Scientific Method

How can we tell a Hard boiled egg from a raw egg without breaking them?
The class will be broken up into groups.

Each group will receive 2 eggs. One is raw and the other is hard boiled. The eggs will be labeled A and B.

Within your group, you will come up with a way to figure out if the egg is cooked or raw without breaking it open, and at the end we will test your predictions by cracking the eggs.
What is the Scientific method?

1. Ask Question
2. Do Background Research
3. Construct Hypothesis
4. Test with an Experiment
5. Analyze Results
   - Draw Conclusion
     - Hypothesis Is True
     - Hypothesis Is False or Partially True
6. Report Results
7. Think! Try Again
Form a Hypothesis...

**Variables**

- Independent variable: What is staying the same in the experiment.

- Dependent variable: What is affected or changed by the dependent variable.

- What are the dependent and independent variables in your experiment?
Perform your experiment

- Now that you have formed a hypothesis, take some time to test it out.

- What are your results?
Results

- Each group will bring which egg they think is hard boiled to the front, and we will test to see if your hypothesis is correct.
Accidents Can Happen

**Bhopal, India 1984**
A leak of methyl isocyanate gas and other chemicals from the plant resulted in the exposure of hundreds of thousands of people.

**Baia Mare cyanide spill, 2000**
leak of cyanide near Baia Mare, Romania, into the Somes River by the gold mining company Aurul.

The **Chernobyl disaster** was a nuclear accident that occurred on 26 April 1986 at the Chernobyl Nuclear Power Plan in Ukraine. An explosion and fire released large quantities of radioactive contamination into the atmosphere, which spread over much of Western USSR and Europe.
Waste Disposal
The **carbon cycle** is the biogeochemical cycle by which carbon is exchanged among the biosphere, pedosphere, geosphere, hydrosphere and atmosphere of the Earth. It is one of the most important cycles of the earth and allows for carbon to be recycled and reused throughout the biosphere and all of its organisms.
A carbon footprint is "the total set of greenhouse gas (GHG) emissions caused by an organization, event, product or person." Greenhouse gases can be emitted through transport, land clearance, and the production and consumption of food, fuels, manufactured goods, materials, wood, roads, buildings, and services. It is often expressed in terms of the amount of carbon dioxide emitted.
Reducing Carbon Footprint

What are some of the possibilities to reduce everyday pollution?
Reduce, Re-Use, Recycle

Reduce

• avoid products with excessive packaging
• production of the packaging uses additional energy
• extra volume and weight will have to be transported (by lorries, aircraft, ships etc.)
• packaging will be thrown out and will need to be collected from your home by a large waste disposal truck
• packaging then takes more space at land fill sites
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Re-use
• Everyone should try and re-use products for as long as feasibly possible. It is amazing how often people buy certain products and use them only once or twice, even though they can be re-used many times. For instance can you think of some items of clothing you have worn only once?
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Recycle
• Recycling uses less energy and produces less pollution than making things from scratch.
• For example:-
• Making Aluminium cans from old ones uses one twelfth of the energy to make them from raw materials.
• Making bags from recycled polythene takes one third the Sulphur Dioxide and half the Nitrous Oxide, than making them from scratch.
Reduce, Re-Use, Recycle

Give an example of everyday items that can be reduces, re-used and/or recycled?
What are the Different Types of Pollution?

Think of a way that you may be affected directly by pollution. How is this affecting you? What is the source of this pollution?
Air Pollution

- Any contamination of the Atmosphere that changes its natural Chemical composition.

