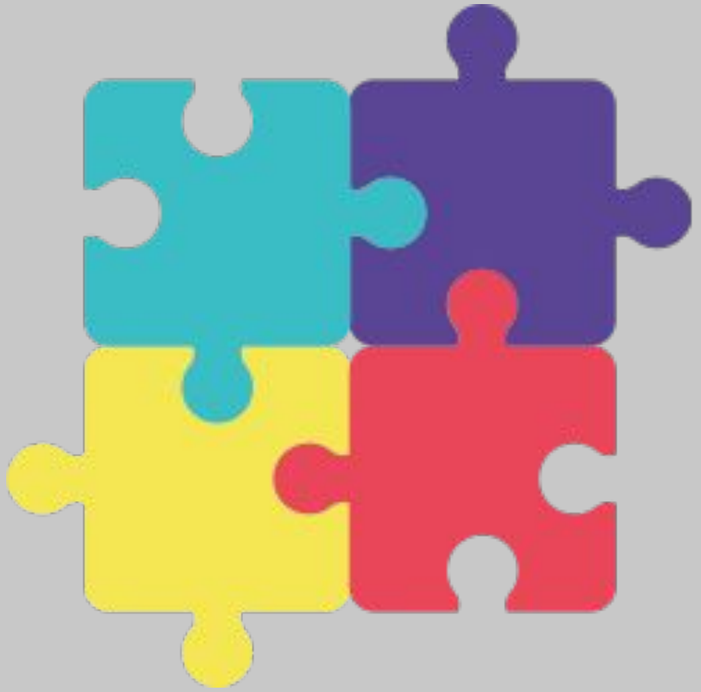
# NEWTON'S LAWS OF MOTION



SCIENCE CLASS

# FORCE AND MASS

- Mass – measurement of how difficult it is to change the object's velocity
- Inertia – resistance to change in velocity
- So mass is a measurement of an object’s inertia

# NEWTON'S LAWS

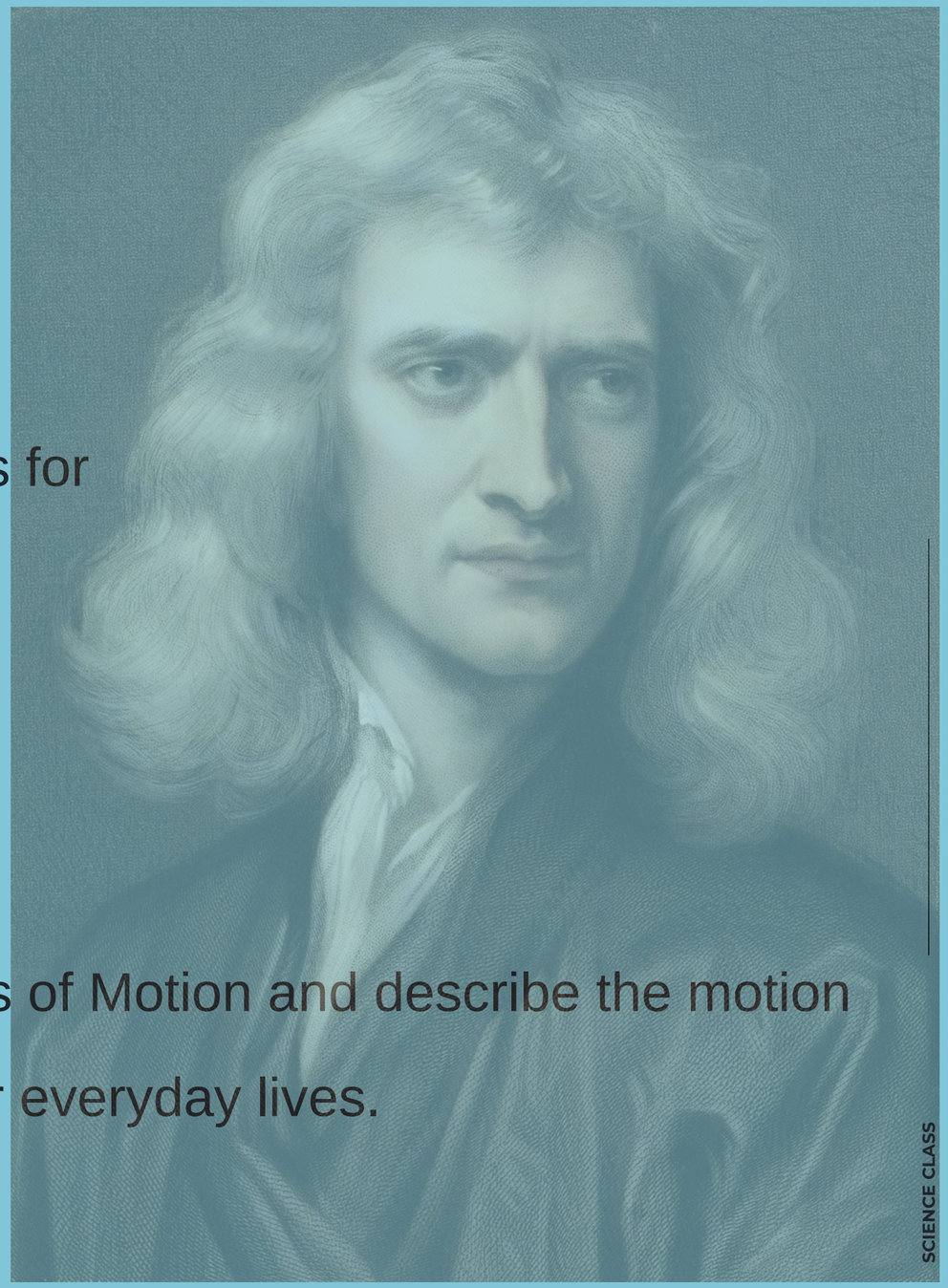
SCIENCE CLASS

# BACKGROUND

Sir Isaac Newton (1643-1727)

an English scientist and mathematician famous for his discovery of the law of gravity also discovered the three laws of motion.

Today these laws are known as Newton’s Laws of Motion and describe the motion of all objects on the scale we experience in our everyday lives.



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# NEWTON'S LAWS OF MOTION

1. An object in motion tends to stay in motion and an object at rest tends to stay at rest unless acted upon by an unbalanced force.
2. Force equals mass times acceleration (F = ma).
3. For every action there is an equal and opposite reaction.

