



Unit 1

Chapter 3: Newton's First Law of Motion-Inertia

I. Aristotle on Motion (3.1)

A. **Aristotle** (4th century BC— first to suggest force causes motion.

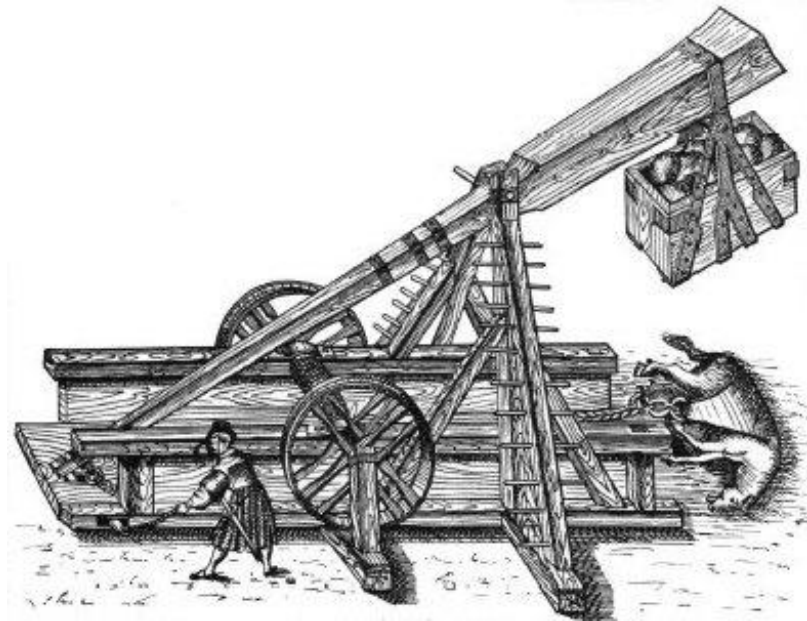
1. Divided motion into two types

a. ***Natural Motion***— said to be either straight up or down. Objects would seek their natural resting place (boulder fall to ground, smoke rise)

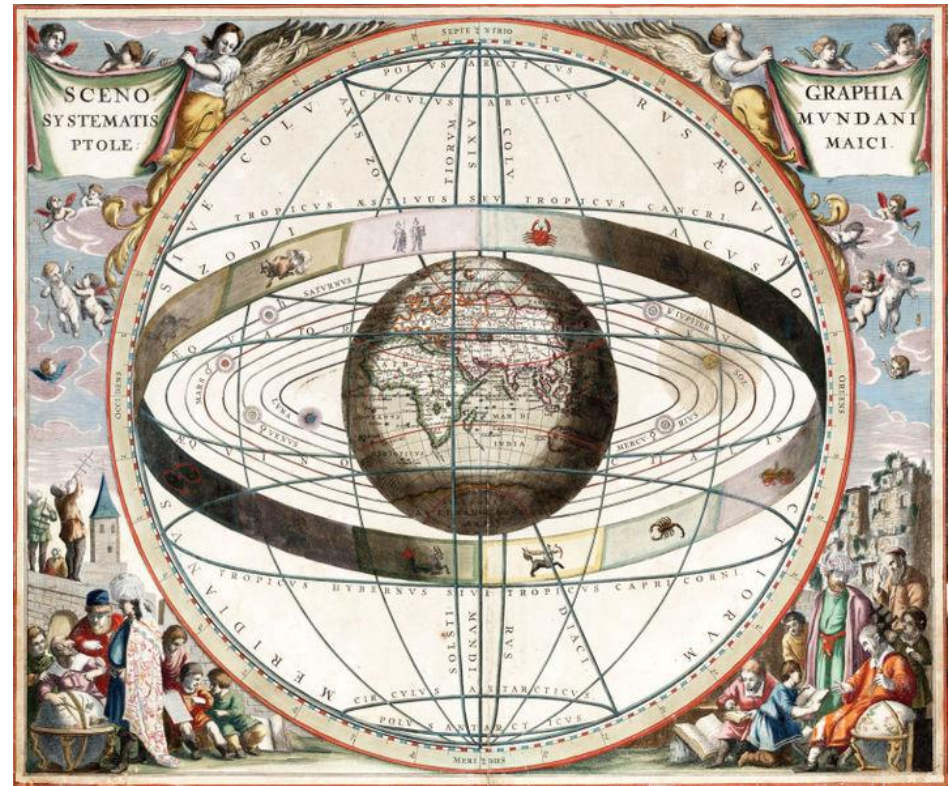
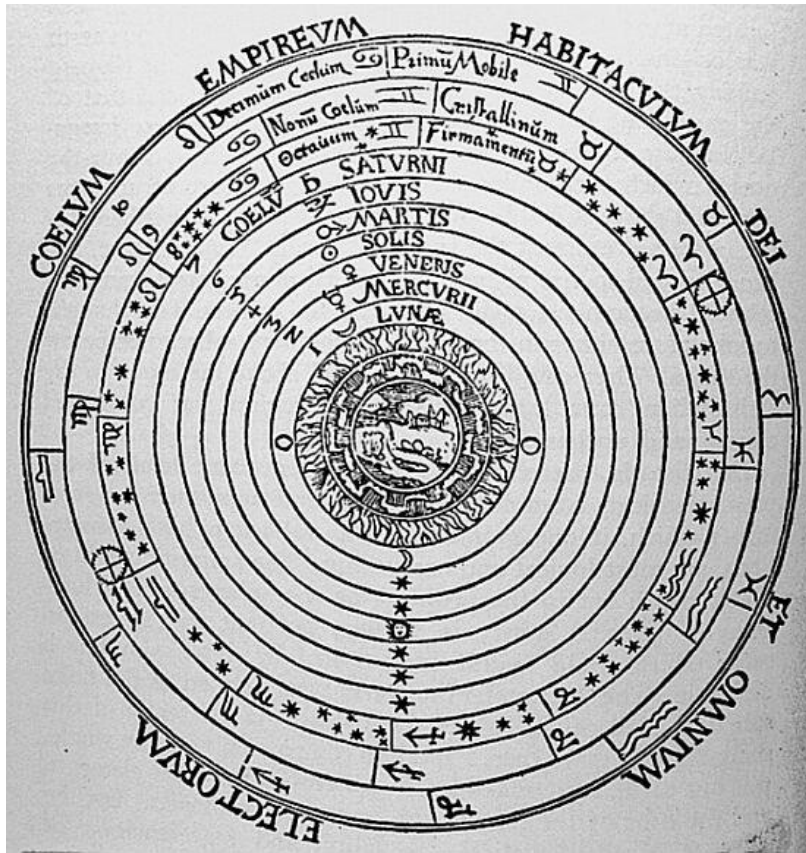


b. ***Violent Motion*** -was “imposed” motion. Result of forces that pushed or pulled. (this motion had an external force)

