

## 7.4: Newton's Third Law- Action-Reaction Pairs

Newton realized that when two bodies interact via a force, then the force on one body is equal in magnitude and opposite in direction to the force acting on the other body.

*Law III: To every action there is always opposed an equal reaction: or, the mutual action of two bodies upon each other are always equal, and directed to contrary parts. Whatever draws or presses another is as much drawn or pressed by that other. If you press on a stone with your finger, the finger is also pressed by the stone.*

The Third Law, commonly known as the “action-reaction” law, is the most surprising of the three laws. Newton’s great discovery was that when two objects interact, they each exert the same magnitude of force on each other but in opposite directions. We shall refer to the pair of forces between two interacting bodies as an interaction pair of force, or more briefly as an interaction pair.

Consider two bodies engaged in a mutual interaction. Label the bodies 1 and 2 respectively. Let  $\vec{\mathbf{F}}_{1,2}$  be the force on body 2 due to the interaction with body 1, and  $\vec{\mathbf{F}}_{2,1}$  be the force on body 1 due to the interaction with body 2. These forces are depicted in Figure 7.5.



Figure 7.5 Interaction pair of forces

These two vector forces are equal in magnitude and opposite in direction,

$$\vec{\mathbf{F}}_{1,2} = -\vec{\mathbf{F}}_{2,1}$$

We shall employ these definitions, Newton’s three laws, and force laws to describe the motion of bodies, a subject known as classical mechanics or Newtonian Mechanics, and hence explain a vast range of phenomena. Newtonian mechanics has important limits. It does not satisfactorily explain systems of objects moving at speeds comparable to the speed of light (  $v > 0.1 c$  ) where we need the theory of special relativity, nor does it adequately explain the motion of electrons in atoms, where we need quantum mechanics. We also need general relativity and cosmology to explain the largescale structure of the universe.

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