GENERAL CERTIFICATE OF EDUCATION BOARD
General Certificate of Education Examination

Pure Maths With Mechs 3
0765

JUNE 2022 **ADVANCED LEVEL**

Subject Title	**Pure Mathematics with Mechanics**
Paper No.	**Paper 3**
Subject Code No.	**0765**

Three hours

Full marks may be obtained for answers to ALL questions.

All questions carry equal marks.

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

Mathematical formulae booklet published by the GCE Board are allowed.

In calculations, you are advised to show all the steps in your working, giving the answer at each stage.

Calculators are allowed.

Start each question on a fresh page.

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1. The position vector $\mathbf{r}$ of a particle of mass 3 kg at time t seconds is given by

$$\mathbf{r} = [(3\sin 2t)\mathbf{i} + (4\cos 2t)\mathbf{j})] \text{ m}.$$

Find when $t = \frac{\pi}{8}$,

(a) the magnitude of the momentum of the particle, **(6 marks)**

(b) the force acting on the particle, **(4 marks)**

(c) the power developed by the particle. **(3 marks)**

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2. (i) A body P of mass 10 kg, lying on a smooth plane inclined at 30° to the horizontal, is connected to another body Q, of mass 20 kg, by a light inextensible string which passes over a fixed smooth pulley at the top of the plane. The system is released from rest when Q is hanging vertically. Given that the coefficient of friction between P and the plane is $\frac{2}{5}$, find

(a) the acceleration of P, **(5 marks)**

(b) the tension in the string, **(2 marks)**

(c) the magnitude of the force exerted by the string on the pulley. **(2 marks)**

(ii) A particle moves in a circle of radius 2 m with an acceleration of $\frac{8\pi^2}{81}$ m s^{-2}.
Find its angular displacement in 3 s. **(4 marks)**

(Take g as 10 m s^{-2})

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3. Sphere A of mass 2 kg moving with speed 4 m s^{-1} along a horizontal smooth surface collides directly with sphere B of mass 8 kg initially at rest. Given that the coefficient of restitution between A and B is $\frac{1}{2}$, calculate

(a) the velocities of A and B after impact and comment on the result, **(7 marks)**

(b) the the magnitude of the impulse experience by A due to the impact, **(2 marks)**

(c) the total loss of kinetic energy due to the impact. **(4 marks)**

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4. (i) An elastic string AB, of natural length 1 m, has a particle of mass 2 kg attached to the end B and the end A is attached to a fixed point. When the system is in equilibrium with B hanging vertically below A, the length of the loaded string is 1.2 m.. Calculate the work that must be done in stretching the loaded string from a length of 1.5 m to a length of 1.75 m. **(6 marks)**

(ii). A car of mass 1000 kg moves along a straight horizontal road. The engine works at a constant rate of 50 kW against a constant resistance of magnitude 5000 N to the motion of the car.

(a) Find the maximum speed of the car. **(3 marks)**

(b) If the speed v of the car is not maximum, show that the acceleration a of the car is given by

$$a = \frac{50 - 5v}{v}.$$ **(4 marks)**

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5. A particle P is projected from a point O on a horizontal plane at time $t = 0$ with velocity $(5\mathbf{i} + 5\sqrt{3}\,\mathbf{j})$ m s^{-1}, where $\mathbf{i}$ and $\mathbf{j}$ are are unit vectors along Ox and Oy respectively.
Find,

(a) the cartesian equation of the trajectory of P, **(4 marks)**

(b) the maximum height which P attains above the horizontal plane through O, **(5 marks)**

(c) the distance of P from the point O when $t = 2$ s. **(4 marks)**

(Take g as 10 m s^{-2})

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6. (i) Forces $\mathbf{F}_1 = (-\mathbf{i} + 2\mathbf{j} + \mathbf{k})$ N and $\mathbf{F}_2 = (3\mathbf{i} + 6\mathbf{k})$ N act through the point with position vectors $\mathbf{r}_1 = (\mathbf{i} - \mathbf{j} + 3\mathbf{k})$ m and $\mathbf{r}_2 = (-3\mathbf{i} + \mathbf{j} - 2\mathbf{k})$ m respectively.
Show that the lines of action of these forces intersect and find the position vector of their point of intersection. **(10 marks)**

(ii) The acceleration of a particle starting from rest is $\frac{10}{v}$ m s^{-2}, where v is the speed of the particle at time t seconds.
Find the speed of the particle when $t = 5$. **(3 marks)**

7.

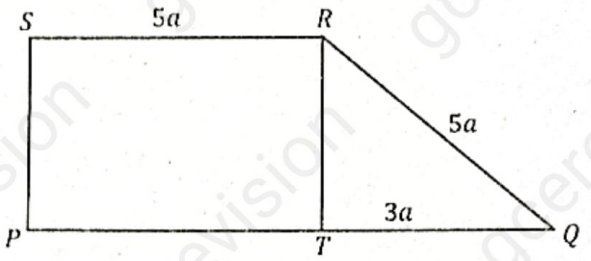

Fig. 1

Fig. 1 shows a uniform lamina in the form of a trapezium where $QR = RS = 5a$ and $TQ = 3a$.
(a) Find the distances from PS and PQ of the centre of mass of the lamina. **(11 marks)**

If the lamina is freely suspended from S,
(b) calculate the tangent of the angle the edge PS makes with the vertical. **(2 marks)**

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8 (i) Two events A and B are such that $P(A) = \frac{3}{5}$, $P(A \cup B) = \frac{7}{10}$ and $P(A \cap B') = \frac{3}{10}$.

Find $P(B)$ **(5 marks)**

(ii) At lunch time, a man can choose at random from three restaurants X, Y or Z to have lunch with probabilities 0.5, 0.1 and 0.4 respectively. His choice will be ready at X, Y and Z for lunch (L) with probabilities 0.25, 0.3 and 0.2 respectively.
Find the probability that
(a) the man will have lunch, **(3 marks)**
(b) the man will not have lunch, **(2 marks)**
(c) Y is chosen given that man will have lunch. **(3 marks)**

GO BACK AND CHECK YOUR WORK