WELSH JOINT EDUCATION COMMITTEE
General Certificate of Education
Advanced Subsidiary/Advanced

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980/01

MATHEMATICS M1

Mechanics 1

A.M. MONDAY, 16 January 2006

(1 $\frac{1}{2}$ hours)

NEW SPECIFICATION

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

- a 12 page answer book;
- a Formula Booklet;
- a calculator.

INSTRUCTIONS TO CANDIDATES

Answer **all** questions.

Take g as 9·8 ms $^{-2}$.

INFORMATION FOR CANDIDATES

Graphical calculators may be used for this paper.

The number of marks is given in brackets at the end of each question or part-question.

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

1. A small object, of mass 0·02kg at the top of a building 160 m high, is dropped from rest.

(a) Ignoring air resistance, calculate

(i) the speed of the object as it hits the ground,

(ii) the time taken for the object to reach the ground. [6]

(b) Assuming that the air resistance has magnitude 0·096 N, calculate

(i) the magnitude of the acceleration of the object,

(ii) the height of the object above the ground 4 s after it was dropped. [6]

2. Two spheres *A* and *B,* of equal radii, lie at rest on a smooth horizontal table. Sphere *A* has mass $2m$ kg and sphere *B* has mass $16m$ kg. Sphere *A* is projected with speed 3 ms^{-1} towards sphere *B* and collides directly with it. The coefficient of restitution between *A* and *B* is $\frac{1}{2}$.

(a) Find the speeds of *A* and *B* after the collision. [7]

(b) Determine the magnitude and direction of the impulse exerted by *B* on *A,* stating your units. [4]

3. At time $t = 0$, Car *A,* which is travelling at a constant speed of 20 ms^{-1} on a straight horizontal road, overtakes Car *B* travelling at a speed of 15 ms^{-1}. Car *B* immediately accelerates uniformly and, *T* seconds later, it overtakes Car *A,* which has kept its speed at 20 ms^{-1}. The distance travelled by each car in time *T* is 600 m.

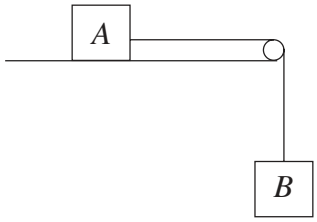
(a) Show that $T = 30$. [1]

(b) Calculate the magnitude of the acceleration of car *B*. [3]

(c) Find the speed of car *B* at the moment it overtakes car *A*. [3]

(d) On the same diagram, draw velocity-time graphs for *A* and *B*. Find the time when the speeds of cars *A* and *B* are equal. [4]

4. The diagram shows a body *A*, of mass 9 kg, connected by a light inextensible string passing over a smooth light pulley to a body *B*, of mass 5 kg. Body *A* is on a rough horizontal table and body *B* is hanging freely. The coefficient of friction between the body *A* and the table is μ.



(a) If the system is in equilibrium, show that $\mu \geqslant \frac{5}{9}$. [5]

(b) If $\mu = 0{\cdot}5$,

(i) show that the magnitude of the acceleration of the body *A* is $0{\cdot}35\ \text{ms}^{-2}$,

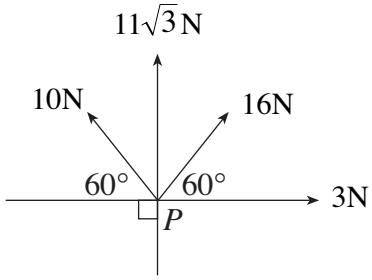
(ii) calculate the tension in the string. [8]

5. A **non-uniform** rod *AB*, of mass 7·5 kg and length 8 m, rests horizontally in equilibrium on two smooth supports at *C* and *D*, where *AC* = 1·5 m and *AD* = 5·0 m. The reaction of the support at *D* on the rod is 56·7 N.

(a) Calculate the distance of the centre of gravity of the rod from *C*. [4]

(b) Determine the reaction of the support at *C* on the rod. [2]

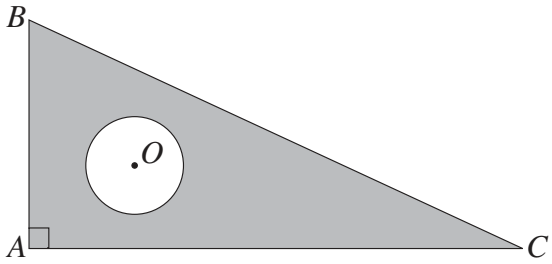
6. Four coplanar forces of magnitudes 10 N, $11\sqrt{3}$ N, 16 N and 3 N act at the point *P* in the directions as shown in the diagram.



Resolve the forces in two perpendicular directions and deduce the magnitude and direction of the resultant force. [10]

TURN OVER.

7. A uniform lamina consists of a right-angled triangle ABC with a circular hole, of radius 1·5 cm, cut out of it. Lengths AB = 7 cm, AC = 10 cm and the centre O of the circular hole is 2·5 cm from AB and 2·5 cm from AC.



(a) Find, correct to two decimal places, the distance of the centre of mass of the lamina from

(i) AB,

(ii) AC. [10]

(b) The lamina is freely suspended from A and hangs in equilibrium. Calculate the angle AC makes with the vertical. [2]