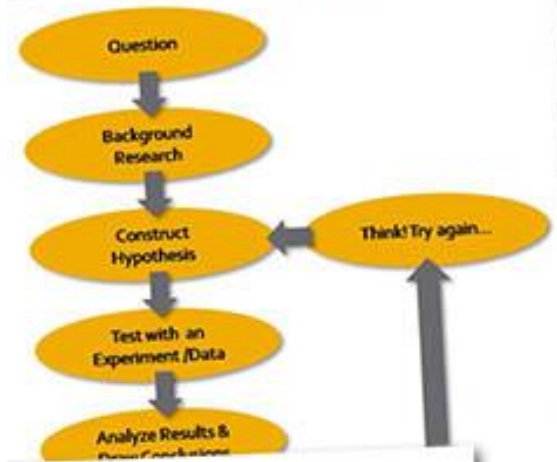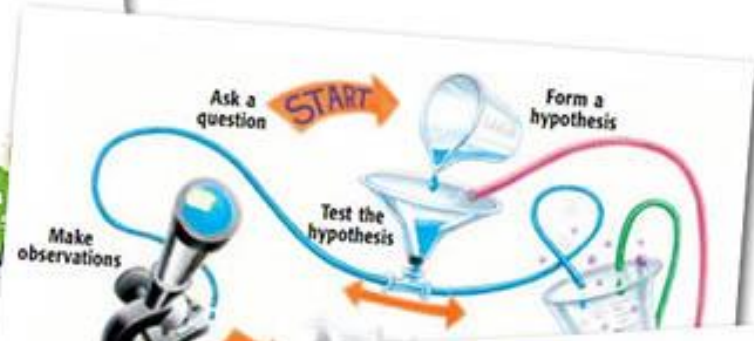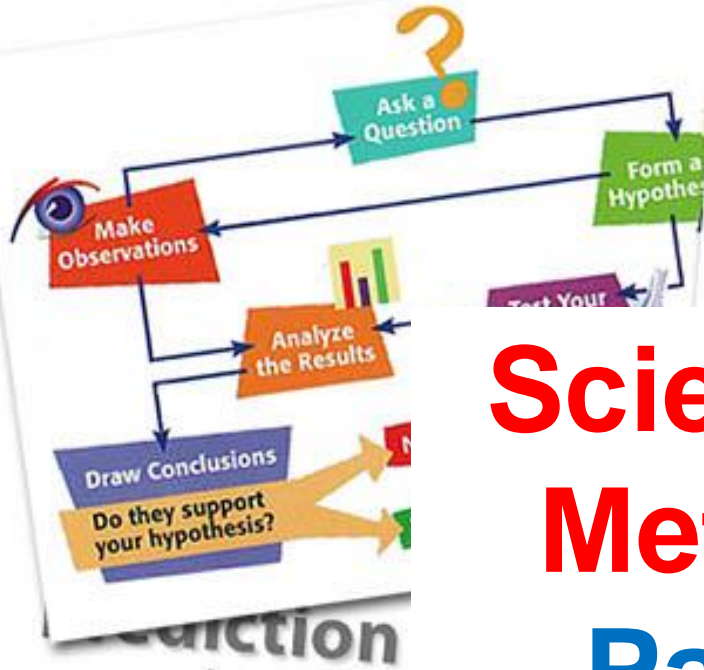# Scientific Method
Part 2

Analyzing results of the experiment

1. **Organize your observations:**
   - ✓ Make a table.   ✓ Make a graph.

2. **Review data (look with a critical eye):**
   - ✓ Is it *complete*, or did you forget something?
   - ✓ Do you need to collect *more data*?
   - ✓ Did you make any *mistakes*?
   - ✓ Decide on the next actions to take (repeat? analyze?).

3. **Analyze:**
   - ✓ If appropriate, *calculate an average* for the different trials of your experiment.
   - ✓ Observe *trends* (increasing or decreasing numbers), outcome *frequency*, and note *correlations*.

Working with your results

Excellent way to <u>organize</u> your results: a table.

Table 1. Science and Earth Science classes enrollment.

YEAR	EARTH SCIENCE	SCIENCE
2014/2015	15	8
2015/2016	14	13
2016/2017	10	16
2017/2018	12	4

Famous Table:
The Periodic Table of Elements

Dmitri Mendeleev, 1869, and Julius Lothar Meyer, 1870.

