SWE Program Number DRO74
Final Report – 20th July, 2000

"GEARING UP FOR ENGINEERING"

An Engineering Summer Institute

Jointly Sponsored by
Huntsville Branch - American Society of Civil Engineers
North Alabama Chapter - Society of Women Engineers
Society of Women Engineers – National Career Guidance Committee
University of Alabama in Huntsville
University Transportation Center of Alabama

Executive Summary

The numbers of female and minority students enrolled in engineering schools are increasing slowly, however there is still a relatively small percentage drawn to the field of civil engineering. As a consequence, there is a need to educate young people about the profession to encourage under-represented individuals to appreciate the contributions of engineers and encourage them to become CEs. This summer institute project consists of bringing selected students to the UAH campus to learn about engineering as a career and experience a variety of engineering design topics. The participants will gain knowledge about the role of engineers in society as well as learn how engineers use their knowledge in design applications. Several University of Alabama faulty members and SWE professionals will act as team mentors. As an important part of this project, local minority and female engineers will act as mentors for the program.

1. What did you originally hope to accomplish under your grant?

The major goal of this program is to introduce middle to high school students from under-represented groups to basic scientific and engineering concepts. These groups have potential for science and engineering, but might lack role models and motivation to pursue a career in engineering.

We were successful in recruiting over 75% female student requests for the program. The selection committee used the teacher references to rate the students (criteria were student statements of interest, teacher comments and ethnicity). The committee chose 15 females and 5 males students. The ethnicity breakdown is as follows: African American, Asian, Hispanic, and Caucasian.

2. How did you go about realizing the project goals?

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December - March

1. Recruiting: Letter to schools, telephone calls, and school visits
2. Fundraising: proposal to University Transportation Center of Alabama (UTCA) to fund professors, student mentors, and graduate student instructors.
3. Finding female and minority professional engineers to act as instructors and mentors

April

1. Selection of students by SWE committee

May

1. Invitation to students (letter) then follow-up phone call to parents
    a. Permission of parents and legal release forms
2. Schedule Mentors
    a. Professional organizations: ASCE, SWE, SAME, AUH
    b. Local civil engineering firms
    c. Minority and female students
2. Work on lab experiences and draft copy of manual
3. Get 3 girl scouts to run through lab exercises to time and locate flaws

June

1. Set-up final schedule for instructors and team mentors.
2. Arrange field trips to local CE sites: railroad museum, City engineering office, multi-modal facility, and NASA space station mock-up at MSFC.
3. Run program
4. Post-program survey of students

July-August

Evaluation

1. Review of results: student questionnaires and mentor comments
2. Feedback provided to sponsors
3. Final report to SWE & UTCA

The students went on four field trips and participated in eight (2 hour) hands-on experiments. The experiments are listed below, (but a lab manual is included in the final report package)

#1 Bridges

#2 Space Transportation

#3 Construction Materials

#4 Surveying & Mapmaking

#5 Alternative Energy

#6 Magnetic Levitation

#7 Transportation Safety

#8 Soil & Geotech Materials

3. What are the principal outcomes of your project? Are these all the outcomes that you anticipated? What is the potential significance of the outcomes for SWE?

After the program was finished the students completed a survey and all thought that the program was fun and educational. Most of them didn't know what civil engineers did prior to coming to UAH and were surprised at all the variations. Finally they'd all recommend the program to their friends.

4 **Are there any recommendations to continue or build on the work accomplished under the grant?**

I plan on writing another proposal to UTCA to use the materials that were developed by the SWE grant for a 2001 summer program. We will include students from nearby counties as well as local students.

5 Were the monies you received adequate for the project? If you could go back and start again, would you change your budget? How?

Yes, the budget was adequate. The SWE portion covered the supplies and other miscellaneous items; while the UTCA grant paid 5 professors and 8 student assistants to help.

6 Was the time allotted for your project adequate? If no, please explain.

Yes, We really needed the eight month lead time to be able to have the program in June.

7 Did you encounter any significant problems in carrying out your project? What were they? Could they in hindsight have been avoided? How?

We didn't have any significant problems. The only negative that I can describe is that only 4 of the professional SWE members were available for the program. I was a little bit disappointed with this.

8 **Has your project received any public attention to date? If so, please describe, and if possible, enclose copies of any pertinent articles, speeches, etc.**

Not yet

Budget:

EXPENSE ITEM	**COST**
1. Professional Services and Consulting Fees (paid non-SWE consultants) Supported by funding from University Transportation Center of Alabama	0
2. Travel (Van rentals)	300
3. Lodging	0
4. Meals	
Lunches	745
Snacks & drinks	174
5. Equipment and supplies	
T-shirts	274
Notepads, pencils	116
Design kits	443
Lab supplies	1840
6. Publications	
Lab manual & reproduction	148
7. Distribution (postage)	
8. Advertising (PR costs not included under publications)	0
9. Misc.	
Admission - railroad museum	100
Total SWE PORTION	**3880**

Contact:

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Photo of program participants

"GEARING UP FOR ENGINEERING SUMMER INSTITUTE"

Field Trips

Past Modes of Transportation -- North Alabama Railroad Museum (Chase) 851-6276
Current Modes of Transportation --- Huntsville Jet port and Inter-modal facility (Tammy Dodson -- 772-9395 ext. 108)
Transportation Engineering -- City of Huntsville Engineering and Sign Shop (Tim Barnett & Don Sanders, 427-5328)
Future Modes of Transportation --NASA space station mock-ups (MSFC- Education Office, Alicia Beam, 544-9492)
Awards - Dean

Seminars

History of Transportation Engineering (Mike A)
Team Building (K. Leonard)

Hands-On Sessions (4 Groups of 5 students each)

Title (coordinator)	**Room**
1. Bridges -- (Norb & Leah)	TH S239
2. Space transportation -- (SWE: Alisa and Mary Anne)	TH S208 & 206
3. Construction Materials -- (HT)	TH S228 & 230
4. Surveying - (MA)	Outside
5 Alternative Energy/Solar Cars -- (KL & Paige)	TH S209
6. Future Transportation/Maglev - (MA)	TH S239
7 Environmental concerns (sound, air pollution) -- (KL)	TH S205
8 Soil & Geotech Materials - (Mohammed & Jeanelle)	TH S212

