SCIENCE

TECHNOLOGY

Science * Technology * Engineering * Mathematics

STARBASE Oklahoma

AEROSPACE EDUCATION

An Oklahoma National Guard Youth Program

MATH

ENGINEERING

DoD STARBASE

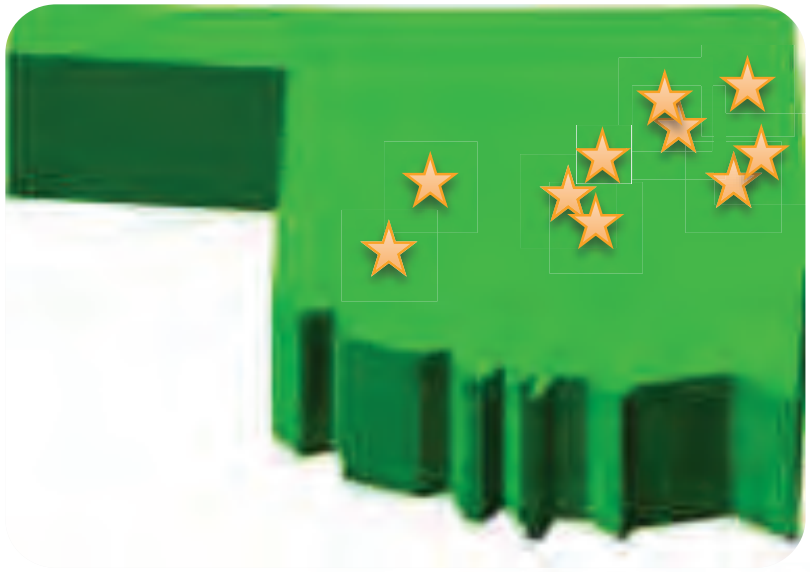
A Department of Defense Youth Program

Name _____ Call Sign _____

Date _____ Teacher _____

School _____ Team _____

www.starbaseok.org www.starbasedod.org



Locations

Tulsa Air National Guard
9131 E Viper St.
Bldg 031
Tulsa, OK 74115
918-833-7757
FAX 918-833-7769

Tulsa Army Aviation Support Facility
4242 N. Mingo
Valley Expressway
Tulsa, OK 74116
918-832-6619

Will Rogers Air National Guard
5920 Air Guard Dr
Oklahoma City, OK 73179
405-686-5950
FAX 405-686-5229

Tinker Air Force Base
Tinker Youth Center
Midwest City, OK
918-833-7747

Camp Gruber Training Center
Bldg. 327
Braggs, OK 74423
918-549-6226

Whitaker Education and Training Center
Oklahoma National Guard
824 Park St. Blg. 500
Pryor, OK 74361
918-824-4827

Muskogee Armed Forces Reserve Center
6800 S. Cherokee
Muskogee, OK 74403

OSIDA - Oklahoma Space Industry Development Authority
501 Sooner Drive
PO Box 689
Burns Flat, OK 73624
580-562-3500

Fort Sill
1721 Macomb Road
Ft. Sill, OK 73503
580-442-4179
580-442-4266

STARBASE *Oklahoma*
Past, Present, Future

In 1993, Congress authorized and funded the National Guard Bureau to enter into agreements with the Nation's Governors for the purpose of conducting programs targeted at youth in general, and youth at risk in particular. The goals of the program included providing young people with the values, self-esteem, skills, education and self-discipline needed to succeed as students and adults.

Brigadier General Kenneth McGill, former commander of the 138th Fighter Wing of Tulsa Air National Guard, learned about the youth program after his Public Affairs personnel, 2nd Lt. Kimberly (Maloy) Howerton and TSgt Michael Bennett, had attended a conference where the program was highlighted. Believing that the youth of Oklahoma deserved the program, they, along with Air Force Advisor, Lt. Col. Tom Hughes, organized Project Future STARBASE which would become STARBASE Oklahoma. Support of the program by volunteers from the Air National Guard and the local community was strong. Without funding or supplies, Oklahoma began a pilot program conducted in Tulsa in July of 1993. Tulsa Public Schools selected 20 students from two schools that met the "at - risk" criterion, and the first Academy was underway. In order to conduct the class, a base facility was converted into a classroom and volunteers donated supplies, time and talent.

In September of 1993, at the request of the Governor and the Adjutant General of the Oklahoma National Guard, the National Guard Bureau funded Oklahoma at the Air National Guard Base in Tulsa. By the end of September, two schools with high Native American populations, Woodall and Locust Grove, had been added to the schedule. Woodall is the only school to attend STARBASE Oklahoma classes every year since 1993. In the summer of 1995, STARBASE Oklahoma moved into a permanent, well-equipped classroom.

In May of 2000, Major General Stephen P. Cortright, Oklahoma's Adjutant General, announced the opening of our second site in Oklahoma City. The site was to be operated on limited state and private funding. Federal funding was approved in November 2000 for the second site to begin operation in January 2001.

In September 2003, Oklahoma was tapped to conduct a Native American Initiative with federal funding. Classrooms were opened at Camp Gruber near Braggs, Okla., Pryor's Whitaker Education and Training Campus operated by the Oklahoma National Guard and the Anadarko Armory. In 2008, the Anadarko Armory was closed and the classroom moved to Davis Field in Muskogee.

Also in August of 2009, the leadership at Fort Sill applied to begin a STARBASE classroom at Fort Sill to answer the Lawton community's request for returning STARBASE to their classrooms. Fort Sill 's commanding general Major General Pete Vangjel signed an agreement with Oklahoma National Guard Adjutant General Major General Harry M. "Bud" Wyatt to operate the program. The Lawton classroom filled every class within one week of the announcement.

STARBASE Oklahoma currently hosts 10 classrooms in seven cities throughout the state of Oklahoma. Classrooms at Camp Gruber, at the Muskogee Armed Force Reserve Center, and in Pryor are designated as Native American Initiative classrooms and seek classes with high Native American populations. The remaining seven classrooms are in Tulsa at the Tulsa Air National Guard Base and the Tulsa Army Aviation Support Facility, in Oklahoma City at Will Rogers Air National Guard Base and Tinker Air Force Base, Fort Sill in Lawton and in Burns Flat. The Burns Flat classroom is funded by the Oklahoma Space Industry Development Authority at Oklahoma's Spaceport.

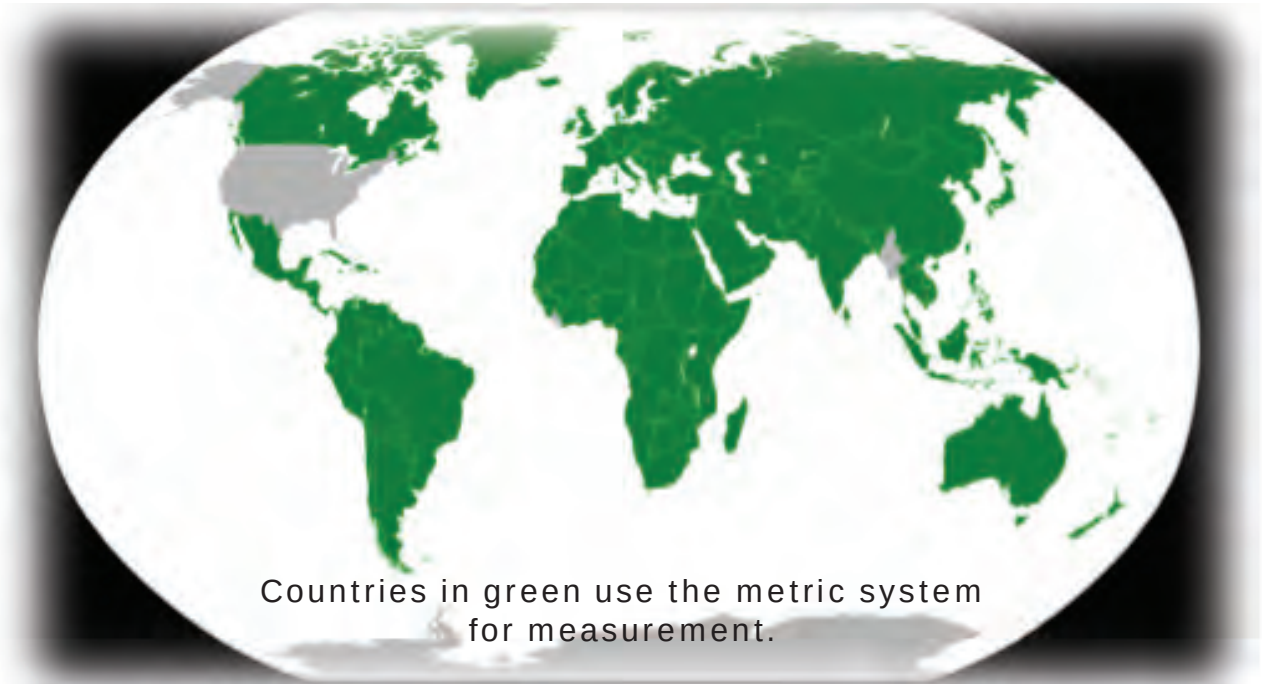
Phonetic Alphabet

A	Alpha
B	Bravo
C	Charlie
D	Delta
E	Echo
F	Foxtrot
G	Golf
H	Hotel
I	India
J	Juliet
K	Kilo
L	Lima
M	Mike
N	November
O	Oscar
P	Papa
Q	Quebec
R	Romeo
S	Sierra
T	Tango
U	Uniform
V	Victor
W	Whiskey
X	X - ray
Y	Yankee
Z	Zulu

1	Wun
2	Too
3	Tree
4	Fow - er
5	Fife
6	Six
7	Sev - en
8	Ait
9	Nin - er
0	Zero

STARBASE Oklahoma – STEM

- Science –
  - Physics , Biology, Chemistry,
  - Astronomy
- Technology –
  - Innovations: Nanotechnology
  - Navigation and Mapping
- Engineering –
  - Intro to CAD
  - Engineering Design Process (EDP)
- Math –
  - Number Relationships
  - Measurement
  - Geometry
  - Data Analysis
- Have FUN!

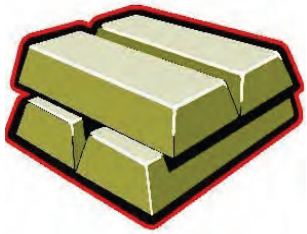
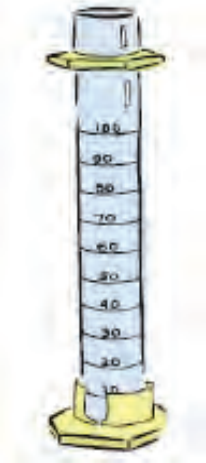


Countries in green use the metric system for measurement.

KEY VOCABULARY

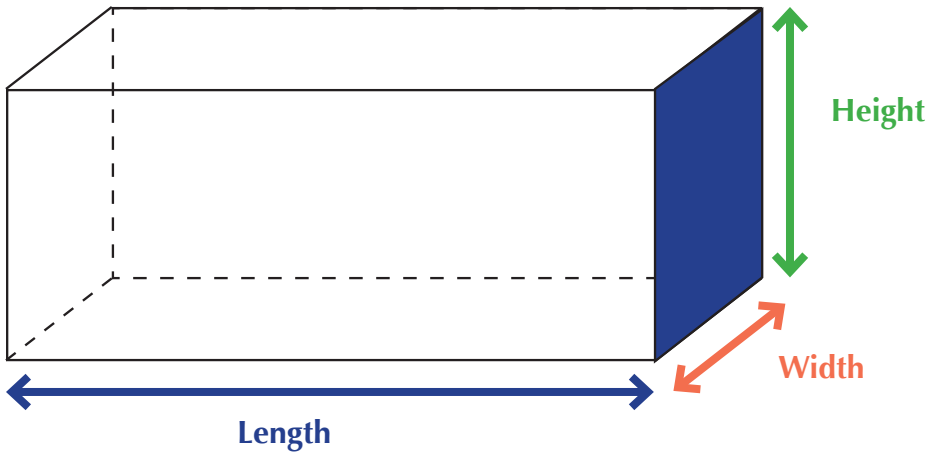
Celsius	Standard metric unit used to measure temperature.
Graduated Cylinder	A container used for measuring liquids marked with a graded scale.
Gram	Standard metric unit used to measure the mass of an object.
Liter	Standard metric unit used to measure liquid volume.
Mass	The amount of matter in an object or substance.
Meniscus	The convex or concave upper surface of a column of liquid, the curvature of which is caused by surface tension.
Meter	Standard metric unit used to measure the length of an object or the distance between two objects.
Metric System	Universal system of measurement used by scientists all over the world: based on 10 and powers of 10.
Triple Beam Balance	Measures the mass of an object by using a set of three sliding weights to balance the mass on a pan.
Volume	The amount of space an object occupies.

The Metric System is based on _____ and powers of _____.

MASS	LENGTH OF DISTANCE	LIQUID VOLUME	TEMPERATURE
Standard Metric Unit:	Standard Metric Unit:	Standard Metric Unit:	Standard Metric Unit:
_____	_____	_____	_____
			
Tool Used:	Tool Used:	Tool Used:	Tool Used:
_____	_____	_____	_____
			

Station #1:
Measuring Length and Calculating Solid Volume

VOLUME = Length (cm) X Width (cm) X Height (cm)



Fudgesicle® Box:

Length: _____ cm

Width: _____ cm

Height: _____ cm

Volume = _____ cm^3

Skinny Cow® Fudgesicle® Box:

Length: _____ cm

Width: _____ cm

Height: _____ cm

Volume = _____ cm^3

You have 20,000 cm^3 of space available for the **Fudgesicle® Boxes**. How many of each will you be taking?

A. Fudgesicle® Boxes _____ X _____ CM^3 = _____

B. Skinny Cow® Fudgesicle® Boxes _____ X _____ CM^3 = _____

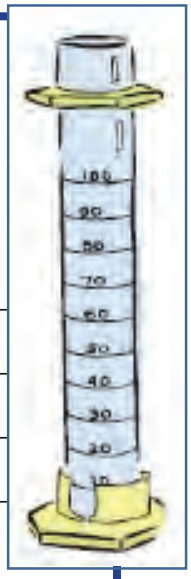
What is the total volume of space you will be using? (A+B) _____

What is the total volume of space left empty? _____

How did you make your decision? _____

_____

Station #2: Measuring Liquid Volume



Container A: _____ ml
Container B: _____ ml
Container C: _____ ml
Container D: _____ ml

Liquid A Identity: _____
Liquid B Identity: _____
Liquid C Identity: _____
Liquid D Identity: _____

Station #3: Measuring Mass

Example: *Object in Classroom*

Triple Beam Balance Readings

Hundreds Beam	___ ___ ___ . 0	g
Tens Beam	+ ___ ___ . 0	g
Grams Beam	+ ___ . ___	g
Total Mass	___ ___ ___ . ___	g

Mass of Sample A: _____ g
Mass of Sample B: _____ g
Mass of Sample C: _____ g
Mass of Sample D: _____ g

Identity of Sample A: _____
Identity of Sample B: _____
Identity of Sample C: _____
Identity of Sample D: _____

Station #4: Units and Prefixes

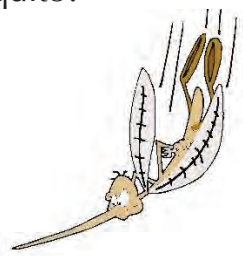
PREFIXES			UNITS	PREFIXES			
kilo	hecto	deka	(gram, meter, liter)	deci	centi	milli	nano
(X1000)	(X100)	(X10)		(÷10)	(÷100)	(÷1000)	(÷1,000,000,000)

Which unit would you most likely use to measure:

the mass of a pilot?

- ☐ Liter
- ☐ Kilogram
- ☐ Meter

the length of a mosquito?



- ☐ Meter
- ☐ Gram
- ☐ Millimeter

the volume of liquid fuel in a rocket?

- ☐ Kiloliter
- ☐ Decimeter
- ☐ Centigram

the volume of water in a raindrop?

- ☐ Liter
- ☐ Kilogram
- ☐ Meter

the mass of a feather?

- ☐ Milliliter
- ☐ Millimeter
- ☐ Milligram

the distance from STARBASE to your school?

