Quiz 4 - Solutions

Make sure your name is on your quiz, and please box your final answer. Because we will be giving partial credit, be sure to attempt all the problems, even if you don’t finish them!

1. A skater with an initial speed of 7.60 m/s stops propelling himself and begins to coast across the ice, eventually coming to rest. Air resistance is negligible.

(a) The coefficient of kinetic friction between the ice and skate blades is 0.100. Find the deceleration caused by the friction.

(b) How far will the skater travel before coming to rest?

2. Suppose that you have a box of mass $m = 5.00$ kg and you need to put it on a shelf on the far side of the room which is 1.0 m tall. To do this, you lift the box up and rest it on your shoulder, which is 1.6 m high. Then you walk to the far side of the room, which is 8 m away. Finally, you take the box down from your shoulder, and set the box down on the shelf. How much work do you do against the force of gravity?

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Solution

1. (a) The frictional force is given by $F_f = \mu_k F_N = \mu_k mg$, where we have used $F_N = mg$ for the normal force. Newton tells us that the force is $F = ma$, where $a$ is the acceleration, and so $ma = -\mu_k mg$, where we take a minus sign since the skater is slowing down, and find

$$a = -\mu_k g.$$  

With the given numbers, 

$$a = -\mu_k g = -0.100 \times 9.8 = -0.98 \text{ m/s}^2.$$  

(b) We know the initial speed of the skater, as well as his final speed ($v_f = 0$). Furthermore, we know the acceleration. Thus, we can simply use our kinematics equation $v_f^2 = v_i^2 + 2aD$, where $D$ is the distance that he travels (which is what we are looking for). So, setting $v_f = 0$ and solving for $D$ we find

$$D = \frac{-v_i^2}{2a} = \frac{7.60^2}{2(0.98)} = 29.5 \text{ m}.$$  

2. Since you don’t do any work against gravity while you are walking across the room, the only work that you do is to lift the box up to the shelf, which is just $W = mgh = 5 \times 9.8 \times 1 = 49$ J. The extra work that you do in lifting the box up to your shoulder is gotten back when you drop it back down to the shelf, which we can easily see. The work in lifting it to your shoulder is $W_{up} = mgh_{shoulder} = 5 \times 9.8 \times 1.6 = 78.4$ J. Then, when you drop it back down from 1.6 m to 1 m you do a work of $W_{down} = -mgh_{down} = -5 \times 9.8 \times 0.6 = -29.4$ J, for a total work of $W = 78.4 - 29.4 = 49$ J, as claimed.