

0765/3/2023

P.M.M. A/L

**SOUTH WEST REGIONAL MOCK EXAMINATION
GENERAL EDUCATION**

THE TEACHERS' RESOURCE UNIT (TRU)

IN COLLABORATION WITH

THE REGIONAL INSPECTORATE OF PEDAGOGY FOR SCIENCE

AND

THE SOUTH-WEST ASSOCIATION OF MATHEMATICS TEACHERS

(SWAMT)

WEDNESDAY: 29/03/2023-AFTERNOON

ADVANCED LEVEL

Subject Title	Pure Mathematics with Mechanics
Paper Number	Paper 3
Subject Code Number	0765

THREE HOURS

INSTRUCTIONS TO CANDIDATES:

Answer ALL questions.

For your guidance, the approximate mark allocation for parts of each question is indicated in brackets.

You are reminded of the necessity for good English and orderly presentation in your answers.

Mathematical formulae and tables published by the CGCE Board and noiseless, non-programmable calculators are allowed.

*In calculations, you are advised to show all the steps in your working, giving your answer at each stage.
Where necessary, take g as 10 ms^{-2} .*

1. A particle P of mass 5 kg moves with velocity, $v \text{ m s}^{-1}$, where $v = 3t^2\mathbf{i} + (1-t)\mathbf{j}$ at time t seconds. Given that the particle is initially at rest at the origin, find,

- (a) the speed of P when $t = 1$ second, (2 marks)
 (b) the displacement and acceleration vectors of P at any time t , (5 marks)
 (c) the work done in moving the particle from $t = 1$ to $t = 3$ seconds, (4 marks)
 (d) the magnitude of the force acting on P at time t seconds. (2 marks)

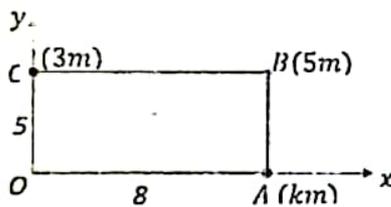
2. Particles P and Q , of masses 0.55 kg and 0.45 kg respectively, are attached to the ends of a light inextensible string which passes over a smooth, fixed pulley. The particles are held at rest with the string taut and its straight parts vertical. Both particles are at a height of 5 m above the ground. The system is released. Find,

- (a) the acceleration with which P starts to move and the tension in the string (6 marks)
 (b) the reaction exerted by the string on the pulley. (2 marks)

The string breaks after 2 s and in the subsequent motion P and Q move vertically under gravity. At the instant that the string breaks, find,

- (c) the speed of the particles just when the string breaks. (2 marks)
 (d) the height above the ground of P and of Q . (3 marks)

3.



The diagram above shows a rectangular lamina $OABC$. The coordinates of O, A, B and C are $(0,0), (8,0), (8,5)$ and $(0,5)$ respectively. Particles of mass $k \text{ m}$, 5 m and 3 m are attached to the lamina at A, B and C respectively.

The x -coordinate of the centre of mass of the three particles without the lamina is 6.4

- (a) Show that $k = 7$.
 The lamina $OABC$ is uniform and has mass 12 mg . (4 marks)
 (b) Find the coordinates of the centre of mass of the combined system consisting of the three particles and the lamina (7 marks)

The combined system is freely suspended at O and hangs in equilibrium.

- (c) Find the tangent of the angle which OC makes with the vertical. (2 marks)

4 (i) Forces $F_1 = (i - j)\text{N}$, $F_2 = (pi + j)\text{N}$ and $F_3 = (4i + qj)\text{N}$ act at the points with position vectors r_1 , r_2 and r_3 respectively, where $r_1 = (2i - 3j) \text{ m}$, $r_2 = (-i + 4j) \text{ m}$ and $r_3 = (4i - 2j) \text{ m}$. Given that the system reduces to a couple, find,

- (a) the values of p and q . (3 marks)
 (b) the magnitude of the moment of the couple. (3 marks)

(ii) A particle of mass $m \text{ kg}$ lies on a smooth horizontal table and is attached by an inextensible string which passes through a smooth hole in the table, to a particle of mass $2m \text{ kg}$ which hangs freely below the table. The particle of mass $m \text{ kg}$ moves in a horizontal circle of radius 1 m on the table with uniform speed such that the particle of mass $2m \text{ kg}$ remains at rest. Calculate the uniform speed of the particle and the reaction force from the table. (7 marks)

- 5 A particle P is projected with velocity $(2u\mathbf{i} + 3u\mathbf{j}) \text{ m s}^{-1}$ from a point O on a horizontal plane, where \mathbf{i} and \mathbf{j} are horizontal and vertical unit vectors respectively. The particle P strikes the plane at the point A which is 480 m from O
- (a) Show that $u = 20$. (6 marks)
- (b) Find the time of flight from O to A . (2 marks)
- The particle P passes through a point B with speed 50 ms^{-1} .
- (c) Find the possible time taken by P to travel from O to B . (5 marks)

- 6 A particle A of mass $2m$ is moving with speed $3u$ in a straight line on a smooth horizontal table. The particle collides directly with a particle B of mass m moving with speed $2u$ in the opposite direction to A . Immediately after the collision the speed of B is $\frac{8u}{3}$ and the direction of motion of B is reversed.
- (a) Calculate the coefficient of restitution, e , between A and B . (5 marks)
- (b) Show that the kinetic energy lost in the collision is $7mu^2 \text{ J}$. (4 marks)

After the collision B strikes a fixed vertical wall that is perpendicular to the direction of motion of B . The magnitude of the impulse of the wall on B is $\frac{14mu}{3}$

- (c) Calculate the coefficient of restitution between B and the wall. (4 marks)
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- 7 (i) A car of mass 1,500 kg tows a carriage of mass 500 kg. The frictional resistance to the motion of the car is 700 N and the frictional resistance to the motion of the carriage is 300 N. The engine of the car works at a constant rate of 20 kW. Find the acceleration of the car and the carriage and the tension in the tow rope when the speed of the car is 5 ms^{-1} .
- (a) on level ground, (4 marks)
- (b) directly up a track inclined at an angle θ to the horizontal, where $\sin \theta = \frac{1}{20}$. (5 marks)
- (ii) A particle of mass 4 kg is suspended from an elastic string of natural length 1.5 m and modulus of elasticity 180 N. The particle is pulled vertically downwards and then released when the length of the string is 2 m. Find its acceleration at the instant when it is released. (4 marks)

- 8 (i) A and B are two events such that $P(A) = \frac{3}{8}$, $P(B) = \frac{1}{2}$ and $P(A \cap B) = \frac{1}{4}$.

Find,

- (a) $P(A' \cup B')$ (2 marks)
- (b) $P(A'/B)$ (3 marks)
- (ii) Three men X , Y and Z play a game of shooting at a target. The probabilities that they hit the target are, respectively $\frac{1}{4}$, $\frac{2}{5}$ and $\frac{3}{5}$. Given that each person shoots once at the target, find the probability that
- (a) none of them hits the target (2 marks)
- (b) exactly one of them hits the target. (4 marks)
- Given that only one of them hits the target, find
- (c) the probability that it was hit by X . (2 marks)

END.