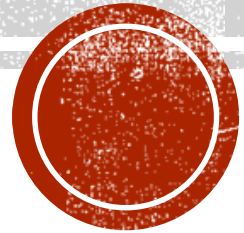
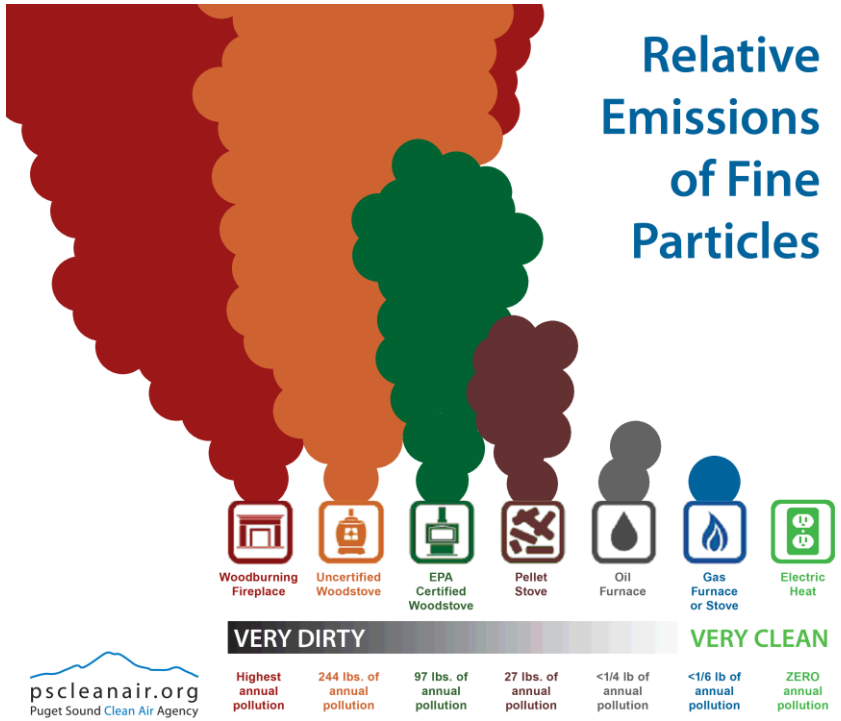
# CHAPTER 4

