Name: _____**Tutorial section** _____

More on refining intuition:
The case of Newton's 3rd law

I. Pushing off: Does Newton's 3rd law hold?

A heavier and a lighter rollerblader, Bob and Alice, stand facing each other as drawn here. Putting his hands on Alice's shoulders, Bob "pushes off" so that the two rollerbladers end up rolling in opposite directions.

A. (*Work individually*) Which force, if either, do you think is greater during the "push-off": The force exerted by the Bob on Alice, or the force exerted by Alice on Bob? Explain.

B. Discuss your part A answer with a neighbor. If you change your mind about something, summarize the change.

✭   *Class discussion & Experiment*

C. (*Work together*) If we asked your (English major) roommate which rollerblader feels the greater force, how would the roommate be likely to respond? Explain.

D. (*Work together*) Is there some common-sense explanation—an explanation that would make sense to your roommate—about why Alice ends up with more speed *even though* she feels no stronger a force from Bob than Bob feels from her? Or would you just have to tell the roommate to accept Newton's 3rd law because the experiment confirmed it? Explain.

✭   *Class discussion*

II. Refining intuition explained

In the rollerblading scenario, as in the truck-and-car scenario from tutorial, most people have the intuition that "the lighter object reacts more." So, if the heavier object is twice as heavy, that intuition says that "the lighter objects reacts twice as much."

A. (*Work together*) Is that intuition a *raw intuition* you had even before taking physics, or is it a *refined intuition* shaped in part by your physics class? If it's raw, where did you get it?

B. (*Work together*)   A *refined* intuition is cast in formal physics language. One way to refine "the lighter object reacts twice as much" is to say "the lighter object feels twice as much **force**." What's another refinement of that raw intuition, a refinement that doesn't involve force?

★ *Class discussion: Intuition refinement diagram*

C. (*Work together*) A physics question often nudges your brain toward using a specific refinement of your raw intuition—even if you're not consciously aware of it! For instance, consider the truck-and-car scenario from tutorial. At the beginning of the tutorial, we asked you which object (if either) feels a bigger force during the collision.

1. When answering that question, which refinement of "the lighter object reacts twice as much" did you use?

2. Did that refinement agree or disagree with Newton's 3rd law and with experiment?

D. (*Work together*) Later in tutorial, we asked you a question about how much the car speeds up, assuming the truck slows down by a given amount.

1. When answering that question, which refinement of "the lighter object reacts twice as much" did you use?

2. Did that refinement agree or disagree with Newton's 3rd law? See if you can summarize the relevant reasoning from tutorial.

★ *Class discussion: Making refinements consciously, and tracing implications*