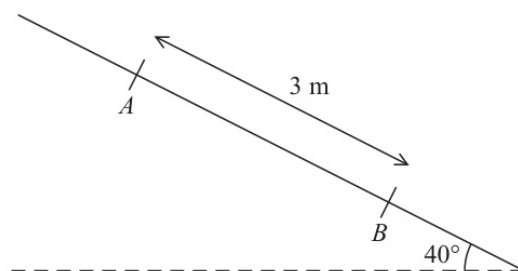


Figure 2

A rough plane is inclined at 40° to the horizontal. Two points A and B are 3 metres apart and lie on a line of greatest slope of the inclined plane, with A above B , as shown in Figure 2. A particle P of mass m kg is held at rest on the plane at A . The coefficient of friction between P and the plane is $\frac{1}{2}$. The particle is released.

- (a) Find the acceleration of P down the plane. (5)
- (b) Find the speed of P at B . (2)

Question 2 continued

Question 2 continued

Question 2 continued

Question 3

2. Tessa owns a small clothes shop in a seaside town. She records the weekly sales figures, £ 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 -0.915

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

Tessa 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 Tessa's suggestion. (1)
- (d) State, giving a reason, which variable would be the explanatory variable. (1)

Tessa calculated the linear regression equation as $w = 10\,755 - 171t$

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

Question 2 continued

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Question 4

7.

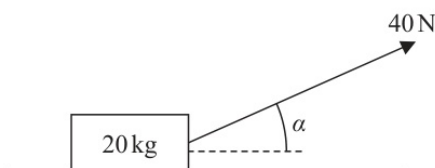


Figure 1

A wooden crate of mass 20 kg is pulled in a straight line along a rough horizontal floor using a handle attached to the crate.

The handle is inclined at an angle α to the floor, as shown in Figure 1, where $\tan \alpha = \frac{3}{4}$

The tension in the handle is 40 N.

The coefficient of friction between the crate and the floor is 0.14

The crate is modelled as a particle and the handle is modelled as a light rod.

Using the model,

- (a) find the acceleration of the crate.

(6)

The crate is now pushed along the same floor using the handle. The handle is again inclined at the same angle α to the floor, and the thrust in the handle is 40 N as shown in Figure 2 below.

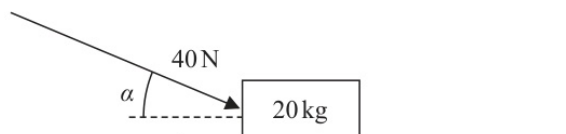


Figure 2

- (b) Explain briefly why the acceleration of the crate would now be less than the acceleration of the crate found in part (a).

(2)

Question 7 continued

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Question 7 continued

(Total for Question 7 is 8 marks)

Question 5

2. A car of mass 1000 kg is towing a caravan of mass 750 kg along a straight horizontal road. The caravan is connected to the car by a tow-bar which is parallel to the direction of motion of the car and the caravan. The tow-bar is modelled as a light rod. The engine of the car provides a constant driving force of 3200 N. The resistances to the motion of the car and the caravan are modelled as constant forces of magnitude 800 newtons and R newtons respectively.

Given that the acceleration of the car and the caravan is 0.88 m s^{-2} ,

- (a) show that $R = 860$,

(3)

- (b) find the tension in the tow-bar.

(3)

Question 2 continued

(Total 6 marks)

Figure 1 is a graph showing the trajectory of a rugby ball.

The ball travels in a vertical plane.

(a) Find a quadratic equation linking H with x that models this situation.

(3)

(b) Use your equation to find the greatest horizontal distance of the bar from O .

(3)

(c) Give one limitation of the model.

(1)

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Question 8 continued

Lined area for writing the answer to Question 8 continued.



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Question 8 continued

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Question 8 continued

Lined area for writing the answer to Question 8.

(Total for Question 8 is 7 marks)



Question 7

5. The lifetime, L hours, of a battery has a normal distribution with mean 18 hours and standard deviation 4 hours.

Alice's calculator requires 4 batteries and will stop working when any one battery reaches the end of its lifetime.

- (a) Find the probability that a randomly selected battery will last for longer than 16 hours.

(1)

At the start of her exams Alice put 4 new batteries in her calculator.

She has used her calculator for 16 hours, but has another 4 hours of exams to sit.

- (b) Find the probability that her calculator will not stop working for Alice's remaining exams.

(5)

Alice only has 2 new batteries so, after the first 16 hours of her exams, although her calculator is still working, she randomly selects 2 of the batteries from her calculator and replaces these with the 2 new batteries.

- (c) Show that the probability that her calculator will not stop working for the remainder of her exams is 0.199 to 3 significant figures.

(3)

After her exams, Alice believed that the lifetime of the batteries was more than 18 hours. She took a random sample of 20 of these batteries and found that their mean lifetime was 19.2 hours.

