Paper Reference(s)

6677

Edexcel GCE

Mechanics M1
(New Syllabus)
Advanced/Advanced Subsidiary
Tuesday 5 November 2002 – 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 $g = 9.8$ m s^{-2}.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.

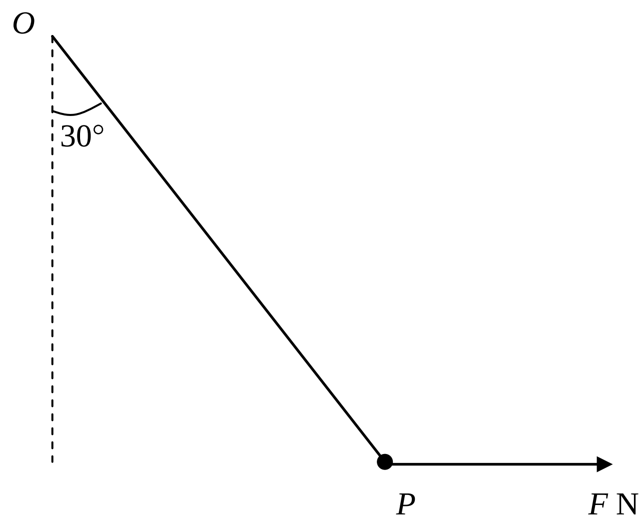
Information for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
This paper has eight questions. 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. **Figure 1**



A particle P of weight 6 N is attached to one end of a light inextensible string. The other end of the string is attached to a fixed point O. A horizontal force of magnitude F newtons is applied to P. The particle P is in equilibrium under gravity with the string making an angle of 30° with the vertical, as shown in Fig. 1. Find, to 3 significant figures,

(*a*) the tension in the string,

(3)

(*b*) the value of F.

(3)

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2. A particle P of mass 1.5 kg is moving under the action of a constant force $(3\mathbf{i} - 7.5\mathbf{j})$ N. Initially P has velocity $(2\mathbf{i} + 3\mathbf{j})$ m s^{-1}. Find

(*a*) the magnitude of the acceleration of P,

(4)

(*b*) the velocity of P, in terms of $\mathbf{i}$ and $\mathbf{j}$, when P has been moving for 4 seconds.

(3)

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3. A car accelerates uniformly from rest to a speed of 20 m s^{-1} in T seconds. The car then travels at a constant speed of 20 m s^{-1} for $4T$ seconds and finally decelerates uniformly to rest in a further 50 s.

(*a*) Sketch a speed-time graph to show the motion of the car.

(2)

The total distance travelled by the car is 1220 m. Find

(*b*) the value of T,

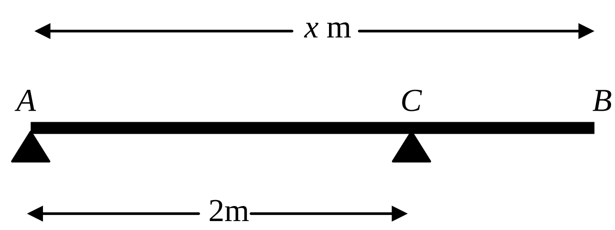
(3)

(*c*) the initial acceleration of the car.

(2)

4.

Figure 2



A uniform plank *AB* has weight 80 N and length *x* metres. The plank rests in equilibrium horizontally on two smooth supports at *A* and *C*, where *AC* = 2m, as shown in Fig. 2. A rock of weight 20 N is placed at *B* and the plank remains in equilibrium. The reaction on the plank at *C* has magnitude 90 N. The plank is modelled as a rod and the rock as a particle.

(*a*) Find the value of *x*.

(4)

(*b*) State how you have used the model of the rock as a particle.

(1)

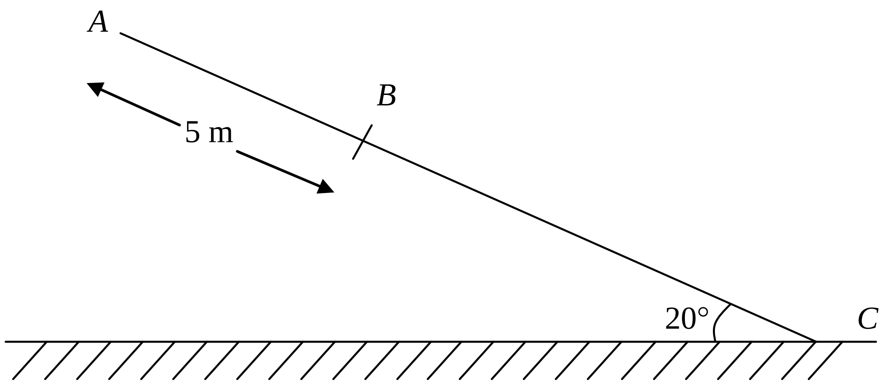
The support at *A* is now moved to a point *D* on the plank and the plank remains in equilibrium with the rock at *B*. The reaction on the plank at *C* is now three times the reaction at *D*.

