Help Sheet on Newton's Third Law of Motion

Newton's Third Law of Motion, as described in Hewitt[1]:

> "Whenever one object exerts a force on a second object, the second object exerts an equal and opposite force on the first."

How many of the forces described above are acting on the first object: 0, 1, or 2?

How many of the forces described above are acting on the second object: 0, 1, or 2?

Choose your answers to the 2 questions above and then scroll down to see the answers.

[1] Hewitt, Paul G., John Suchocki, Leslie A. Hewitt, Conceptual Physical Science, 3rd Edition, San Francisco: Addison Wesley, 2004.

1 of the forces described by the third law is acting on the first object.

1 of the forces described by the third law is acting on the second object.

Now, we know that these 2 forces described by Newton's Third Law of Motion are not acting on the same object. Of course, we can have 2 (or more forces acting on a single object), but the action/reaction pair indicated in this law are not acting on the same object.

Practice: For each situation below, a force is listed. Identify the reaction force described by the third law for each:

1. A person is leaning against the wall: $F_{\text{person pushing on wall to the right}}$
2. Goldilocks, when she sits on mama bear's chair: $F_{\text{Goldilocks pushing down on chair}}$
3. Goldilocks, when she sits on baby bear's chair, while it is breaking: $F_{\text{Goldilocks pushing down on chair}}$

Write down your answers and then scroll down to check them.

Answers to above:

1. A person is leaning against the wall: $F_{\text{person pushing on wall to the right}}$ The reaction force is $F_{\text{wall pushing on the person to the left.}}$
2. Goldilocks, when she sits on mama bear's chair: $F_{\text{Goldilocks pushing down on chair}}$ The reaction force is $F_{\text{mama bear's chair pushing up on Goldilocks.}}$
3. Goldilocks, when she sits on baby bear's chair, while it is breaking: $F_{\text{Goldilocks pushing down on chair}}$ The reaction force is $F_{\text{baby bear's chair pushing up on Goldilocks.}}$

The two forces described in number 2 are equal to each other. Also the two forces described in number 3 are equal to each other. However, the forces in number 3 are not as large as the forces in number 2. While baby bear's chair is breaking, it does not push up as hard on Goldilocks nor is she able to push down as hard on it.

More Practice: Identify the reaction force described by the third law for each:

4. You punch a wall: $F_{\text{you pushing on wall to the left}}$
5. You punch a piece of paper: $F_{\text{you pushing on paper to the left}}$
6. A helium balloon is at rest, touching only the ceiling: $F_{\text{ceiling pushing down on balloon}}$

Write down your answers and then scroll down to check them.

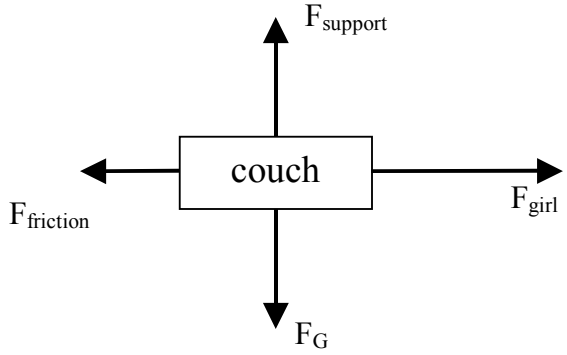
Answers to above:

4. You punch a wall: $F_{\text{you pushing on wall to the left}}$ The reaction force is $F_{\text{wall pushing on you to the right.}}$
5. You punch a piece of paper: $F_{\text{you pushing on paper to the left}}$ The reaction force is $F_{\text{paper pushing on you to the right.}}$
6. A helium balloon is at rest, touching only the ceiling: $F_{\text{ceiling pushing down on balloon}}$ The reaction force is $F_{\text{balloon pushing up on the ceiling.}}$

Which force is larger: $F_{\text{you pushing on wall to the left}}$ or $F_{\text{you pushing on paper to the left}}$?

The force of you pushing on the wall is greater than the force of you pushing on the paper!

Okay, now for more practice, but let's try a different approach. A girl is pushing a couch across her living room at increasing velocity. Shown below is the force diagram for the couch.



7. Give each of these forces a more descriptive name. For example, F_G could be called: $F_{\text{G, earth pulling down on couch.}}$ This is a helpful, but often overlooked step when analyzing the third law action/reaction pairs. Now, you do the other 3:
   a. F_{girl}
   b. F_{friction}
   c. F_{support}

Write down your answers and then scroll down to check them.

Answers to number 7:

a. $F_{\text{girl pushing on couch to the right}}$
b. $F_{\text{friction, floor pushing on couch to the left}}$
c. $F_{\text{floor pushing up on the couch}}$

8. Name the reaction force, as described by Newton's Third Law of Motion for each of the four forces in the force diagram of the girl pushing the couch.

Forces acting on couch	Third Law pair
$F_{\text{G, earth pulling down on couch}}$	?
$F_{\text{girl pushing on couch to the right}}$	?
$F_{\text{friction, floor pushing on couch to the left}}$	?
$F_{\text{floor pushing up on the couch}}$	?

Write down your answers and then scroll down to check them.

With the descriptive version of each force on the left, finding the reaction force is much simpler- the order of the objects is reversed and the opposite direction is given!

Forces acting on couch	Third Law pair
$F_{G,\ earth\ pulling\ down\ on\ couch}$	$F_{G,\ couch\ pulling\ up\ on\ earth}$
$F_{girl\ pushing\ on\ couch\ to\ the\ right}$	$F_{couch\ pushing\ on\ girl\ to\ the\ left}$
$F_{friction,\ floor\ pushing\ on\ couch\ to\ the\ left}$	$F_{friction,\ couch\ pushing\ on\ floor\ to\ the\ right}$
$F_{floor\ pushing\ up\ on\ the\ couch}$	$F_{couch\ pushing\ down\ on\ floor}$

The column on the left shows us forces that are acting on the couch. Notice how none of the forces in the column on the right are acting on the couch! This matches our interpretation of Newton's Third Law of Motion at the very top of this help sheet.