## Interrelated Scientific Principles: Matter, Energy, and Environment



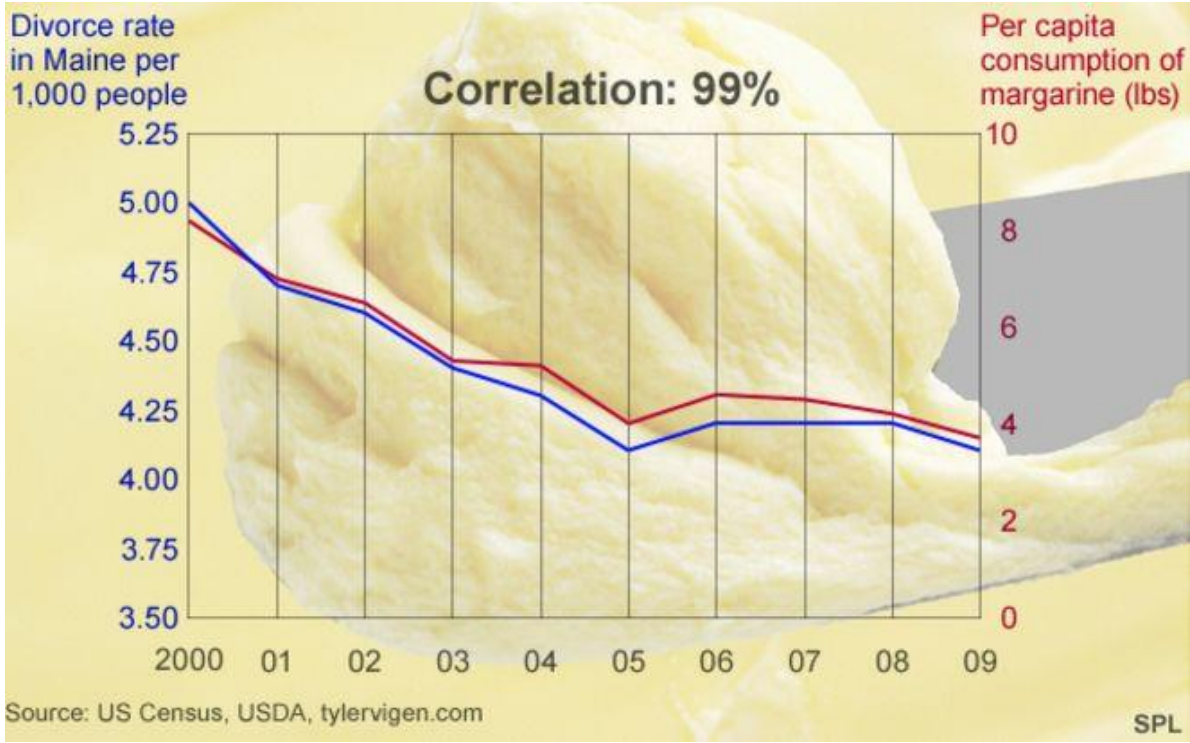
# WOOD STOVES = AIR POLLUTION

- EPA estimates wood stoves are responsible for 5% of the smallest, deadliest particles emitted in the US.
- ¾ of current stoves are pre-EPA certified
- EPA education campaign
  using fee from sale
  of wood-burning device



