Dynamics
Chapters 2,3 p. 68-171

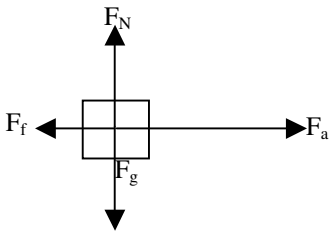
The first unit dealt with kinematics which describes motion. In this unit we will concern ourselves with explaining why things move. A force is a push or a pull (a vector quantity). Contact forces, such as friction or normal forces, occur through direct contact. Non-contact forces act at a distance. Magnetic, electrical, nuclear and gravitational forces are all non-contact forces. Since there are many different types of forces subscripts are used to differentiate them (table 1 p. 71). When one analyzes forces on a molecular level contact forces reduce to non-contact forces. Tension is a force caused by stretching a material. Static friction is the force that resists the movement of a stationary object while kinetic friction acts against the movement of a moving object.

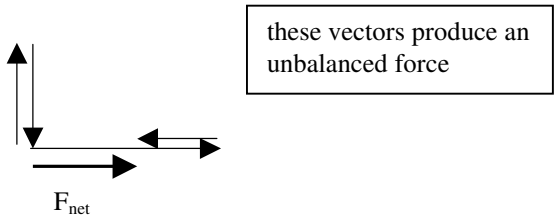
Newton's First Law (Law of Inertia), p. 77-81

When no external, unbalanced force acts on an object, its velocity remains constant.
or
If no net force acts on an object, it maintains its state of rest or its constant speed in a straight line.

Several forces may act simultaneously on an object. A free body diagram (FBD) shows all of the forces acting on a object. All forces are shown as a pull on the object. By using the rules of vector addition and free-body diagrams one can determine if there is a net force vector acting upon an object.

Some reminders for free-body diagrams:
-sketch the object in isolation
-represent each of the force vectors acting on the object properly by showing magnitude and direction, the vector should originate from the center of the object
-only include forces acting **<u>on</u>** the object





-a group of balanced forces produces a net force vector of 0

The ability of an object to resist changes in its state of motion is a fundamental property of all matter and is called inertia. Remember that to change something's velocity means to accelerate it. The greater an object's inertia the more difficult it is to accelerate it.

Problems: p. 80 1-9 (6, 7 are the longest solutions and need vector diagrams, the other answers are quick)

Newton's Second Law (Law of Motion) p. 81-83

When an external, unbalanced force acts on an object, the object accelerates. The acceleration is in the same direction as the net force acting on the object. The acceleration varies directly with the net force applied. The

$\vec{a} \alpha \frac{\vec{F}}{m}$ $\quad \vec{F}_R = m\vec{a}$ $\quad$ the units of Force are Newtons (N), $\quad 1N = 1\frac{kg \cdot m}{s^2}$

acceleration varies inversely with the mass of the object.

Remember that all of the acceleration, velocity and displacement equations that were developed in the kinematics unit (for constant acceleration) still apply.

Problems: p. 83 10-14

Newton's Third Law p84-85

For every action force, there exists a simultaneous reaction force that is equal in magnitude but opposite in direction.

An action force and reaction force have 1 similarity and 2 differences:

-**same** magnitude of force, **different** direction of force, each force works on a **different** object

Some examples:

Earth pulls on Amanda (action), Amanda pulls on Earth (reaction).
Billy pushes the wall (action); the wall pushes Billy (reaction)
The rope pulls the sled (action); the sled pulls the rope (reaction).

An object's acceleration is determined by the net force acting on it. The action force or reaction force is just one part of the net force. Consider all of the forces acting on an object (but only the forces acting **on** the object) at one time to determine its acceleration.

problems: **p86** 20,21 **p.87** 8,9 **p.94** 10,11

FRICTIONAL FORCES

section 2.4: p. 97-101 p. 102-105 (good reading)

Coefficients of Friction Table: p. 98

The force of friction (F_f) is the resistance to motion because of the interaction of the object with its surroundings (gas, liquid, solid).Forces of friction are very important because they allow things to move or stop. Ultimately friction involves the electrostatic forces between atoms or molecules where the surfaces are in contact.

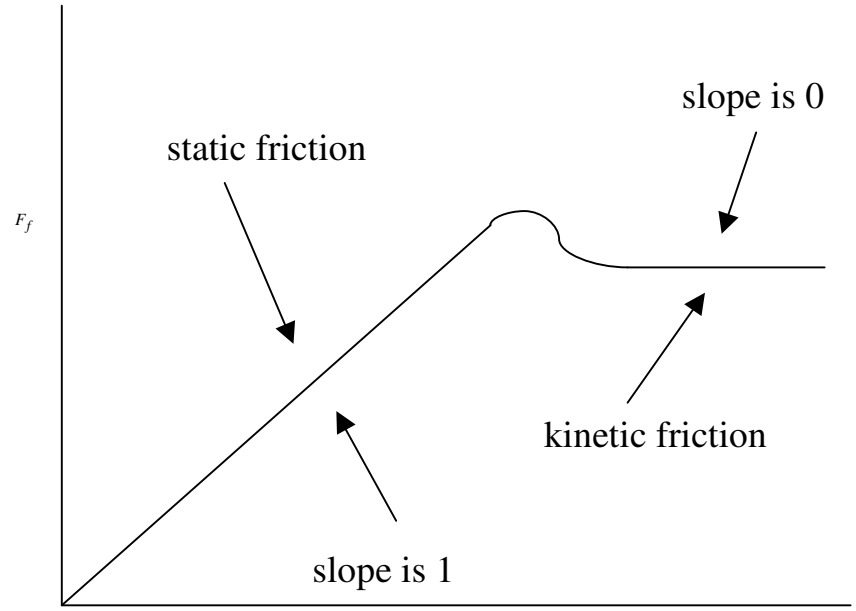
There are two types of friction. Static friction (F_S) occurs when an object is stationary while kinetic friction (F_K) occurs when an object is moving. Friction follows these two empirical laws.

1. It is proportional to the normal force. $F_f = \mu F_N$

2. It is approximately independent of the area of contact over wide limits.

When a stationary object is acted upon by an unbalanced force that increases so too does static friction (and the object does not move). When the static frictional force reaches a maximum it grows no longer and the object begins to move. $F_s \leq \mu_s F_N$

The frictional force often decreases at this moment since the coefficient of kinetic friction is generally lower than the coefficient of static friction.



Kinetic frictional forces do change with increasing velocity but not that dramatically. We will treat kinetic friction as being independent of an object's velocity. Both coefficients of friction are dimensionless constants that are generally less than one in value. In calculating the normal force remember that we have dealt with two general cases. On a flat surface one must consider all of the up and down forces when calculating the normal force. On an inclined plane the normal force is equal to the component of gravity perpendicular to the surface.

FORCE OF GRAVITY

The force of gravity is calculated by a well-known equation.

$\vec{F}_g = mg$ — force of gravity near Earth's surface; 9.81 N/kg [down]

The force of gravity calculation is also important to normal force calculations, which are in turn important to frictional force calculations. Since the gravitational field strength and forces, which depend on it often, do not have the same direction the absolute value of the gravitational field strength will be used. The direction of the force will be determined from the fbd and the direction systems.