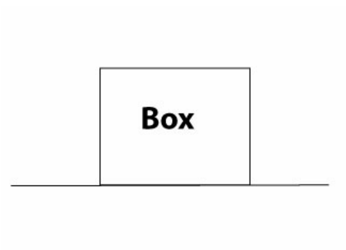
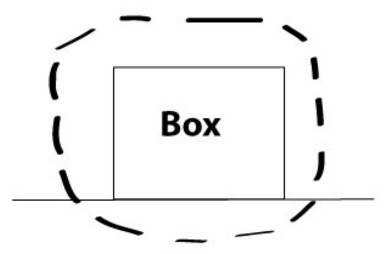
How to Draw Force Diagrams

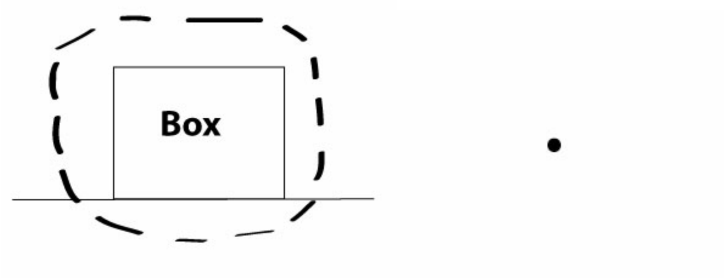
1. Draw a picture of the situation. In this example a box is sitting on the floor.



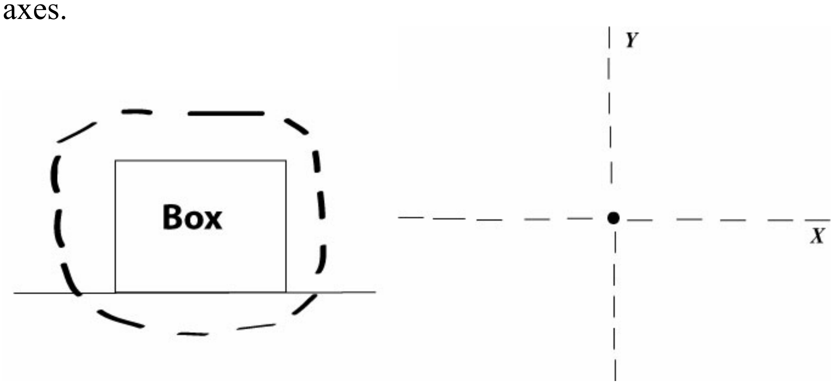
2. Identify and isolate the object in consideration by drawing a dotted line around it.



3. Draw a **dot** to the side of the picture to represent the object. So, in this case, the dot represents the box. We do this to simplify the physics analysis.



4. Draw a coordinate system (dotted lines) with the dot at the origin. Be sure to label the y and x axes.



5. Identify the forces **<u>on the object</u>** and label them. All forces can be divided into two types. Always identify the forces in the following order:

a. **Long Range Forces**

i. These are forces that are NOT caused by physical contact.

ii. There are only three (since most problems we will be doing this year are on earth, the gravitational force is generally acting on the object).

- •Gravitational Force
- •Magnetic Force
- •Electric Force

b. **Contact Forces**

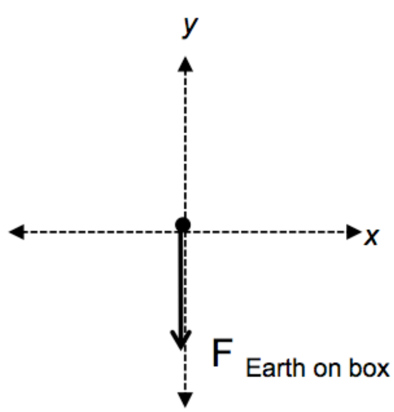
i. There are forces caused by physical contact.

- •Anything touching the object is considered a contact force. The way to tell if a contact force exists: it crosses the dotted line and is touching the object
- •There can be many different contact forces.

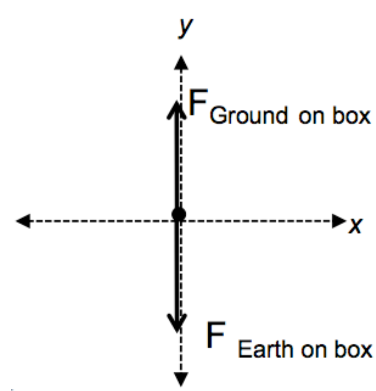
In our example:
One long range force: Force of earth on the box
One contact force: Force of ground on the box

6. Represent each force by an arrow pointing in the direction the force is acting.
•The tail of the arrow goes on the dot
•The length of the arrow represents the magnitude of the force.

Long Range Force



Long Range Force and Contact Force



7. Potential pitfalls when identifying and drawing forces.
• It is important that you label the forces exerted **<u>on the object</u>**, NOT forces the object exerts on something else! In this example we are looking at forces "on the box," so all the forces should indicate this, e.g. $F_{\text{Earth } \mathbf{on\ Box}}$ and $F_{\text{Ground } \mathbf{on\ Box}}$
•Identify only forces acting at the instant shown, NOT before or after. A force diagram only represents the forces on an object at **one moment in time**. It does not represent what happened before this moment or after this moment.
•You cannot tell the motion of an object from a force diagram!
•Remember Newton's First Law: Constant velocity is a "natural state" of an object in the absence of any net force and therefore it does NOT require a force! Many students, in fact, all

students at one point or another, confuse inertia with a force. Inertia is NOT a force. Repeat inertia is NOT a force!!

•If you cannot identify a **long range force** or a **contact force** you should NOT have an arrow on your force diagram, no matter how much you "feel" it should be there!!

8. Create a sum of the forces equation for all the forces on each axis (x and y).
The symbol ∑ is the Greek letter **sigma** and it means "sum of." It simply means to add up. So, $\sum F_y$ means to add up all the forces in the y direction. Here is how we write it:

$$\Sigma F_y = F_{\text{Ground on box}} + F_{\text{Earth on box}}$$

$\sum F_x$ means to add up all the forces in the y direction. Since there are no forces in the x direction we simply write:

$$\Sigma F_x = 0$$

9. Why do we do all this? So we can analyze motion because once you have created a force diagram you can determine what kind of motion your object is experiencing.
If the **sum of the forces is zero** (i.e. the net force is zero) then according to Newton's First Law the object is either **at rest** or **moving at a constant velocity**.
If the **sum of the forces is not zero** (i.e. the net force is not zero), then the object **must be accelerating** (speeding up, slowing down, or changing direction).