2. Objects in natural resting places could not move by themselves. (had to be pushed or pulled)



B. Before 16th century though Earth must be in its natural resting place (a force large enough to move it was unthinkable)



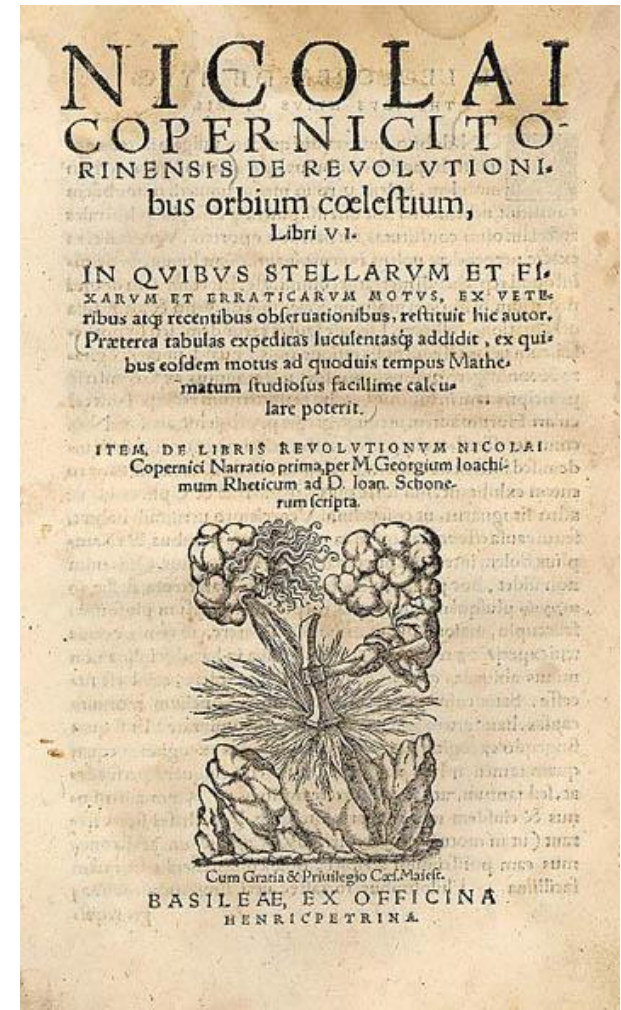
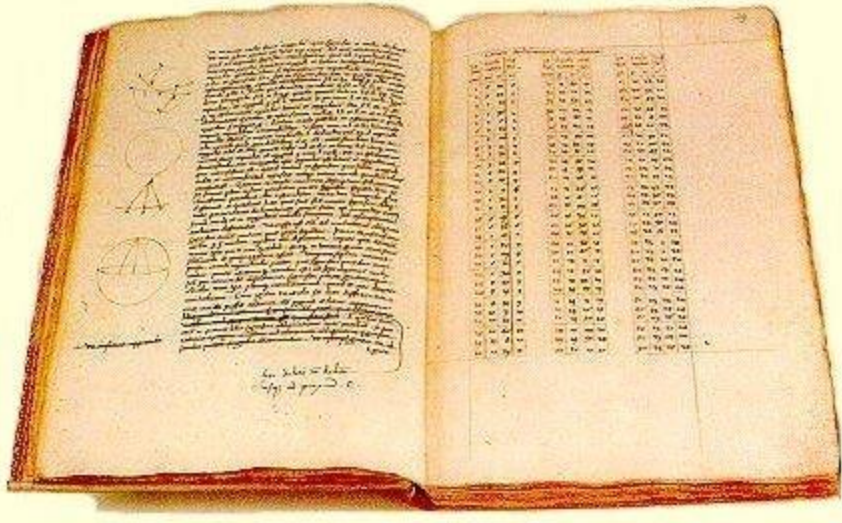
II. Copernicus and the Moving Earth (3.2)

