Physics 105 Class 5
NEWTON'S LAWS

Force:

A push or pull between **pairs** of objects

How would an astronaut in orbit tell the difference between full and empty containers? (WITHOUT OPENING THEM!)

Demo: inertia balls demonstration

Newton's first law

Mass: (m) a measure of _____

Weight:

Newton's second law

The **acceleration** of an object is _____ to the total force on it, and _____ to the mass:

a =

F =

Units of force: In terms of a 1 kg mass…

Forces are vectors!

P1. You push your 40 kg shopping cart with a constant force of 50 N, and find there is a backwards frictional force of 20 N on it. What will be the acceleration?

Free-body diagrams

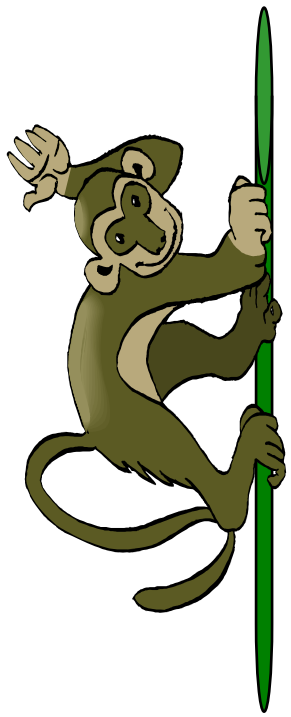
1. Draw the object of interest **alone** (you can combine several objects as a "single object" if they have the same **a**).
2. Draw forces on the object exerted by **other things**
3. Label each force with a different symbol
4. Choose a positive direction
5. Draw the vector **a** on the diagram, but not on the object (it's not a force)
6. For the FBD you can write

$\Sigma F_x = ma_x$ and $\Sigma F_y = ma_y$

(m is the mass of the object *in the diagram*)

You need as many equations as you have unknowns. Substitute to solve.

P2. A monkey starts to slide down a rope. As it speeds up, it tightens its grip, until it slides at a constant velocity down the rope. Which of these choices correctly represents the relative magnitude of the forces as it is sliding with constant velocity?



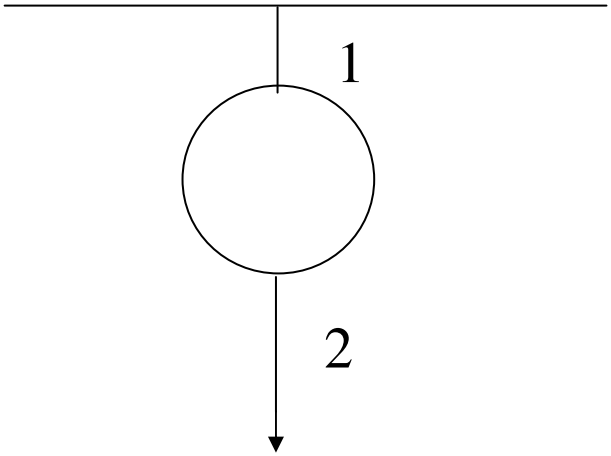
a) The gravitational force is equal to the frictional force.
b) The gravitational force is greater than the frictional force.
c) The gravitational force is less than the frictional force.

A bowling ball is hung by a string.

Hint: For the tension at 1 to increase as I pull 2, does the mass have to do anything?

P3. If I pull the bottom string slowly, the string will most likely break at location:

1. **1**
2. **2**
3. **Equally likely at points 1 or 2.**



Demo: carts and ropes

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Newton's third law

Forces always come in *pairs*, one on *each object* in the pair.

The magnitudes of the forces in a pair are always _____, and the direction is _____.

Are the acceleration **magnitudes** of the two objects in a pair the same?

A car is at rest on a road. Identify the forces on the car, and their partners on other objects.