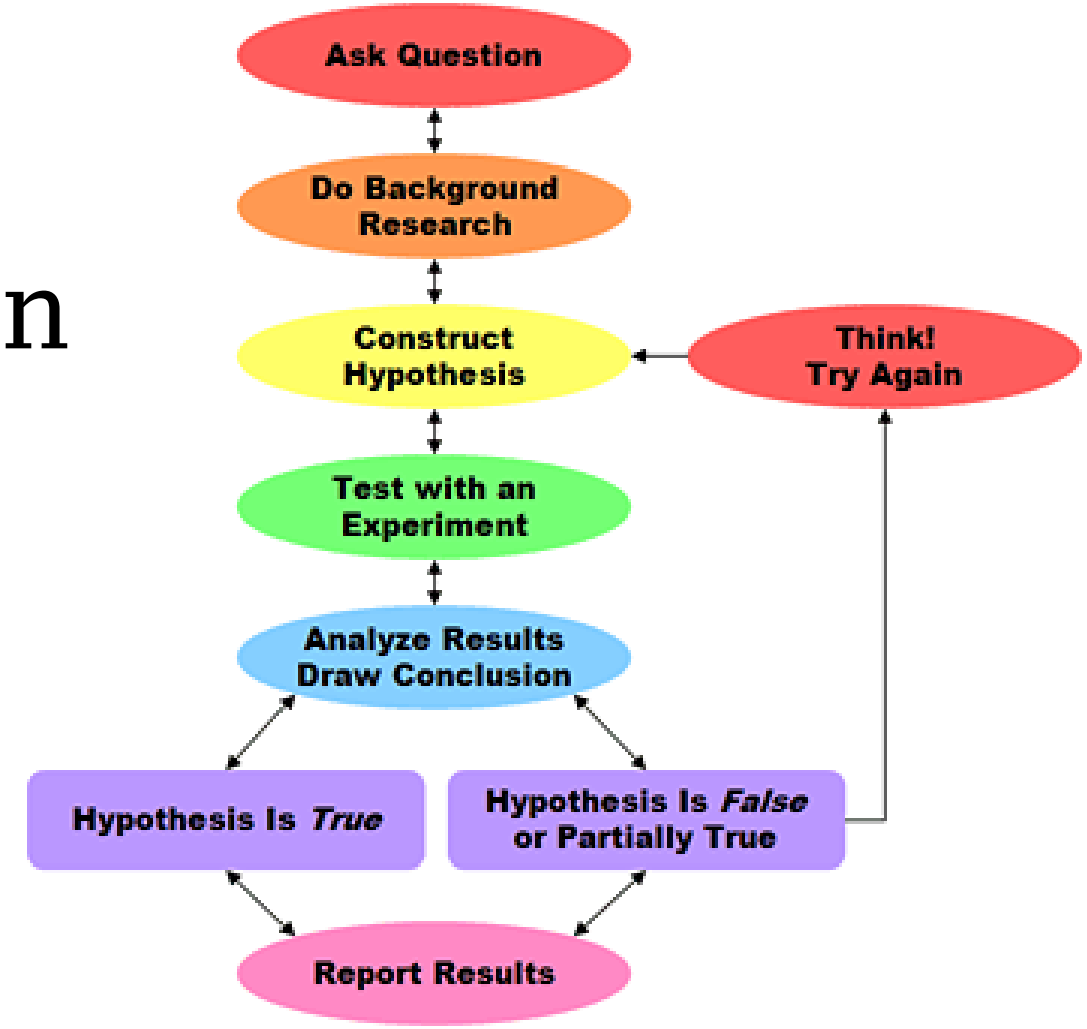
# SCIENCE

- Process to solve problems or understand nature that involves testing possible answers.
- <u>Cause and effect relationship</u>: Winter rain leads to spring "green-up"
- Not every correlation implies a cause and effect:



# CONTROLLED EXPERIMENTS

- When two groups differ in Only one way
- High sample size
- Reproducible results



# SCIENTIFIC METHOD IN ACTION – ACID RAIN

- Fish and forests dying
- Tested pH of rain and lakes
- Tested emissions from upwind factories
- Tested pH of rivers upwind and downwind of factories
- Reduced emissions and re-tested

# “FRQ STEW”

- 1) Reads FRQ question aloud
- 2) Gives answer
- 3) Gives answer (states whether agrees or disagrees why?/why not?)
- 4) Approve/Correct using Scoring Guide
- Rotate roles after each question
- Everyone write answers and corrections

# DESIGN AN EXPERIMENT WITH YOUR GROUP

- A student wants to test the effects of caffeine on the growth rate of sunflowers.
- Write a hypothesis
- Design an experiment to test this hypothesis.
- What is the control?
- What is the dependent variable?
- How will you know if the hypothesis is supported?

# WHICH IS THE CONTROL?

- A. The group that receives the blood pressure medicine.

