The Laws of Motion

Essential Question:

How are the concepts of motion helpful and important to one's life?

Sir Isaac Newton
(1643-1726)

He was an English physicist, mathematician, astronomer, natural philosopher, alchemist, and theologian and one of the most influential

Newton's Laws of Motion:

LAW OF INERTIA

LAW OF ACCELERATION

Newton's First Law:

LAW OF INERTIA

changes in state of motion

States of motion may be:

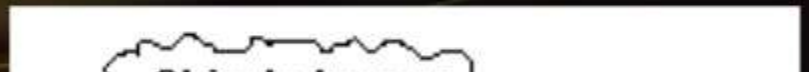
-At rest

-Moving with a constant velocity

-Moving with changing velocity (Accelerating)

Law of Inertia

An object at rest will remain at rest and an object in motion will remain in motion moving with constant velocity unless acted upon by a net force.



Law of Inertia

An object at rest will remain at rest and an object in motion will remain in motion moving with constant velocity unless acted upon by a net force

Law of Inertia

An object at rest will remain at rest and an object in motion will remain in motion moving with constant velocity unless acted upon by a net force

Law of Inertia

An object at rest will remain at rest and an object in motion will remain in motion moving with constant velocity unless acted upon by a NET FORCE

net force

- unbalanced force

balanced forces

- forces that are equal in magnitude and opposite in direction

equilibrium

Law of Inertia

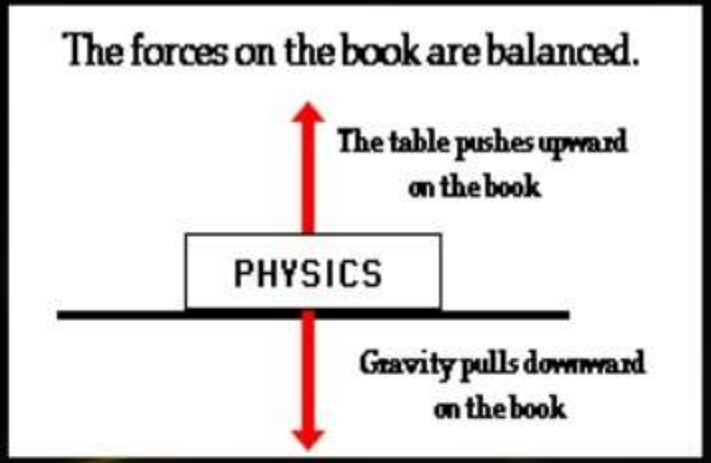
Force, in its simplest sense, is a push or a pull.

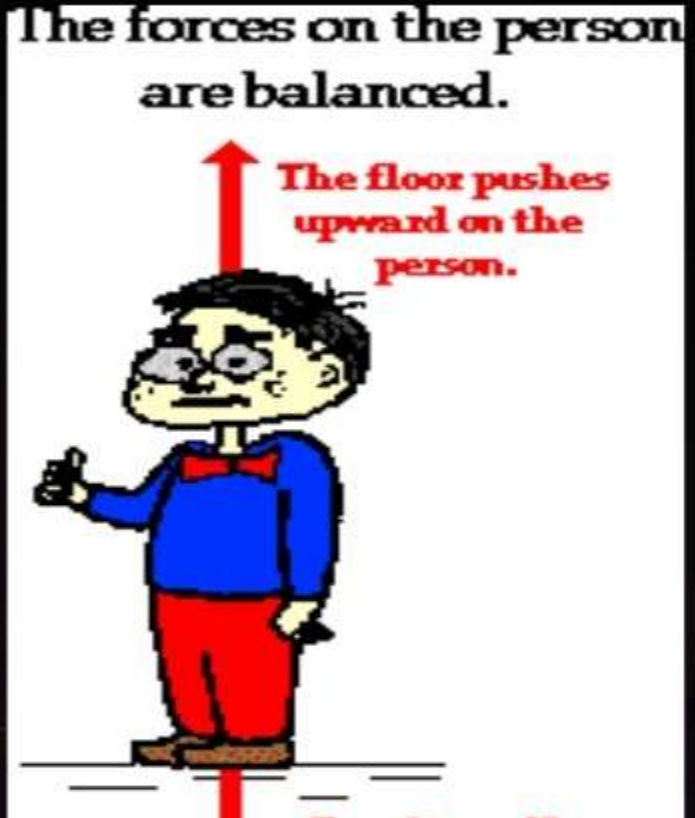
It can be an influence capable of producing a change in the state of

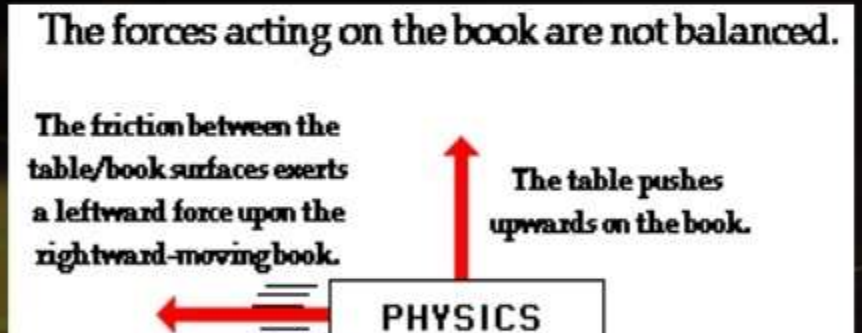
Law of Inertia

Types of Forces:

contact forces – forces that require physical contact between objects


The forces on the book are balanced.
The table pushes upward on the book
PHYSICS
Gravity pulls downward on the book


The forces on the person are balanced.
The floor pushes upward on the person.