A. Nicolaus Copernicus (1473-1543)- said Earth and other planets move around sun.

1. Worked on his idea in secret to escape persecution



2. Wrote book ***De Revolutionibus*** about his work (reached him on the day of his death)



III. **Galileo** on Motion (3.3)

A. Foremost scientist of the late-Renaissance Italy

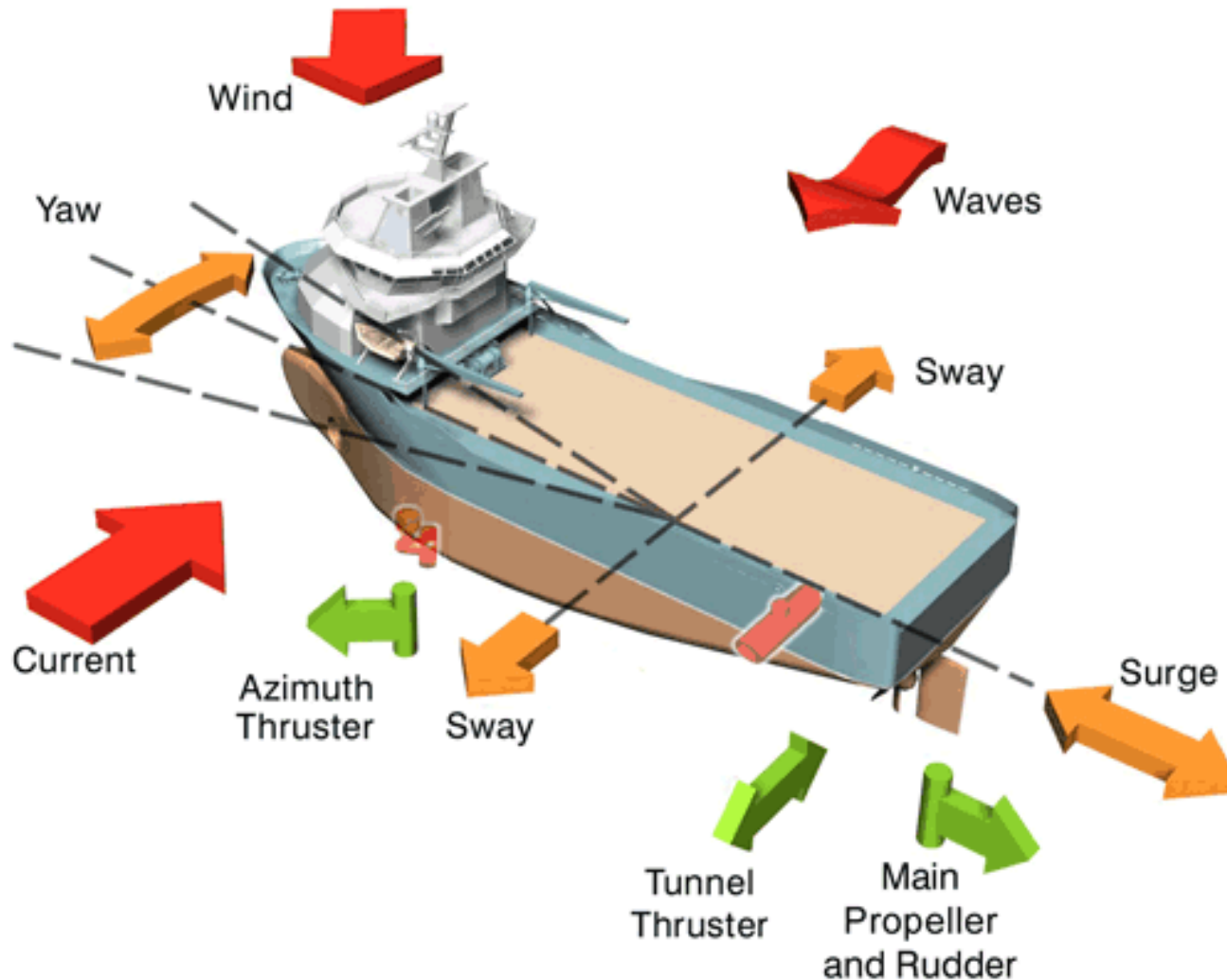


1. supported **Copernicus**—heliocentric theory (planets rotate around sun)
2. Resulted in house arrest for his thinking



B. Said force was not necessary to keep an object moving

1. **Force**— is any push or pull

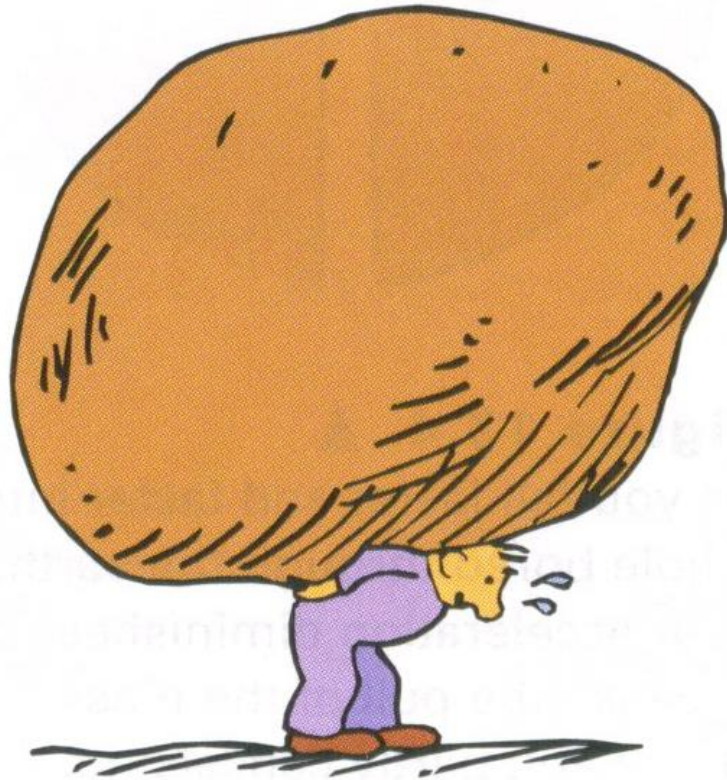


Contact vs. Long Range Force

Contact Force- acts on an object by touching it.

