The Georgia Tech Student and Teacher Enhancement Partnership (STEP) Program

Donna Llewellyn, Center for the Enhancement of Teaching and Learning (CETL)

Marion Usselman, Center for Education Integrating Science, Mathematics and Computing (CEISMC)

Sponsored by the National Science Foundation through the GK-12 program

Primary Goals

- **To broaden the education of science, technology, engineering, and mathematics (STEM) graduate students to include intensive experiences in educational pedagogy and process;**
- **To encourage the participation of STEM faculty and students in the difficult issues facing K-12 educators through the nurturing of university-school partnerships;**
- **To assist K-12 teachers in their endeavor to improve classroom instruction;**
- **To help schools improve K-12 student achievement in STEM.**

Important Program Components

- **10-week Summer Training Program for Fellows**
- **School year spent paired with Metro-Atlanta area high school.**
- **Time Commitment--10 hours per week in school, 5 hours per week preparation.**
- **Compensation--$26.5 K for students who are post Ph.D. qualifying exams, $21.5K for students who are pre-qualifying exams, plus tuition.**

STEP Fellows - Cedar Grove High School, DeKalb County

Pamela Reid--Ph.D. student in Chemical Engineering.

Sundiata Jangha--Ph.D student in Mechanical Engineering

STEP Fellows at Dunwoody High School, DeKalb County

Frank Pyrtle--Ph.D. student in Mechanical Engineering

Kendra Taylor—Ph.D. student in Industrial and Systems Engineering

STEP Fellows at Westlake High School, Fulton County

David Woessner--Masters student in Mechanical Engineering and Management

Scott Cowan—Ph.D student in Mechanical Engineering

STEP Fellows at Tri-Cities High School, Fulton County

Christal Gordon--Ph.D. student in Electrical and Computer Engineering

Rick Peltier--Ph.D. student in Earth and Atmospheric Science

STEP Fellows at Marietta High School, Cobb County

Adam Austin--Ph.D. student in Electrical and Computer Engineering

Demetris Geddis--Ph.D. student in Electrical and Computer Engineering

STEP Fellows at Rockdale Magnet School for Science and Technology, Rockdale County

Yolanda Alexander--Ph.D. student in Industrial Engineering

Kacy Cullen--Ph.D. student in Bioengineering

STEP Philosophy of Partnerships

- **Partnerships must be based on common goals.**
- **All partners must experience benefits from the partnership.**
- **School-University partnerships that flourish are based on genuine mutual respect by all parties.**
- **Team-building and proactive communication are crucial to a successful partnership.**

K-12 Benefits from STEP Program

- **Fellows serve as content experts for both high school students and teachers, and challenge students to improve critical thinking skills**
- **Fellows can help increase level of academic bar**
- **Fellows serve as mentors who can relate to students**
- **Program provides some funding to initiate new activities at the high schools**
- **Schools can take advantage of Georgia Tech resources**
- **Fellows provide fresh energy and enthusiasm to schools**

University Benefits from STEP Program

Valuable Graduate Student Experience

- Increases leadership and communication skills
- Improves teaching skills
- Increases confidence working with students
- Helps broaden or sharpen perspective on career paths
- Provides avenue for graduate students to “give back” to community

Mutual Benefits from STEP Program

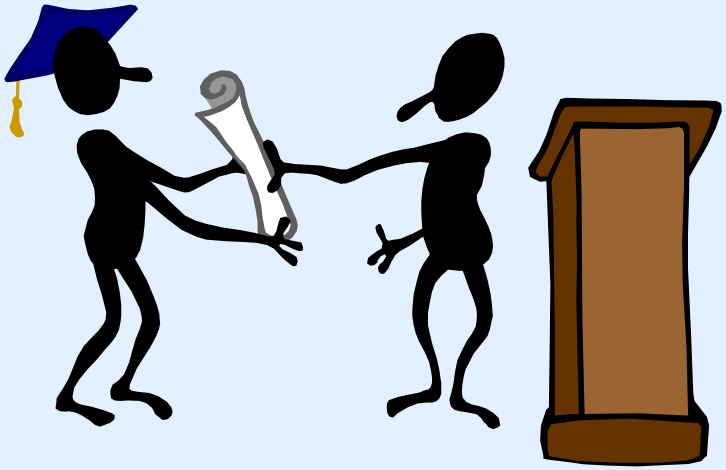
Strengthens K-12/University Connections

- **Positively influences the pipeline of students entering the university.**
- **Increases SMET career expectations of minority students.**
- **Facilitates developing mutually rewarding professional opportunities for both K-12 and university faculty.**

One-on-One Tutoring for the Georgia High School Graduation Test

William H. Robinson
Ph.D. Candidate in Electrical Engineering
Georgia Institute of Technology

GHSGT Information



- Based on Quality Core Curriculum (QCC) learning objectives (grades 9-12)
- Required for graduation
- Tutored seniors retaking the science test

Web Resources

- Georgia Department of Education

http://www.doe.k12.ga.us/sla/ret/ghsgt.asp

- The Mental Edge

http://www.learningshortcuts.com

- GaTest.com

http://www.gatest.com

Tutoring Strategies

- Review material from Passing the Science Graduation Test
- Provide worksheet activities
  - Crossword puzzles, word searches
- Provide sample tests
  - Feedback for students

The Tutoring Dilemma

Teaching the material

VS.