General Schedule of Sessions

	Monday 19th	**Tuesday 20th**	**Wednesday 21st**	**Thursday 22nd**	**Friday**
9-10	Introduction - History	Jet port	RR museum	Break Concrete/Video	Design
10-11	Team building	Jet port	City of HSV Engineering	NASA	Design
11-12	*Lunch - Pizza*	*Lunch - Hamburgers*	*Lunch - Picnic*	*Lunch - UC*	*Lunch -*
12 -1:45	Exp 1,2,3,4	Exp 1, 2, 3, 4	Exp 5,6,7,8	Exp 5,6,7,8	Competition
1:45- 2:00	break	break	break	break	break
2:00-3:45	Exp 1,2,3,4	Exp 1, 2, 3, 4	Exp 5,6,7,8	5,6,7,8	Awards
4	Depart	Depart	Depart	Depart	Depart

"GEARING UP FOR TRANSPORTATION ENGINEERING SUMMER INSTITUTE"

TEAM A: Schedule (Student Mentor: Melissa Coffey)

	Monday 19th	**Tuesday 20th**	**Wednesday 21st**	**Thursday 22nd**	**Friday**
9-10	Introduction - History	Jet port	RR museum	Break Concrete/ Video	Design
10-11	Team building exercise	Jet port	City of HSV Engineering	NASA	Design
11-12	*Lunch - Pizza*	*Lunch - Hamburgers*	*Lunch - Picnic*	*Lunch - UC*	*Lunch - (TH)*
12 -1:45	Exp 1 (TH239)	Exp 3 (TH228)	Exp 5 (TH S239)	Exp 7 (TH S205)	Competition
1:45- 2:00	break	break	break	break	break
2:00-3:45	Exp 2 (TH S208)	Exp 4 (Back lot)	Exp 6 (TH S208)	Exp 8 (TH S212)	Awards
4:00	Depart	Depart	Depart	Depart	Depart

Student Name	**School**
Melissa Coffey	UAH
Autumn	
Jeremy	
Ashley	
Tiffany	
Heather	

	Mon 12 pm	**Mon. 2 pm**	**Tues. 12 pm**	**Tues. 2 pm**	**Wed 12 pm**	**Wed. 2 pm**	**Thur. 12 pm**	**Thur. 2 pm**
GROUP A	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8
GROUP B	Exp 2	Exp 3	Exp 4	Exp 1	Exp 6	Exp 7	Exp 8	Exp 5
GROUP C	Exp 3	Exp 4	Exp 1	Exp 2	Exp 7	Exp 8	Exp 5	Exp 6
GROUP D	Exp 4	Exp 1	Exp 2	Exp 3	Exp 8	Exp 5	Exp 6	Exp 7

	Student Mentor	**Group Members**	**T B**	**1**	**2**	**3**	
	GROUP A						
	Melissa Coffey	Autumn					
		Jeremy					
		Ashley					
		Tiffany					
		Heather					
	GROUP B						
	Melanie Sharp	Jayde					
		Carissa					
		Xia					
		Kristi					
		Carl					
	GROUP C						
	Heather Gallardy	Susan					
		DeRon					
		Ashley					
		Courtney					
		Letandra					
	GROUP D						
	Terrell Gibbs	Marco					
		Tierra					
		Brook					
		Aaron					
		Cierra					

"GEARING UP FOR TRANSPORTATION ENGINEERING SUMMER INSTITUTE"

TEAM B: Schedule (Student Mentor: Melanie Sharp)

	Monday 19th	**Tuesday 20th**	**Wednesday 21st**	**Thursday 22nd**	**Friday**
9-10	Introduction - History	Jet port	RR museum	Break Concrete/ Video	Design
10-11	Team building exercise	Jet port	City of HSV Engineering	NASA	Design
11-12	*Lunch - Pizza*	*Lunch - Hamburgers*	*Lunch - Picnic*	*Lunch - UC*	*Lunch - (TH)*
12 -1:45	Exp 2 (TH S208)	Exp 4 (Back lot)	Exp 6 (TH S208)	Exp 8 (TH S212)	Competition
1:45- 2:00	break	break	break	break	break
2:00-3:45	Exp 3 (TH228)	Exp 1 (TH239)	Exp 7 (TH S205)	Exp 5 (TH S239)	Awards
4:00	Depart	Depart	Depart	Depart	Depart

Student Name	**School**
Melanie Sharp	UAH
Jayde	
Carissa	
Xia	
Kristi	
Carl	

"GEARING UP FOR TRANSPORTATION ENGINEERING SUMMER INSTITUTE"

TEAM C: Schedule (Student Mentor: Heather Gallardy)

	Monday 19th	**Tuesday 20th**	**Wednesday 21st**	**Thursday 22nd**	**Friday**
9-10	Introduction - History	Jet port	RR museum	Break Concrete/ Video	Design
10-11	Team building exercise	Jet port	City of HSV Engineering	NASA	Design
11-12	*Lunch - Pizza*	*Lunch - Hamburgers*	*Lunch - Picnic*	*Lunch - UC*	*Lunch - (TH)*
12 -1:45	Exp 3 (TH228)	Exp 1 (TH239)	Exp 7 (TH S205)	Exp 5 (TH S239)	Competition
1:45- 2:00	break	break	break	break	break
2:00-3:45	Exp 4 (Back lot)	Exp 2 (TH S208)	Exp 8 (TH S212)	Exp 6 (TH S208)	Awards
4:00	Depart	Depart	Depart	Depart	Depart

Student Name	**School**
Heather Gallardy	UAH
Susan	
DeRon	
Ashley	
Courtney	
Letandra	

"GEARING UP FOR TRANSPORTATION ENGINEERING SUMMER INSTITUTE"

TEAM D: Schedule (Student Mentor: Terrell Gibbs)

	Monday 19th	**Tuesday 20th**	**Wednesday 21st**	**Thursday 22nd**	**Friday**
9-10	Introduction - History	Jet port	RR museum	Break Concrete/ Video	Design
10-11	Team building exercise	Jet port	City of HSV Engineering	NASA	Design
11-12	*Lunch - Pizza*	*Lunch - Hamburgers*	*Lunch - Picnic*	*Lunch - UC*	*Lunch - (TH)*
12 -1:45	Exp 4 (Back lot)	Exp 2 (TH S208)	Exp 8 (TH S212)	Exp 6 (TH S208)	Competition
1:45- 2:00	break	break	break	break	break
2:00-3:45	Exp 1 (TH239)	Exp 3 (TH228)	Exp 5 (TH S239)	Exp 7 (TH S205)	Awards
4:00	Depart	Depart	Depart	Depart	Depart