- (d) Stating your hypotheses clearly and using a 5% level of significance, test Alice's belief.

(5)

Question 5 continued

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(Total for Question 5 is 14 marks)

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Question 8

SECTION A: STATISTICS

Answer ALL questions. Write your answers in the spaces provided.

1. The number of hours of sunshine each day, y , for the month of July at Heathrow are summarised in the table below.

Hours	$0 \leq y < 5$	$5 \leq y < 8$	$8 \leq y < 11$	$11 \leq y < 12$	$12 \leq y < 14$
Frequency	12	6	8	3	2

A histogram was drawn to represent these data. The $8 \leq y < 11$ group was represented by a bar of width 1.5 cm and height 8 cm.

- (a) Find the width and the height of the $0 \leq y < 5$ group. (3)

- (b) Use your calculator to estimate the mean and the standard deviation of the number of hours of sunshine each day, for the month of July at Heathrow.
Give your answers to 3 significant figures. (3)

The mean and standard deviation for the number of hours of daily sunshine for the same month in Hurn are 5.98 hours and 4.12 hours respectively.
Thomas believes that the further south you are the more consistent should be the number of hours of daily sunshine.

- (c) State, giving a reason, whether or not the calculations in part (b) support Thomas' belief. (2)

- (d) Estimate the number of days in July at Heathrow where the number of hours of sunshine is more than 1 standard deviation above the mean. (2)

Helen models the number of hours of sunshine each day, for the month of July at Heathrow by $N(6.6, 3.7^2)$.

- (e) Use Helen's model to predict the number of days in July at Heathrow when the number of hours of sunshine is more than 1 standard deviation above the mean. (2)

- (f) Use your answers to part (d) and part (e) to comment on the suitability of Helen's model. (1)

Question 1 continued

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Question 9

2. A meteorologist believes that there is a relationship between the daily mean windspeed, w kn, and the daily mean temperature, t °C. A random sample of 9 consecutive days is taken from past records from a town in the UK in July and the relevant data is given in the table below.

t	13.3	16.2	15.7	16.6	16.3	16.4	19.3	17.1	13.2
w	7	11	8	11	13	8	15	10	11

The meteorologist calculated the product moment correlation coefficient for the 9 days and obtained $r = 0.609$

- (a) Explain why a linear regression model based on these data is unreliable on a day when the mean temperature is 24 °C (1)
- (b) State what is measured by the product moment correlation coefficient. (1)
- (c) Stating your hypotheses clearly test, at the 5% significance level, whether or not the product moment correlation coefficient for the population is greater than zero. (3)

Using the same 9 days a location from the large data set gave $\bar{t} = 27.2$ and $\bar{w} = 3.5$

- (d) Using your knowledge of the large data set, suggest, giving your reason, the location that gave rise to these statistics. (1)

Question 2 continued

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Question 10

5. A company sells seeds and claims that 55% of its pea seeds germinate.

- (a) Write down a reason why the company should not justify their claim by testing all the pea seeds they produce.

(1)

A random selection of the pea seeds is planted in 10 trays with 24 seeds in each tray.

- (b) Assuming that the company's claim is correct, calculate the probability that in at least half of the trays 15 or more of the seeds germinate.

(3)

- (c) Write down two conditions under which the normal distribution may be used as an approximation to the binomial distribution.

(1)

A random sample of 240 pea seeds was planted and 150 of these seeds germinated.

- (d) Assuming that the company's claim is correct, use a normal approximation to find the probability that at least 150 pea seeds germinate.

(3)

- (e) Using your answer to part (d), comment on whether or not the proportion of the company's pea seeds that germinate is different from the company's claim of 55%

(1)

Question 5 continued

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(Total for Question 5 is 9 marks)

TOTAL FOR SECTION A IS 50 MARKS

Question 11

2. A small stone is projected vertically upwards with speed 39.2 m s^{-1} from a point O .

The stone is modelled as a particle moving freely under gravity from when it is projected until it hits the ground 10 s later.

Using the model, find

- (a) the height of O above the ground, (3)
- (b) the total length of time for which the speed of the stone is less than or equal to 24.5 m s^{-1}
- (c) State one refinement that could be made to the model that would make your answer to part (a) more accurate.

Question 2 continued

(Total for Question 2 is 7 marks)

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Question 12

3.

In this question you must show all stages of your working.

Solutions relying entirely on calculator technology are not acceptable.

A fixed point O lies on a straight line.

A particle P moves along the straight line such that at time t seconds, $t \geq 0$, after passing through O , the velocity of P , $v \text{ ms}^{-1}$, is modelled as

$$v = 15 - t^2 - 2t$$

- (a) Verify that P comes to instantaneous rest when $t = 3$
- (b) Find the magnitude of the acceleration of P when $t = 3$
- (c) Find the total distance travelled by P in the interval $0 \leq t \leq 4$

(4)

Question 3 continued

(Total for Question 3 is 8 marks)

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