Working with your results

Excellent way to display your results: a graph.
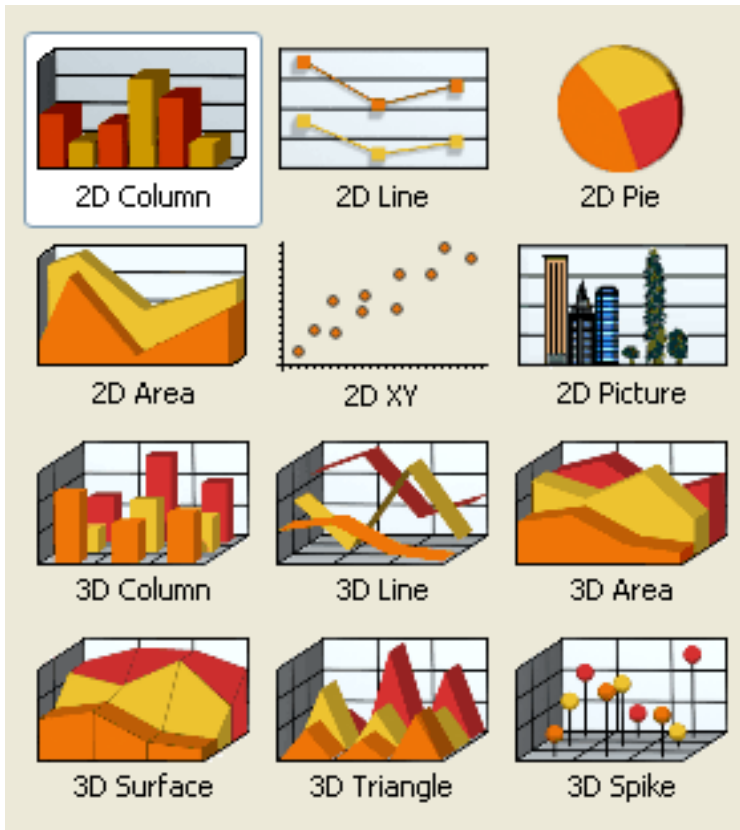
Different types of graphs are appropriate for different experiments!

Types of graphs

Favorite Sports of Third – and Fourth – Graders

- Grade 3
- Grade 4

Number of Students: 30, 25, 20, 15, 10, 5, 0

Sports: Soccer, Baseball, Swimming, Basketball

Grade Determination

- Final Exam — 50%
- Quizzes — 20%
- Class Project — 20%
- Class Participation — 10%