- B. The group that receives the placebo

# WHY IS A CONTROL NECESSARY?

# WHICH WOULD GIVE THE MOST RELIABLE RESULTS?

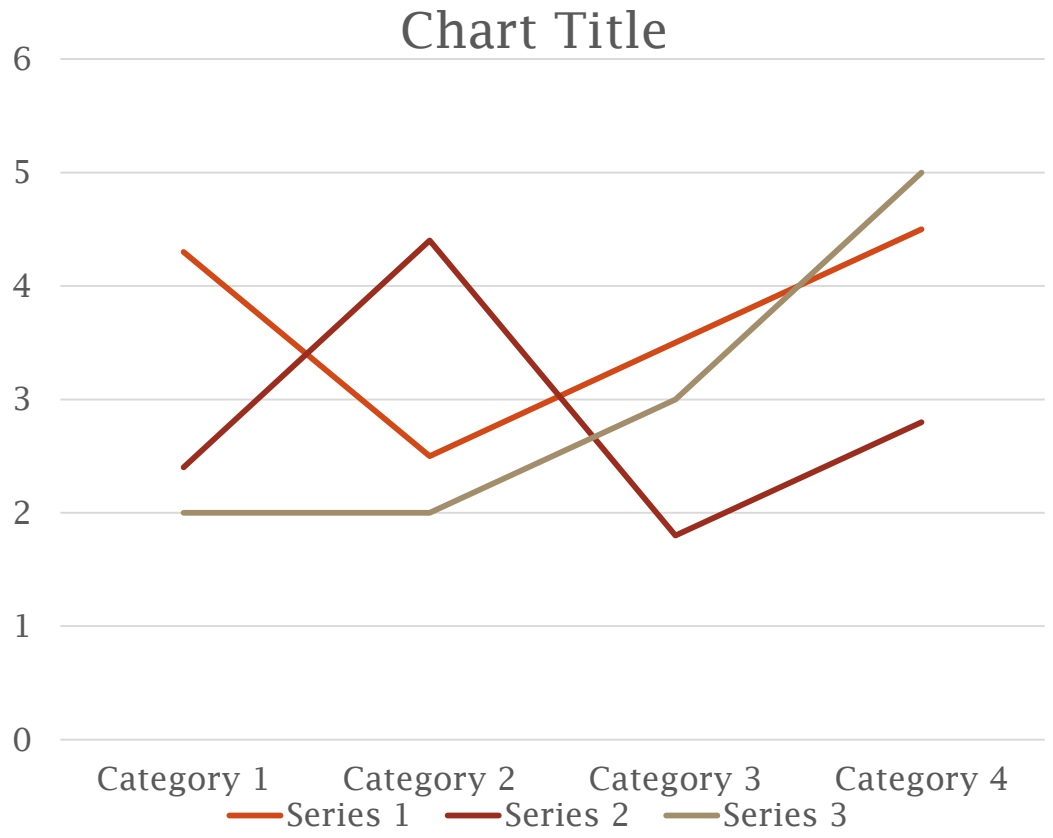
- A) A sample size of 10
- B) A sample size of 100
- C) A sample size of 1000

# WHICH IS THE DEPENDENT VARIABLE?

- A. The blood pressure of the individuals
- B. The type and dose of medication given
- C. The timing of the medication

# WHICH AXIS OF A GRAPH WOULD THE DEPENDENT VARIABLE GO ON?

- A) X Axis
- B) Y Axis



# THEORIES AND LAWS


- *Laws describe what happens and theories describe why things happen*
- Law: Uniform, constant fact in nature
- Theory: widely accepted generalization that explains why things happen
  - Supported by massive amount of evidence/data
  - Broad concept that shapes how scientists look at the world
    - Germ theory, molecular theory, gravitational theory, evolutionary theory

# "Just a Theory?"

Myth: In science if it's not called a law it's not proven, thus it's just a guess.

| Observable Fact | Current Best Explanation of the Fact |
|---|---|
| Gravity | Theory of Relativity and Special Relativity (A. Einstein) |
| Infectious Disease | Germ Theory of Disease (A. Bassi) |
| Evolution | Theory of Evolution by Natural Selection* (C. |
| Earthquakes and Volcanoes | Theory of Plate Tectonics (J. Tuzo Wilson) |

# PSEUDOSCIENCE

- A deceptive practice that uses the appearance or language of science to convince, confuse or mislead.
- Not supported by unbiased tests or evidence

# HAND-UP, STAND-UP, PAIR-UP!

- 1. "Rally-Robin" pseudoscientific ideas (back and forth)
- 2. Switch partners (when instructed) and repeat
- 3. Share-out

