



Rewarding Learning

ADVANCED  
General Certificate of Education  
2025

Centre Number

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Candidate Number

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## Mathematics

Assessment Unit A2 2

*assessing*

Applied Mathematics

**MV24**

[AMT21]

WEDNESDAY 4 JUNE, AFTERNOON

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### Time

1 hour 30 minutes, plus your additional time allowance.

### Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer **all ten** questions in the spaces provided.

**Do not write on blank pages.**

Complete in black ink only.

**Do not write with a gel pen.**

Questions which require drawing or sketching should be completed using an HB pencil.

Candidates must answer **all** questions from sections A and B.

Equal time should be spent on each section. Show clearly the full development of your answers.

**Answers without working may not gain full credit.**

Answers should be given to three significant figures unless otherwise stated.

You are permitted to use a graphic or scientific calculator in this paper.

## **Information for Candidates**

The total mark for this paper is 100. The total available mark for each section of this paper is 50.

Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

Answers should include diagrams where appropriate and marks may be awarded for them.

Take  $g = 9.8 \text{ m s}^{-2}$ , unless specified otherwise.

A copy of the **Mathematical Formulae and Tables booklet** is provided.

Throughout the paper the logarithmic notation used is  $\ln z$  where it is noted that  $\ln z \equiv \log_e z$



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The particle has a velocity of  $(6\mathbf{i} + 2\mathbf{j}) \text{ m s}^{-1}$  when  $t = 0$

**(ii)** Find the velocity of the particle when  $t = 3$  [5 marks]

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2 Two particles P and Q have masses 4 kg and 6 kg respectively.

They both move along the same straight line in the same direction.

C has a constant velocity of  $(5\mathbf{i} + 4\mathbf{j}) \text{ m s}^{-1}$

D has a constant velocity of  $(7.5\mathbf{i} + 6\mathbf{j}) \text{ m s}^{-1}$

D catches up with C.

D collides directly with C and they coalesce.

(i) Find their common velocity after the collision in vector form. [5 marks]

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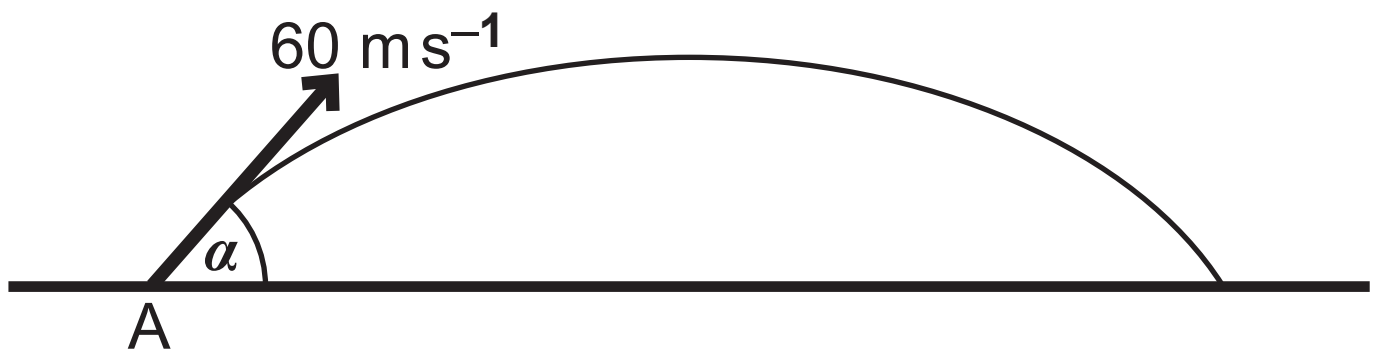
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- 3 A projectile is launched from a point A on horizontal ground with an initial velocity of  $60 \text{ m s}^{-1}$  and at an angle  $\alpha$  to the horizontal as shown in **Fig. 1** below.

**Fig. 1**



- (i) Show that the range,  $R$  metres, of the projectile is given by: [6 marks]

$$R = \frac{3600 \sin 2\alpha}{g}$$

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**(Questions continue overleaf)**

**5 Fig. 2** opposite shows a non-uniform rod AB, of length 10 m and mass 12 kg, which is hinged at end A to a vertical wall.

