Paper Reference(s)

6677

Edexcel GCE

Mechanics M1

Advanced/Advanced Subsidiary

Monday 12 January 2004 – 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 $g = 9.8 \text{ m s}^{-2}$.
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. Two trucks A and B, moving in opposite directions on the same horizontal railway track, collide. The mass of A is 600 kg. The mass of B is m kg. Immediately before the collision, the speed of A is 4 m s^{-1} and the speed of B is 2 m s^{-1}. Immediately after the collision, the trucks are joined together and move with the same speed 0.5 m s^{-1}. The direction of motion of A is unchanged by the collision. Find

(*a*) the value of m,

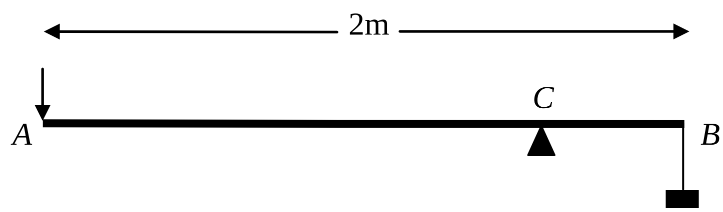
(4)

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

(3)

2.

Figure 1



A lever consists of a uniform steel rod AB, of weight 100 N and length 2 m, which rests on a small smooth pivot at a point C of the rod. A load of weight 2200 N is suspended from the end B of the rod by a rope. The lever is held in equilibrium in a horizontal position by a vertical force applied at the end A, as shown in Fig. 1. The rope is modelled as a light string.

Given that BC = 0.2 m,

(*a*) find the magnitude of the force applied at A.

(4)

The position of the pivot is changed so that the rod remains in equilibrium when the force at A has magnitude 120N.

(*b*) Find, to the nearest cm, the new distance of the pivot from B.

(5)

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3. The tile on a roof becomes loose and slides from rest down the roof. The roof is modelled as a plane surface inclined at 30° to the horizontal. The coefficient of friction between the tile and the roof is 0.4. The tile is modelled as a particle of mass *m* kg.

(*a*) Find the acceleration of the tile as it slides down the roof.

(7)

The tile moves a distance 3 m before reaching the edge of the roof.

(*b*) Find the speed of the tile as it reaches the edge of the roof.

(2)

(*c*) Write down the answer to part (*a*) if the tile had mass 2*m* kg.

(1)

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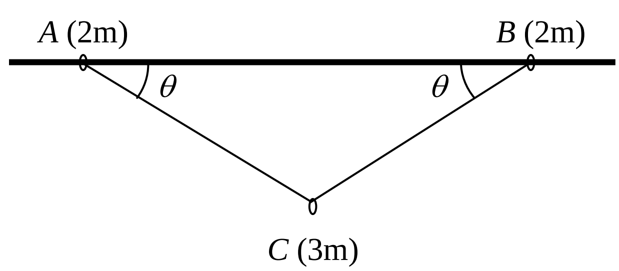
4. **Figure 2**



Two small rings, *A* and *B*, each of mass 2*m*, are threaded on a rough horizontal pole. The coefficient of friction between each ring and the pole is μ. The rings are attached to the ends of a light inextensible string. *A* smooth ring *C*, of mass 3*m*, is threaded on the string and hangs in equilibrium below the pole. The rings *A* and *B* are in limiting equilibrium on the pole, with $\angle BAC = \angle ABC = \theta$, where $\tan\theta = \frac{3}{4}$, as shown in Fig. 2.

(*a*) Show that the tension in the string is $\frac{5}{2}mg$.

(3)

(*b*) Find the value of μ.

(7)

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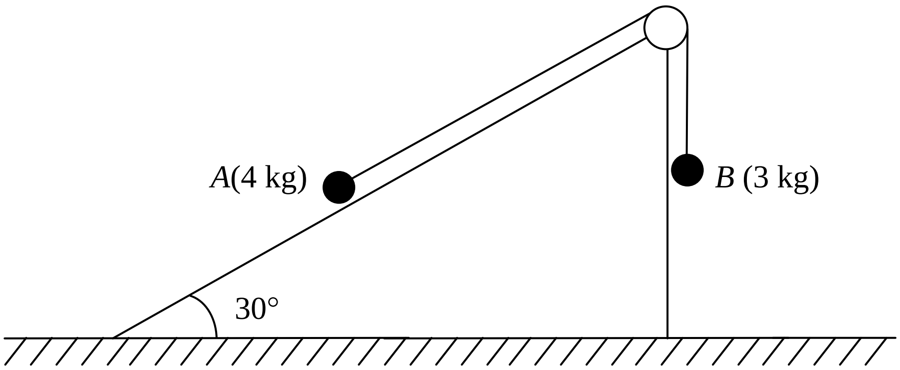
5. **Figure 3**



A particle *A* of mass 4 kg moves on the inclined face of a smooth wedge. This face is inclined at 30° to the horizontal. The wedge is fixed on horizontal ground. Particle *A* is connected to a particle *B*, of mass 3 kg, by a light inextensible string. The string passes over a small light smooth pulley which is fixed at the top of the plane. The section of the string from *A* to the pulley lies in a line of greatest slope of the wedge. The particle *B* hangs freely below the pulley, as shown in Fig. 3. The system is released from rest with the string taut. For the motion before *A* reaches the pulley and before *B* hits the ground, find

(*a*) the tension in the string,

(6)

(*b*) the magnitude of the resultant force exerted by the string on the pulley.

(3)

(*c*) The string in this question is described as being 'light'.

(i) Write down what you understand by this description.

(ii) State how you have used the fact that the string is light in your answer to part (*a*).

(2)

6. A train starts from rest at a station *A* and moves along a straight horizontal track. For the first 10 s, the train moves with constant acceleration 1.2 m s^{-2}. For the next 24 s it moves at a constant acceleration 0.75 m s^{-2}. It then moves with constant speed for *T* seconds. Finally it slows down with constant deceleration 3 m s^{-2} until it comes to a rest at station *B*.

(*a*) Show that, 34 s after leaving *A*, the speed of the train is 30 m s^{-1}.

(3)

(*b*) Sketch a speed-time graph to illustrate the motion of the train as it moves from *A* to *B*.

(3)

(*c*) Find the distance moved by the train during the first 34 s of its journey from *A*.

(4)

The distance from *A* to *B* is 3 km.

(*d*) Find the value of *T*.

(4)

7. [*In this question the vectors* **i** *and* **j** *are horizontal unit vectors in the direction due east and due north respectively*.]

Two boats *A* and *B* are moving with constant velocities. Boat *A* moves with velocity 9**j** km h^{-1}. Boat *B* moves with velocity (3**i** + 5**j**) km h^{-1}.

(*a*) Find the bearing on which *B* is moving.

(2)

At noon, *A* is at point *O*, and *B* is 10 km due west of *O*. At time *t* hours after noon, the position vectors of *A* and *B* relative to *O* are **a** km and **b** km respectively.

(*b*) Find expressions for **a** and **b** in terms of *t*, giving your answer in the form *p***i** + *q***j**.

(3)

(*c*) Find the time when *B* is due south of *A*.

(2)

At time t hours after noon, the distance between *A* and *B* is *d* km. By finding an expression for $\overrightarrow{AB}$,

(*d*) show that $d^2 = 25t^2 - 60t + 100$.

(4)

At noon, the boats are 10 km apart.

(*e*) Find the time after noon at which the boats are again 10 km apart.

(3)

END