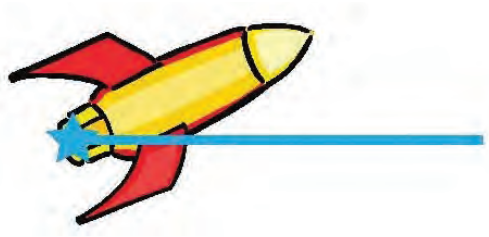
- ☐ Kilometer
- ☐ Milliliter
- ☐ Milligram

Station #5:
Measuring Angles

LAUNCH A:

Current launch degree: _____

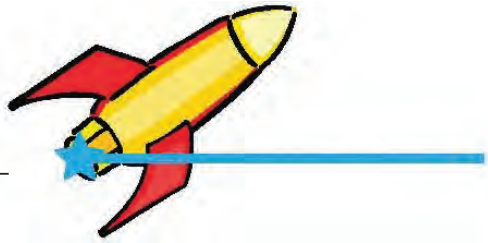
Adjustment needed to reach 45°: _____



LAUNCH B:

Current launch degree: _____

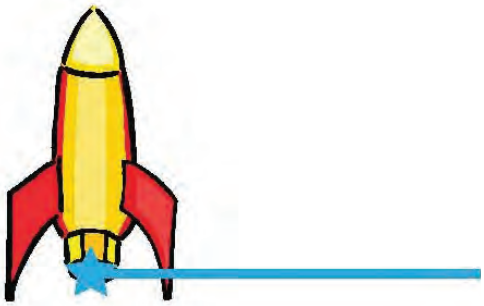
Adjustment needed to reach 45°: _____



LAUNCH C:

Current launch degree: _____

Adjustment needed to reach 45°: _____



Which launch would need the least adjustment to reach 45°? _____

1. Identify the problem/ question to be tested - Make a hypothesis. This is an educated, scientific guess.

2. Design the experiment -
Plan and build an experiment which will test the effect of the variable you noted in the hypothesis. You will be testing your variable against results obtained from a control group. (The variable is the part of the experiment being tested to see if a change occurs when it is present or absent.)

3. Collecting experimental data –
Data are the information you will collect while the experiment is in progress. (Data usually consist of measurements of the changes you observed during the experiment.)

4. Analysis of the data –
This is a step in the experimental process where you will look at the data you have collected. You will see if the data you collected support your hypothesis.

5. Conclusion – Now write a summary of your findings saying whether the analysis shows the experimental data support your original hypothesis or the data do not.

KEY VOCABULARY

Acceleration	The rate of change of the velocity of a moving body. An increase in the magnitude of the velocity of a moving body (an increase in speed) is called a positive acceleration; a decrease in speed is called a negative acceleration.
Axis of Rotation	The center around which something rotates.
Center of Gravity	The point at which the mass of an object is distributed evenly, resulting in an equal amount of gravitational pull on all sides — also called "balance point."
Center of Pressure	The point at which the air pressure is acting on all sides of an object — the greater the amount of surface area, the greater the amount of pressure.
Drag	Is the resistance the air offers because of friction that slows the forward movement of an airplane. It is a backward force that works against the thrust.
Force	A push or a pull that gives energy to an object, sometimes causing a change in the motion of the object.
Friction	The resistance produced when two surfaces rub together.
Gravity	The natural force of attraction exerted by a celestial body, such as Earth, upon objects at or near its surface, tending to draw them toward the center of the body.
Inertia	The tendency of an object to resist a change in motion. An object at rest, will remain at rest unless a force acts on it. An object in motion, will continue in the same direction at the same speed, unless an outside force acts on it. Newton's First Law of Motion pertains to inertia.
Mass	The amount of matter in an object, independent of gravity. Mass is different from weight of an object. Weight is the gravitational effect on a mass.
Momentum	The product of an object's mass and velocity, which determines how difficult it is to stop the object's motion.
Thrust	The forward - directed force developed in a jet or rocket engine as a reaction to the high - velocity rearward ejection of exhaust gases.

Wernher Von Braun
March 23, 1912 – June 16, 1977

Wernher Magnus Maximilian Freiherr von Braun (March 23, 1912 – June 16, 1977) was a German - American rocket scientist, astronautics engineer and space architect, becoming one of the leading figures in the creation of rocket technology in Germany and the United States.

Von Braun worked on the US Army intermediate range ballistic missile (IRBM) program before his group was assimilated by NASA, under which he served as director of the newly formed Marshall Space Flight Center and as the chief architect of the Saturn V launch vehicle, the superbooster that propelled the Apollo spacecraft to the Moon. According to one NASA source, he is "without doubt, the greatest rocket scientist in history. His crowning achievement ... was to lead the development of the Saturn V booster rocket that helped land the first men on the Moon in July 1969." He received the 1975 National Medal of Science.

SOURCE: http://en.wikipedia.org/wiki/Wernher_von_Braun

Newton's Three Laws

PHYSICS

Newton Notes:

Sir Isaac Newton
(1642 - 1727)

Newton, Sir Isaac (1642 - 1727), English physicist, mathematician, and natural philosopher, considered one of the most important scientists of all time.

Newton formulated laws of universal **gravitation** and motion — laws that explain how objects move on Earth as well as through the heavens.
He established the modern study of **optics** — or the behavior of light — and built the first reflecting **telescope**.

His mathematical insights led him to invent the area of mathematics called **calculus**.

He is referred to as the father of **physics**.

LAWS OF MOTION:

1st Law Any object moving in a straight line will continue in a straight line unless acted upon by an outside force. Any object in a state of rest will remain in a state of rest unless acted upon by an outside force. This is also known as the *Law of Inertia*.

Inertia is the tendency of an object to resist a change in motion.

2nd Law A force can be applied to a moving object. The greater the force, the greater the acceleration. The greater the mass of the object, the greater the force necessary to accelerate it. The mathematics formula for this law is F = MA.

F = M x A, FORCE = MASS x ACCELERATION;
A = F/M, ACCELERATION = FORCE divided by MASS.

3rd Law For every action, there is an equal and opposite reaction.

Sir Isaac Newton made these laws in reference to ideal motion, motion in which there is no friction present. Scientists need to consider the affects friction will have on an object.

Use the space below to calculate Newton's age when he died and what his age would be if he were still alive today.

Newton's Age		**Newton's Age Today**	
Died	1727	Current Year	
Born	-1642	Born	-1642
Answer		Answer	

According to *Newton's 1st Law*, **an object at rest will stay at rest unless acted upon by an outside force.**

The engines of a rocket create the force of thrust which makes the rocket go upward or forward. Before thrust is applied to our rocket, it is an object at _____.

Once a force (thrust) is applied, the rocket becomes an object in _____.

Newton also explained that ***an object in motion will continue in motion unless acted upon by an outside force.***
What outside force slows a rocket down?
_____

What outside force helps bring a rocket down to the surface of the Earth? _____

Newton's 2nd Law **states that F=ma.**

If you ***increased*** the ***mass*** of the rocket, what would happen to the acceleration if the force remains the same?
_____
_____

What would you need to do if you wanted to ***increase*** the amount of acceleration of your rocket? To increase the acceleration you could _____
_____or you could _____
_____.

Newton's 3rd Law explains that for every ***action, there is an equal and opposite reaction.***

Applying this law to launching your rocket,
the **action** is _____
and the **reaction** is _____

Straw Rocket

Launch: Mass as Variable

Predict

1. As I ***increase*** the amount of ***mass*** on the rocket but keep the applied force the same, the rocket will

☐ travel a longer distance ☐ travel a shorter distance

	Mass of Rocket	Force Applied	Launch Angle	Distance Traveled
Launch 1				
Launch 2				
Launch 3 (optional)				

Launch: Force as Variable

Predict

1. As I ***increase*** the amount of ***force*** on the rocket but keep the mass the same, the rocket will

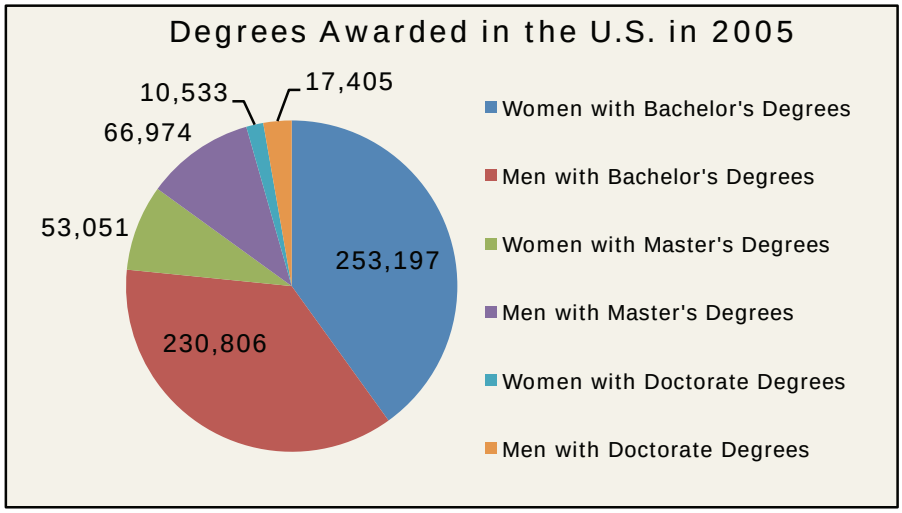
☐ travel a longer distance ☐ travel a shorter distance

	Mass of Rocket	Force Applied	Launch Angle	Distance Traveled
Launch 1				
Launch 2				
Launch 3 (optional)				

Introduction to Graphing & Analyzing Data

KEY VOCABULARY

Data	Individual facts, statistics, or items of information.
Mean	The average value of a set of numbers.
Table	An arrangement of words, numbers, or signs, or combinations of them, as in parallel columns, to exhibit a set of facts or relations in a definite, compact, and comprehensive form; a synopsis or scheme.
Trend	A prevailing tendency.

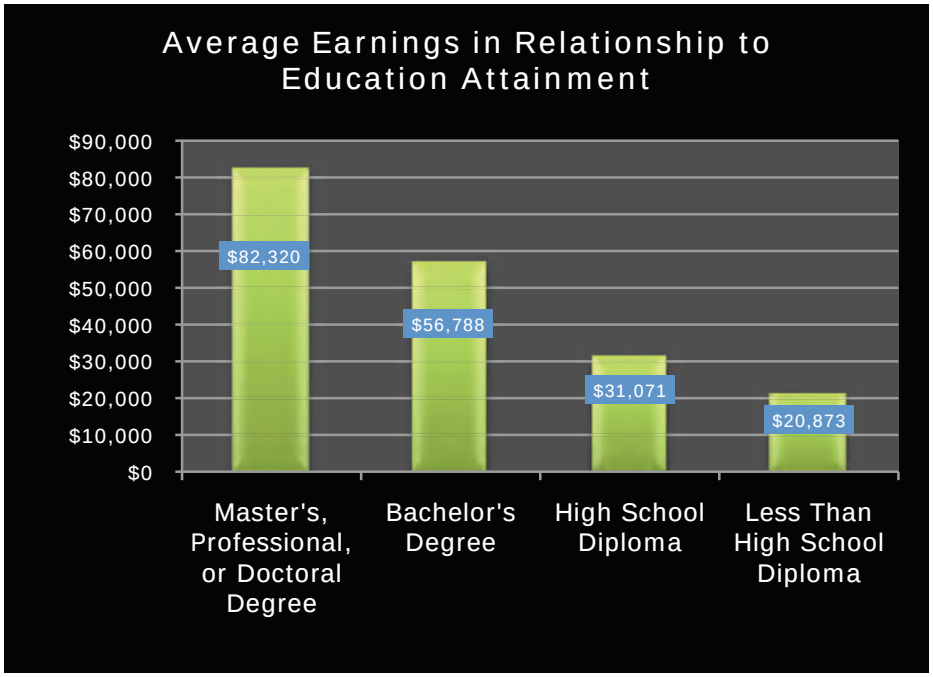


Pie or circle graph: Useful in representing the comparative sizes of the parts that make up a whole.

Source: Curious Cat Science and Engineering Blog: Data on degrees awarded men and women in the USA in 2005, from NSF*

Bar graph: Useful in comparing the amounts or frequency of occurrence of different characteristics of data. They are used to compare groups, and to make generalizations about the data quickly.

Source U.S. Census Bureau, Educational Attainment in the United States in 2007



Data Analysis–Rocket Launch

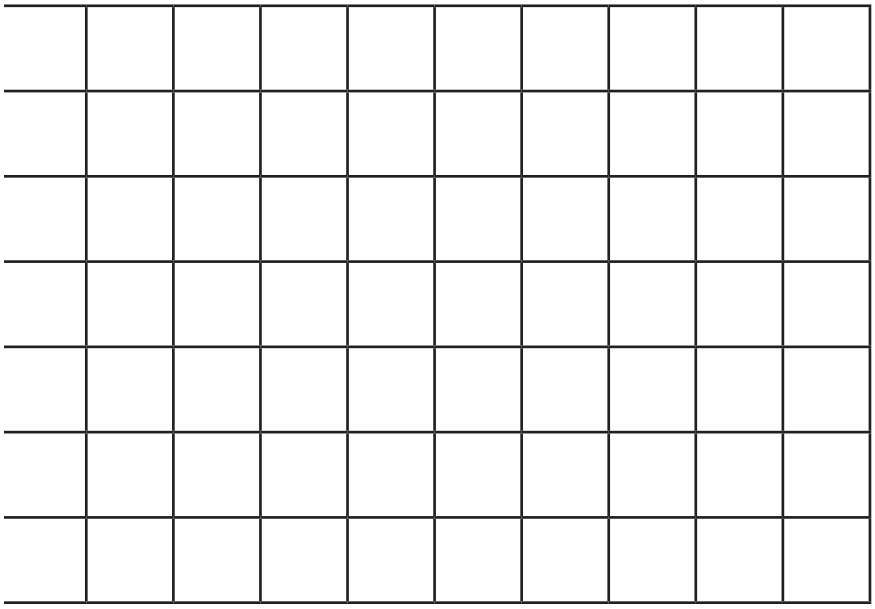
Distance of Rocket Launch: Mass as Independent Variable

Type of rocket launched: _____

Constant: _____

Dependent Variable: _____

Y-axis: _____ (unit of measurement: _____)



X-axis: _____

(unit of measurement: _____)

Data Analysis

When applying an equal amount of force, the rocket with greater mass will travel a distance

☐ further than ☐ less than

the rocket with less mass.

Data Analysis–Rocket Launch

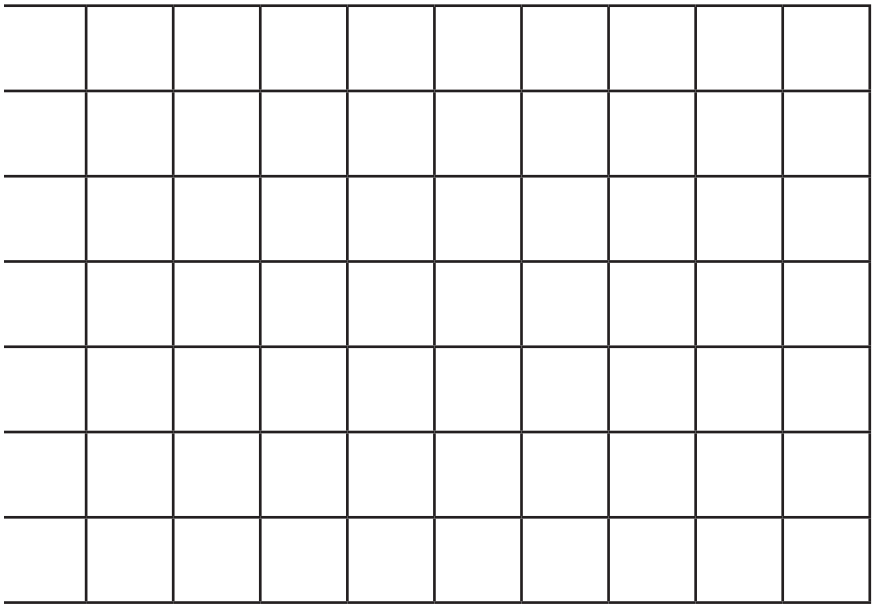
Distance of Rocket Launch: Force as Independent Variable

Type of rocket launched: _____

Constant: _____

Dependent Variable: _____

Y-axis: _____ (unit of measurement: _____)



X-axis: _____

(unit of measurement: _____)

Data Analysis

When launching rockets of equal mass, the rocket that has a greater amount of force applied to it will travel

☐ further than ☐ less than

the rocket which has a smaller force applied to it.

