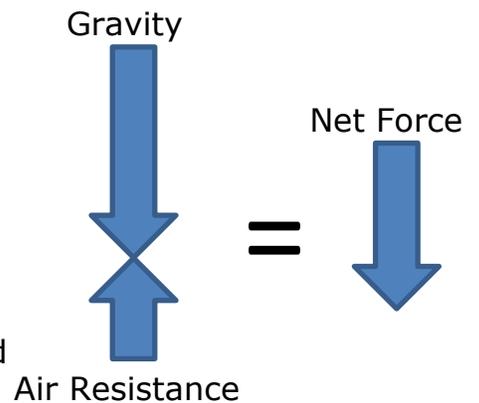


## STAAR Science Tutorial 26 TEK 8.6A: Unbalanced Forces

**TEK 8.6A: Demonstrate and calculate how unbalanced forces change the speed or direction of an object's motion.**

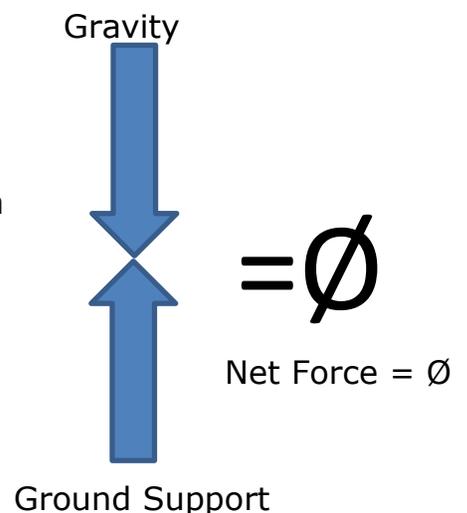
- On Earth, it is rare for only one force to act upon an object. All objects are pulled towards the center of the Earth by gravity, a long-range attractive force between any two objects with mass. (See Tutorial 33.) If the object is falling (accelerating) towards the center of Earth because of gravity, that motion will be slowed by **air resistance**, the force of air molecules pushing back against the falling motion. The object falls because the force of gravity is stronger than the opposing force of air resistance. That sum of all forces acting on the object is called the **net force**.

- Unbalanced forces** exist on an object when the net force acting on that object is greater than zero. In the above example, gravity pulls down more strongly than the air resistance pushes back. The two forces can be represented by arrows, as shown to the right. The size of the arrows represent the relative strength of the two forces. The larger down arrow represents gravity, and the smaller up arrow represents air resistance. By subtracting the down arrow length from the up arrow length, the net force arrow shows the smaller downward acting force

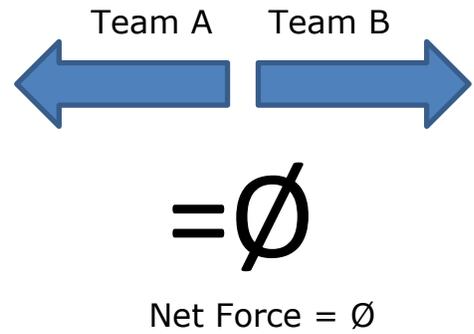


- Newton's Second Law of Motion states that an object acted on by an unbalanced force will accelerate in the direction of the force. In the above example, the object falls because the net force is downward and is greater than zero.

- Balanced forces** exist when all of the forces acting on an object cancel each other out, resulting in a net force of zero. If the object pulled down by gravity is resting on the ground, which is strong enough to push up with equal force, the two forces cancel each other out, and no motion results. In the diagram to the right, the down arrow (gravity) and the up arrow (ground support) are of equal length but opposite direction. If the net force is zero, the forces are balanced, and no acceleration (change of motion) occurs.

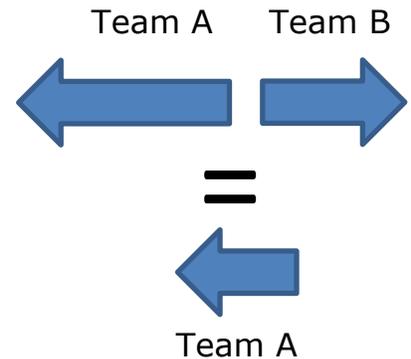


- A good example of balanced and unbalanced forces is a tug-of-war between two teams of students. If the opposing teams are of equal strength, neither team can move the other, because their net force is zero and the forces are balanced. This is shown in the diagram to the right.

