Newton's First Law of Motion

by

Nada Saab-Ismail, PhD, MAT, MEd, IB

nhsaab.weebly.com

nhsaab2014@gmail.com

P3.2 Net Forces

Forces have magnitude and direction. The net force on an object is the sum of all the forces acting on the object. Objects change their speed and/or direction only when a net force is applied. If the net force on an object is zero, there is no change in motion (Newton's First Law).

P3.2C Calculate the net force acting on an object.

Items:

1. Newton’s First Law of Motion.

2. Net Force.

3. Calculation of the Net Force.

Isaac Newton (ca. 1687) came up with three laws of motion which form the basis of (classical) mechanics. They described the effects of forces on objects with mass.

Newton's First Law of Motion

An object continues in a state of rest or in a state of motion at a constant speed along a straight line. A net force (F net) can change that state.

The net force is the vector sum of all of the forces acting on an object.

The SI unit of force is the Newton (N).

Steps to be used to calculate the net force

Step One: Add all the forces in the same direction.

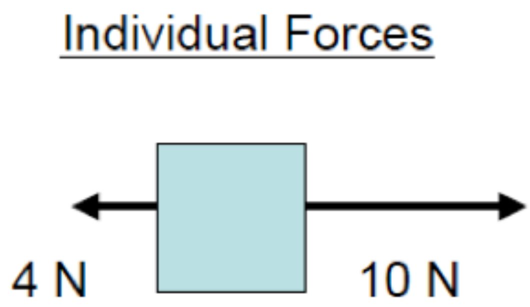
Step Two: Choose a positive direction. Then, the opposite direction would be the negative direction.

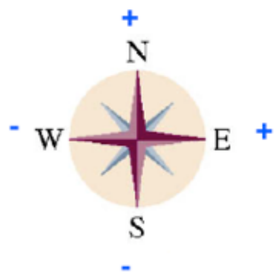
Step Three: Calculate the net force by subtracting the forces in the different directions, as shown in the formula below:

Net Force (F net) = All forces in the positive direction - All forces in the negative direction

Example 1: *Opposing Forces Acting on an Object:*

This is an example of individual forces acting on an object.





1. What is the net force?

2. Does the object move forward or backward?

Answer: Follow the steps in page 4 to solve the problem.

Step One: *Add all the forces in the same direction*

There are two forces acting on this object:

One is 10 N pushing the object forward to the right.

The other force is 4 N pulling the object back to the left.

Step Two: *Choose a positive direction. Then, the opposite direction would be the negative direction.*

Assume that the east direction (forward, to the right) is the positive direction.

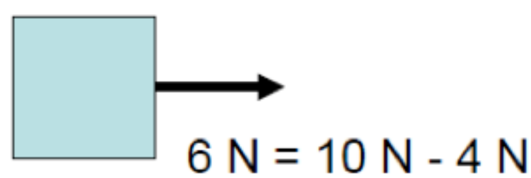
So, the west direction (backward, to the left) is the negative direction.

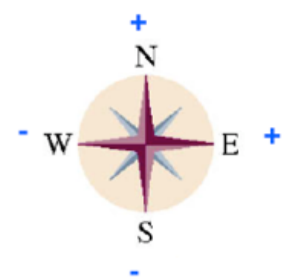
Step Three: *Net Force = All forces in the positive direction - All forces in the negative direction*

The net force = 10 N - 4 N = 6 N.

The net force is positive, so the object moves forward.

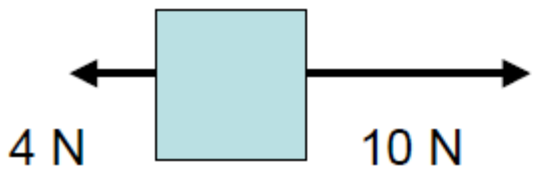
<u>Net Force</u>



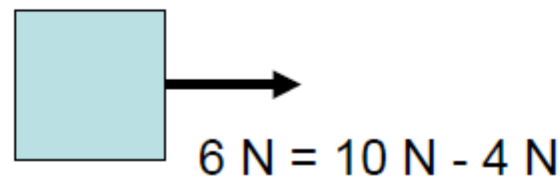


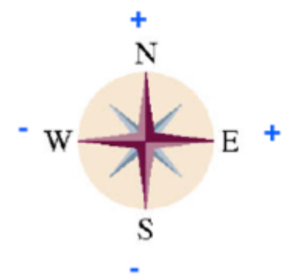
This is a summary of the sample problem.

