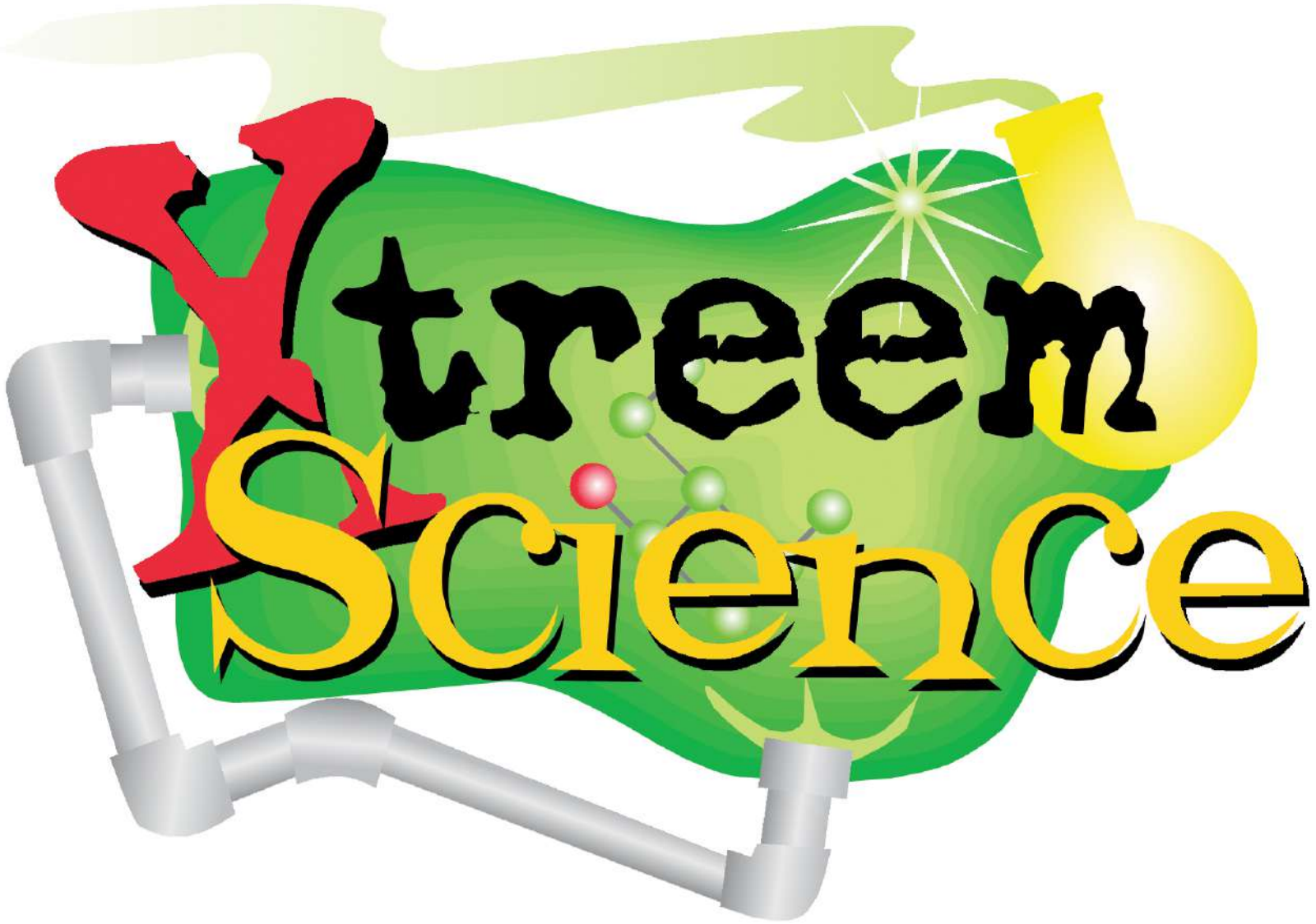

Xtreem
Science

The Force Is with You

TAKS Objective Four

TAKS Objective 4 – **The student will demonstrate an understanding of motion, forces, and energy.**

TEKS 8.7

The student knows that there is a relationship between force and motion. The student is expected to:

A. demonstrate how unbalanced forces cause changes in the speed or direction of an object's motion.

Learning Objectives

- The learner will interpret free-body force diagrams

Review: Newton's 1st Law

An object in motion stays in motion in a straight line, unless acted upon by unbalanced force. A push or pull will cause object to speed up, slow down, or change direction.

Review: Forces are Balanced

Object at Rest

V = zero m/s

$a = 0\ m/s^2$

Stay at Rest

Objects in Motion

V ≠ zero m/s

$a = 0\ m/s^2$

Stay in Motion (same speed and direction

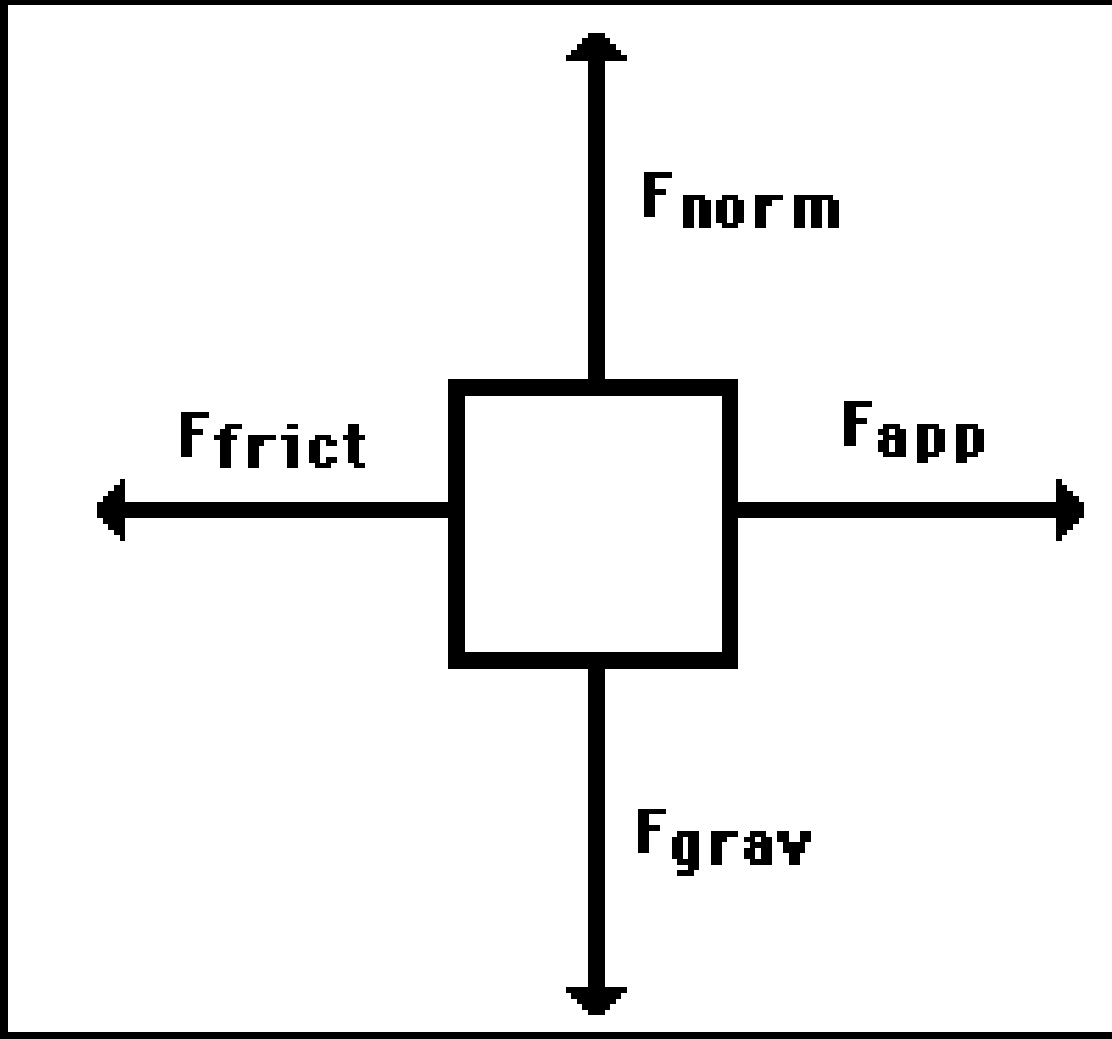
Basically, objects just keep on doing whatever they are doing unless they are acted upon by an unbalanced force.

