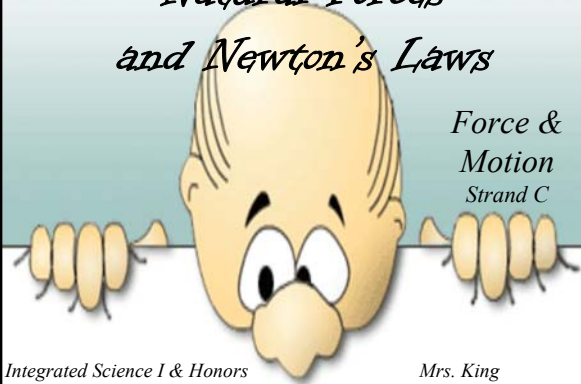


Natural Forces and Newton's Laws

Force &
Motion
Strand C



Integrated Science 1 & Honors

Mrs. King

Motion



Speed and Velocity
Momentum

Speed

- Calculated as distance divided by time

$$v = \frac{\text{distance}}{\text{time}}$$



- Insert the known information in the equation and solve.

Velocity

- Describes both **speed and direction**
- speed + direction of motion = velocity
 - 4.8 m/s to the mall
 - Or 6.2 km/h toward the North Pole



Momentum

- Mass in motion
- Also has direction
- The product of the object's mass and velocity

➤ Momentum = mass x velocity

$$p = mv \quad (\text{for straight line motion})$$

Momentum

- Larger objects are harder to stop
 - Greater mass
- *Speed* also effects the ability to stop
- The faster an object is moving, the greater it's momentum



Acceleration and Force

Acceleration
Force
Friction and Air Resistance
Gravity

Acceleration

$$acceleration = \frac{final_{velocity} - initial_{velocity}}{time}$$

$$a = \frac{\Delta v}{t}$$



← delta sign means change

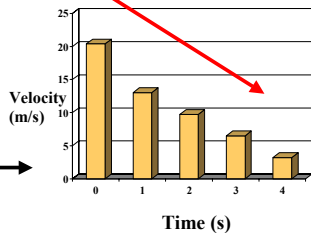


Graphing Data

Notice the negative slope

Practice....

- Distance and time
- Velocity vs. time



X axis: Independent Variable : Time

Y axis: Dependent Variable : Velocity

What is this graph telling you?

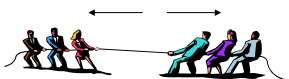
Fundamental Forces

- Gravity
- Electromagnetism
- Strong Nuclear Forces
- Weak Nuclear Forces

Balanced & Unbalanced Forces

Balanced Forces

- Forces acting on an object that combine to produce a net force equal to zero
- Think of tug of war with no winner



Unbalanced Forces

- Forces acting on an object that combine to produce a net nonzero force
- Think of the same tug of war, only this time one team wins



Friction

- Friction is the force between two objects in contact that opposes the motion of either object.
- Frictional force varies depending on the surfaces in contact.
- Car tires are designed to use friction to increase their grip on the road.
 - So tell me, why are there so many different types of tires?



Gravity

- The force of attraction between two particles of matter due to their **mass**
- Everything has gravitational force, even you.
 - *Your gravitational force is very small*
 - *Earth's gravitational force is very large*



- Mass and distance affect gravitational force
- As the distance of the object changes so does the gravitational force between them
 - Closer together = **stronger**
 - Farther apart = **weaker**

Newton's Laws of Motion

Newton's first law
Newton's Second Law
Free Fall and Weight
Newton's Third Law

Newton's 1st Law

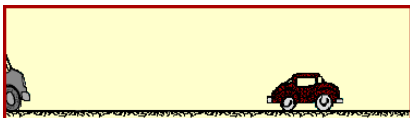
- An object at rest remains at rest and an object in motion maintains its velocity **unless** it experiences an unbalanced force.
- Aka *Inertia*



<http://www.physicsclassroom.com/mmedia/newtlaws/cci.html>



Human on motor cycle becomes projectile object



Ladder becomes projectile object

<http://www.physicsclassroom.com/mmedia/newtlaws/cci.html>

Newton's 2nd Law

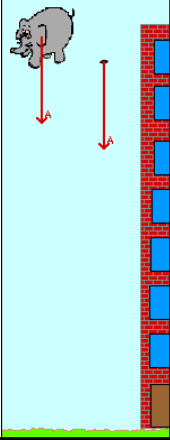
- The unbalanced force acting on an object equals the object's mass times its acceleration
- *force = mass x acceleration*

$$f=ma$$

Difference: pushing a full and empty cart

Free Fall

- In the absence of air resistance, the elephant and the feather hit the ground at the same time.
- Why is this so?
- All objects (regardless of their mass) experience the same acceleration when in a state of **free fall**.