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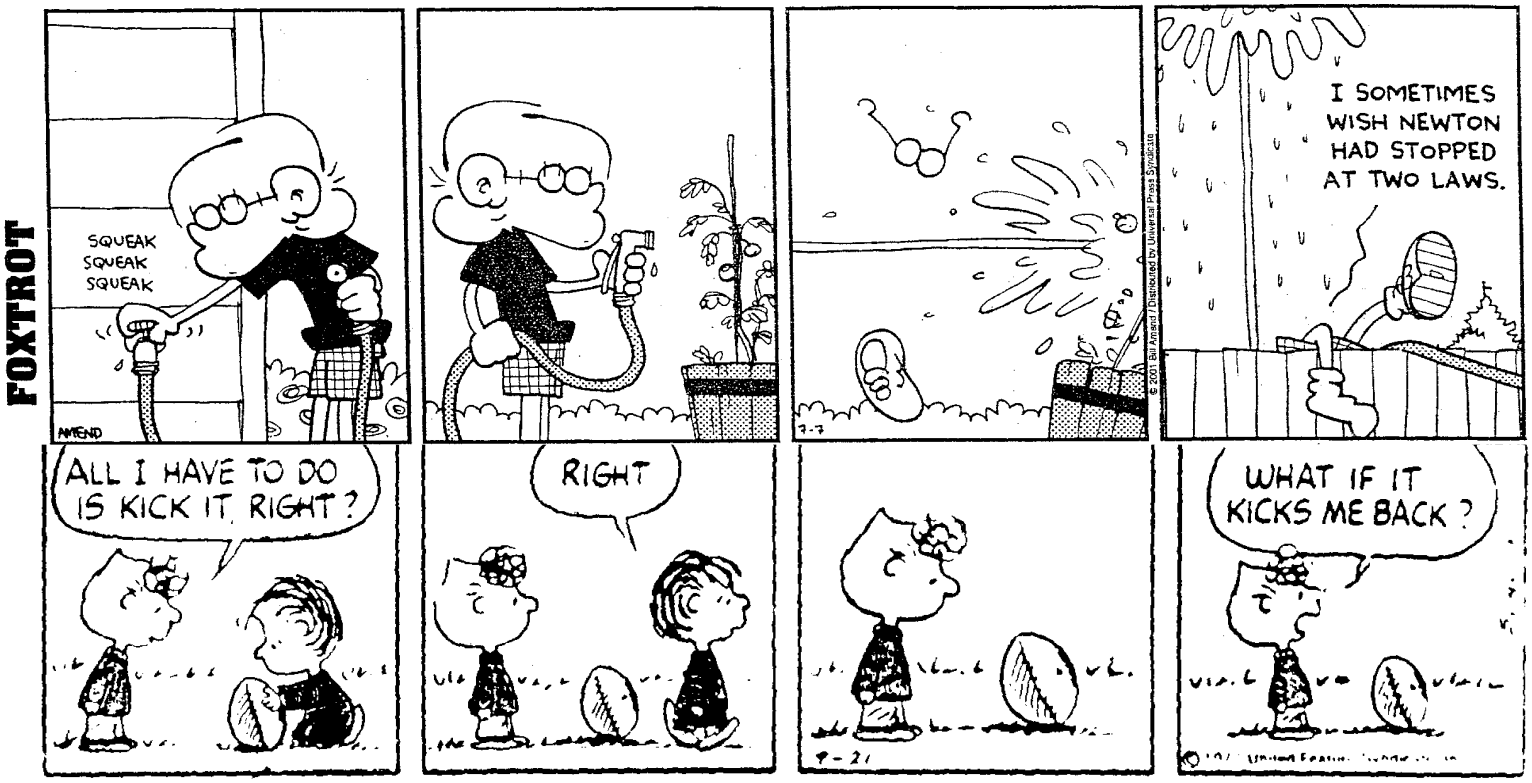
P5. The car accelerates forward when the gas pedal is pushed.

The **force** that actually **accelerates** the car is:

1. a force of the car pushing backward on the road
2. a force of the car pushing forward on the road
3. a force of the road pushing forward on the car
4. a force of the road pushing backward on the car

Hint: the acceleration is in the same direction as the total force.



Mary (40 kg) and Fred (60 kg) have an argument on frictionless ice. Mary pushes Fred with a force of 120 N.

What is Fred's acceleration while she pushes him?

Mary's acceleration while she pushes him?

What is Fred's acceleration after he is out of Mary's reach?

A 3000 kg truck pushes on a 1000 kg stalled car, giving it an acceleration of 2 m/s^2

P6. What is the force of the truck on the car?

P7. What is the force of the car on the truck?

If the truck and car accelerate together, what must be the **total force** on the truck?

Mary has a mass of 40 kg, and stands on a scale in the elevator.

a) The elevator is at rest. What is the scale reading?

b) The elevator accelerates upward at 2 m/s^2. What is the scale reading?

c) After a while the elevator moves at a constant speed. What is the scale reading?

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Ping-pong ball cannon: (Demo)

A 2-gram (0.002 kg) ping-pong ball is pushed 3 meters along an evacuated tube by a constant force of 40 N from air behind it.

P9. Find **a,** and how many g's this is.

How fast is it going at the end?

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HOMEWORK 5 NOTES: