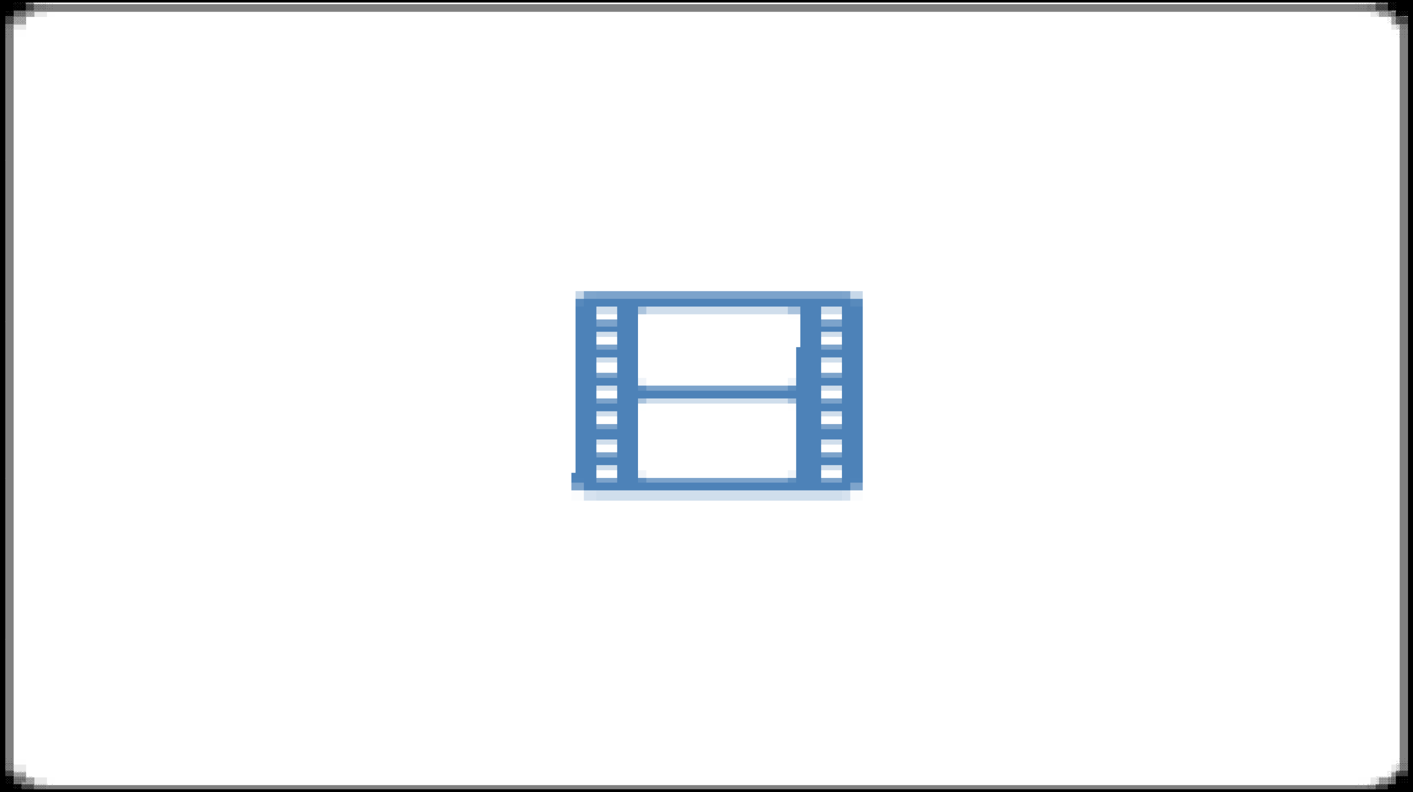
Introductory Oceanography Lab

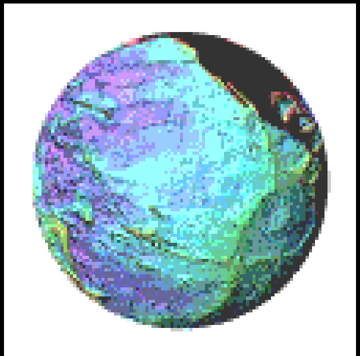


Oceanography 101L – Intro Ocean Laboratory

Spring 2020 Semester - MiraCosta College

Instructor: Ray Rector

First Day Agenda



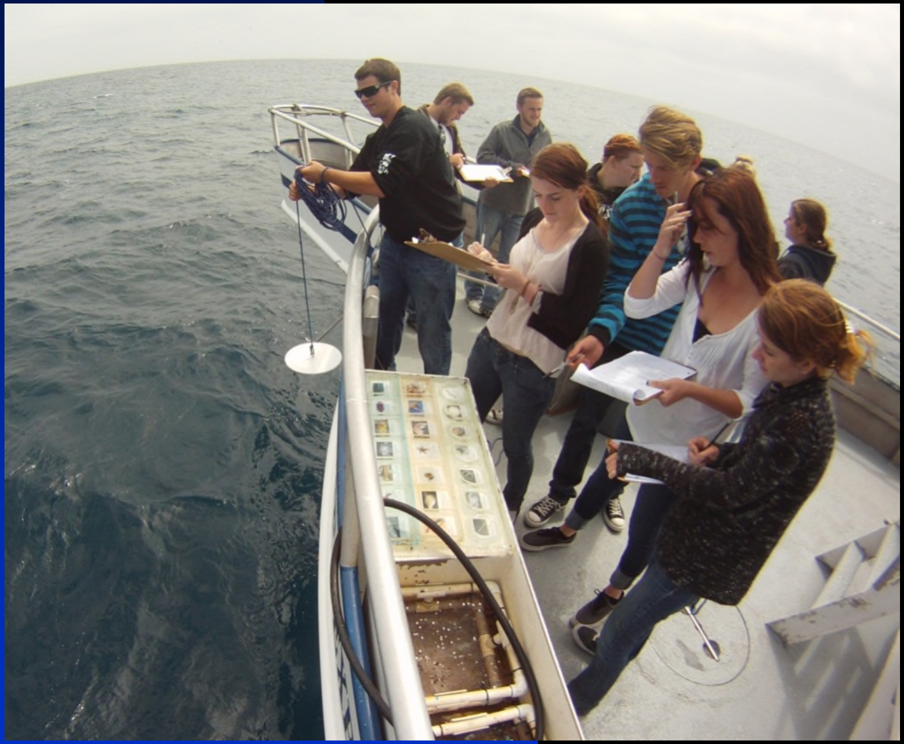
- Course Description
- Review of Course Syllabus
- Safety Instruction
- Instructor Background
- Student Introductions
- Scientific Method Activity
- Density Inquiry Activity
- Unit Conversion Activity

Course Description

- Hands-on, Inquiry-based Lab and Field Activities that Examine the Features and Processes of the Ocean and Marine Life
- Topics Include:
  - Navigation – Maps, Charts and GPS
  - Seafloor Physiology and Plate Tectonics
  - Marine Sediments
  - Seawater Properties
  - Waves, Tides and Currents
  - Shoreline Processes / Beaches
  - Marine Life and Habitats
  - Environmental Concerns

Course Format

- Laboratory and Field Studies
- Course Activities Include:



  - Student-centered
  - Hands-on activities
  - Class discussions
  - Instructor pre-lab lectures
  - Demonstrations
  - Online interactive exercises
  - Shore and boat field trips
  - Extra credit activities

Course Syllabus

- Basic Logistics
- Course Objectives
- Important Enrollment Dates
- Instructor's Attendance Policy
- Classroom Do's and Don'ts
- Grading
- Field Trips
- Extra Credit
- Professor's Classroom Website
- Schedule of Study
- Pointers on How to Succeed in this Class

www.seascisurf.com

MiraCosta OCEA 101L Tu Link

Course information also on the college's official Canvas site

Laboratory Safety Issues

Laboratory Safety Rules

1) No food or drinks allowed in lab at any time. Drinks to be stored outside of lab.

2) Everyone must wear closed-toed shoes while in lab – no exceptions. Any student who shows up without closed-toed shoes on will not get credit for that days laboratory work.

3) Any/all lab accidents, injuries, or unsafe medical/health conditions/events – however minor – must be reported to the lab instructor immediately.

4) Only authorized lab experiments or procedures can be preformed. All authorized experiments or procedures must be performed as described and/or demonstrated by the laboratory instructor.