Review: Common Examples

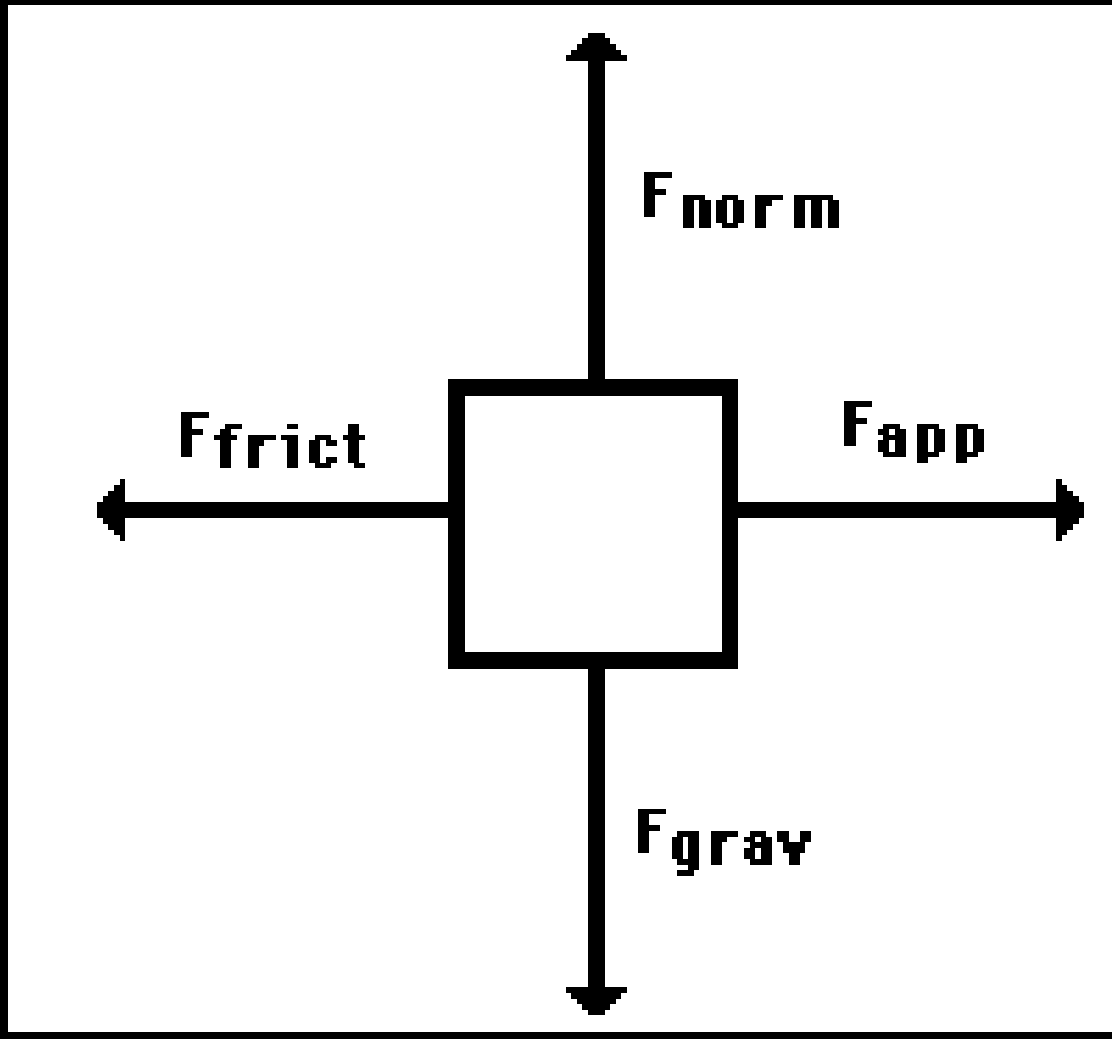
- Ketchup stays in the bottom (at rest) until you bang (outside force) on the end of the bottom.
- A headrest in a car prevents whiplash injuries during a rear-end collision (your head goes forward and then jerks backward).
-
- Animation 1 – ladder truck
- Animation 2 – no seatbelt

Free-body diagrams

Free-body diagrams are used to show the relative magnitude and direction of all forces acting on an object.



This diagram shows four forces acting upon an object. There aren't always four forces, For example, there could be one, two, or three forces.