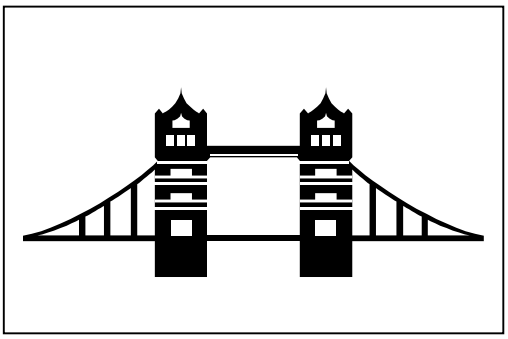
Student Name	**School**
Terrell Gibbs	UAH
Marco	
Tierra	
Brook	
Aaron	
Cierra	

	Mon 12 pm	**Mon. 2 pm**	**Tues. 12 pm**	**Tues. 2 pm**	**Wed 12 pm**	**Wed. 2 pm**	**Thur. 12 pm**	**Thur. 2 pm**
GROUP A	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8
GROUP B	Exp 2	Exp 3	Exp 4	Exp 1	Exp 6	Exp 7	Exp 8	Exp 5
GROUP C	Exp 3	Exp 4	Exp 1	Exp 2	Exp 7	Exp 8	Exp 5	Exp 6
GROUP D	Exp 4	Exp 1	Exp 2	Exp 3	Exp 8	Exp 5	Exp 6	Exp 7

Gearing Up For Engineering Curriculum

Kathleen Leonard, Ph.D. SWE North Alabama

1. Bridge Design: Learn about different types of bridges by building simple models.
2. Space Transportation: Demonstrate how rocket liftoff is an application of Newton's Laws of Motion. Students also will learn about the history and future of space transportation in the USA.
3. Construction Materials: Learn about different types of materials used for roads, bridges, parking lots dams, and buildings.
4. Surveying and Map Making: Learn about different ways to measure distance and make a simple map.
5. Alternative Energy: Explore alternative energy sources, other than fossil fuels, for future transportation modes. Also, to stress the importance and effectiveness of alternative energy sources.
6. Magnetic Levitation Design: Learn about new high speed rail systems based on magnetic energy.
7. Transportation Safety: Explore issues related to automobile safety. Also learn ways to alleviate unwanted noise near highways.
8. Soils and Geotechnical Materials: Explore classification of soil types and engineering descriptions of soils.



1. Bridge Design

Science Standards
Science as inquiry
Unifying Concepts and Processes

Science Process Skills
Measuring
Collecting Data
Constructing
Inferring
Interpreting Data
Controlling Variables
Investigating

Objective:
To learn about different types of bridges by building simple models.

Description:
In this activity, students construct a simple span bridge. They will use an interactive computer simulation model to design a suspension bridge to carry the load of a truck. They will also build a scale model of their bridge design.

Materials and Tools
Paper
200 paper clips
scissors
West Point bridge design computer model (from http://www.dean.usma.edu/cme/outreach/WPBD/wpbdhome.htm)
Notebook
Scale
K'nex
Ruler
Paper cups for side supports

Background:
Bridges have been used for over 3,000 years to cross rivers and valleys. Their design ranges from simple planks, to complicated arches and suspension bridges. They are used in both urban and rural areas.

Concepts
The topics covered are forces inside structures - compression, tension, shear and torsion. They will become familiar with terms such as beams, arches, spans, cables, trusses, piers, dead load, live load and abutments.

Paper Bridge Challenge for students
To build a bridge that can support 100 pennies, using a single sheet of paper and five paper clips that can span a river 23 cm (about 8 inches) wide and withstand the weight of at least 100 paper clips. The bridge will rest on top of paper cups and cannot be taped or

attached to the books, table, or desk.

Procedure:

1a. Paper Bridge Challenge

1. Divide your team into groups of two. Have one student in each group collect the materials.

2. .Before starting ask yourself : *What do you think might work?*

3. Once the group has completed a bridge design, set it up across the book supports, placed 23 cm apart. One of the group members place the pennies on the bridge until it collapses. The group should record how many pennies their bridge supported.

1b. .Computer Simulation Model

4. Run the West Point Bridge Designer program for each group member. You are able to change the size and type of steel members. Print out your results and cost of construction.

1c. Build a model

5. Using K'nex, build a model of the bridge you designed on the computer, using the blueprints you printed out. Change your original design a little if you need to.

6. Answer questions on worksheets

Discussion

Define the following terms:

1. Tension
2. Compression
3. Bending
4. Shear
5. Torsion
6. Cable
7. Strut
8. Beam
9. Arch
10. Slab
11. Pier
12. Abutment

Anwer following questions:.

Why do we need bridges?

What do bridges look like?

What shapes have you seen in bridges?

What are qualities a bridge should have?

Describe how the bridge behaved.

Was it as strong as you thought?

Can you identify where their bridge failed?

How could they redesign the bridge to be stronger?

Are there similarities in the designs of each group's strongest bridge?

Additional Information:

"Web sites" for more information:
http://www.dean.usma.edu/cme/outreach/WPBD/wpbdhome.htm -

1. Bridge Design Report Sheet

Group Name: _____

1. Test your paper bridge deck. How many paper clips did it hold? Write your data in the spaces below.
2. Run the computer model and print out the results.
3. Build a model of your bridge using K'nex. How many pieces did you use ? If you had time, could you build a bridge with fewer pieces ?

Bridge #1*: Paper* Make notes about the experiments here

How many paperclips did it hold? _____	

West Point Bridge Designer

What was your bridge cost? _____	

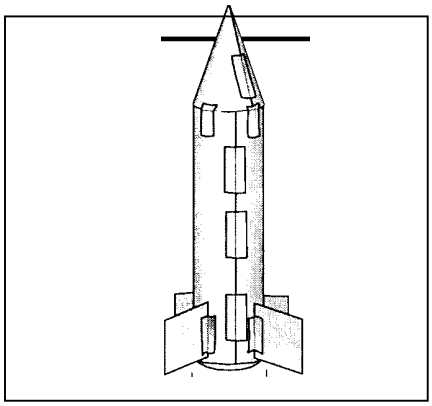
West Point Bridge Designer questions:

1. What does it mean when the bridge parts (members) turn red?

2. What does it mean when the bridge parts (members) turn blue?

3. Do any change from red to blue, or the other way around? Which stay red, and which stay blue?

4. Could you build a plastic model of your bridge, or did you have to change it?



Science Standards

Physical Science -]
Position and motion of objects
Science and Technology -
Abilities of technological design -
Understanding about science and technology

Process Skills

Observing
Communicating
Making Models
Inferring

2
Space Transportation

Objective:

To demonstrate how rocket liftoff is an application of Newton's Laws of Motion. Students also will learn about the history and future of space transportation in the USA.