The forces acting on the book are not balanced.
The friction between the table/book surfaces exerts a leftward force upon the rightward-moving book.
The table pushes upwards on the book.
PHYSICS

Mass and Inertia

- ✓ The tendency of objects to resist changes in state of motion varies with mass.
- ✓ A more massive object has a greater tendency to resist changes in its state of motion

Which has more inertia?

Everyday Applications of the 1st Law

- The head of a hammer can be tightened onto the wooden handle by banging the

Everyday Applications of the 1st Law

- To dislodge ketchup from the bottom of a ketchup bottle, it is often turned upside down and thrusted downward at high

Everyday Applications of the 1st Law

- A brick is painlessly broken over the hand of a physics teacher by slamming it with a hammer. (CAUTION: do not attempt this at

Everyday Applications of the 1st Law

- Headrests are placed in cars to prevent whiplash injuries during rear-end collisions.

Everyday Applications of the 1st Law

- While riding a skateboard (or wagon or bicycle), you fly forward off the board when hitting a curb or rock or other object

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.

Check Your Understanding

2. 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.

Check Your Understanding

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

Check Your Understanding

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

Check Your Understanding

5. Ben Tooclose is being chased through the woods by a bull moose that 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

Newton's Second Law:

LAW OF ACCELERATION

Law of Acceleration

The acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the

Law of Acceleration

Expressing that statement into equation form, we will have

$$a = \frac{Fnet}{m}$$

or

$$Fnet = ma$$

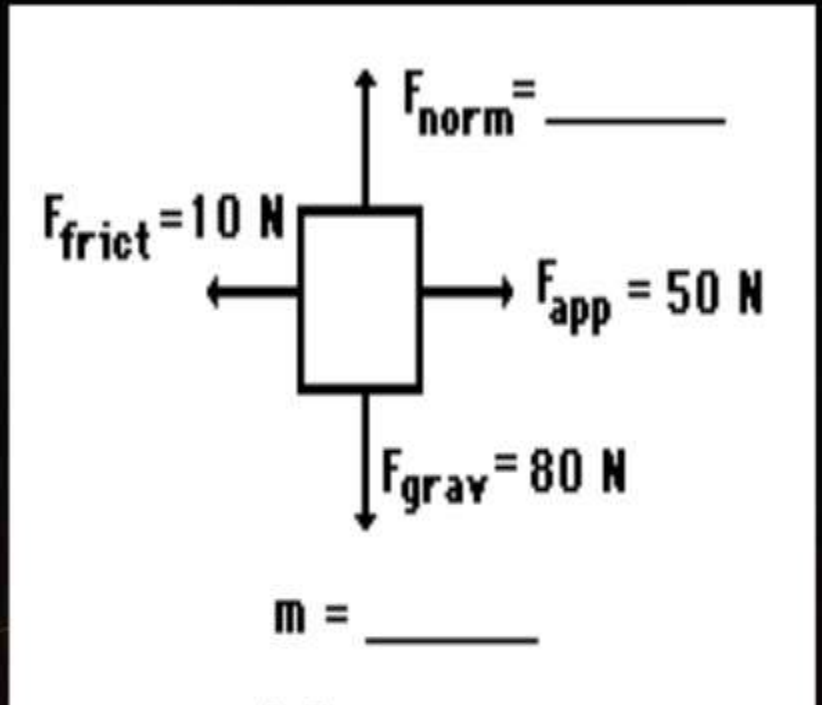
- Newton's second law pertains to the behavior of objects for which all existing forces are NOT balanced (there is acceleration).
- The second law states that the acceleration of an object is dependent upon two variables - the net force acting upon the

Using the equation of the second law, fill the table below.