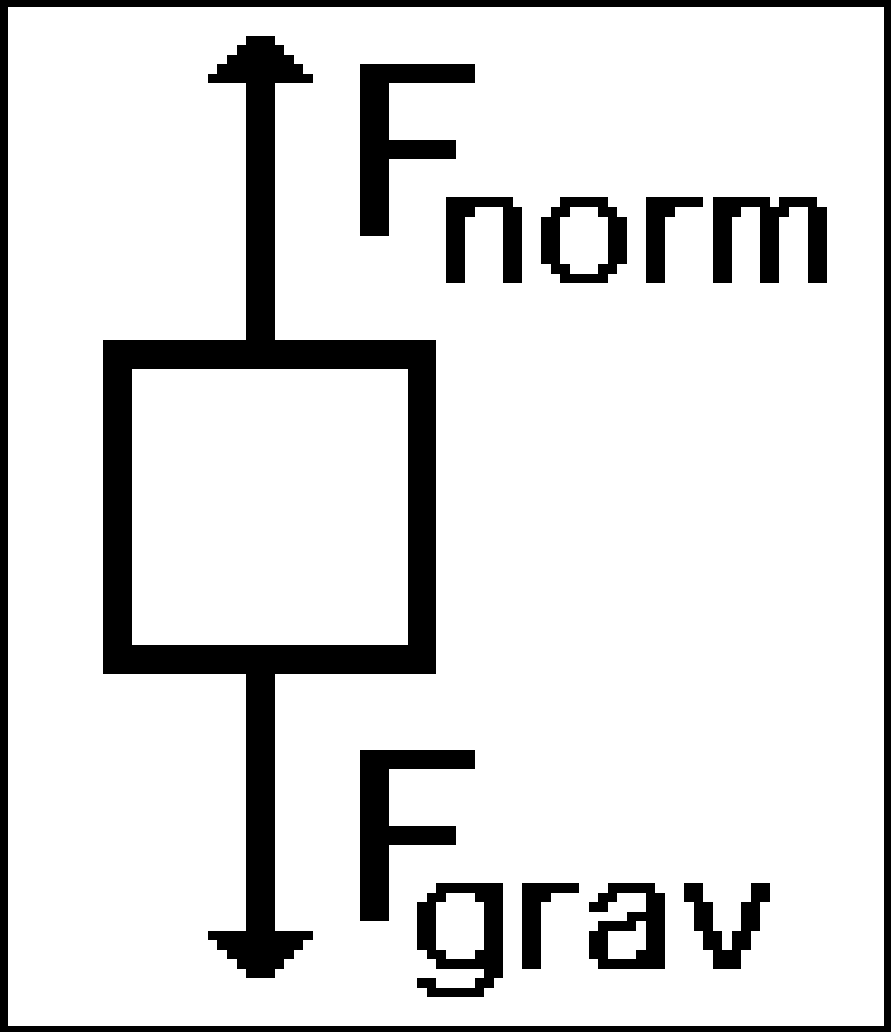


Problem 1

A book is at rest on a table top. Diagram the forces acting on the book.

Problem 1

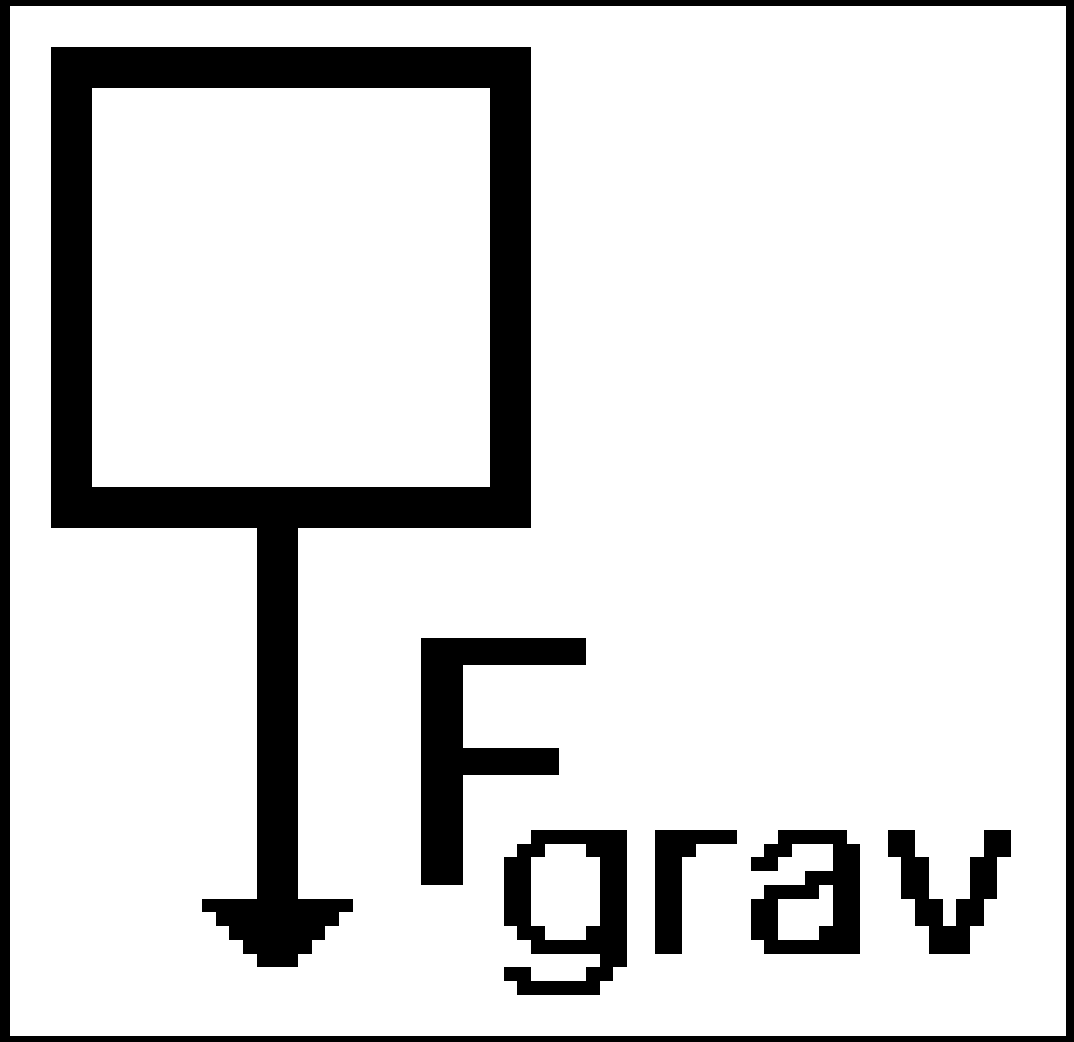
In this diagram, there are normal and gravitational forces on the book.



Problem 2

An egg is free-falling from a nest in a tree. Neglect air resistance. Draw a free-body diagram showing the forces involved.