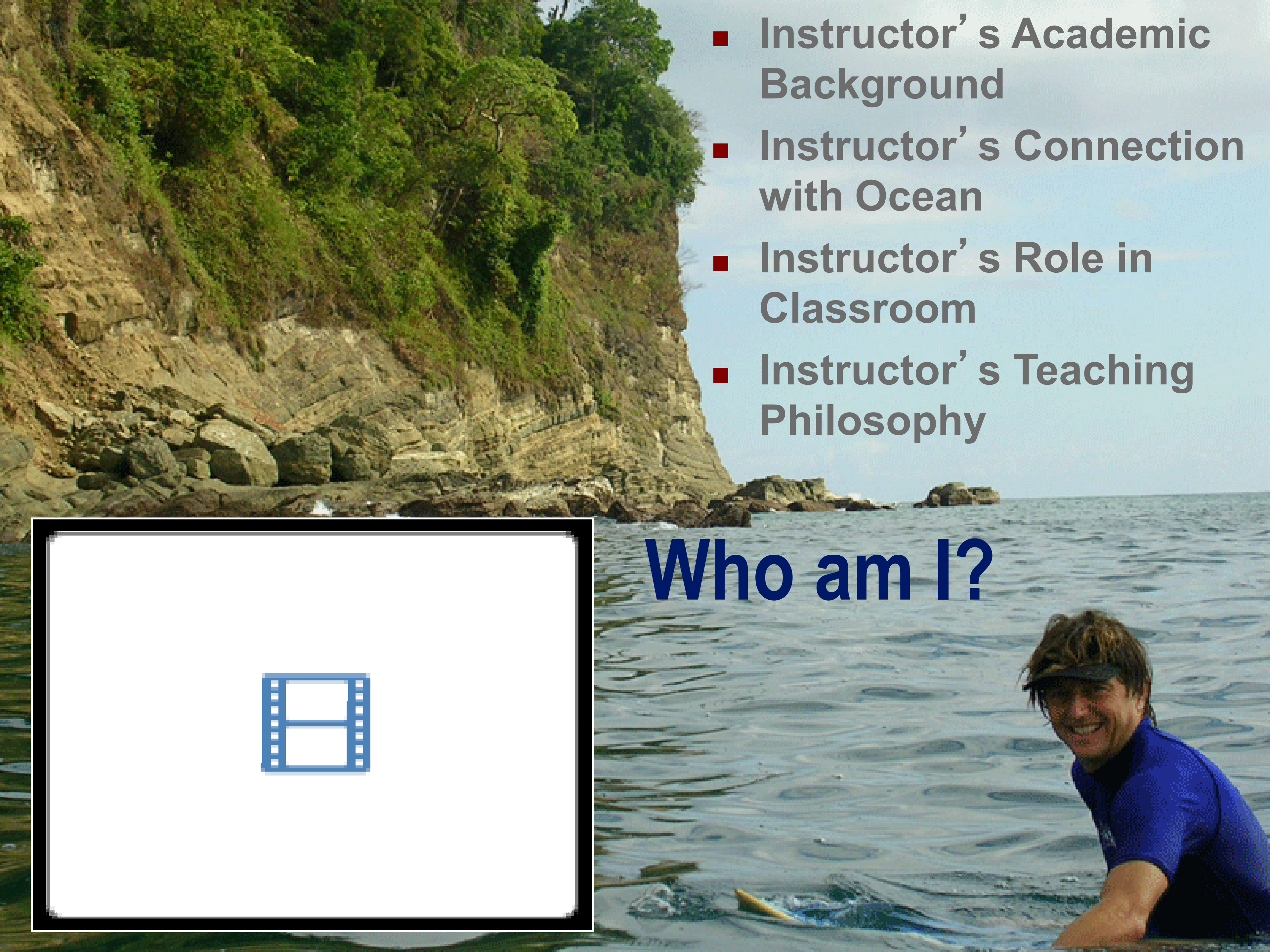
5) Personal belongings need to be stored in a place that will not impede students' movement in and around the lab, nor clutter lab table space.

6) Horseplay, running, or other potentially unsafe activities while in lab is strictly forbidden.

7) When the fire alarm goes off, everyone must leave the lab room immediately - in a calm orderly fashion - to the designated outside emergency assembly area. Know where the assembly area is located.

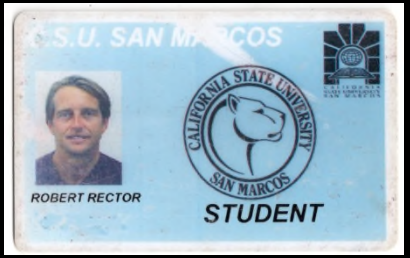
Wise Suggestions for my Students of Oceanography

- 50% Motivation – 50% Perspiration
- SHOW UP for ALL laboratory meetings
- DO the Pre-lab assignment BEFORE the corresponding laboratory meeting
- ASK lots of questions
- BE PROACTIVE in lab and field activities and discussions – Help each other
- STUDY instructor's posted online lecture notes and presentations
- GO on the voluntary weekend field trips
- HAVE FUN learning about the Ocean


Instructor's Academic Background
Instructor's Connection with Ocean
Instructor's Role in Classroom
Instructor's Teaching Philosophy
Who am I?

EARTH SCIENCE EDUCATION

California Single Subject Teaching Credential – Geosciences -
California State University, San Marcos, CA
- 35 graduate-level semester units completed; GPA = 3.9
- Cross-Cultural Language and Academic Development
- Additional emphasis of technology in the classroom



Earth Science Doctoral Program – Volcanism and Tectonics
University of California Riverside, Riverside, CA.
- 38 graduate-level semester units completed; GPA = 3.9
- Graduate Division Fellowship
- Mineralogical Society of America scholarship

Master of Science Degree – Igneous Petrology
San Diego State University, San Diego, CA
- 35 graduate-level semester units completed; GPA=3.9
- Achievement Rewards for College Scientists Scholarship

Bachelor of Science Degree - Magna Cum Laude - Geology
San Diego State University, San Diego, CA
- 172 semester units completed; GPA = 3.8
- Outstanding Senior Research Award--College of Sciences
- Outstanding Research Award—Department Of Geology

Engineering Undergraduate Program
California State University, Northridge, CA
- Marine Engineering emphasis

TEACHING EARTH SCIENCE

Cuyamaca College, El Cajon, CA — **2013 - 2016**
- Oceanography Lecture

University of San Diego, San Diego, CA — **2007 - Present**
- Earth Science Laboratory

MiraCosta College, Oceanside, CA — **2004 - Present**
- Oceanography Lecture and Laboratory
- Online Geology

San Diego Miramar College, San Diego, CA — **2003 - Present**
- Geology Laboratory
- Online Oceanography Lecture

San Diego Mesa College, San Diego, CA — **2002 - Present**
- Online Geology Lecture
- Geology Laboratory

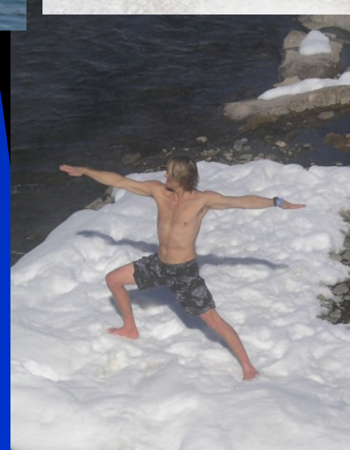
University of California Riverside, Riverside, CA — **1994-1997**
- General geology, Historical geology, Mineralogy, Optical mineralogy, Igneous petrology, and Metamorphic petrology

San Diego State University, San Diego, CA — **1991-1993**
- General geology laboratory
- Advanced field geology course in Baja, Mexico.

Professor's Interests

Travel to Cool Places, Adventure, Hanging Out, and Partying with Fun and Interesting Friends

Outdoor Sports



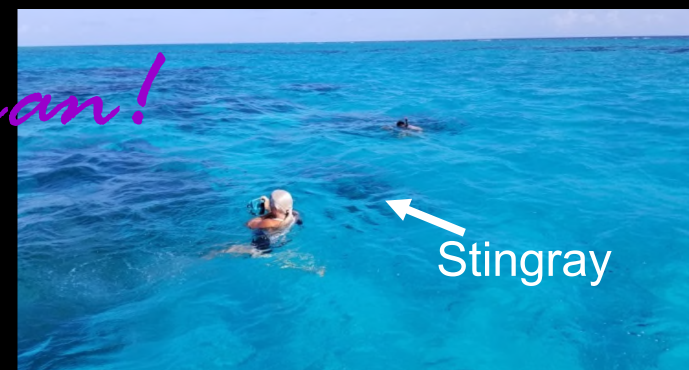
Summer 2018 Adventure – Lake Tahoe

Keep Tahoe

Blue!

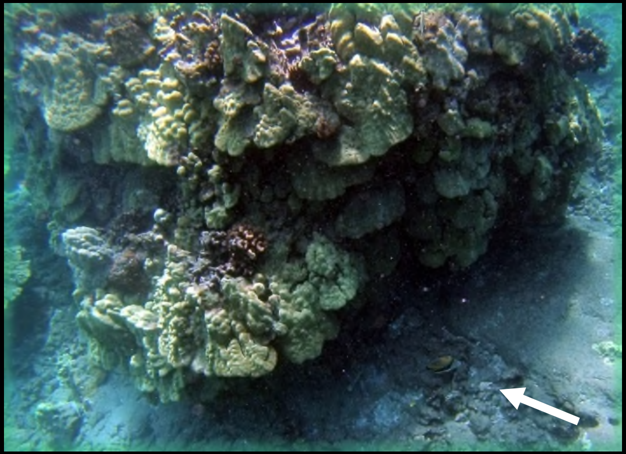
Last Summer's Adventure – Grand Cayman Island

Aloha from Grand Cayman!



Winter 2020 Adventure – The Big Island

Aloha from Hawaii!



Personal Introductions

Who are you?

- Your Name?
- Academic Focus?
- Personal Interests?
- Your Connection with the Ocean?


Wishing Everyone a Great Spring Semester!

OUR PLANET IS A WATER WORLD: *PLANET OCEAN*?