- Sources include
  - Vahicle or manufacturing exhaust
  - Forest fires, volcanic eruption
  - Building contraction/demolition
  - What other sources can you think of?
Water Pollution

- This includes ANY contamination of water that changes its purity
- Sources of water pollution
  - Organic decay in water
  - Improper Waste disposal
  - Leeching of Soil pollution
Soil Pollution

- Sources include
  - Hazardous waste and sewage spill
  - Use of heavy pesticides
  - Strip Mining, Deforestation
Light Pollution

- This is in large cities like New York, when the amount of light prevents us from seeing details of the night sky.
Noise Pollution

- Prolonged Exposure to high levels of noise can cause hearing loss
- Common sources include
  - Concerts
  - Car / Bus / Trains / Planes
  - Construction / demolition
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Give an example of everyday items that can be reduced, re-used and/or recycled?
Tree Measurements: Population Density
Schematic representation of the photosynthetic reaction is given by:

\[ 6\text{CO}_2 + 6\text{H}_2\text{O} \xrightarrow{\text{Sun}} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \]

From the photosynthetic reaction 0.264kg of CO\textsubscript{2} are sequestered to produce 0.180kg of tree. The weight of the Carbon Dioxide that needs to be sequestered to produce the tree is:
Photosynthesis:

- Schematic representation of the photosynthetic reaction is given by:

\[
6\text{CO}_2 + 6\text{H}_2\text{O} \xrightarrow{\text{Sun}} \text{C}_6\text{H}_12\text{O}_6 + 6\text{O}_2
\]

- 0.264 kg of CO₂ → 0.18 kg of tree
Average person eats around 2000 Food Calories/ Day. Assuming that he gets all of his needed energy from eating sugar (glucose). The person will produce his needed energy through the respiration reaction. He will need 0.52kg/day to produce the energy that he needs and in the process he will release 0.7kg of CO₂/day.
Respiration

\[ C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{biologically stored energy} \]

0.52 kg of glucose \rightarrow 0.7 kg of CO_2
Sources of Error

- We will be using an average of population density for the whole neighborhood and dividing it by the areas we measured trees and counted cars in to get a general estimate for the number of people.

- What are possible sources of error that we may encounter?
Do Now: Create a map of anything you want (class room, hometown, city, etc.)
NYC Subway Map
NYC
Brooklyn
Bus Map
Map should include the following:

- Title
NYC Brooklyn Bus Map

Map should include the following:

- Title
- North Arrow
Map should include the following:

- Title
- North Arrow
- Scale
Map should include the following:

- Title
- North Arrow
- Scale
- Legend
NYC
Brooklyn Bus Map

Map should include the following:

- Title
- North Arrow
- Scale
- Legend
Pollution in NYC
Where is the following on the map:

- Title
- North Arrow
- Scale
- Legend
Where is the following on the map:

- **Title ???**
- North Arrow
- Scale
- Legend
PM - Particulate Matter - are tiny subdivisions of solid matter suspended in a gas or liquid (air pollution, water pollution, etc)

Where is the following on the map:

- Title
- North Arrow
- Scale
- Legend
Particulate Matter are tiny subdivisions of solid matter suspended in a gas or liquid (air pollution, water pollution, etc).

Where is the following on the map:

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- Title
- North Arrow
- Scale
- **Legend**
Where is the following on the map:

- Title
- North Arrow
- Scale
- Legend
Where is the following on the map:

- **Title**
- **North Arrow**
- **Scale**
- **Legend**
Where is the following on the map:

- Title
- North Arrow
- Scale
- Legend
Where is the following on the map:

- Title
- North Arrow
- Scale
- Legend
Where is the following on the map:

- Title
- North Arrow
- Scale
- Legend ???
Map of Population in the US

Note: Population figures for cities shown are for city proper only.

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Where is the following on the map:

- Title ???
- Scale
- Legend
- North Arrow
Where is the following on the map:

- **Title**
- **Scale**
- **Legend**
- **North Arrow**
Where is the following on the map:

- Title
- **Scale ??**
- Legend
- North Arrow
Where is the following on the map:

- Title
- Scale
- Legend
- North Arrow
Where is the following on the map:

- Title
- Scale
- Legend ???
- North Arrow
Where is the following on the map:
- Title
- Scale
- Legend
- North Arrow
Where is the following on the map:

- Title
- Scale
- Legend
- North Arrow ????
Revisit the map you made for the do now, and then improve it based on what you learned in class today.