Teaching the test

- **Addressing fundamental concepts**
  - Scientific method, periodic chart, etc.
- **Common test questions**
  - Element least likely to react (noble gas)
  - Measure liquid accurately (graduated cylinder)
  - Complete the electrical circuit (metal object)

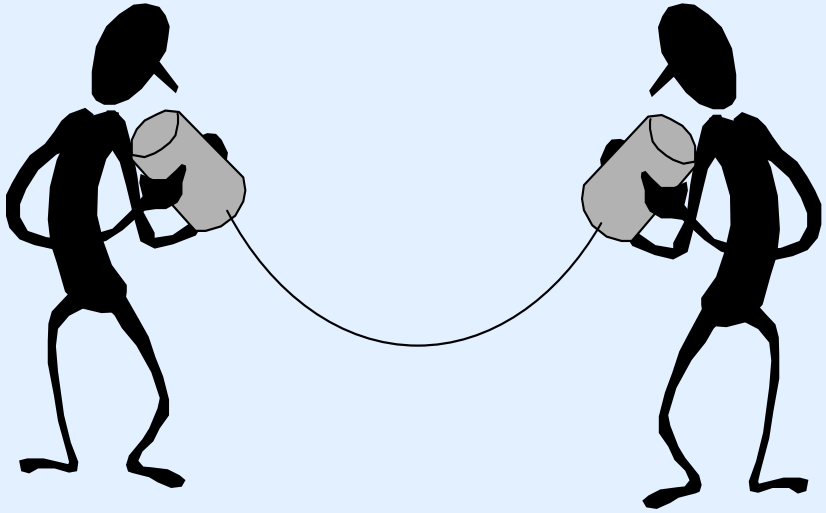
Keys for One-on-One Tutoring

- Understand the student's perspective
- Use the student's prose
- Uplift the student's participation

Understand The Student's Perspective

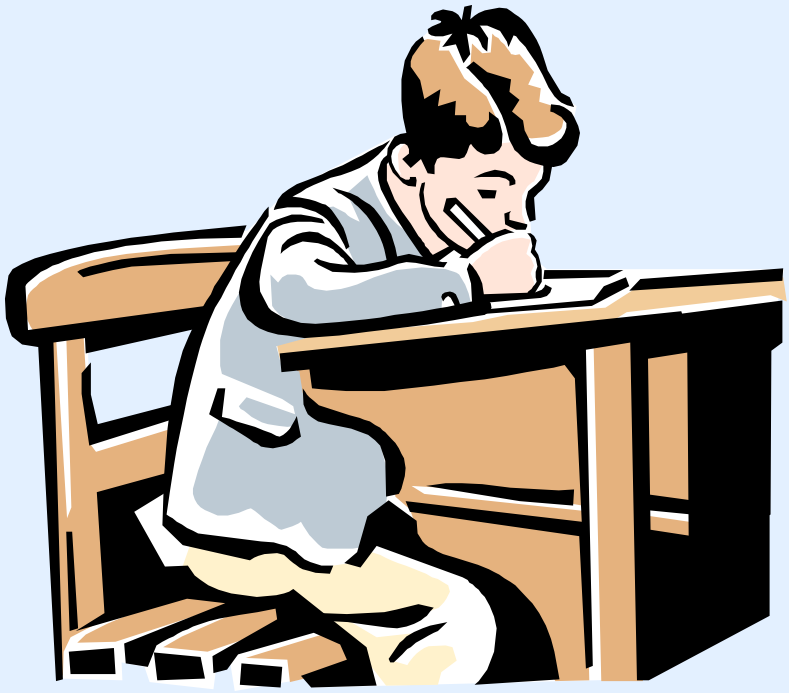
- **Motivation**
  - Previously unsuccessful
  - Scientific aversion
  - ✓ Willing to learn
- **Academics**
  - Fundamental concepts
  - Test-taking skills
  - ✓ Access knowledge

Use The Student's Prose



- Translate our knowledge into words
- Illustrate concepts with creative metaphors
- Emphasize key points

Uplift The Student's Participation



- Allow students to do the work
- Avoid telling the correct answer
- Augment confidence

STEP Fellow Enrichment

- **Personal**
  - Assist students
  - Develop mentorship
- **Professional**
  - Improve communication skills
  - Improve lecturing style

The High School Teacher & Graduate Student Commonality

Genara Andrade, Chemistry
Georgia Institute of Technology
Margaret Tarver, High School Teacher
Tri-Cities High School

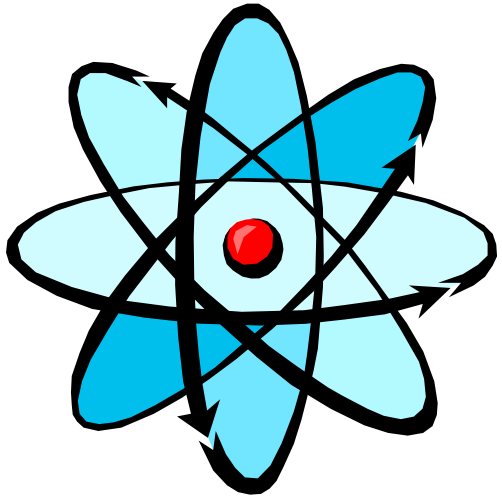
The High School Teacher & Graduate Student

- Implementing Current Research
- Communicating Technical Information
- Innovative Approaches
- Reality

Graduate Student -→ Teacher

- Current Research from GA Tech
- Development of Lab Activities
- Use of Web Page
- Science Research Projects

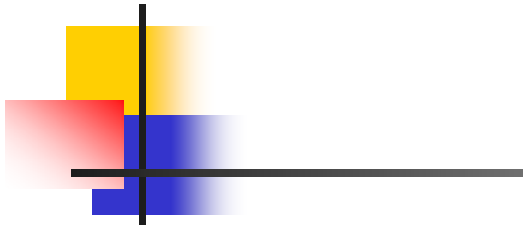
Teacher---→Graduate Student



The Art

Of

Simplification



A “Technically Correct” Lecture

Four quantum numbers are used to describe every electron in an atom. The first three numbers give the location of the electron, the fourth number describes its orientation.