How Long Animals Can Hold Their Breath

Type of Animal: Whales, Dolphins, Seals

Number of Minutes: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20
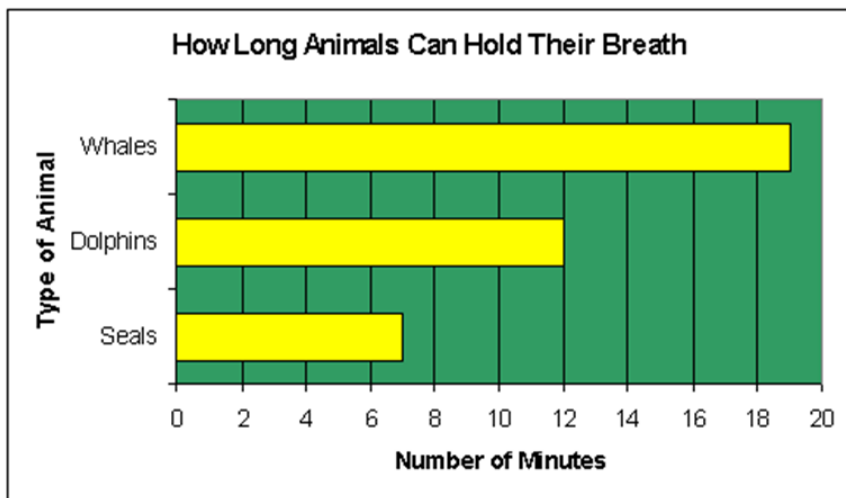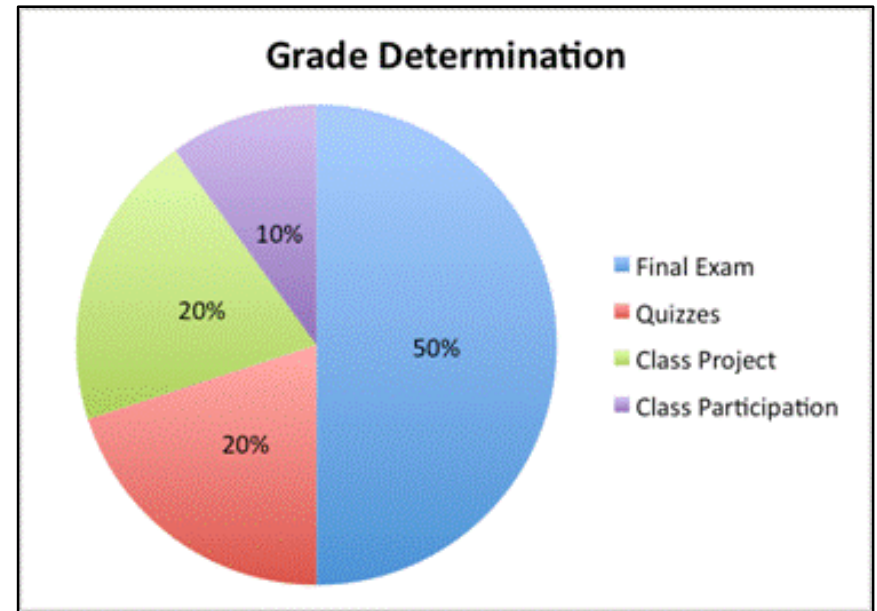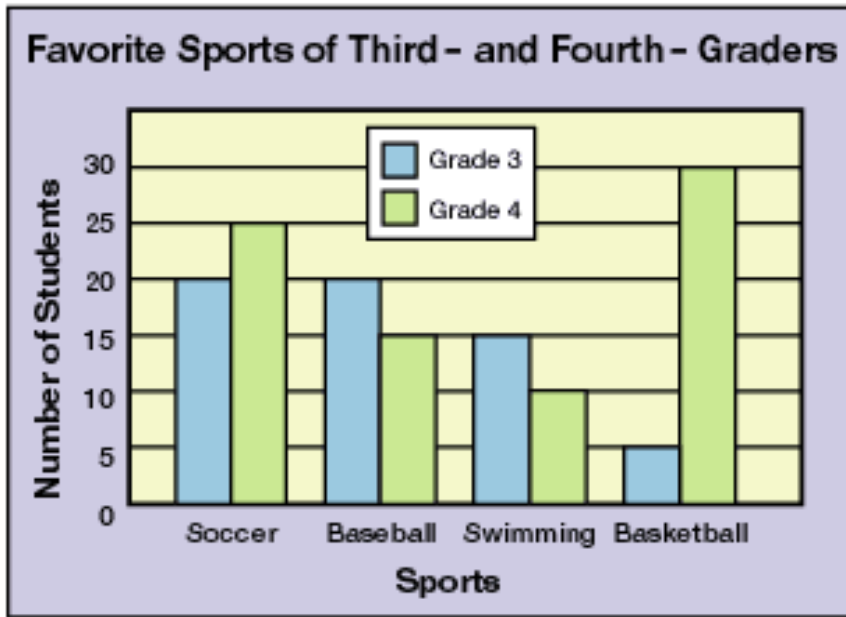
Bar graphs and **circle graphs** should be used to represent *categorical data* (comparison, sometimes called "side by side" data).