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

(4)

Turn over

5. **Figure 3**



A suitcase of mass 10 kg slides down a ramp which is inclined at an angle of 20° to the horizontal. The suitcase is modelled as a particle and the ramp as a rough plane. The top of the plane is *A*. The bottom of the plane is *C* and *AC* is a line of greatest slope, as shown in Fig. 3. The point *B* is on *AC* with *AB* = 5 m. The suitcase leaves *A* with a speed of 10 m s^{-1} and passes *B* with a speed of 8 m s^{-1}. Find

(*a*) the decleration of the suitcase,

(2)

(*b*) the coefficient of friction between the suitcase and the ramp.

(6)

The suitcase reaches the bottom of the ramp.

(*c*) Find the greatest possible length of *AC*.

(2)

6. A railway truck P of mass 1500 kg is moving on a straight horizontal track. The truck P collides with a truck Q of 2500 kg at a point A. Immediately before the collision, P and Q are moving in the same direction with speeds 10 m s^{-1} and 5 m s^{-1} respectively. Immediately after the collision, the direction of motion of P is unchanged and its speed is 4 m s^{-1}. By modelling the trucks as particles,

(*a*) show that the speed of Q immediately after the collision is 8.6 m s^{-1}.

(3)

After the collision at A, the truck P is acted upon by a constant braking force of magnitude 500 N. The truck P comes to rest at the point B.

(*b*) Find the distance AB.

(3)

After the collision Q continues to move with constant speed 8.6 m s^{-1}.

(*c*) Find the distance between P and Q at the instant when P comes to rest.

(5)

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7. Two helicopters P and Q are moving in the same horizontal plane. They are modelled as particles moving in straight lines with constant speeds. At noon P is at the point with position vector $(20\mathbf{i} + 35\mathbf{j})$ km with respect to a fixed origin O. At time t hours after noon the position vector of P is $\mathbf{p}$ km. When $t = \frac{1}{2}$ the position vector of P is $(50\mathbf{i} - 25\mathbf{j})$ km. Find

(*a*) the velocity of P in the form $(a\mathbf{i} + b\mathbf{j}) \text{ km h}^{-1}$,

(2)

(*b*) an expression for $\mathbf{p}$ in terms of t.

(2)

At noon Q is at O and at time t hours after noon the position vector of Q is $\mathbf{q}$ km. The velocity of Q has magnitude 120 km h^{-1} in the direction of $4\mathbf{i} - 3\mathbf{j}$. Find

(*d*) an expression for $\mathbf{q}$ in terms of t,

(3)

(*e*) the distance, to the nearest km, between P and Q when $t = 2$.

(4)

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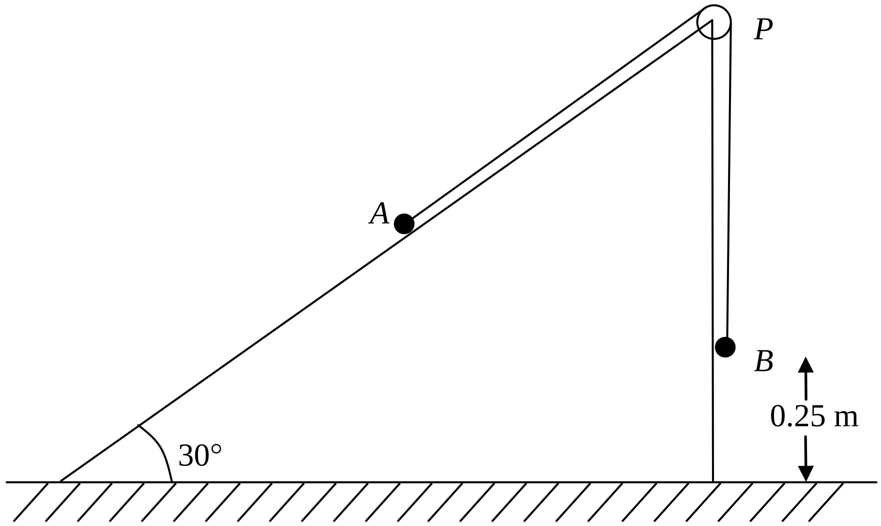
8. **Figure 4**



Two particles A and B, of mass m kg and 3 kg respectively, are connected by a light inextensible string. The particle A is held resting on a smooth fixed plane inclined at 30° to the horizontal. The string passes over a smooth pulley P fixed at the top of the plane. The portion AP of the string lies along a line of greatest slope of the plane and B hangs freely from the pulley, as shown in Fig. 4. The system is released from rest with B at a height of 0.25 m above horizontal ground. Immediately after release, B descends with an acceleration of $\frac{2}{5}g$. Given that A does not reach P, calculate

(*a*) the tension in the string while B is descending,

(3)

(*b*) the value of m.

(4)

The particle B strikes the ground and does not rebound. Find

(*c*) the magnitude of the impulse exerted by B on the ground,

(3)

(*d*) the time between the instant when B strikes the ground and the instant when A reaches its highest point.

(4)

END