- The Ocean covers about 71% of Earth's surface
- About 98% of Earth's surface water is ocean

Our Awesome Water Planet

Everything is ***connected*** to everything else

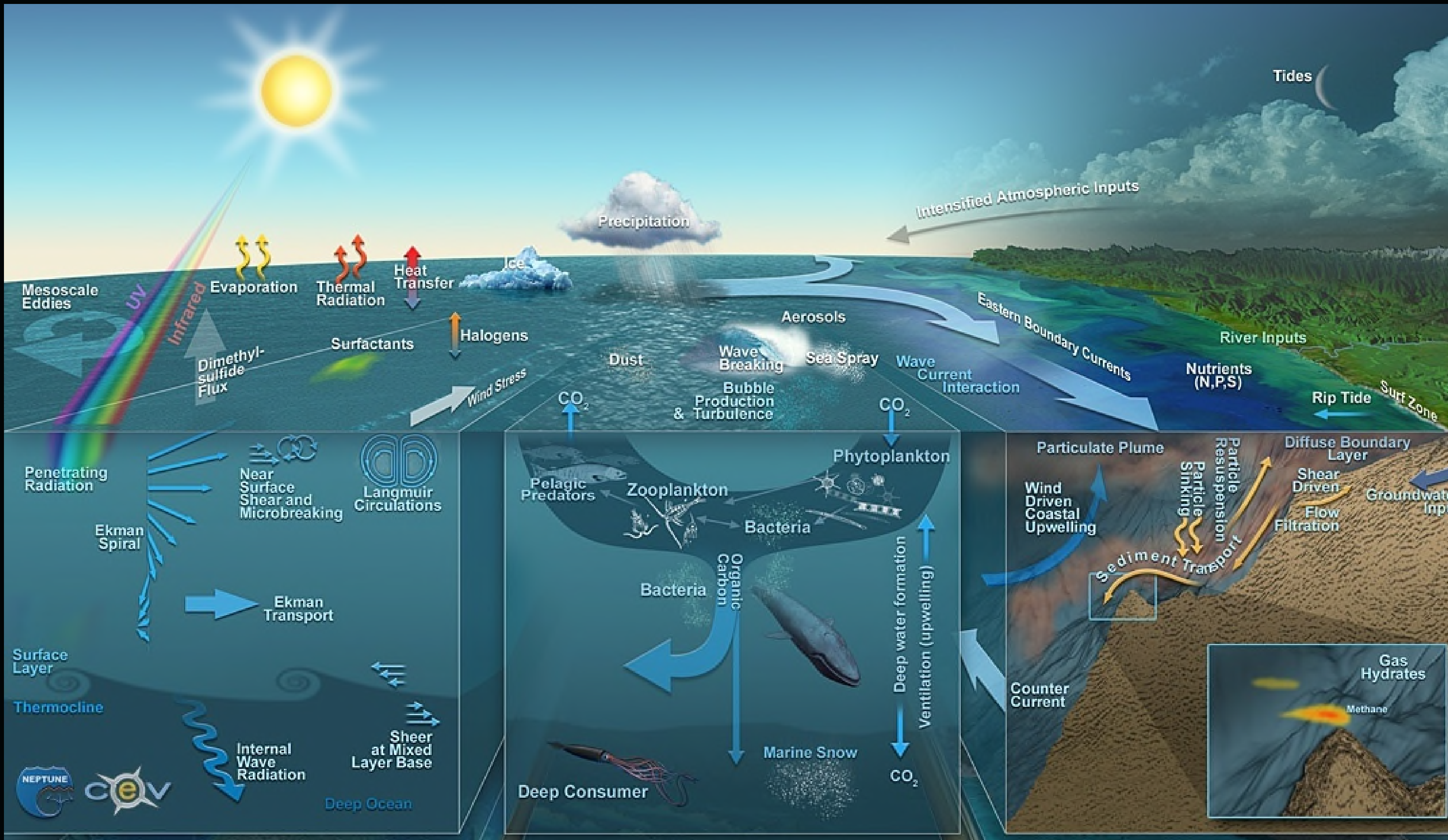
Everything ***affects*** everything else

How is the Ocean Connected with Everything Else?

Ocean is Key Part of Earth's Dynamics

How Does The Whole Thing *Work*?

The Ocean is a Complicated System!

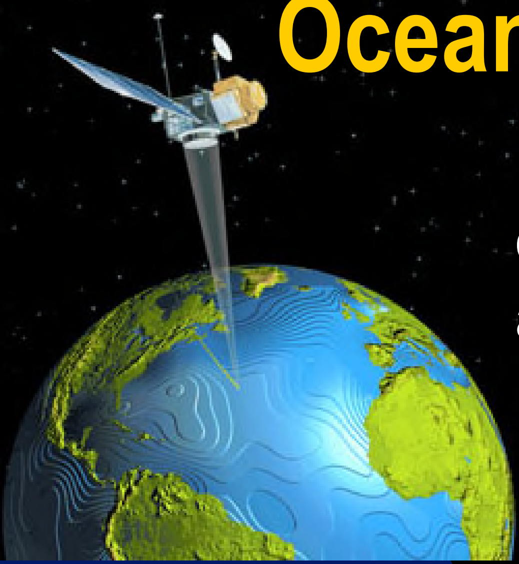


There is an intimate relationship between the living and nonliving world on earth – essential to life in the ocean

What Part Do Humans Play?

How Do We Affect the Earth?

Oceanography – A Multi-Field Science



✓ The scientific study of the ocean, seafloor, coasts, sea life, and climate:

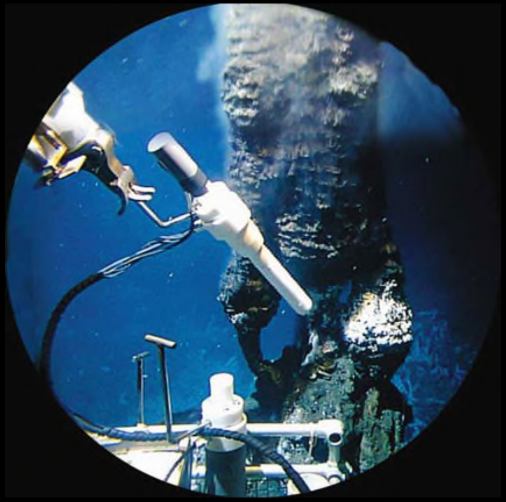
✓ Waves and Currents

✓ Seawater properties

✓ Seafloor and shore features

✓ Marine life

✓ An interdisciplinary science



FIELDS OF OCEANOGRAPHY
An Interdisciplinary Science

Oceanography integrates many different types of science.

- **Marine geology** - the study of Earth's crust and composition
- **Chemical oceanography** - the study of the gases and solids dissolved in the ocean
- **Physical oceanography** - study of ocean's water column and water-air interactions: temperature, pressure, waves, currents, weather, climate
- **Marine biology** – the study of the nature and distribution of marine organisms and their associated marine habitats
- **Marine engineering** - the design and construction of structures used in or on the ocean: ships, machines, instruments, edifices, etc.
- **Environmental oceanography** - the study of human's impact on marine ecosystems

Are there any others?

What Do Oceanographers Do?

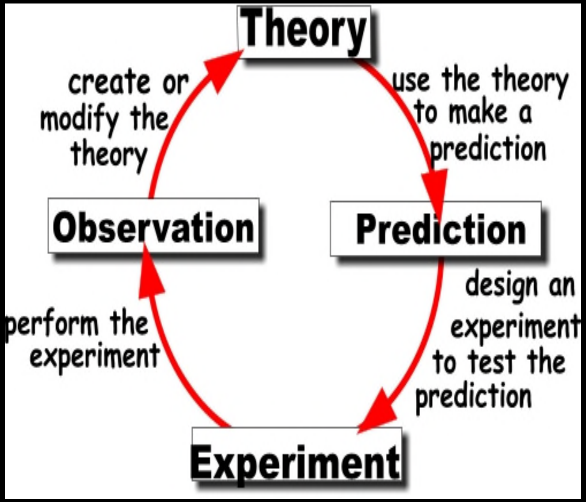
Answer……they do ***ocean science***.

Ocean Science defined: The investigation and acquisition of useful, reliable knowledge and understanding of our ocean that is based on empirical observations and measurements (physical evidence).

- ✓ Ocean scientists use a powerful way of thinking, that is rational, logical, and organized, called ***scientific thinking***.
- ✓ Intelligence, imagination, creativity, inspiration, and luck are other important attributes of scientific study.
- ✓Like all other sciences, oceanographers use a powerful approach to ocean inquiries called the ***scientific method.***
- ✓ Central to science is community and peer review.

