Cambridge International AS & A Level

Mathematics 9709/42

Paper 4 Mechanics October/November 2024

Question No(2)

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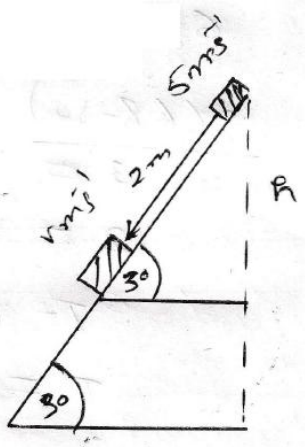
A block of mass 20 kg is held at rest at the top of a plane inclined at 30° to the horizontal. The block is projected with speed 5 m s^{-1}down a line of greatest slope of the plane. There is a resistance force acting on the block. As the block moves 2 m down the plane from its point of projection, the work done against this resistance force is 50 J.

Find the speed of the block when it has moved 2 m down the plane.

Solution:



Given data

mass of the block, $m = 20$ kg

angle, $\theta = 30°$

initial speed, $u = 5$ m/s

distance moved down the slope, $s = 2$ m

work done against resistance, $W = -50$ J

$g = 9.8$ m/s^2

we shall find the speed v of the block after moving 2 m.

DATE :- (5)

From the diagram or fig

$$\frac{h}{2} = \sin 30$$

$$h = 2 \sin 30$$

$$h = 2 \cdot \tfrac{1}{2} = 1 \text{ m}$$

Loss in potential energy $\Delta U = -mg\Delta h$

$$= -20(9.8)(1)$$

$$= -196 \text{ J}$$

Change in K.E

Let v be the speed after moving 2m

$$\Delta K = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

$$= \frac{1}{2}(20)(v^2) - \frac{1}{2}(20)(5)^2$$

$$\Delta K = 10v^2 - 250$$

By work energy principle

$$W = \Delta K + \Delta U$$

$$-50 = (10v^2 - 250) - 196$$

$$10v^2 = 396 \Rightarrow v^2 = 39.6$$

$$v = \sqrt{39.6} = 6.29 \text{ m/s}$$