

## Information

### Newton's Second Law

As stated in the first law, the presence of an unbalanced force will accelerate an object - changing either its speed, its direction, or both its speed and direction.

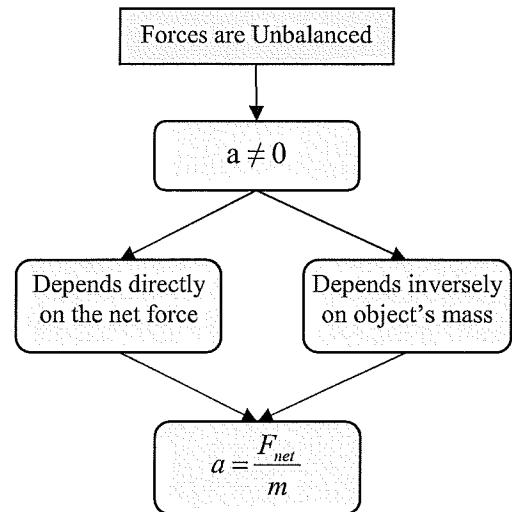
Newton's second law of motion pertains to the behavior of objects for which all existing forces are not balanced. The second law states that the acceleration of an object is dependent upon two variables - the net force acting upon the object and the mass of the object. The acceleration is always in the same direction as the net force.

Mathematically this means:

$$\text{acceleration} = \frac{\text{Force}_{net}}{\text{mass}};$$

$$\text{commonly written as: } F_{net} = ma$$

Do not use the value of merely any force in the above equation. It is the net force which is related to acceleration. The net force is the sum of all the forces acting on an object.



## Critical Thinking Questions

1. What two variables is acceleration dependent on? What is the relationship between these variables and acceleration? (i.e. if you increase one variable what happens to the acceleration?)
2. If an object is not accelerating what can you determine about the sum of all the forces on the object?
3. If the net force on an object is in a negative direction, what will the direction of the resulting acceleration be?
4. If you double the net force on an object what is the result on the acceleration?
5. If you double the mass of an object while leaving the net force unchanged what is the result on the acceleration?
6. A Cadillac Escalade has a mass of 2 569.6 kg, if it accelerates at  $4.65\text{m/s}^2$  what is the net force on the car?

7. A 7.26kg bowling ball (16 pounds) is at rest at the end of a bowling lane. Use this information to answer the following questions.
- What is the net force acting on the ball?
  - You push the ball with a force of 22.8N which induces a -2.3N frictional force. What is the net force while you push the ball?
  - What is the acceleration caused by your push on the ball?
  - Following your push the ball rolls down the lane at 4.2m/s. What is the net force on the ball as it rolls down the lane at the constant speed?
  - CHALLENGE: How long did you push the ball in this situation?

### Exercises

8. Complete the following table. Be sure to include units in your answer.

Net Force (N)	Mass (kg)	Acceleration
5.0	2.5	
2.32	12	
18.2	1.967	
0.87	21.2	
180	1.793	

9. Complete the following table. Be sure to include units.

Net Force (N)	Mass (kg)	Acceleration ( $m/s^2$ )
	4.0	4.0
25.0		4.998
53	3	
172.44		4.665
	1 225	3.43