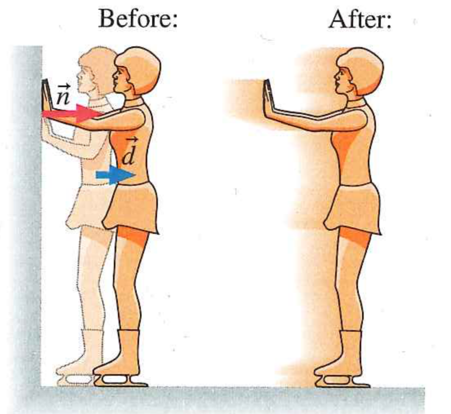
A number of freshman physics textbooks correctly point out that, since *work* is properly calculated using the displacement of the contact point, the *normal force* from a stationary wall does no *work.*

When a skater pushes off the side of a rink, the wall does no *work* on the skater – no energy is transferred from the wall to the skater. There is an internal energy conversion within the skater, transforming the chemical energy to kinetic energy.



If the part of the object on which the force acts undergoes no displacement, no work is done.

Even though the wall pushes on the skater with a normal force $\vec{n}$ and she undergoes a displacement $\vec{d}$, the wall does no work on her, because the point of her body on which $\vec{n}$ acts—her hands—undergoes no displacement. This makes sense: How could energy be transferred as work from an inert, stationary object? So where does her kinetic energy come from? This will be the subject of much of Chapter 11. Can you guess?

Knight, Jones, & Field

Sadly, some "standard" freshman textbooks then proceed to calculate "work done by friction" on a sliding object, using the frictional force *and the motion of the center of mass.* While this may give correct answers to kinematic questions, such as how far a block will skid, it is conceptually flawed, **since the "work" done by friction does not represent energy transferred out of the sliding block.** Much of the block's energy remains in the block, but is simply converted into thermal energy. (Additionally, of course, work must be calculated by using the motion of the contact points, not the center of mass. Since friction involves surface deformation, the exact and correct calculation of "work done by friction" is an impossible task.)

Knight, Jones & Field do **not** make this mistake; they are careful never to ask for the work done by friction. They do show that you may calculate the amount of kinetic energy converted into thermal energy by using the “work” formula, by considering a block pulled at constant speed across a rough surface.

Some examples of work in situations involving friction may be useful. Consider a soft clay ball thrown against a perfectly rigid wall. In this case, the contact point does not move; no work is done. **All the energy in the ball remains in the ball;** it is simply converted into thermal energy. (The wall, being perfectly rigid, does not gain any energy in the collision, though it may gain energy afterwards through heat transfer.)

Suppose instead the ball is perfectly rigid and the wall is clay. In this case, the wall will deform as the ball slows. The work done on the ball is negative and is equal in magnitude to its initial kinetic energy. Energy has been transferred from the ball to the wall, and it is the wall that gains thermal energy.

Other examples:
Two astronauts (of equal mass) in space push off each other and move in opposite directions. The contact point (their hands) does not move. No energy has been transferred from one to the other.

Alternatively, if astronaut A pushes on astronaut B’s back, the contact point moves with astronaut B’s center of mass; A does work on B, and energy is transferred from A to B.