The Scientific Method – Heart of Science

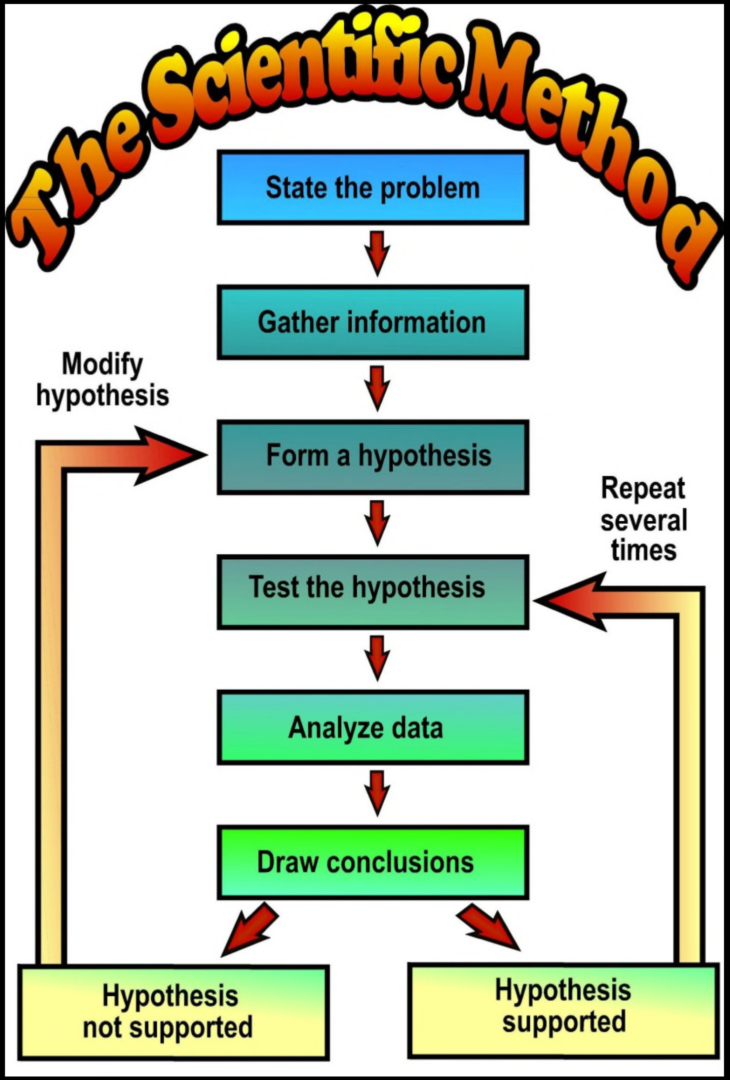
Investigation and Application of the Scientific Method



THE SCIENTIFIC METHOD

The Basic Components

- ✓ *Empirical Observations*
- ✓ *Questions / Problems*
- ✓ *Hypotheses / Models*
- ✓ *Predictions*
- ✓ *Tests / Experiments*
- ✓ *Analysis of Results*
- ✓ *Draw Conclusions*
- ✓ *Reevaluate Hypothesis*

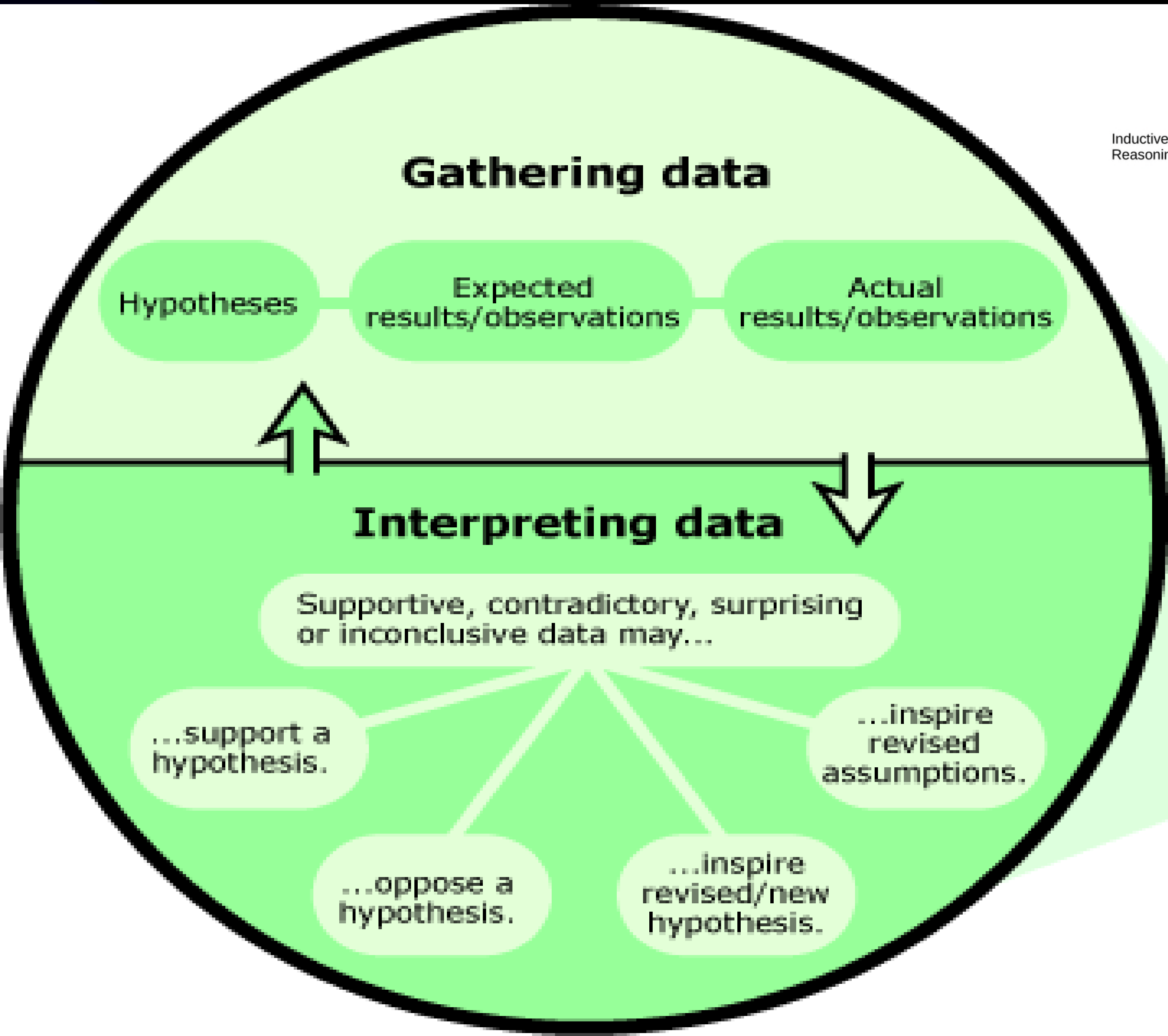


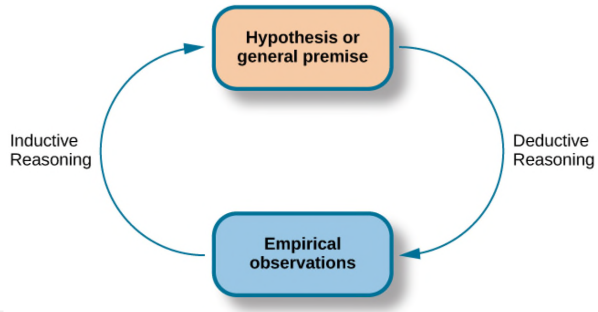
Note: Scientific method is NOT a *Recipe* – it's a *Cyclic Process*

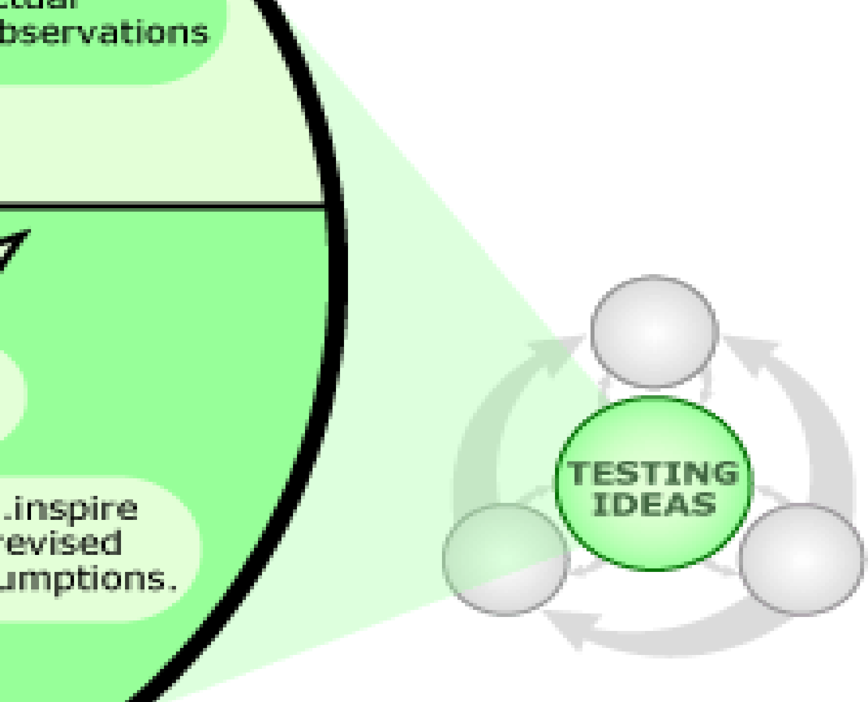
Empirical Observations:
Basis of All Scientific Studies and Theories

Empirical Observations: Basis of All Scientific Studies and Theories

Gathering Data







Two Types of Empirical Observations:

Making Observations

- There are two different types of observations – **quaLitative** observations and **quaNtitative** observations.