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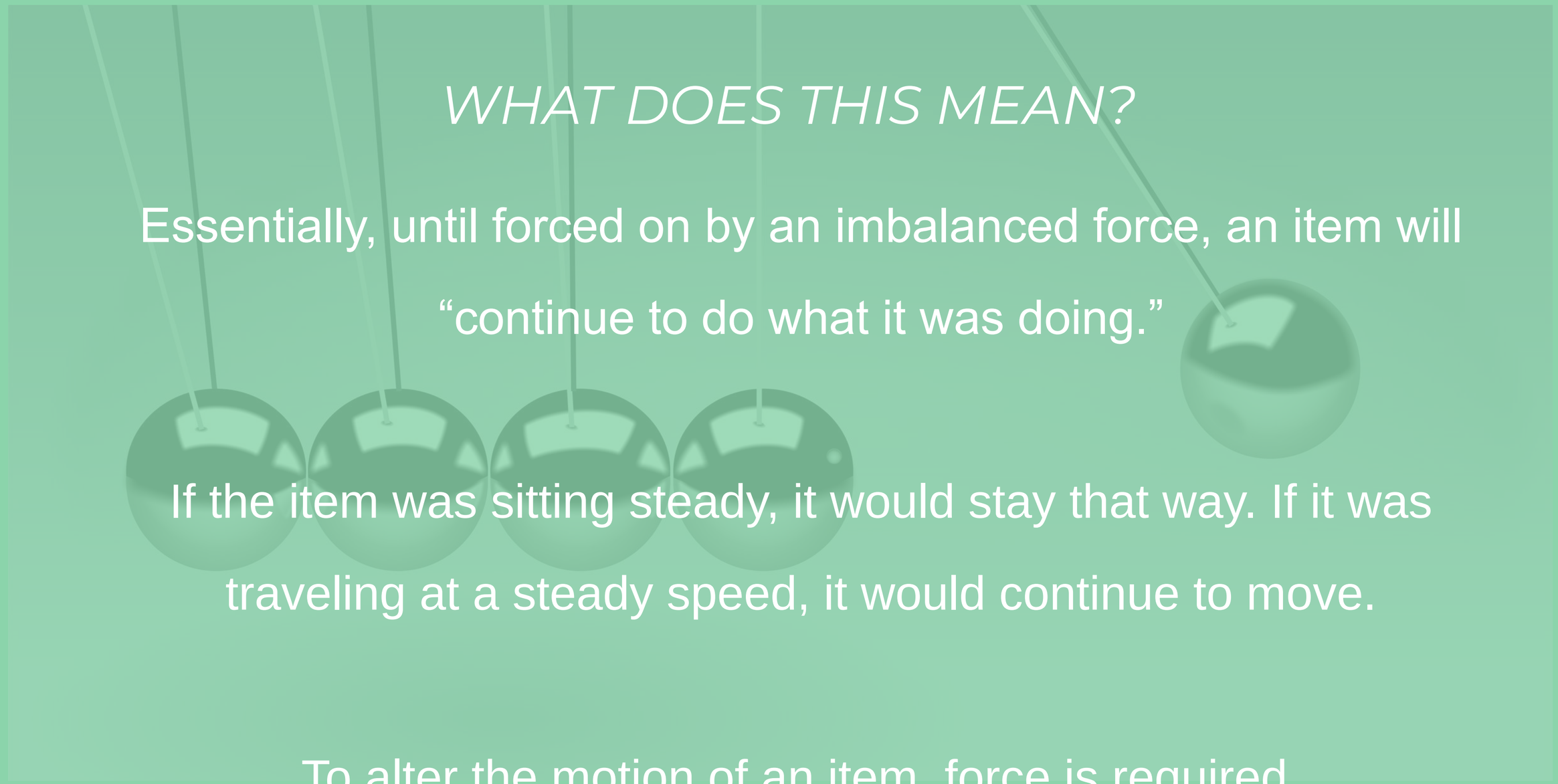
# NEWTON'S FIRST LAW

An object at rest tends to stay at rest and an object in motion tends to stay in motion unless acted upon by an unbalanced force.



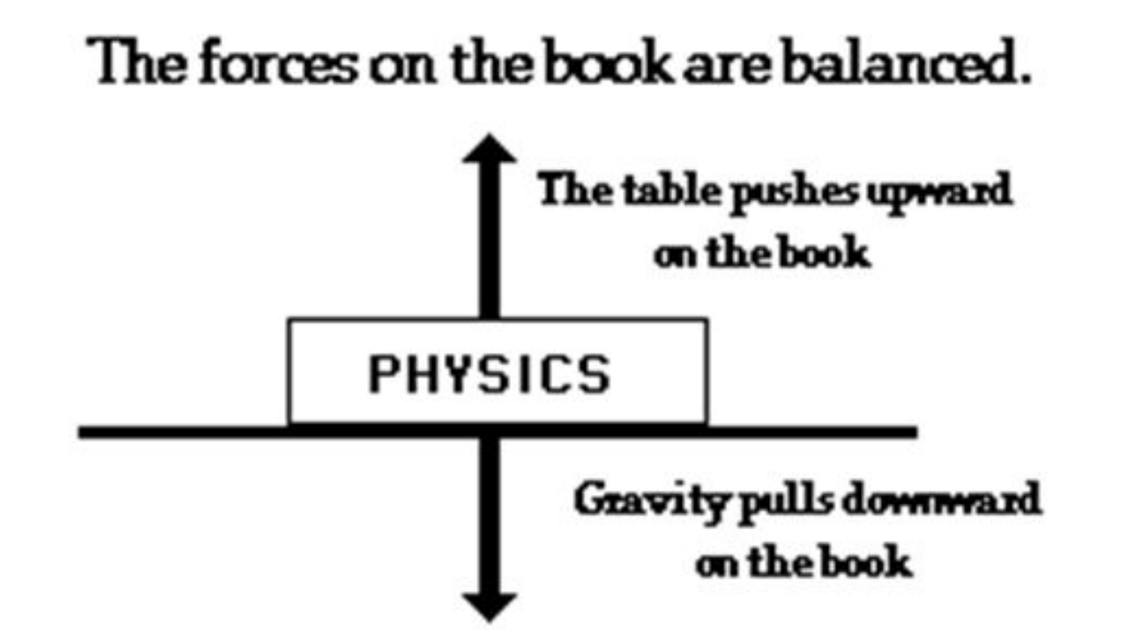
# *WHAT DOES THIS MEAN?*

Essentially, until forced on by an imbalanced force, an item will “continue to do what it was doing.”

If the item was sitting steady, it would stay that way. If it was traveling at a steady speed, it would continue to move.

To alter the motion of an item, force is required.

# WHAT IS MEANT BY UNBALANCED FORCE?




When the forces acting on an item are equal and opposing, the object is said to be balanced, and there is no change in motion. If they are not equal and opposing, the forces are imbalanced, and the object's motion alters.

# SOME EXAMPLES FROM REAL LIFE

The soccer ball is at rest. To alter the motion of a kick, an imbalanced force is required.

Two teams are competing in a tug of war. They are each exerting equal power in opposing directions on the rope. This balanced force has no effect on motion.

# NEWTON’S FIRST LAW IS ALSO CALLED THE Law of Inertia

Inertia: an object's tendency to resist changes in its state of motion.

