Paper Reference(s)

6677

Edexcel GCE

Mechanics M1
(New Syllabus)
Advanced/Advanced Subsidiary
Friday 12 January 2001 − Afternoon
Time: 1 hour 30 minutes

Materials required for examination	**Items included with question papers**
Answer Book (AB16)	Nil
Graph Paper (GP02)	
Mathematical Formulae	

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 6, 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.

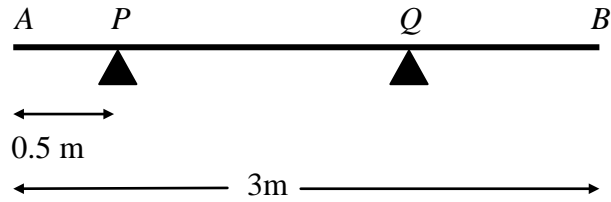**1.**

Fig. 1

A uniform rod AB has weight 70 N and length 3m. It rests in a horizontal position on two smooth supports placed at P and Q, where $AP = 0.5$ m, as shown in Fig. 1. The reaction on the rod at P has magnitude 20 N. Find

(*a*) the magnitude of the reaction on the rod at Q,   **(2 marks)**

(*b*) the distance AQ.   **(4 marks)**
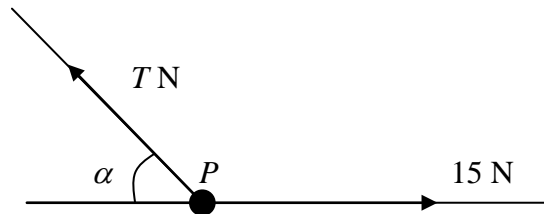
2.

Fig. 2

A particle P of mass 2 kg is held in equilibrium under gravity by two light inextensible strings. One string is horizontal and the other is inclined at an angle α to the horizontal, as shown in Fig. 2. The tension in the horizontal string is 15 N. The tension in the other string is T newtons.

(*a*) Find the size of the angle α.   **(6 marks)**

(*b*) Find the value of T.   **(2 marks)**
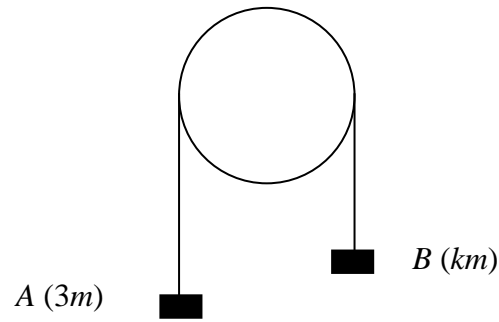
3.

Fig. 3

Two particles *A* and *B* have masses *3m* and *km* respectively, where *k* > 3. They are connected by a light inextensible string which passes over a smooth fixed pulley. The system is released from rest with the string taut and the hanging parts of the string vertical, as shown in Fig. 3. While the particles are moving freely, *A* has an acceleration of magnitude $\frac{2}{5}g$.

(*a*) Find, in terms of *m* and g, the tension in the string. **(3 marks)**

(*b*) State why *B* also has an acceleration of magnitude $\frac{2}{5}g$. **(1 mark)**

(*c*) Find the value of *k*. **(4 marks)**

(*d*) State how you have used the fact that the string is light. **(1 mark)**

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4. A particle *P* moves in a straight line with constant velocity. Initially *P* is at the point *A* with position vector $(2\mathbf{i} - \mathbf{j})$ m relative to a fixed origin *O,* and 2 s later it is at the point *B* with position vector $(6\mathbf{i} + \mathbf{j})$ m.

(*a*) Find the velocity of *P*. **(3 marks)**

(*b*) Find, in degrees to one decimal place, the size of the angle between the direction of motion of *P* and the vector **i**. **(2 marks)**

Three seconds after it passes *B* the particle *P* reaches the point *C*.

(*c*) Find, in m to one decimal place, the distance *OC*. **(4 marks)**

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5. Two small balls *A* and *B* have masses 0.6 kg and 0.2 kg respectively. They are moving towards each other in opposite directions on a horizontal table when they collide directly. Immediately before the collision, the speed of *A* is 4.5 m s^{-1} and the speed of *B* is 3 m s^{-1}. Immediately after the collision, *A* and *B* move in the same direction and the speed of *B* is twice the speed of *A*.

By modelling the balls as particles, find

(*a*) the speed of *B* immediately after the collision, **(4 marks)**

(*b*) the magnitude of the impulse exerted on *B* in the collision, stating the units in which your answer is given. **(3 marks)**

The table is rough. After the collision, *B* moves a distance of 2 m on the table before coming to rest.

(*c*) Find the coefficient of friction between *B* and the table. **(6 marks)**

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6. A parachutist drops from a helicopter *H* and falls vertically from rest towards the ground. Her parachute opens 2 s after she leaves *H* and her speed then reduces to 4 m s^{-1}. For the first 2 s her motion is modelled as that of a particle falling freely under gravity. For the next 5 s the model is motion with constant deceleration, so that her speed is 4 m s^{-1} at the end of this period. For the rest of the time before she reaches the ground, the model is motion with constant speed of 4 m s^{-1}.

(*a*) Sketch a speed-time graph to illustrate her motion from *H* to the ground.
(3 marks)

(*b*) Find her speed when the parachute opens. **(2 marks)**

A safety rule states that the helicopter must be high enough to allow the parachute to open and for the speed of a parachutist to reduce to 4 m s^{-1} before reaching the ground. Using the assumptions made in the above model,

(*c*) find the minimum height of *H* for which the woman can make a drop without breaking this safety rule. **(5 marks)**

Given that *H* is 125 m above the ground when the woman starts her drop,

(*d*) find the total time taken for her to reach the ground. **(4 marks)**

(*e*) State one way in which the model could be refined to make it more realistic.
(1 mark)

7. A sledge of mass 78 kg is pulled up a slope by means of a rope. The slope is modelled as a rough plane inclined at an angle α to the horizontal, where $\tan \alpha = \frac{5}{12}$. The rope is modelled as light and inextensible and is in a line of greatest slope of the plane. The coefficient of friction between the sledge and the slope is 0.25. Given that the sledge is accelerating up the slope with acceleration 0.5 m s^{-2},

(*a*) find the tension in the rope. **(9 marks)**

The rope suddenly breaks. Subsequently the sledge comes to instantaneous rest and then starts sliding down the slope.

(*b*) Find the acceleration of the sledge down the slope *after* it has come to instantaneous rest. **(6 marks)**

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