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ADVANCED
General Certificate of Education
2019

Centre Number

Candidate Number

Mathematics

Assessment Unit A2 2
assessing
Applied Mathematics

MV18

[AMT21]
WEDNESDAY 5 JUNE, MORNING

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 the questions in the spaces provided.
Do not write on blank pages or tracing paper.
Complete in black ink only. Questions which require drawing or sketching should be completed using an H.B. pencil.
Candidates must answer **all** questions from sections A and B.
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.

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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 $g = 9.8\,\text{m}\,\text{s}^{-2}$, 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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(Questions start overleaf)

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Answer all questions.

Section A

Mechanics

1 A uniform rod AB, of mass 15 kg, is held horizontally in equilibrium by two strings attached at C and D as shown in **Fig. 1** below.

The strings hang vertically and are light and inextensible.

AB = 6 m, BD = 1 m and CD = 2.5 m.

(i) Complete the diagram below showing all the external forces acting on the rod. [1 mark]

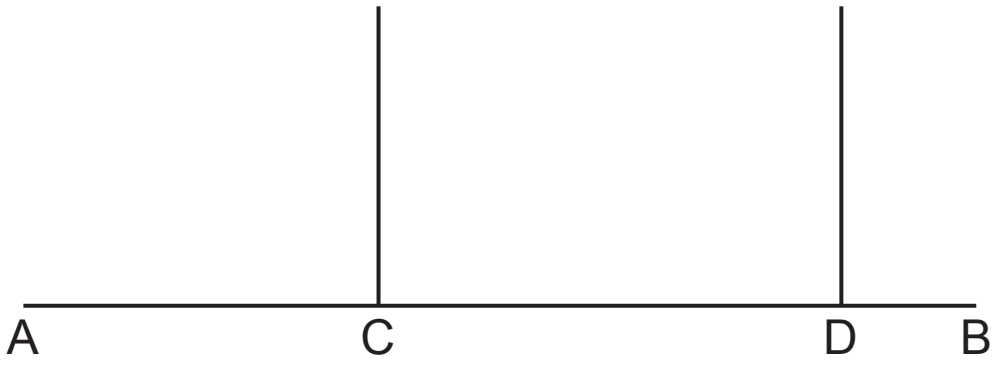

Fig. 1

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(ii) Find the tension in each string. [5 marks]

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2 Two particles S and T, of masses $6m$ kg and $3m$ kg respectively, are travelling in a straight line when they collide.

Before the collision the particles are moving in opposite directions. S has a speed of $2u$ m s^{-1} and T has a speed of $6u$ m s^{-1}

After the collision the direction of each particle is reversed. S continues to travel with a speed of $2u$ m s^{-1} and T has a speed of ku m s^{-1} where k is a constant.

(i) Find the value of k. [4 marks]

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(ii) Find the impulse on T. [3 marks]

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3 The velocity v m s^{-1} of a particle travelling in a straight line at time t seconds is given by

$$v = 2t^2 - 9t + 4$$

The particle is instantaneously at rest on two different occasions.

(i) Find the times when the particle is at rest. [3 marks]

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(ii) Find the acceleration of the particle when $t = 3$
[4 marks]

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(iii) Find the total distance covered by the particle in the first 5 seconds of motion. [8 marks]

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4 A footballer taking a free kick strikes the ball and it leaves the horizontal ground with speed u m s^{-1} at an angle α to the horizontal. The ball is projected from O, as shown in **Fig. 2** below, and is modelled as a particle. The ball remains in the same vertical plane and experiences no air resistance.

