

## Comments about the solutions:

**Model A**: No force is acting on the box other than the force due to gravity (the weight of the box) and the force of the table pushing back on the box (frequently called the normal force).

**Model B**: A push is applied to the box but this push is not strong enough to overcome the friction force that acts in the opposite direction (due to the interaction of the box and the surface of the table). The forces are balanced and the box is not moving – this is equivalent to a constant speed of zero.

**Model C**: The push on the box is exactly matched by the resisting friction force, indicating that the forces are balanced, resulting in constant speed as the box slides across the table.

You'll notice that model C is very similar to model B except the magnitude of the push and friction force is greater for model C. Therefore, model B and model C could represent either scenario (push without movement, or push and slides at constant speed). The forces are balanced in both directions, and the only difference is the magnitude of the push and resisting friction force. (When forces are balanced, an object moves at constant speed, and the speed could have a magnitude of zero.) There are different explanations for which the placement of either description could work for both models, and it's useful to have students explain their thinking for why they placed the cards with the model they did. (Specific examples to come.)

**Model D**: The only force acting on the box in the "x" direction is the friction force between the box and the table, which causes the box to slow down. The model represents the forces on the box *after* the shove, and since there is no contact after the shove, there is no force due to the shove. The forces are not balanced.

**Model E**: The push on the box is greater than the friction force between the box and the table, the forces are not balanced in the "x" direction, and the box accelerates.

**Model F**: The box is no longer in contact with the table and is falling through the air. The only forces acting on the box are the force due to gravity acting on the box and the opposing force due to air resistance as the box falls.