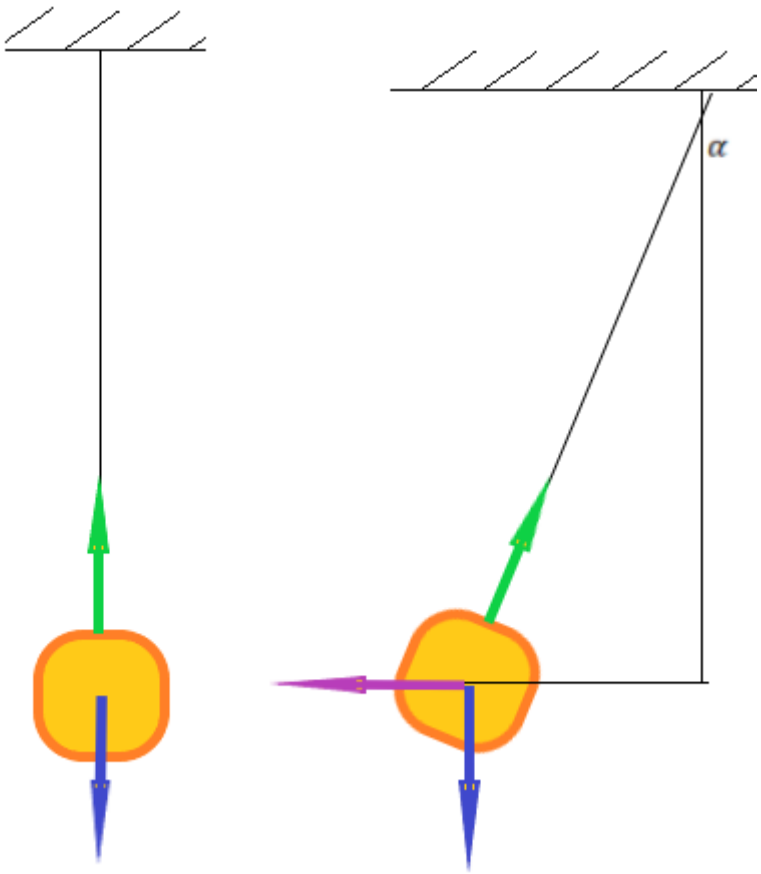
Answer on Question #33232 - Physics - Mechanics – Relativity

A 115kg kg mail bag hangs by a vertical rope 3.6m m long. A postal worker then displaces the bag to a position 2.1m m sideways from its original position, always keeping the rope taut.

1) What horizontal force is necessary to hold the bag in the new position?
2) As the bag is moved to this position, how much work is done by the rope?
3) As the bag is moved to this position, how much work is done by the worker?

Solution



1) Use Newton's second law (the bag is in equilibrium) for the bag held by the postal worker:

$$Ox: T\sin\alpha - F_h = 0,$$

$$Oy: T\cos\alpha - mg = 0.$$

From the triangle:

$$\alpha = \arcsin\frac{h}{l}.$$

Thus

$$F_h = mg\tan\alpha = mg\tan\arcsin\frac{h}{l} = 115\cdot 9.8\cdot\tan\left(\arcsin\frac{2.1}{3.6}\right) = 809.4\ \text{N}.$$

2) The tension of the rope is radial, the displacement is tangential (perpendicular to the rope), that is why rope does the work of

$$W_R = T \cdot d \cdot \cos 90° = 0.$$

3) Before the postal worker touches the bag its potential energy is 0 relative to the line crossing the bag. After applying the force its potential energy relative to the same line before interaction is

$$E_P = mgh = mg(l - l\cos\alpha) = 115 \cdot 9.8 \cdot 3.6\left(1 - \cos\left(\arcsin\frac{2.1}{3.6}\right)\right) = 761.8 \text{ J}.$$

The work done is

$$W = E_P - 0 = 761.8 \text{ J}.$$

Answers

1) 809.4 N;
2) 0;
3) 761.8 J.