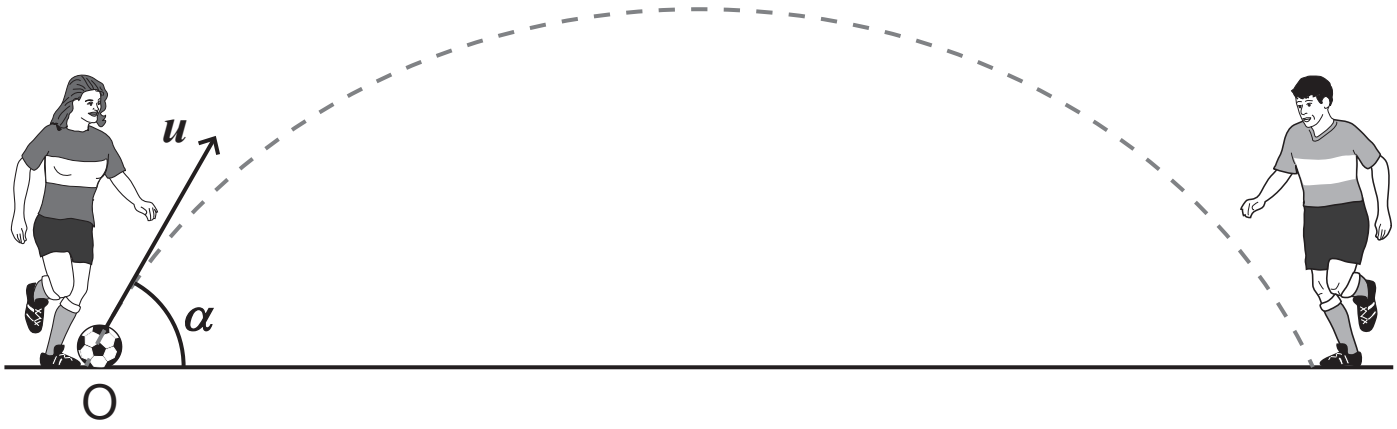

Fig. 2

(i) Show that the equation of trajectory for the ball is

$$y = x\tan\alpha - \frac{gx^2}{2u^2}(1 + \tan^2\alpha)$$

where x and y are the horizontal and vertical displacements of the ball from O. [7 marks]

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The ball is kicked towards a stationary teammate who is 15 m from O and on the same horizontal level. The initial speed of the ball is $14\,m\,s^{-1}$

(ii) Hence find the possible angles of projection for the ball to land at the foot of the other player. [5 marks]

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5 A uniform ladder AB, of mass m_1 kg and length 6 m, rests with end A on rough horizontal ground.

The ladder is inclined at an angle θ to the horizontal, where $\sin\theta = \frac{12}{13}$

The other end B rests against a smooth vertical wall.

When John stands on the ladder, a distance of x m from A, the ladder is on the point of slipping. John has a mass m_2 kg.

If μ is the coefficient of friction between the ladder and the ground show that

$$x = \frac{72\mu(m_1 + m_2) - 15m_1}{5m_2}$$ [10 marks]

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Section B

Statistics

6 **(a)** The owner of a local shop noticed that 40% of customers bought milk, 25% of customers bought bread and 55% of customers bought neither.

(i) Calculate the probability that a customer selected at random bought bread and no milk. [2 marks]

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(ii) Calculate the probability that a customer selected at random bought bread given that they bought milk. [2 marks]

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(iii) Determine whether the event “buying milk” is statistically independent of the event “buying bread”. [2 marks]

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(b) Jenny has two bags. Bag A contains 5 white marbles and 2 black marbles.

Bag B contains 2 white marbles and 6 black marbles.

One marble is selected at random from bag A and placed in bag B.

One marble is then selected at random from bag B.

(i) Find the probability that the selected marbles are both white. [2 marks]

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(ii) Find the probability that the second marble is white.
[2 marks]

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(iii) Find the probability that the first marble is black given that the second is white. [3 marks]

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7 **(a)** The length, in cm, of a copper pipe has a normal distribution with mean μ and variance σ^2

It is found that 12% of the pipes exceed 17.5 cm and that 25% of the pipes are less than 16.8 cm.

(i) Find the values of μ and σ^2 [8 marks]

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The copper pipe required for a certain bathroom unit must be less than 17.2 cm.

(ii) Calculate the percentage of copper pipes that will be too long for the bathroom unit. [5 marks]

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(b) Give a reason why the normal distribution is important in statistics. [1 mark]

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8 It has been established that 40% of children at a particular school reach a higher level of reading by the start of Year 5.

Ten children are chosen at random from those starting Year 5 at the school.

(i) Calculate the probability that at least one of these children has reached the higher level of reading. [4 marks]

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Following a new reading incentive introduced by the school, a teacher believes that there has been an improvement in the percentage of children achieving the higher reading level.

The teacher randomly selects 10 children who are starting Year 5.
It was found that 7 of them had reached the higher level of reading.

(ii) Perform a suitable hypothesis test to determine whether the teacher's belief is true at the 5% level. [9 marks]

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(iii) How could the test be improved? [1 mark]

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9 A retiring parkrun organiser informs the new organiser that the time taken by the participants of the regular 5 kilometre run is normally distributed with mean 28 minutes and standard deviation 7.5 minutes.

The new organiser believes that the times for the month of December will have a different mean. Subsequently, he randomly selects 30 of the times recorded for participants during December. The mean time of this sample is 24.5 minutes.

(i) Carry out a hypothesis test and show that the new organiser's belief can be accepted at the 10% significance level. [8 marks]

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(ii) In this context, give a reason why the new organiser's belief could be true. [1 mark]

This is the end of the question paper

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Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
8	
Total Marks	

Examiner Number

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