

PHYZ SPRINGBOARD

NEWTON'S FIRST LAW



THE FIRST PHYSICS

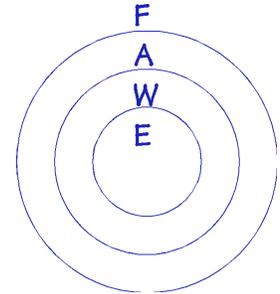
1. What was Aristotle's model of motion as he described it in his fourth century BCE book, *Physics*?

a. Describe Aristotle's elements, their hierarchy, and their characteristics.

Elements: Earth, Water, Air, and Fire

Earth's natural place was the lithosphere, water's place was the hydrosphere, air's natural place was the atmosphere, and fire's natural place was the celestial sphere.

Earth was the center of all things



b. Why would objects undergo "natural motion"?

Things tended to be in their natural place; if not, they would tend to move so as to return to their natural place. Rocks fall to rejoin Earth, water flows to rejoin water, air bubbles up through water to rejoin air, fire licks toward the heavens.

c. What was "violent motion"?

An example of violent motion is throwing a rock upward (away from its natural place); eventually, natural motion prevails.

d. Aristotle's model persisted for about 2000 years. What was so compelling about his model?

It appeared to be consistent with everyday observations.

2. Early in the 1600s, Galileo Galilei found problems with Aristotle's physics. What were they, and how did Galileo go about demonstrating them to his contemporaries?

Aristotle's model said that heavy objects fall faster than lighter ones. They were attracted to their natural place more because they were composed of more Earth.

Galileo showed all objects fall at the same rate.

3. One of Galileo's conclusions was that moving bodies would continue to move as long as nothing interfered with them. This conclusion became Newton's first law of motion. It states that...

bodies tend to maintain their state of rest or of uniform motion in a straight line unless compelled to change that state by unbalanced, external forces impressed upon them.

SURPRISING EQUIVALENCE

4. a. The most surprising and counter-intuitive contention of the first law is...

the dynamic equivalence of rest and uniform motion.

Rest = Uniform Motion!

b. Suppose you're sitting on an aisle seat in a passenger jet. You hold a coin out in the aisle and drop it. The coin lands in the aisle directly below your hand. From this you can conclude

___ the jet is **at rest** on the runway.

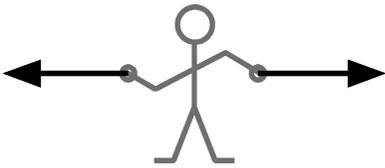
___ the jet is **in uniform motion** flying at a speed of 600 mph.

✓ **neither** of these: either motion described above could be happening.

c. What experiment can be conducted to distinguish rest from uniform motion?

None.

5. a. If you are being pulled from opposite sides by equal forces, what kind of motion—if any—could you have?



Rest, uniform motion in any direction!

b. Suppose you're traveling down the highway at 60 mph in cruise control. Which set of forces—if either—is greater: the forces pushing the car forward or the forces pushing the car backward?



Neither: no unbalanced forces are allowed for uniform motion!

EPILOG: WHO SAID IT WHEN? WHAT'D HE SAY?

6. Newton's first law was stated in his 1687 book, *Philosophiae Naturalis Principia Mathematica* (*Mathematical Principles of Natural Philosophy*). What are the sources of statements a. and b. below, and what did Alfred North Whitehead say in statement c.?

a. **"The cessation of motion is due to the opposing force.... If there is no opposing force...the motion will never stop."**

Mo Ching, fourth or third century BCE China.

*(Joseph Needham's research quoted by Robert Temple, *The Genius of China*)*

b. **"It is impossible to say why a body that has been set in motion in a vacuum should ever come to rest; why, indeed, should it come to rest at one place rather than at another. As a consequence, it will either necessarily stay at rest or, if in motion, will move indefinitely unless some obstacle comes into collision with it."**

*Aristotle, in *Physics*, Book IV, Chapter XI. Aristotle was actually arguing against the possibility of a vacuum in this context, not eloquently characterizing the nature of inertia.*

c. *" Everything of importance has been said before by someone who did not discover it."*

Alfred North Whitehead (19th-20th century British mathematician and philosopher, coauthor of the 1913 book, *Principia Mathematica* with Bertrand Russell.)