GCE AS/A level

0980/01

MATHEMATICS – M1
Mechanics 1

A.M. TUESDAY, 10 June 2014

1 hour 30 minutes

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Answer **all** questions.

Take g as $9{\cdot}8\,\text{ms}^{-2}$.

Sufficient working must be shown to demonstrate the **mathematical** method employed.

INFORMATION FOR CANDIDATES

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 crate of mass 25 kg rests on the floor of a lift, which is descending. Find the reaction of the floor of the lift on the crate when

(a) the acceleration of the lift is $1{\cdot}2\,\text{ms}^{-2}$, [3]

(b) the velocity of the lift is constant. [1]

2. A vehicle travels along a straight horizontal road. As it passes point *A* with speed $10\,\text{ms}^{-1}$, it accelerates at a constant rate for 21 s until it reaches a speed of $24\,\text{ms}^{-1}$. It then travels at this constant speed of $24\,\text{ms}^{-1}$ for T s before decelerating at a uniform rate, coming to rest at a point *B*. The time taken to decelerate to rest is 16 s.

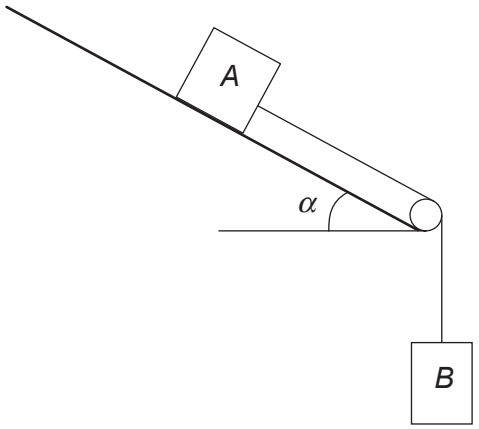
(a) Calculate the magnitude of the acceleration of the vehicle. [3]

(b) Determine the distance taken for the vehicle to decelerate to rest. [3]

(c) Draw a sketch of the velocity-time graph for the motion of the vehicle between *A* and *B*. [4]

(d) Given that the distance between *A* and *B* is 15 000 m, find the value of T. [4]

3. The diagram below shows two objects connected by means of a light inextensible string passing over a smooth light pulley. The pulley is fixed at the bottom of a rough plane inclined at an angle α to the horizontal, where $\tan\alpha = \frac{3}{4}$. Object *A*, of mass 7 kg, lies on the inclined plane and object *B*, of mass 3 kg, is hanging freely. The coefficient of friction between the plane and object *A* is 0·6.



Initially, the objects are held at rest with the string just taut. The objects are then released so that *A* slides down the plane.

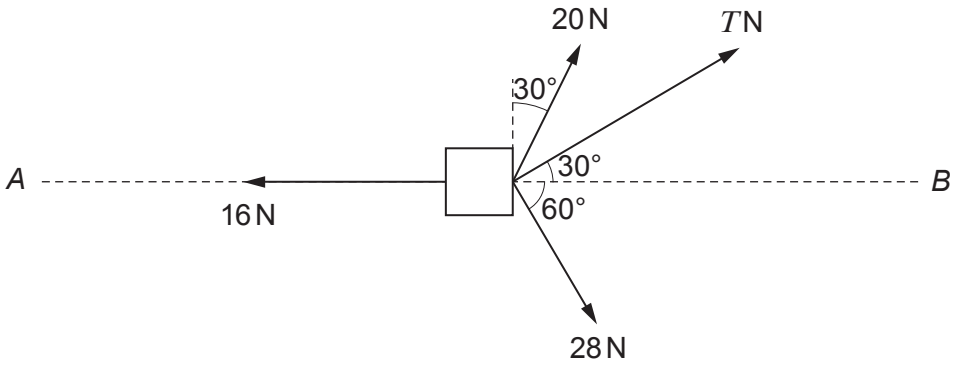
(a) Determine the magnitude of the frictional force acting on *A*. [3]

(b) Calculate the magnitude of the acceleration of the objects and the tension in the string. [7]

4. The diagram shows a uniform rod AB, of length 1·8 m and mass 3 kg, held in horizontal equilibrium by two small fixed cylinders C and D. An object of mass 12 kg rests on the rod at B. The length AC is 0·3 m and CD, the distance between the cylinders, is 0·4 m. The force exerted on the rod by each of the cylinders is vertical.