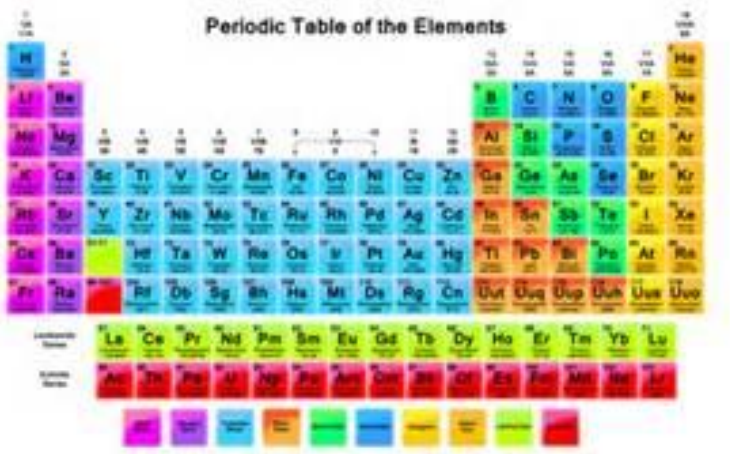
# SHARE-OUT

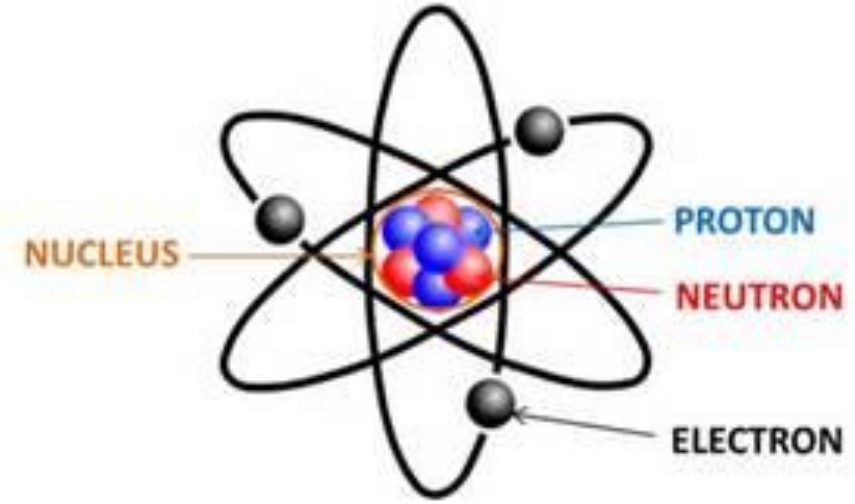
- Many infomercials like alkaline water
- Astrology
- Paranormal investigators
- Big Foot, mermaids etc.

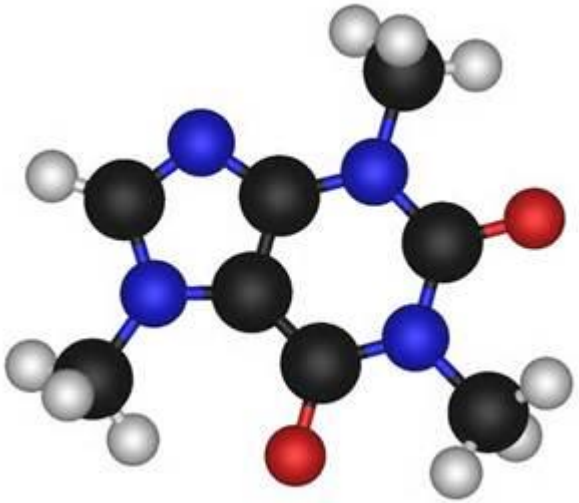
| Science | Pseudoscience |
| --- | --- |
| Willingness to change with new evidence | Fixed ideas |
| Ruthless peer review | No peer review |
| Takes account of all new discoveries | Selects only favourable discoveries |
| Invites criticism | Sees criticism as conspiracy |
| Verifiable results | Non-repeatable results |
| Limits claims of usefulness | Claims of widespread usefulness |
| Accurate measurement | “Ball-park” measurement |


# STRUCTURE OF MATTER

- Matter is anything that takes up space and has mass
- Atoms are fundamental units of matter
- Elements are specific types of matter