Newton's Three Laws

PHYSICS

A	S	D	F	C	I	T	A	N	O	O	L	O	R	T	S	A	A	A
A	K	J	K	L	A	E	G	S	H	A	H	J	E	A	H	H	Y	Z
L	M	O	T	I	O	N	C	S	I	T	R	F	C	F	E	O	R	X
A	M	S	E	L	R	A	H	A	E	C	A	D	R	N	R	I	A	D
E	T	N	E	M	E	V	O	M	K	A	N	W	O	S	Y	Y	L	R
G	M	W	B	E	F	R	L	Y	A	R	N	T	F	E	U	Y	U	T
G	I	E	R	O	J	R	A	M	Y	F	W	A	D	R	R	U	B	Y
B	K	I	N	E	R	T	I	A	O	E	L	D	S	F	W	I	A	U
E	F	G	A	I	R	S	M	C	N	R	A	P	H	Y	S	I	C	S
R	F	H	A	C	I	L	B	C	T	U	P	F	A	Y	W	E	O	Q
T	A	T	I	R	F	O	A	E	C	I	E	S	I	C	E	L	V	E
U	N	I	V	E	R	A	A	L	N	M	O	A	J	I	R	I	B	R
L	L	F	P	U	S	R	E	E	S	I	E	N	H	T	Y	B	Z	T
P	U	L	L	I	M	I	A	R	S	F	R	S	G	A	U	O	Q	D
O	M	N	R	E	S	T	R	A	I	N	T	F	F	N	I	M	S	E
L	F	I	D	F	A	A	G	T	G	S	E	D	D	O	O	N	C	V
Y	S	D	A	G	R	A	V	I	T	Y	R	M	S	O	O	O	F	I
H	R	G	S	B	J	J	T	O	J	J	D	S	W	L	O	T	W	C
E	O	A	C	C	I	T	A	N	U	L	P	I	E	R	W	W	R	E
D	L	X	Z	S	N	O	I	T	I	V	A	R	G	W	E	E	E	A
R	O	B	N	M	L	K	J	H	G	F	S	P	O	Z	R	N	R	G
O	C	X	H	X	A	Q	S	U	L	U	C	L	A	C	Q	W	E	H
N	X	V	S	N	N	M	L	K	K	J	H	G	D	F	E	S	A	J
L	K	J	U	G	D	A	F	F	E	C	T	E	D	F	D	S	A	K
Q	W	L	P	T	Y	U	I	O	P	W	E	T	U	I	Q	R	S	L

Word Bank

Acceleration
Calculus
Force
Friction
Gravity
Inertia
Loonatic
Lunatic
Mass
Motion
Prism
Restraint
Sir Isaac Newton
Weight

BONUS Words

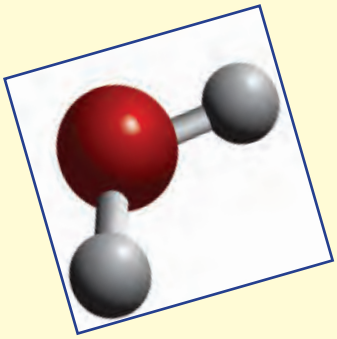
Affected
Astroloonatic
Device
Colors
Device
Eggbert
Movement
Newtonmobile
Physics
Polyhedron
Pull
Push
Refract
Vocabulary

KEY VOCABULARY

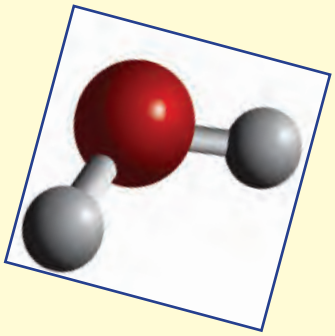
Atoms	An atom is the smallest particle of an element that retains all the properties of that element.
Chemical change	A change resulting from a chemical reaction in which bonds are broken and new bonds are formed between different atoms in a substance. A chemical change produces one or more new substances with different chemical properties.
Chemical formula	A model that gives information about the atoms that make up a particular chemical compound. They are used in chemical equations to represent how atoms are rearranged in a chemical reaction.
Compounds	Substances made of two or more types of atoms. Example: Water, H_2O
Electrons	Negatively charged particles that exist in a cloud surrounding the nucleus.
Elements	Substances made of only one type of atom. Example: Oxygen O_2
Fluids	Fluids are substances that flow freely and tend to assume the shape of the container in which they are held. Liquids, gases, and plasmas are considered fluids.
Gases	The molecules in gases are not bound to one another. Because of this, a gas does not have a fixed shape or volume. It will expand to fill any container in which it is placed. Example: Air.
Kinetic energy	Energy of motion.
Liquids	The molecules in liquids are loosely bound and are in motion. Because its molecules are loosely bound, a liquid will take the shape of the container in which it is placed. Example: Water.
Mass	The amount of matter in an object.
Molecule	A particle made of two or more atoms that are chemically bonded.
Nucleus	The center or core of an atom. It is made up of protons and neutrons.

KEY VOCABULARY Continued

Periodic Table of Elements	A list of elements ordered in rows according to atomic number (number of protons in the nucleus of an atom of the element). The rows are arranged so that elements with similar chemical properties occur in the same column.
Phase or state of matter	Distinct forms in which material can exist.
Physical change	A change in physical properties that does not affect the chemical nature of a substance. Examples include changes in texture, shape, size, color, odor, volume, mass, weight, and density.
Plasmas	Plasma is like a gas in that it spreads out to fill the space that contains it, but plasma is composed of ions (atoms with a negative or positive charge) and free - moving electrons. As a result, plasma conducts electricity. Examples: Lightning, found in neon signs, fluorescent light bulbs.
Protons	Subatomic particles with a positive electric charge found in the center of an atom.
Single and double bonds	A single bond is a chemical bond in which one pair of electrons is shared by two atoms in a molecule. A double bond is a chemical bond in which two pairs of electrons are shared by two atoms in a molecule.
Solids	The molecules in solids are bound tightly and do not move much. This is why solids maintain their shape and volume. Example: Rock
Weight	Measure of the pull of gravity on an object or substance. It is proportional to the mass. The greater the mass, the greater the weight.



Ernest Rutherford



Ernest Rutherford, (30 August 1871–19 October 1937) was a British - New Zealand chemist and physicist who became known as the father of nuclear physics. In 1908, he was awarded the Nobel Prize in Chemistry "for his investigations into the disintegration of the elements, and the chemistry of radioactive substances".

His most famous work was performed after he received his Nobel Prize. In 1911, he hypothesized that atoms have their positive charge concentrated in a very small nucleus, and thereby pioneered the Rutherford model, or planetary, model of the atom,. This was accomplished through his discovery and interpretation of Rutherford scattering in his gold foil experiment. He is widely credited with first splitting the atom in 1917, and leading the first experiment to "split the nucleus" in a controlled manner by two students under his direction, John Cockcroft and Ernest Walton in 1932.

SOURCE: http://en.wikipedia.org/wiki/Ernest_Rutherford

What's the Matter?

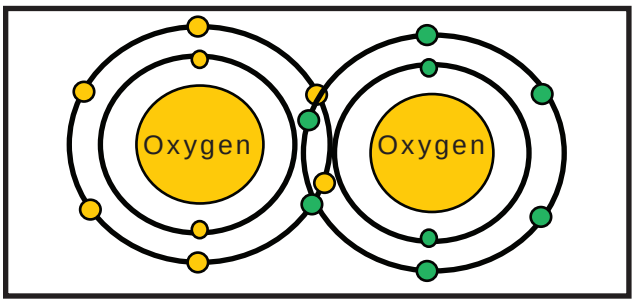
All matter is made of small particles called _____ .

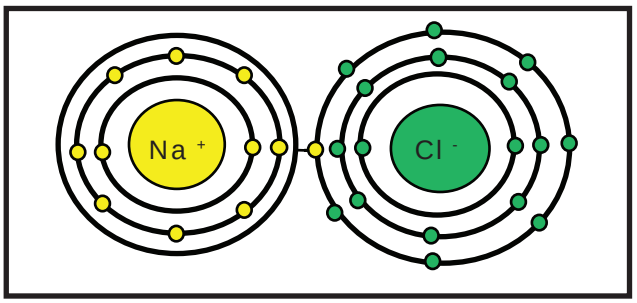
Atoms bond together to form _____.

When two or more different kinds of atoms bond together, they form a(n) _____.

Most substances are _____ .

Directions: Identify which model represents an element and which represents a compound. What substance is represented by each model?





_____ _____

Phases of Matter

The phase of matter can be changed by increasing or decreasing the amount of _____.

Greater heat energy causes greater _____ energy, or energy of motion.

Label each phase:

Periodic Table of Elements

LEGEND

Black – Solids Red – Gases White – Artifical Blue – Liquids

Alkaline Metals Alkali Metals Other Metals Transition Metals
Halogens Actinide Series Lanthanide Series
Other Nonmetals Noble Gases

1 H Hydrogen																2 He Helium
3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Florine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium											13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
37 Rb Rubidium	38 Sr Strontium	39 Y Yurium	40 Zr Zirconium	41 NB Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
55 Cs Cesium	56 Ba Barium	57 La Lanthanum	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89 Ac Actinium	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Sezborgaim	107 Bh Barium	108 Hs Hassium	109 Mg Maitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Uub Unumbium	113 Uut Ununtrium	114 Uuq Ununquadrium	115 Uup Ununpertium			

Lanthanide Series	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Sb Antimony	69 Tm Thulium	70 Yb Ytterbium	71 Lu Luterium
Actinide Series	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Po Polonium	102 No Nobellium	103 Lr Lawrencium

KEY VOCABULARY

Atoms	An atom is the smallest particle of an element that retains all the properties of that element.
Atmospheric pressure	The force exerted by air on a unit area.
Compounds	Substances made of two or more types of atoms. Example: Water (H_2O)
Control	A standard against which experimental observations may be evaluated. A procedure identical to the experimental procedure except for the one factor being studied.
Density	The amount of mass per volume. Something that is more tightly packed is more dense than something that has more space between the molecules.
Density of air	Mass per unit volume of Earth's atmosphere.
Dependent Variable	A factor that is measured to learn the effect of one or more independent variables. It is what happens as a result of the independent variable.
Elements	Substances made of only one type of atom. Example: Oxygen O_2
Equilibrium	A state of rest or balance due to the equal action of opposing forces.
Experimental design	The method or process of designing an experimental investigation used to test cause-and-effect relationships between variables. The classic experimental design specifies an experimental group and a control group.
Fluids	Fluids are substances that flow freely and tend to assume the shape of the container in which they are held. Liquids, gases, and plasmas are considered fluids.
Gases	The molecules in gases are not bound to one another. Because of this, a gas does not have a fixed shape or volume. It will expand to fill any container in which it is placed. Example: Air.

KEY VOCABULARY Continued

Independent Variable	A variable that is manipulated (controlled) by the researcher and evaluated by its measurable effect on the dependent variable or variables. It is purposely changed so that the effect can be tested.
Liquids	The molecules in liquids are loosely bound and are in motion. Because its molecules are loosely bound, a liquid will take the shape of the container in which it is placed. Example: Water.
Mass	The amount of matter in an object.
Molecules	A particle made of two or more atoms that are chemically bonded.
Plasmas	Plasma is like a gas in that it spreads out to fill the space that contains it, but plasma is composed of ions (atoms with a negative or positive charge) and free - moving electrons. As a result, plasma conducts electricity. Examples: Lightning, found in neon signs, fluorescent light bulbs.
Solids	The molecules in solids are bound tightly and do not move much. This is why solids maintain their shape and volume. Example: Rock.
Volume	The amount of space an object occupies.
Weight	The pull of gravity on an object or substance. It is proportional to the mass. The greater the mass, the greater the weight.

Atmospheric Properties

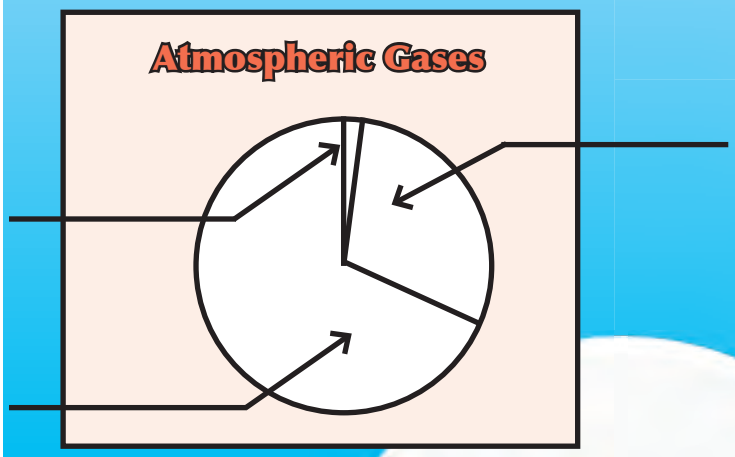
CHEMISTRY

Ocean of Air

The atmosphere is the blanket of _____ that surrounds Earth. It is made up of small particles so small you can't see them around you. They are held in place by _____.

The Gases In the Atmosphere				
Type of Gas	Number of Particles	Equivalent Fraction	Decimal Equivalent	Percentage of Gases in the Atmosphere
Nitrogen (Blue)		___/100	0. ___	___ %
Oxygen (Red)		___/100	0. ___	___ %
Water Vapor and Trace Gases (White)		___/100	0. ___	___ %

Increasing Altitude



EARTH'S ATMOSPHERE

About _____ km thick

Elevation and Air Density

Farther from the surface of Earth, the air is _____ dense.

Closer to the surface of the Earth, the air is _____ dense.

The Properties of Air

Experiment #1:

_____

Air molecules have _____.

Air molecules take up _____.

Experiment #2: _____

Air molecules have _____.

What is the force of gravity acting downward on an object? _____

Weight of Bottle and Air	
Ending weight	___ ___ ___ . ___ ___ g
Beginning weight	___ ___ ___ . ___ ___ g
Difference	___ ___ ___ . ___ ___ g

Experiment #3: _____

Air molecules exert _____ in all directions.

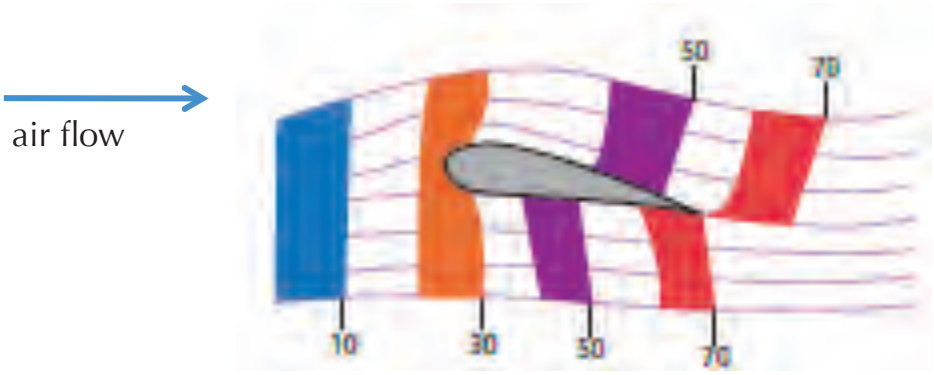
When air pressure is *decreased* in the syringe, the marshmallow _____.

When air pressure is *increased* in the syringe, the marshmallow _____.

On Earth, air exerts 14.7 lbs. of pressure per square inch.

What Is a Fluid?			
A fluid:			
- does not have its own shape	Is a solid a fluid?	YES	NO
- separates and flows	Is a liquid a fluid?	YES	NO
- can be poured	Is a gas a fluid?	YES	NO

Experimental Observation of Air Velocities Over and Under a Wing



time elapsed from start (milliseconds)

KEY VOCABULARY

Airfoil	A shape of a wing or blade (of a propeller, rotor or sail) as seen in cross-section.
Fluid	Substances that flow freely and tend to assume the shape of the container in which they are held.
Hydrodynamics	The study of water flow and its principles.
Lift	The force that raises an aircraft off the ground and keeps it aloft.
Nonturbulent	A term describing a streamlined flow in which all particles move at the same speed and in the same direction.
Nonviscous	A true "nonviscous" fluid would flow a solid wall without any slowing down because of friction.
Turbulent	A term describing a highly irregular form of flow, in which a fluid is subject to continual changes in speed and direction.
Velocity	The rate of motion in a particular direction.

Daniel Bernoulli

Daniel Bernoulli was a Swiss mathematician.

He was born on February 8, 1700 in Groningen, Netherlands.

As a university student, his favorite subjects were math and mechanics.

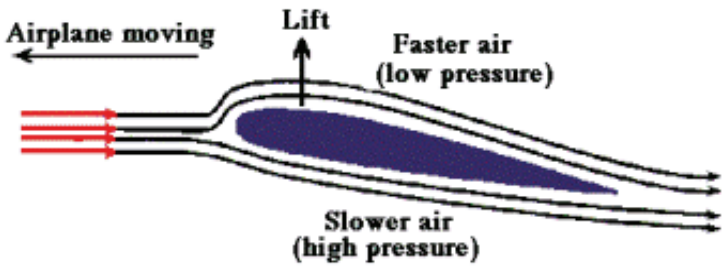
He is famous for his work in the field of fluid dynamics. In 1738, he wrote a book called *Hydrodynamica.*

In this book, he explained his theories about how gas and fluids move and how the speed at which they move affects the pressure they exert on the objects they flow around. This is the basis for the explanation of lift. His works helped to lay the foundation for aeronautics.

He worked as a professor at the University of Basel in Switzerland until his death March 17, 1782.

Bernoulli's Principle states:

As the speed of a moving fluid increases, the pressure with the fluid decreases.



According to Bernoulli's Principle, slower air has higher pressure than faster air. The air above a wing moves faster than the air below it.

That means that the air pressure pushing up on the bottom of the wing is greater than the pressure pushing down, so the wing goes up.