What were the most important points on your map that were missing?

Did you have the title, legend, scale and north arrow on your map?
Carbon Footprint Project

Results
How do figure out how much CO2 is being emitted by the cars we counted up?

- First we find the Length of the Block we counted.
Convert Length to Miles

1 mile = 5280 ft

So... 1000 ft = ? Miles?

\[
\frac{5280}{1} = \frac{1000}{?} \rightarrow \frac{1000}{5280} = 0.1894 \text{ miles}
\]
Figure out the Gas Mileage for each Car Type.

- Small Car = ~22 mpg
- Large Car = ~18 mpg
- Box Truck = ~11 mpg
- Semi Truck = ~6 mpg
- Bus = ~8 mpg
How Many Gallons per block?

- For Each car type, measure the gallons of gasoline being used per block.

- \[ \frac{22 \text{ miles}}{1 \text{ gallon}} = \frac{0.1894}{22} \Rightarrow 0.00859 \text{ gallons per block for small cars} \]
How many grams of CO2 are being emitted per gallon of gasoline?

- 8920 grams of CO2 per gallon of gasoline

How is this possible if a gallon of gasoline weighs about 6lbs?
Now we can figure out how much CO2 is being emitted on the block per car.

- 8920 grams per gallon × 0.00859 gallons (for small cars)

- This equals:
  - 46.22182 grams of CO2 per small car for this block
So, what is the final result?

<table>
<thead>
<tr>
<th>Car Counting Data</th>
<th>Box Truck</th>
<th>Semi</th>
<th>Bus</th>
<th>Beverly Rd</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>block l(ft)</td>
<td>block l(m)</td>
<td>gallons per block</td>
<td>grams CO2 per block</td>
</tr>
<tr>
<td></td>
<td>600</td>
<td>0.114</td>
<td>0.005182</td>
<td>46.22182</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>0.189</td>
<td>0.008591</td>
<td>76.63981</td>
</tr>
<tr>
<td></td>
<td>1200</td>
<td>0.227</td>
<td>0.010319</td>
<td>92.03919</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tilden Ave area</th>
<th>Tilden Ave</th>
<th>Ralph Ave</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1000ft long</td>
<td>600ft</td>
</tr>
<tr>
<td>2:35-2:50</td>
<td>2:00-2:15</td>
<td>12:20-12:35</td>
</tr>
<tr>
<td>car type</td>
<td>sm car</td>
<td>lg car</td>
</tr>
<tr>
<td>car count</td>
<td>99</td>
<td>21</td>
</tr>
<tr>
<td>g of CO2</td>
<td>7586.46</td>
<td>1966.86</td>
</tr>
<tr>
<td>combined</td>
<td>4156.482</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Kings Hwy</th>
<th>E56st, E57st, E59st</th>
<th>600ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:43-1:57</td>
<td>2:00-2:15</td>
<td></td>
</tr>
<tr>
<td>car type</td>
<td>sm car</td>
<td>lg car</td>
</tr>
<tr>
<td>car count</td>
<td>499</td>
<td>46</td>
</tr>
<tr>
<td>g of CO2</td>
<td>21678.03</td>
<td>4519.467</td>
</tr>
</tbody>
</table>

Total CO2 emissions in area over a 15 minutes time period:
80820.04
in a day:
7759724
Tree Data

- Carbon Sequestration

- Based on the weight of the tree, we can figure out how much CO2 it holds.

- A tree holds .246kg of CO2 for every .18 kg of the tree.
So...

- If we use this formula we can figure out how much CO2 each tree is holding.

  \[(\text{Weight of tree}/0.18\text{kg}) \times 0.246\text{kg}\]
How do the trees compensate for humans?

- An average human exhale about 0.7kg of CO2 in a day. Therefore, we can figure out how many people are being compensated for by each tree.