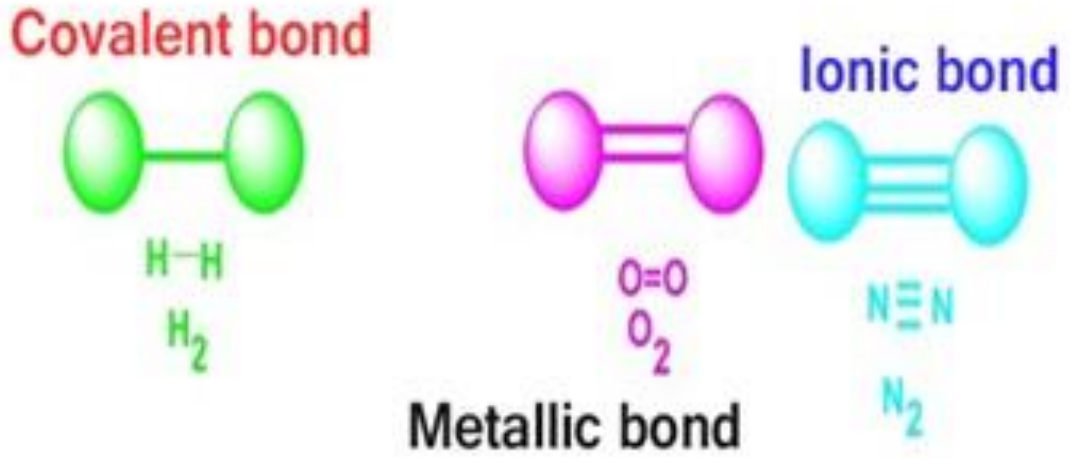


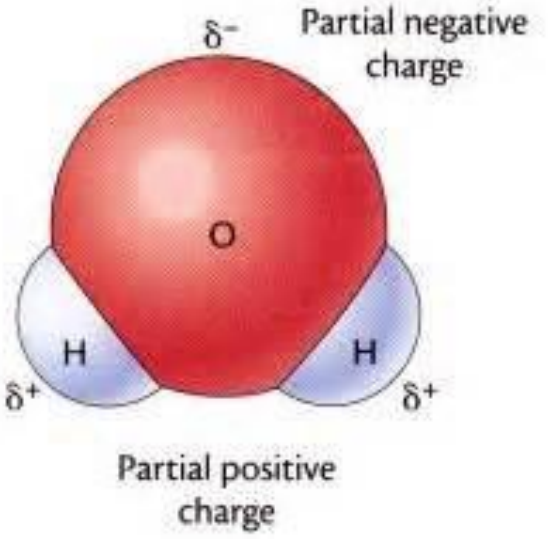
# CHEMICAL BONDS

- Physical attractions between atoms resulting from the interaction of their electrons.
- When bonds are broken or formed, a chemical reaction occurs, and the amount of energy is changed.