Station: Computer Animation

1. What do you notice as you increase the width of a section of the pipe?

_____

2. What do you notice when you decrease the width of a section of the pipe?

_____

3. Draw two pipes showing how you changed the fluid flow. Explain how the velocity and pressure changed in each case.

_____

_____

_____

_____

Station: Lift

	Blower Off	Blower Slow Speed	Blower High Speed
Digital Scale Reading			

1. Predict how the scale reading will change as you increase the blower speed.

_____

2. How did the scale reading change as you increased the blower speed?

_____

3. Explain your observation.

_____

_____

4. Were you surprised by the changes you observed? Explain.

_____

_____

Station: Paper Bridge

1. Predict what will happen when you blow a steady stream of fast air underneath the paper bridge.

_____

2. What actually happened?

_____

3. Why do you think the paper reacted that way?

_____

Station: Bernoulli Strips

1. Predict what will happen when the air is sped up across the paper strip.

_____

2. What happened when air was gently sped up across the paper strip?

_____

3. Explain your observations.

_____

4. What other objects could you use with this experiment?

_____

Station: Bringing It Together

1. Predict what the cans will do when air is blown between them.

_____

2. What did the cans do when air was blown between them?

_____

3. Explain your observations.

_____

4. What other objects could you use with this experiment?

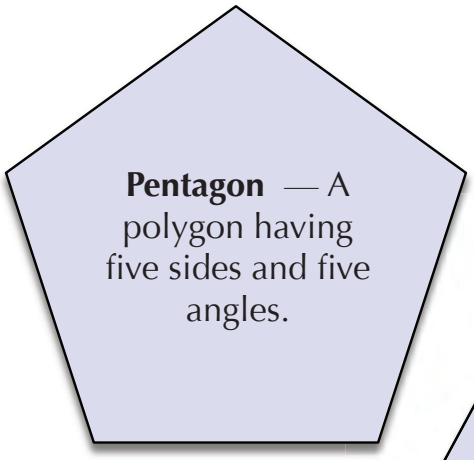
_____

KEY VOCABULARY

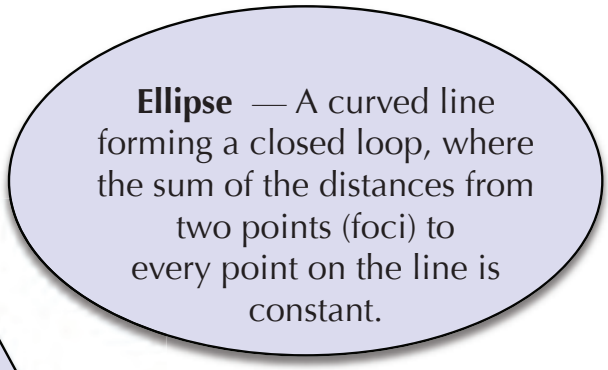
Adjacent	Close to or nearby.
Angle	A figure formed by two rays having a common endpoint (vertex).
Axis	A number line which may be vertical or horizontal.
Base	A side of a geometric figure.
Coordinate	An ordered pair of numbers which give the location of a point on a plane.
Coordinate Plan	A grid on a plane with two perpendicular and intersecting lines of axes.
Edge	A line segment formed by the intersection of two faces of a geometric space figure.
Ellipse	A curved line forming a closed loop, where the sum of the distances from two points (foci) to every point on the line is constant.
Face	A plane region serving as a side of a space figure.
Geometry	The study of space and figures in space.
Grid	A set of horizontal and vertical lines spaced uniformly.
Hexagon	A polygon having six sides and six angles.
Horizontal	A line that runs parallel to a base.
Octagon	A polygon having eight sides and eight angles.
Ordered Pair	Also called coordinate. A pair of numbers used to locate a point on a grid. The first number tells the left - right position (x - axis) and the second number tells the up - down position (y - axis).
Origin	The point where the two axes of a coordinate plane intersect.

KEY VOCABULARY Continued

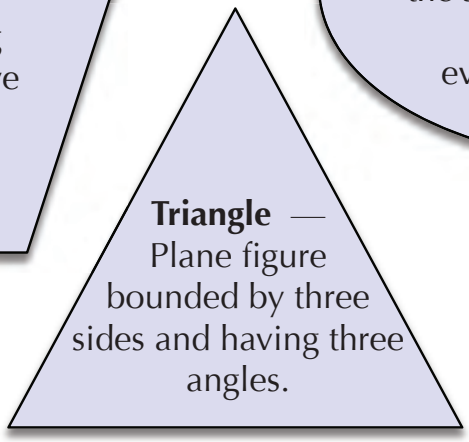
Parallel Lines	Lines in the same plane which do not intersect.
Parallelogram	A quadrilateral whose opposite sides are parallel.
Pentagon	A polygon having five sides and five angles.
Perpendicular Lines	Two lines in the same plane that intersect at right angles.
Polygon	A simple, closed plane figure having line segments as sides.
Quadrant	One section of a coordinate plane formed by the intersection of the x - and y - axes.
Rhombus	An equilateral parallelogram.
Square	A parallelogram with four equal sides and four right angles.
Triangle	Plane figure bounded by three sides and having three angles.
Trapezoid	A quadrilateral having only two sides that are parallel.
Vertex	The point where the two sides meet.
Vertical	A line that is perpendicular to a horizontal base line.
X - axis	The horizontal axis of a graph or coordinate plane.
Y - axis	The vertical axis of a graph or coordinate plane.



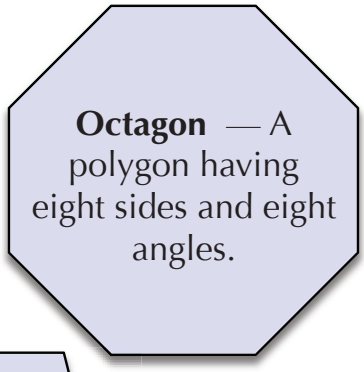
Pentagon — A polygon having five sides and five angles.



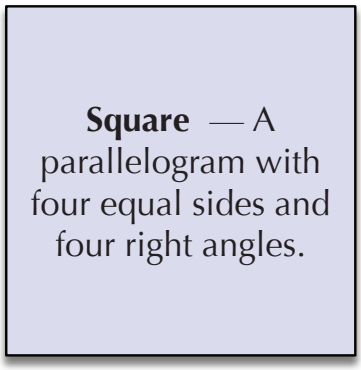
Ellipse — A curved line forming a closed loop, where the sum of the distances from two points (foci) to every point on the line is constant.



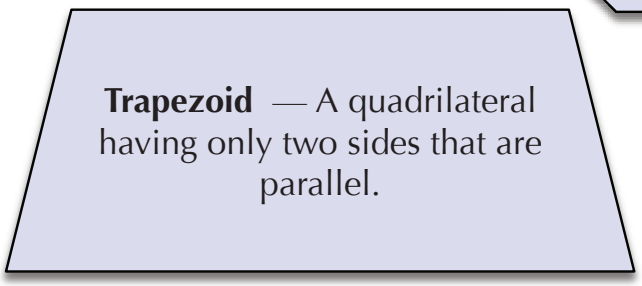
Triangle — Plane figure bounded by three sides and having three angles.



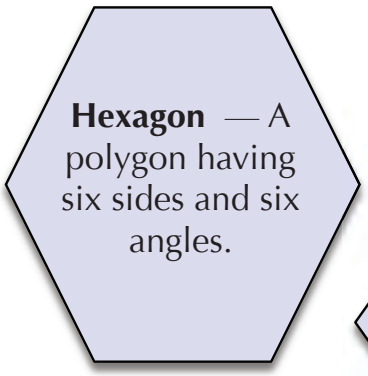
Octagon — A polygon having eight sides and eight angles.



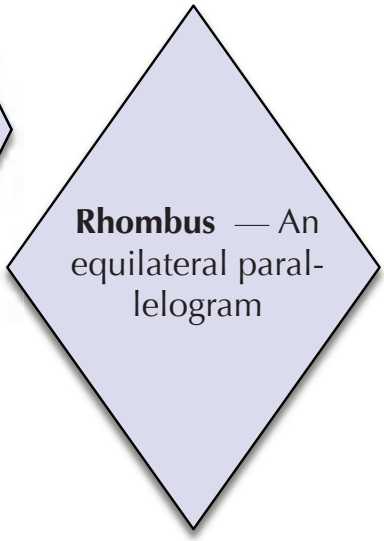
Square — A parallelogram with four equal sides and four right angles.



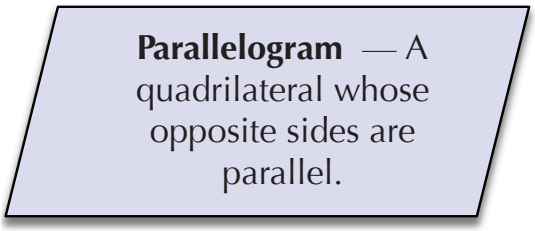
Trapezoid — A quadrilateral having only two sides that are parallel.



Hexagon — A polygon having six sides and six angles.



Rhombus — An equilateral parallelogram



Parallelogram — A quadrilateral whose opposite sides are parallel.

Quadrant IV

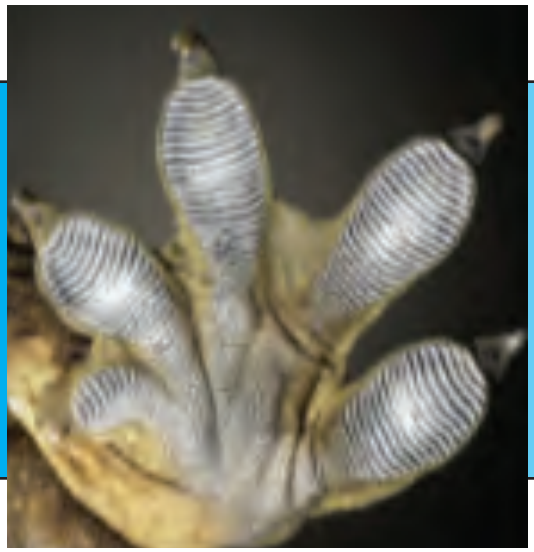
X-axis

Y-axis

	1	2	3	4	5	6	7	8	9	10
-1										
-2										
-3										
-4										
-5										
-6										
-7										

KEY VOCABULARY

Atom	The smallest unit of an element having all the chemical properties of the element.
Centimeter	10^{-2} (a hundredth) of a meter.
Decimeter	10^{-1} (a tenth) of a meter.
Exponent	Shows how many times to multiply the number by itself, used in scientific notation.
Micrometer	10^{-6} (a millionth) of a meter.
Millimeter	10^{-3} (a thousandth) of a meter.
Molecule	The smallest particle of an element or compound that retains the chemical and physical properties of the substance; composed of two or more atoms.
Nanoengineering	Manufacturing or engineering on the molecular level.
Nanometer	10^{-9} (a billionth) of a meter.
Nanoparticle	Sized between 1 and 100 nanometers.
Physical properties	The characteristics of a substance that can change without involving a change in chemical composition (color, absorption, mass, density, viscosity, etc.).
Scientific Notation	A shorthand way to write numbers that are either very large or very small by using powers of ten.



The Sole of a gecko's foot has millions of nanoscale hairs that help it grip to almost any surface.

Credit: A. Dhinojwala, University of Akron

This NiTinol heart stent will expand to its original shape when inserted into a blood vessel to help open blockages and prevent future strokes.

Credit: U.S. Food and Drug Administration

Meter Sizing Scaled

Nanometer	10^{-9} (a billionth) of a meter.
Micrometer	10^{-6} (a millionth) of a meter.
Millimeter	10^{-3} (a thousandth) of a meter.
Centimeter	10^{-2} (a hundredth) of a meter.
Decimeter	10^{-1} (a tenth) of a meter.

Numbers & Number Relationships

MATHEMATICS

1. A. Using the picture side of the cards, order the objects from largest to smallest.

   B: Turn photos over and compare their actual sizes. Line up their place values (all of the ones in place, etc.) and put them in order with the largest number on top. Use this to write the name of the object in the first column, and the size of the object in the scientific notation column.

   C: Using the word bank, list the best Viewing Technology to observe the detail in your objects.

Object	Size (in nanometers)	Size of Object in Scientific Notation	Viewing Technology
Stick of Gum	75,000,000	7.5×10^{7}	UE
	2,344,000		
	293,000		
	73,000		
	9,200		
	1,100		
	70		
	2.3		

Viewing Technology:

Unaided Eye (UE)
larger than a few millimeters

Magnifying Glass (MG)
between one and several millimeters

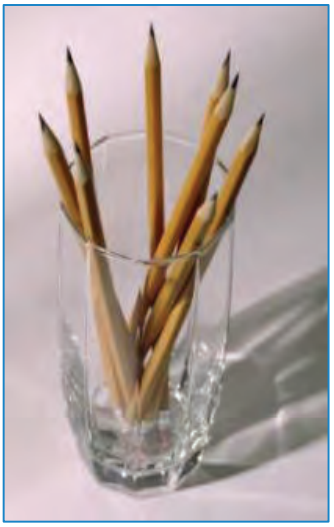
Microscope (M)
between one micrometer (1/1,000,000 and one millimeter 1/1,000)

Scanning Electron Microscope (SEM)
between one nanometer (1,000,000,000) and one hundred nanometers

2. Complete the table with the correct decimal and exponent numbers.

Abbreviation	Prefix	In Words	Fraction	Decimal	Exponent
cm	centi-	hundredths	1/100	.01	1×10^{-2}
mm	milli-	thousandth	1/1000	.001	1×10^{-3}
µm	micro-	millionth	1/1,000,000		
nm	nano-	billionth	1/1,000,000,000		

Carbon in *different* forms



KEY VOCABULARY

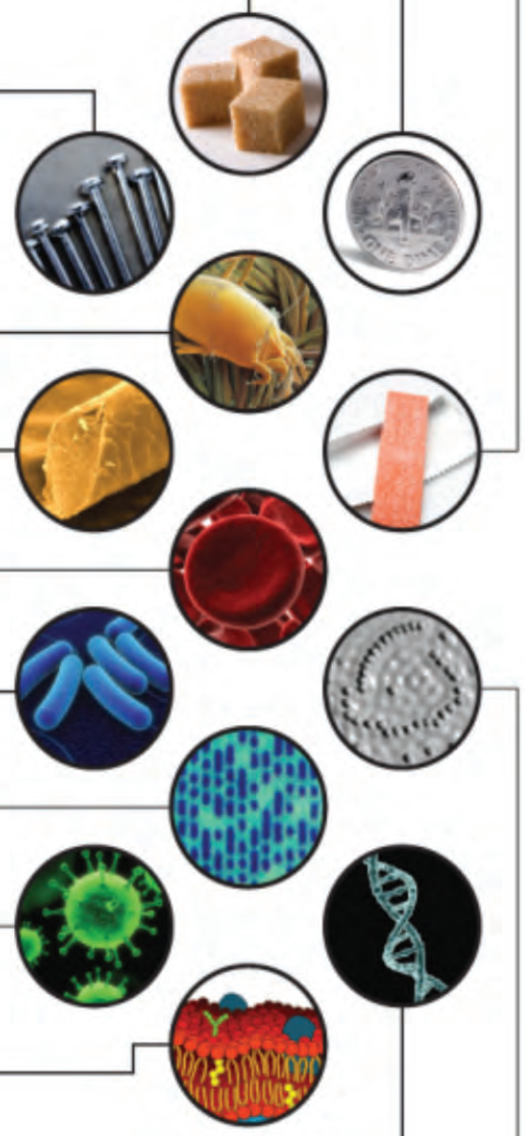
Atom	The smallest unit of an element having all the chemical properties of the element.
Hydrophilic	Physical property of matter in which molecules bond with water.
Hydrophobic	Physical property of matter in which molecules repel water.
Malleability	Ability to be shaped or formed.
Molecule	A particle consisting of two or more atoms that are chemically bonded.
Nano	Related to anything that exists or occurs at the atomic level.
Nanoengineering	The development of materials that operate on an atomic scale and take advantage of the unique physical processes that occur at the atomic level.
Nanometer	One billionth of a meter.
Nanoparticle	Sized between 1 and 10 nanometers.
Nanotechnology	The study and manipulation of matter at an atomic scale; dealing with structures less than 100 nanometers.
Physical property	The characteristics of a substance that can change without involving a change in chemical composition.

CUTTING IT DOWN TO NANO

Cut paper strips in half. Tape onto worksheet. Repeat

number of cuts

0	150,000,000 nanometers: length of pencil
1	75,000,000 nanometers: **length of a stick of gum**
2	37,500,000 nanometers
3	18,750,000 nanometers: **diameter of a dime**
4	9,375,000 nanometers: **width of a sugar cube**
5	4,688,000 nanometers
6	2,344,000 nanometers: **head of a pin**
7	1,172,000 nanometers
8	586,000 nanometers
9	293,000 nanometers: **length of a dust mite**
10	146,000 nanometers
11	73,000 nanometers: **width of a human hair**
12	36,600 nanometers
13	18,300 nanometers
14	9,200 nanometers: **length of a red blood cell**
15	4,600 nanometers
16	2,300 nanometers
17	1,100 nanometers: **length of bacteria**
18	570 nanometers: **width of pits on CD**
19	296 nanometers
20	143 nanometers
21	72 nanometers: **length of a virus**
22	36 nanometers
23	18 nanometers
24	9 nanometers: **thickness of cell membrane**
25	4.5 nanometers
26	2.2 nanometers: **width of the DNA helix**
27	1.1 nanometers: **length of 10 hydrogen atoms**



Sand Investigation

Scenario

The Department of Defense is constructing an underwater training tank for military rescue divers. Inside the tank there will be obstacles that the rescue divers must swim around. To simulate a real body of water, the water in the tank will have a current that creates movement in the water. Two companies have applied to make these obstacles out of sand. Each company uses a different type of sand to create their sculptures.

