Paper Reference(s)

6677

Edexcel GCE

Mechanics M1

Advanced/Advanced Subsidiary

Monday 24 May 2004 – 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 $g = 9.8 \text{ m s}^{-2}$.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.

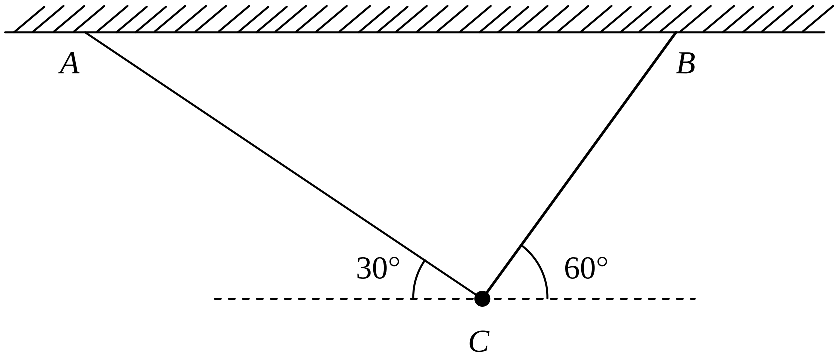
Information for Candidates

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. **Figure 1**



A particle of weight W newtons is attached at C to the ends of two light inextensible strings AC and BC. The other ends of the strings are attached to two fixed points A and B on a horizontal ceiling. The particle hangs in equilibrium with AC and BC inclined to the horizontal at 30° and 60° respectively, as shown in Fig.1. Given the tension in AC is 50 N, calculate

(*a*) the tension in BC, to 3 significant figures,

(3)

(*b*) the value of W.

(3)

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2. A particle P is moving with constant acceleration along a straight horizontal line ABC, where AC = 24 m. Initially P is at A and is moving with speed 5 m s^{-1} in the direction AB. After 1.5 s, the direction of motion of P is unchanged and P is at B with speed 9.5 m s^{-1}.

(*a*) Show that the speed of P at C is 13 m s^{-1}.

(4)

The mass of P is 2 kg. When P reaches C, an impulse of magnitude 30 Ns is applied to P in the direction CB.

(*b*) Find the velocity of P immediately after the impulse has been applied, stating clearly the direction of motion of P at this instant.

(3)

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3. A particle P of mass 2 kg is moving with speed u m s^{-1} in a straight line on a smooth horizontal plane. The particle P collides directly with a particle Q of mass 4 kg which is at rest on the same horizontal plane. Immediately after the collision, P and Q are moving in opposite directions and the speed of P is one-third the speed of Q.

(*a*) Show that the speed of P immediately after the collision is $\frac{1}{5}u$ m s^{-1}.

(4)

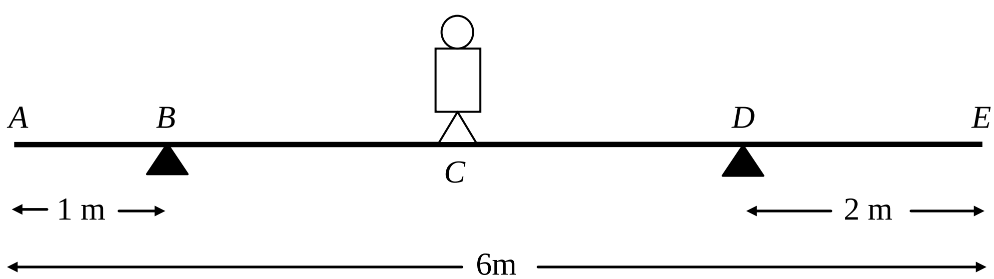
After the collision P continues to move in the same straight line and is brought to rest by a constant resistive force of magnitude 10 N. The distance between the point of collision and the point where P comes to rest is 1.6 m.

(*b*) Calculate the value of u.

(5)

4.

Figure 2



A plank AE, of length 6 m and mass 10 kg, rests in a horizontal position on supports at B and D, where AB = 1 m and DE = 2 m. A child of mass 20 kg stands at C, the mid-point of BD, as shown in Fig. 2. The child is modelled as a particle and the plank as a uniform rod. The child and the plank are in equilibrium. Calculate

(*a*) the magnitude of the force exerted by the support on the plank at B,

(4)

(*b*) the magnitude of the force exerted by the support on the plank at D.