Description:

Objective to demonstrate how rocket liftoff if an application of Newton's Laws of Motion. Students construct a rocket powered by the pressure generated from an effervescing antacid tablet reacting with water.
Students also use the NASA disk "Space Transportation: Past, Present and Future" to learn about space applications.

Materials and Tools

Heavy paper (stock or construction paper)
Plastic 35 mm film cannister (the film cannister must have an internal-sealing lid)
Student sheets
Cellophane tape
Scissors
Evervescing antacid tablet: Alka seltzer
Paper towels
Water
Eye Protection

Background:

This activity is a simple but exciting demonstration of Newton's Laws of Motion. The rocket lifts off because it is acted upon by an unbalanced force (First Law). This is the force produced when the lid blows off by the gas formed in the canister. The rocket travels upward with a force that is equal and opposite to the downward force propelling the water, gas, and lid (Third Law). The amount of force is directly proportional to the mass of water and gas expelled from the canister and how fast it accelerates (Second Law).

Instructions

2a. Propulsion

1. Build the rocket out of construction paper and a film canister as shown on the following page.
2. Turn the rocket upside down and fill the canister 1/3 full of water.
3. Drop in antacid 1/2 tablet.
4. Snap lid on tight
5. Stand rocket on launch pad
6. Stand back
7. Hold an altitude (angle) contest to see which rocket can fly the highest.

2b. Space Transportation History - NASA

8. Using the NASA "Space transportation, Past, Present and Future," disk, answer the questions posed by the instructors.

Discussion:

· How does the amount of water placed in the cylinder affect how high the rocket will fly?

· How does the temperature of the water affect how high the rocket will fly?

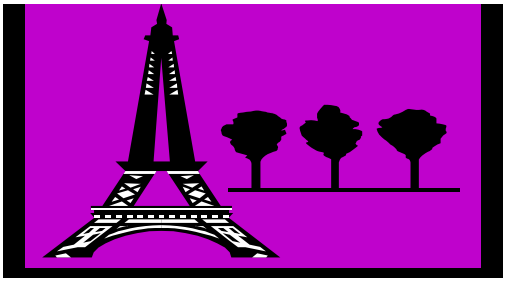
How does the amount of the tablet used affect the flight?

· How does the length or empty weight of the rocket affect how high the rocket will fly?

How would it be possible to create a two-stage rocket?

More Information

Taken from Rockets: A Teacher's Guide with Act/v/ties in Science, Mathematics, and Technology



3 Construction Materials

Science Standards
Science as inquiry
Unifying Concepts and Processes

Science Process Skills
Measuring
Collecting Data
Constructing
Inferring
Interpreting Data
Investigating

Objective:
To learn about different types of materials used for roads, bridges, parking lots dams, and buildings.

Description:
In this activity, students learn about different materials used in transportation, such as wood, metals concrete, pavements and composite materials. They will prepare and test some of these materials.

Materials and Tools
Material specimens made out of wood, concrete, fiber composites (Hughes Bros.)
Stone, sand, cement, and water
Plastic molds
Compression and Torsion loading frame
Scale
Notebook
Gloves
Eye Protection
Dust Mask

Background:
Roads have been used for transportation for over 3,000 years. They are made of different materials such as wood, metals asphalts, concrete and composites. Before using these materials in roads, building and bridges, we must test them to make sure they are strong enough to take the load.

Instructions

1. Mix concrete to make small specimens. Different mixtures will be made
2. Test the specimens under different loading.
3. Make plates out of concrete and graphite fibers. Load the plates in tension compression and flexure
4. Review different slides of different concrete structures: tall buildings, bridges, dams and historical structures
5. Compare different materials and list the advantages and disadvantages.
6. Answer questions on worksheets
7. Break the samples after curing for 24-36 hours.
8. Plot strength of each concrete on graphs versus curing time

More Information:

American Concrete Institute
www.aci.org
American Society of Civil Engineers
www.asce.org

More Information

3. **Materials Design Report Sheet**

Group Name: _____

1. Test your specimens. How many pounds did your cube take before it broke? Write your data in the spaces below.
2. Test the flat plate.
3. Answer the following questions:
   a. What are the advantages of using concrete? _____
   b. Which is stronger: concrete or wood? _____
   c. Which is lighter: concrete or wood? _____
   d. Which is lighter: metal or wood? _____
   e. Which material would you use to build your house? _____
   f. Why does lightweight concrete float? _____

Cube #1 *Regular concrete* Make notes about the experiments here

How many pounds did it hold? _____	

Cube # 2: *Lightweight Concrete* Make notes about the experiments here

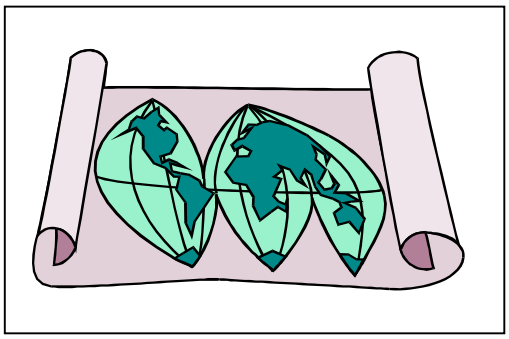
How many pounds did it hold? _____	

Cube #3: *Wood* Make notes about the experiments here

How many pounds did it hold? _____	

Torsion test

Which metal was better at being twisted?: _____	



4

Surveying and Mapmaking

Science Standards
Science as inquiry
Unifying Concepts and Processes

Science Process Skills
Measuring
Collecting Data
Inferring
Interpreting Data
Controlling Variables

Objective:
To learn about different ways to measure distance and make a simple map.

Description:
In this activity, students will learn how to use simple ratios to estimate distances. The use of a level and tape will beused to estimate slope. They will also learn how use their stride and a compass to make a simple map.

Materials and Tools
2 Meter sticks
GPS meter
100 foot tape
dumpy level
rod
compass
?
Notebook

Background:
Surveying has been used for millennia to determine lengths, area and angles for construction projects and .. Although equipment has changed over the years, basic mathematical principals are still used. For example, height can be estimated by using length of shadows and trigonometry. The slope of a landscape can be measured by simple calculations and ..??
The topics covered are length, height, right angles, degrees, slope, latitude and longitude. Students will participate in a ?treasure hunt using a compass and their strides to identify and map landmarks on campus.

Direct and Indirect Measurements are made by comparing an object to be measured directly with some measuring tool. For example, a pencil can be measured with a ruler. Your weight can be measured with a scale.
Sometimes direct measurement is impossible. A tree may be too tall for its height to be measured with a tape measure. In cases like this, when a direct measure is difficult or impossible

to make, there are ways to make an indirect measurement. The height of a tall object may be found by comparing its shadow to the shadow of an object of known height. The ratio of the shadow lengths equals the ratios of the heights:
tree height = tree shadow
stick height stack shadow
This is an example of indirect measurement.

Estimating Distances

Skill at estimating can take a long time to develop, but an improved level can be developed easily. You can count the number of steps it takes you to pace off 100 feet. If you divide 100 ft by that number you have the length of your average stride. Then you can pace off distances and multiply by your stride length to estimate long distances.
If you can use a compass for direction, you can make a map of the area.

Instructions

1. Direct and Indirect Measurement
   Place a meter stick upright -- check that it is at 90^{o} angle. Measure the shadow of the stick and note on report sheet.

2. Measure the shadow of a tree using the100 foot tape and note on report.

3. Calculate the ratio of height of shadow from meter stick -- Determine the height of the tree using the same ratio.

4. Using the level and rod. Find the elevation difference between two places. Measure the length distance between the two points and find slope by calculation on report sheet.

5. Count the number of steps (paces) it takes you to complete the 100 foot measured length. Divide 100 ft by that number to estimate the length of your normal stride (do not run or take big steps).

6. Learn how to use the compass by making sure that the needle and magnetic North are lined up.. Follow the directions given by the instructor.

7. Mapmaking and Treasure hunt?

8. Answer questions on worksheets

Discussion

What are some sources of error in your measurements?

Additional Information:

"Web sites" for more information --

4. Surveying and Mapmaking Report Sheet

Group Name: _____

1. Make all measurements. Write your data in the spaces below.
2. Slope experiment.
3. Treasure hunt -- record the data below

#4a*: Meter Stick* Make notes about the experiments here

Height of stick _____ Length of shadow _____ Ratio of stick:shadow _____	

4b: Height of Tree Make notes about the experiments here

Length of tree shadow _____ x Ratio of stick:shadow _____ = Height of stick _____	

#4c: Slope Calculation Make notes about the experiments here

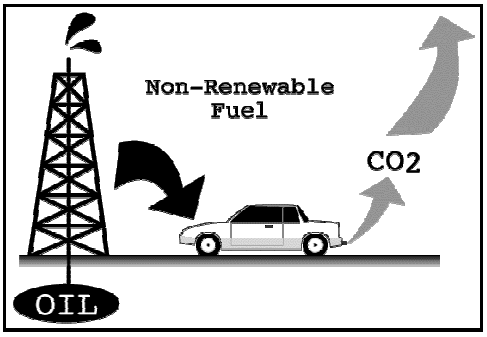
Reading of first site using rod _____ Reading of second site using rod _____	

Distance between sites Slope of land = (difference in height)/distance _____ _____	

4d. Estimating Distances with Pacing Make notes about the experiments here

Number of steps in 100 ft _____ Length of your average stride = Divide100 ft/ number of steps _____	

4e. Map making



5 Alternative Energy

Science Standards

Science as inquiry
Unifying Concepts and Processes

Science Process Skills

Observing
Measuring
Collecting Data
Constructing
Making Models
Interpreting Data
Controlling Variables

Objective:

To explore alternative energy sources, other than fossil fuels, for future transportation modes**.** Also, to stress the importance and effectiveness of alternative energy sources.

Description:

In this activity, students perform experiments using a solar cell and test a small solar powered car. They will observe the physical power of light/heat absorption through a small free moving device with black and white panels. Then they will construct a battery-fan powered boat.

Materials and Tools

Solar Panels
Small Electric Motor
Various wooden parts
Light source
Eye protection
Notebook
motor (1)
propeller (1)
film canister (1)
velcro or sticky backs (2)
battery holder (1)
batteries, AA (2paper clip (1)
paper fasteners (2)
rubber bands (4)
dowel (1)
Empty water bottles (2)

Background:

As the world's supply of fossil fuels is being used up, there is a need for new energy sources. Adding to this need is the fact that the current use of fossil fuels causes pollution in the form of carbon monoxide, unburned hydrocarbons, nitrogen oxides, soot, and particulates. Some of the alternatives that have been suggested are batteries (electricity), hydrogen fuel (fuel cells), solar panels (photovoltaic), ethanol, methanol, natural gas, geothermal, biomass, hydroelectric, and electric wind

generators. Methanol is made from natural gas, while ethanol is made by fermenting crop (primarily corn) starches and sugars. Geothermal energy is created when we force hot steam from the earth. Scientists can also harness the energy from the ocean and its thermal changes; this type of energy is classified as a biomass energy source. Other, more common types of energy sources are electric wind and hydroelectric generators. All of these various types of fuels are in the form of either liquid, gas or electric energy. Any of the alternatives listed above are much cleaner and healthier for us and our environment because they do not emit harmful gases or use valuable non-renewable resources.

Electric cars have been around a lot longer than one would think – since the 1830's. In fact, there were more electric cars being used at the end of the 1800's than there are in use today. Electric cars have improved a lot since then; now, some cars can travel over 150 miles before having to be recharged.

Fuel cells, which act similar to a battery, are also being considered. The cells are filled with hydrogen, methanol, phosphoric acid or molten carbonate salts and can store energy until it is needed.

The more popular option today for car manufacturers is a hybrid type of vehicle. This car is powered by an electric motor and another form of energy (gas, fuel cell, solar, etc.)

Solar powered cars have also been researched and manufactured to a very limited extent. This type of car would transfer the sun's energy trapped on a solar cell to an electrical battery used to power the automobile.

More than ever before, auto manufacturers are spending a lot of time and money researching the alternative energy sources listed above. Soon, this new technology will replace the use of non-renewable energy sources.

Topics covered are alternative fuels, fuel cells, and solar collectors. Students become familiar with terms such as velocity, rpm, and light intensity.