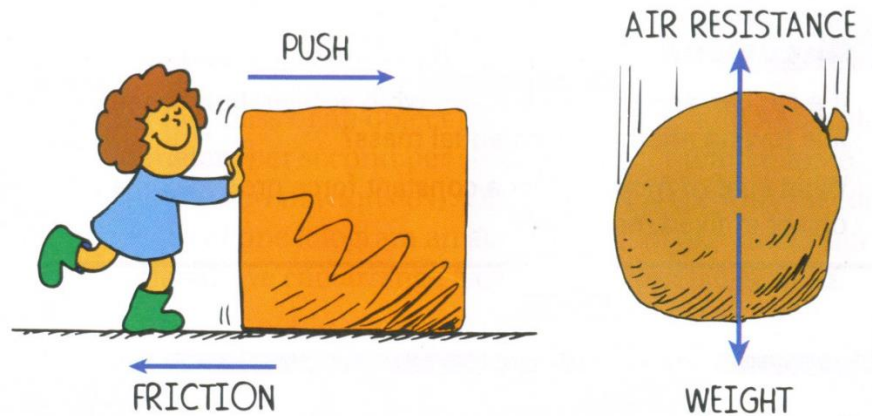
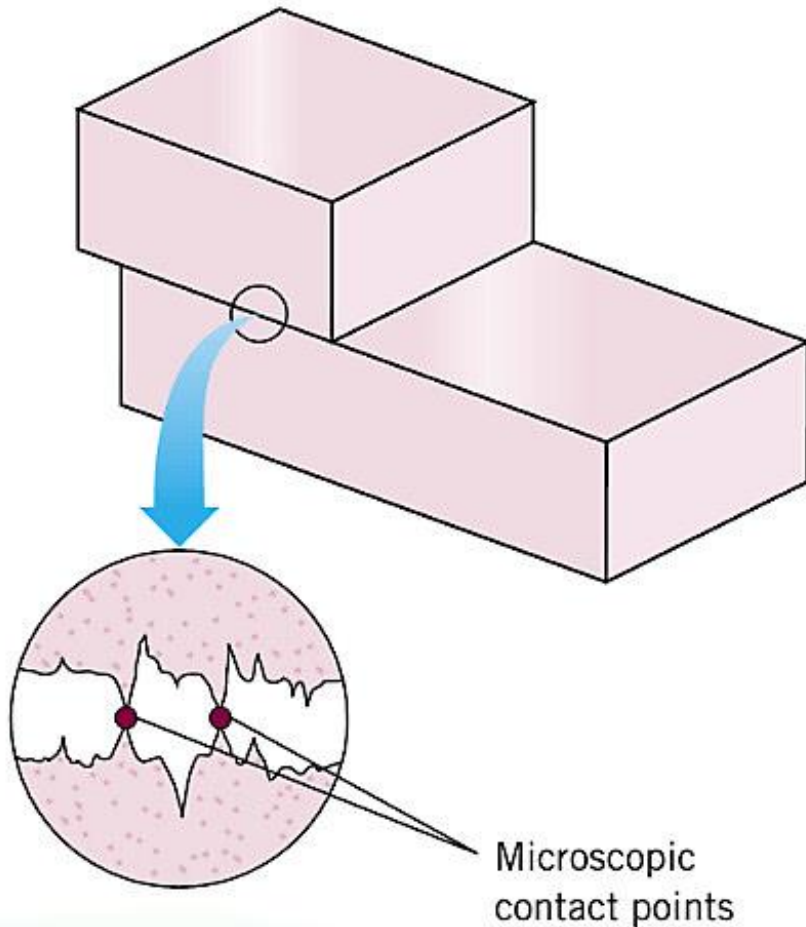


Long-range Force- is exerted without contact (e.g. magnetic forces, gravity)



Which kind of force is acting here?

2. **Friction**— name given to the force that acts between materials that touch as they move past each other



Galileo on Motion

- Galileo stated that if friction were entirely absent, a ball moving horizontally would move forever.
- No push or pull would be required to keep it moving once it is set in motion.

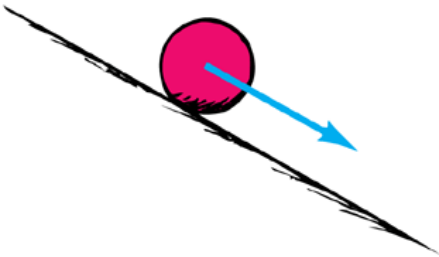
Galileo on Motion

Galileo tested his idea by rolling balls along plane surfaces tilted at different angles.

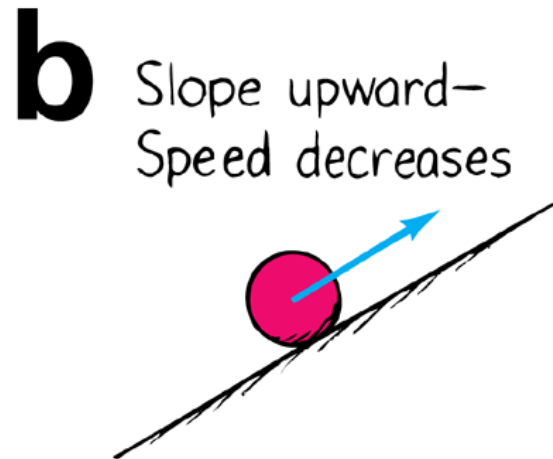
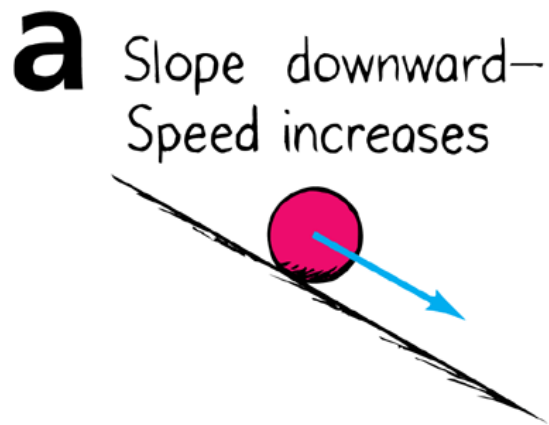
- A ball rolling down an inclined plane speeds up.
- A ball rolling up an inclined plane—in a direction opposed by gravity—slows down.
- A ball rolling on a smooth horizontal plane has almost constant velocity.

- Downward, the ball moves with Earth's gravity.

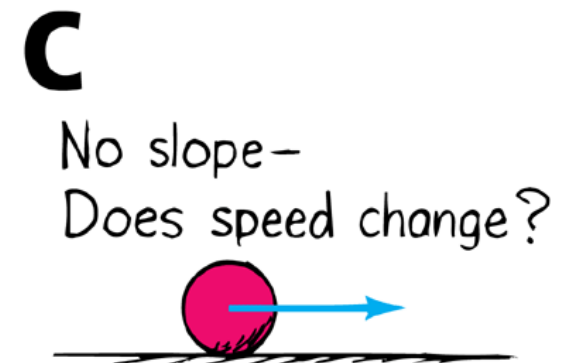
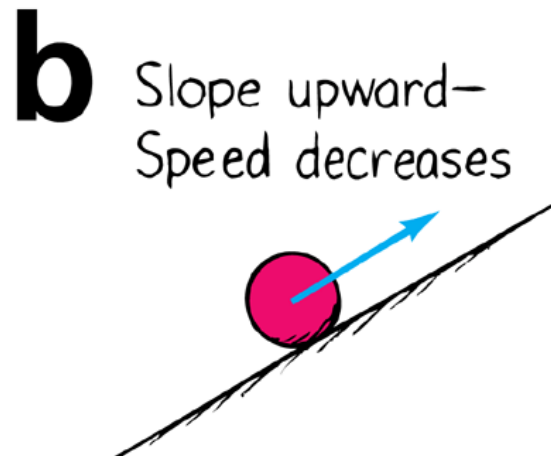
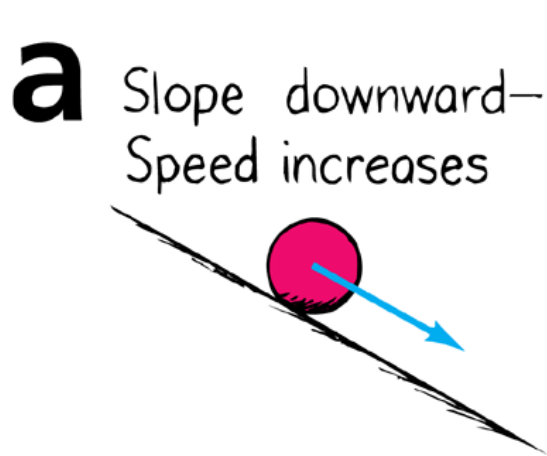
a Slope downward—
Speed increases