- When the only force is gravity, the acceleration is the same value for all objects.
- On Earth, this acceleration value is 9.8 m/s/s.
- Aka: the acceleration of gravity

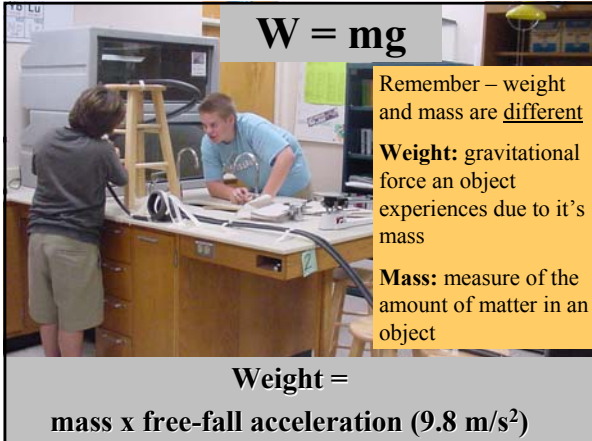
$$W = mg$$

Remember – weight and mass are different

Weight: gravitational force an object experiences due to its mass

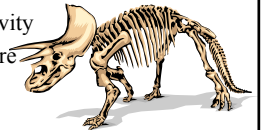
Mass: measure of the amount of matter in an object

Weight =
mass x free-fall acceleration (9.8 m/s²)



Gravity Influences Shape

- Land
 - Support mass against gravity
 - Strong skeletal structure
 - Tree trunk
- Water
 - Downward force of gravity balanced by upward forces of the water
 - strong skeletons not necessary
 - Jelly fish



Air Resistance

- Is also a form of friction
- The amount of resistance depends on the objects **size** and **shape** as well as **speed**.
- Larger object will experience greater air resistance due to their large surface area.
- Think of a semi-truck vs. a Porsche.

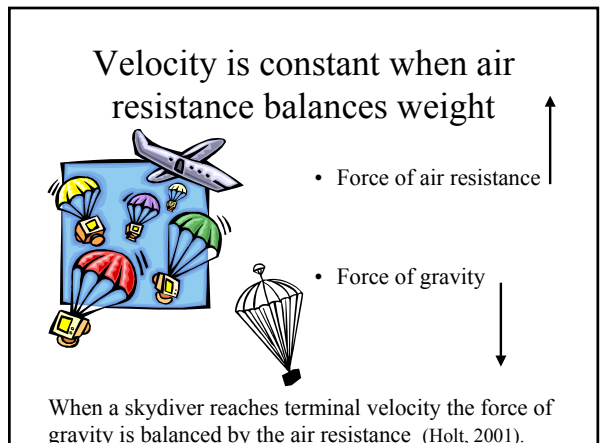
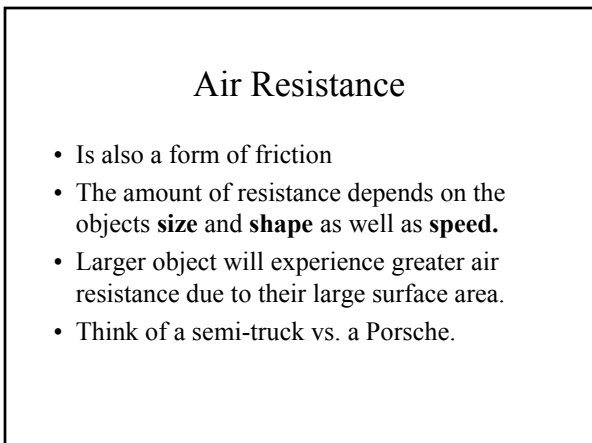
Velocity is constant when air resistance balances weight



• Force of air resistance ↑

• Force of gravity ↓

When a skydiver reaches terminal velocity the force of gravity is balanced by the air resistance (Holt, 2001).



Newton's 3rd Law

- Forces always come in pairs
 - equal and opposite action-reaction
- For every **action** force, there is an equal and opposite **reaction** force
 - occur at the same time

Rockets and the 3rd Law



- Action-reaction pairs
- The upward push on the rocket **equals** the downward push on the exhaust gasses



L-R: Sonny (Homer) Hickam, Quentin Wilson, Roy Lee Cooke, O'Dell Carroll with Ark Rocket Model.

Force is measured in

Newtons

$$1 \text{ N} = 1 \text{ kg} \times 1 \text{ m/s}^2$$

Impulse

$$F_{\text{net}} = ma$$

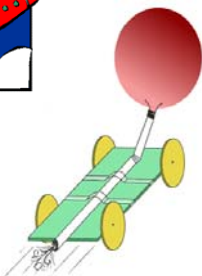
Manipulation of Newton's 2nd Law [click here](#)

Your Rocket Car



Experimental Design

Who will build the best rocket car that can travel the farthest ?



Works Cited

- Hickham, Homer. Retrieved Tuesday, December 02, 2003 from <http://www.homerhickam.com/new1.htm>
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- Physics Classroom. Retrieved Sunday, November 14, 2004 from <http://www.glenbrook.k12.il.us/gbssci/phys/Class/momentum/u411a.html>