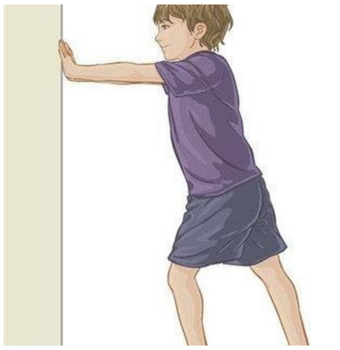
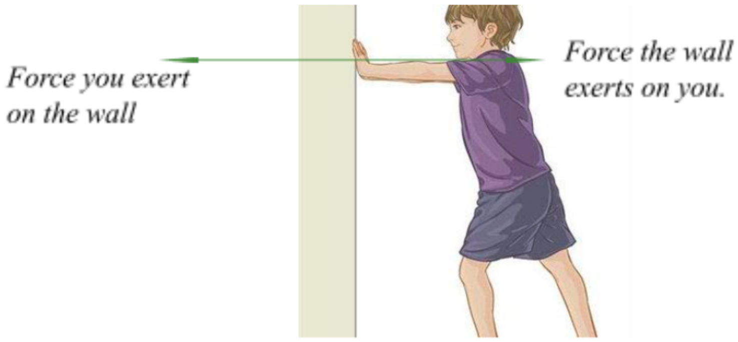
Subject Code	PHY 1	**Physics 1**
Module Code	5.0	**Newton's Laws of Motion**
Lesson Code	5.4	**Newton's 3rd Law of Motion**
Time Frame		30 minutes

Components	Tasks	TA[1] (min)	ATA[2] (min)
Target	By the end of this learning guide, the student should be able to ● recognize that for every force exerted by one object to another object, there is a reaction force that is equal in magnitude and opposite in direction ● identify action-reaction pairs of forces acting between two objects ● recognize that action-reaction pairs act on different objects	1	
Hook	Have you tried pushing a wall very hard? If not, give it a try this time. Stand in front of a wall. Press your both hands on the wall and give the strongest push you can exert. What do you notice?  You may observe that the harder you push on the wall, your feet start to slide gradually backward. Does this mean that the wall also exerts a force on you? Scenarios like this can be better understood through the third law of motion formulated by Sir Isaac Newton.	5	
Ignite	Newton's third law of motion describes that **forces are a result of interaction between two bodies.** **Newton's Third Law of Motion** *When two bodies (A and B) interact, A exerts a force on B and B also exerts a force on A. The magnitudes of these forces are equal but they act in opposite directions.* If a body (let's call it A) exerts a force on another body (let's call it B), B also exerts force on A. The magnitude of the force exerted by A on B is equal to the magnitude of the force exerted by B on A. These two forces, however, act in opposite directions. When	12	

[1] Time allocation suggested by the teacher.
[2] Actual time allocation spent by the student (for information purposes only).

you exert a push on the wall, the wall, in return, also exerts the same amount of force back to you.



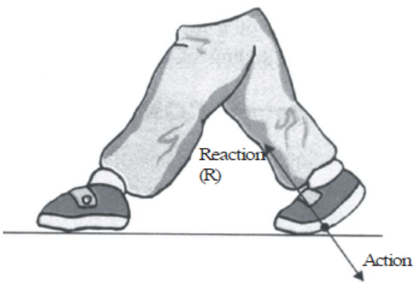
In equation form, we express Newton's third law of motion as

$$F_{AB} = \; -F_{BA}$$

It can be noted from the subscripts that these forces act on different bodies.

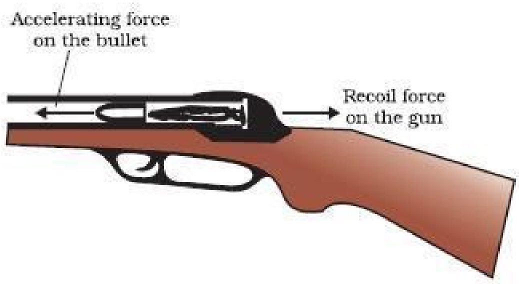
By virtue of the third law of motion, forces always come in pairs. We refer to this pair as an **action-reaction pair.** The choice as to which is the action or reaction force is arbitrary.

An example of an action-reaction pair at work is when we take a walk. Whenever we step our foot on the ground, the ground also exerts a force on us. How do we account for the fact that while these two forces are equal in magnitude, the resulting motion is different for the two bodies?

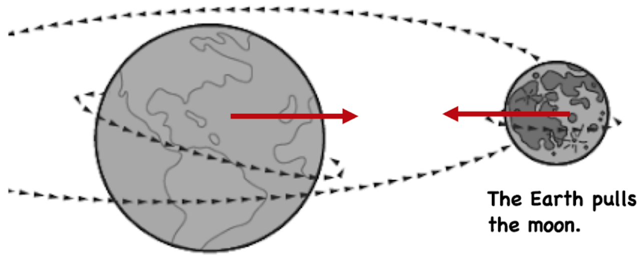


From Newton's second law of motion, acceleration is inversely proportional to the net force. Note that the mass of the person is much smaller compared to the entire Earth. So the force of the ground on the foot will result in acceleration. On the other hand, the mass of the Earth is so large that the force exerted by the foot is negligible.

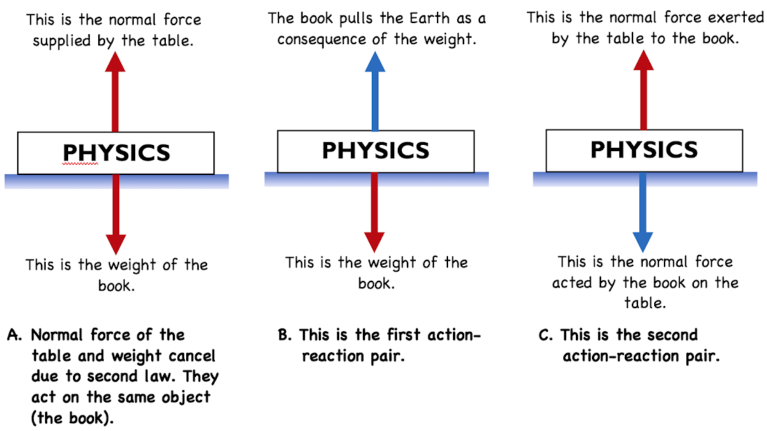
When a sharpshooter pulls the trigger of a gun, the gun recoils due to the reaction force exerted by the bullet. The force that caused the escape of the bullet from the gun is equal to the force of recoil. But since the mass of the bullet is relatively smaller than the entire gun, the gun's recoil is slower compared to the speed of the bullet.



Newton's third law of motion does not only apply to contact forces. It also applies to non-contact or long-range forces, such as the force of gravity. Any falling object to the ground experiences the pull of gravity. In effect, the Earth is also pulled by that falling object. But because the mass of the Earth is much larger than the mass of the falling object, that pulling effect is negligible.



One usual misconception regarding action-reaction pairs is that they cancel each other. Let's take the case of a book resting on a table. There are two forces acting on the book: the upward force exerted by the table and the downward pull of gravity or weight. These two forces, which are equal in magnitude and opposite in direction, cancel out each other. But note that these two don't comprise an action-reaction pair. Action-reaction pairs act on different objects. The reaction force to the weight of the book is the gravitational pull of the book on the Earth, while the reaction to the upward normal force exerted by the table is the downward normal force exerted by the book on the table. Although in each pair the forces are equal in magnitude and opposite each other, we don't add them because they act on different objects. We only sum up forces acting on the same object.

			
Navigate 	Write your answers on a clean sheet of paper. Follow your teacher's instructions regarding submission. 1. Sketch an illustration for each of the following scenarios. Identify the action-reaction pair and represent them in your illustration using vector arrows. a. Movement of a boat away from the dock whenever passengers alight from the boat b. A swimmer's movement in a swimming pool when he or she stumps on the pool wall. c. A rocket that accelerates to space d. A farmer trying to pull the trunk of a tree through a rope 2. A truck and tricycle had a head-on collision. The tricycle was displaced at a far distance after the collision. a. Which between the truck and tricycle exerted a greater amount of force? Explain. b. Explain why the tricycle was displaced at a far distance.	10	
Knot 	Here are some of the key takeaways after working on this learning guide. • Newton's third law of motion describes that forces are a result of interaction between two bodies. • The force exerted by body A to B is equal to the magnitude of the force exerted by B to A, but these forces act in different directions. Mathematically, it can be described as $F_{AB} = -F_{BA}$ • Newton's third law of motion always involves an action-reaction pair. These forces act in different bodies.	2	

References

1. Hewitt, P. (2006). *Conceptual Physics.* Pearson Education, Inc.
2. Young, H. & Freedman, R. (2016). *Sear's and Zemansky's University Physics with Modern Physics.* Pearson Education, Inc.

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