- Downward, the ball moves with Earth's gravity.
- Upward, the ball moves against gravity.



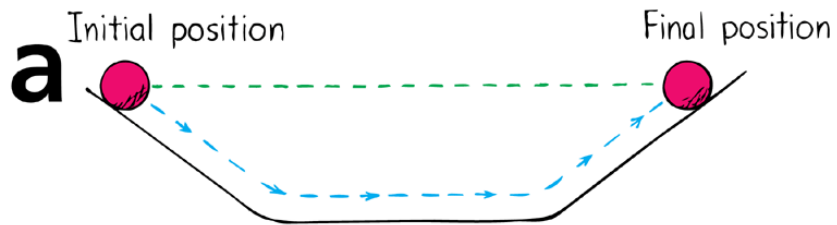
- Downward, the ball moves with Earth's gravity.
- Upward, the ball moves against gravity.
- On a level plane, it does not move with or against gravity.



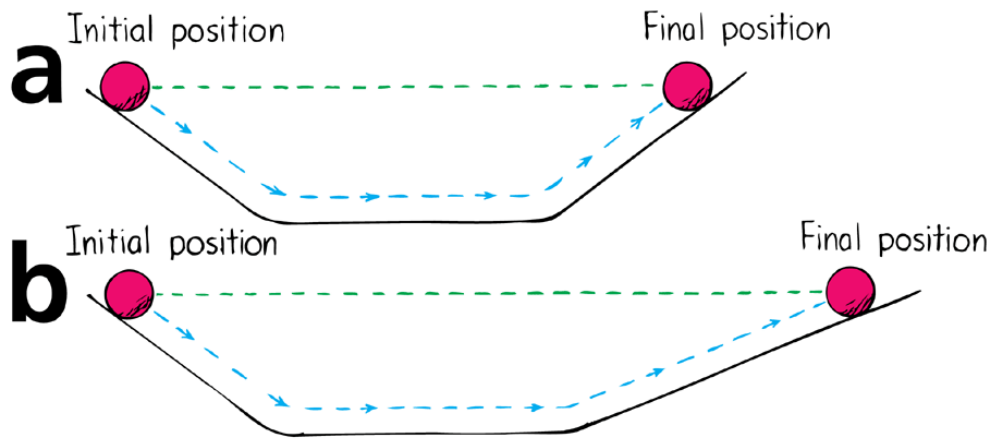
Galileo on Motion

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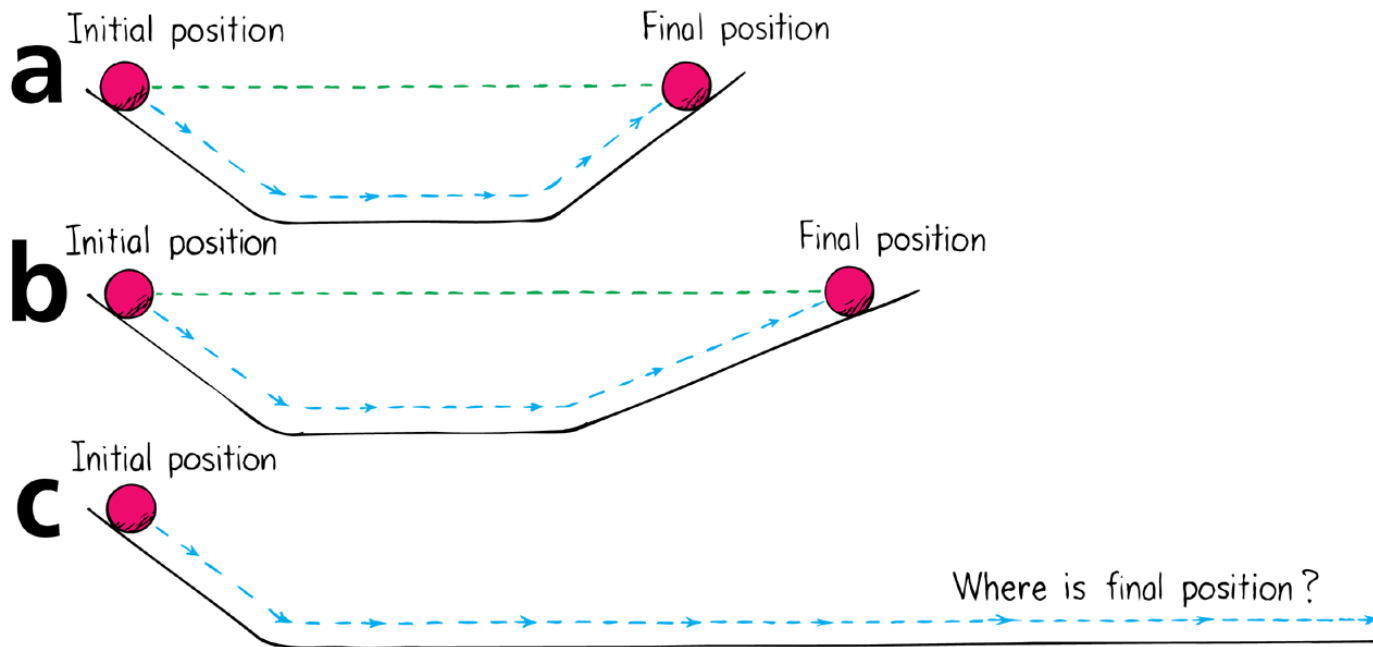
- The ball rolling down the incline rolls up the opposite incline and reaches its initial height.