Quantitative Units of Measurement

US Standard System of Units

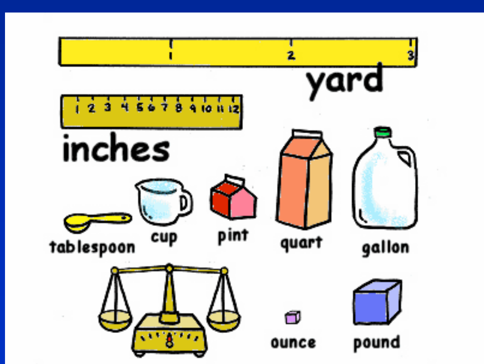
inch/foot
square foot
ounce/gallon
ounce/pound
second
Fahrenheit

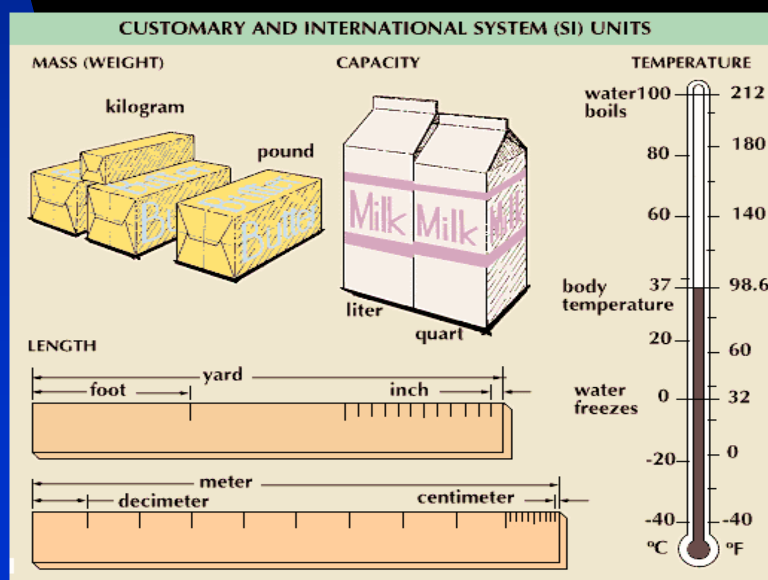
Measurable Physical Quantities

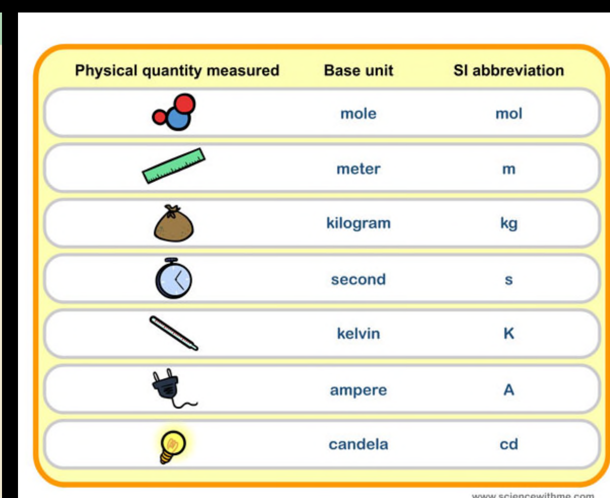
1) Distance -
2) Area -
3) Volume -
4) Mass -
5) Time -
6) Temperature -

International Metric System of Units

centimeter/meter
square meter
milliliter/liter
gram/kilogram
second
Kelvin/Celsius





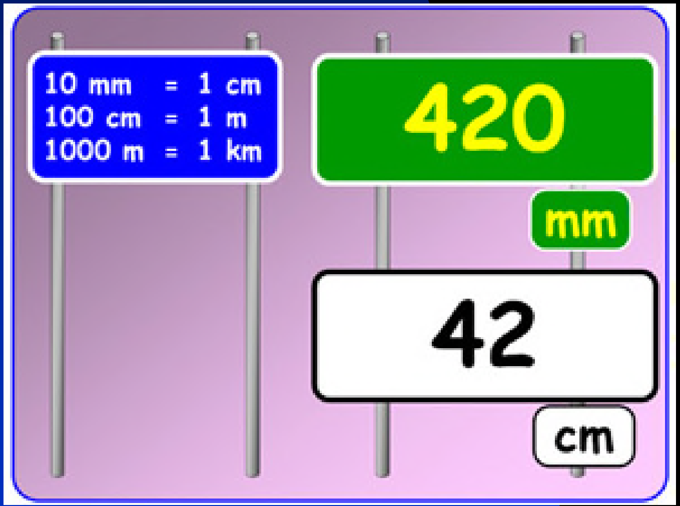


Physical quantity measured	Base unit	SI abbreviation
	mole	mol
	meter	m
	kilogram	kg
	second	s
	kelvin	K
	ampere	A
	candela	cd

International Metric Units

Quantity measured	Unit	Symbol	Relationship		
	millimeter	mm	10 mm	=	1 cm
Length, width, distance, thickness, girth, etc.	centimeter	cm	100 cm	=	1 m
	meter	m			
	kilometer	km	1 km	=	1000 m
	milligram	mg	1000 mg	=	1 g
Mass (“weight”)*	gram	g			
	kilogram	kg	1 kg	=	1000 g
	metric ton	t	1 t	=	1000 kg
Time	second	s			
Temperature	degree Celsius	° C			
	square meter	m^2			
Area	hectare	ha	1 ha	=	10 000 m^2
	square kilometer	km^2	1 km^2	=	100 ha
	milliliter	mL	1000 mL	=	1 L
Volume	cubic centimeter	cm^3	1 cm^3	=	1 mL
	liter	L	1000 L	=	1 m^3
	cubic meter	m^3			
	meter per second	m/s			
Speed, velocity	kilometer per hour	km/h	1 km/h	=	0.278 m/s

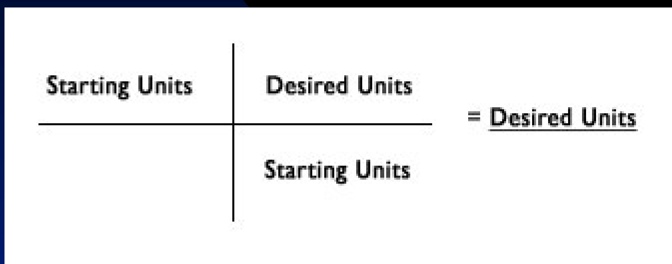
Metric Unit Prefixes



Prefix	Symbol	Factor	Numerically	Name
giga	G	10^9	1 000 000 000	billion**
mega	M	10^6	1 000 000	million
kilo	k	10^3	1 000	thousand
centi	c	10^{-2}	0.01	hundredth
milli	m	10^{-3}	0.001	thousandth
micro	μ	10^{-6}	0.000 001	millionth
nano	n	10^{-9}	0.000 000 001	billionth**

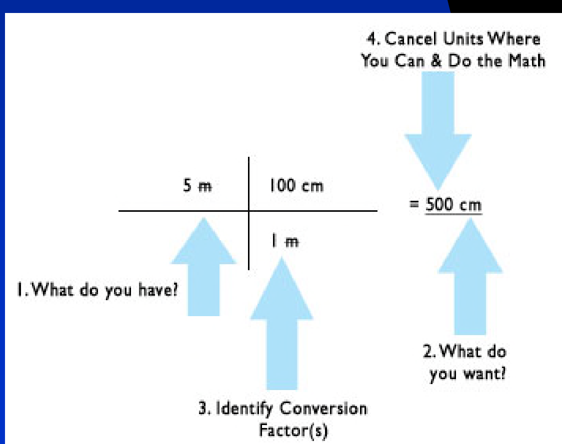
Converting Units of Measurement

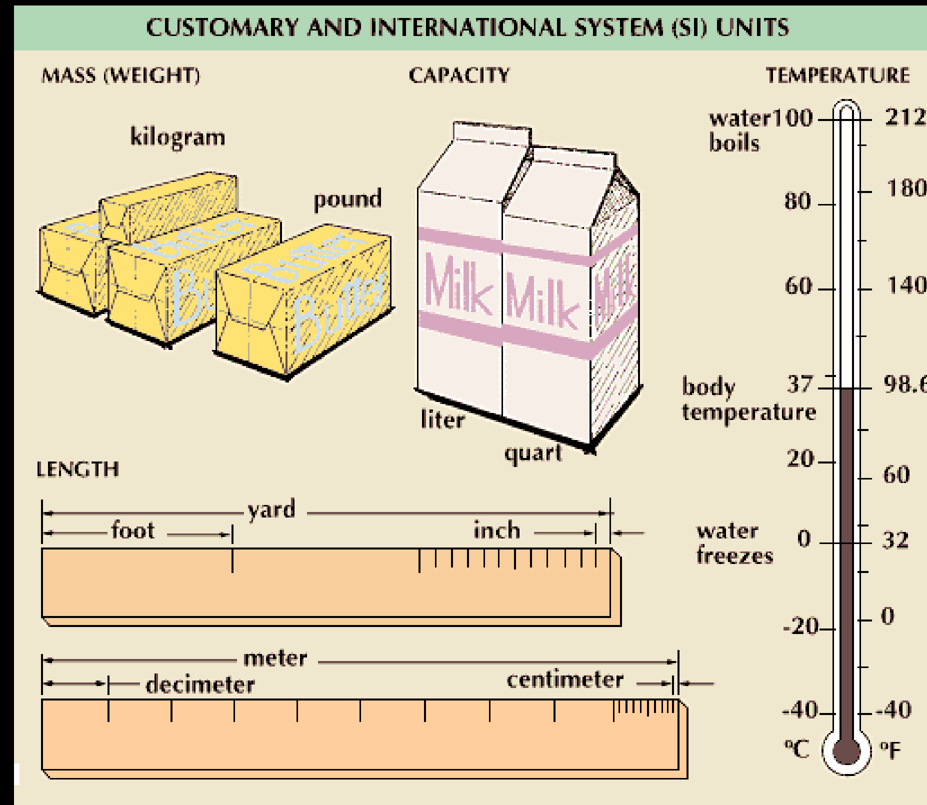
Setting Up the Problem:

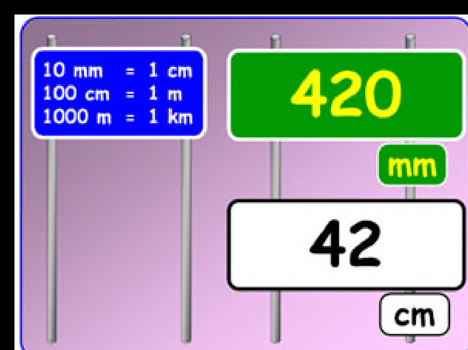


Example:

Convert 15 m to ? cm







Converting Units

Make sure to:

1) Find the proper conversion factor for the two units
2) Set up the equation with all numeric values having a unit symbol
3) Do the conversion making sure that the old unit cancels

APPROXIMATE CONVERSIONS FROM ENGLISH UNITS TO SI UNITS				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY (CF)**	**TO FIND**	**SYMBOL**
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32) ÷ 9	Celsius	°C

Metric Conversion Chart and Table

Length

1 centimeter (cm)	=	10 millimeters (mm)
1 inch	=	2.54 centimeters (cm)
1 foot	=	0.305 meters (m)
1 foot	=	12 inches
1 yard	=	3 feet
1 meter (m)	=	100 centimeters (cm)
1 meter (m)	≅	3.281 feet
1 furlong	=	660 feet
1 kilometer (km)	=	1000 meters (m)
1 kilometer (km)	≅	0.62137119 miles
1 mile	=	5280 ft
1 mile	=	1.61 kilometers (km)
1 nautical mile	=	1.85 kilometers (km)

Area

1 square foot	=	144 square inches
1 square foot	=	929.03 square centimeters
1 square yard	=	9 square feet
1 square meter	≅	10.76104 square feet
1 acre	=	43,560 square feet
1 hectare	=	10,000 square meters
1 hectare	≅	2.47 acres
1 square kilometer	=	100 hectares
1 square mile	≅	2.59 square kilometers
1 square mile	=	640 acres

Speed

1 mile per hour (mph)	≅	1.467 feet per second (fps)
1 mile per hour (mph)	=	1.61 kilometers per hour
1 knot	≅	1.15 miles per hour
1 foot per second	≅	0.68 miles per hour (mph)
1 kilometer per hour	≅	0.62 miles per hour (mph)

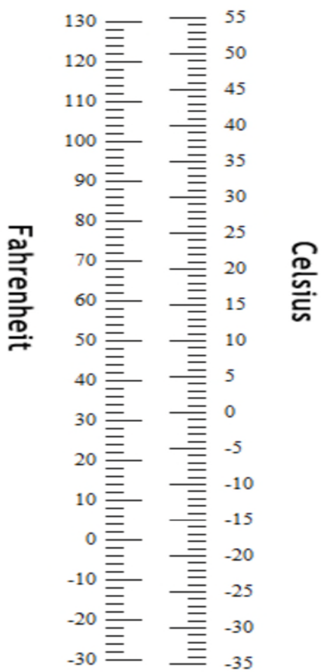
Volume

1 US tablespoon	=	3 US teaspoons
1 US fluid ounce	≅	29.57 milliliters (ml)
1 US cup	=	16 US tablespoons
1 US cup	=	8 US fluid ounces
1 US pint	=	2 US cups
1 US pint	=	16 US fluid ounces
1 liter (l)	≅	33.81 US fluid ounces
1 liter (l)	=	1000 milliliters (ml)
1 US quart	=	2 US pints
1 US gallon	=	4 US quarts
1 US gallon	=	3.785 liters

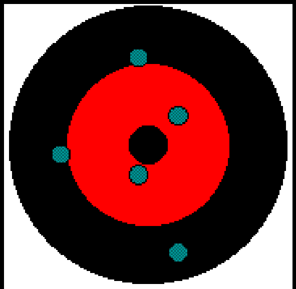
Weight

1 milligram (mg)	=	0.001 grams (g)
1 gram (g)	=	0.001 kilograms (kg)
1 gram (g)	≅	0.035 ounces
1 ounce	=	28.3 grams (g)
1 ounce	=	0.0625 pounds
1 pound (lb)	=	16 ounces
1 pound (lb)	=	0.45 kilograms (kg)
1 kilogram (kg)	=	1000 grams
1 kilogram (kg)	≅	35.27 ounces
1 kilogram (kg)	≅	2.2 pounds (lb)
1 stone	=	14 pounds
1 short ton	=	2000 pounds
1 metric ton	=	1000 kilograms (kg)

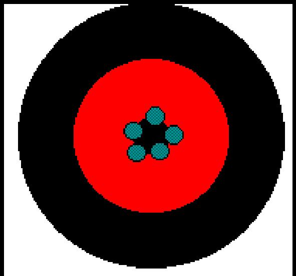
Temperature



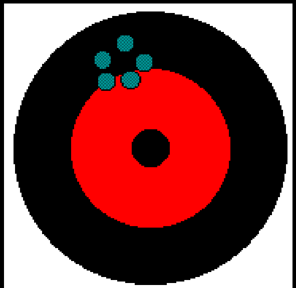
Accuracy, Precision and Uncertainty in Measurement



1) ***Accuracy*** of the measurement refers to how close the measured value is to the true or accepted value.
2) ***Precision*** refers to how close together a group of measurements actually are to each other.



3) Accuracy can be determined by only one measurement, while precision can only be determined with multiple measurements.
4) Precision has nothing to do with the true or accepted value of a measurement, so it is quite possible to be very precise and totally inaccurate.



5) When precision is high and accuracy is low, the fault can lie with the instrument.

Significant Figure Rules

1) Non-zero numbers are always significant.

2) Zeroes between two significant figures are always significant.

Ex. 90.007 kg 1.0046 L

3) All zeroes after both a significant figure and a decimal point are significant.

Ex. 24.000 m 936.0400 g

4) Leading zeroes are not significant.

Ex. .000483 m .0791 kg

5) Trailing zeroes in integers with no decimal point are not significant?

Ex. 230,000 years -400 cm/s

*How many significant figures are in each of the following?

a) 803 m b) .0004050 kg c) 23.040? d) 750,000

Examples of Sig Figs

Example 1 Round 49 984 to 3 significant figures. 49 9 84 (+1)
Answer: 50 0 00
[The last two '0's serve as place-holders.]

Example 2 Round 49 984 to 4 significant figures. 49 98 4
Answer: 49 98 0 [Note that the last '0' serves as a place-holder.]

Example 3 Round 0.007 049 to 1 significant figure. 0.00 7 049
Answer: 0.00 7
[The left '0's are place-holders.]

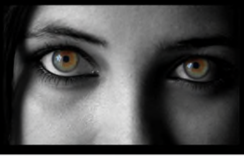
Example 4 Round 0.007 049 to 2 significant figures. 0.00 7 0 49
Answer: 0.00 70
[The left '0's are place-holders. The right-most '0' is not a place-holder, but it is needed because you want to show 2 significant figures.]

Example 5 Round 0.007 049 to 3 significant figures. 0.00 7 04 9 (+1)
Answer: 0.00 7 05
[All the zeros are place-holders. The '0' between the '7' and '5' highlighted in yellow is one of the significant figures, and also a place-holder.]

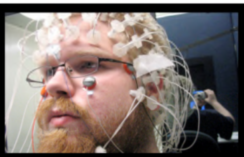
Questioning and the Scientific Method

Formulating good, relevent questions concerning the natural phenomena under study is fundamental to this method.