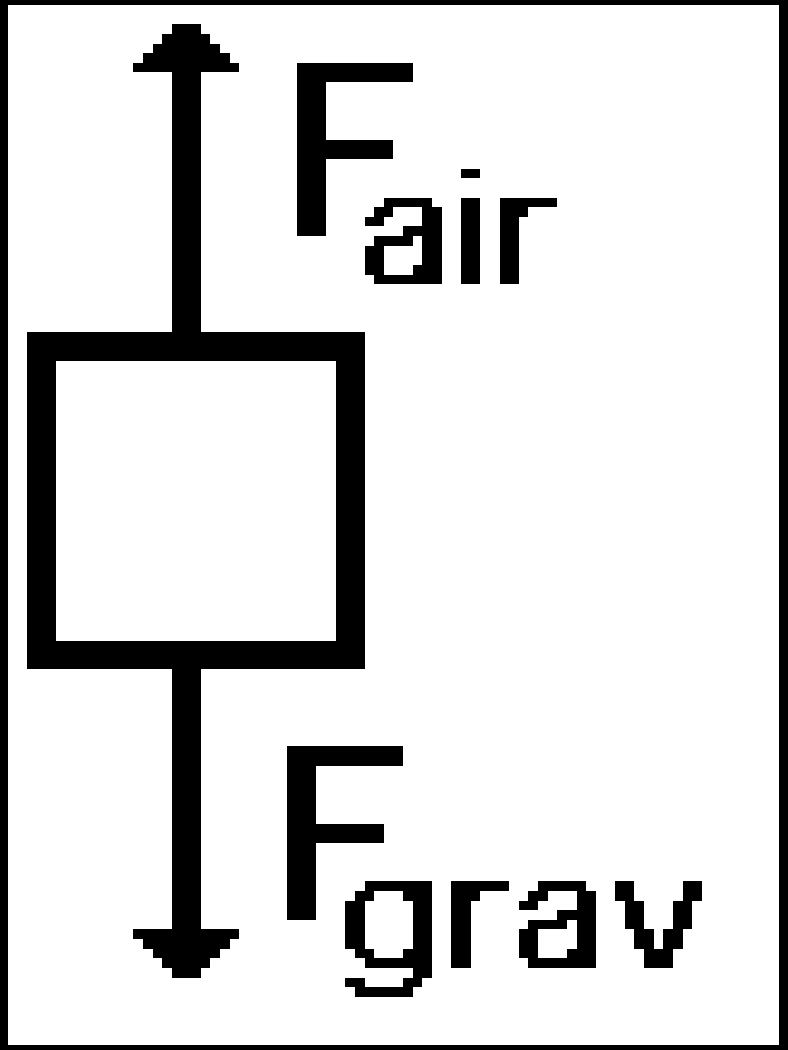
Gravity is the only force acting on the egg as it falls.



Problem 3

A flying squirrel is gliding (no wing flaps) from a tree to the ground at constant velocity. Consider air resistance. A free body diagram for this situation looks like…

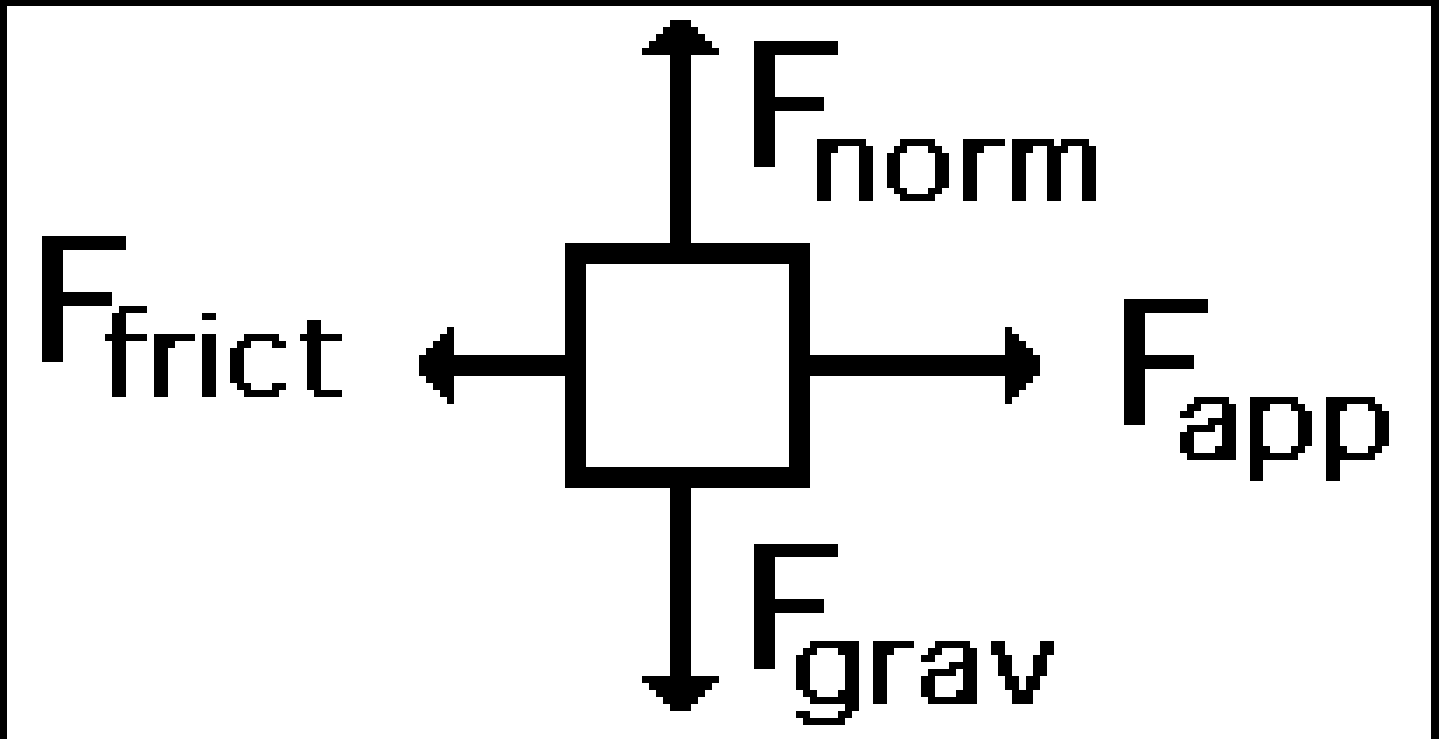
Gravity pulls down on the squirrel while air resistance keeps the squirrel in the air for a while.



Problem 4

A rightward force is applied to a book in order to move it across a desk. Consider frictional forces. Neglect air resistance. Construct a free-body diagram. Let's see what this one looks like.