The four quantum numbers are:

n, λ, m $_{\lambda}$, m_s

Principle Quantum Number (n)

n = 1, 2, 3, 4,…

The principle quantum number describes the major energy levels

As the value of n increases, the distance of the electron from the nucleus increases

There can be several sub-levels in each energy level

Subshell Quantum Number (λ)

$\lambda = 0, \ldots, n-1$

The secondary quantum number describes the shape of the electronic sublevels or atomic orbitals

As the value of λ increases, the energy of the orbital increases

These sublevels are generally referred to by letters

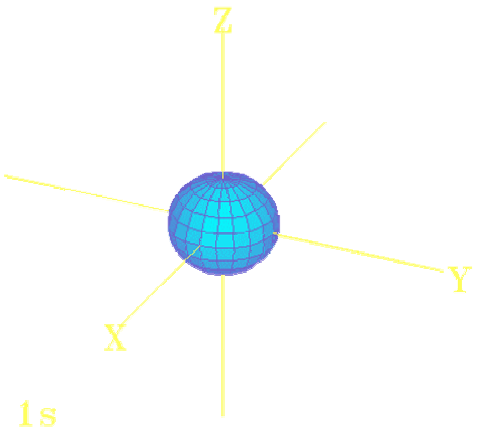
0…***s*** orbital

1…***p*** orbital

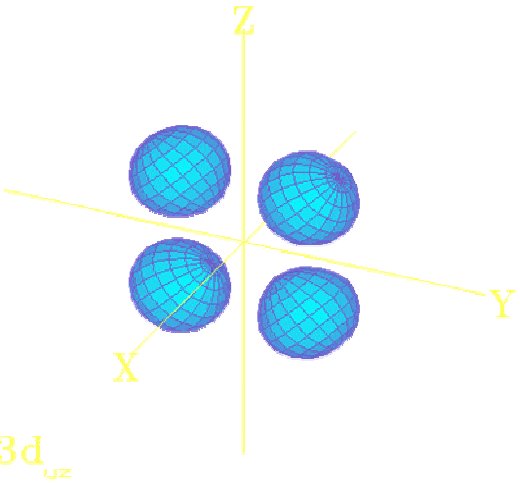
2…***d*** orbital

3…***f*** orbital

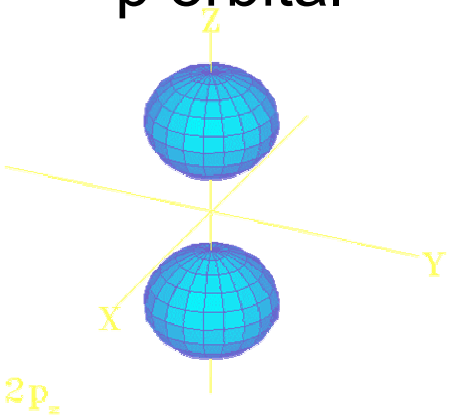
s orbital



d orbital



p orbital



Magnetic Quantum Number (m_λ)

$m_\lambda = (2\lambda+1) = +\lambda \ldots 0 \ldots -\lambda$

The magnetic quantum number describes the orientation of the atomic orbitals

The value of m_λ is the number of orbitals in each sublevel

s orbital = one orbital

p orbital = three orbitals

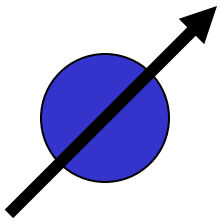
Each orbital can only hold 2 electrons

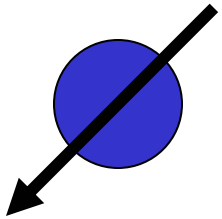
Spin Quantum Number (m_s)

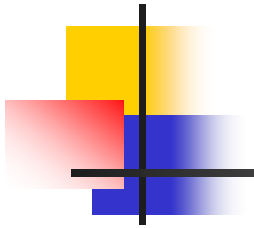
m_s = +1/2 or -1/2

The spin quantum number describes the orientation of the electron

Electrons with the same value of n, λ, and m_λ CANNOT have the same value of m_s







VS.

A Lecture

The Students Will Understand

Electrons in an Atom

Electrons are placed in different energy levels.

This helps to explain and predict the behavior of an atom.

Principle Energy Levels

The principle energy levels are described by numbers

1, 2, 3, 4,…

Each energy level has one or more sublevels

- The 1st energy level has 1 sublevel
- The 2nd energy level has 2 sublevels
- The 3rd energy level has 3 sublevels
- Energy levels 4 and up have 4 sublevels

The sublevels are described by letters

Sublevels

The 1st sublevel is “s”

There is 1 orbital in this sublevel

The 2nd sublevel is “p”

