Edexcel GCE

Mechanics M1
(New Syllabus)
Advanced/Advanced Subsidiary
Thursday 23 May 2002 – Afternoon
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. Pages 7 and 8 are blank.

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 car moves with constant acceleration along a straight horizontal road. The car passes the point A with speed 5 m s^{-1} and 4 s later it passes the point B, where $AB = 50\text{m}$.

   (*a*) Find the acceleration of the car.

   (3)

   When the car passes the point C, it has speed 30 m s^{-1}.

   (*b*) Find the distance AC.

   (3)

2. The masses of two particles A and B are 0.5 kg and m kg respectively. The particles are moving on a smooth horizontal table in opposite directions and collide directly. Immediately before the collision the speed of A is 5 m s^{-1} and the speed of B is 3 m s^{-1}. In the collision, the magnitude of the impulse exerted by B on A is 3.6 Ns. As a result of the collision the direction of motion of A is reversed.

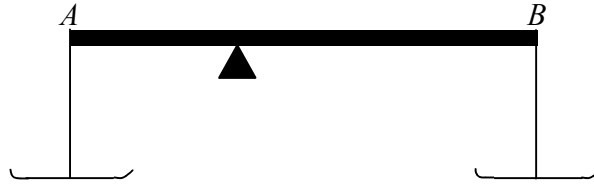   (*a*) Find the speed of A immediately after the collision.

   (3)

   The speed of B immediately after the collision is 1 m s^{-1}.

   (*b*) Find the two possible values of m.

   (4)

3.

Figure 1

A uniform rod *AB* has length 100 cm. Two light pans are suspended, one from each end of the rod, by two strings which are assumed to be light and inextensible. The system forms a balance with the rod resting horizontally on a smooth pivot, as shown in Fig. 1.

A particle of weight 16 N is placed in the pan at *A* and a particle of weight 5 N is placed in the pan at *B*. The rod rests horizontally in equilibrium when the pivot is at the point *C* on the rod, where *AC* = 30 cm.

(*a*) Find the weight of the rod.

(3)

The particle in the pan at *A* is replaced by a particle of weight 3.5 N. The particle of weight 5 N remains in the pan at *B*. The rod now rests horizontally in equilibrium when the pivot is moved to the point *D*.

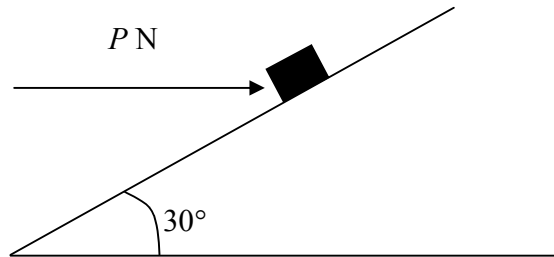(*b*) Find the distance *AD*.

(4)

(*c*) Explain briefly where the assumption that the strings are light has been used in your answer to part (*a*).

(1)

4.

Figure 2

A box of mass 6 kg lies on a rough plane inclined at an angle of 30° to the horizontal. The box is held in equilibrium by means of a horizontal force of magnitude *P* newtons, as shown in Fig. 2. The line of action of the force is in the same vertical plane as a line of greatest slope of the plane. The coefficient of friction between the box and the plane is 0.4. The box is modelled as a particle.

Given that the box is in limiting equilibrium and on the point of moving up the plane, find,

(*a*) the normal reaction exerted on the box by the plane,

(4)

(b) the value of *P*.

(3)

The horizontal force is removed.

(*c*) Show that the box will now start to move down the plane.

(5)

5. A particle *P* of mass 2 kg moves in a plane under the action of a single constant force **F** newtons. At time *t* seconds, the velocity of *P* is **v** m s^{-1}. When *t* = 0, **v** = (−5**i** + 7**j**) and when *t* = 3, **v** = (**i** − 2**j**).

(*a*) Find in degrees the angle between the direction of motion of *P* when *t* = 3 and the vector **j.**

(3)

(*b*) Find the acceleration of *P.*

(2)

(*c*) Find the magnitude of **F**.

(3)

(*d*) Find in terms of *t* the velocity of *P.*

(2)

(*e*) Find the time at which *P* is moving parallel to the vector **i** + **j**.

(3)

6. A man travels in a lift to the top of a tall office block. The lift starts from rest on the ground floor and moves vertically. It comes to rest again at the top floor, having moved a vertical distance of 27 m. The lift initially accelerates with a constant acceleration of 2 m s^{-1} until it reaches a speed of 3 m s^{-1}. It then moves with a constant speed of 3 m s^{-1} for T seconds. Finally it decelerates with a constant deceleration for 2.5 s before coming to rest at the top floor.

(*a*) Sketch a speed-time graph for the motion of the lift.

(2)

(*b*) Hence, or otherwise, find the value of T.

(3)

(*c*) Sketch an acceleration-time graph for the motion of the lift.

(3)

The mass of the man is 80 kg and the mass of the lift is 120 kg. The lift is pulled up by means of a vertical cable attached to the top of the lift. By modelling the cable as light and inextensible, find

(*d*) the tension in the cable when the lift is accelerating,
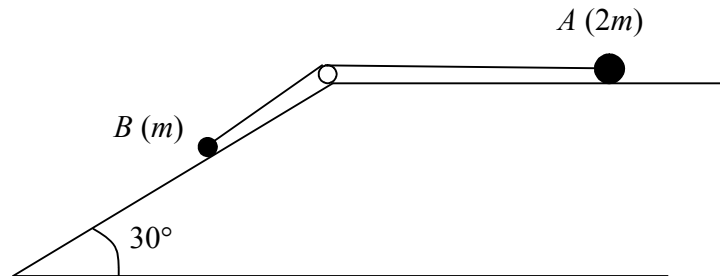
(3)

(*e*) the magnitude of the force exerted by the lift on the man during the last 2.5 s of the motion.

(3)

TURN OVER FOR QUESTION 7

7.   **Figure 3**

Particles A and B, of mass $2m$ and m respectively, are attached to the ends of a light inextensible string. The string passes over a small smooth pulley fixed at the edge of a rough horizontal table. Particle A is held on the table, while B rests on a smooth plane inclined at 30° to the horizontal, as shown in Fig. 3. The string is in the same vertical plane as a line of greatest slope of the inclined plane. The coefficient of friction between A and the table is μ. The particle A is released from rest and begins to move.

By writing down an equation of motion for each particle,

(*a*) show that, while both particles move with the string taut. each particle has an acceleration of magnitude $\frac{1}{6}(1 - 4\mu)g$.

(7)

When each particle has moved a distance h, the string breaks. The particle A comes to rest before reaching the pulley. Given that $\mu = 0.2$,

(b) find, in terms of h, the total distance moved by A.

(6)

For the model described above,

(c) state two physical factors, **apart** from air resistance, which could be taken into account to make the model more realistic.

(2)

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END