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International Examinations Papers
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# Mechanics

## TOPIC- Energy, Work & Power

## PRINCIPLE

0 1 Loads $A$ and $B$, of masses 1.2 kg and 2.0 kg respectively, are attached to the ends of a light inextensible string which passes over a fixed smooth pulley. $A$ is held at rest and $B$ hangs freely, with both straight parts of the string vertical. $A$ is released and starts to move upwards. It does not reach the pulley in the subsequent motion.

**(i)** Find the acceleration of $A$ and the tension in the string. [4]


**(ii)** Find, for the first 1.5 metres of $A$'s motion,

**(a)** $A$'s gain in potential energy,

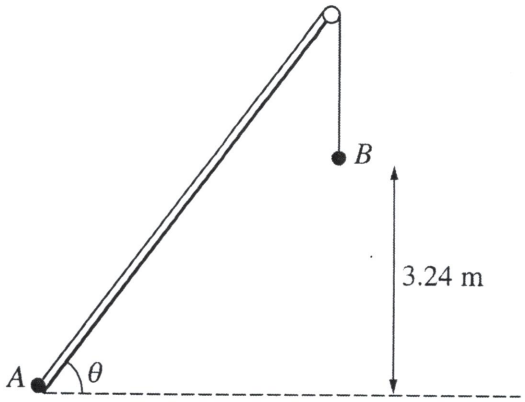
**(b)** the work done on $A$ by the tension in the string,

**(c)** $A$'s gain in kinetic energy. [3]

$B$ hits the floor 1.6 seconds after $A$ is released. $B$ comes to rest without rebounding and the string becomes slack.

**(iii)** Find the time from the instant the string becomes slack until it becomes taut again. [4]

2



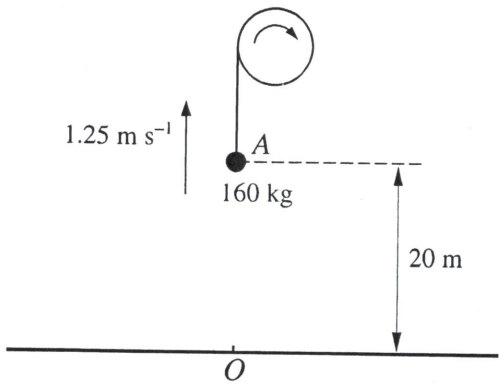



Particle A of mass 1.6 kg and particle B of mass 2 kg are attached to opposite ends of a light inextensible string. The string passes over a small smooth pulley fixed at the top of a smooth plane, which is inclined at angle $\theta$, where $\sin\theta = 0.8$. Particle A is held at rest at the bottom of the plane and B hangs at a height of 3.24 m above the level of the bottom of the plane (see diagram). A is released from rest and the particles start to move. 43-J-13

(i) Show that the loss of potential energy of the system, when B reaches the level of the bottom of the plane, is 23.328 J. [3]

(ii) Hence find the speed of the particles when B reaches the level of the bottom of the plane. [2]

3






A load of mass 160 kg is pulled vertically upwards, from rest at a fixed point $O$ on the ground, using a winding drum. The load passes through a point $A$, 20 m above $O$, with a speed of 1.25 m s$^{-1}$ (see diagram). Find, for the motion from $O$ to $A$,

41-J-12-31

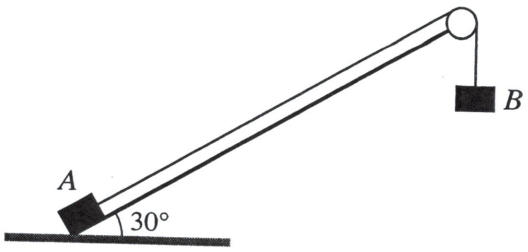
**(i)** the gain in the potential energy of the load, [1]

**(ii)** the gain in the kinetic energy of the load. [2]

The power output of the winding drum is constant while the load is in motion.

**(iii)** Given that the work done against the resistance to motion from $O$ to $A$ is 20 kJ and that the time taken for the load to travel from $O$ to $A$ is 41.7 s, find the power output of the winding drum. [3]

04






A light inextensible rope has a block $A$ of mass 5 kg attached at one end, and a block $B$ of mass 16 kg attached at the other end. The rope passes over a smooth pulley which is fixed at the top of a rough plane inclined at an angle of 30° to the horizontal. Block $A$ is held at rest at the bottom of the plane and block $B$ hangs below the pulley (see diagram). The coefficient of friction between $A$ and the plane is $\frac{1}{\sqrt{3}}$. Block $A$ is released from rest and the system starts to move. When each of the blocks has moved a distance of $x$ m each has speed $v$ m s$^{-1}$. 42-J-14-(51)

**(i)** Write down the gain in kinetic energy of the system in terms of $v$. [1]

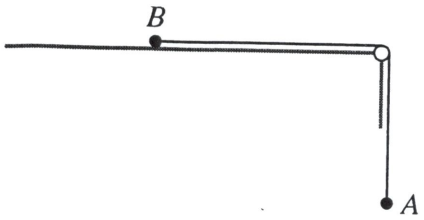
**(ii)** Find, in terms of $x$,

**(a)** the loss of gravitational potential energy of the system, [2]

**(b)** the work done against the frictional force. [3]

**(iii)** Show that $21v^2 = 220x$. [2]

5






Particles $A$ and $B$, each of mass 0.3 kg, are connected by a light inextensible string. The string passes over a small smooth pulley fixed at the edge of a rough horizontal surface. Particle $A$ hangs freely and particle $B$ is held at rest in contact with the surface (see diagram). The coefficient of friction between $B$ and the surface is 0.7. Particle $B$ is released and moves on the surface without reaching the pulley.

N − 14 − (4.3) = 5

**(i)** Find, for the first 0.9 m of $B$'s motion,

**(a)** the work done against the frictional force acting on $B$, [2]

**(b)** the loss of potential energy of the system, [1]

**(c)** the gain in kinetic energy of the system. [2]

At the instant when $B$ has moved 0.9 m the string breaks. $A$ is at a height of 0.54 m above a horizontal floor at this instant.

**(ii)** Find the speed with which $A$ reaches the floor. [3]

**6** A block of mass 50 kg is pulled up a straight hill and passes through points $A$ and $B$ with speeds $7\ \text{m s}^{-1}$ and $3\ \text{m s}^{-1}$ respectively. The distance $AB$ is 200 m and $B$ is 15 m higher than $A$. For the motion of the block from $A$ to $B$, find

J-6-(6)

**(i)** the loss in kinetic energy of the block, [2]

**(ii)** the gain in potential energy of the block. [2]

The resistance to motion of the block has magnitude 7.5 N.

**(iii)** Find the work done by the pulling force acting on the block. [2]

The pulling force acting on the block has constant magnitude 45 N and acts at an angle $\alpha°$ upwards from the hill.

**(iv)** Find the value of $\alpha$. [3]