Types of graphs

Cedar Beach visitors
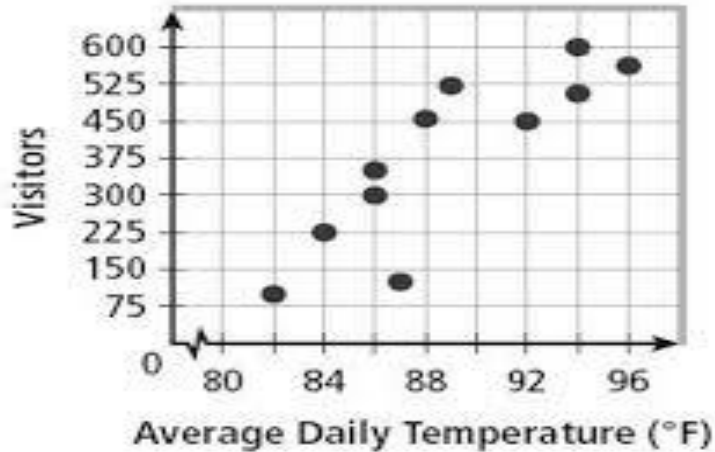
← **Scatter plots** are used to show *numerical* data.

Hummingbird sightings in Bend, Oregon, 2009

- Ariochus colubris
- Ariochus alexandri
- Calypte anna

Brain growth

Brain grows rapidly
Brain growth slows
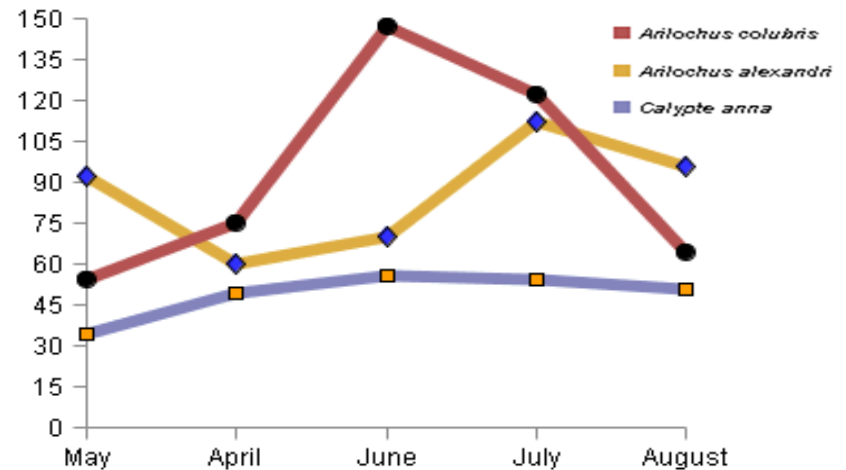