According to Newton's First Law, all things have inertia. The more an object's mass, the greater its inertia (and the harder it is to change its motion).

# MORE EXAMPLES FROM REAL LIFE

A bug flies into your windshield as you drive to school. Because the bug is so little, it has extremely little inertia and exerts such a small force on your car that you don't even notice it.

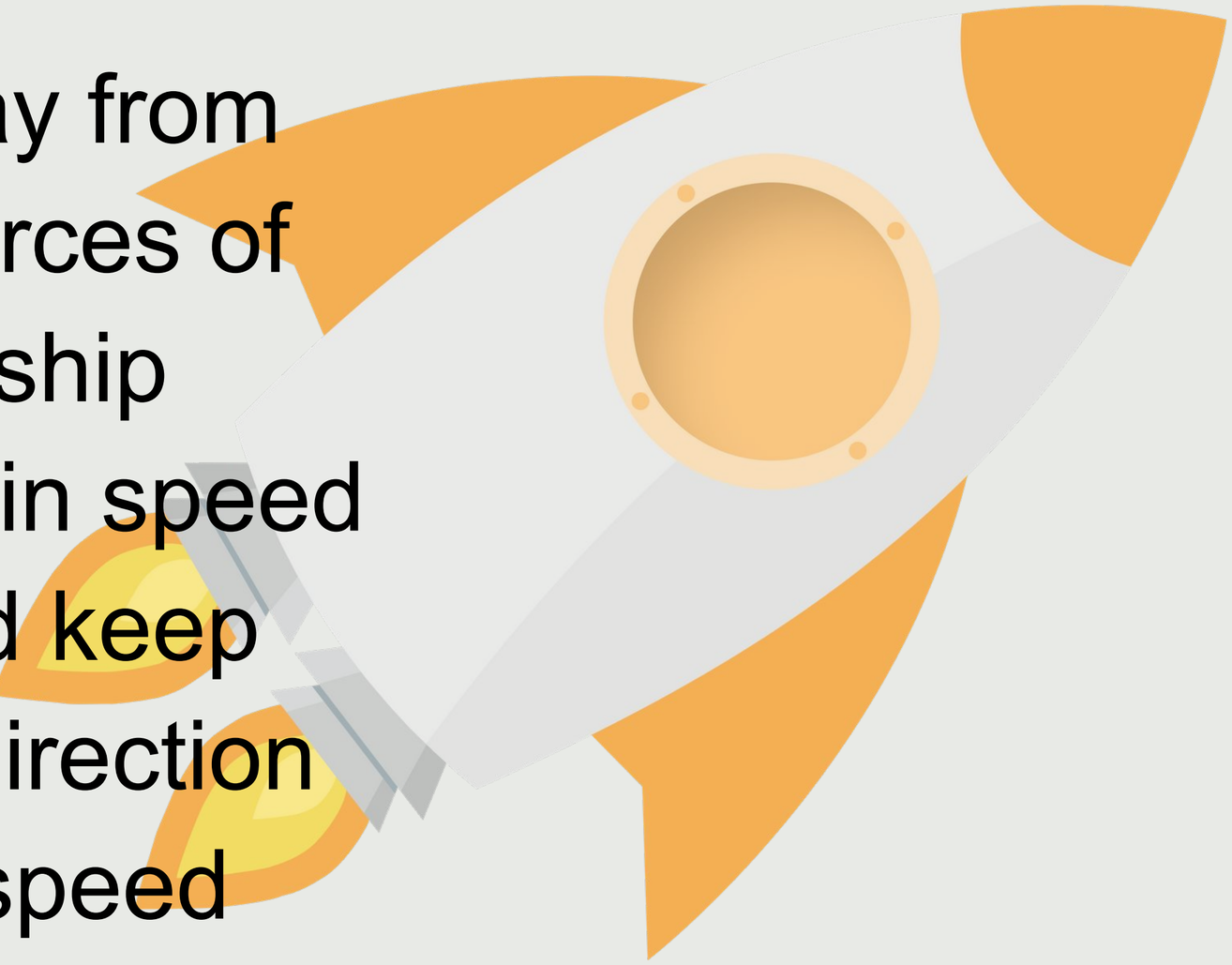
If objects in motion tend to stay in motion, why don’t moving objects keep moving forever?

Things don’t keep moving forever because there’s almost always an unbalanced force acting upon it.

A book sliding across a table slows down and stops because of the force of friction.

If you throw a ball upwards it will eventually slow down and fall because of the force of gravity.

In outer space, away from gravity and any sources of friction, a rocket ship launched with a certain speed and direction would keep going in that same direction and at that same speed forever.



# QUESTION

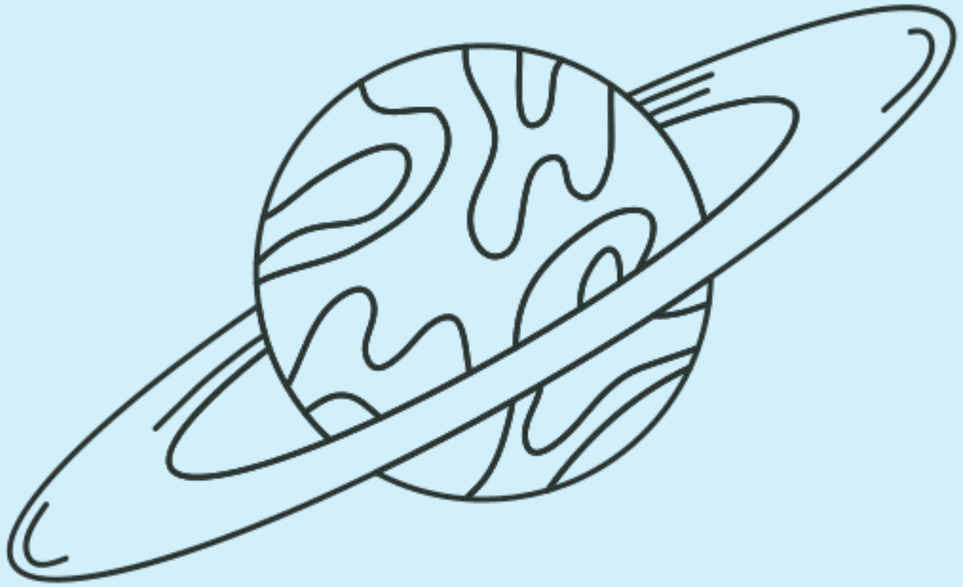
WHAT IS THE RELATIONSHIP BETWEEN MASS AND INERTIA?

Mass is a measure of how much inertia something has.

# Is inertia a force?

No, inertia is a property of matter. Something has inertia.  Inertia does not act on something.

A gravitational pull between the sun and its planets keeps the planets in orbit around the sun. What kind of path would the planets take if the force of gravity suddenly vanished?



Each planet would travel in a straight line at the same steady speed.

