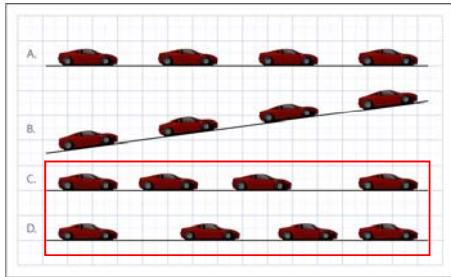


In which of the following cases is the car in accelerated motion?



Net force

- Are there forces acting on the rock?
- Is there a net force on the rock?



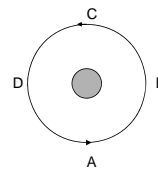
Some Key Ideas

- If you observe an object at rest or in uniform motion then:
 - The acceleration is 0 by definition.
 - There are no unbalanced forces.
- If you observe an acceleration then:
 - There is an unbalanced force.

NO EXCEPTIONS!!!!

David and Goliath

- At what point should David let go of the rock?



Goliath's Head

Halftime



In addition to the net force, an object's mass also determines how it will accelerate

- Mass: the property of objects that determines how much they accelerate in response to a given applied force. (mass resists acceleration)



Some comments on units.

- Metric units are used in most of the civilized world.
- The metric unit of mass is the kilogram (or grams, centigrams, etc.)
- What is the unit of mass in the English system of units (used in the U.S.)?
- **Mass is not the same thing as weight!**



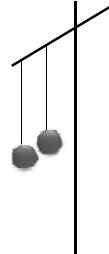
The Second Law

- Acceleration is
 1. proportional to force
 2. inversely proportional to mass.

$$\text{Acceleration} = \frac{\text{Force}}{\text{mass}}$$

or

$$F = ma$$



Which statement best describes the situation pictured below

- A. The racket is exerting a force on the ball
- B. The ball is exerting a force on the racket
- C. Both A and B are correct, but the force on the ball is greater
- D. Both A and B are correct and the forces are equal in magnitude



Photo by Amoz Eckerson, 1995

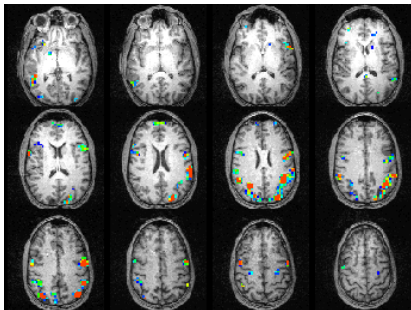
The Third Law

- All forces result from interaction between pairs of objects. No Exceptions.
- When interacting, each object exerts a force on the other. The two forces have the same strength, and act in exactly opposite directions.



Photo by Amoz Eckerson, 1995

A memory device...



Artillery experiment

- Did we create a force on the cannonball?
- What exerted the force on the cannonball?
- Did the cannonball exert a force on anything?
- Why did the two objects accelerate differently?



How does a rocket work?



New York Times on Robert Goddard
January 13, 1920

- ... after the rocket quits our air and really starts on its longer journey it will neither be accelerated nor maintained by the explosion of the charges it then might have left. To claim that it would be is to deny a fundamental law of dynamics, and only Dr. Einstein and his chosen dozen, so few and fit are licensed to do that. ...
- [Professor Goddard] does not know of the relation of action to reaction, and the need to have something better than a vacuum against which to react.
- [He] only seems to lack the knowledge ladled out daily in high schools.



New York Times on Robert Goddard
July 17, 1969

- Further investigation and experimentation have confirmed the findings of Isaac Newton in the 17th century and it is now definitely established that a rocket can function in a vacuum as well as in an atmosphere. The Times regrets the error.



Using the laws of motion, we can predict the future



Something to think about: The reluctant horse

- "Every time I pull on the cart, it pulls back with equal force. Therefore I cannot pull the cart."