Working as a team with an engineer and a chemist, your mission is to test the two types of sand for properties that will allow it to hold a shape in water. Based on your investigation findings, you will recommend the best sand to create the sculptures.

To get started:

Read the Scenario and identify the problem you and your partner are to solve.

Follow the directions below.

1. Using the scale, measure 15 grams of sand from container A into the empty cup labeled Test A and measure 15 grams of sand from container B into the empty cup labeled Test B. **DO NOT mix the two types of sand.**

2. Identify the physical properties of Sand A and Sand B. Pick up a few grains of Sand A in your hand and examine them closely. How big are the grains? What color is the sand? Is it shiny or dull? Is it rough or smooth? Is it wet or dry? Record your answers in **Table #1**. Return the grains of Sand A to the Test A cup. **DO NOT mix the two types of sand.**

3. Repeat for Sand B. Record answers in Table #1. Return the grains of Sand B to the Test B cup. DO NOT mix the two types of sand.

Physical Properties

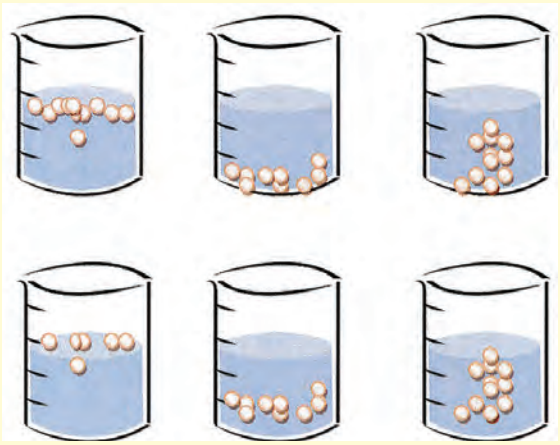
	Grain Size: (describe)	Color: (name)	Luster: (circle)	Texture: (circle)	Wet or Dry: (circle)
Sand A			Shiny Dull	Rough Smooth	Wet Dry
Sand B			Shiny Dull	Rough Smooth	Wet Dry

Predictions

Circle the beaker that best shows how you predict Sand A and Sand B will look in STILL WATER:

Sand A →

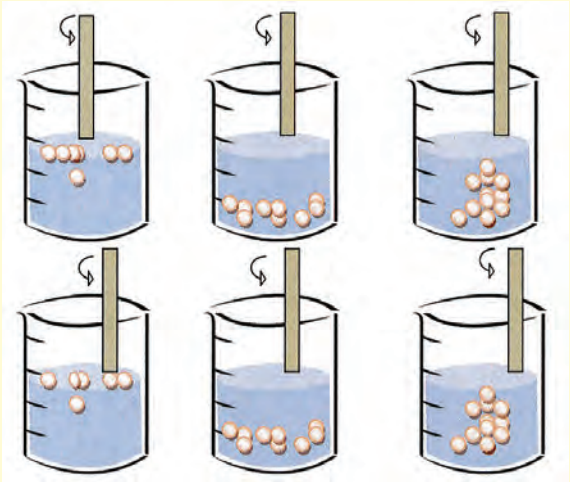
Sand B →



Circle the beaker that best shows how you predict Sand A and Sand B will look in MOVING WATER.

Sand A →

Sand B →



Hydrophilic - attracts water and spreads out

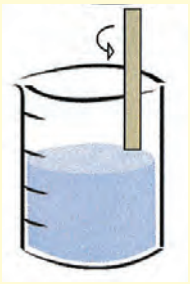
Hydrophobic - repels water and stays together

Sand A Investigation

Draw how the sand actually looked.

1. In still water, Sand A: sinks floats
(circle one)

2. In moving water, Sand A: sinks floats
(circle one)



3. Were your predictions for Sand A correct? Yes No

If no, what was the difference? _____

4. Circle the true statement below:

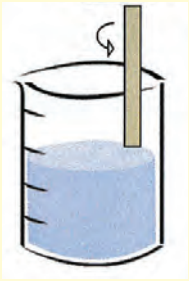
Sand A is hydrophilic. Sand A is hydrophobic.

Sand B Investigation

Draw how the sand actually looked.

5. In still water, Sand B: sinks floats
(circle one)

6. In moving water, Sand B: sinks floats
(circle one)



7. Were your predictions for Sand B correct? Yes No

If no, what was the difference? _____

8. Circle the true statement below:

Sand B is hydrophilic. Sand B is hydrophobic.

Conclusion Questions

1. What physical properties are different from Sand A and Sand B?

2. Which sand behaved in an unexpected way? (circle) Sand A Sand B

Recommendation

1. Based on investigation findings, which sand is the best choice to use for making the sand sculptures?

   (circle) Sand A Sand B

2. Explain your decision.

   _____

   _____

   _____

   _____

Fabric Investigation

Scenario

The Department of Defense is replacing field tents for training areas. The new tents should be stain resistant and water repellant. Two companies have applied to make the tents. Each company uses a different type of fabric.

Working as a team with a textile engineer and a chemist, your mission is to test the two types of fabric for stain resistant and water-repellant qualities. Based on your investigation findings, you will recommend the best fabric.

To get started:

Read the scenario and identify the problem you and your partner are to solve.

Identify Physical Properties

Follow the directions below.

1. Remove fabric swatch from bag A, zip close the bag, and place the swatch on top of the bag.

2. Remove fabric swatch from bag B, zip close the bag, and place the swatch on top of the bag. **Do not mix the swatches**.

3. Identify physical properties of Fabric A and Fabric B. Examine Fabric A. Is the weave tight or loose? Is it rough or smooth? What color is it? Is it strong or weak? Record data in **Table #1**. Repeat for Fabric B. Record data in **Table #1**.

4. Test for the hydrophilic ("water attracting") and hydrophobic ("water repelling") properties of each fabric by placing 1 drop of water in a corner of each fabric. Wait 30 seconds, then lift each fabric and shake the water into the bowl:

Physical Properties

Physical Properties of Fabric					
	Weave Size: (circle)	**Color** (name)	**Strength:** (circle)	**Texture:** (circle)	**Hydrophilic** attracts water or **Hydrophobic** repels water (Circle one)
Fabric A	Loose Tight		Strong Weak	Rough Smooth	Hydrophilic Hydrophobic
Fabric B	Loose Tight		Strong Weak	Rough Smooth	Hydrophilic Hydrophobic

Predictions

1. Which physical property is most likely to determine if the fabric will stain?_____

2. Based on the physical properties of Fabric A, PREDICT if the following liquids will leave a stain on Fabric A.

Fabric A

Steak sauce (circle) YES NO

Red Punch (circle) YES NO

3. Based on the physical properties of Fabric B, PREDICT if the following liquids will leave a stain on Fabric B.

Fabric B

Steak sauce (circle) YES NO

Red Punch (circle) YES NO

Results

1. Did the liquids leave a stain on Fabric A?

Steak Sauce		Red Punch	
Yes	No	Yes	No

2. Did the liquids leave a stain on Fabric B?

Steak Sauce		Red Punch	
Yes	No	Yes	No

Conclusion Questions

1. What physical properties are different between Fabric A and Fabric B?

2. A physical property that describes Fabric B is :

Hydrophobic Hydrophilic
(circle one)

Recommendation

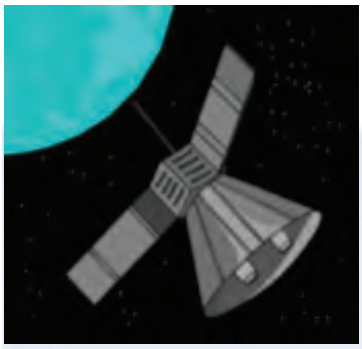
1. Based on your investigation findings, which fabric is the best choice to use for making the new tents?

Fabric A Fabric B

2. Explain why.

Wire Investigation

Scenario



The Department of Defense needs an antenna for its new communication satellite. Traditional antennas are too long to fit into their launch vehicle. The engineers at the Department of Defense must locate an antenna made of a metal that can be bent to fit into the launch vehicle and then returned to its original shape once it is attached to the satellite. Two companies have applied to build the antenna. Each company uses a different type of metal.

Working as a team with a structural engineer and a chemist, your mission is to test the two types of metal and based on your investigation findings; recommend the metal that best meets the requirements fot the new satellite antenna.

To get started:

Read the scenario and identify the problem you and your partner are to solve.

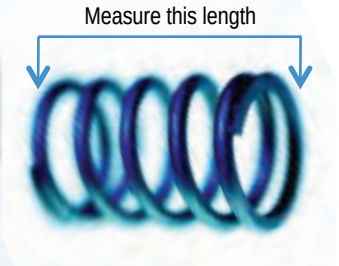
Identify Physical Properties

Table #1 – Physical Properties of Wire						
	Color: (name)	**Luster:** (circle)	**Texture:** (circle)	**Hardness:** (circle)	**Malleability:** (ability to be shaped or formed) (circle)	**Magnetic:** (circle)
Wire A		Shiny Dull	Rough Smooth	Hard Soft	Yes No	Yes No
Wire B		Shiny Dull	Rough Smooth	Hard Soft	Yes No	Yes No

Wrap Wire A and Wire B loosely around a pencil several times, making a coil. Tape one end of Wire A on Bag A and one end of Wire B on Bag B. Measure the length of each wrapped wire from end to end.

Wire A length: _____

Wire B length: _____



Draw the shape and label length below.

Wire A **Wire B**

Predictions

Predict if cool air or hot air will change the physical properties of the wires.

	Cool Air	Hot Air	If yes, which physical property do you think will change?
Wire A	Yes No	Yes No	
Wire B	Yes No	Yes No	

Observations

Apply air to the wire for approximately 20 seconds.

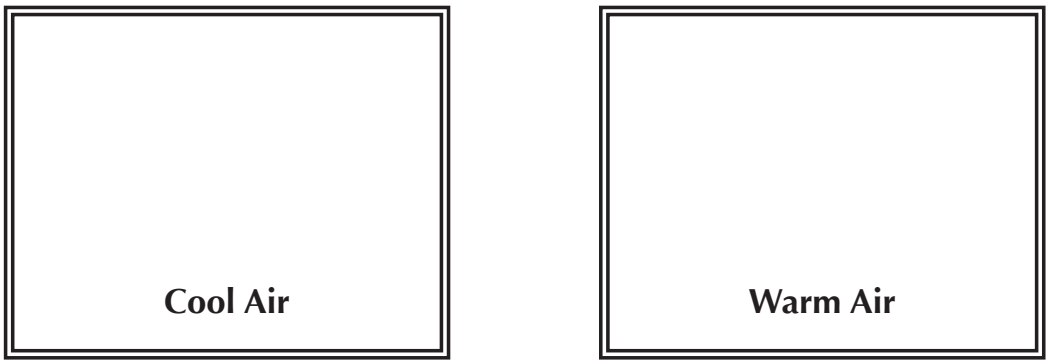
Wire A: Draw the Shape and Label the Length Below:

Cool Air	**Warm Air**

Were your predictions for Wire A correct? (circle) Yes No

Explain: _____

Wire B: Draw the Shape and Label the Length Below:



Were your predictions for Wire B correct? (circle) Yes No

Explain: _____

Conclusion Questions

1. What physical properties are different between Wire A and Wire B?

2. Which wire changed when heat was applied? (circle) Wire A Wire B

3. Which physical properties of this wire changed when heat was applied?

Recommendation

1. Based on your investigation findings, which metal is the best choice to use for the new communications satellite antenna?

   (circle) Metal A Metal B

2. Explain why.

Nanoengineered Socks

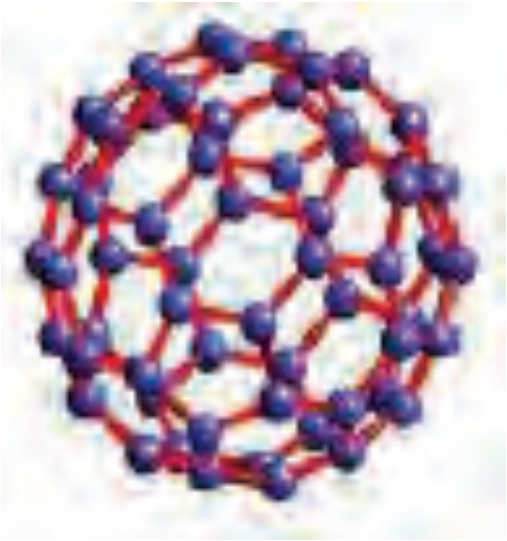
Sock fibers are coated with silver nanoparticles that reduce bacterial growth and foot odor.

Would you buy this product? Yes or No?

1. Read each of the facts and decide if the fact is a benefit or a potential risk.
2. Place a check mark in the yes or no column. Yes if you believe it is a risk, no if you do not believe it is a risk.
3. Decide if this product should be allowed to stay on the market and explain why below.

Description	Yes	No
Silver nanoparticles have strong antimicrobial properties.		
The product reduces bacterial growth on socks and feet.		
Product reduces foot odor and feet smell better.		
Health risk unknown because no long term studies have been done.		
The product's silver nano coating could eventually wear off, wash away, and enter the water supply		
Silver is known to be toxic to living things.		
Negative health effects of silver in the environment is a known problem.		

Nanoengineered Medicinal Buckyballs



Buckyballs containing specialized drugs can be injected into the body and can target the specific area where medical treatment is needed.

Would you want to be treated with this type of drug? Yes or No?

1. Read each of the facts and decide if the fact is a benefit or a potential risk.
2. Place a check mark in the yes or no column. Yes if you believe it is a risk, no if you do not believe it is a risk.
3. Decide if this product should be allowed to stay on the market and explain why below.

Description	Yes	No
Buckyballs would allow inner organs to be treated without surgery.		
Patients would have a faster recovery time.		
Drugs can be delivered directly to the problem area and will not damage surrounding cells.		
Studies show brain damage in fish when exposed to buckyballs.		
Currently no studies demonstrate any side effects in humans.		
Currently there is no governmental regulation on this type of drug delivery.		
Insurance companies may not pay for this treatment until the side effects are known.		

KEY VOCABULARY

Cartography	The art of making maps or charts.
Compass Rose	Image commonly found on maps that is used to display direction such as north, south, east, or west. A compass rose is also a term for markings on a compass and is used in nearly all navigation systems.
Contour Interval	The vertical distance between contour lines.
Contour Lines	Imaginary lines on a map in which all points along it are at the same elevation.
Elevation	A point on the Earth's surface that is at, above, or below sea level.
Equator	Imaginary line that divides the northern and southern hemispheres of the Earth. The zero reference for measurements of latitude.
Geospatial Intelligence (GEOINT)	The exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities on Earth. GEOINT answers the questions "When?" and "Where?" It uses imagery to make sense of volumes of data and information. GEOINT builds the bridge from information to intelligence, from decision to action. GEOINT is made of imagery, imagery intelligence, and geospatial information. In simple terms, geospatial intelligence is taking all the information there is about a point on the Earth (above, on, or under the surface) and putting it together to answer questions about that place.
Imagery Analysis	Carefully examining 2 - D and 3 - D graphics in the form of photographs, satellite transmissions, etc., to gain useful information about physical features and cultural events that help to solve problems, answer questions, and make decisions.
Latitude	The distance of a point north or south of the equator. The rings around the Earth, parallel to the equator, are called parallels.

KEY VOCABULARY Continued

Legend	Tells the user what different symbols mean. It is important to have a legend; otherwise, the user may not know what they are looking at since all maps may use different symbols.
Longitude	The distance east or west of the Prime Meridian. Lines of longitude (meridians) extend north - south.
Map	Visual representation of an area highlighting relationships between elements, such as objects, regions, and themes.
Map Scale	The ratio of the distance on a map to the corresponding distance on the surface of the Earth.
NGA	The National Geospatial - Intelligence Agency (NGA) is a Department of Defense combat support agency and a member of the national Intelligence Community (IC). NGA develops imagery and map - based intelligence solutions for U. S. national defense, homeland security, and safety of navigation.
Prime Meridian	Imaginary line that divides the eastern and western hemispheres of the Earth. It stretches from the True North Pole to the South Pole, running through Greenwich, England. The zero reference for measurements in longitude.
Satellite Imagery	A visual display of the Earth or other places made by means of artificial satellites.
Scale Bar	A graphic printed on the map which is used to convert distances on the map to actual ground distances, usually found on the bottom of the map.