2

# NEWTON'S SECOND LAW

FORCE EQUALS MASS TIMES ACCELERATION.

F = MA

Acceleration: a measurement of how quickly an object is changing speed.

# ACCELERATION

An unbalanced force causes something to accelerate.

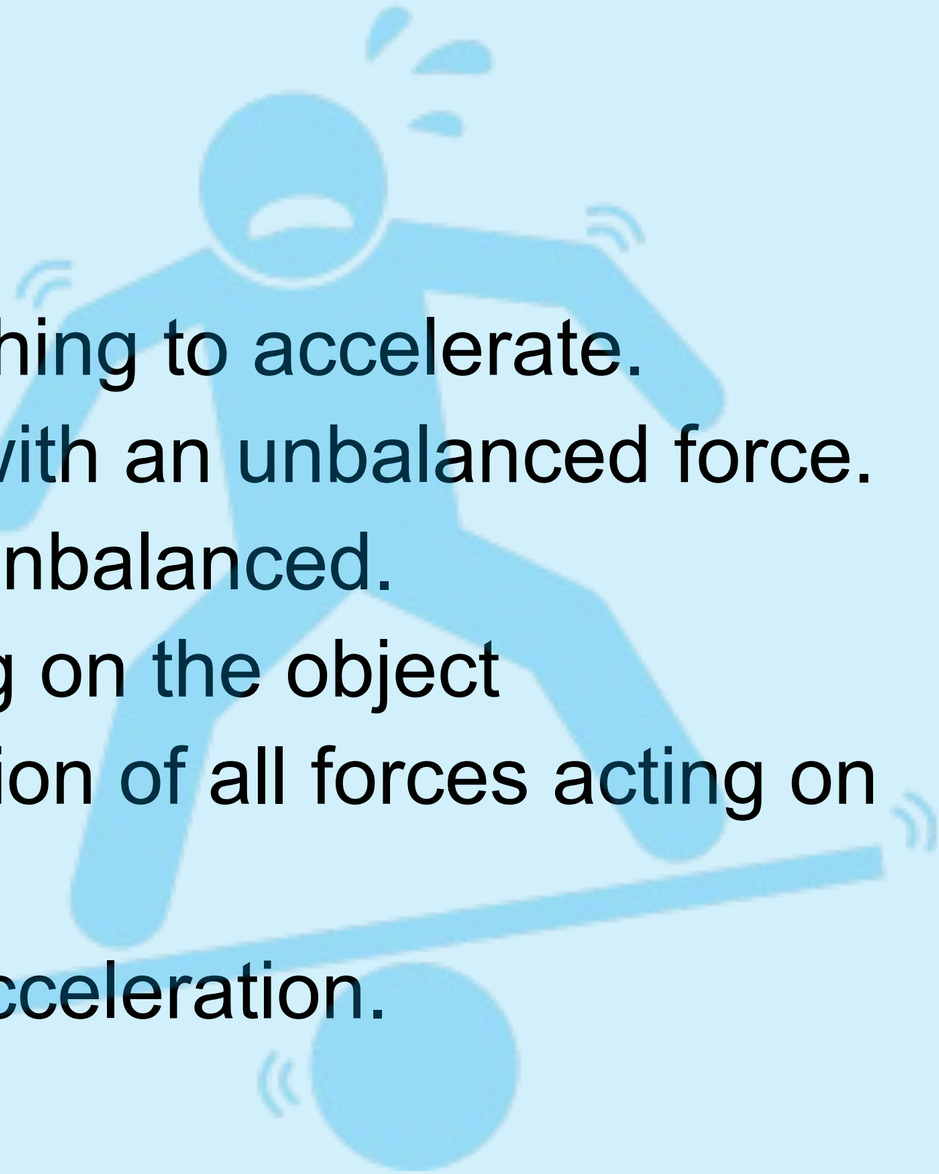
A force can cause motion only if it is met with an unbalanced force.

Forces can be balanced or unbalanced.

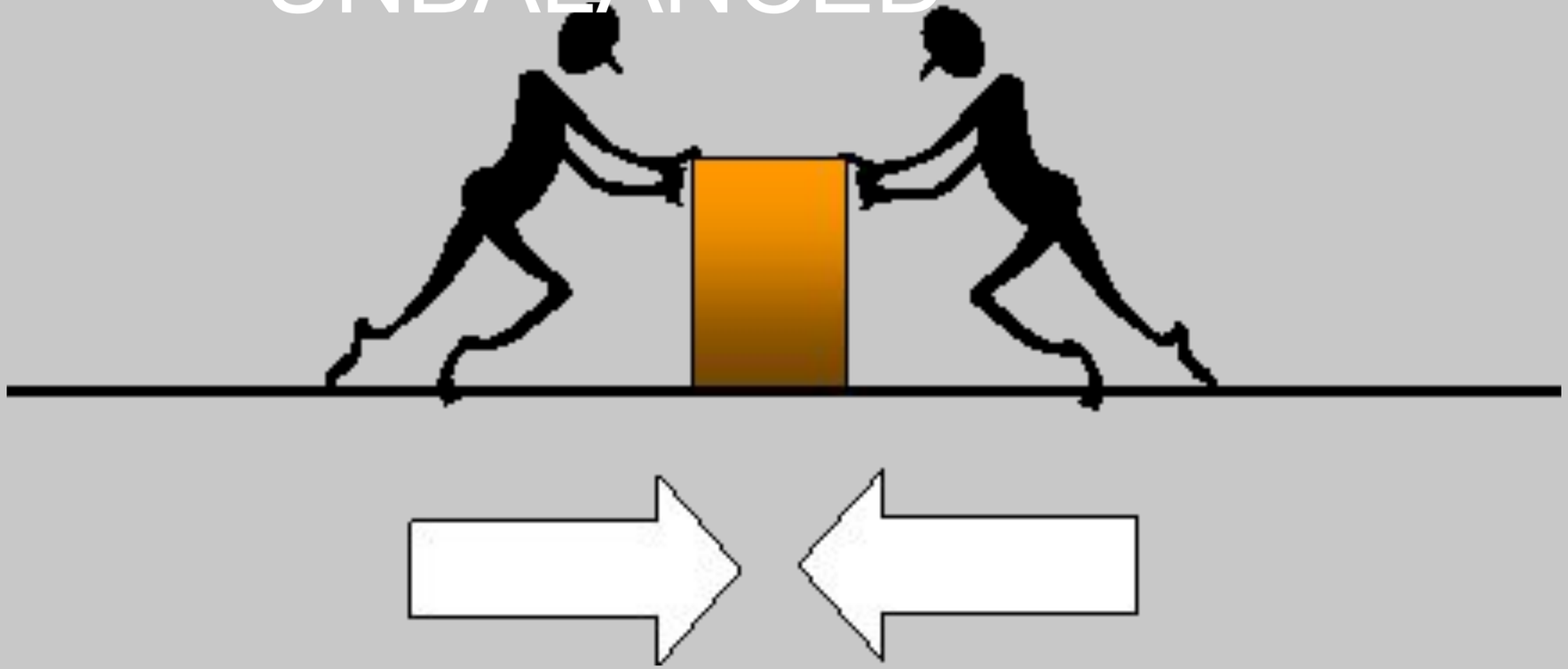
Depends on the net force acting on the object

Net force (Fnet):  The sum total and direction of all forces acting on the object.