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

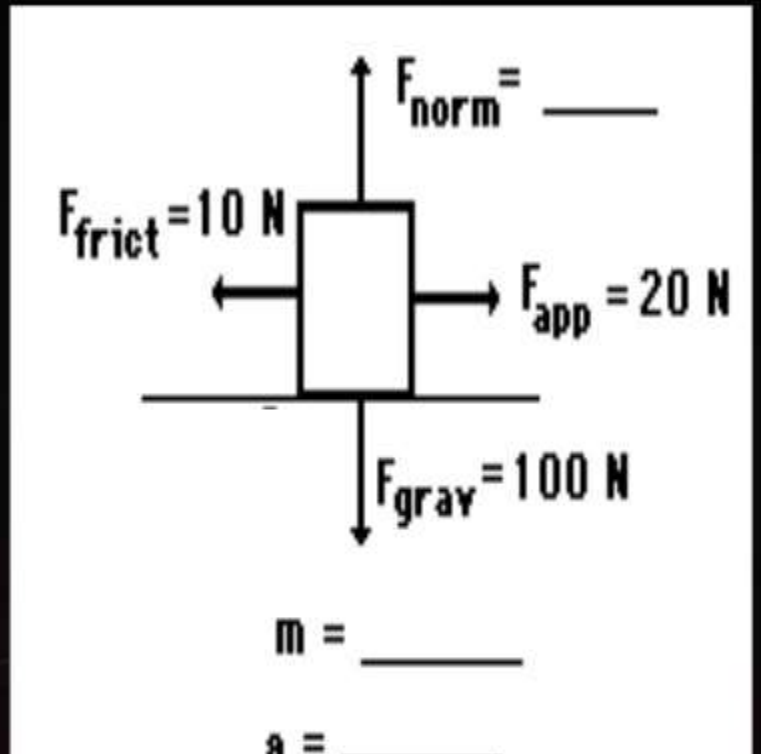
Finding Acceleration: Practice Problems

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



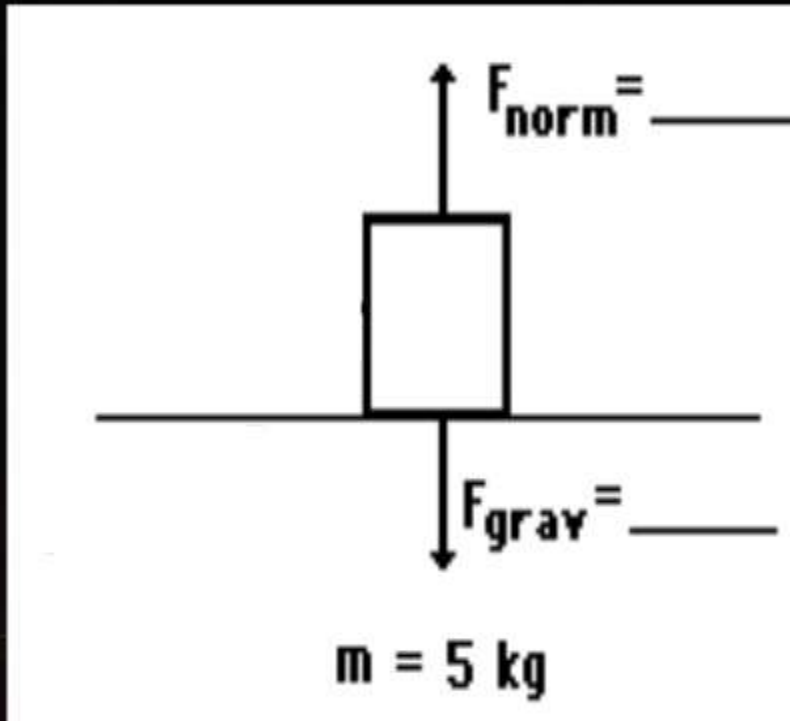
Finding Acceleration: Practice Problems

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



Finding Acceleration: Practice Problems

3. A 5-kg object is resting on top of a table. Determine the force of gravity, the normal force, the net force, and the acceleration. (Neglect air resistance.)



Finding Acceleration: Practice Problems

1. How much net force will be required to move a 1500 kg car with an acceleration of 4 m/s^2?

2. What is the weight of a 50 kg sack of rice?

Newton's Third Law:

LAW OF INTERACTION

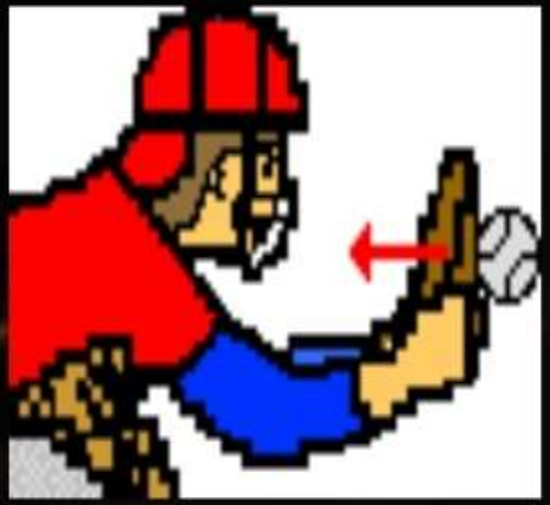
Law of Interaction

For every action force, there is always an equal but opposite reaction force.

Law of Interaction

- The action and reaction forces are **contact forces** (forces acting in contact).
- Action-reaction forces act on **different bodies**.
  - ✓ a wall-hand system

Law of Interaction



1. Bowling ball pushes pin leftwards
2. Pin pushes bowling ball rightwards

1. Baseball pushes

Tell the law present in each situation.

1. The bicycle moves faster as the rider pedals faster
2. A rolling ball stops when blocked by a wall
3. You feel pain when you kick the ball
4. The weight lifter lifting a barbell
5. Birds fly in V- formation
6. A vase on the table
7. Pushing a metal cabinet