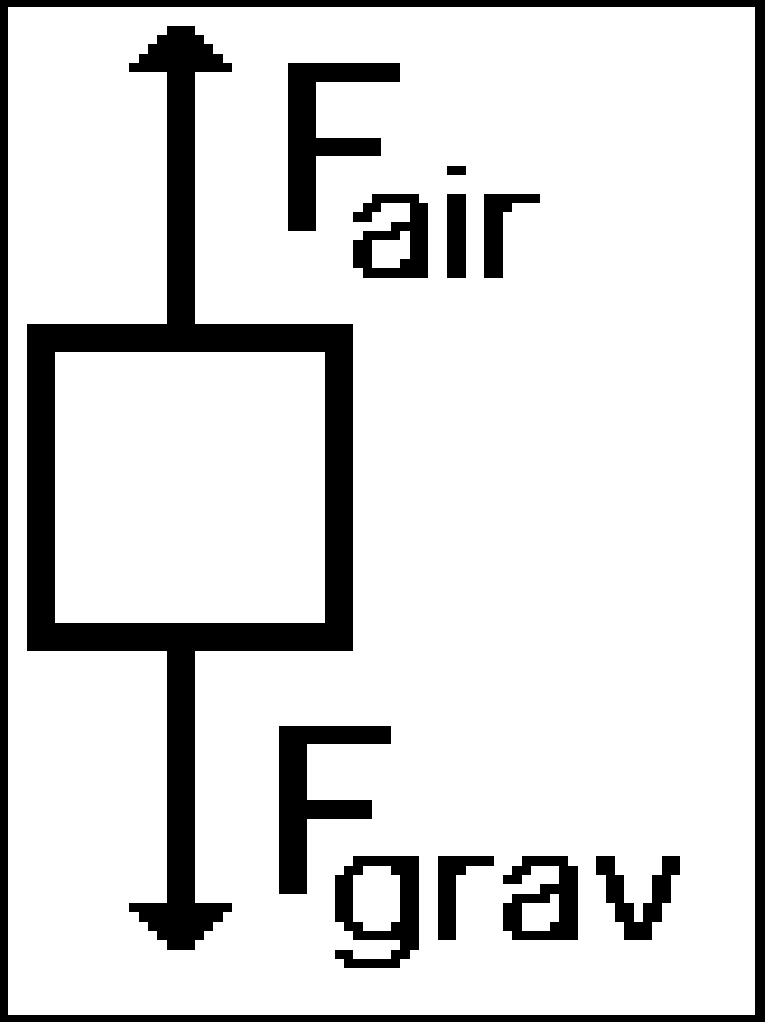
Note the applied force arrow pointing to the right. Notice how friction force points in the opposite direction. Finally, there is still gravity and normal forces involved.



Problem 5

A skydiver is descending with a constant velocity. Consider air resistance. Draw a free-body diagram.

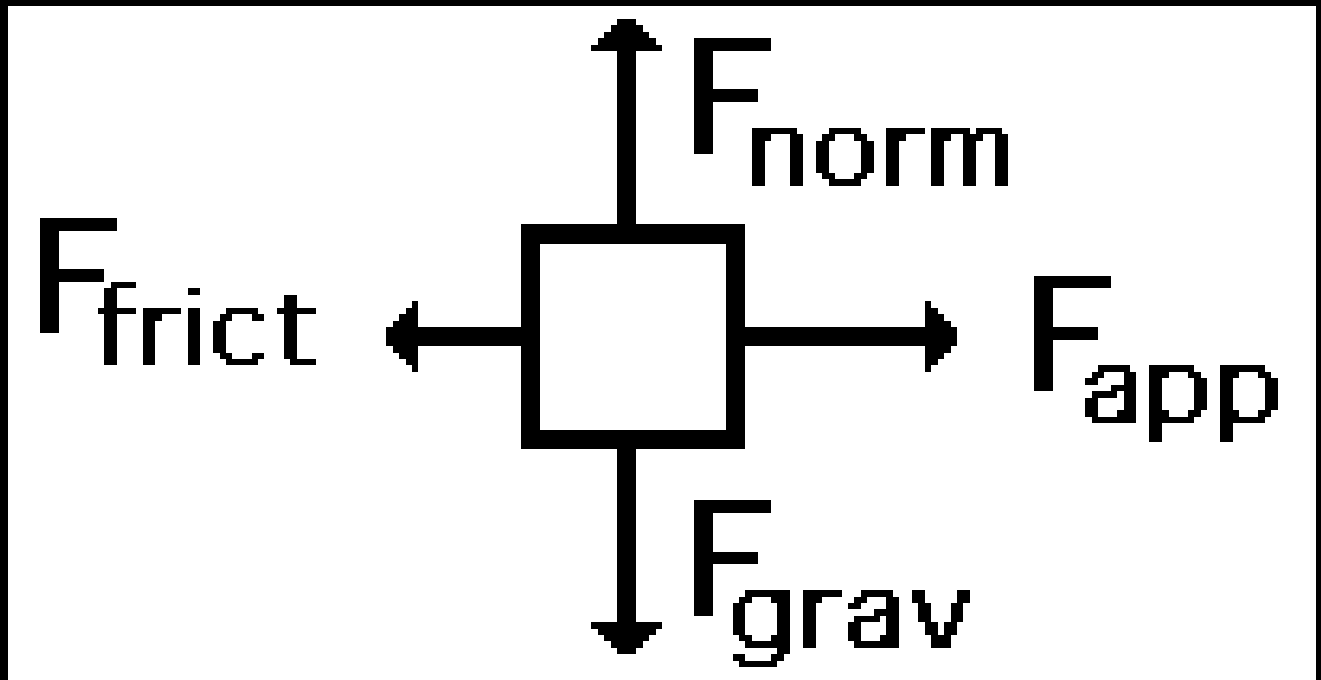
Gravity pulls down on the skydiver, while air resistance pushes up as she falls.



Problem 6

A man drags a sled across loosely packed snow with a rightward acceleration. Draw a free-body diagram.