Net forces:  Always cause acceleration.

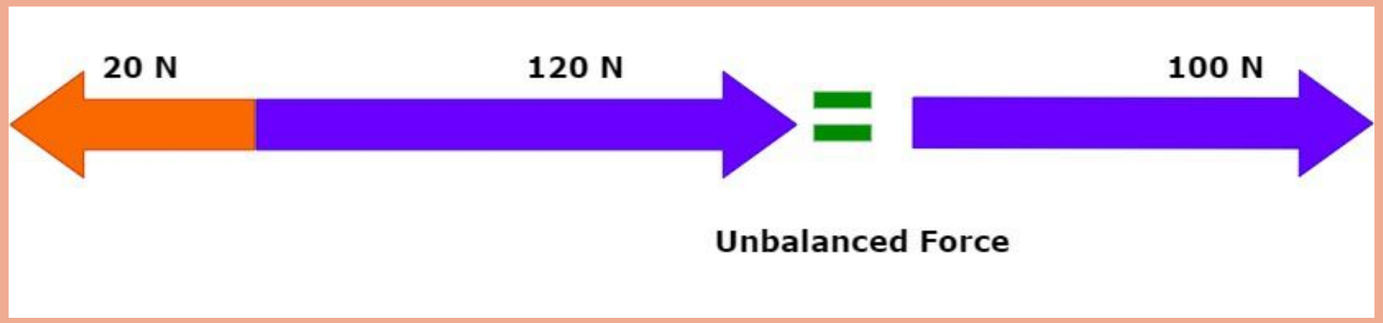


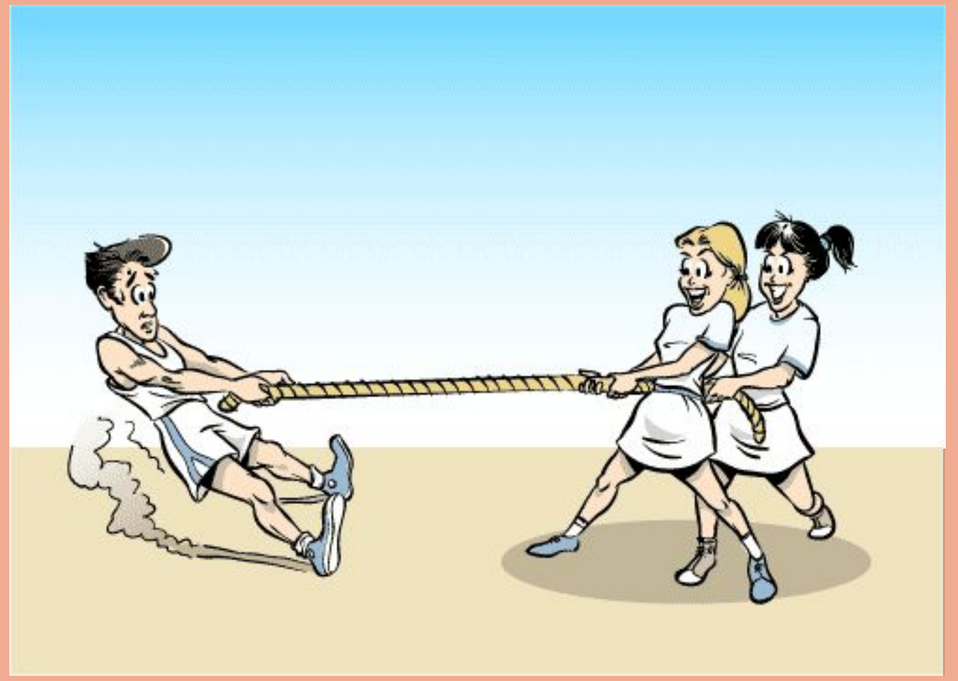
# BALANCED VERSUS UNBALANCED



Balanced forces cause no acceleration.

# BALANCED VERSUS UNBALANCED



Unbalanced forces cause acceleration.

# WHAT DOES F = MA MEAN?

Mass and acceleration are directly proportional to force. Consider a ball of a particular mass travelling at a certain speed. This ball possesses a unique force.

Assume we double the size of the ball (double the mass) while keeping the acceleration unchanged. According to F = ma, the new ball has double the force of the previous ball.
Consider the original ball moving at twice the initial speed. F = ma states that the ball will have double the force it had at its initial acceleration.

IN OTHER WORDS…

SMALL FORCE = SMALL ACCELERATION

LARGE FORCE = LARGE ACCELERATION

**So….if you push twice as hard, it accelerates twice as much.**

# BUT THERE IS A TWIST….

Acceleration is INVERSELY related to the mass of the object.

That is, applying the same amount of force...