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- The ball rolls a greater distance to reach its initial height.



- The ball rolling down the incline rolls up the opposite incline and reaches its initial height.
- The ball rolls a greater distance to reach its initial height.
- If there is no friction, the ball will never stop.



Typical Coefficients of Friction

Surface	μ_s	μ_k
Rubber on concrete	0.80	0.65
Rubber on wet concrete	0.60	0.40
Wood on wood	0.50	0.20
Steel on steel (dry)	0.78	0.58
Steel on steel (with oil)	0.15	0.06
Teflon on steel	0.04	0.04

3. Galileo argued that only when friction is present— as it usually is— a force needed to keep an object moving.

4. He stated— every material object resists change to its state of motion— called **ineretia**

5. Led the way for Isaac Newton



IV. Newton's Law of Inertia (3.4)

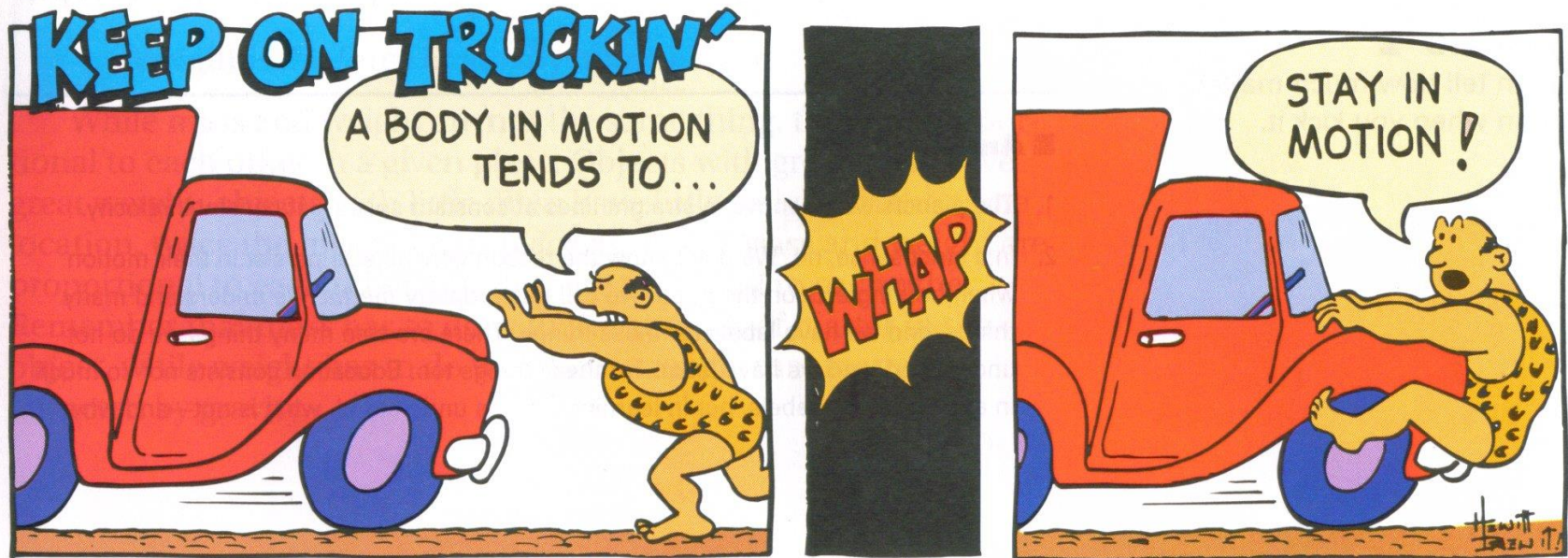
A. **Isaac Newton** (1642-1727)- born same year that Galileo died

B. Developed famous laws of motion (replaced Aristotelian ideas that dominated for previous 2000 years)



1. **Newton's First Law of Motion**— usually referred to as the law of inertia

Every object continues in a state of rest, or of motion in a straight line at constant speed, unless it is compelled to change that state by forces exerted upon it.



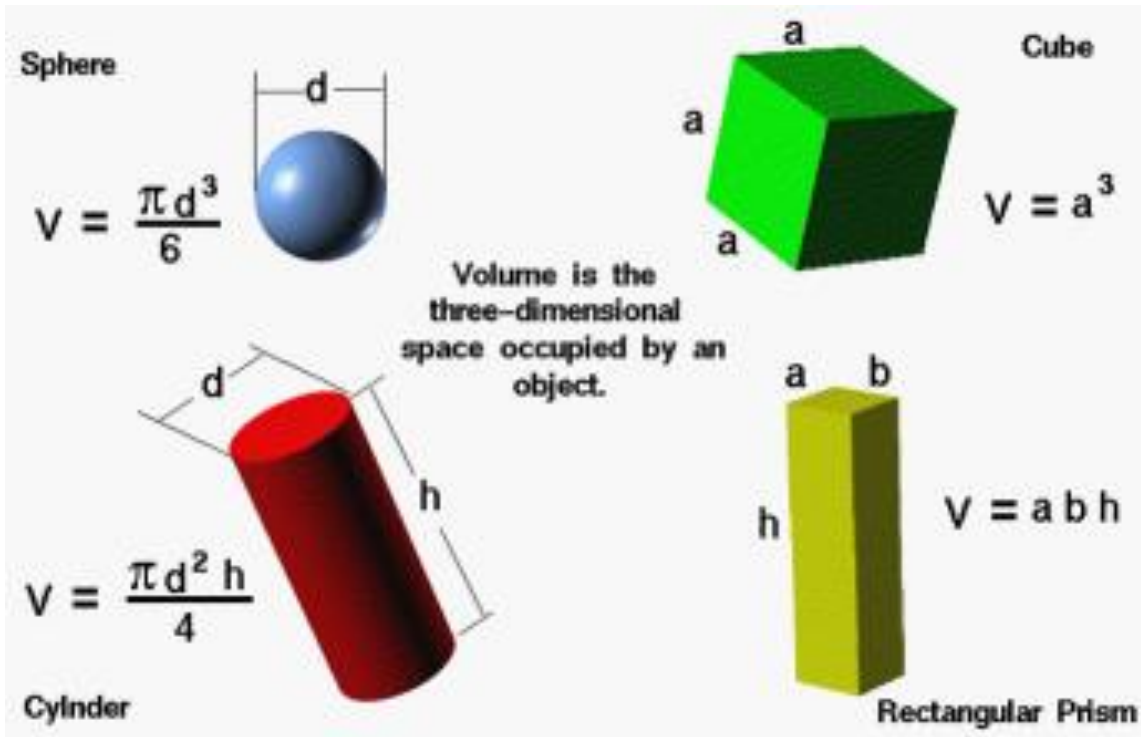
- a. Restatement of Galileo's ideas
- b. Simply put— **things tend to keep doing what they're already doing**