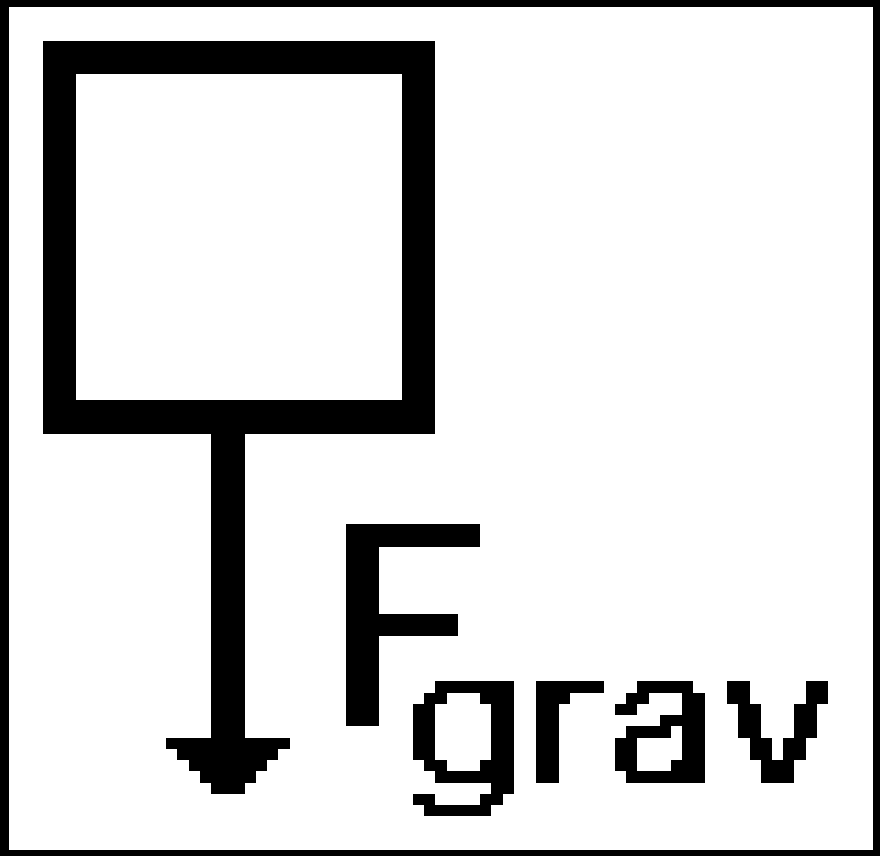
The rightward force arrow points to the right. Friction slows his progress and pulls in the opposite direction. Since there is not information that we are in a blizzard, normal forces still apply as does gravitational force since we are on planet Earth.



Problem 7

A football is moving upwards toward its peak after having been booted by the punter. Draw a free-body diagram.

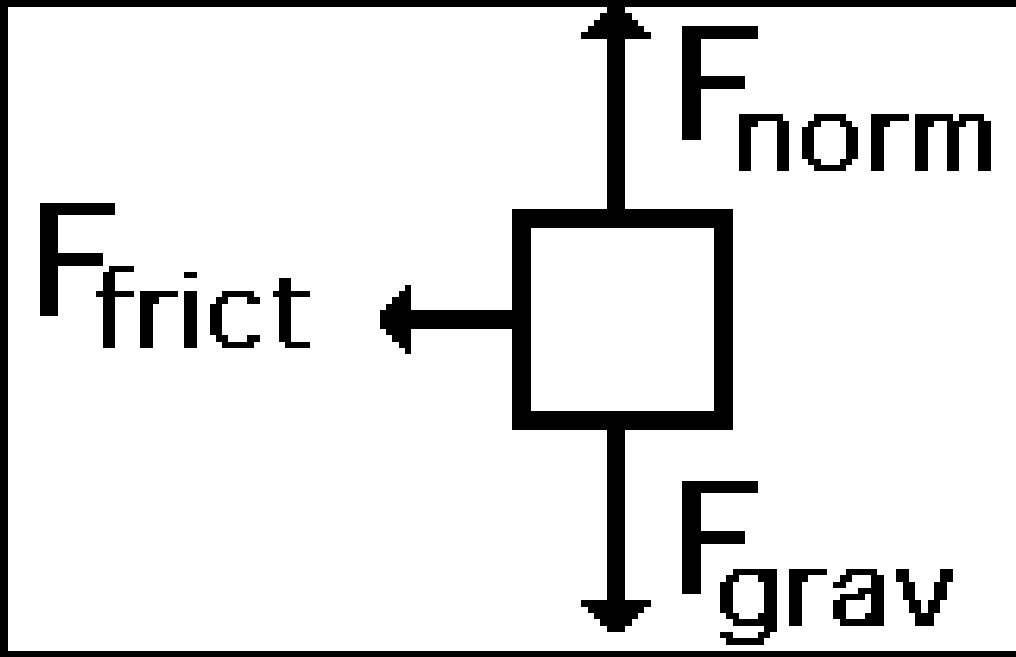
The force of gravity is the only force described. It is not a windy day (no air resistance).



Problem 8

A car runs out of gas and is coasting down a hill.

Even though the car is coasting down the hill, there is still the dragging friction of the road (left pointing arrow) as well as gravity and normal forces.



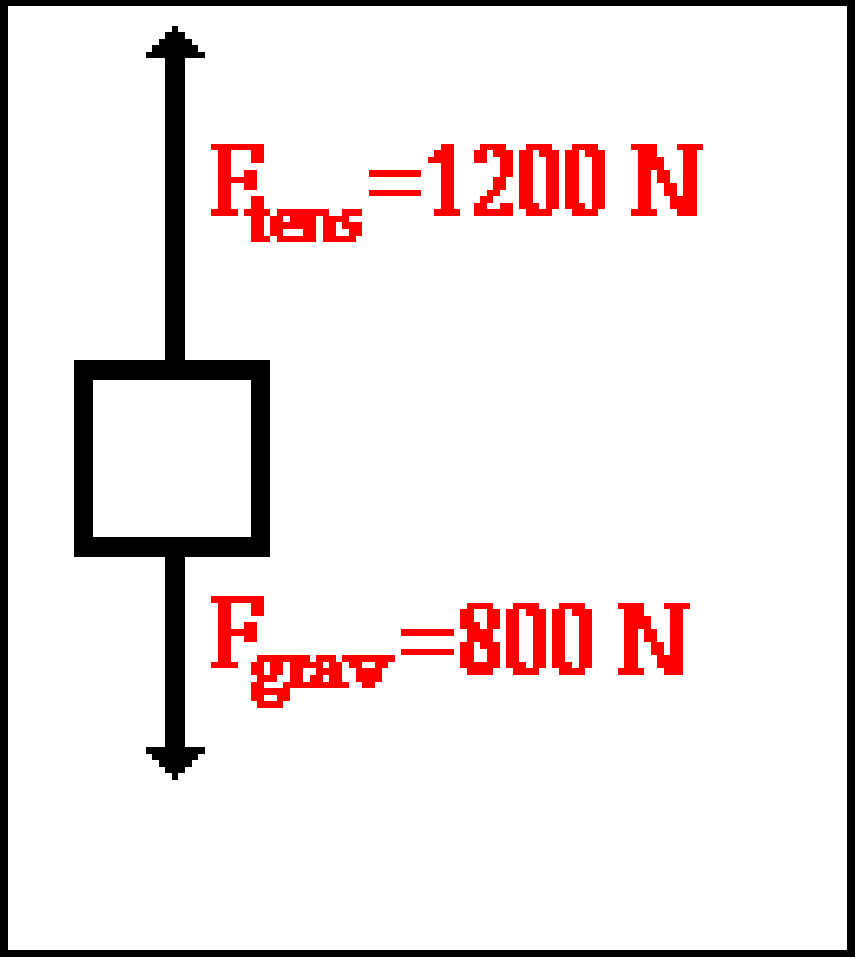
Net Force

Now let's take a look at what happens when unbalanced forces do not become completely balanced (or cancelled) by other individual forces.