(3)

The child now stands at a point F on the plank. The plank is in equilibrium and on the point of tilting about D.

(*c*) Calculate the distance DF.

(4)

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5. **Figure 3**

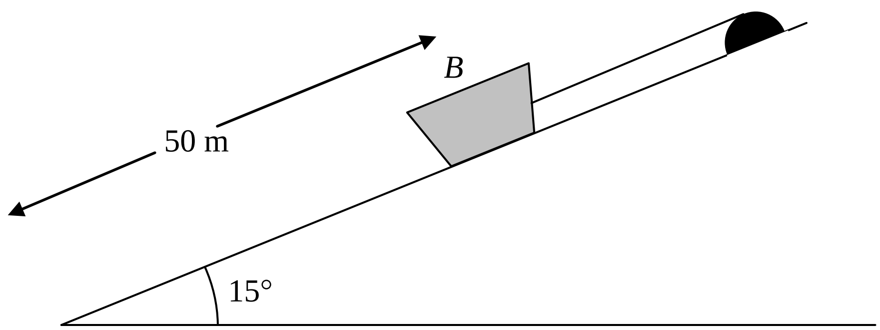

Figure 3 shows a boat *B* of mass 400 kg held at rest on a slipway by a rope. The boat is modelled as a particle and the slipway as a rough plane inclined at 15° to the horizontal. The coefficient of friction between *B* and the slipway is 0.2. The rope is modelled as a light, inextensible string, parallel to a line of greatest slope of the plane. The boat is in equilibrium and on the point of sliding down the slipway.

(*a*) Calculate the tension in the rope.

(6)

The boat is 50 m from the bottom of the slipway. The rope is detached from the boat and the boat slides down the slipway.

(*b*) Calculate the time taken for the boat to slide to the bottom of the slipway.

(6)

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6. A small boat *S*, drifting in the sea, is modelled as a particle moving in a straight line at constant speed. When first sighted at 0900, *S* is at a point with position vector $(4\mathbf{i} - 6\mathbf{j})$ km relative to a fixed origin *O*, where **i** and **j** are unit vectors due east and due north respectively. At 0945, *S* is at the point with position vector $(7\mathbf{i} - 7.5\mathbf{j})$ km. At time *t* hours after 0900, *S* is at the point with position vector **s** km.

(*a*) Calculate the bearing on which *S* is drifting.

(4)

(*b*) Find an expression for **s** in terms of *t*.

(3)

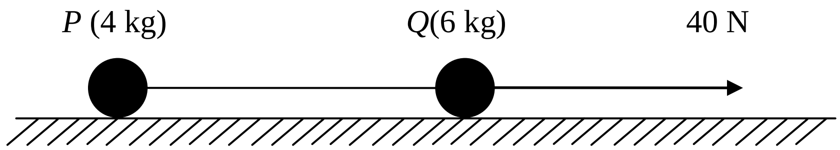
At 1000 a motor boat *M* leaves *O* and travels with constant velocity $(p\mathbf{i} + q\mathbf{j})$ km h^{-1}. Given that *M* intercepts *S* at 1015,

(*c*) calculate the value of *p* and the value of *q*.

(6)

7.

Figure 4



Two particles P and Q, of mass 4 kg and 6 kg respectively, are joined by a light inextensible string. Initially the particles are at rest on a rough horizontal plane with the string taut. The coefficient of friction between each particle and the plane is $\frac{2}{7}$. A constant force of magnitude 40 N is then applied to Q in the direction PQ, as shown in Fig. 4.

(*a*) Show that the acceleration of Q is 1.2 m s^{-2}.

(4)

(*b*) Calculate the tension in the string when the system is moving.

(3)

(*c*) State how you have used the information that the string is inextensible.

(1)

After the particles have been moving for 7 s, the string breaks. The particle Q remains under the action of the force of magnitude 40 N.

(*d*) Show that P continues to move for a further 3 seconds.

(5)

(*e*) Calculate the speed of Q at the instant when P comes to rest.

(4)

END