There are 3 orbitals in this sublevel

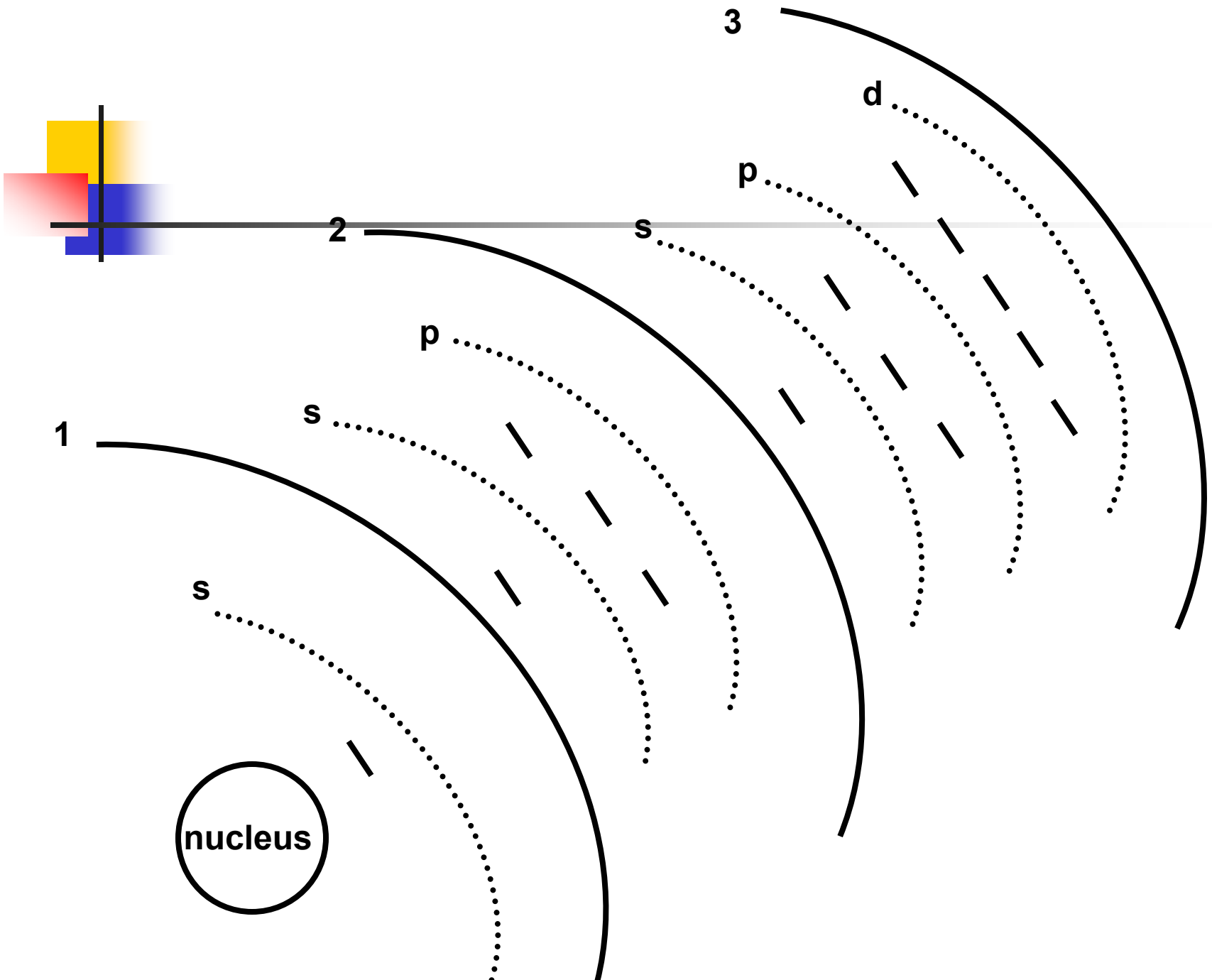
The 3rd sublevel is “d”

There are 5 orbitals in this sublevel

The 4th sublevel is “f”