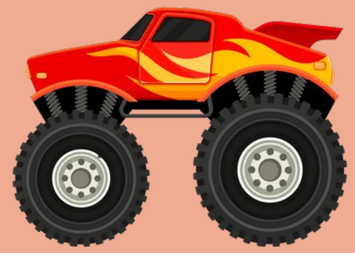
F

Large mass

small acceleration

a

F



Small mass

large acceleration

a

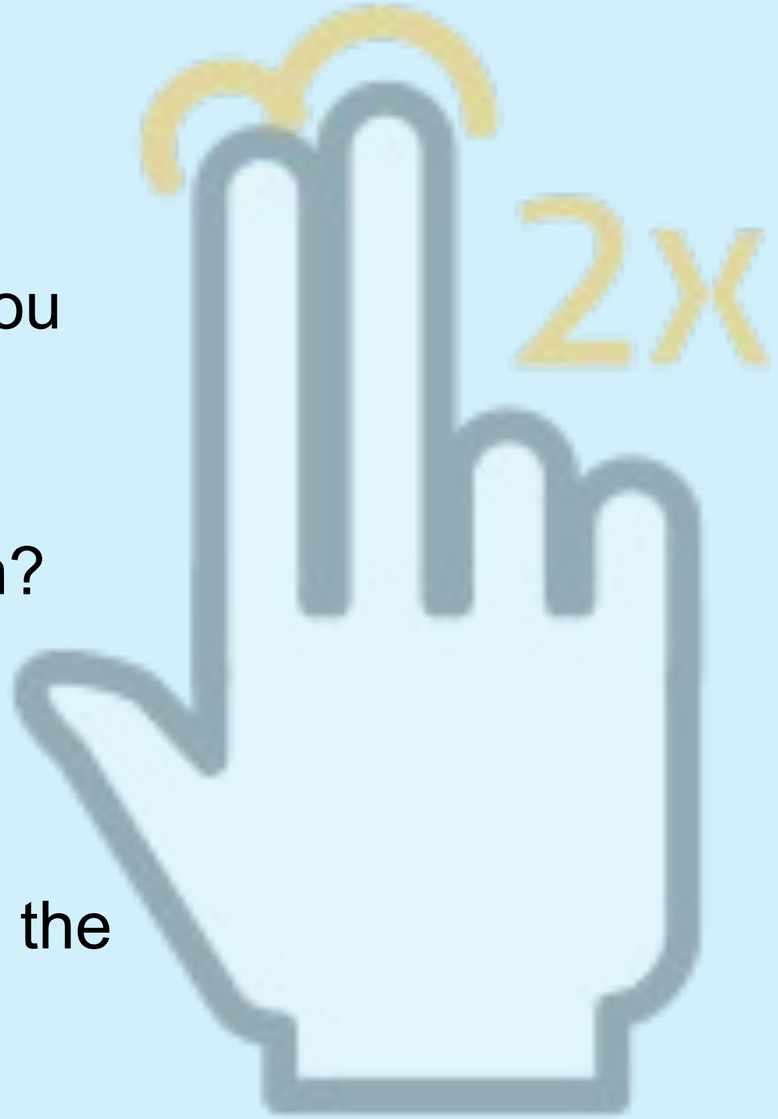
# More about F = ma

If you double the mass, you double the force.  If you double the acceleration, you double the force.

What if you double the mass and the acceleration?

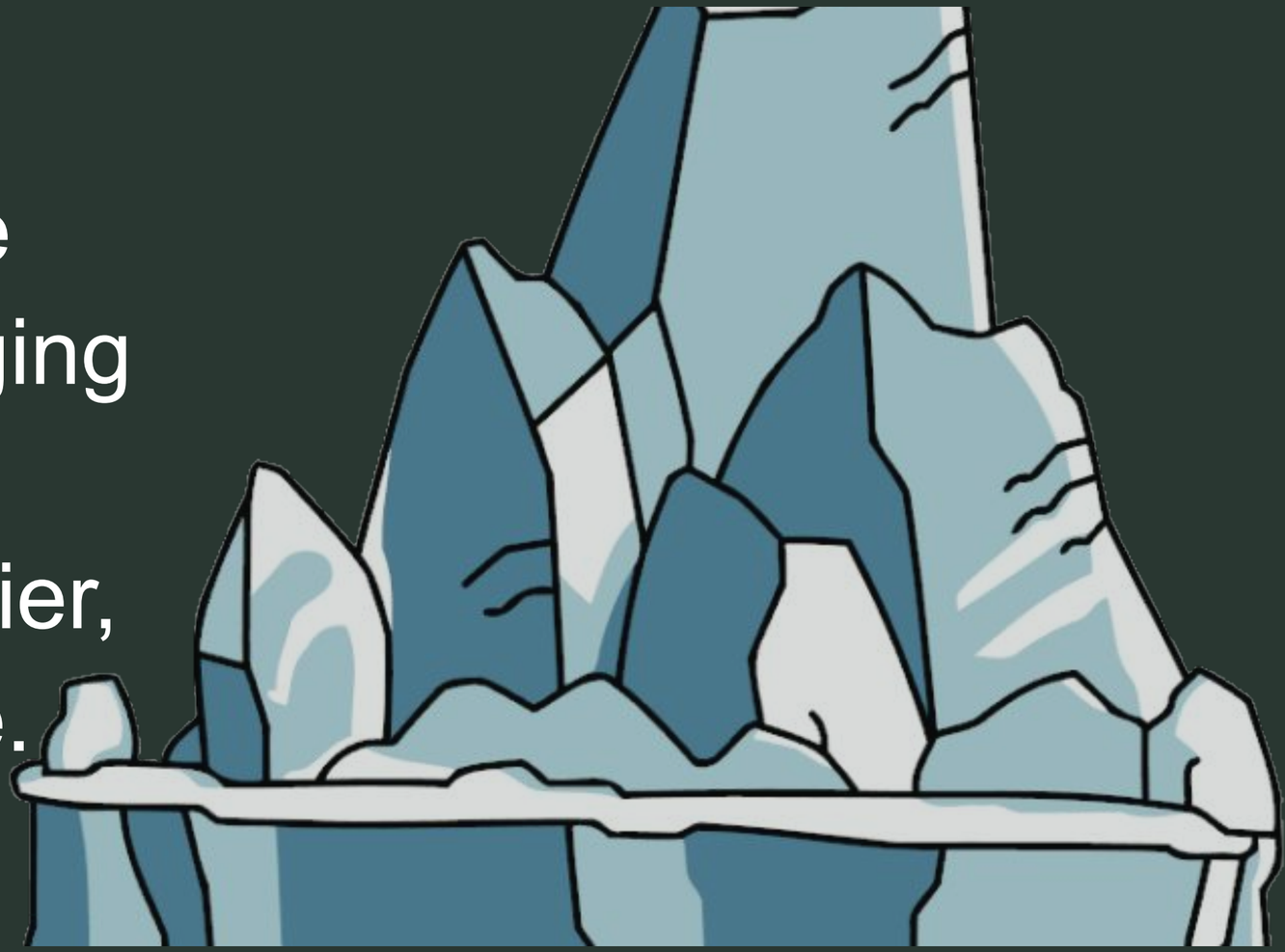
$$(2m)(2a) = 4F$$

Doubling the mass and the acceleration quadruples the force.



# HIGH MASS

Something very massive (high mass) that’s changing speed very slowly (low acceleration), like a glacier, can still have great force.