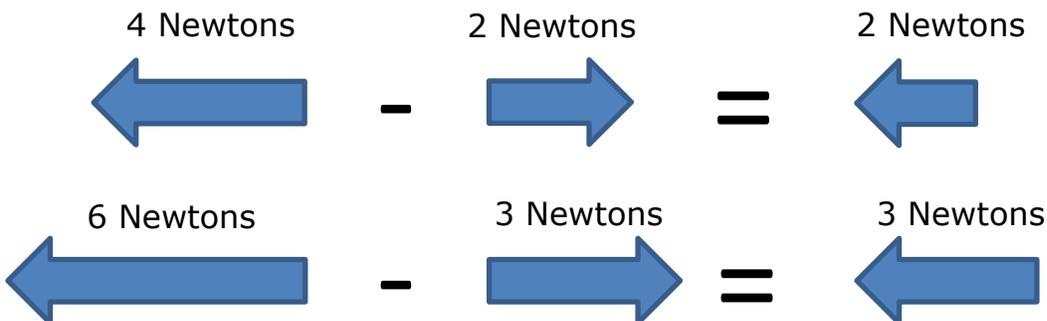


- The same result occurs when a force pushes on an unmovable object, or when friction prevents the motion of an object because not enough force was applied to overcome that friction. In both of these cases, the two forces are equal but in opposite directions—they cancel each other out.

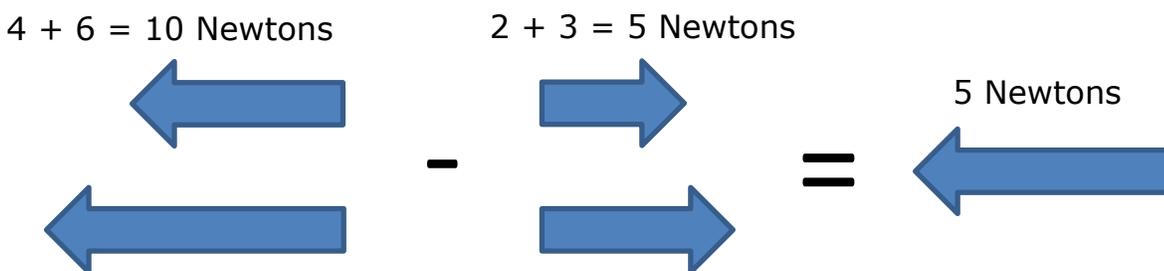
- If Team B becomes tired, and pulls less hard than Team A, Team B eventually lose because they were moved (accelerated) to the left, the direction of the greater force.



- **Calculations of net force, where the two forces act in opposite directions,** simply require that you subtract the weaker force from the stronger force. The result of this subtraction is the net force, acting in the direction of the stronger force. Study the examples below to see how this process works.



- When there are more than two forces, first add all of the forces acting in the same direction together, and then subtract the smaller net force from the larger net force. Again the resulting net force will be acting in the direction of the larger net force.



## Practice Questions

1. The sum of all forces acting on the object is called the \_\_\_\_\_.
2. When the net force acting on an object is greater than zero, the forces are \_\_\_\_\_.
3. When the net force acting on an object is zero, the forces are \_\_\_\_\_.
4. Newton's \_\_\_\_\_ Law of Motion states that an object acted on by an \_\_\_\_\_ force will accelerate in the direction of the force.
5. To calculate net force, when two unequal forces are acting in opposite directions, subtract the \_\_\_\_\_ force from the \_\_\_\_\_ force. The result of that subtraction is the size of the net force, which will act in the direction of the \_\_\_\_\_ force.
6. Two forces are acting on an object. One force is pulling 5 newtons to the left, and the other is pulling 7 newtons to the right. What is the size and direction of the net force? \_\_\_\_\_
7. Two forces are acting on an object. One force is pulling 9 newtons to the left, and the other is pulling 3 newtons to the right. What is the size and direction of the net force? \_\_\_\_\_
8. Four forces are acting on an object. One force is pulling 2 newtons to the left, the second force is pulling 2 newtons up, the third is pulling 3 newtons down, and the last is pulling 2 newtons to the right. What is the size and direction of the net force? \_\_\_\_\_
9. \_\_\_\_\_ forces result in no change of motion (no acceleration).
10. \_\_\_\_\_ forces result in a change of motion (acceleration).