Paper Reference(s)

6677

Edexcel GCE

Mechanics M1

Advanced/Advanced Subsidiary

Tuesday 4 November – Morning

Time: 1 hour 30 minutes

Materials required for examination	**Items included with question papers**
Answer Book (AB16)	Nil
Mathematical Formulae (Lilac)	
Graph Paper (ASG2)	

Candidates may use any calculator EXCEPT those with the facility for symbolic algebra, differentiation and/or integration. Thus candidates may NOT use calculators such as the Texas Instruments TI 89, TI 92, Casio CFX 9970G, Hewlett Packard HP 48G.

Instructions to Candidates

In the boxes on the answer book, write the name of the examining body (Edexcel), your centre number, candidate number, the unit title (Mechanics M1), the paper reference (6677), your surname, other name and signature.
Whenever a numerical value of g is required, take $g = 9.8$ m s^{-2}.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
This paper has seven questions.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner. Answers without working may gain no credit.

1. A small ball is projected vertically upwards from a point A. The greatest height reached by the ball is 40 m above A. Calculate

    (*a*) the speed of projection,

    (3)

    (*b*) the time between the instant that the ball is projected and the instant it returns to A.

    (3)

2. A railway truck S of mass 2000 kg is travelling due east along a straight horizontal track with constant speed 12 m s^{-1}. The truck S collides with a truck T which is travelling due west along the same track as S with constant speed 6 m s^{-1}. The magnitude of the impulse of T on S is 28 800 Ns.

    (*a*) Calculate the speed of S immediately after the collision.

    (3)

    (*b*) State the direction of motion of S immediately after the collision.
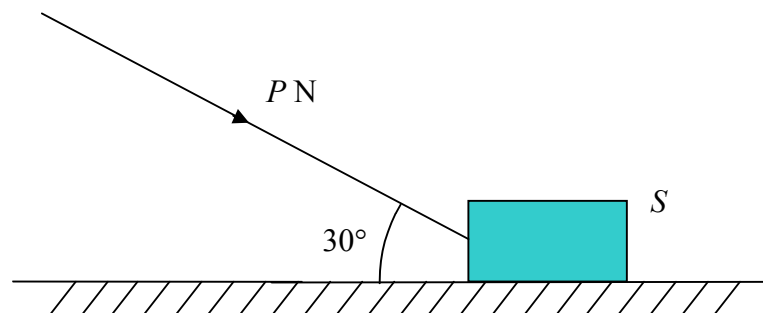
    (1)

    Given that, immediately after the collision, the speed of T is 3.6 m s^{-1}, and that T and S are moving in opposite directions,

    (*c*) calculate the mass of T.

    (4)

3.

<div align="center">Figure 1</div>

    A heavy suitcase S of mass 50 kg is moving along a horizontal floor under the action of a force of magnitude P newtons. The force acts at 30° to the floor, as shown in Fig. 1, and S moves in a straight line at constant speed. The suitcase is modelled as a particle and the floor as a rough horizontal plane. The coefficient of friction between S and the floor is $\frac{3}{5}$.

    Calculate the value of P.

    (9)

4. A car starts from rest at a point *S* on a straight racetrack. The car moves with constant acceleration for 20 s, reaching a speed of 25 m s^{-1}. The car then travels at a constant speed of 25 m s^{-1} for 120 s. Finally it moves with constant deceleration, coming to rest at a point *F*.

(*a*) In the space below, sketch a speed-time graph to illustrate the motion of the car.

(2)

The distance between *S* and *F* is 4 km.

(*b*) Calculate the total time the car takes to travel from *S* to *F*.

(3)

A motorcycle starts at *S*, 10 s after the car has left *S*. The motorcycle moves with constant acceleration from rest and passes the car at a point *P* which is 1.5 km from *S*. When the motorcycle passes the car, the motorcycle is still accelerating and the car is moving at a constant speed. Calculate

(*c*) the time the motorcycle takes to travel from *S* to *P*,

(5)

(*d*) the speed of the motorcycle at *P*.

(2)

5. A particle *P* of mass 3 kg is moving under the action of a constant force **F** newtons. At *t* = 0, *P* has velocity (3**i** – 5**j**) m s^{-1}. At *t* = 4 s, the velocity of *P* is (–5**i** + 11**j**) m s^{-1}. Find

(*a*) the acceleration of *P*, in terms of **i** and **j**.

(2)

(*b*) the magnitude of **F**.

