A cart of mass M_1 = 6 kg is attached to a block of mass M_2 = 3 kg by a string that passes over a frictionless pulley. The system is initially at rest and the table is frictionless. After the block has fallen a distance h = 1 m. What is the work W_s done on the cart by the string?

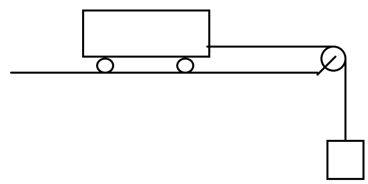
Answer:

The work done by the gravity on M_2 is the loss of potential energy of the block M_2 that is given by

$$W = M_2*g*h = 3*9.8*1 = 29.4 \text{ J}$$

This loss of energy is equal to the gain in kinetic energy of both masses (as they move with the same speed), hence if the speed v, gained by the cart and the block will given by law of conservation of energy as

$$\tfrac{1}{2} (M_1+M_2)\, v^2 = M_2*g*h$$



gives $v^2 = \dfrac{2*M_2*g*h}{(M_1+M_2)}$

or $v^2 = 2*29.4/9.0 = 6.5333$

and $v = 2.556$ m/s

Now the string is doing work on the cart and according to the work energy rule, work done by the string on the cart is equal to the increase in its kinetic energy and hence the work done on the cart by the string is given by

$$W_s = \tfrac{1}{2} M_1 v^2 = \frac{M_1*M_2*g*h}{(M_1+M_2)} = \frac{6*3*9.8*1}{(6+3)} = 19.6 \text{ J}$$

Alternative Method:

Consider the two blocks as a system. As there is no external force, the work on the system by gravity M_2gh. As the velocity of both the cart and the block is same the work done by the gravity is distributed in the ratio of their mass and thus the work done on the cart will be

$$W_s = \frac{M_1}{(M_1+M_2)}*M_2*g*h = \frac{6*3*9.8*1}{(6+3)} = 19.6 \text{ J}$$

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