There are 7 orbitals in this sublevel

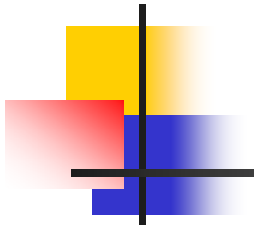
Each orbital can only hold 2 electrons


3
d
p
2
s
p
s
1
s
nucleus

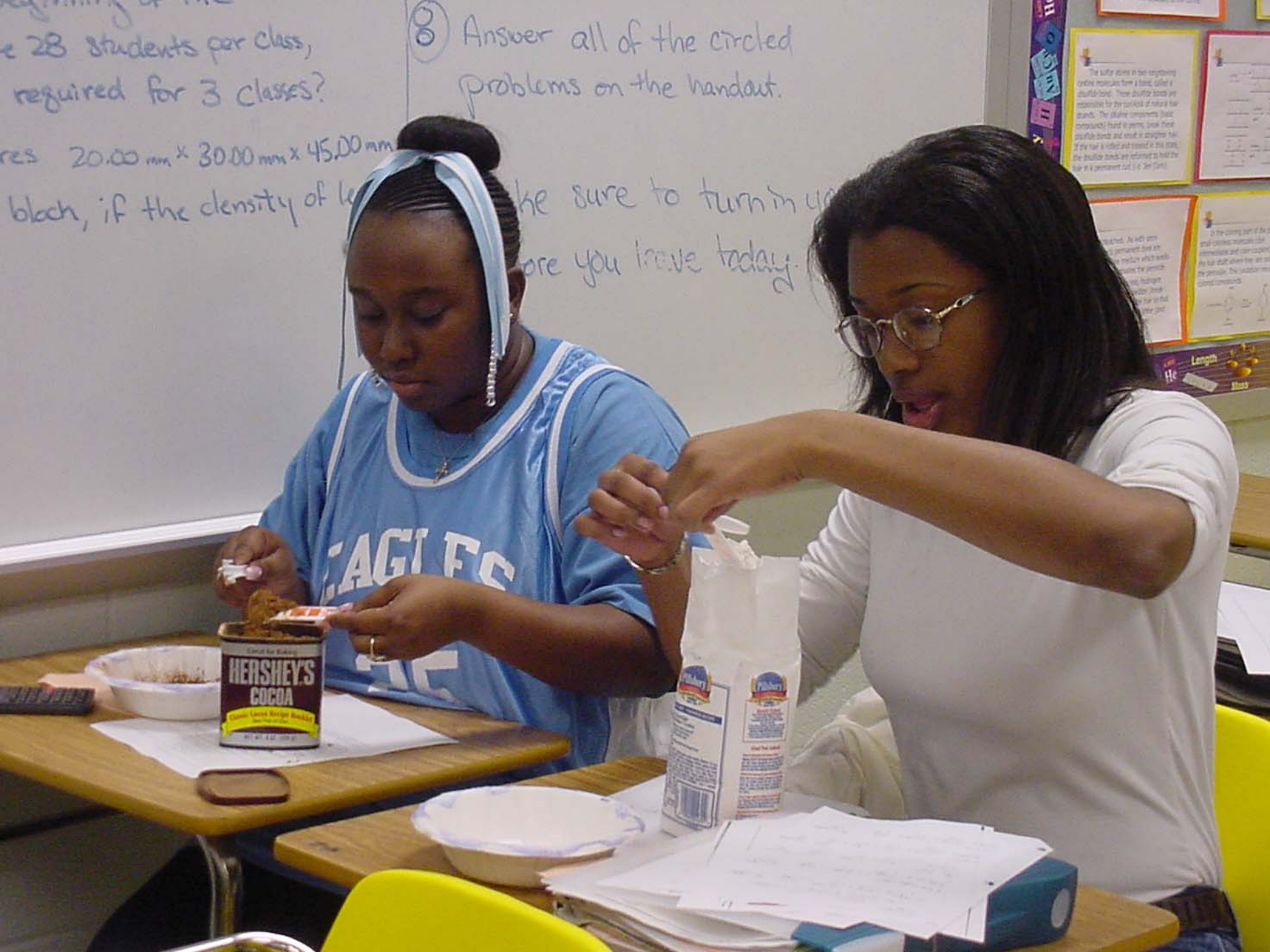
Graduate Student--→ Teacher

Putting A New Twist

On an Old Idea

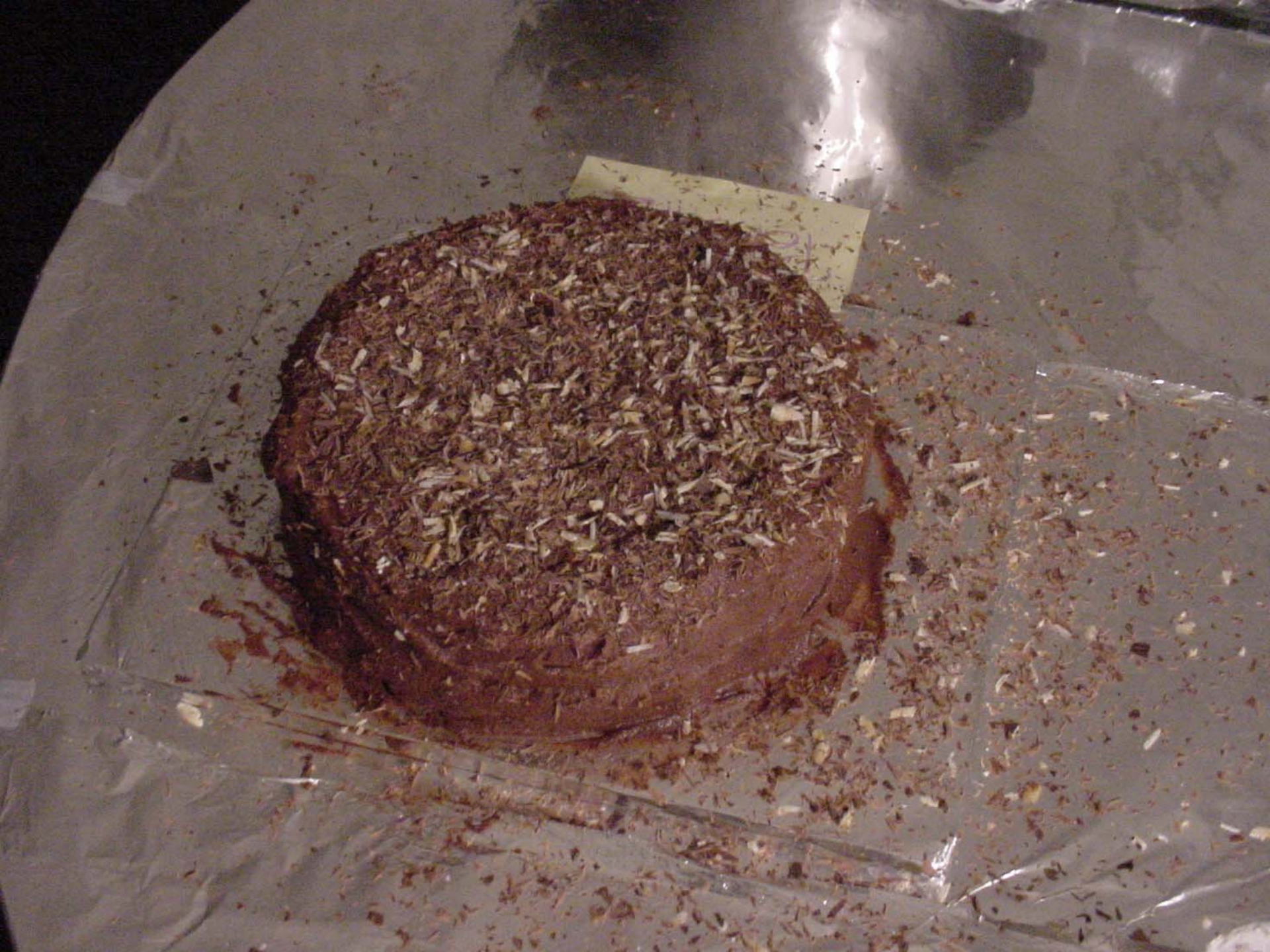


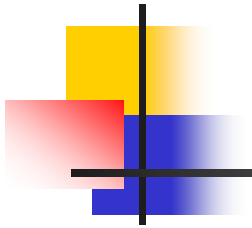
Dimensional Analysis Lab


e 28 students per class,
required for 3 classes?
res 20.00 mm x 30.00 mm x 45.00 mm
block, if the density of
8 Answer all of the circled
problems on the handout.
ke sure to turn in
ore you leave today.
EAGLES
HERSHEY'S
COCOA
Length
Mass


Periodic Table of the Elements
JORDAN


Periodic Table of the Elements





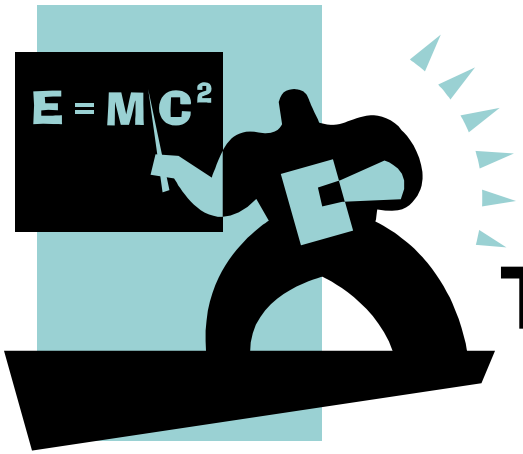
Mole Day
October 23, 2001

Mole Day Activities

Molympics

- Number of particles of sugar in a jar of skittles
- Mole Drop Relay
- It's a Gas Relay
- Mystery Mole

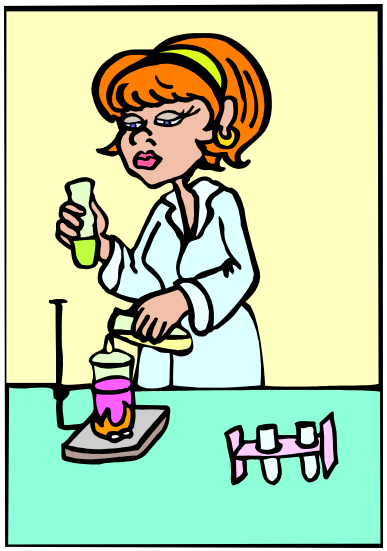
Teacher-→ Graduate Student



Art

Vs.

The Teacher's Job



Ready, Aim, Teach

Christal Gordon, MSEE

Rick Peltier, MPH

Georgia Institute of Technology

Rick Peltier – STEP Fellow Extraordinaire

School of Earth and Atmospheric Sciences

Research Interests:

Public Health and Air Quality

Christal Gordon – Super STEP Fellow

School of Electrical and Biomedical Engineering

Research Interests:

On-Chip Learning Design

Planet You

- Inquiry-based approach to environmental sciences.
- Semester-long project for (near) at-risk students.
- Incorporates all learning styles.
- Creativity, physical principles, and integration of knowledge required.
- Multidisciplinary learning.

And you thought you were just going to listen…

- *Your mission (should you choose to accept it):*

Astronomers have discovered that Planet Earth will be pummeled by a comet in 60 days, ending life as we know it. Your task – design a new planet that will sustain life for 6.5 billion earthlings.

Planet Design

- First thing's first – design the structure of your new planet. Tell us about the inside of your planet, the atmosphere, the lithosphere, and the characteristics of where the 6.5 billion humans will live.

- Creativity is required – feel free to draw, graph, write, or use any other appropriate way to describe your planet. You are free to choose any design for your planet, but your decisions must fit within the laws of physics, chemistry, and biology.

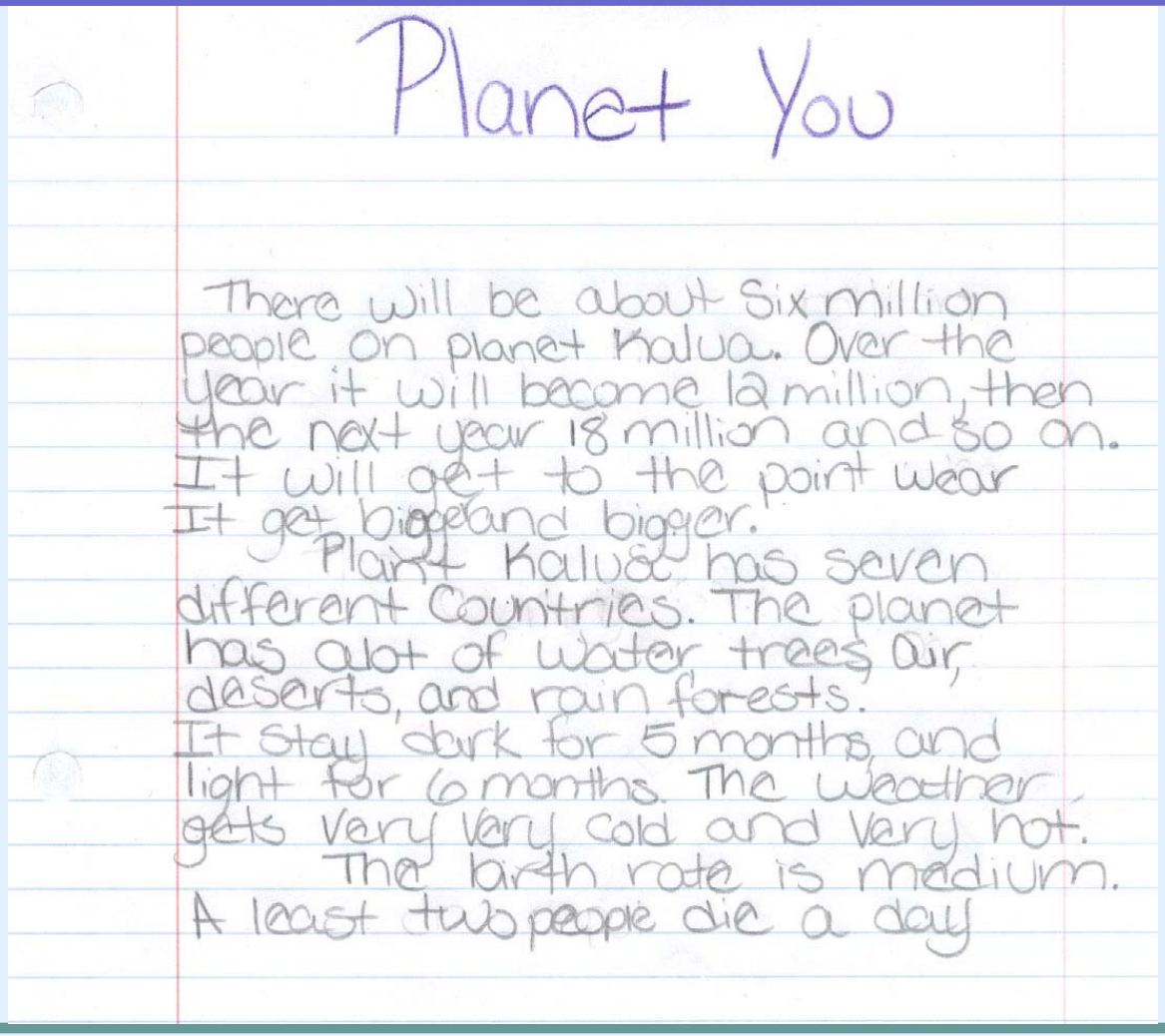
My Planet

My World

Student Table Representing Data

Energy Type	Number of MW	Immediate Environmental Concerns	Social Concerns	Upfront Costs (Upfront Cost per MW x # of MW)	Cost per Year (# MW x Cost per MW x 365)	Sustainability
Solar Energy	1,000,000 2,000,000	Battery disposal/waste, ground coverage of solar panels near heavy-users.	Minimal	$8,000 x 1,000,000 MW = $8,000,000,000 8,000x2,000,000mw= 16,000,000	$16 x 1,000,000 x 365 days = $5,840,000,000 $16x2,000,000x365da= 116,800,000	Endless supply of energy.
Hybrid energy Fuel cells	2,000,000	not many.	minimal	Fuel cells 12,000x2,000,000= 24,000,000	$75 x2,000,000x365= 54,750,000	moderate supply
coal	2,000,000	Surface mining Particularly destructive to the environment, burning coal gives off pollution.	Significant.	6,000 x 2,000,000mw 12,000,000	$350x2,000,000x365= 2555,0000	has roughly 25 yrs, of coal left on it.
Nuclear	2,000,000	they generate radioactive waste. It takes hundreds or thousands of years to decompose it.	Significant.	14,000x2,000,000 mw= 28,000,000	$00 x2,000,000x365= 21,900,000	Can be regardless as an endless supply of energy.
Hydroelectric	2,000,000	moderate amt of fish + Plants.	Few	8,000 x2,000,000mw= 16,000,000	$200 x2,000,000x365= 14,600,000	Truly dependant on mother nature.
	Total # MW:			Total Upfront Cost: $16,000,000	Total Cost per Year: ~~24,820,116~~ 35,948,000	

Descriptive Writing



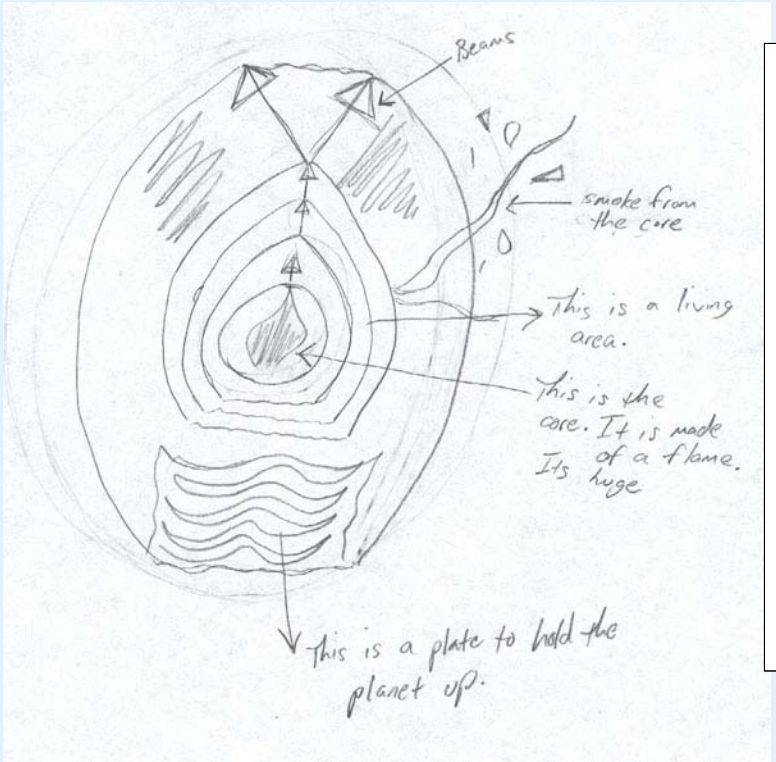
Planet You

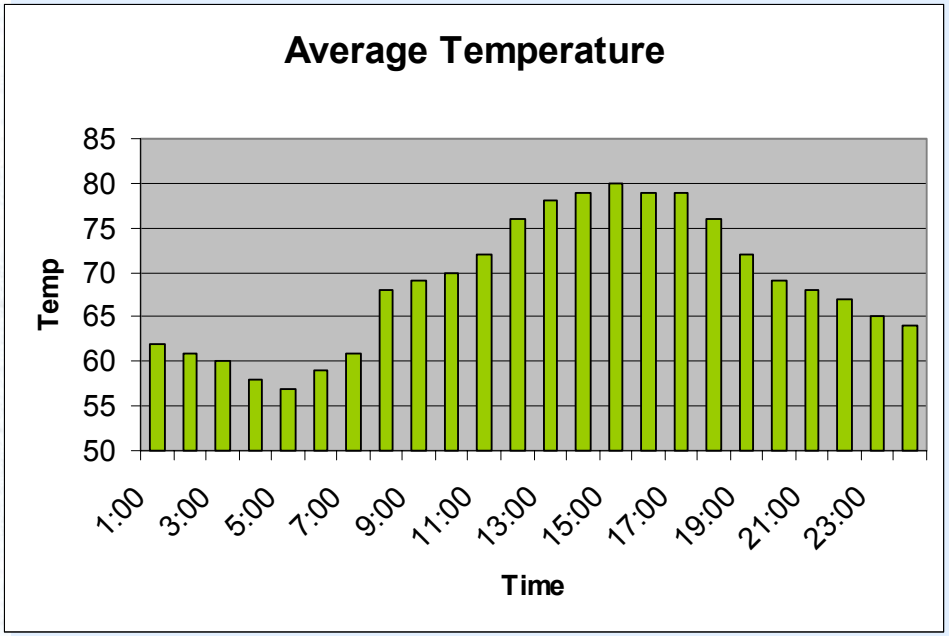
There will be about Six million people on planet Kalua. Over the year it will become 12 million, then the next year 18 million and so on. It will get to the point wear It get bigger and bigger.