(4)

At *t* = 6 s, *P* is at the point *A* with position vector (6**i** – 29**j**) m relative to a fixed origin *O*. At this instant the force **F** newtons is removed and *P* then moves with constant velocity. Three seconds after the force has been removed, *P* is at the point *B*.

(*c*) Calculate the distance of *B* from *O*.

(6)

6.

<div align="center">Figure 2</div>
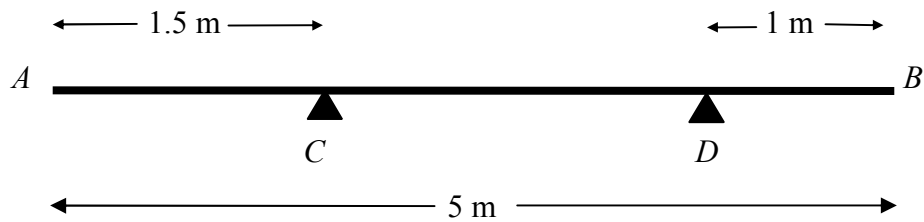
A non-uniform rod AB has length 5 m and weight 200 N. The rod rests horizontally in equilibrium on two smooth supports C and D, where $AC = 1.5$ m and $DB = 1$ m, as shown in Fig. 2. The centre of mass of AB is x metres from A. A particle of weight W newtons is placed on the rod at A. The rod remains in equilibrium and the magnitude of the reaction of C on the rod is 160 N.

(*a*) Show that $50x - W = 100$.

(5)

The particle is now removed from A and placed on the rod at B. The rod remains in equilibrium and the reaction of C on the rod now has magnitude 50 N.

(*b*) Obtain another equation connecting W and x.

(3)

(*c*) Calculate the value of x and the value of W.
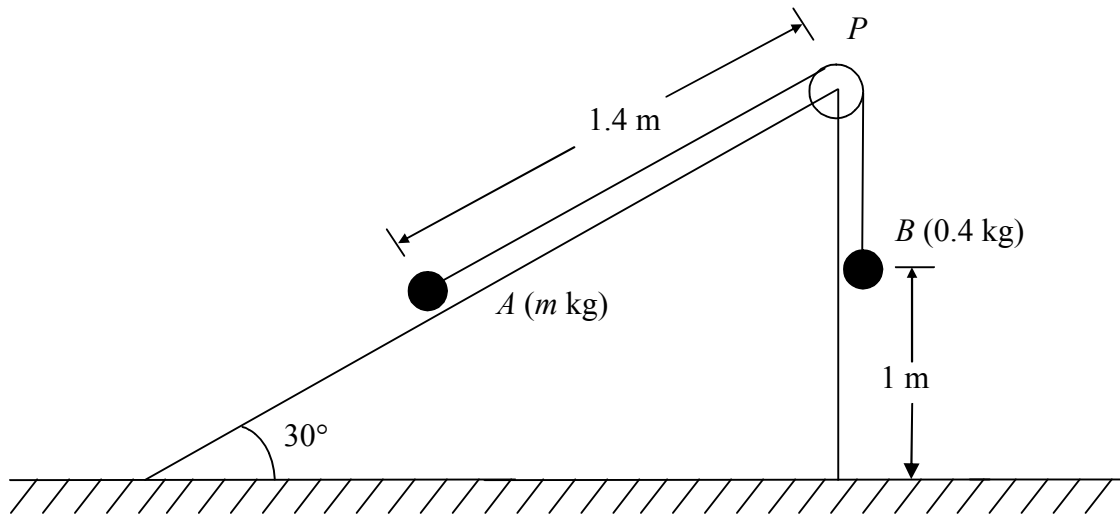
(4)

7.

Figure 3

Figure 3 shows two particles A and B, of mass m kg and 0.4 kg respectively, connected by a light inextensible string. Initially A is held at rest on a fixed smooth plane inclined at 30° to the horizontal. The string passes over a small light smooth pulley P fixed at the top of the plane. The section of the string from A to P is parallel to a line of greatest slope of the plane. The particle B hangs freely below P. The system is released from rest with the string taut and B descends with acceleration $\frac{1}{5}g$.

(*a*) Write down an equation of motion for B.

(2)

(*b*) Find the tension in the string.

(2)

(*c*) Prove that $m = \frac{16}{35}$.

(4)

(*d*) State where in the calculations you have used the information that P is a light smooth pulley.

(1)

On release, B is at a height of one metre above the ground and $AP = 1.4$ m. The particle B strikes the ground and does not rebound.

(*e*) Calculate the speed of B as it reaches the ground.

(2)

(*f*) Show that A comes to rest as it reaches P.

(5)

END