- Carbon footprint of tree = # of ppl compensated
  
  0.07kg
Results

- Combined Tree data
  - Total CO2 sequestered: 6483146.40kg
  - Total # of ppl compensated for: 9261638ppl

- In the area we measured, there are about 255 people.
- The trees can make up for the people’s CO2 emissions in the direct area for 36392 days or about 100 years! (not including cars)
How are we affected by excessive noise?

Do Now: What are the different types of pollution?
Noise Pollution

• Prolonged Exposure to high levels of noise can cause hearing loss
• Common sources include
  o concerts
  o car / bus / trains / planes
  o construction / demolition
What Is Sound?

• Sound is defined as any pressure variation heard by the human ear.
• Sound is created by waves of pressure moving through gas, liquid or solid.
What causes hearing Loss?

• Sensitive structures called **hair cells** are small sensory cells that convert sound energy into electrical signals that travel to the brain.

• When you expose yourself to sounds that are too loud for too long, you will damage these Hair cells, causing permanent hearing loss.
How Loud Is Loud?

<table>
<thead>
<tr>
<th>Continuous dB</th>
<th>Permissible Exposure Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>85 dB</td>
<td>8 Hours</td>
</tr>
<tr>
<td>88 dB</td>
<td>4 Hours</td>
</tr>
<tr>
<td>91 dB</td>
<td>2 Hours</td>
</tr>
<tr>
<td>94 dB</td>
<td>1 hour</td>
</tr>
<tr>
<td>97 dB</td>
<td>30 minutes</td>
</tr>
<tr>
<td>100 dB</td>
<td>15 minutes</td>
</tr>
<tr>
<td>103 dB</td>
<td>7.5 minutes</td>
</tr>
<tr>
<td>106 dB</td>
<td>3.75 minutes (&lt; 4 min)</td>
</tr>
<tr>
<td>109 dB</td>
<td>1.875 minutes (&lt; 2 min)</td>
</tr>
<tr>
<td>112 dB</td>
<td>.9375 min (~ 1 min)</td>
</tr>
<tr>
<td>115 dB</td>
<td>.46875 min (~ 30 sec)</td>
</tr>
</tbody>
</table>

- Softest sound you can hear: 0 dB
- rocket launch: 165 dB
- 12-gauge shotgun: 155 dB
- fireworks gun shot: 145 dB
- jet plane (from 100 ft): 135 dB
- ambulance jack hammer: 125 dB
- leaf blower rock concert chainsaw: 115 dB
- walkman tractor gas mower hair dryer: 105 dB
- busy city traffic washing machine: 95 dB
- typical speech: 90 dB
- rainfall: 85 dB
- whisper: 55 dB
- softest sound you can hear: 0 dB
Now that we have collected our data, we must organize it.

**Format:**

- **Atlantic Ave**
  - Add up the amount of time, and find the average of each data point, then add the averages. Note the highest and lowest data in between each stop (not for each point)

- **Franklin Ave**
  - Stops where we have platform data will be open circles

- **President St**
  - Stops where data was not collected will be closed circles
Example
Why Chemistry?

Malgorzata Frik
Brooklyn College
Graduate Center of the City University Of New York
PERIODIC TABLE OF THE ELEMENTS

Dmitri Mendeleev (1834 - 1907)

The Russian chemist, Dmitri Mendeleev, was the first to observe that elements vary systematically in order of several reasons, they showed regular periodic properties. He formulated his discovery as a periodic table of elements, now regarded as the backbone of modern chemistry.

The growing achievement of Mendeleev's periodic table for his prototype of then, undiscovered elements. In 1869, the year he published his periodic classification, the elements gallium, germanium and scandium were unknown. Mendeleev left spaces for them in his table and even predicted their atomic masses and other chemical properties. Six years later, gallium was discovered and its properties were found to be as expected. Other discoveries followed and their chemical behavior matched that predicted by Mendeleev.