Individual Forces



Net Force

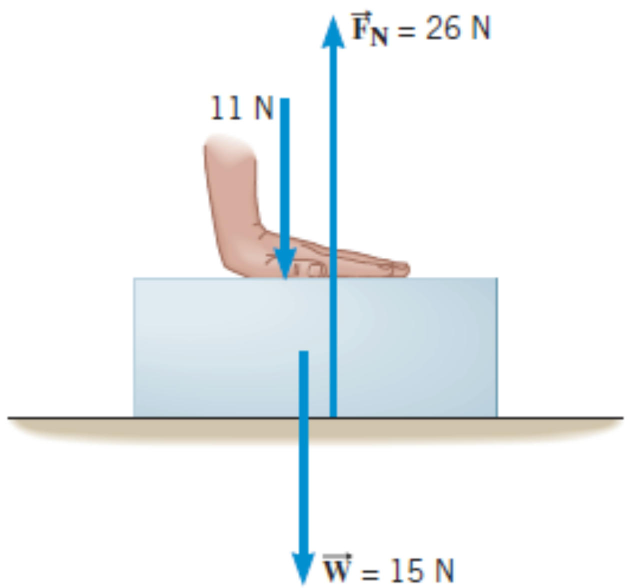


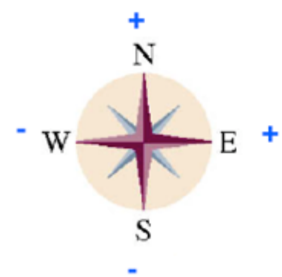


There is a net force of 6 N pushing the object forward to the right.

Example 2: *A Hand Pushing on a Box*

A box has weight W =15 N directed downward toward the earth. Also, a hand pushes the box downward, also, with a force F_H = 11 N. There is an upward force called normal force (support force) F_N = 26 N acting on the box and pushes it up. What is the net force (F net) acting on the box? Does the box move?





Answer: Follow the steps in page 4 to solve the problem.

Step One: *Add all the forces in the same direction*

Downward direction: A box has weight W =15 N and the hand pushes the box with a force FH = 11 N. So, the sum of the downward forces = 15 + 11 = 26 N.

Upward direction: There is an upward normal force FN = 26 N.

Step Two: *Choose a positive direction. Then, the opposite direction would be the negative direction.*

Assume that the upward direction is the positive direction.

So, the downward direction is the negative direction.

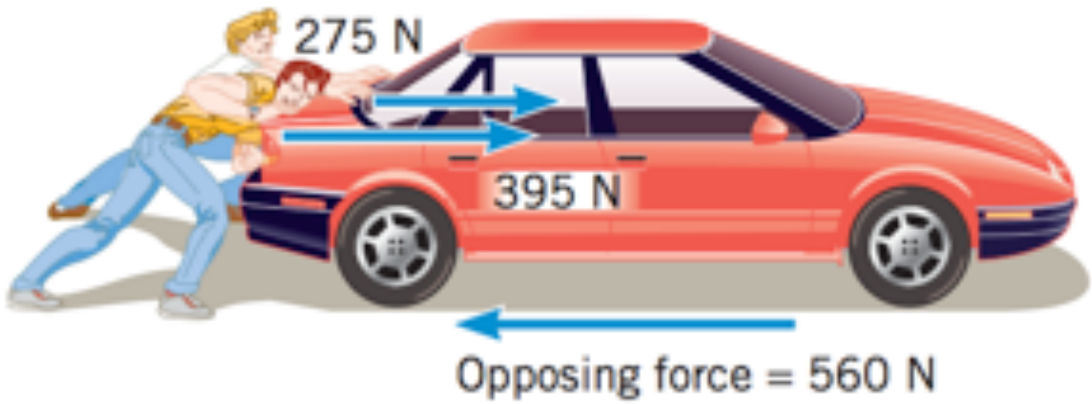
Step Three: *Net Force = All forces in the positive direction - All forces in the negative direction*

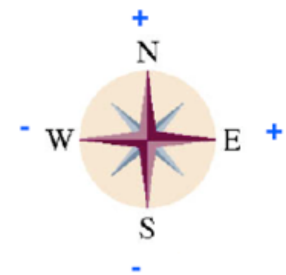
The net force (F net) = 26 N - 26 N = 0 N.