Instructions

5a. Power of Light

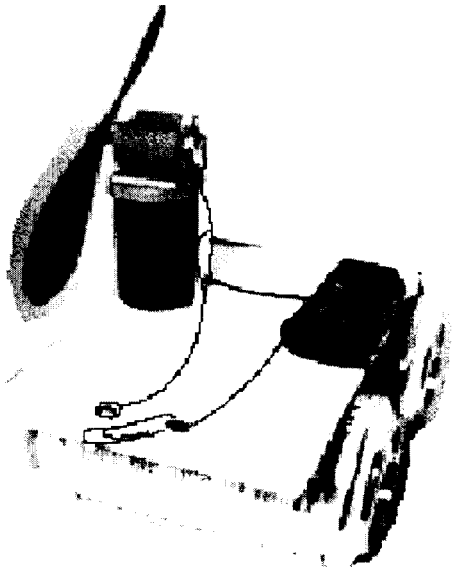
1. Demonstrate the power of light with the radiometer (creative collectibles, 1-973-808-1800) Why does it spin?
2. Solar cell and motor with blade "What can this be used for?"
3. Count the rotations per minute with several distances of light sources. (note distances and rpms on data report sheet)

5b. Solar Power

4. Using the photon racecar (Solar World, www.solar-world.com) Test out on sidewalk using a measured distance (25 feet) and time the speed of car. What is the velocity?
5. Answer questions on the attached activity sheets.

5c. **Battery Fan Boat**

6. Build a fan-boat using recycled materials. See instructions on following pages.
7. Operate the boat in the tub?
8. Answer the discussion questions



Additional Information:

Several web sites are available for more information on alternative energy:

- Office of Transportation Technologies Kids' Page
http://www.ott.doe.gov/kids.html
- Clean Cities Web Site
http://www.ccities.doe.gov
- Alter Fuels Data Cntr
http://www.afdc.doe.gov
- AFV Resources
http://www3.cerritos.edu/atc/resources.htm
- San Diego Clean Cities
http://www.sdrafvc.org
- Miramar College
http://www.miramar.sdccd.cc.ca.us

5. Alternative Energy Report Sheet

Group Name: _____

5a. Power of Light

1. Using the radiometer bulb. Write your data in the spaces below.

   Answer the following questions: Why does it spin?

2. Using the solar cell and motor -- What are the rotations per minute?

3. Photon Solar Racer- Time the 25 foot track. - Record the data below

#1*: What makes it spin?* Make notes about the experiments here

Gravity? _____ Magnets? _____ Heat? _____ Magic? _____ What? _____	

2: Rotations per minute Make notes about the experiments here

Distance from Light _____ Number of rotations _____ = rotations per minute (RPM) _____	

5b: Photon Racer Time the 25 foot track Make notes about the experiments here

Velocity - 25 feet/time	

5c. Build a FanBoat*

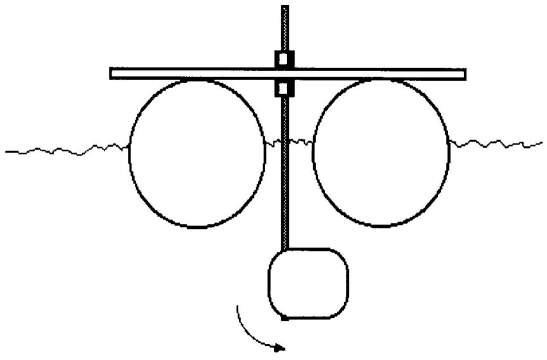
Build a fan-boat using recycled materials.

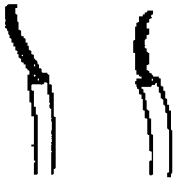
Instructions

Mount a deck (coroplast, thick cardboard, sticks, etc.) onto flotation devices (plastic pop bottles, milk cartons, etc.) using elastic bands looped over the cartons and the platform. Use a sticky-back to mount the film canister onto the deck, and mount the motor clip onto the top of the film canister. Attach wires, being sure to take some plastic insulation off the ends, and build a paper clip switch into the circuit. Mount the propeller on the motor shaft, and clip the motor into the mounting clip. Note that the motor can turn in either direction depending on how the wires are attached...reversing the connections reverses the motor's turning.

You may want to include a rudder with your boat, to ensure steering. A rudder can be a piece of dowel, and some coroplast, mounted through a hole in the deck, with vinyl tubing pieces.

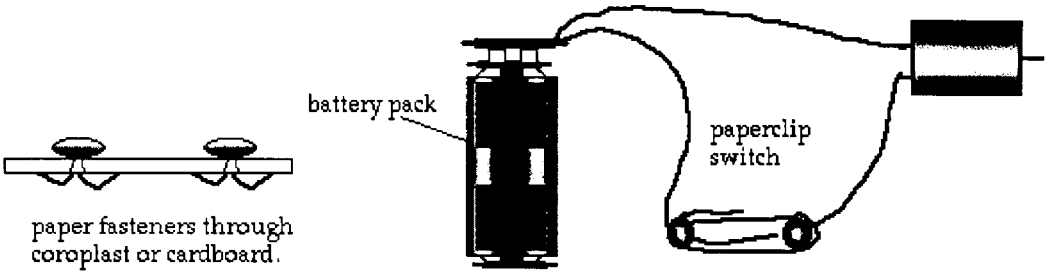
Using a wirestripper remove about 1-1/2 cm of the outer plastic insulation covering the ends of each wire.





Twist loose wire strands together.

Bend wire into a curl and hook through connectors. Twist tight, or solder.



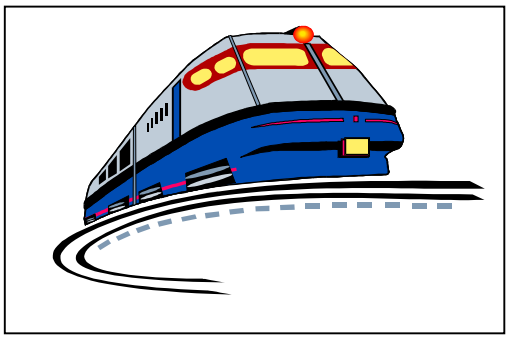
DISCUSSION:

1. Can your ship carry a cargo?
2. Can you control its direction?
3. How sturdy is it?

Note: There are 4 ways to make the propeller go: mounting it forwards or backwards; and running it clockwise, or counter-clockwise, once mounted.

More Information:

This experiment taken from www.web.net/~sunwind/technology



6

Magnetic Levitation Design

Science Standards
Science as inquiry
Unifying Concepts and Processes

Science Process Skills
Collecting Data
Constructing
Inferring
Interpreting Data
Controlling Variables
Investigating

Objective:
To learn about new high speed rail systems based on magnetic energy.

