



GCE AS/A level

0980/01

MATHEMATICS – M1

Mechanics 1

A.M. TUESDAY, 10 June 2014

1 hour 30 minutes plus your additional time allowance

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, black ball-point pen or your usual method.

Answer ALL questions.

Take g as 9.8 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 **1.2 ms^{-2}** [3 marks]

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

2. A vehicle travels along a straight horizontal road.

As it passes point **A** with speed 10 ms^{-1} , it

accelerates at a constant rate for **21 s** until it

reaches a speed of 24 ms^{-1} . It then travels

at this constant speed of 24 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**

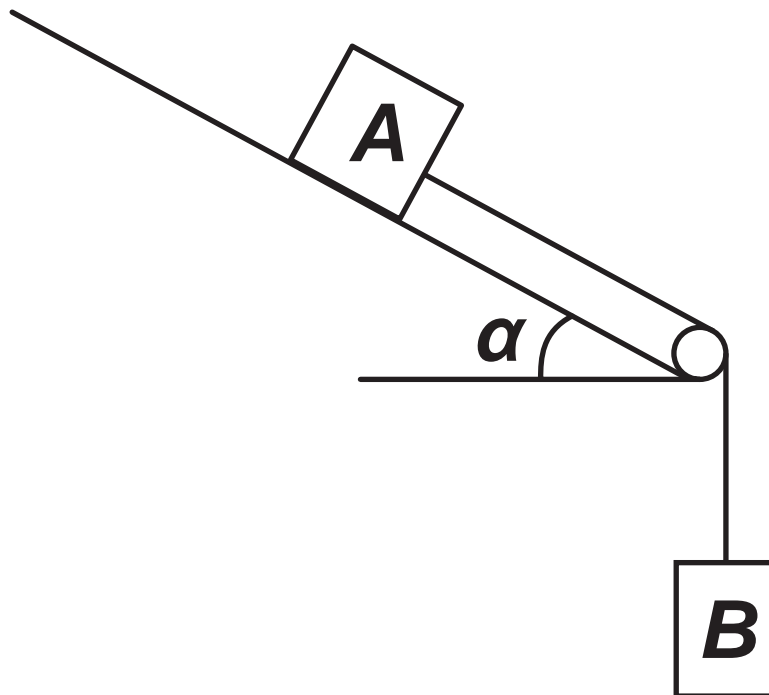
(a) Calculate the magnitude of the acceleration of the vehicle. [3 marks]

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

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

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

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.

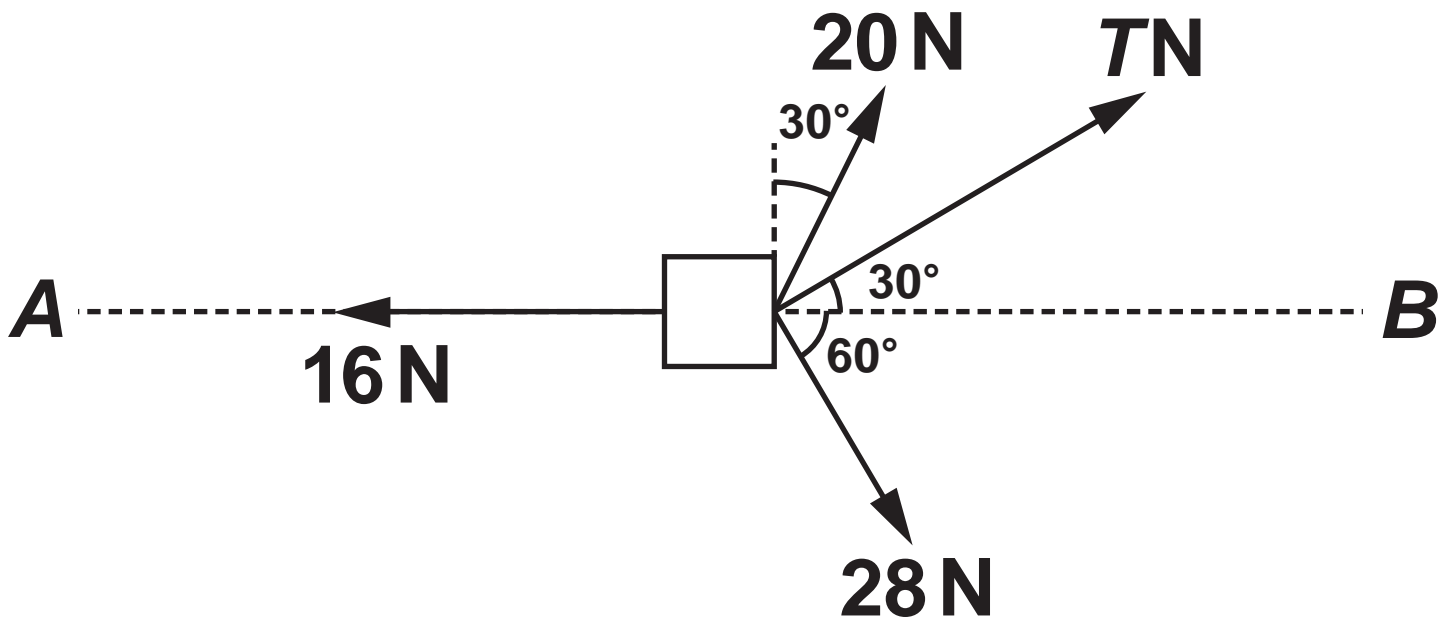
- 3(a) Determine the magnitude of the frictional force acting on **A** [3 marks]
- (b) Calculate the magnitude of the acceleration of the objects and the tension in the string. [7 marks]

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 marks]

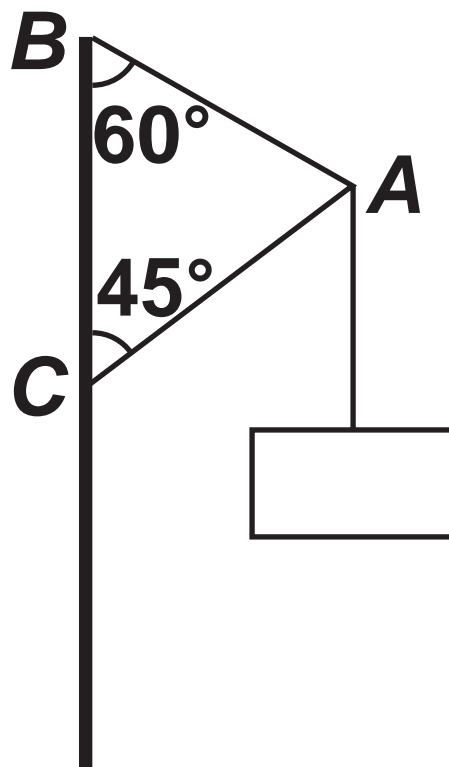
5. An object of mass **80 kg** is being dragged along a straight line ***AB*** by means of three horizontal forces of magnitude and direction as shown in the diagram. The resistance to the motion of the object is constant and of magnitude **16 N**



- 5(a) Show that $T = 8\sqrt{3}$ [3 marks]
- (b) Determine the magnitude of the acceleration of the object. [4 marks]
- (c) When the object is moving with a speed of 12 ms^{-1} , the three horizontal forces of 20 N , 28 N , and $T \text{ N}$ are removed. Calculate the time taken for the speed of the object to reduce to 4 ms^{-1} [5 marks]

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

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 marks]

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 opposite.

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

(i) AD

(ii) AB

[10 marks]

- (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 mark]