The net force is zero, so the object does not move and remains at rest.

Example 3: *Two People Push a Stalled Car.*

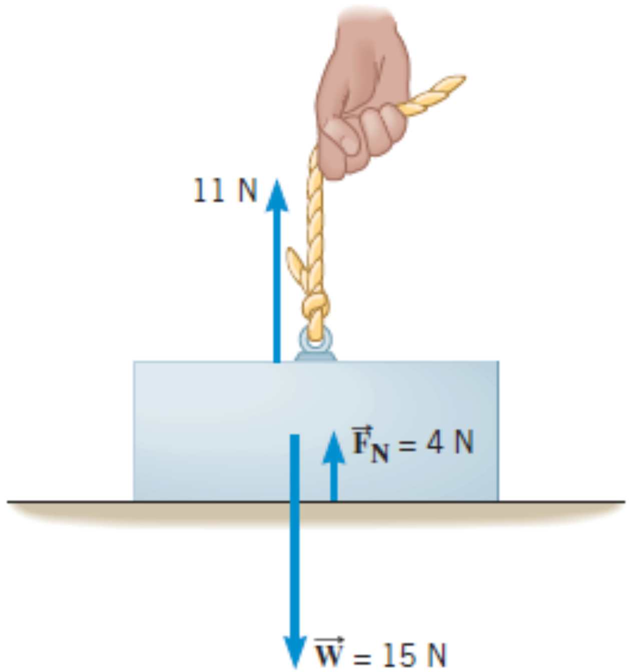
Two people are pushing a stalled car, as shown below. One person pushes with a force of 275 N. The other pushes with a force of 395 N. A third force of 560 N in the opposing direction is the friction and the pavement.



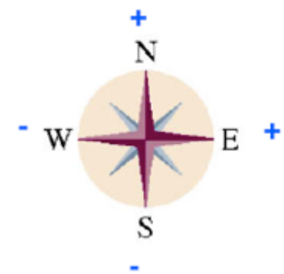


Example 4: *A hand is acting on a rope to pull a box.*

A box has weight W =15 N directed downward toward the earth. Also, a hand pulls the box upward, also, with a force F_H = 11 N. There is an upward force called normal force (support force) F_N = 4 N acting on the box and pushes it up.



(b)



References:

1) Humanic. (2013). www.physics.ohio-state.edu/~humanic/. In Thomas Humanic Brochure Page.

Physics 1200 Lecture Slides: Dr. Thomas Humanic, Professor of Physics, Ohio State University, *2013-2014 and Current.* *www.physics.ohio-state.edu/~humanic/*

2) Cutnell, J. D. & Johnson, K. W. (1998). *Cutnell & Johnson Physics, Fourth Edition*. New York: John Wiley & Sons, Inc.

The edition was dedicated to the memory of Stella Kupferberg, Director of the Photo Department:"We miss you, Stella, and shall always remember that a well-chosen photograph should speak for itself, without the need for a lengthy explanation"

3) Martindale, D. G. & Heath, R. W. & Konrad, W. W. & Macnaughton, R. R. & Carle, M. A. (1992). *Heath Physics.* Lexington: D.C. Heath and Company

4) Zitzewitz, P. W. (1999). *Glencoe Physics Principles and Problems*. New York: McGraw-Hill Companies, Inc.

5) Nada H. Saab (Saab-Ismail), (2010-2013) Westwood Cyber High School, Physics.

6) Nada H. Saab (Saab-Ismail), (2009- 2014) Wayne RESA, Bilingual Department.