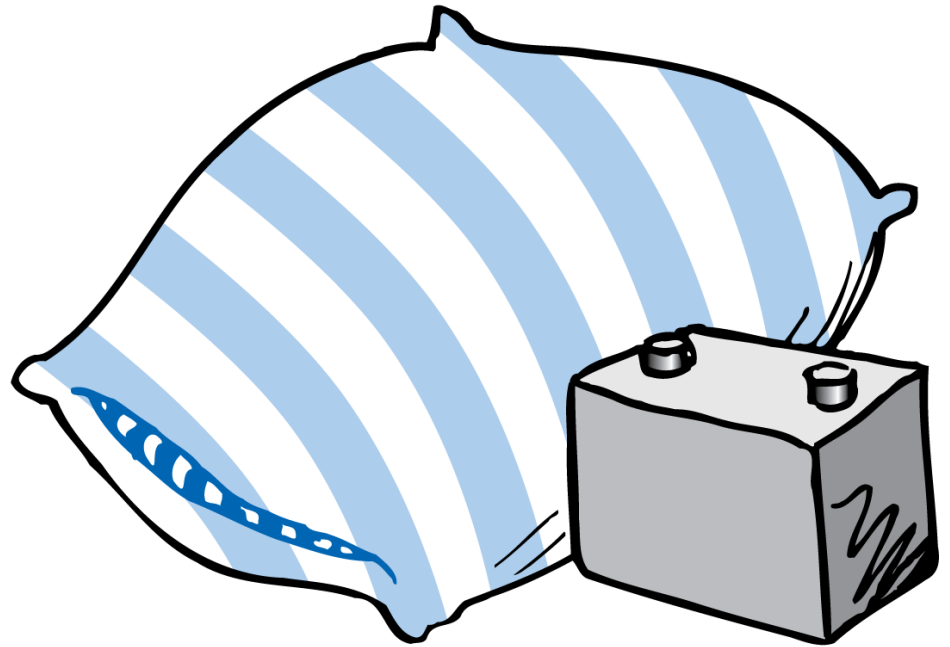
V. Mass-A Measure of Inertia (3.5)

A. Mass is Not Volume– entirely different concepts

1. **Volume**-a measure of space (units like cubic meters, liters, etc.)
2. **Mass** -measured in ***kilograms***



Which has a larger mass, the pillow or the battery? A larger volume?



B. Mass is Not Weight

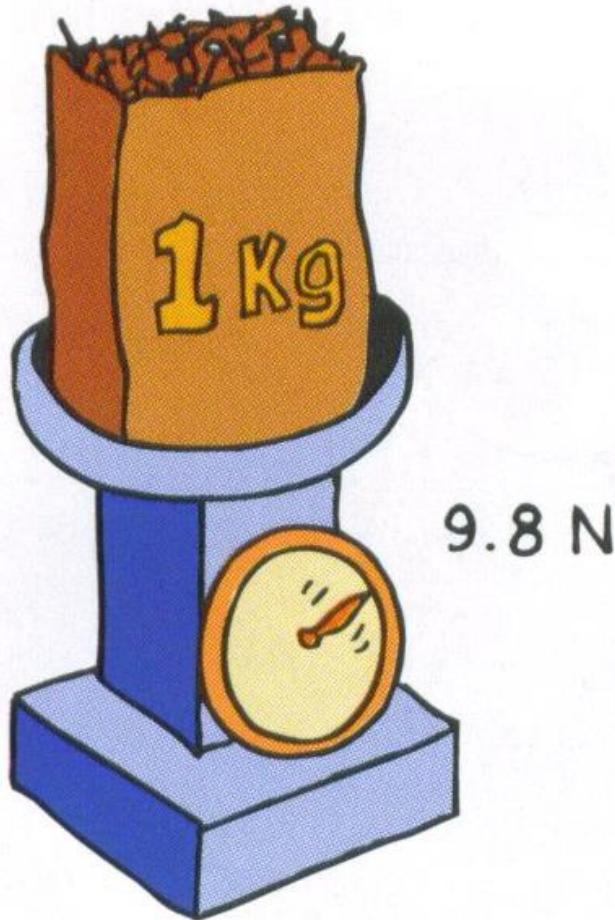
1. Often confused with weight
2. **Mass**— measurement of amount of material in an object and depends on number of and kind of atoms that compose it