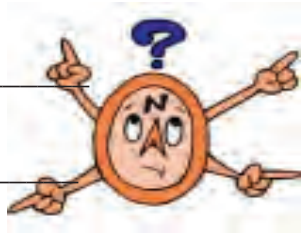

The Washington Monument

EXPLORE WASHINGTON, DC

1. **Grids (NGA map):**
   a. The horizontal rows are labeled with _____ and the vertical columns are labeled with _____.
   b. If you were crossing grid square D-2, which would be more useful? (circle answer)

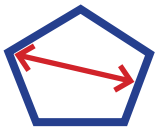
   A boat *Comfortable shoes*

2. **Compass Rose (NGA map):**
   a. Which grid square is the farthest northeast? _____
   b. What structure would you cross in the northern section of grid square A-3? _____



3. **Legend (NGA map):**
   a. Which Metro line runs farthest west on the map? _____
   b. If you were traveling on the Yellow Metro Line leaving from the Pentagon, in which direction would you travel over the river? _____

4. **Scale Bar (NGA map):**
   a. What is the approximate distance in meters of the double bridge crossing the river in grid squares C4 and C5? _____
   b. What is the approximate distance of the Pentagon from any point to the opposite outer wall? _____



   c. What is the approximate distance from the Lincoln Memorial in grid square B-2 to the US Capitol Building in grid square H-2? _____

5. **Locate the latitude and longitude lines marked on the DC Geographic Coordinates map:**
   a. What is the farthest latitude line marked to the south? _____
   b. What is the farthest longitude line marked to the west? _____
   c. What building is located at the intersection of these two lines? _____
   d. The Washington Monument and the Lincoln Memorial are both located on latitude 38° 53′ 23″ N. Find the longitude for each using their location on the grid map.
      - Washington Monument (D-2): _____
      - Lincoln Memorial (B-2): _____

Top Secret Mission: Washington, DC

The US Capitol Building

The White House

The Pentagon

Note: Use the "Washington, DC Geographic Coordinates" map and the above images for your mission.

Part 1 of your mission: *Leaving Andrews Air Force Base, fly to Latitude 38° 52′ 15″ N, Longitude 77° 03′ 19″ W*

In what grid location are these coordinate points located? _____

Using the images above, identify the building in this location. _____

Part 2 of your mission: *Proceed to Latitude 38° 53′ 23″ N, Longitude 77° 00′ 32″ W*

In what grid location are these coordinate points located? _____

Using the images above, identify the building in this location. _____

Part 3 of your mission: *Proceed to Latitude 38° 53′ 51″ N, Longitude 77° 02′ 11″ W*

In what grid location are these coordinate points located? _____

Using the images above, identify the building in this location. _____

Return to Andrews Air Force Base (AFB) with the signed documents.
You have completed your mission!

Debrief–How you navigated your mission:

After leaving Andrews AFB you flew to the _____ (building).

From that location, you flew _____ (direction) to the _____ (building).

From that location, you flew _____ (direction) to the _____ (building).

You then returned to Andrews Air Force Base.

Directions
N, S, E, W, NE, SE, NW, SW

Buildings
US Capitol
White House
Pentagon

Unmanned Aerial Vehicle

The Department of Defense Unmanned Aerial Vehicle is a remote controlled aircraft used for photographing areas that are not accessible by land vehicles. This vehicle must be located at an airport and should be placed in a location that has the quickest access to any area on the island.

Submersible

The Department of Defense Submersible is used to deliver materials to researchers doing underwater studies. It is also used to rescue injured divers, so it is important that the vehicle has easy access to a medical facility.

All-Terrain Rover

The Department of Defense All-Terrain Rover is equipped with medical supplies. This rover has been built to withstand extreme weather conditions, such as high temperatures and strong winds. It will be used by campground park rangers to aid in rapid response to both on-highway and off-road emergencies

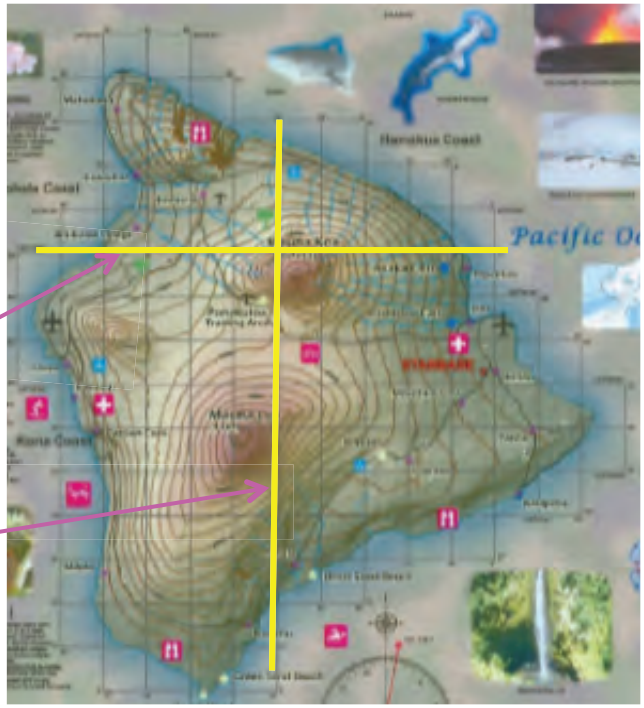
Search and Rescue on the Big Island of Hawai'i

Part One:
Latitude and Longitude:

Latitude and longitude lines on a globe or map are used to describe locations anywhere on Earth. The point where a latitude line intersects with a longitude line is the coordinate.

a. Distances north or south of the _____ are described with lines of _____.

b. Distances east or west of the _____ are described with lines of _____.



Mission – Part One:

Your team has been directed to decide on the best location for placing three DoD search and rescue vehicles in various places around the island. All vehicles are currently located at the STARBASE headquarters on the east side of the island. Using the information on your NGA map, determine the best location for each vehicle, identify the latitude and longitude points for each, and determine how far from the STARBASE site they will be located by using the bar scale.

Search and Rescue Vehicle	Latitude and Longitude Coordinates	Nearest City or Landmark Approximate Distance from STARBASE
Unmanned Aerial Vehicle 	____° ____ ' 00 " N ____° ____ ' 00 " W	_____ _____
Submersible 	____° ____ ' 00 " N ____° ____ ' 00 " W	_____ _____
All-Terrain Rover 	____° ____ ' 00 " N ____° ____ ' 00 " W	_____ _____

Search and Rescue on the Big Island of Hawai'i

Mission – Part Two:

A cyclist is injured on a bike trail at Saddle Pass and must be transported to the nearest medical facility as quickly as possible. You must send one of the vehicles on a search and rescue mission. First, determine which search and rescue vehicle to use. Then navigate the route by identifying the nearest latitude and longitude coordinates from where the vehicle will begin, the coordinates for where you will pick up the cyclist, and the ending coordinates at the closest hospital.

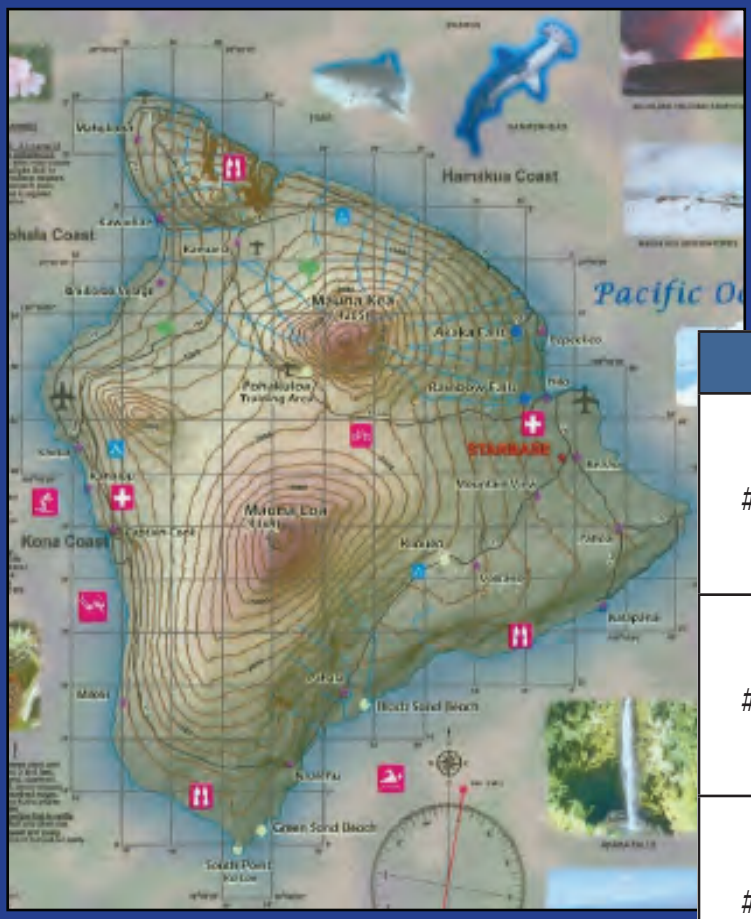
Which search and rescue vehicle will you use? _____

_____

Why?_____

_____

NGA Hawai'i map



Use your NGA Hawai'i map to find your locations. Then label the point where you begin the rescue #1.

Label the point at which you pick the injured cyclist #2. Label the hospital #3.

Navigation Route	
#1	____° ____ ' 00 " N ____° ____ ' 00 " W
#2	____° ____ ' 00 " N ____° ____ ' 00 " W
#3	____° ____ ' 00 " N ____° ____ ' 00 " W

THE DESIGN PROCESS

Define the problem
- What does the client want?
- How can we improve this situation?

Brainstorm
- What are some different ways to tackle today's challenge?
- Off-the-wall suggestions often spark GREAT ideas. How creative can you be?

Design
- Which brainstormed ideas are really possible, given your time, tools, and materials?
- What are some problems you need to solve as you build your project?
- How can a sketch help clarify your design?

Build
- What materials will you need?
- What can you learn by looking at other kids' projects?

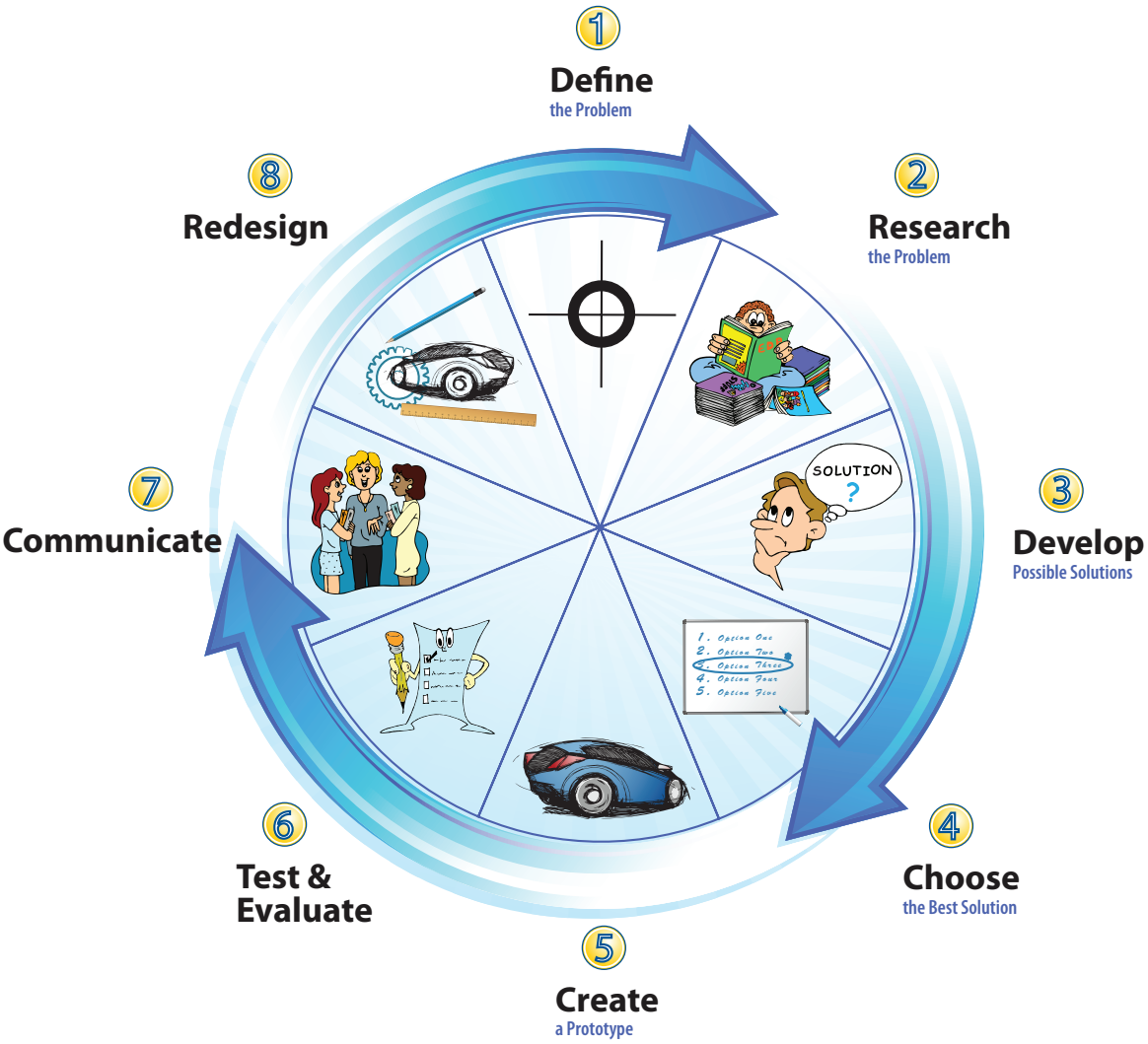
Test, evaluate, and redesign
- Why is it a good idea to keep testing a design?
- What things do you need to tweak to get it to work?
- What specific goal are you trying to achieve, and how will you know if you've achieved it?
- How well does the design meet the challenges's criteria or the client's needs?

Share solutions
- What's the best feature of your design? Why?
- What was the hardest problem to solve?
- If you had more time, how would you improve your project?
- What other clients might be interested in what you invented?

What is the Engineering Design Process?

The Engineering Design Process is a series of steps that aid in the design of an effective solution for a given problem. Engineers use different versions of the steps. Here is one example of the steps of the process:

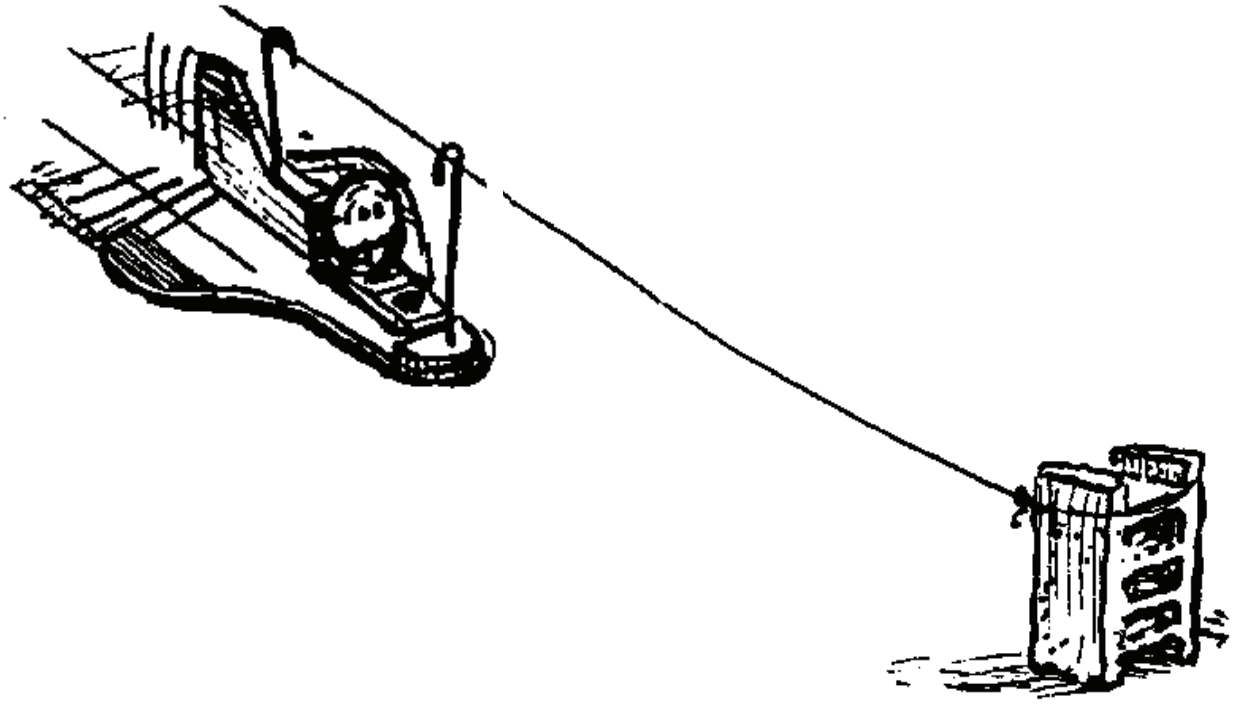
- Define
- Research
- Develop
- Choose
- Create
- Test and Evaluate
- Communicate
- Redesign



▶ Engineering Design Process (EDP)

KEY VOCABULARY

Acceleration	A change in velocity (speeding up or slowing down).
Engineering Design Process	A cyclical method of problem solving used to create a system, a product, or a process that meets an identified need.
Force	A push or a pull that gives energy to an object, sometimes causing a change in the motion of the object.
Inertia	The tendency of an object to resist a change in motion. An object at rest, will remain at rest unless a force acts on it. An object in motion, will continue in the same direction at the same speed, unless an outside force acts on it. Newton's First Law of Motion deals with inertia.
Kinetic Energy	Energy in motion.
Momentum	The product of an object's mass and velocity, which determines how difficult it is to stop the object's motion.
Potential Energy	Energy that is stored within an object, not in motion but capable of becoming active.