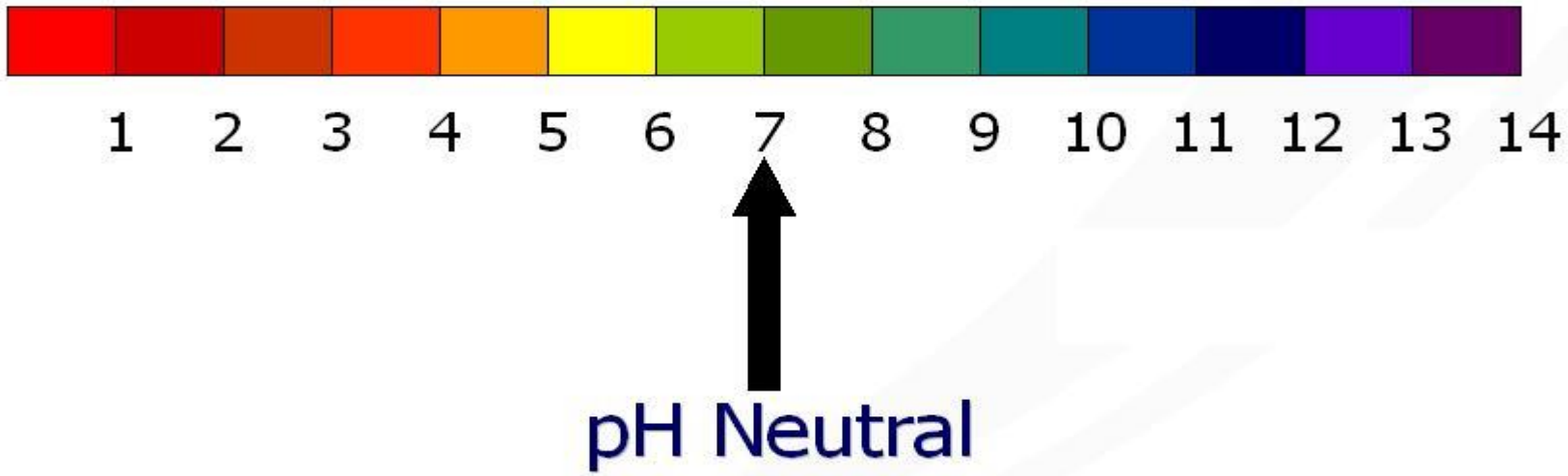
# WATER

- Polar (negative on one end, positive on the other)
  - Cohesive
  - Evaporation of water cools surroundings
  - Universal solvent



# ACIDS AND BASES

- Acid: releases hydrogen ions (protons) in solution (below pH of 7) - acidic
- Base: accepts hydrogen ions in solution (above pH of 7) - alkaline