Line graphs should be used to show *how data changes over time*.
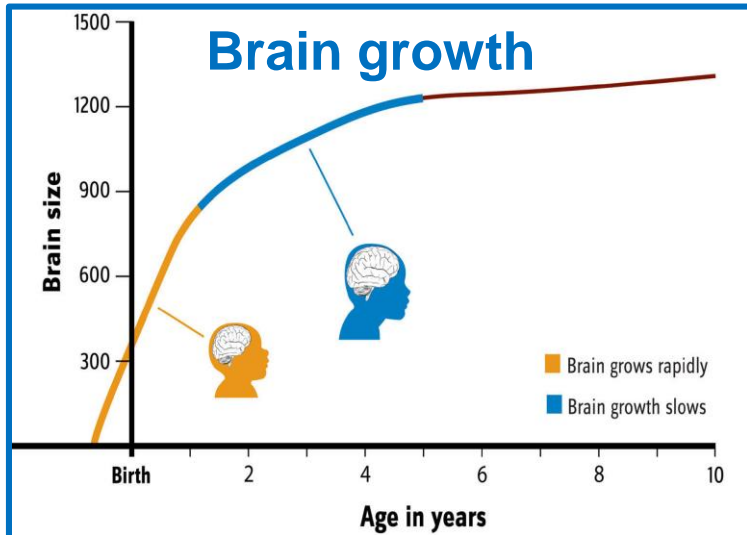
Famous Graph:
HR (Hertzsprung-Russell) Diagram
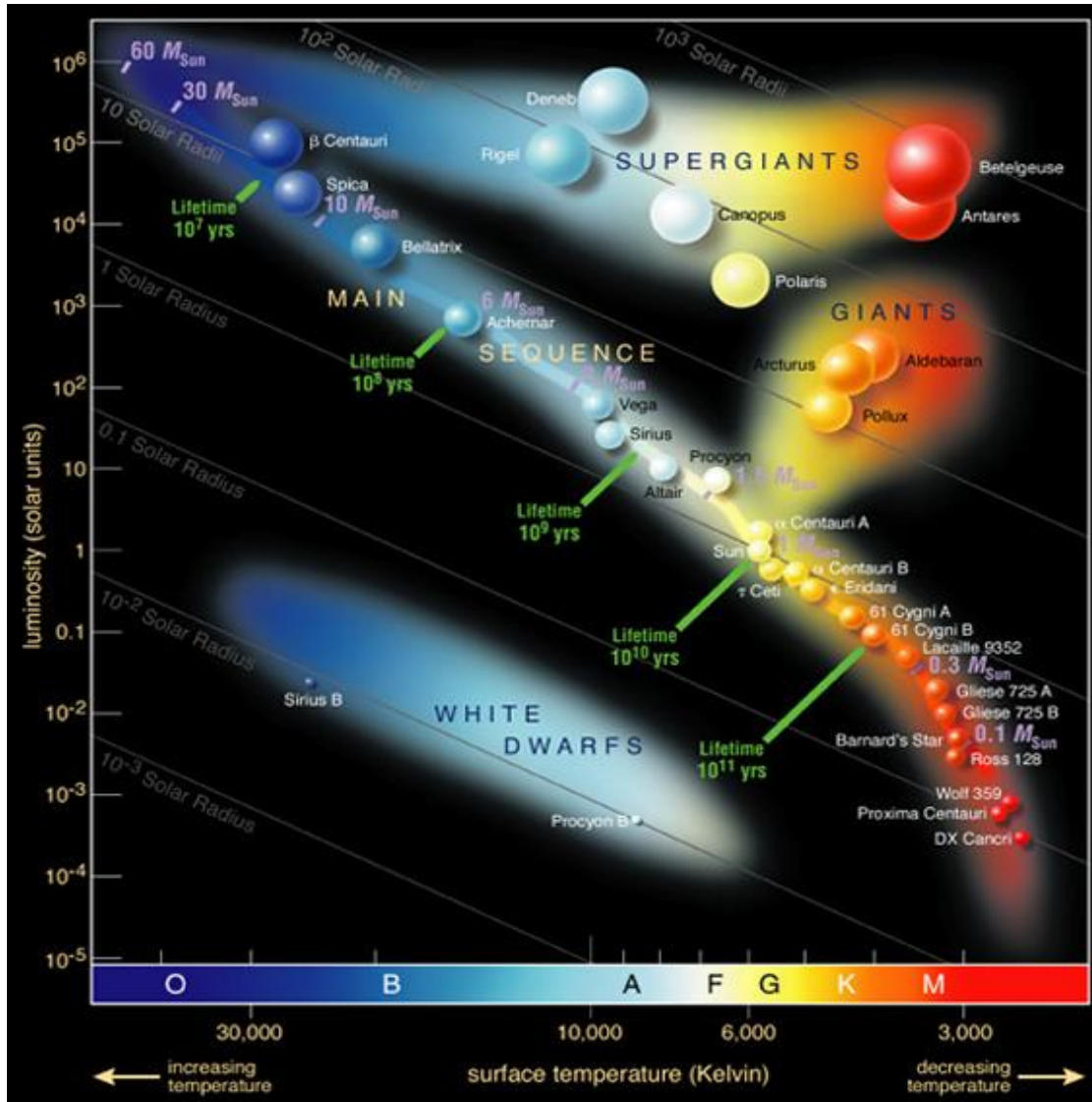
- **Created in 1910:**
  **a major step towards
  our understanding
  of stellar evolution
  or "the lives of stars".**