Description:
In this activity, students explore magnets and perform simple experiments to determine magnetic energy. They will also use a MAGLEV model to design a commercial passenger train.

Materials and Tools
Several different types of magnets
MAGLEV model
Notebook
Scale
Compass

Background:
Railroad systems have carried cargo and people for over 100 years. The first trains were powered by steam engines using coal. Modern trains such as Amtrak, depend on other fossil fuels. A new concept uses magnets to lift and propel train at incredible speeds. They travel at speeds in excess of 300 miles per hour.
The topics covered are magnetic fields, friction and magnetism. Students become familiar with terms such as light rail and MAGLEV.

Instructions

1. The instructor will demonstrate a magnetic levitation model.

2. You will use the levitron as an introduction to magnetism and the concept of magnetic forces. Note the magnet numbers on the data report sheet.

3. Demonstrate the magnetic levitation using magnets from the test kit. You will test several magnets to determine the forces created by magnets. Print out your results

4. Use the sample MAGLEV models to develop initial calculations for designing a real MAGLEV train system.

6. Magnetic Levitation Design Report Sheet

Group Name: _____

1. Test your magnet. How many paper clips did it hold? Write your data in the spaces below.
2. Test the ability of a magnet to magnetize other objects -- record the data below
3. Test the forces generated by a magnet and determine how much force is required for magnetic levitation.

Test #1*:* *Power of attraction* Make notes about the experiments here

How many paper clips did the magnet hold? _____ What is the weight of the paperclips? _____	

Magnet #2*:* *Chaining of magnets* Make notes about the experiments here

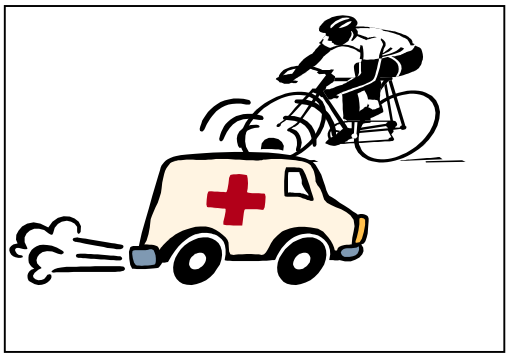
How many paperclips could be suspended from one magnet in a chain? _____	

Magnet #3*:* *Repulsive forces* Make notes about the experiments here

At what distance are the repulsive magnets suspended? _____ What is the weight of the magnet being repulsed? _____ What is the repulsive force? Note that the force is opposite gravity's pull on the magnet. _____	

Magnet #4*:* *Model Train* Make notes about the experiments here

What is the weight of the model train? _____ How high is the model train suspended? _____ What force is required to levitate an actual train weighing 50,000 lbs.? _____	



Science Standards
Science as inquiry
Physical Science - Motion

Science Process Skills
Measuring
Collecting Data
Interpreting Data
Controlling Variables
Investigating

7

Transportation Safety

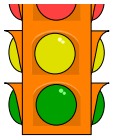
Objective:
To explore issues related to automobile safety. Also learn ways to alleviate unwanted noise near highways**.**

Description:
In this activity, students learn about bike, bus and auto restraints safety. They also perform experiments illustrating air bag physics and sound barrier materials.

Materials and Tools
"Safety Challenge":
Raw eggs (4-6)
Single Bed Sheet
2 large wooden dowels
Needle and Thread
Sound meter
Tapes of various transportation and neighborhood sounds
Sound isolation chamber (plastic box)
Barrier materials: concrete board, wood plank, acoustic tile, carpet, plant material
Notebook
Yard stick

Background:
Safety
Transportation safety includes bike safety, pedestrian safety, car safety and passenger (auto, air, and train) safety and other related areas. Airline safety can also be included in this topic. Although airlines have a better safety record than automobiles, airports are becoming more congested each year.

The sad fact is that yearly thousands of people still die in traffic crashes. When a vehicle is involved in a crash, passengers are still traveling at the vehicles original speed at the moment of impact. When the vehicle finally comes to a complete stop, unbelted passengers slam into the



steering wheel, windshield or other part of the vehicle's interior.
Seat belts are your best protection in a crash. They are designed so that the forces in a crash are absorbed by the strongest area of your body -- the bones of your hips, shoulders and chest. They keep you in place so that your head, face and chest are less likely to strike the windshield, dashboard, other vehicle interiors or other passengers. They also keep you from being thrown out of a vehicle.
Did you know that airbags save over 1,500 lives per year? Amazing isn't it. For adults, airbags can seriously reduce the chance of injury in a crash that's a good thing. What's not so good is that the force of an airbag when it's deployed can severely injure small children.
An air bag is made of coated fabric and is stored in a module mounted on the steering wheel. Crash sensors, which activate upon impact at speeds of 10-15 miles per hour, are mounted in several locations on the car chassis.

In a crash, the sensors ignite a chemical, sodium azide, which releases harmless nitrogen gas to instantly inflate the bag. As the driver or passenger is thrown into the bag, it applies a restraining force. Even though this entire process happens in only 1/25th of a second, the added time is enough to slow momentum to prevent serious injury.

Drinking and driving don't mix.
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Drinking and driving don't mix.
No matter how many times you've heard it, there are people who just don't get it. In fact, every 30 minutes, someone in this country dies in an alcohol-related crash. Every 30 minutes! And last year alone over one million people were injured in alcohol-related traffic crashes. (In Alabama alone last year approximately 115 people were killed.)

Noise
Highway's criss-cross America and can cause high levels of noise (unwanted sound) within both urban and rural areas. A common method for overcoming noise is to build sound barriers (usually high walls) around interstates. This raises many questions: Do these work, what materials are best, Are these a good option?

Instructions

7a. Safety Challenge

1. Answer questions on worksheet about bicycle, bus and automobile safety

7b. Automobile Safety

Purpose: Design ways to cushion an egg that is thrown through the air. Using the theories behind air bags in automobiles, find the best way to protect it from impact so you can throw it faster and further**.**

1. Turn under the bottom edge of the sheet about 10 cm. Sew the flap up and insert the wooden dowels into the top cuff and the one you have just sewn.

2.Have four classmates hold the corners of the sheet out horizontally to the ground.

3.Have a fifth student take aim, wind up and pitch the egg up and over onto the sheet.

4. Experiment with different speeds and distances to see how far and how fast you can throw the egg without breaking it.

7c. Sound Barriers

Purpose: Design ways to alleviate sound from highways to protect residential areas from noise.