Plant Kalua has seven different Countries. The planet has alot of water trees, air, deserts, and rain forests. It stay dark for 5 months and light for 6 months. The weather gets very very cold and very hot.

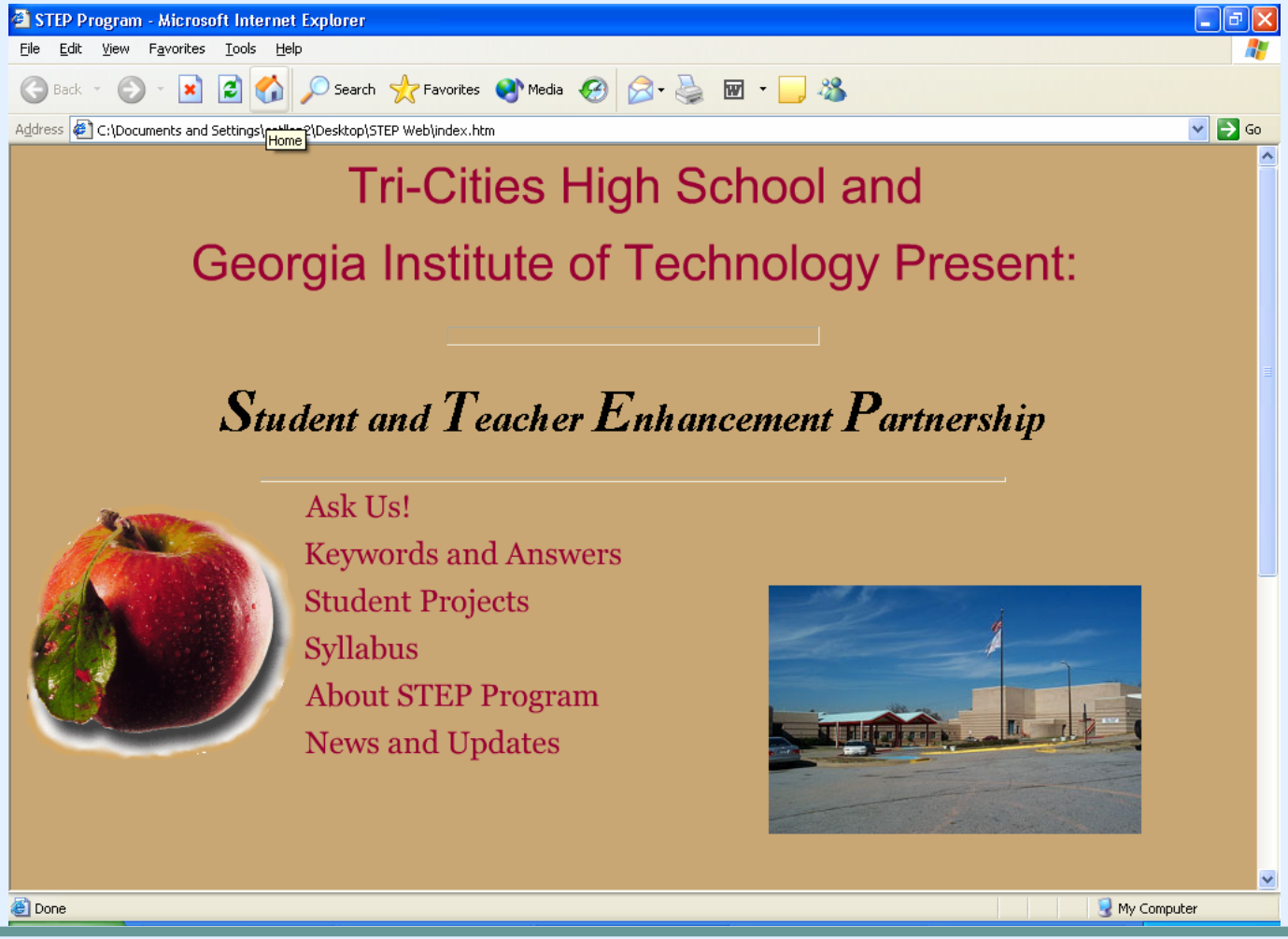
The birth rate is medium. A least two people die a day

Schematics and Charting





STEP Webpage



Tri-Cities High School
Challenges

- Basic competence in mathematics, computer skills, life-science principles.
- Maintaining student attention.
- Highly mixed class in terms of academic skill.

Tri-Cities High School
Successes

- Curriculum emphasized in a “why-is-this-important-to-me” method.
- Creativity allows for incorporation of many learning styles at once.
- Promotion of extracurricular student activities.

Rick: expertise in earth science curriculum
Christal: succeeds in developing/building age-appropriate learning tools

Undergraduate STEP Fellows

- Classroom presence at least doubled.
- Improved student-fellow relations.
- Diverse backgrounds/research assist with novel curriculum development.
- Highly cost-effective
- Requires some additional work from graduate fellows (management, meetings, performance evals., etc.)

Ready, Aim, STEP

- Multidisciplinary curriculum reinforces previously-learned material.
- Novel approaches to material are effective at reaching at-risk students.
- STEP Fellows assist with tangential discussions
- Undergraduate STEP Fellows are an excellent compliment to program.

Conclusions

- Discussion
- Questions
- Contact Info:
  - Marion Usselman – marion.usselman@ceismic.gatech.edu
  - Donna Llewellyn – donna.lewellyn@cetl.gatech.edu

http://www.cetl.gatech.edu/menu_options/gta/step/stepfellowindex.htm

http://www.ehr.nsf.gov/dge/programs/gk12