Paper Reference(s)

6677

Edexcel GCE

Mechanics M1

Advanced/Advanced Subsidiary

Monday 19 May 2003 – Morning

Time: 1 hour 30 minutes

Materials required for examination papers	**Items included with question**
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.

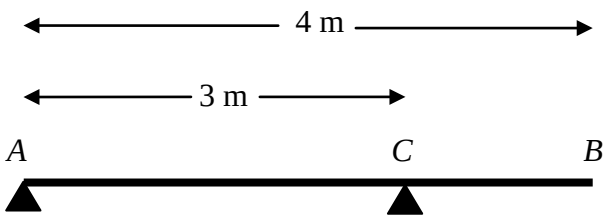
Information for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
This paper has eight 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 uniform plank *AB* has mass 40 kg and length 4 m. It is supported in a horizontal position by two smooth pivots, one at the end *A*, the other at the point *C* of the plank where *AC* = 3 m, as shown in Fig. 1. A man of mass 80 kg stands on the plank which remains in equilibrium. The magnitudes of the reactions at the two pivots are each equal to *R* newtons. By modelling the plank as a rod and the man as a particle, find

(*a*) the value of *R*,

(2)

(*b*) the distance of the man from *A*.

(4)

---

2. Two particles *A* and *B* have mass 0.12 kg and 0.08 kg respectively. They are initially at rest on a smooth horizontal table. Particle *A* is then given an impulse in the direction *AB* so that it moves with speed 3 m s^{-1} directly towards *B*.

(*a*) Find the magnitude of this impulse, stating clearly the units in which your answer is given.

(2)

Immediately after the particles collide, the speed of *A* is 1.2 m s^{-1}, its direction of motion being unchanged.

(*b*) Find the speed of *B* immediately after the collision.

(3)

(*c*) Find the magnitude of the impulse exerted on *A* in the collision.

(2)

---

3. A competitor makes a dive from a high springboard into a diving pool. She leaves the springboard vertically with a speed of 4 m s^{-1} upwards. When she leaves the springboard, she is 5 m above the surface of the pool. The diver is modelled as a particle moving vertically under gravity alone and it is assumed that she does not hit the springboard as she descends. Find

(*a*) her speed when she reaches the surface of the pool,

(3)

(*b*) the time taken to reach the surface of the pool.

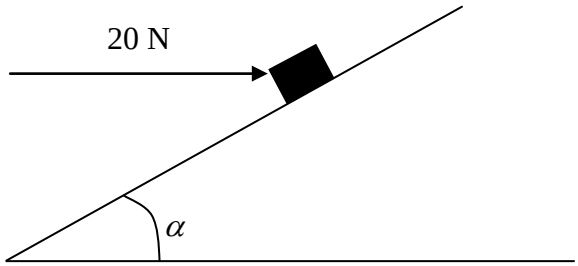
(3)

(*c*) State two physical factors which have been ignored in the model.

(2)

---

4. **Figure 2**



A parcel of mass 5 kg lies on a rough plane inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$. The parcel is held in equilibrium by the action of a horizontal force of magnitude 20 N, as shown in Fig. 2. The force acts in a vertical plane through a line of greatest slope of the plane. The parcel is on the point of sliding down the plane. Find the coefficient of friction between the parcel and the plane.

(8)

---

5. A particle *P* moves with constant acceleration $(2\mathbf{i} - 3\mathbf{j})$ m s^{-2}. At time *t* seconds, its velocity is $\mathbf{v}$ m s^{-1}. When $t = 0$, $\mathbf{v} = -2\mathbf{i} + 7\mathbf{j}$.

(*a*) Find the value of *t* when *P* is moving parallel to the vector **i**.

(4)

(*b*) Find the speed of *P* when $t = 3$.

(3)

(*c*) Find the angle between the vector **j** and the direction of motion of *P* when $t = 3$.

(3)

---

6. A particle P of mass 3 kg is projected up a line of greatest slope of a rough plane inclined at an angle of 30° to the horizontal. The coefficient of friction between P and the plane is 0.4. The initial speed of P is 6 m s^{-1}. Find

(*a*) the frictional force acting on P as it moves up the plane,

(4)

(*b*) the distance moved by P up the plane before P comes to instantaneous rest.

(7)

---

7. Two trains A and B run on parallel straight tracks. Initially both are at rest in a station and level with each other. At time $t = 0$, A starts to move. It moves with constant acceleration for 12 s up to a speed of 30 m s^{-1}, and then moves at a constant speed of 30 m s^{-1}. Train B starts to move in the same direction as A when $t = 40$, where t is measured in seconds. It accelerates with the same initial acceleration as A, up to a speed of 60 m s^{-1}. It then moves at a constant speed of 60 m s^{-1}. Train B overtakes A after both trains have reached their maximum speed. Train B overtakes A when $t = T$.

(*a*) Sketch, on the same diagram, the speed-time graphs of both trains for $0 \leq t \leq T$.

(3)

(*b*) Find the value of T.

(9)

---

8. A car which has run out of petrol is being towed by a breakdown truck along a straight horizontal road. The truck has mass 1200 kg and the car has mass 800 kg. The truck is connected to the car by a horizontal rope which is modelled as light and inextensible. The truck's engine provides a constant driving force of 2400 N. The resistances to motion of the truck and the car are modelled as constant and of magnitude 600 N and 400 N respectively. Find

(*a*) the acceleration of the truck and the ear,

(3)

(*b*) the tension in the rope.

(3)

When the truck and car are moving at 20 m s^{-1}, the rope breaks. The engine of the truck provides the same driving force as before. The magnitude of the resistance to the motion of the truck remains 600 N.

(*c*) Show that the truck reaches a speed of 28 m s^{-1} approximately 6 s earlier than it would have done if the rope had not broken.

(7)

END