- **Temperature (x) vs
  Luminosity (y) plot.**

- **Stars tend to group
  into certain areas;
  most of the stars
  occupy the region
  in the diagram along
  the line called the
  main sequence.**

- **During that stage
  stars are fusing
  hydrogen inside
  their cores.**

Most Watched Graph: Climate Change

1.62°F warmer than 20th century average

Global Temperature Anomaly Since the Beginning of Records

20th century

NCEI / NESDIS / NOAA
http://www.ncei.noaa.gov/
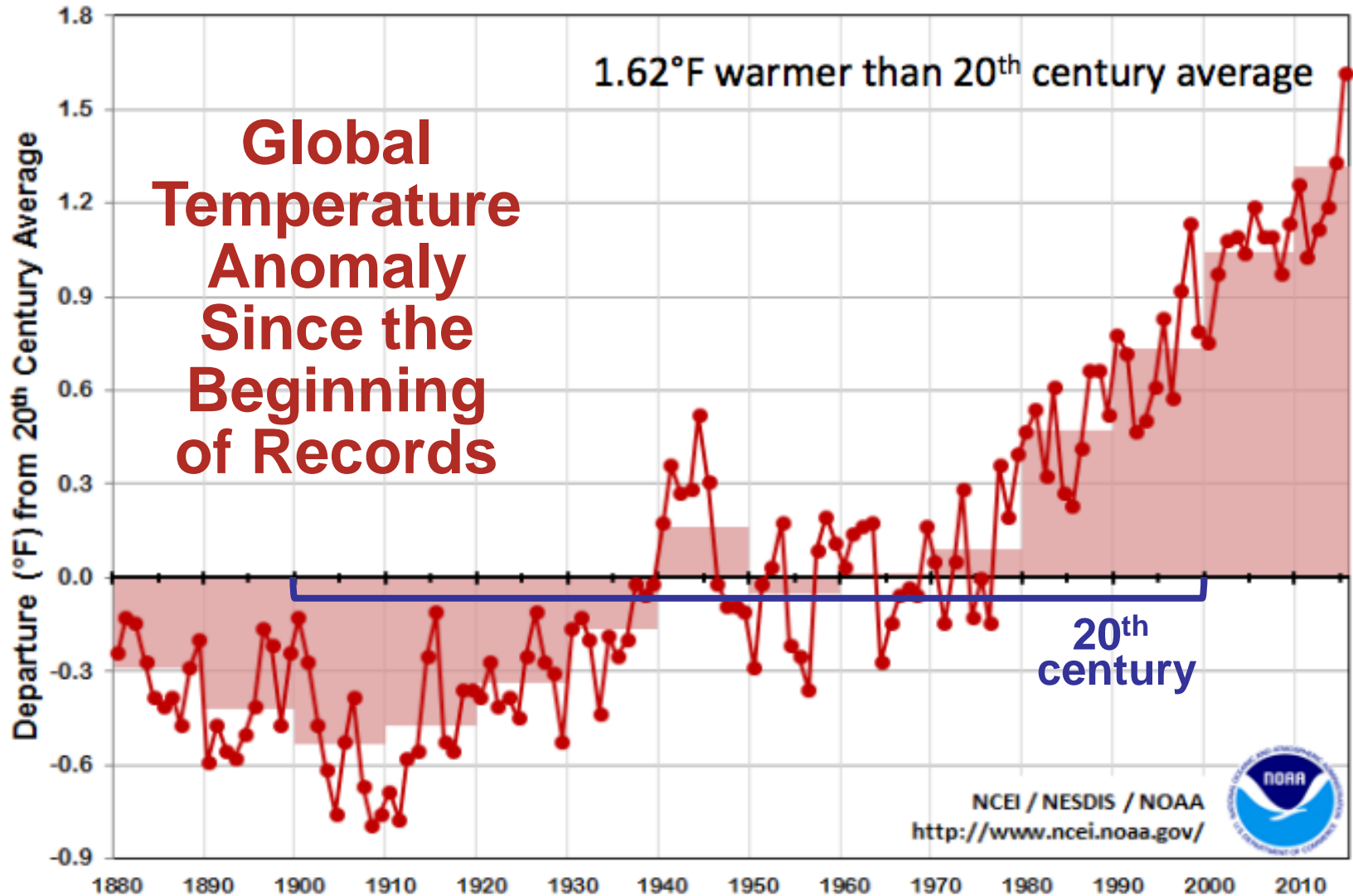
How to make a good graph?