1. Handout on common noise levels -- what is a "bel"?

2. Demonstrate the sound meter using common sounds. "How many decibels is common conversation?…

3. Demonstrate the attenuation of sound by taking sound readings at 10, 25 and 50 foot distances.

4. Place tape recorder in booth and set up first barrier material. Place sound meter in the booth and measure decibel level.

5. Set up second barrier material and repeat at same distance

6. Repeat for third material

7. Answer questions on worksheets

Discussion

Air bags:

- *What happens to the egg's momentum?*
- *What would happen if you were dropping the egg on a concrete floor?*
- *How could you cushion the egg itself? Would that transfer the momentum of the egg?*
- *Would a parachute attached to the egg provide enough cushion to keep it from breaking? How high could you drop an egg attached to a parachute?*
- *Does the size of the sheet make a difference in your experiments? What if you pulled the sheet taut?*

Additional Information:

"Web sites" for more information:
http://www.nhtsa.dot.gov/kids/research/airbag/index.html

www.wsdot.wa.gov/regions/northwest/Noise/8.html

www.fhwa.dot.gov/environment/probresp.htm

www.guilite.com/highway.html

7c. Highway Noise Control Report Sheet

Group Name: _____

1. Test sound attenuation by using any tape recording and taking measurements at 10, 25 and 50 feet from source
2. Test your first noise barrier wall with the traffic sounds. Record the highest decibel reading in the space below.
3. Rewind the tape and do the experiment with the second noise barrier material--record the data below
4. Repeat for a third material or several layers of your choice.
5. Graph the results in excel on the computer and save your file to disk.

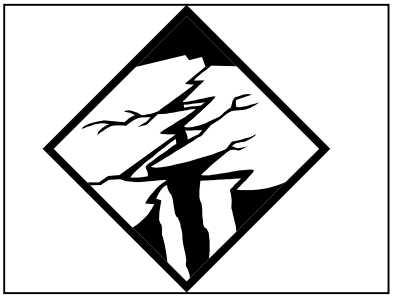
What was the sound reading	10 feet from source	25 feet from source	50 feet from source

Barrier material study

What was the sound reading:	Concrete Board	Wooden Fence	Other Material

Conclusions from the distance measurements?

Conclusions from the barrier material measurements?



8

Soils and Geotechnical Materials

Science Standards
Science as inquiry

Science Process Skills
Measuring
Collecting Data
Interpreting Data
Controlling Variables
Investigating

Objective:
To explore classification of soil types and engineering descriptions of soils**.**

Description:
In this activity, students perform simple soil experiments to determine types of soils and engineering properties.

Materials and Tools
Soil samples & containers
Microwave oven
Scale balance
Set of sieves
Shaker (optional)
Liquid limit device
Notebook

Background:
Structures of all types rest on soils thus proper analysis of these soils is necessary to ensure that structures remain stable and do not collapse. A classic example of poor soil conditions is the leaning tower of Pisa. This structure is leaning 5 degrees off of perpendicular due to the sandy (unconsolidated) soil and low water tables of the region. Soil testing is an important step in construction design projects. They are used to quantify the type of foundations needed for a specific site.

An easy method for identifying soils is to use sieves to measure the sizes of particles in the soil. Another important identification tool is moisture content. We will also be doing a liquid limit test to determine the way a soil "flows" to look at compression settlement.

Concepts & Terms:
Soil classification, moisture content, and liquid limit

Instructions

Moisture content

1. Determine the weight (mass) of a dry, clean container. Note on report.
2. Place the soil sample in the container and weigh?
3. Place the filled container in the microwave oven and set the time for 3 minutes. Check to see if dry -- If not, reset oven for 3 more minutes
4. After the time has elapsed and the soil is dry, the instructor will remove the container. Allow to cool. Note the weight on the sheet.

Grain size analysis

5. Weight (5) empty sieves and pan. Note weights on work sheet.
6. Stack sieves in the following order from top to bottom: #10, #40, #100, # 200, and pan (Larger holes on the top)
7. Place 1 kg of dry soil in the top of a #10 sieve and set up on shaker device.
8. Shake for 2 minutes.
9. Weight each sieve filled with soil. Use report sheet to document results.

Liquid Limit

10. Using soil given by the instructor (that has passed the #40 sieve) weigh out approximately 150 grams.
11. Add enough water to make a thick paste. Add the sample to the liquid limit device. Smooth out the surface.
12. Make a groove with the knife (about 1/2 inch deep)
13. Lift and drop the cup by turning the crank. Count the number of drops it takes to close the gap. Take a small sample out for moisture tests.
14. Remix the soil sample with 5 mL of water.
15. Place back in Liquid limit device and make another groove. Repeat dropping and counting procedure until the groove closes. Take a small sample out for moisture tests
16. Go back to #15 and repeat again.
17. Determine the water content of the soil for each trial (#1-4)
18. Perform calculations and answer questions on worksheet

Discussion

1. *What type of soil is this?*
2. *Would you be able to build a tall structure on it?*
3. *What are some properties of clay?*

Additional Information:

"Web sites" for more information -

www.asce.org
www.lamotte.com/WEB-SITE/SIDEFRAM/PROJECTS/ACIDRAIN.HTM

8. Soils and Geotechnical Materials

Group Name: _____

8a. Moisture content

	Weight (grams)
Weight of empty container?	
Weight of container & wet sample?	
Weight of container & dry sample?	
Difference between wet and dry sample = Weight of water?	
Difference between dry sample and container = Weight of dry soil?	
Moisture content	

8b. Grain size analysis

	Weight of Sieve Empty	Weight of Sieve with soil	Weight of soil on sieve	Weight of soil passed
#10 sieve (2.0 mm)	661.6			
#40 sieve (0.42 mm)	390.7			
#100 sieve (0.15 mm)	521.9			
#200 sieve (0.08 mm)	333.8			
pan	383.9			
Total				

Draw a graph (excel) with the percent retained numbers. Identify the soil types.

8c. Liquid Limit

Make notes about the experiments here

Number of drops to close groove:	**Sample 1**	**Sample 2**	**Sample 3**
Moisture Content	**Sample 1**	**Sample 2**	**Sample 3**
Weight of empty container?			
Weight of container & wet sample?			
Weight of container & dry sample?			
Difference between wet and dry sample = Weight of water?			
Difference between dry sample and container = Weight of dry soil?			
Moisture content			

Draw a graph (excel) with the number of drops versus moisture content. What does this tell us?