# LOW MASS

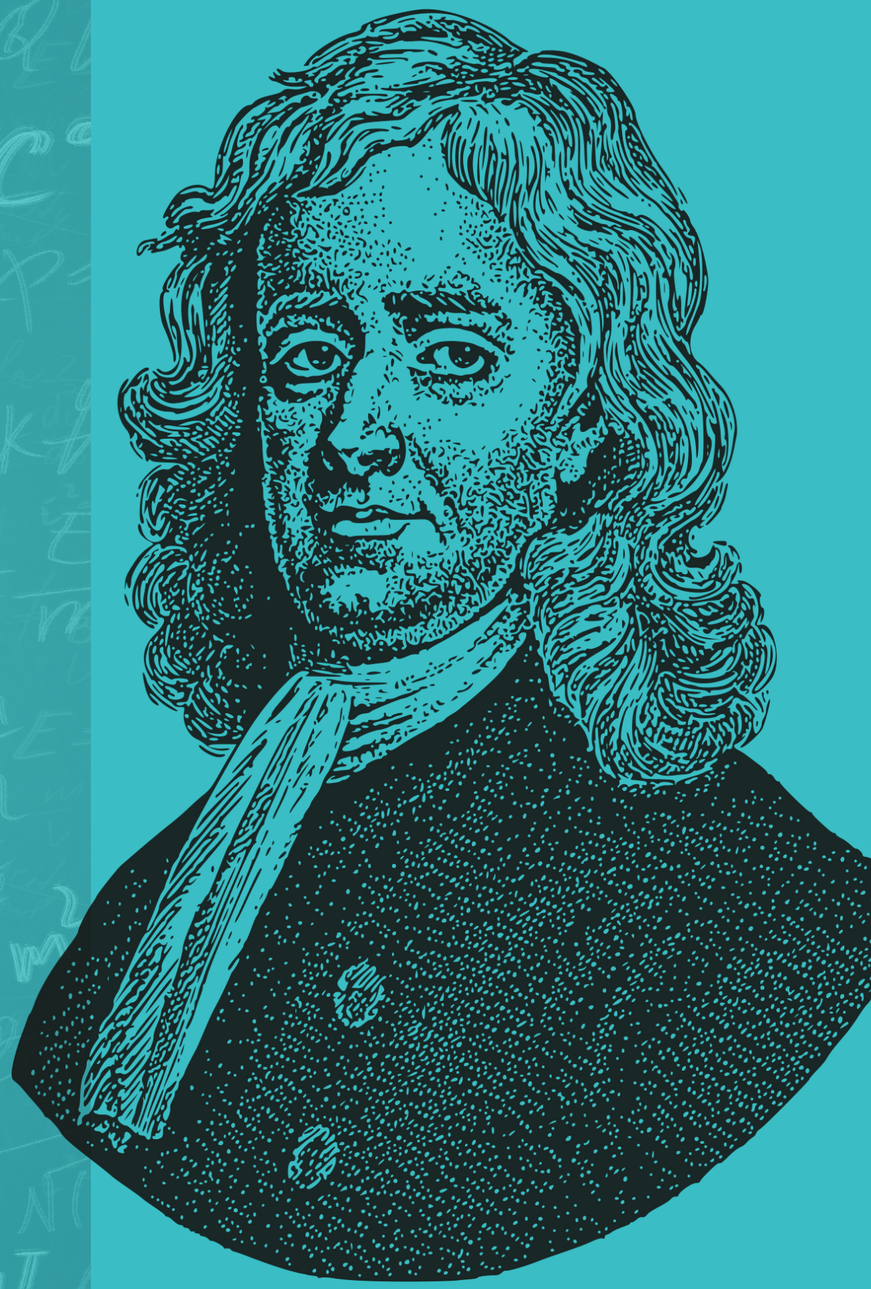
Something very small (low mass) that’s changing speed very quickly (high acceleration), like a bullet, can still have a great force.  Something very small changing speed very slowly will have a very weak force.

BRIEFLY,

The acceleration of an object is directly proportional to the net force & inversely proportional to its mass.

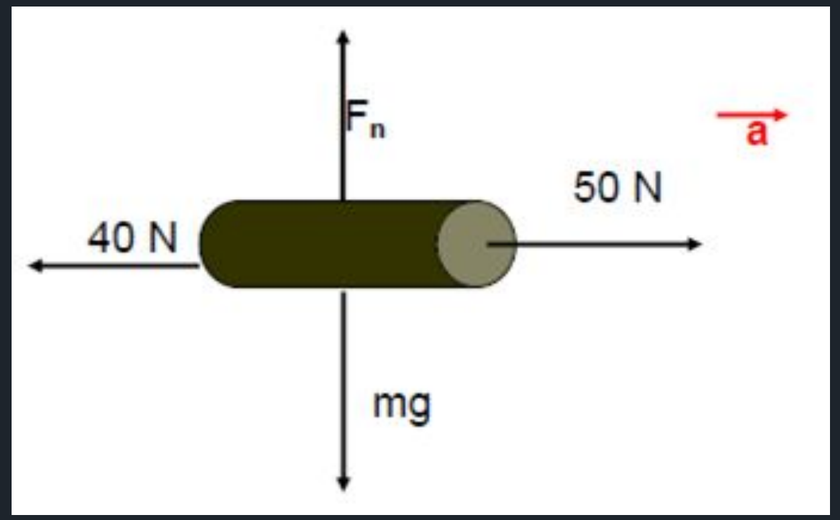
$$F = ma$$

Force = Mass x Acceleration



# PROBLEM SOLVING

A 50 N applied force drags an 8.16 kg log to the right across a horizontal surface. What is the acceleration of the log if the force of friction is 40.0 N?




$$F_{NET} = ma$$

$$F_a - F_f = ma$$

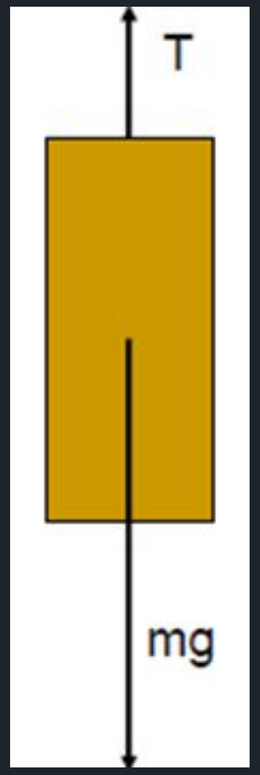
$$50 - 40 = 8.16a$$

$$10 = 8.16a$$

$$a = \text{1.23 m/s/s}$$

# PROBLEM SOLVING

•An elevator with a mass of 2000 kg rises with an acceleration of 1.0 m/s/s. What is the tension in the supporting cable?




Equation of Motion

$$F_{NET} = ma$$

$$T - mg = ma$$

$$T = ma + mg$$

$$T = (2000)(1) + (2000)(9.8)$$

$$T = \text{21,600 N}$$

# QUESTION

Suppose that the acceleration of an object is zero. Does this mean that there are no forces acting on it?

# ANSWER

No, it means the forces acting on it are balanced and the net force is zero.

# QUESTION

When a basketball player dribbles a ball, it falls to the floor and bounces up. Is a force required to make it bounce?Why? If a force is needed, what is the agent.

