Unit 2C – Newton's First Law of Motion

(A) Statement of Newton's First Law

Newton's first law of motion is often stated as:

Alternative statement:

Diagram:

In fact, it is the _____ of objects to _____ changes in their state of motion. This tendency to resist changes in their state of motion is described as _____.

Inertia:

The tendency of an object to resist changes in its state of motion varies with _____.

Mass is that quantity which is solely dependent upon the inertia of an object. The more inertia which an object has, the more mass it has. A more massive object has a greater tendency to resist changes in its state of motion.

Check Your Understanding

1. Imagine a place in the *cosmos* far from all gravitational and frictional influences. Suppose that you visit that place (just suppose) and throw a rock. The rock will

    a. gradually stop.
    b. continue in motion in the same direction at constant speed.

2. A 2-kg object is moving horizontally with a speed of 4 m/s. How much net force is required to keep the object moving at this speed and in this direction?

3. Mac and Tosh are arguing in the cafeteria. Mac says that if he flings the Jell-O with a greater speed it will have a greater inertia. Tosh argues that inertia does not depend upon speed, but rather upon mass. Who do you agree with? Explain why.

4. Supposing you were in space in a *weightless environment*, would it require a force to set an object in motion?

5. Fred spends most Sunday afternoons at rest on the sofa, watching pro football games and consuming large quantities of food. What effect (if any) does this practice have upon his inertia? Explain.

6. Ben Tooclose is being chased through the woods by a bull moose which he was attempting to photograph. The enormous mass of the bull moose is extremely intimidating. Yet, if Ben makes a zigzag pattern through the woods, he will be able to use the large mass of the moose to his own advantage. Explain this in terms of inertia and Newton's first law of motion.

7. Two bricks are resting on edge of the lab table. Shirley Sheshort stands on her toes and spots the two bricks. She acquires an intense desire to know which of the two bricks are most massive. Since Shirley is vertically challenged, she is unable to reach high enough and lift the bricks; she can however reach high enough to give the bricks a push. Discuss how the process of pushing the bricks will allow Shirley to determine which of the two bricks is most massive. What difference will Shirley observe and how can this observation lead to the necessary conclusion?

(B) Balanced & Unbalanced Forces

DIAGRAM:

Since these two forces are of _____ and _____, ***they balance each other***. The book is said to be at _____. There is no unbalanced force acting upon the book and thus the book maintains its state of motion.

Now consider a book sliding from left to right across a table top.

DIAGRAM:

The force of gravity pulling downward and the force of the table pushing upwards on the book are of equal magnitude and opposite directions. _____ . Yet there is _____ . As the book moves to the right, friction acts to the left to slow the book down. _____ ; and as such, the book _____. The book is not at equilibrium and subsequently accelerates.

Unit 2D – Newton's Second Law of Motion

Newton's second law of motion pertains to the behavior of objects for which

The second law states that the acceleration of an object is dependent upon two variables

DIAGRAM:

Newton's second law of motion can be formally stated as follows:

This verbal statement can be expressed in equation form as follows:

The above equation is often rearranged to a more familiar form as shown below.

EXAMPLE

	Net Force (N)	**Mass (kg)**	**Acceleration (m/s/s)**
1.	10	2	
2.	20	2	
3.	20	4	
4.		2	5
5.	10		10

Check Your Understanding

1. Determine the accelerations which result when a 12-N net force is applied to a 3-kg object and then to a 6-kg object.

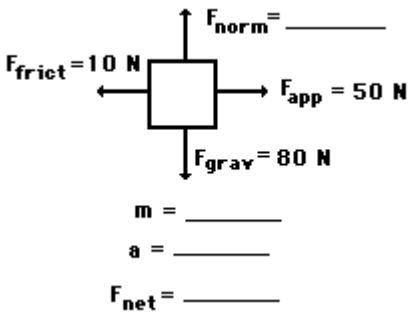
2. A net force of 15 N is exerted on an encyclopedia to cause it to accelerate at a rate of 5 m/s^2. Determine the mass of the encyclopedia.

3. Suppose that a sled is accelerating at a rate of 2 m/s^2. If the net force is tripled and the mass is doubled, then what is the new acceleration of the sled?

4. Suppose that a sled is accelerating at a rate of 2 m/s^2. If the net force is tripled and the mass is halved, then what is the new acceleration of the sled?

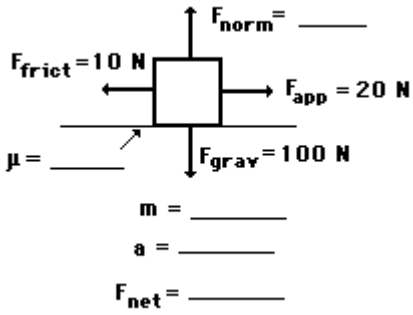
Practice #1

An applied force of 50 N is used to accelerate an object to the right across a frictional surface. The object encounters 10 N of friction. Use the diagram to determine the normal force, the net force, the mass, and the acceleration of the object.