Engineering Design Process (EDP)

Item	Number of Item Allowed	Cost Per Item	Quantity Ordered	TOTAL
Felt Piece	2	$48.00		
Chenille Stick	1	$99.00		
Cotton Ball (Sets of 2)	2	$101.00		
Foam Piece	1	$96.00		
Shoestrings	2	$49.00		
Zip Lock Bag	2	$120.00		
Rubber Bands	2	$99.00		
Masking Tape	30cm	FREE		
			Grand Total	

► Engineering Design Process (EDP)

1. Sketch and label the parts of your team's design.

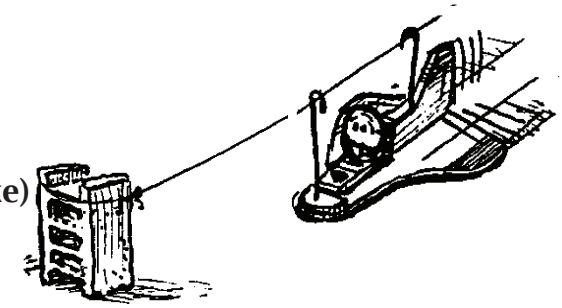
2. How well did your design work? *Circle the condition of Eggbert after launch.*

Survival (no damage)

Living…with cracked skull (shell cracked)

Unconscious with brain damage (yolk broke)

Totally scrambled (everything is broken)



3. How could your group modify your design to make it better?

_____

_____

_____

_____

_____

4. How did your group work as a team? What was the most difficult part?

_____

_____

_____

_____

_____

Computer-Aided Design

A ***CAD system*** is a combination of hardware and software that enables engineers and architects to design everything from furniture to airplanes.

CAD systems allow an engineer to view a design from any angle with the push of a button and to zoom in or out for close-ups and long-distance views.

Until the mid 1980s, all CAD systems were specially constructed computers. Now, you can buy CAD software that runs on general-purpose workstations and personal computers.

A _____ is a closed curve in a plane. All of its points are an equal distance from its center.

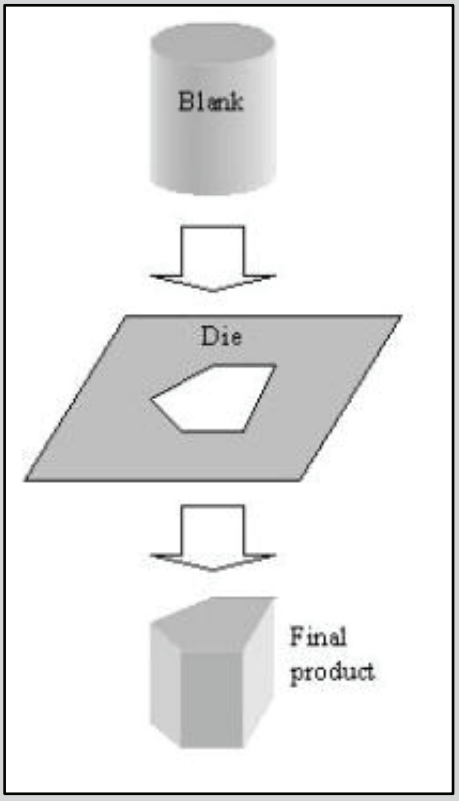
The ***radius*** of a circle is formed by a straight line extending from the center of a circle to its edge or from the center of a sphere to its surface.

The ***diameter*** of a circle is a line segment that has both of its endpoints on the circle and passes through the center point of the circle.

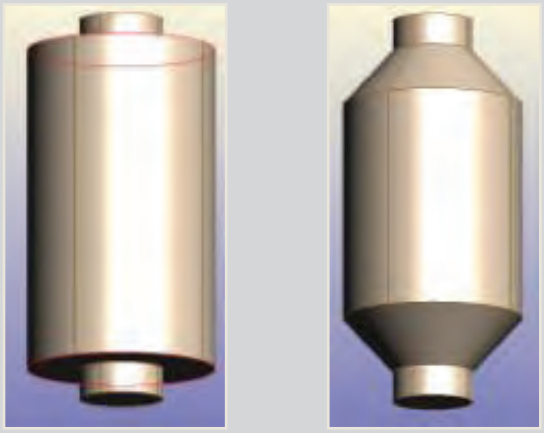
Computer-Aided Design

When constructing items with the Pro/Engineer software, the phrase "view isometric" is used. This command alters the view of the object being designed. This view is called an isometric projection.

Isometric projection is a form of graphical projection. It is a method of visually representing three-dimensional objects in two dimensions.



Another phrase used with CAD design is "Extrude" or **"Extrusion"**. To extrude an object you would shape something by forcing or pushing it through an opening.



The image on the left has not been chamfered. The image at the right has been chamfered.

A chamfer is a beveled edge connecting two surfaces. "Chamfer" is a term commonly used in industrial engineering.

KEY VOCABULARY

Absorbant	A substance that is capable of absorbing.
Absorbant	A substance usually porous in nature and with a high surface area that can absorb substances onto its surface by intermolecular forces.
Analytical Chemistry	A branch of chemistry that deals with the devleopment and use of techniques for chemical measurement. These techniques are used in analyzing the chemcial composition of substances.
Capillary Action	Capillary action is the tendency of a liquid to rise in narrow tubes or to be drawn into small openings such as those between grains of a rock. Capillary action, also known as capillarity, is a result of the intermolecular attraction within the liquid and solid materials. A familiar example of capillary action is the tendency of a dry paper towel to absorb a liquid by drawing it into the narrow openings between the fibers.
Chromatography	Any of various processes of chemical analysis in which the constituents of a mixture are separated into distinct bands or spots on an absorbent material.
Chromatogram	The pattern of separated substances obtained by chromatography.
Solvent	The component of a solution that is present in the greatest amount. It is the substance in which the solute is dissolved.
Solubility	The ability of a substance to dissolve. The quantity of a substance that may be dissolved in a given amount of solvent.
Solute	A substance dissolved in a solution. For solutions of fluids, the solvent is present in greater amount than the solute.
Solution	A solution is a homogeneous mixture of two or more substances that can exist in any phase. An example of a solid solution is brass. An example of a liquid solution is aqueous hydrochloric acid. An example of a gaseous solution is air.
Medium	Intervening substance through which something else is transmitted or carried on.

KEY VOCABULARY Continued

Non-polar Molecules	A non-polar molecule is one that the electrons are distributed more symmetrically and thus does not have an abundance of charges at the opposite sides. The charges all cancel out each other.
Pigment	Any material from which a dye, a paint, or the like, may be prepared.
Polar Molecules	Chemical bonding is the result of either an atom sharing one or more outer orbit electrons with another atom or an atom taking outer orbit electrons from the atom with which it is bonding. Normally, an atom has an even distribution of electrons in the orbits or shells, but if more end up on one side than the other in a molecule, there can be a resulting electrical field in that area. Water is a polar molecule because of the way the atoms bind in the molecule such that there are excess electrons on the oxygen side and a lack or excess of positive charges on the hydrogen side of the molecule.

Chromatography C.S.I

CHEMISTRY

Someone used a black marker to write a mean message on the bathroom wall, criticizing the cafeteria food. It has to be one person from a group of four students who left the cafeteria early. Each of the four students has a different brand of black marker. Discover which marker was used to write the message.

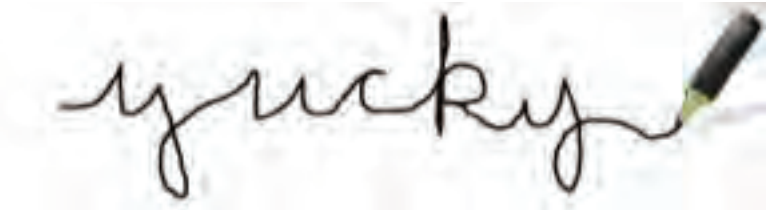
You will use the analytical chemistry process called chromatography. Using chromatography, you will investigate each marker's solubility, or how easily it dissolves.

1. The solvent, or substance you use to make the ink dissolve, is _____.
2. The solute, or substance you will dissolve, is _____.
3. The medium to hold the substance is _____.

Student Identifier	Marker Brand	Matching Chromatogram
1		
2		
3		
4		

4. The chromatogram of the marker used to write the message was _____.
5. Which student's marker matched that chromatogram? ☐ #1 ☐ #2 ☐ #3 ☐ #4
6. Is this conclusive evidence that the student who owned the marker was the one who wrote the message? ☐ Yes ☐ No
7. Why or why not? _____

_____



8. Of the pigments mixed to create the black ink in the marker, which pigment do you think is the most soluble? _____ Why? _____

_____

9. Which do you think is the least soluble? _____Why? _____

_____

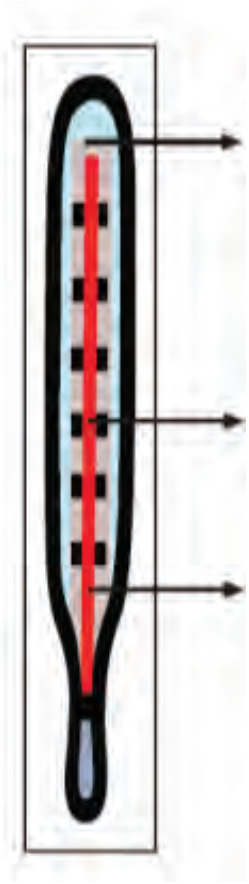
KEY VOCABULARY

Celsius temperature scale	The temperature scale named after Swedish astronomer Anders Celsius, according to which the temperature difference between the reference temperatures of the freezing (0°) and boiling points (100°) of water are divided into 100 degrees.
Chemical change	A change resulting from a chemical reaction in which bonds are broken and new bonds are formed between different atoms in a substance. A chemical change produces one or more new substances with different chemical properties.
Chemiluminescent reaction	A reaction in which light is emitted but no heat is emitted.
Control	A standard against which experimental observations may be evaluated. A procedure identical to the experimental procedure except for the one factor being studied.
Dependent Variable	A factor that is measured to learn the effect of one or more independent variables. It is what happens as a result of the independent variable.
Endothermic reaction	A chemical reaction that absorbs energy in the form of heat.
Exothermic reaction	A chemical reaction in which energy is released in the form of heat.
Experimental design	The method or process of designing an experimental investigation used to test cause-and-effect relationships between variables. The classic experimental design specifies an experimental group and a control group. The independent variable is administered to the experimental group and not to the control group, and both groups are measured on the same dependent variable.

KEY VOCABULARY Continued

Independent Variable	A variable that is manipulated (controlled) by the researcher and evaluated by its measurable effect on the dependent variable or variables. It is purposely changed so that the effect can be tested.
Physical change	A change in the physical properties that does not affect the chemical nature of a substance. Examples would include changes in texture, shape, size, color, odor, volume, mass, weight, and density.
Slope	In graphing, slope refers to the general direction in which a line points. It is usually referenced as an upward or downward slope.
Temperature	The measurement of heat energy in a system or substance.
Trend	The general course or prevailing tendency of a line of data. If one variable increases as the other increases, the trend is said to be positive. If one variable decreases as the other increases, the trend is said to be negative.

Warm Ups and Cool Downs



A *physical change* is a change in state or appearance. An example of a physical change is:

_____

_____

A *chemical change* is a change in which a new substance is formed. An example of a chemical change is:

_____

_____

Background Information:

In chemical reactions and physical changes energy is either absorbed or released from, the surrounding environment. This transfer of energy sometimes produces a change in temperature.

(out) (heat)	(in) (heat)
exo/thermic	endo/thermic

If heat is released to the surrounding environment, the reaction is called an _____ reaction. This will make the surrounding environment _____.

If heat is absorbed from the surrounding environment, the reaction is called an _____ reaction. This will make the surrounding environment _____.

Predictions:

1. If we mix calcium chloride and water, then the temperature of the water will increase/decrease.
2. This will be an endo/exo thermic reaction.
3. If we mix Alka-Seltzer® and water, then the temperature of the water will increase/decrease.
4. This will be an endo/exo thermic reaction.

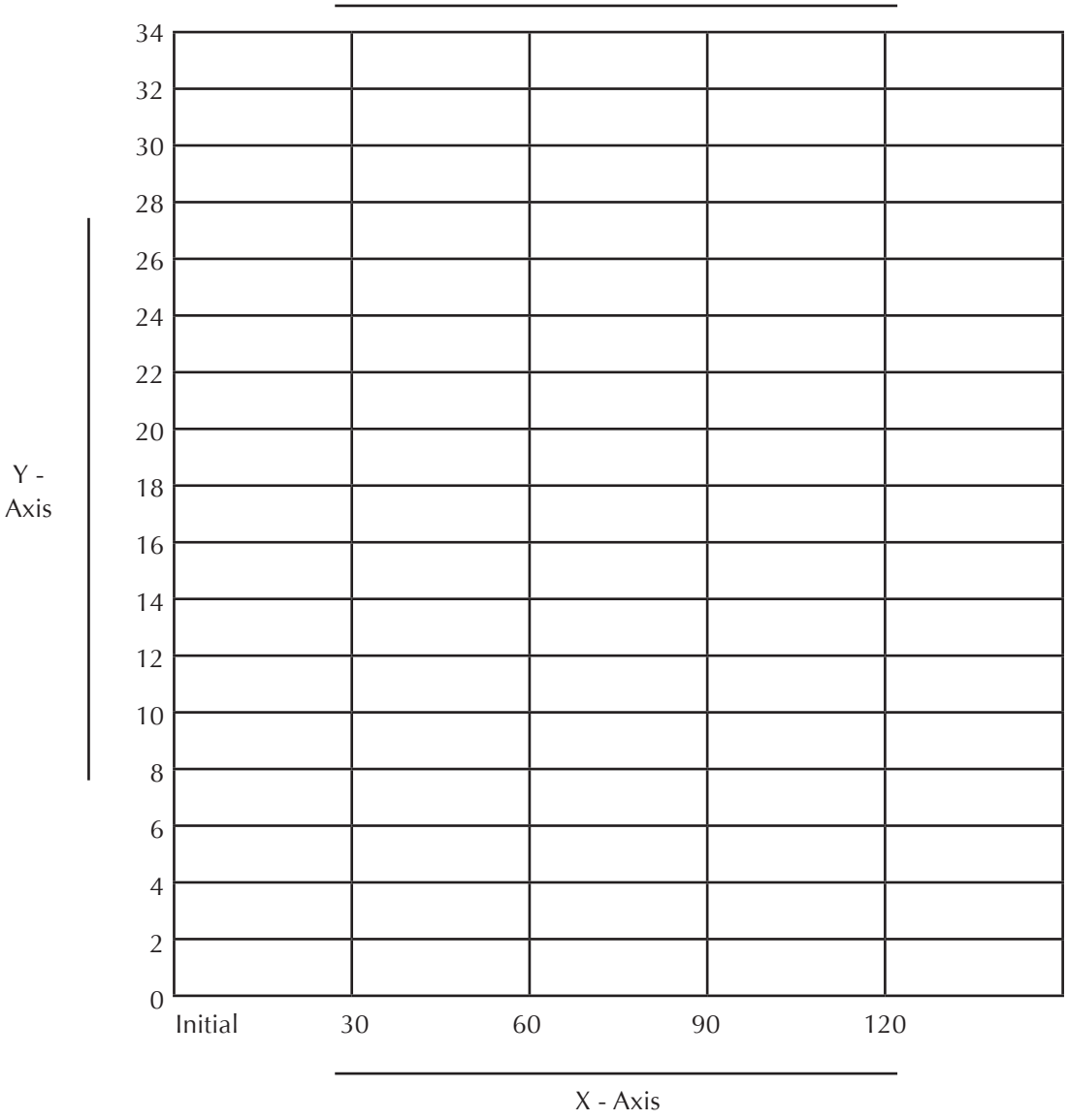
Experiment Directions

You will place one of two chemicals in ordinary tap water.

1) Measure the temperature of the water with a hand-held thermometer.
2) Observe and record initial temperature.
3) Mix chemical into water (stir).
4) Observe and record temperature every 30 seconds for two minutes (continue to stir between temperature observations).