Find the magnitude of each of the forces exerted on the rod by the cylinders. [7]

5. An object of mass 80 kg is being dragged along a straight line AB by means of three horizontal forces of magnitude and direction as shown in the diagram. The resistance to the motion of the object is constant and of magnitude 16 N.



(a) Show that $T = 8\sqrt{3}$. [3]

(b) Determine the magnitude of the acceleration of the object. [4]

(c) When the object is moving with a speed of 12 ms^{-1}, the three horizontal forces of 20 N, 28 N, and T N are removed. Calculate the time taken for the speed of the object to reduce to 4 ms^{-1}. [5]

6. A sphere A of mass 3 kg, moving with speed 2 ms^{-1}, collides directly with another sphere B, of mass 7 kg, moving in the opposite direction with speed 5 ms^{-1}. The coefficient of restitution between the spheres is 0·6.

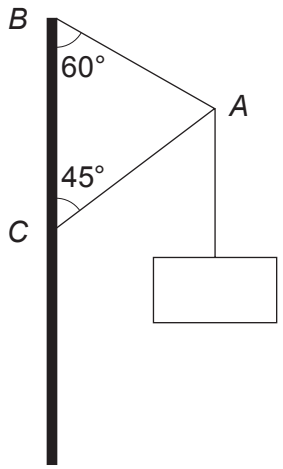
(a) Calculate the speed of sphere A and the speed of sphere B immediately after the collision. [7]

(b) Determine the impulse exerted by sphere A on sphere B during the collision. [2]

(c) After the collision with sphere B, sphere A collides with a wall which is perpendicular to the line of motion of the spheres. It rebounds with speed 3·65 ms^{-1}. Determine the coefficient of restitution between the wall and sphere A. [1]

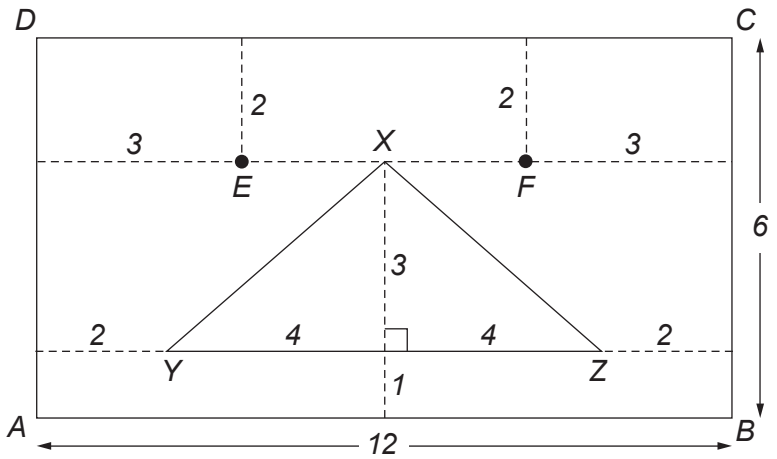
TURN OVER.

7. The diagram shows an object of mass 9 kg attached at a point *A* to two light rigid supports *AB* and *AC*. The support *AB* is inclined at an angle of 60° to the vertical and the support *AC* is inclined at an angle of 45° to the vertical.



Calculate the tension in *AB* and the thrust in *AC*. [7]

8. A piece of jewellery is made up of a uniform rectangular lamina *ABCD* with an isosceles triangle *XYZ* **removed** and two stones *E* and *F* **added**.
In triangle *XYZ, XY = XZ*.
YZ is parallel to *AB*.
The stone *E* has a mass twice that of the removed triangle *XYZ* and the stone *F* has a mass three times that of the triangle *XYZ*.
The dimensions, in cm, are as shown in the diagram.



(a) Calculate the distance of the centre of mass of the piece of jewellery from

(i) *AD,*
(ii) *AB*. [10]

(b) The piece of jewellery is suspended freely from a point *P* on *DC* so that *AD* is vertical. Determine the length of *PC*. [1]

END OF PAPER