An unbalanced forces exists when the vertical and horizontal forces do not cancel each other out.

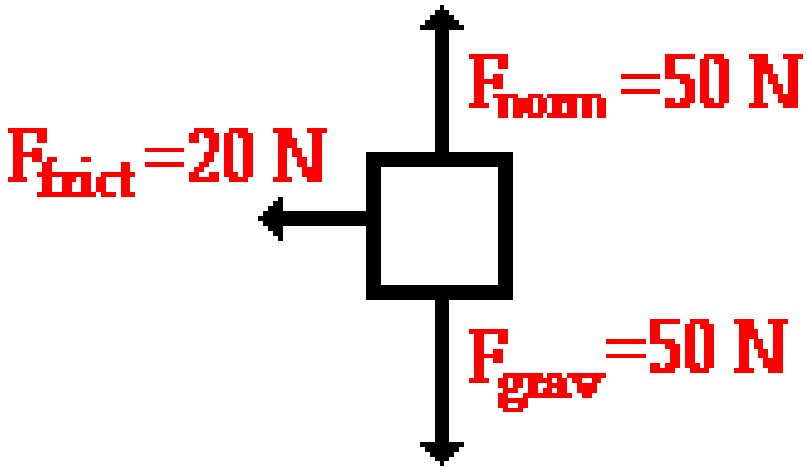
Example 1

Notice the upward force of 1200 Neutons (N) is more than gravity (800 N). The net force is 400 N up.

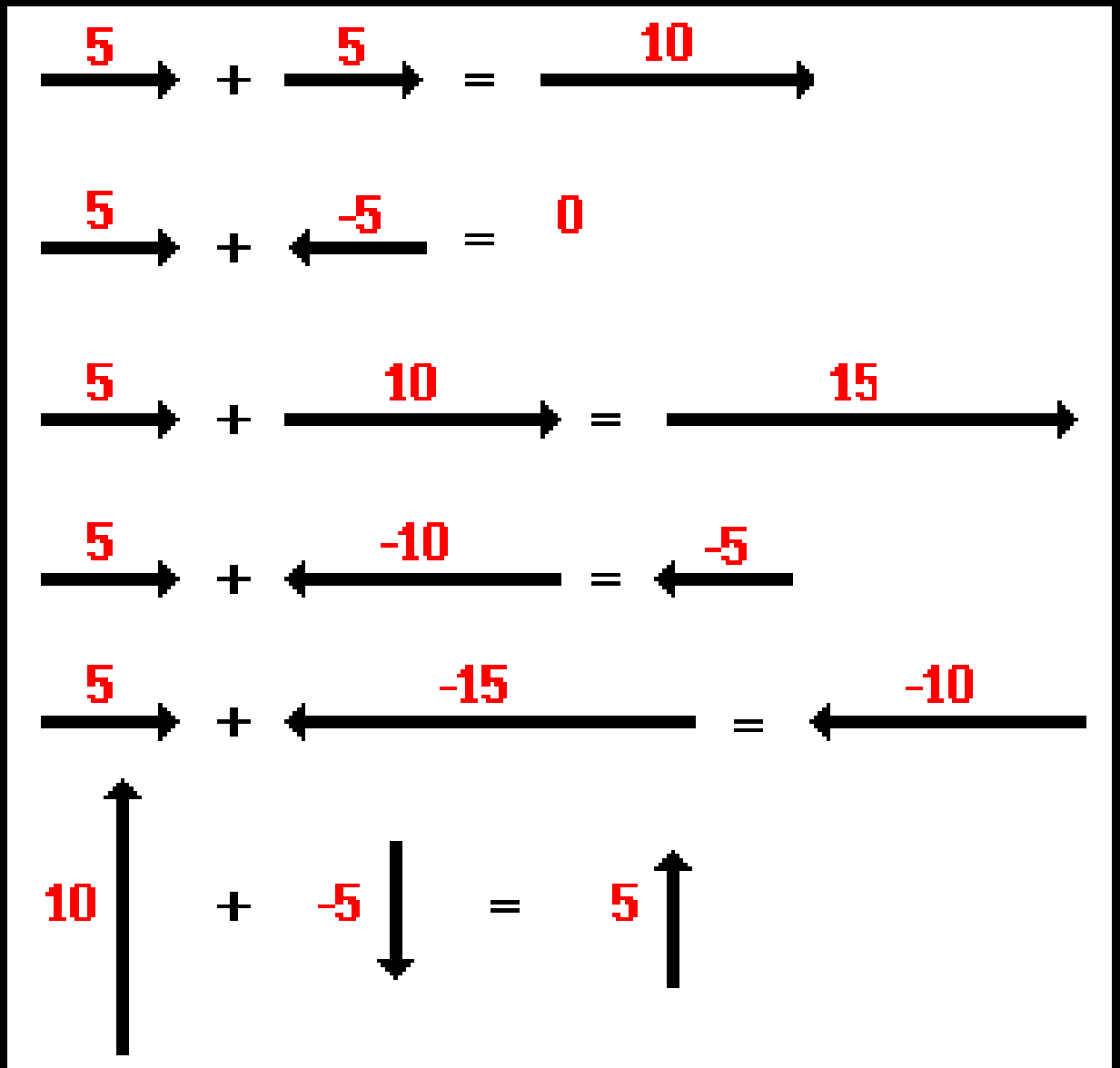


Example 2

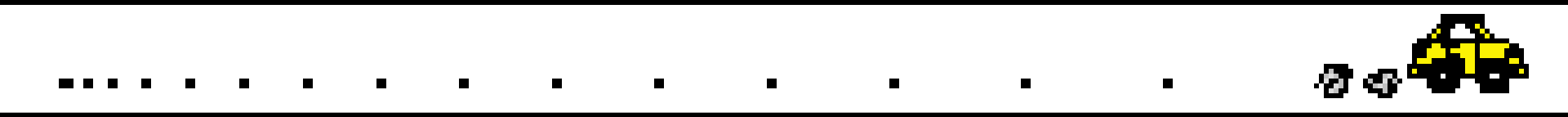
Notice that while the normal force and gravitation forces are balanced (each are 50 N) the force of friction results in unbalanced force on the horizontal axis. The net force is 20 N left.

