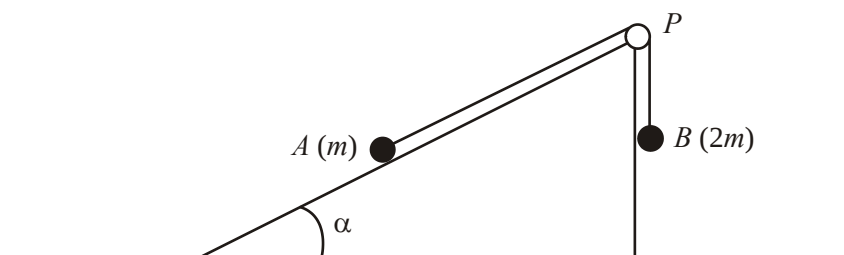


1.



Two particles A and B , of mass m and $2m$ respectively, are attached to the ends of a light inextensible string. The particle A lies on a rough plane inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$. The string passes over a small light smooth pulley P fixed at the top of the plane. The particle B hangs freely below P , as shown in the diagram above. The particles are released from rest with the string taut and the section of the string from A to P parallel to a line of greatest slope of the plane. The coefficient of friction between A and the plane is $\frac{5}{8}$. When each particle has moved a distance h , B has not reached the ground and A has not reached P .

- (a) Find an expression for the potential energy lost by the system when each particle has moved a distance h .

(2)

When each particle has moved a distance h , they are moving with speed v . Using the work energy principle,

- (b) find an expression for v^2 , giving your answer in the form kgh , where k is a number.

(5)

(Total 7 marks)

1. (a) PE lost = $2mgh - mgh \sin \alpha (= 7mgh/5)$ M1A1 2

(b) Normal reaction $R = mg \cos \alpha (= 4mg/5)$ B1

Work-energy: $\frac{1}{2}mv^2 + \frac{1}{2} \cdot 2mv^2 = \frac{7mgh}{5} - \frac{5}{8} \cdot \frac{4mg}{5} \cdot h$ M1A2,1,0

$\Rightarrow \frac{3}{2}mv^2 = \frac{9mgh}{10} \Rightarrow v^2 = \frac{3}{5}gh$ A1 5

M1 Two term expression for PE lost. Condone sign errors and sin/cos confusion, but must be vertical distance moved for A.

A1 Both terms correct, $\sin \alpha$ correct, but need not be simplified. Allow $13.72mh$. Unambiguous statement.

B1 Normal reaction between A and the plane. Allow when seen in (b) provided it is clearly the normal reaction. Must use $\cos \alpha$ but need not be substituted.

M1 (NB QUESTION SPECIFIES WORK & ENERGY) substitute into equation of the form

PE lost = Work done against friction plus KE gained. Condone sign errors. They *must include KE of both particles*.

A1A1 All three elements correct (including signs)

A1A0 Two elements correct, but followed their GPE and μx their $R \times h$.

A1 v^2 correct (NB kg specified in the Q)

[7]

1. Many candidates lost several marks on this question. Some simply did not attempt the question, other presented confident, but incorrect working.
- (a) Many errors were made; some were simply a case of the ambiguous answer “loss of GPE $= -\frac{7mgh}{5}$ ”, but it was also common to see both particles regarded as losing GPE, or the assumption that both particles move a vertical distance h .
- (b) Some candidates clearly did not want to attempt this using work and energy. Those who did often tried to look at each particle separately rather than consider the system as a whole, and often ran into difficulties, double counting some elements. The normal reaction was usually identified correctly, leading to a correct expression for the work done against the frictional force. Two particularly common errors were the omission of the kinetic energy of B (giving an equation with $\frac{1}{2}mv^2$ rather than $\frac{3}{2}mv^2$), and double counting the increase in GPE for A .