3. **Weight**– a measure of the gravitational force acting on the object

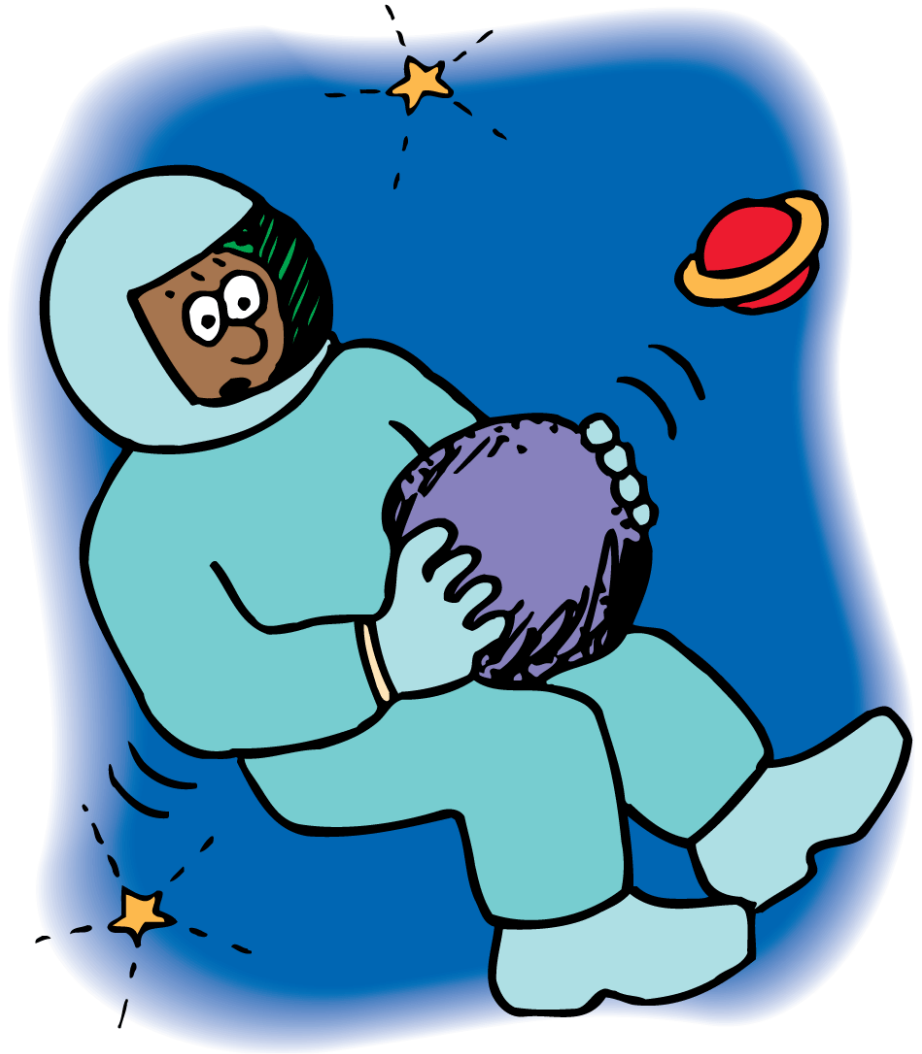
a. One Kilogram Weighs 9.8 Newtons

1). **Newton** (N)-SI unit of mass



Mass—A Measure of Inertia

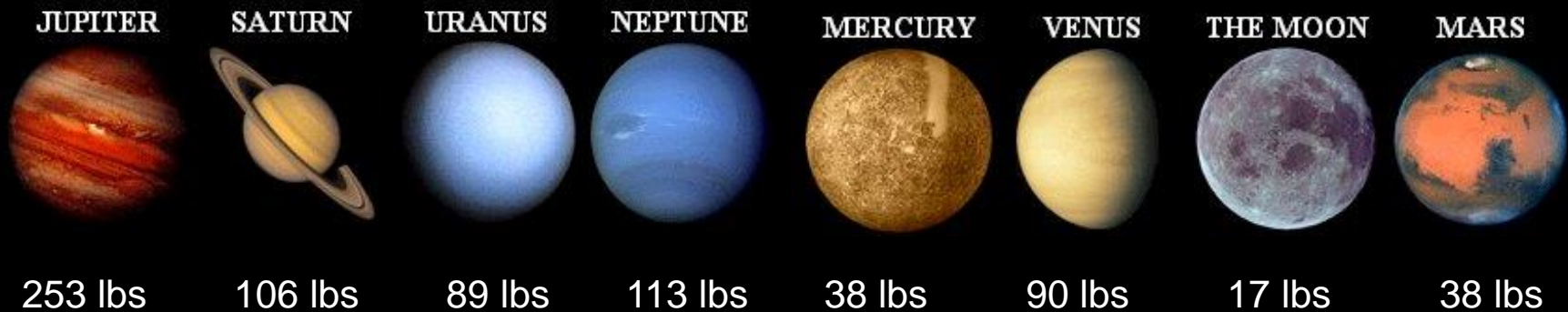
Which would be harder to shake? A stone in its weightless state in space or in its weighted state on Earth?



2). Weight = Mass x acceleration of gravity

$$\textit{Weight} = mg$$

$$F_g = mg$$



The Moons of Jupiter



A Few Different Types of Stars

(better land at night to avoid burning your feet!)



If you weighed 100 lbs. on earth this is what you would weigh on some of the other celestial bodies!

Assessment Questions

1. Two thousand years ago, people thought that Earth did not move. One major reason for thinking this was that
 - a. no force was large enough to move the Earth.
 - b. Earth's motion would be unnatural.
 - c. Earth was near the center of the universe.
 - d. Earth moved in a perfect circle.

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Answer: A

Assessment Questions

2. According to Aristotle and his followers over centuries, Earth was at the center of the universe. The first European to effectively challenge that notion was
 - a. Copernicus.
 - b. Galileo.
 - c. Newton.
 - d. Einstein.

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Answer: A

Assessment Questions

3. Galileo's conclusions about motion helped advance science because they were based on
 - a. experiments rather than philosophical discussions.
 - b. philosophical discussions rather than experiments.
 - c. nonmathematical thinking.
 - d. Aristotle's theories of motion.

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Answer: A

Assessment Questions

4. If gravity between the sun and Earth suddenly vanished, Earth would continue moving in a(n)
- curved path.
 - straight-line path.
 - outward spiral path.
 - inward spiral path.

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Answer: B

Assessment Questions

5. To say that 1 kg of matter weighs 10 N is to say that 1 kg of matter
- will weigh 10 N everywhere.
 - has ten times less volume than 10 kg of matter.
 - has ten times more inertia than 10 kg of matter.
 - is attracted to Earth with 10 N of force.

Assessment Questions

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 - has ten times less volume than 10 kg of matter.
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 - is attracted to Earth with 10 N of force.

Answer: D

Assessment Questions

6. The Earth moves about 30 km/s relative to the sun. But when you jump upward in front of a wall, the wall doesn't slam into you at 30 km/s. A good explanation for why it doesn't is that
- the sun's influence on you is negligible.
 - the air in the room is also moving.
 - both you and the wall are moving at the same speed, before, during, and after your jump.
 - the inertia of you and the wall is negligible compared with that of the sun.

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Answer: C