Results:

Chemical	Temperature Reading (Every 30 Seconds.)					Did the temperature increase or decrease?	Was energy absorbed or released in the reaction?	Was the reaction endothermic or exothermic?
	Initial Temp	30 sec	60 sec	90 sec	120 sec			
Chemical A Calcuim Chloride & Water Red								
Chemical B Alka-Seltzer® & Water Blue								



Chemical	Class Averages of Measured Temperatures (Every 30 seconds)				
	Initial Temp	**30 sec**	**60 sec**	**90 sec**	**120 sec**
Chemical A Calcuim Chloride & Water					
Chemical B Alka-Seltzer® & Water					

Legend:

Red = Calcium Chloride

Blue = Alka Seltzer®

Pop Goes the Fizz

Leonhard Euler

Euler helped develop the Euler - Bernoulli equation, which became a cornerstone of engineering. Aside from successfully applying his analytic tools to problems in classical mechanics, Euler also applied these techniques to celestial problems. His work in astronomy was recognized by a number of Paris Academy Prizes over the course of his career. His accomplishments include determining with great accuracy the orbits of comets and other celestial bodies, understanding the nature of comets, and calculating the parallax of the sun. His calculations also contributed to the development of accurate longitude tables.

Born
15 April 1707
Basel, Switzerland

Died
18 September 1783 (age 76)
St. Petersburg, Russia

Residence
Prussia, Russia, Switzerland

Nationality
Swiss

Fields
Portrait by Emanuel Handmann 1756(?)
Mathematician and Physicist ; complied from Wikipedia

KEY VOCABULARY

Constant	Parts of the trial that remain the same each time the trial is repeated.
Dependent Variable	A variable that is measured to learn the effect of one or more independent variables. It is what happens as a result of the independent variable.
Independent Variable	A variable that is manipulated (controlled) by the researcher and evaluated by its measurable effect on the dependent variable or variables. It is purposely changed so that the effect can be tested.
Mean	The average value of a set of numbers.
Reliability	The extent to which an experiment, test, or measuring procedure yields the same results on repeated trials.

Pop Goes the Fizz

Will increasing the amount of fuel affect the vertical launch height of a film canister?

Hypothesis: If I increase the amount of Alka-Seltzer® "fuel", then the vertical launch height of the film canister will increase / decrease / not change (circle one).

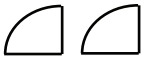
TABLE 1

Independent Variable	Dependent Variable	Constants

TABLE 2

Components of Investigation	Unit of Measurement	Tool to Measure
Height of Launch		
Mass of Alka-Seltzer® Tablets		
Volumn of Water		

TABLE 3

Amount of Alka-Seltzer®	Estimate Unit of Measurement _____	Actual Unit of Measurement _____
Whole Alka-Seltzer® 		
Two 1/4 Alka-Seltzer® 		
One 1/4 Alka-Seltzer® 		

Pop Goes the Fizz

Team Data: Vertical Launch Height of Film Canister

TABLE 4A

Team A: one 1/4 tablet	
Trial	Height (in cm)
1	
2	
3	
Mean	

Collaborate with your team to complete data for both tables.

TABLE 4B

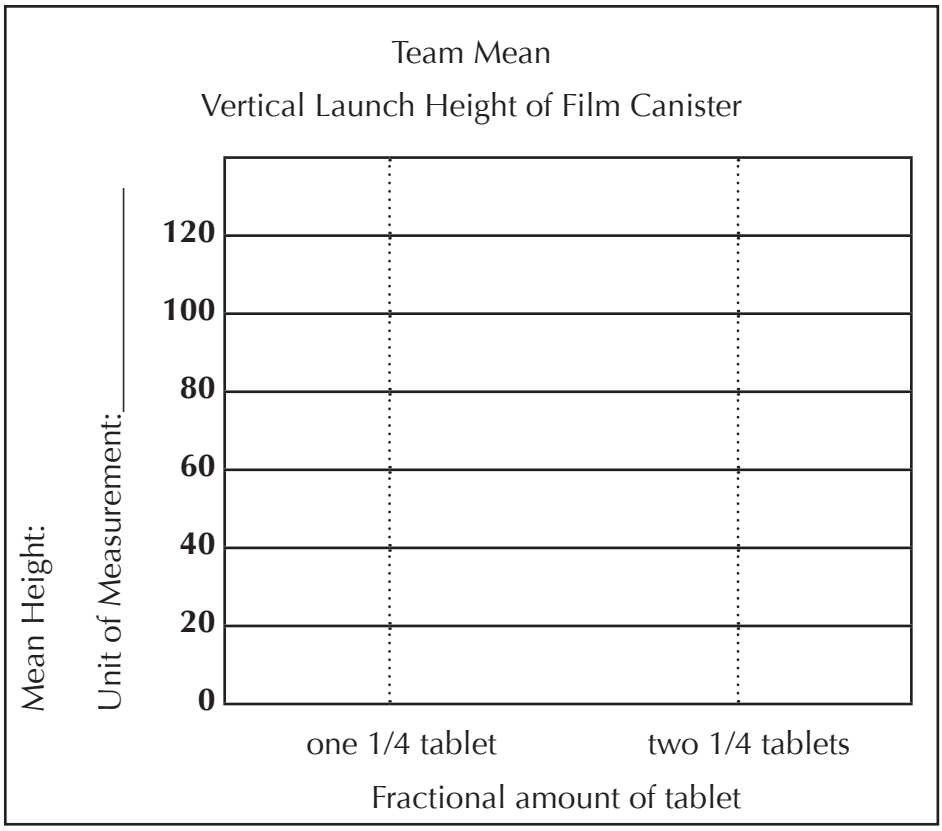
Team B: two 1/4 tablets	
Trial	Height (in cm)
1	
2	
3	
Mean	

TABLE 5

Teams	One 1/4 tablet (Mean found by each team)	Two 1/4 tablets (Mean found by each team)
Alpha		
Bravo		
Charlie		
Delta		
Echo		
Foxtrot		
Golf		

Pop Goes the Fizz

TABLE 6



Conclusion:

The results of my investigation supported or did not support (circle one) my hypothesis because…

_____

_____

_____

_____

_____

_____

_____

_____

Summary:

Compare the results of launching with one ¼ tablet and two ¼ tablets. Analyze the class data and discuss with your team:

Does the data show a relationship between increasing the amount of fuel and the vertical launch height of the film canister? Justify your answer using the data found in the tables and graph.

_____

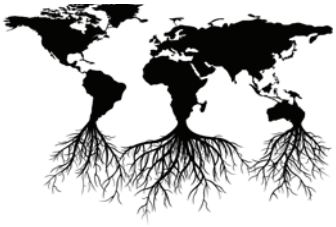
_____

_____

_____

_____

_____



THERE'S ALWAYS TOMORROW...
ACTIVITY II BACKGROUND INFORMATION

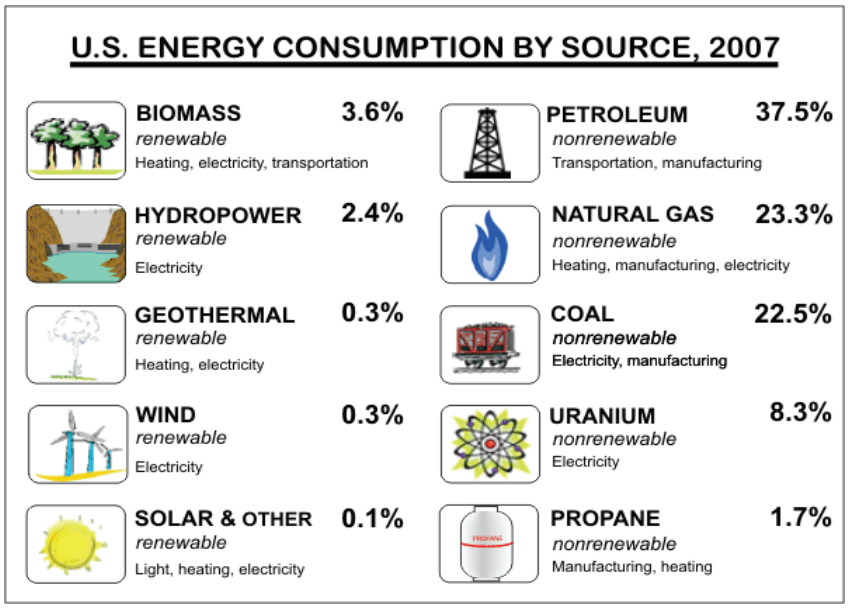
Adequate food supplies are not the only concern of a growing population. Energy is essential to modern society as we know it. Over 85% of the United States' energy demands, two-thirds of our electricity and virtually all of our transportation fuels are currently met by the use of fossil fuels. Once mined or extracted from the ground, the fuels are burned to release the chemical energy that is stored there. Because fossil fuels take millions of years to form, they are considered non-renewable resources. In other words, we use them up faster than the Earth can make them.

Recent instability in oil prices, world unrest and concern over the environment has increased interest in the development of alternative energy forms. Today, the primary alterative energy sources include biofuels and energy harnessed from the sun, water, wind, geothermal sources. Each of these alternative fuels is considered renewable, because it can be replenished at the same rate or faster than we use it.

Compare the available energy supplied by a coal mine and a forest. While it's true the forest could be depleted, with select harvesting, replanting, and careful management it would provide a continuous supply of energy. On-the-other-hand, once the coal has been removed from the mine, the available coal is gone.

In 2007, alternative energy sources supplied less than 10% of our total energy use. So, if they're the solution to non-renewable fuels why don't we use them?

Economics mostly - our industrial structure supports fossil fuel use, it is cheaper and in the **short run**, more cost effective.



Source: Energy Information Administration, Annual Energy Review 2007, June 2008.

Activity modified from Connecticut Energy Education's Ecological Footprint

THERE'S ALWAYS TOMORROW: RENEWABLE VERSUS NON-RENEWABLE RESOURCES

These charts indicate how many tokens to draw out of the container for each year, based on the simulated energy consumption rate.

SIMULATION # 1

ENERGY CONSUMPTION RATE	PREDICTION: ____# YEARS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
TOTAL # TOKENS IN CONTAINER		100									
CONSTANT: REMOVE 10 TOKENS EACH YEAR		-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
# TOKENS REMAINING IN CONTAINER											
# NON-RENEWABLE											
# RENEWABLE											

ENERGY CONSUMPTION RATE	PREDICTION ____# YEARS	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
TOTAL # TOKENS IN CONTAINER											
CONSTANT: REMOVE 10 TOKENS EACH YEAR		-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
# TOKENS REMAINING IN CONTAINER											
# NON-RENEWABLE											
# RENEWABLE											

TOTAL # YEARS NEEDED TO DEPLETE NON-RENEWABLE RESOURCES: _____

WAS YOUR PREDICTION CORRECT? _____

Planning, managing and providing scientific research and professional and technical services (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.

Sample Career Specialisties/Occupations

•Aerospace Engineer	+ •Manufacturing Technician	•Analytical Chemist	•Nanobiologist
•Aeronautical Engineer	•Marine Engineer	•Anthropologist	•Nuclear Chemist
•Agricultural Engineer	•Materials Engineer	•Applied Mathematician	•Nuclear Technician
❑ •Agricultural Technician	•Materials Lab & Supply Technician	•Archeologist	•Numerical Analyst
•Application Engineer	•Mechanical Engineer	+ •Astronomer	•Nutritionist
•Architectural Engineer	•Metallurgic Engineer	•Astrophysicist	+ •Oceanographer
•Automotive Engineer	•Mining Engineer	•Atmospheric Scientist	•Organic Chemist
+ •Biomedical Engineer	•Naval Engineer	•Biologist	•Ornithologist
•Biotechnology Engineer	•Network Technician	+ •Botantist	•Paleontologist
+ •Chemical Engineer	•Nuclear Engineer	•CAD Operator	•Physicist
•Civil Engineer	•Ocean Engineer	•Cartographer	•Polymer Scientist
•Communications Engineer	•Operations Research Engineer	+ •Chemist	•Programmer
•Computer Engineer	•Packaging Engineer	•Communications Technologist	•Protein Scientist
•Computer Hardware Engineer	•Packaging Technician	•Conservation Scientist	•Protozoologist
❑ •Computer Programmer	•Petroleum Engineer	•Cosmologist	•Quality-Control Scientist
•Computer Science Technician	•Pharmaceutical Engineer	•Cryptographer	•Radio Chemist
•Computer Software Engineer	•Plastics Engineer	•Crystallographer	•Research Chemist
•Construction Engineer	•Power Systems Engineer	•Demographer	•Research Technician
•Consultant	•Product Design Engineer	•Dye Chemist	•Science Teacher
•Development Engineer	•Project Engineer	•Ecologist	❑ •Lab Technician
•Drafter	•Project Manager	•Economist	•Scientific Visualization/ Graphics Expert
•Electrical Engineer	•Prototype Engineer	•Electronmicroscopist	•Spectroscopist
❑ •Electrician	•Quality Engineer	•Environmental Scientist	•Statistician
❑ •Electrons Technician	•Quality Technician	•Expert Systems Scientist	+ •Technical Writer
•Energy Transmission Engineer	❑ •Radio/TV Broadcast Technician	•Geneticist	•Technologist
•Environmental Engineer	❑ •Radiology Engineer Researcher	•Geologist	•Toxicologist
•Facilities Technician	•Safety Engineer	•Geophysicist	+ •Zoologist
•Fire Protection Engineer	•Sound Technician	•Geoscientist	
•Geothermal Engineer	•Structural Engineer	•Herpetologist	
•Hazardous Waste Engineer	❑ •Survey Technician	•Hydrologist	
•Hazardous Waste Technician	•Systems Design Engineer	•Ichthyologist	
= •Human Factors Engineer	❑ •Technical Sales Manager	•Inorganic Chemist	
•Industrial Engineer	•Technical Writer	•Laboratory Technician	
❑ •Industrial Engineering Technician	•Telecommunications Engineer	•Mammalogist	
•Licensing Engineer	•Textile Engineer	•Marine Scientist	
•Manufacturing Engineer	•Transportation Engineer	•Materials Analyst	
•Manufacturing Processes Engineer		•Materials Scientist	
		•Mathematician	
		•Metallurgist	
		•Meteorologist	
		+ •Microbial Physiologist	
		•Mycologist	

Pathways		
	Engineering and Technology	Science and Math

Cluster K & S	Cluster Knowledge and Skills		Education Needed for Career
	•Academic Foundations •Communications •Employment and Career •Development •Ethics and Legal Responsibilities •Information Technology Applications	•Leadership and Teamwork •Problem Solving and Critical Thinking •Safety, Health and Environment •Systems •Technical	= High School – completed high school, high school with career and technology training, GED, on-the-job training, or apprenticeship ❑ Junior College – completed junior/community college, postsecondary technical, or career and technology training + Baccalaureate Degree – completed four-year degree or more

Adapted from http://www.okcareertech.org/cac/pages/Career_cluster/pathways/stem_cluster.pdf

Dream Catcher

In Native American culture, a **dreamcatcher** is a handmade object made from a willow hoop. A loose net or web is attached to resemble a spider web. Then it is decorated with personal and sacred items such as feathers and beads.

While dreamcatchers originated in the Ojibwa Nation, during the Pan - Indian Movement of the 1960s and 1970s, they were adopted by Native Americans of a number of different Nations. Some consider the dreamcatcher a symbol of unity among the various Indian Nations.

KEY VOCABULARY

Career	A profession for which one trains and which is undertaken as a permanent calling.
Dreamcatcher	A handmade object based on a willow hoop, on which is woven a loose net or web and decorated with personal and sacred items such as feathers and beads.
Dreams	What you want to achieve.
Goal	The end toward which effort is directed; aim.
Self - esteem	A confidence or satisfaction in oneself.

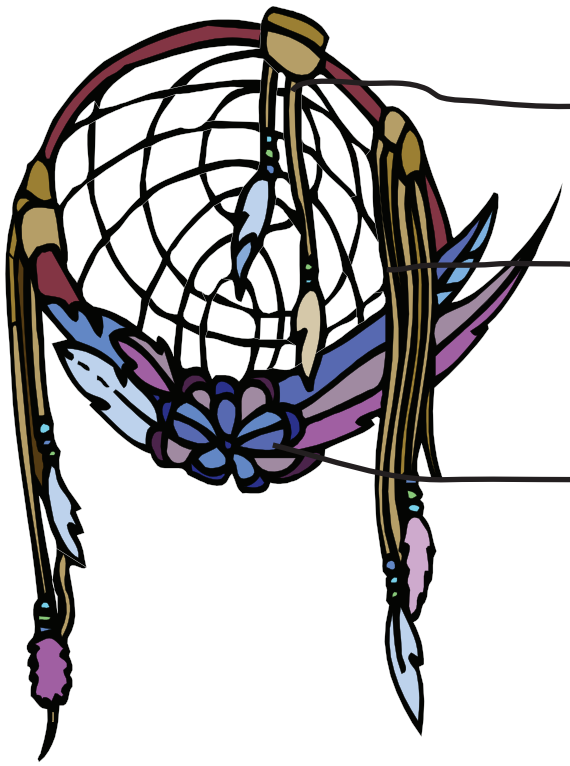
Mapping Out A Dream

On the Dream line, list the career you want to have when you complete your education.

On the Catcher lines, list three things you need to do to reach your Dream.

Dream _____

Catcher



Booklet printing sponsored by:

www.okepscor.org

Oklahoma NASA Space Grant Consortium

http://www.okspacegrant.ou.edu