For any type of graph:

- ✓ **Generally, you should place your independent variable on the x-axis of your graph and the dependent variable on the y-axis (*note that bar graphs are often an exception*).**

- ✓ **Make sure to clearly label all tables and graphs.**

- ✓ **Include the units of measurement (*inches, liters, grams, lbs etc.*).**

- ✓ **Be sure to use proper scale.**

- ✓ **If you have more than one set of data, show each series in a different color or symbol and include a legend with clear labels.**

Trees Planted in Year 2001

Prey-predator population dynamics
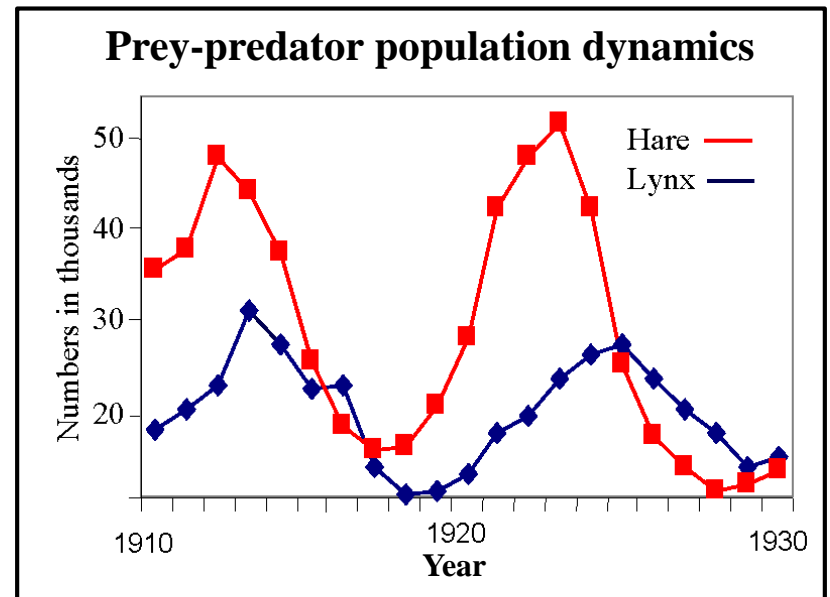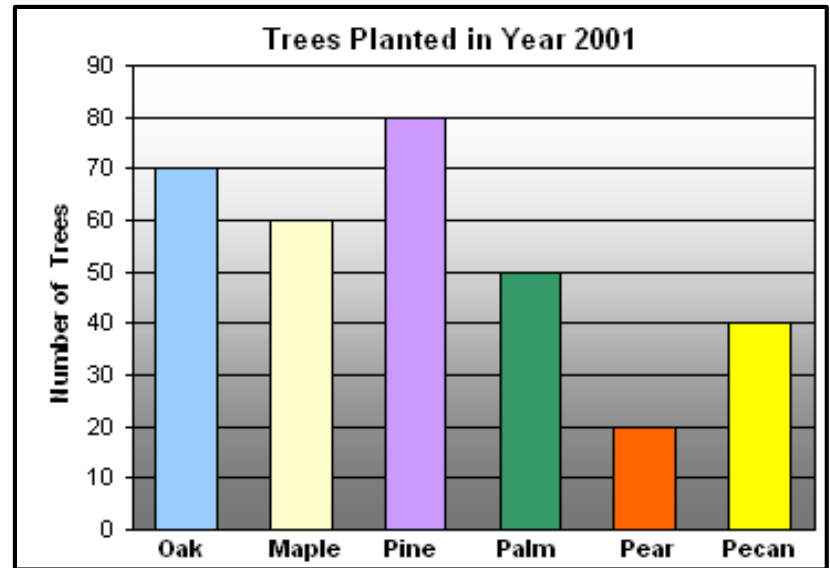
Conclusion

1. **<u>Conclusions</u> are written to answer the original testable question proposed at the beginning of the investigation.**

