Oxford Cambridge and RSA

AS Level Mathematics A

H230/02 Pure Mathematics and Mechanics

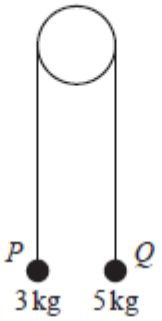
Question Set 2

1 In this question the horizontal unit vectors **i** and **j** are in the directions east and north respectively.

A model ship of mass 2 kg is moving so that its acceleration vector $\mathbf{a}\,\text{m s}^{-2}$ at time t seconds is given by $\mathbf{a} = 3(2t-5)\mathbf{i}+4\mathbf{j}$. When $t = T$, the magnitude of the horizontal force acting on the ship is 10 N.

Find the possible values of T. **[4]**

2 Particles P and Q, of masses 3 kg and 5 kg respectively, are attached to the ends of a light inextensible string. The string passes over a smooth fixed pulley. The system is held at rest with the string taut. The hanging parts of the string are vertical and P and Q are above a horizontal plane (see diagram).

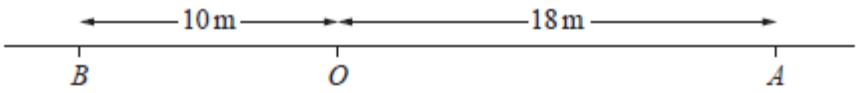


(a) Find the tension in the string immediately after the particles are released. **[4]**

After descending 2.5 m, Q strikes the plane and is immediately brought to rest. It is given that P does not reach the pulley in the subsequent motion.

(b) Find the distance travelled by P between the instant when Q strikes the plane and the instant when the string becomes taut again. **[4]**

3



A particle P is moving along a straight line with constant acceleration. Initially the particle is at O. After 9 s, P is at a point A, where $OA = 18$ m (see diagram) and the velocity of P at A is $8\,\text{m s}^{-1}$ in the direction $\overrightarrow{OA}$.

(a) **(i)** Show that the initial speed of P is $4\,\text{m s}^{-1}$. **[2]**

(ii) Find the acceleration of P. **[2]**

B is a point on the line such that $OB = 10$ m, as shown in the diagram.

(b) Show that P is never at point B. **[4]**

A second particle Q moves along the same straight line, but has variable acceleration. Initially Q is at O, and the displacement of Q from O at time t seconds is given by

$$x = at^3 + bt^2 + ct,$$

where a, b and c are constants.

It is given that

- the velocity and acceleration of Q at the point O are the same as those of P at O,
- Q reaches the point A when $t = 6$.

(c) Find the velocity of Q at A. **[5]**

Total Marks for Question Set 2: 25