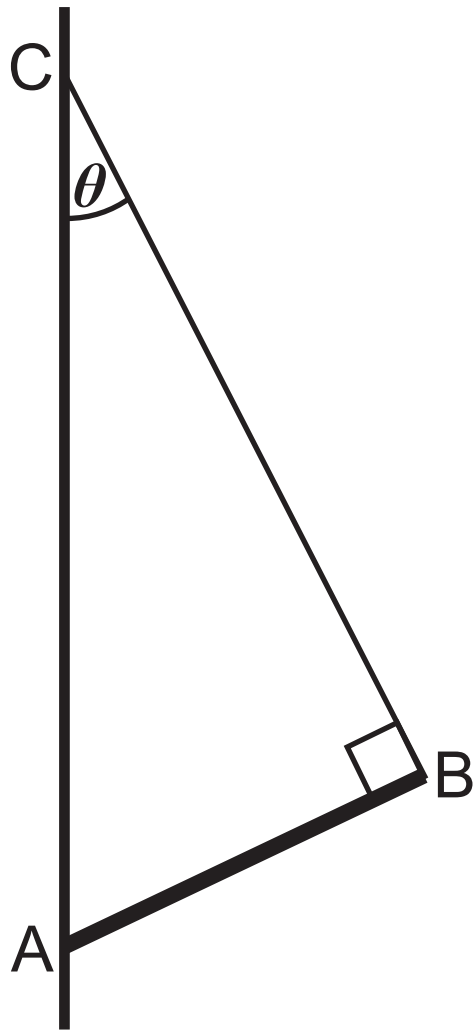
The rod is held in equilibrium by a light inextensible string BC, with C attached to the wall vertically above A.

The string makes  $90^\circ$  with the rod and an angle  $\theta$  with the wall.

The centre of mass of the rod is located at the point D on the rod where  $\frac{AD}{DB} = \frac{2}{3}$

The magnitude of the tension in the string is 42 N.

**Fig. 2**



**(i)** Complete the diagram in **Fig. 2** above to show all the external forces acting on the rod. [2 marks]

**(ii)** Show that  $\cos \theta = \frac{25}{28}$  [6 marks]

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**(iv)** What modelling assumption have you made? [1 mark]

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# Section B

## Statistics

6 The gestation period for a female mammal is the duration of pregnancy.

For a certain type of hippopotamus, the gestation period is normally distributed with mean  $\mu$  months and standard deviation  $\sigma$  months.

It is known that 5% of this type of hippopotamus have a gestation period longer than 8.9 months.

(i) Write down one equation in  $\mu$  and  $\sigma$ .  
[3 marks]

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7 A sports coach is investigating a possible correlation between an athlete's reaction time and their time taken to run 100 metres.

She decides to carry out a hypothesis test and states the following hypothesis:

$$H_0: \rho = 0$$

$$H_1: \rho \neq 0$$

where  $\rho$  is the population correlation coefficient.

(i) State whether this is a one-tailed test or a two-tailed test and explain your answer. [2 marks]

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For a random sample of 18 athletes, the sports coach calculates the product-moment correlation coefficient to be  $r = 0.5217$

**(ii)** State the acceptance region for  $r$ , in this hypothesis test with a 5% level of significance, for a sample of this size.  
[2 marks]

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**(iii)** Hence complete the hypothesis test.  
[3 marks]

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8 Blue-green algae is a type of bacteria which occurs naturally in open water.

A microbiologist models the amount of blue-green algae in a particular lake using a normal distribution with mean 3.8 units and standard deviation 0.7 units.

Following a spell of hot weather, the microbiologist wishes to test if the mean amount of blue-green algae in the lake has increased.

He takes a sample of 60 readings from a randomly selected range of locations on the lake and finds that the mean of this sample is 3.98 units.

Carry out a hypothesis test at the 2.5% level of significance. [9 marks]

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- 9 (a) **Table 1** below shows the fuel type of a number of vehicles and whether they passed their most recent MOT test.

**Table 1**

	Petrol	Diesel	Hybrid
Passed MOT	207	189	78
Failed MOT	12	16	3

- (i) If one of these vehicles is selected at random, write down the probability that it is a diesel vehicle and failed its MOT test. [1 mark]

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**(b)** A wine expert claims to be able to tell the country of origin of a wine by just tasting it.

The probability that he answers correctly on the first attempt is  $p$ . [ $p \neq 0$ ]

The probability of a correct answer increases by 20% after each incorrect response.

The probability that the expert takes exactly 3 attempts to answer correctly is  $0.102p$ .

**(i)** Using a probability tree diagram, or otherwise, calculate the value of  $p$ .  
[8 marks]

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**10** A sporting organisation claims that 1 in 4 sixth form students cannot swim.

Jo suspects that the claim may be incorrect, so she carries out a survey of a random sample of 50 sixth form students at her school.

Jo plans to carry out a hypothesis test at the 10% level of significance to test her suspicion.

**(i)** State the null and alternative hypotheses for this two-tailed test. [2 marks]

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The critical region for this test is such that the probability in each tail is less than 5%.

**(ii)** Calculate the critical region for this test. [5 marks]

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**(iii)** Using your answer to part **(ii)**, find the actual probability of incorrectly rejecting the null hypothesis. [2 marks]

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The results of Jo's survey show that 17 of her sample of students cannot swim.

**(iv)** Using this information, complete the hypothesis test. [3 marks]

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question paper**

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<b>For Examiner's use only</b>	
<b>Question Number</b>	<b>Marks</b>
1	
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<b>Total Marks</b>	

Examiner Number

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