2. **<u>Conclusion</u> is a statement.**

3. **Your <u>conclusion</u> should:**

    ➤ **either support your hypothesis**

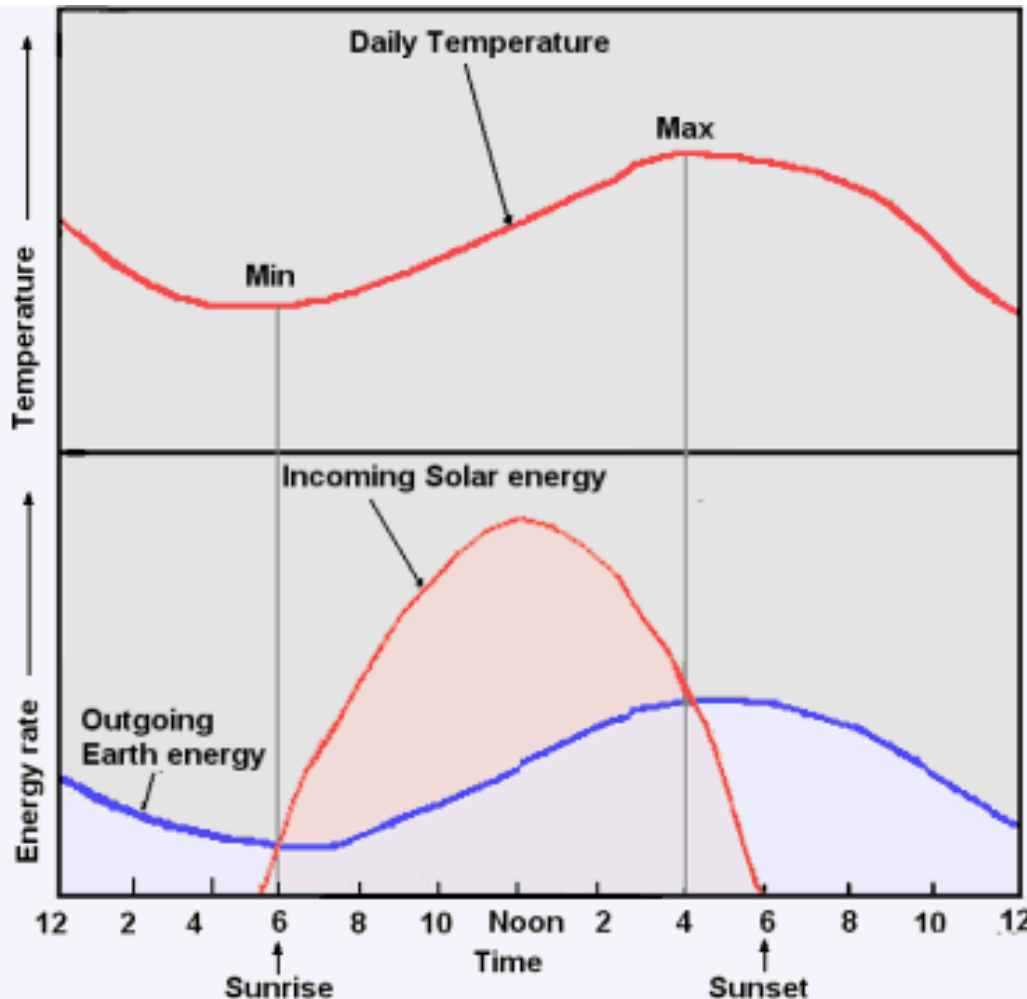   ➤ **or disprove your hypothesis.**

Example: "daily temperature lag"

Hypothesis: it gets warmer in the afternoon.

Data analysis:
The surface temperature is a balance of incoming **sunshine** (short wave radiation) and outgoing **heat** (infrared radiation). As long as the incoming exceeds the outgoing the temperature will increase.

Conclusion:
Generally, in middle latitudes, it gets warmer in the afternoon until it is about 2-3 hours before sunset.
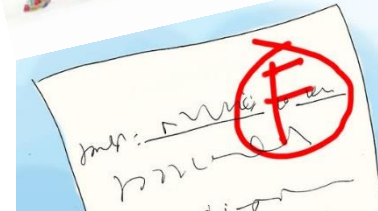
Conclusion: Examples

My experiments showed that **white carnations turn different colors when placed in colored water**.

This study showed that **air-filled balloons cannot float in the air** while **helium-filled balloons can** due to *lower density of helium gas*.

This study proved that indeed **snails are slower than crickets**!

This study found that **eating Smarties before the test does not directly help** you get a *better grade*!

Conclusion: Examples

This study found that eating candy **does not necessarily** cause cavities but **greatly increases the risk** of developing them!

This study showed that cardinal birds *prefer neither sunflower seeds **nor** safflower seeds* but **those that are easier to open**.

This study proved that indeed **cats can eat lobsters**…

My careful examination confirmed that **flashlight was not working due to dead batteries**.

…and a Special One

Hypothesis: ☺**Practice makes Perfect**☺

Experiment and Data analysis: DIY

Conclusion: *No one is perfect…but it is great to always try your best!!!*