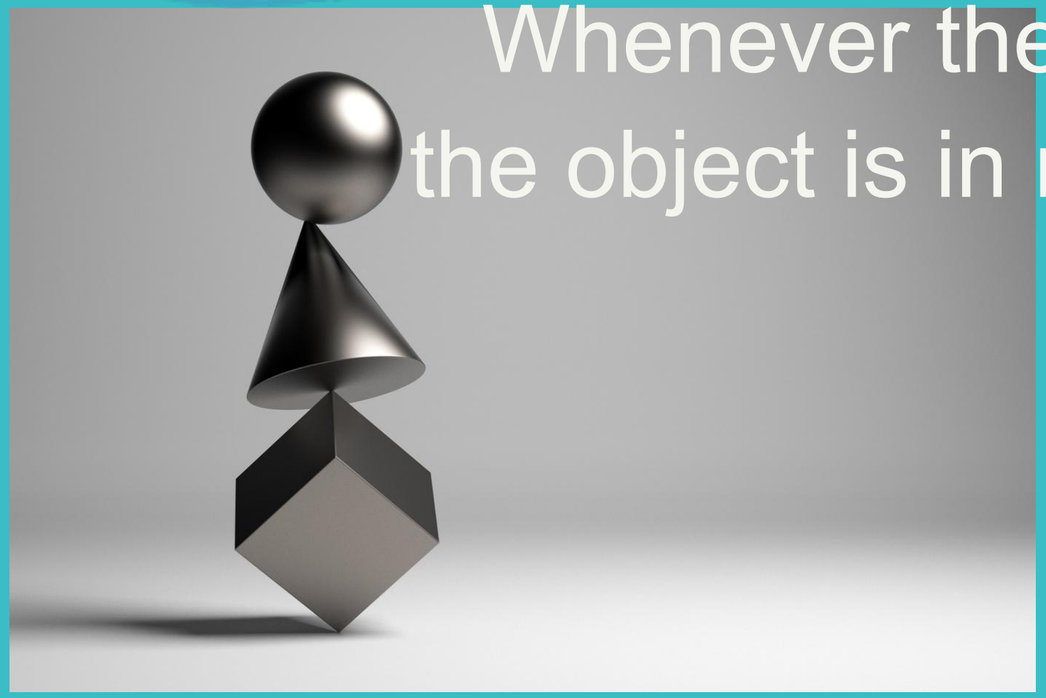
# ANSWER

- Yes, when it bounced it changed direction. A change in direction = acceleration. Acceleration requires a force. The agent was the floor.

# EQUILIBRIUM

Things that are in balance with one another illustrate equilibrium. Things in mechanical equilibrium are stable, without changes of motion. The rocks are in mechanical equilibrium. An unbalanced external force would be needed to change their resting state.

# Mechanical Equilibrium



state wherein no physical changes occur. Whenever the net force on an object is zero, the object is in mechanical equilibrium—this is known as the equilibrium rule.

# EQUILIBRIUM FOR STATIONARY OBJECTS

To determine the force required to bring anything into balance, start by determining the resultant.

The equilibrant force is the force required to bring anything into equilibrium.

The equilibrant force is equal to the resultant but in the opposite direction.

# EQUILIBRIUM FOR MOVING OBJECTS

The state of rest is only one form of equilibrium. An object moving at constant speed in a straight-line path is also in a state of equilibrium. Once in motion, if there is no net force to change the state of motion, it is in equilibrium.

# EQUILIBRIUM FOR MOVING OBJECTS

An object under the influence of only one force cannot be in equilibrium.

Only when there is no force or when two or more forces combine to zero can an object be in equilibrium.

# EQUILIBRIUM FOR MOVING OBJECTS

When the force of friction between the desk and the floor equals the force of push on the desk, the net force is zero, and the desk slides at a steady pace.

For every action there is an equal and opposite reaction.

# 3 NEWTON’S THIRD LAW

# WHAT DOES THIS MEAN?

There is an equal and opposite force operating on an object for every force acting on it. Gravity is dragging you down in your seat right now, yet Newton's Third Law states that your seat is pushing up against you with equal force. This explains why you aren't moving. There is a balancing force at work on you: gravity pulling you down, and your seat pushing you up.

# THINK ABOUT IT . . .

What happens if you push against a wall while standing on a skateboard or a slick floor? You slide in the other direction (away from the wall) because you pushed against it, but it pushed back with equal and opposite power.

# FORCES AND INTERACTIONS

When you push on the wall, the wall pushes on you.

Newton’s third law describes the relationship between two forces in an interaction.

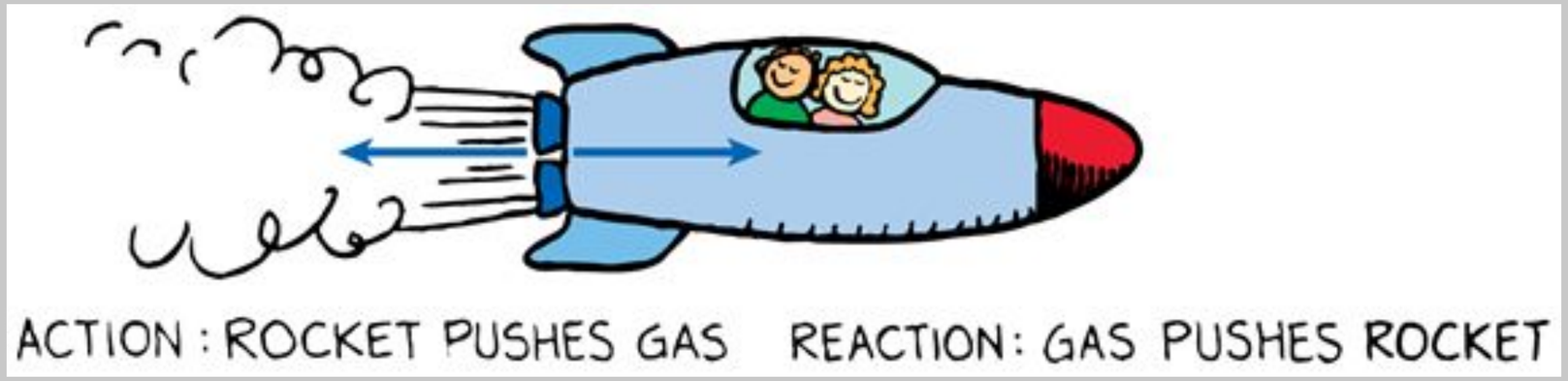
One force is called the action force.

The other force is called the reaction force.

Neither force exists without the other.

They are equal in strength and opposite in direction.

They occur at the same time (simultaneously).


# IDENTIFYING ACTION AND REACTION PAIRS

When action is A exerts force on B, the reaction is simply B exerts force on A.

# ACTION AND REACTION ON DIFFERENT MASSES

Earth is dragged up by the rock with the same power that the boulder is dragged down by Earth.

# REVIEW

## NEWTON'S FIRST LAW:

Objects in motion tend to stay in motion and objects at rest tend to stay at rest unless acted upon by an unbalanced force.

## NEWTON'S SECOND LAW:

Force equals mass times acceleration (F = ma).

## NEWTON'S THIRD LAW:

For every action there is an equal and opposite reaction.

# THANK YOU!

## Reference

Retrieved 17 August 2021, from https://www.romaisd.com/cms/lib/TX02215271/Centricity/Domain/1991/Newtons%20Laws%20of%20Motion%202018.pptx

SCIENCE CLASS