This remarkable man, the youngest in a family of 15 children, has left his scientific communities with a consistent system so powerful that it becomes the cornerstone in chemistry teaching and the prediction of new elements over years. In 1955, element 106 was named after him, "Mendelevium".
Why Chemistry?
Marie Skłodowska–Curie (1867-1934)

- Was a Polish–French physics-chemist famous for her pioneering research on radioactivity.
- She was the first person honored with two Nobel Prizes, in physics and chemistry.
- She was the first female professor at the University of Paris.
- She discovered two elements, polonium and radium.
- Under her direction, the world's first studies were conducted into the treatment of neoplasms, using radioactive isotopes.
- She founded the Curie Institutes: the Curie Institute in Paris and the Curie Institute in Warsaw.
Application of gold compounds as anticancer agents

**Goal**

Our Group research's focuses on the area of inorganic chemistry and, more specifically in the chemistry of coordination and organometallic compounds of gold in different oxidation states.

We thus have two main projects in the areas of homogenous catalysis and green chemistry and in the area of medicinal chemistry.

**Long Term Goal**

To design of gold-anticancer pharmaceuticals that overcome some of the existing clinical problems associated with the use of platinum drugs in cancer chemotherapy.

To understand the mechanism of action of gold derived anticancer pharmaceuticals, and identify their final target.
Cisplatin

- Cisplatin discovered by Rosenberg in 1961
- Approved for human use by FDA in 1979
- One of the most successful drugs ever in cancer treatment, such as small cell lung cancers and ovarian cancer
**Introduction**

- Gold and silver derivatives have been studied in the last few decades for their potential applications in medicine.
- While silver derivatives are used mainly as antibacterial agents, gold compounds have been used in the treatment of rheumatoid arthritis.
- More recently gold(I)-phosphine have been studied as potential antitumor and antimicrobial agents.
- Silver carbene derivatives have also displayed high activity against selected tumor cancer cells *in vitro* and Gram-positive and Gram-negative bacteria.
Project

- To develop luminescent gold compounds as antimicrobial agents.

\[
\begin{align*}
\text{Au} & \rightarrow \text{AsPh}_3 \\
\text{dppe/dppy} & \rightarrow \text{Au} \quad \text{DCM} \\
\text{(2:1)} & \\
\text{P} & \text{P} = \text{dppe (1a), dppy (1b)} \\
\text{Ag} & \rightarrow \text{DCM} \\
X & \rightarrow \text{Cu(CH}_3\text{CN)}_x\text{PF}_6 \\
\text{P} & \text{P} = \text{dppe (4a), dppy (4b)} \\
\end{align*}
\]

\[
\begin{align*}
\text{dppe} &= \text{1,2-Bis(diphenylphosphino)ethane} \\
\text{dppy} &= \text{1,2-Bis(di-3-pyridylphosphino)ethane}
\end{align*}
\]
Antimicrobial Assay:

- The antimicrobial activity of the compounds were evaluated against:
  - gram-negative (*Escherichia coli* and *Salmonella typhymurium*) bacteria,
  - gram-positive (*Bacillus cereus* and *Staphylococcus aureus*) bacteria.
  - yeast (*S. cerevisiae*)
Chemistry is Fun
Final Results
0.18 Kg of Tree = 0.264 Kg of CO$_2$ Sequestered
Sources of CO₂ we measured

People

Cars
People

Digestion

2000 Calories

Respiration

0.7 Kg of CO₂ per day
0.8920 grams of CO$_2$ per gallon of Gasoline
Are we producing more than what the trees can sequester?
Cars and People

![Bar chart showing CO2 sequestered and cars and people combined](chart.png)
Church Ave area

![CO2 Sequestered vs Cars and Humans Combined CO2](chart.png)
What do you think?

- Is our data accurate?
- Is there anything else we should consider?
- What can we conclude with this data?
- Do changes need to be made?