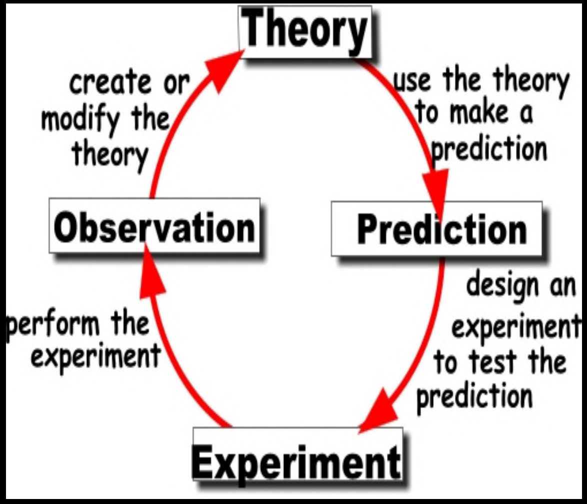
Rationalism
(Logic & Reasoning)



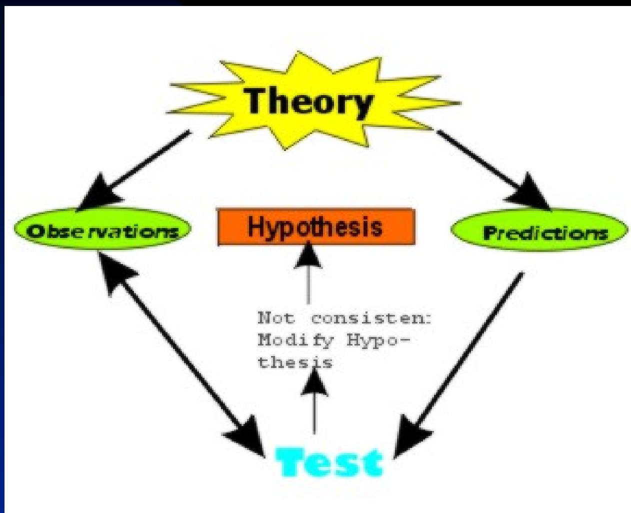
\+ Empiricism
(Experience & Observation)



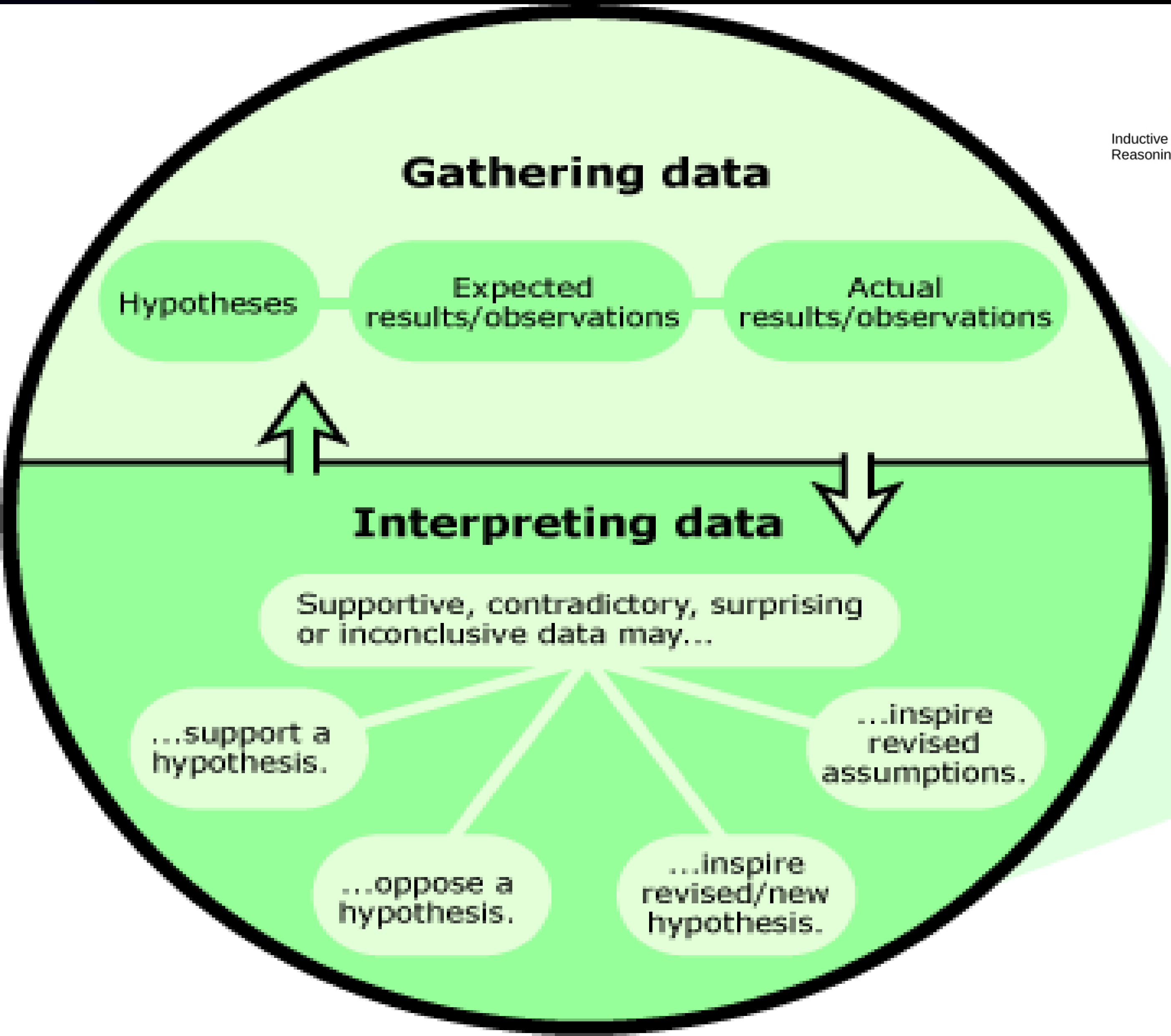
Science

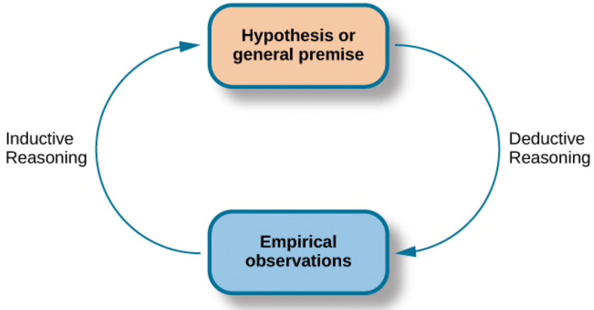


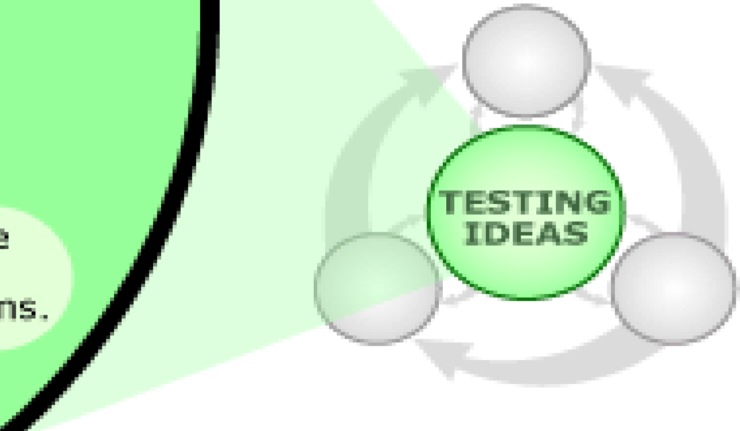
Hypotheses and Scientific Testing



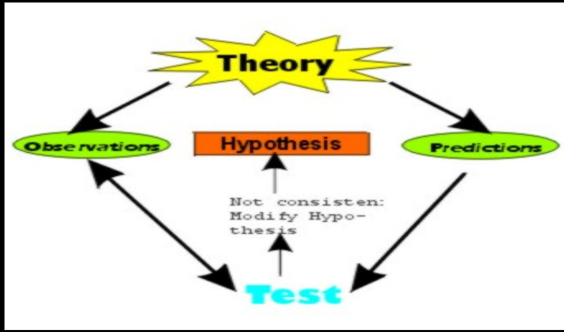
Interpreting Data







Observations, Data, Questions, and Explanations



Hypotheses, Testing and Theories

1) A hypothesis is a proposed explanation, model, or prediction of nature that requires testing (attempt to falsify or confirm).
2) Hypotheses are based on empirical physical evidence (data).
3) Hypotheses must be falsifiable (testable/predictable).
4) Hypotheses can never be proven as an absolute fact.
5) Hypotheses are always open to elimination or modification.
6) A theory is a broad, elegant, set of unifying explanations of a set of otherwise unconnected natural phenomena.
7) A theory is established by the interconnection (framework) of well-tested and confirmed hypotheses that are, in turn, supported by an enormous amount of physical evidence.

Formulate and Test Your Hypothesis

Testing a Hypothesis Activity

1. Presenting Hypothesis: Write down the proposed hypothesis.

2. Making predictions: For each hypothesis, ask yourself what would be true if the hypothesis were true.

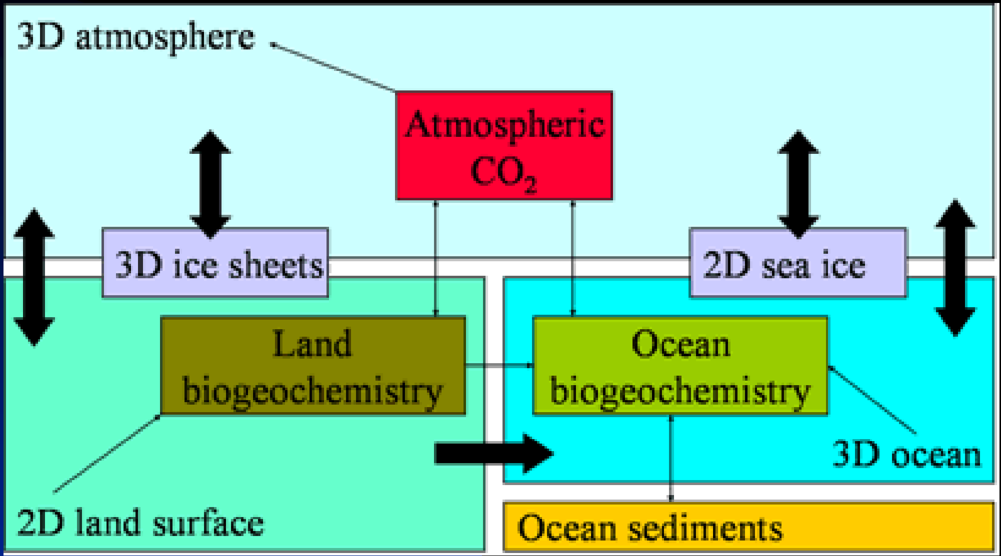
3. Designing Experiments: Design one experiment that tests your hypothesis using the predictions you made from step 2.