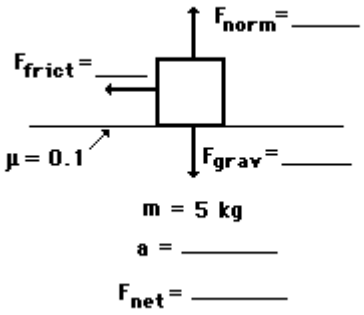
Practice #2

An applied force of 20 N is used to accelerate an object to the right across a frictional surface. The object encounters 10 N of friction. Use the diagram to determine the normal force, the net force, the mass, and the acceleration of the object. (Neglect air resistance.)



Practice #3

A 5-kg object is sliding to the right and encountering a friction force which slows it down. The force of friction ("mu") between the object and the surface is 5N. Determine the force of gravity, the normal force, the net force, and the acceleration. (Neglect air resistance.)



m = 5 kg

a = _____

F_{net} = _____

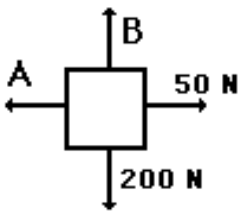
Check Your Understanding

1. Edwardo applies a 4.25-N rightward force to a 0.765-kg book to accelerate it across a table top. The force of friction between the book and the tabletop is 0.314-N. Determine the acceleration of the book.

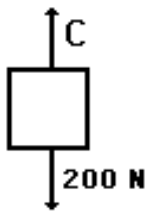
2. In a physics lab, Kate and Rob use a hanging mass and pulley system to exert a 2.45 N rightward force on a 0.500-kg cart to accelerate it across a low-friction track. If the total resistance force to the motion of the cart is 0.72 N, then what is the cart's acceleration?

Practice #1

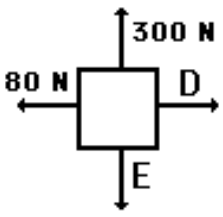
Free-body diagrams for four situations are shown below. The net force is known for each situation. However, the magnitudes of a few of the individual forces are not known. Analyze each situation individually and determine the magnitude of the unknown forces.



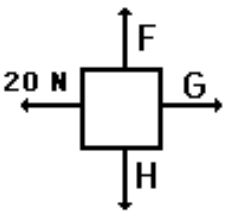
F_{net} = 0 N



F_{net} = 900 N, up



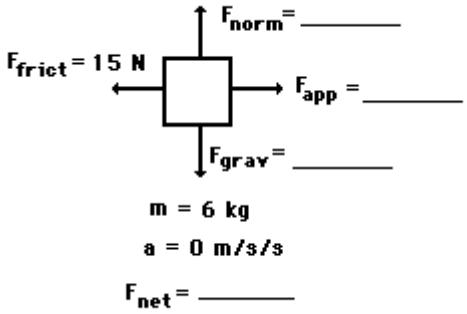
F_{net} = 60 N, left



F_{net} = 30 N, right

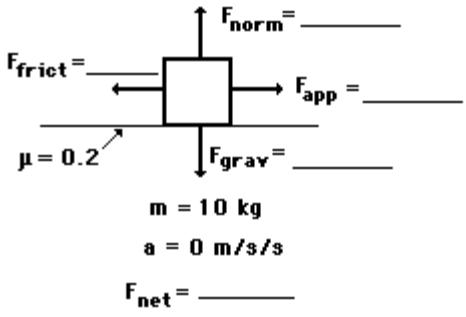
Practice #2

A rightward force is applied to a 6-kg object to move it across a rough surface at constant velocity. The object encounters 15 N of frictional force. Use the diagram to determine the gravitational force, normal force, net force, and applied force. (Neglect air resistance.)



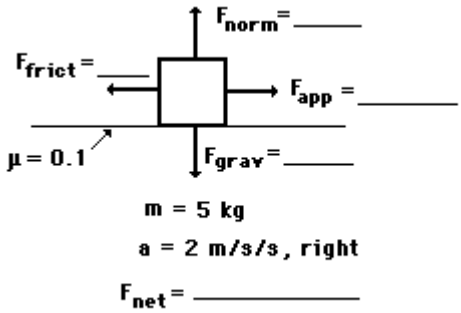
Practice #3

A rightward force is applied to a 10-kg object to move it across a rough surface at constant velocity. The force of friction between the object and the surface is 20 N. Use the diagram to determine the gravitational force, normal force, applied force, and net force. (Neglect air resistance.)



Practice #4

A rightward force is applied to a 5-kg object to move it across a rough surface with a rightward acceleration of 2 m/s/s. The force of friction between the object and the surface is 5.0 N. Use the diagram to determine the gravitational force, normal force, applied force, and net force. (Neglect air resistance.)



Practice #5

A rightward force of 25 N is applied to a 4-kg object to move it across a rough surface with a rightward acceleration of 2.5 m/s/s. Use the diagram to determine the gravitational force, normal force, frictional force, and net force. (Neglect air resistance.)