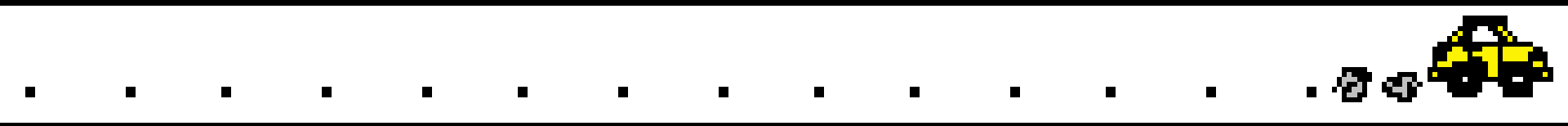


Another way to look at balances and unbalanced forces

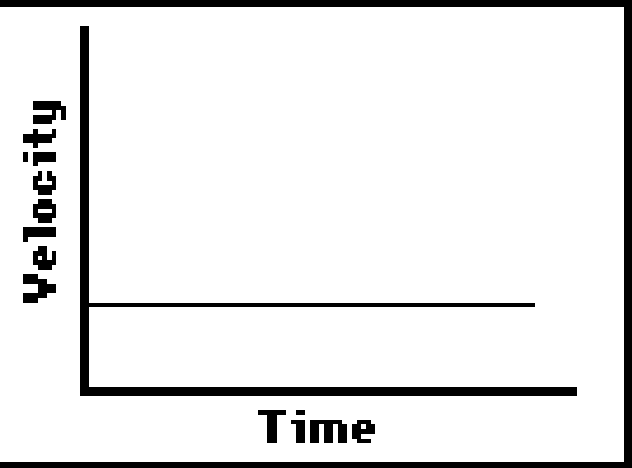


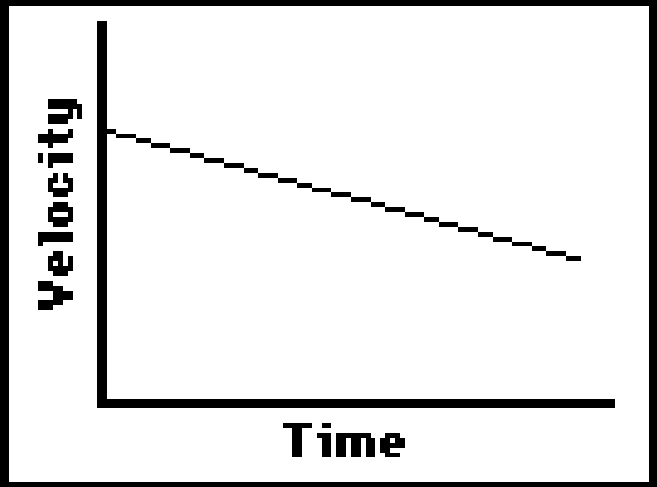
Balanced or unbalanced?

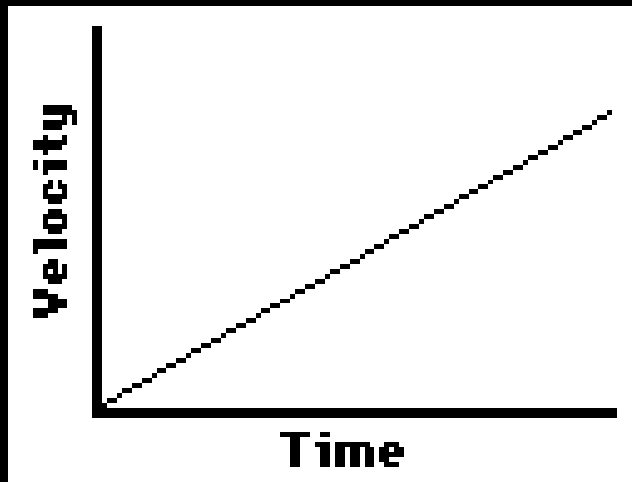




Balanced or Unbalanced?



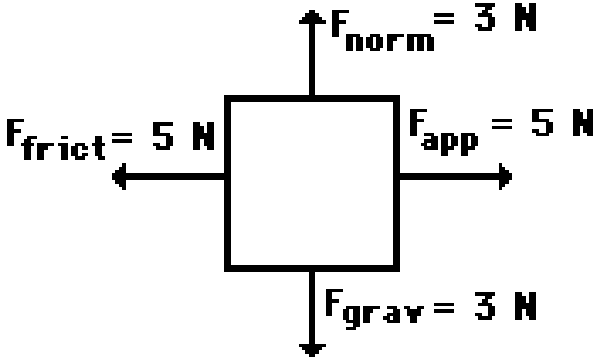




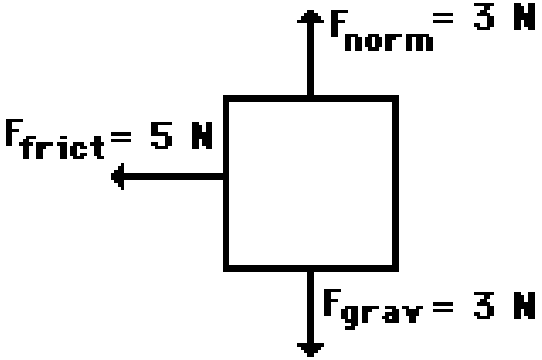
Evaluation

Complete question #9 on the *Free-body Diagram Worksheet.*

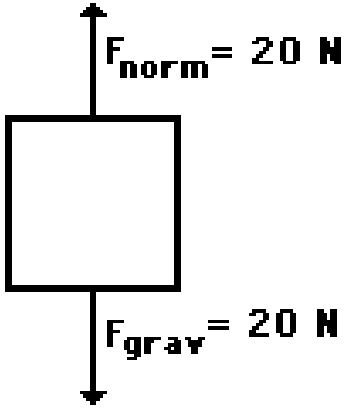
Situation A



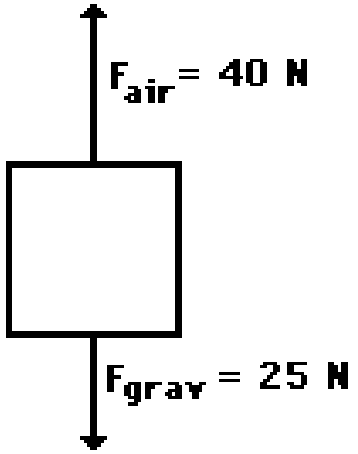
Situation B



Situation C



Situation D



EXPLAIN

Review the *Free-Body Diagram Worksheet with students.*

EVALUATION

Use your science journal to record the answers to these questions:

- **What is force?**
- **What is net force?**
- **How is a free-body diagram used to understand forces acting on an object?**

Special thanks to the Physics Classroom used to prepare this lesson

http://www.glenbrook.k12.il.us/GBSSCI/PHYS/Class/newtlaws/u2l2d.html