# GET YOUR WHITEBOARDS READY!!!

# CHALLENGE #1:

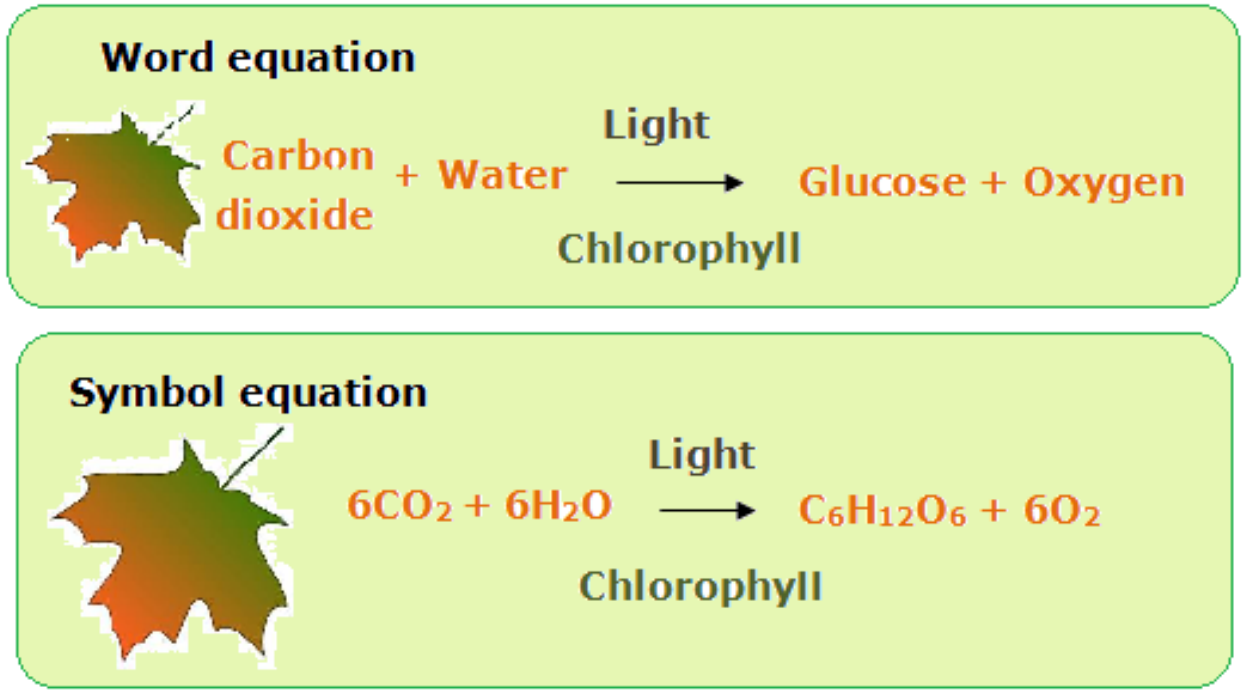
- Write the equation for photosynthesis

# CHALLENGE #2:

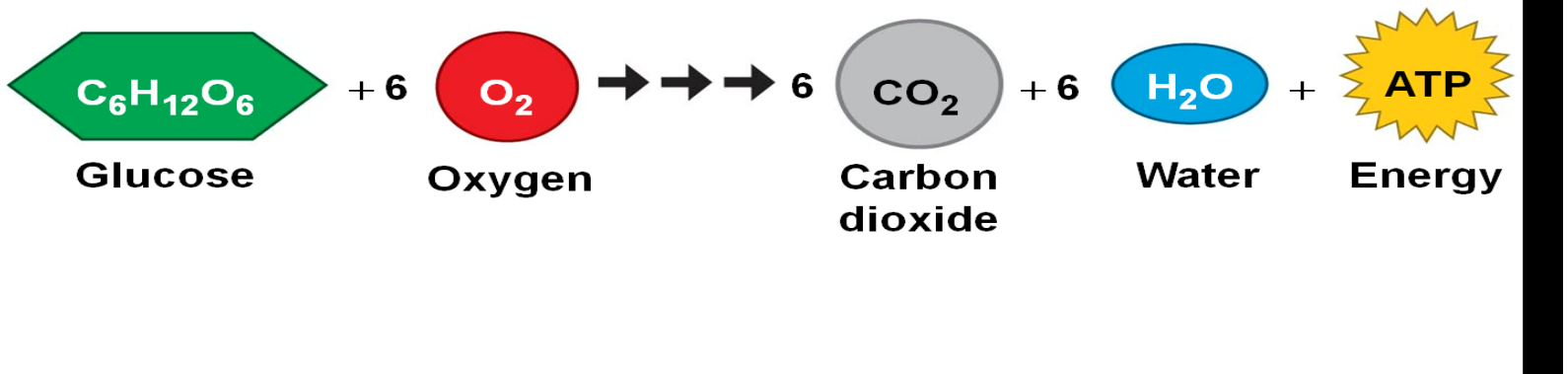
- Write the equation for cellular respiration

# CHEMICAL REACTIONS IN LIVING THINGS

- Photosynthesis:




- Cellular respiration:



# ENERGY IS THE ABILITY TO DO WORK

- Kinetic energy: energy contained by moving objects (moving air molecules, water in a river etc.)

- Potential energy: dependent on position (ex. Plants, water behind a dam)

# THERMODYNAMICS

- First law of thermodynamics: energy can neither be created nor destroyed; it can only be changed from one form to another.
- Second law of thermodynamics: whenever energy is converted from one from to another, some of the useful energy is lost.
  - Entropy: energy that cannot be used to do useful work

# ENVIRONMENTAL IMPLICATIONS OF ENERGY FLOW

- Entropy increases: houses decompose, automobiles rust etc. (releases heat)
- Energy quality:
  - high quality can be harnessed and used (ex. electrical)

  - Low quality can still have significance – ocean temperatures affecting weather patterns etc. and can sometimes be used with the right technology (wind turbines etc.)

# DIESEL ENGINE TRADE-OFFS


- Diesel engine efficiency: 35-42% (more particulate matter and nitrogen oxides)
- Gasoline engine efficiency: 25-30% (20-40% more carbon dioxide)

- ***Should the US switch to diesel engines like Europe?***