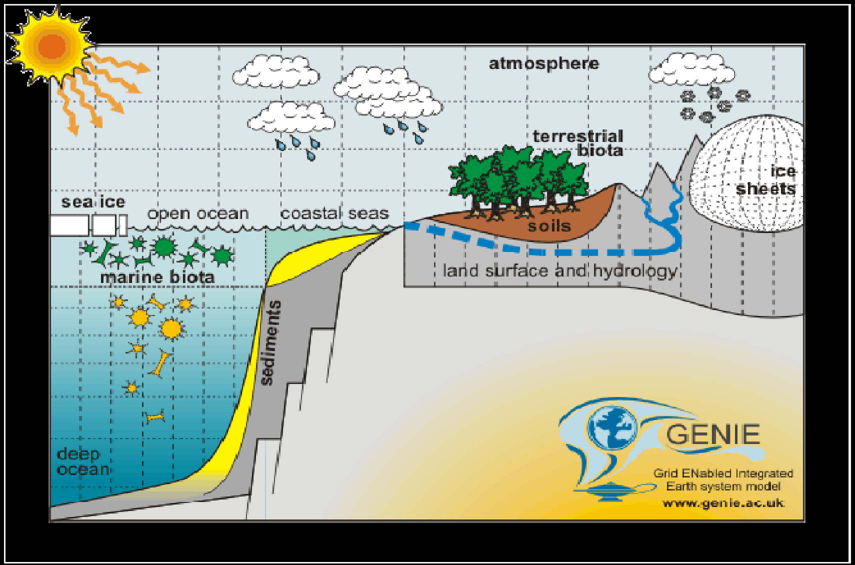
Scientific *Predictions*

Prediction

- A statement of what may happen in the future based on observations, data, experience or scientific reason

Scientific *Modeling* and *Predicting*





Purpose of Modeling: Understand and predict how parts of the Earth operate and interact with each other

--- Start simple and get more complicated over time

--- Add more and more parameters over time

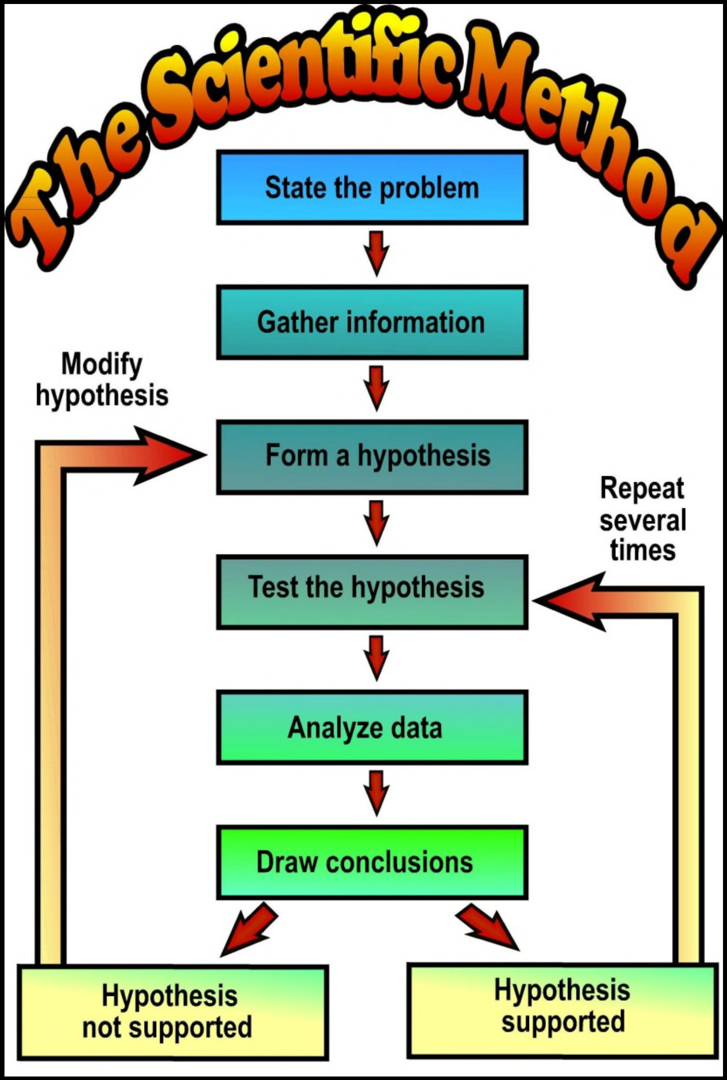
--- Test computer models with real historic data

---- Develop and refine models to predict future scenarios

THE SCIENTIFIC METHOD

The Basic Components

- ✓ *Empirical Observations*
- ✓ *Questions / Problems*
- ✓ *Hypotheses / Models*
- ✓ *Predictions*
- ✓ *Tests / Experiments*
- ✓ *Analysis of Results*
- ✓ *Draw Conclusions*
- ✓ *Reevaluate Hypothesis*



Note: Scientific method is NOT a *Recipe* – it's a *Cyclic Process*

Application of the Scientific Method

Glitter Lamp Inquiry

Purpose:

Use the scientific method to gain a better understanding of how a glitter lamp works as a dynamic system

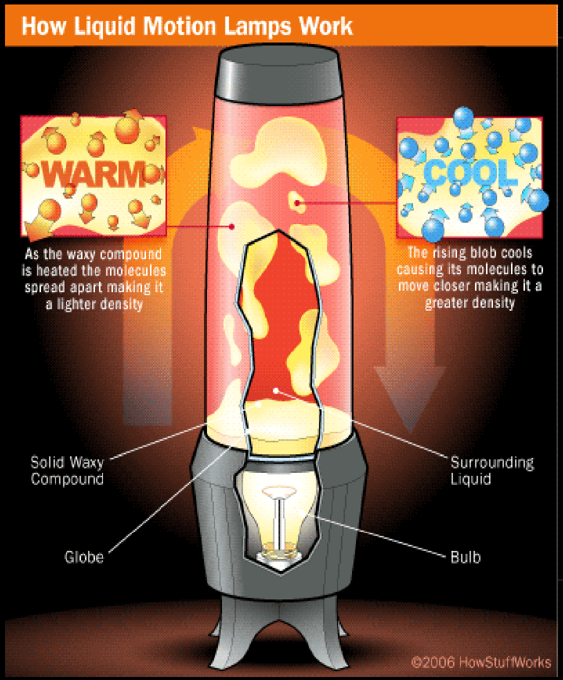
Procedure:

Get into groups of 2 to 4. Make good observations, explanations, predictions, and tests on the lamp. Focus on the dynamic properties of the lamp.

Lava Lamp as a Model for Convection

Convection Process

- ✓ Fluid material at top of lamp is cooler than material at the bottom.
- ✓ Hotter material is less dense than cooler material
- ✓ Less dense fluid rises while more dense fluid sinks
- ✓ Differential heating of fluid in a gravity field drive the fluid circulation system
- ✓ Earth's atmosphere, ocean, mantle and core undergo convection



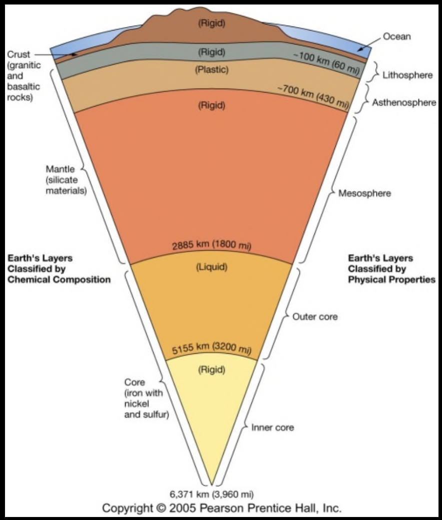
Mantle-Core Convection

Preparation for Next Week' s Lab

Week Two Topic – Isostasy

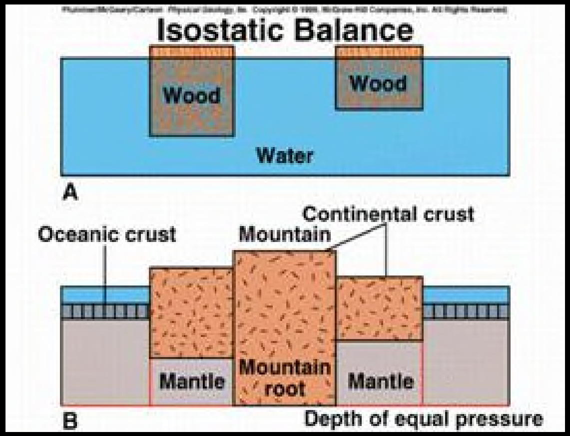
1) The Earth's Interior Layers

2) The Concept of Isostasy



- ❖ Bring the Lab #2 Worksheet with you to lab next week

- ❖ Do the PreLab Before Lab



- ❖ Study the Isostasy PowerPoint on instructor's website:

@ www.seascisurf.com