

Notes - 4.4 Newton's Third Law of Motion: Symmetry in Forces

1. State Newton's 3rd Law of Motion. *When one body exerts a force on another, the other body exerts an equal and opposite force on the first.*
2. Forces always occur in pairs, and one body cannot exert a force on another without experiencing a force itself. This is sometimes referred to as action- reaction.

3. Consider the swimmer pushing off from the side of a pool in Figure 4.9. She pushes against the pool wall with her feet and accelerates in the direction opposite to that of her push. The wall has exerted an equal and opposite force back on the swimmer. Why does the swimmer accelerate? Don't these two forces cancel each other out?

The forces don't cancel as long as the "System" is the swimmer only. The swimmer only experiences the wall's push. She does not get pushed by her own push - the wall does.

** You can't push yourself to a new place*

4. List some other examples of Newton's 3rd Law.

Walking: *Foot pushes ground backward; ground pushes foot forward*

Car: *Tire pushes road backward; road pushes tire forward*

Helicopter: *Blades push air down; Air pushes blades up*

Rocket: *Rocket pushes exhaust particles backward; exhaust pushes rocket forward*

5. Rockets:

A. What is the common misconception regarding rocket propulsion?

People think rockets push the air.

B. What observation disproves this misconception?

Can travel in vacuum of space

1. What is tension? *A force along the length of a string or rope, directed toward the center.*

2. The force of tension at every point in a single rope, chain, wire, cable, or string is equal.

3. Two masses are suspended by a cables of negligible mass, as shown on the right. The acceleration of the masses is a.

4. Consider the "system" to be both of the blocks. Write an equation for Net Force as the vector sum of the forces acting on the two blocks.

Sum of forces

$$\Sigma F = T_1 - m_1g - m_2g$$

5. Use Newton's 2nd Law to write a second equation for the Net force acting on the two blocks.

2nd Law

$$\Sigma F = (m_1 + m_2)a$$

6. Use your two equations above to write an equation for T_1 .

$$T_1 - m_1g - m_2g = (m_1 + m_2)a$$

$$T_1 - g(m_1 + m_2) = a(m_1 + m_2) \Rightarrow T_1 = (a + g)(m_1 + m_2)$$

7. Consider the "system" to be just the bottom block (m_2). Write an equation for Net Force as the vector sum of the forces acting on the bottom block.

$$\Sigma F = T_2 - m_2g$$

8. Use Newton's 2nd Law to write a second equation for the Net force acting on the bottom block.

$$\Sigma F = m_2a$$

9. Use your two equations above to write an equation for T_2 .

$$T_2 - m_2g = m_2a$$

$$T_2 = m_2(g + a)$$

