Paper Reference(s)

6677

Edexcel GCE

Mechanics M1

Advanced/Advanced Subsidiary

Tuesday 2 November 2004 – Morning

Time: 1 hour 30 minutes

Materials required for examination
Answer Book (AB16)
Mathematical Formulae (Lilac)
Graph Paper (ASG2)

Items included with question papers
Nil

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. A man is driving a car on a straight horizontal road. He sees a junction S ahead, at which he must stop. When the car is at the point P, 300 m from S, its speed is $30\ \text{m s}^{-1}$. The car continues at this constant speed for 2 s after passing P. The man then applies the brakes so that the car has constant deceleration and comes to rest at S.

(a) Sketch, in the space below, a speed-time graph to illustrate the motion of the car in moving from P to S.

(2)

(b) Find the time taken by the car to travel from P to S.

(3)

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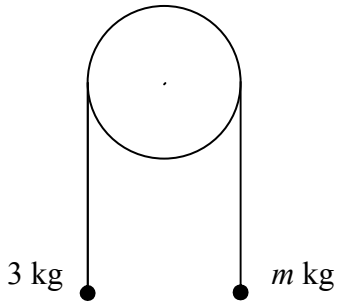
2. **Figure 1**



The particles have mass 3 kg and m kg, where $m < 3$. They are attached to the ends of a light inextensible string. The string passes over a smooth fixed pulley. The particles are held in position with the string taut and the hanging parts of the string vertical, as shown in Figure 1. The particles are then released from rest. The initial acceleration of each particle has magnitude $\frac{3}{7}g$. Find

(a) the tension in the string immediately after the particles are released,

(3)

(b) the value of m.

(4)

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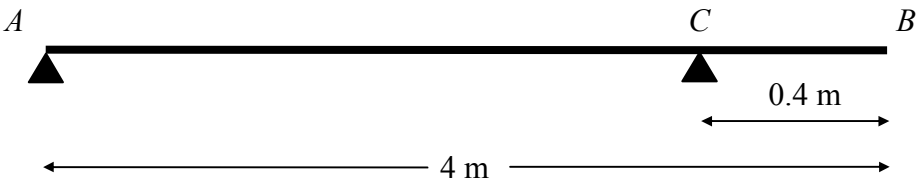
3. **Figure 2**



A plank of wood AB has mass 10 kg and length 4 m. It rests in a horizontal position on two smooth supports. One support is at the end A. The other is at the point C, 0.4 m from B, as shown in Figure 2. A girl of mass 30 kg stands at B with the plank in equilibrium. By modelling the plank as a uniform rod and the girl as a particle,

(a) find the reaction on the plank at A.

(4)

The girl gets off the plank. A boulder of mass m kg is placed on the plank at A and a man of mass 80 kg stands on the plank at B. The plank remains in equilibrium and is on the point of tilting about C. By modelling the plank again as a uniform rod, and the man and the boulder as particles,

(b) find the value of m.

(4)

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4. A tent peg is driven into soft ground by a blow from a hammer. The tent peg has mass 0.2 kg and the hammer has mass 3 kg. The hammer strikes the peg vertically.

Immediately before the impact, the speed of the hammer is $16\ \text{m s}^{-1}$. It is assumed that, immediately after the impact, the hammer and the peg move together vertically downwards.

(a) Find the common speed of the peg and the hammer immediately after the impact.

(3)

Until the peg and hammer come to rest, the resistance exerted by the ground is assumed to be constant and of magnitude R newtons. The hammer and peg are brought to rest 0.05 s after the impact.

(b) Find, to 3 significant figures, the value of R.

(5)

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5. A particle P moves in a horizontal plane. The acceleration of P is $(-\mathbf{i} + 2\mathbf{j})$ m s^{-2}. At time $t = 0$, the velocity of P is $(2\mathbf{i} - 3\mathbf{j})$ m s^{-1}.

(a) Find, to the nearest degree, the angle between the vector $\mathbf{j}$ and the direction of motion of P when $t = 0$.

(3)

At time t seconds, the velocity of P is $\mathbf{v}$ m s^{-1}. Find

(b) an expression for $\mathbf{v}$ in terms of t, in the form $a\mathbf{i} + b\mathbf{j}$,

(2)

(c) the speed of P when $t = 3$,

(3)

(d) the time when P is moving parallel to $\mathbf{i}$.

(2)

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6. Two cars A and B are moving in the same direction along a straight horizontal road. At time $t = 0$, they are side by side, passing a point O on the road. Car A travels at a constant speed of 30 m s^{-1}. Car B passes O with a speed of 20 m s^{-1}, and has constant acceleration of 4 m s^{-2}.

Find

(a) the speed of B when it has travelled 78 m from O,

(2)

(b) the distance from O of A when B is 78 m from O,

(4)

(c) the time when B overtakes A.

(5)

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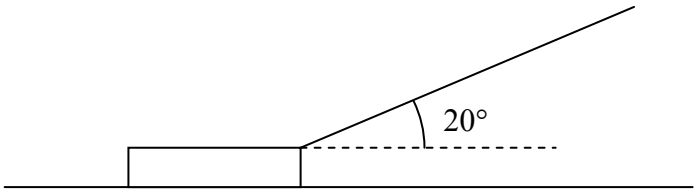
7. **Figure 3**



A sledge has mass 30 kg. The sledge is pulled in a straight line along horizontal ground by means of a rope. The rope makes an angle 20° with the horizontal, as shown in Figure 3. The coefficient of friction between the sledge and the ground is 0.2. The sledge is modelled as a particle and the rope as a light inextensible string. The tension in the rope is 150 N. Find, to 3 significant figures,

(*a*) the normal reaction of the ground on the sledge,

(3)

(*b*) the acceleration of the sledge.

(3)

When the sledge is moving at 12 m s^{-1}, the rope is released from the sledge.

(*c*) Find, to 3 significant figures, the distance travelled by the sledge from the moment when the rope is released to the moment when the sledge comes to rest.

(6)

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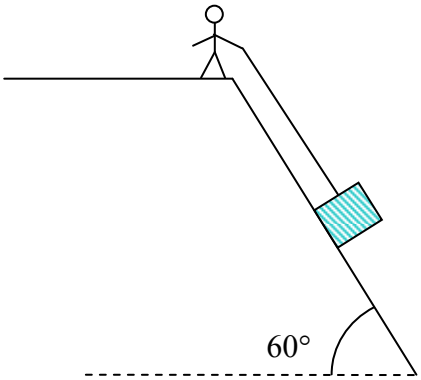
8. **Figure 4**



A heavy package is held in equilibrium on a slope by a rope. The package is attached to one end of the rope, the other end being held by a man standing at the top of the slope. The package is modelled as a particle of mass 20 kg. The slope is modelled as a rough plane inclined at 60° to the horizontal and the rope as a light inextensible string. The string is assumed to be parallel to a line of greatest slope of the plane, as shown in Figure 4. At the contact between the package and the slope, the coefficient of friction is 0.4.

(*a*) Find the minimum tension in the rope for the package to stay in equilibrium on the slope.

(8)

The man now pulls the package up the slope. Given that the package moves at constant speed,

(*b*) find the tension in the rope.

(4)

(*c*) State how you have used, in your answer to part (*b*), the fact that the package moves

(i) up the slope,

(ii) at constant speed.

(2)

END