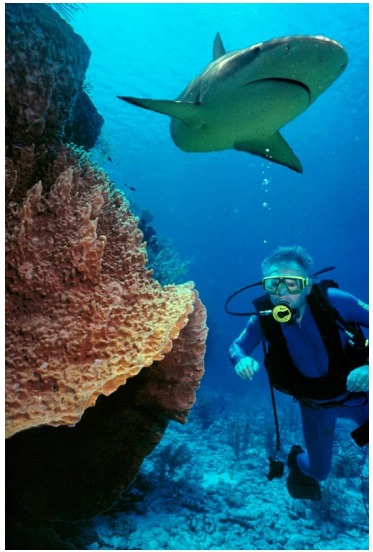
Section 2: The Nature of Science

The word *science* comes from the Latin word *scientia*, meaning “knowledge.”

Science

organized way of gathering and **analyzing evidence** about the natural world



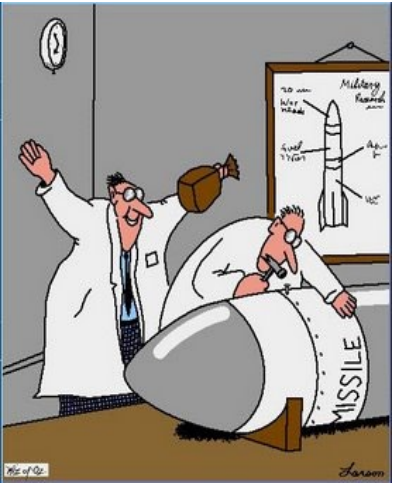
Science

- Science is different from other human works in the following ways:

✓Science deals only with the natural world, not the supernatural.

✓Scientists collect and organize information about the natural world in an orderly way.

Science



- Science is different from other human works in the following ways:

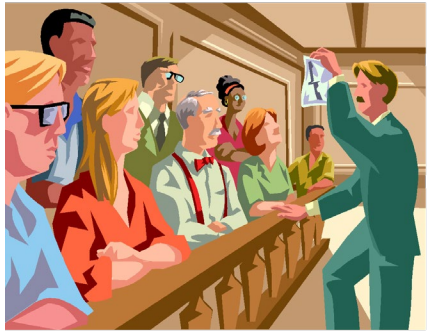
✓Scientists propose explanations that are based on **evidence** from measurements and observations.

✓They test those explanations with more evidence

Evidence

object, testimony of an eyewitness, information, or some other thing used to support an idea, determine a judgment, or draw a **conclusion**

used to prove, explain, predict... something



United Streaming Video
Scientific Investigation: Crime Solving 200 Years Ago

Video Recap

Scientific Investigation: Crime Solving 200 Years Ago

1. What **observations** did the investigators make?

2. How did they use the **evidence** they gathered to find the guilty man?

Science

Goal of science is to provide natural explanations for events in the natural world and to use those explanations to make useful **predictions**.

Science

- Assumes that the natural world functions in accordance with rules that do not change.
- Scientific ideas are “supported,” not “proven,” and “accepted,” not “believed in.”

- **Scientific Method:**

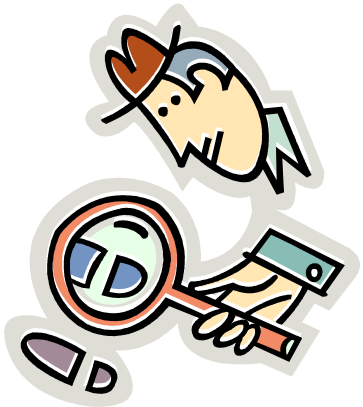
The Heart of Science

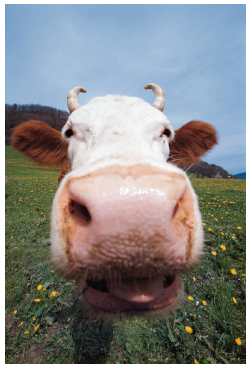
Methodology for scientific investigation involves:

- Making an **observation**. Observation involves the act of noticing and describing events or processes in a careful, orderly way.

Using Your Senses

- Observation - something we see, hear, taste, touch, or smell





- **Scientific Method:**

The Heart of Science

Methodology for scientific investigation involves:

- Scientists use their observations to make inferences. An **inference** is a logical interpretation based on what scientists already know.

Using Your Senses

- Inference – conclusion, idea, judgment, prediction…based on (an) observation(s)

Recap: *Observation vs. Inference

- **Observation** – something based on senses
- Noticing or observing natural events in a logical or orderly way

- **Inference** - description, explanation, interpretation of an observation

United Streaming Video
Scientific Investigation: Who was the Ice Man?

Video Recap

Scientific Investigation: Who was the Ice Man?

1. What **observations** did the researchers make of the body they found?

2. What **inferences** were made – based on their **observations**?

3. How did the researchers use **modeling** to test their idea?

Ice Man

Observations

mummified / frozen body
arrow in back
well preserved clothing

Video Recap

Scientific Investigation: Who was the Ice Man?

1. What **observations** did the researchers make of the body they found?

2. What **inferences** were made – based on their **observations**?

3. How did the researchers use **modeling** to test their idea?

Inferences

- killed → murder
- clothing → determine the age
- shepherd

Modeling

↓

dressed up as a shepherd

Research: an examination or careful, diligent search for information

Re = to do again, repeat

Search: to look for something

Recap: *What is Science? Explanations are based upon…?

- organized way of gathering and analyzing **evidence** about the natural world.
- **Evidence** – not opinions or preferences!

When we need more information and do a search, that is called…?

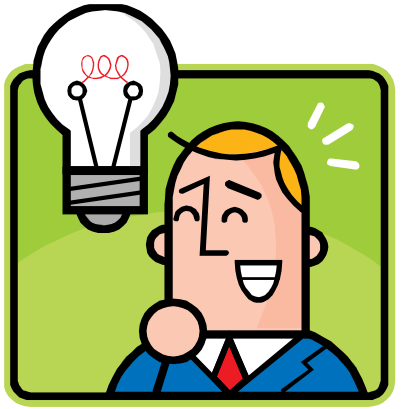
- RESEARCH!

Hypothesis

- statement or explanation, can be tested, studied, or researched
- testable idea

  hypo – insufficient, not enough

  thesis - statement

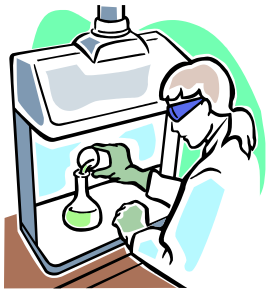


United Streaming Video
Scientific Investigation: Modern Forensics

Video Recap
Scientific Investigation: Modern Forensics

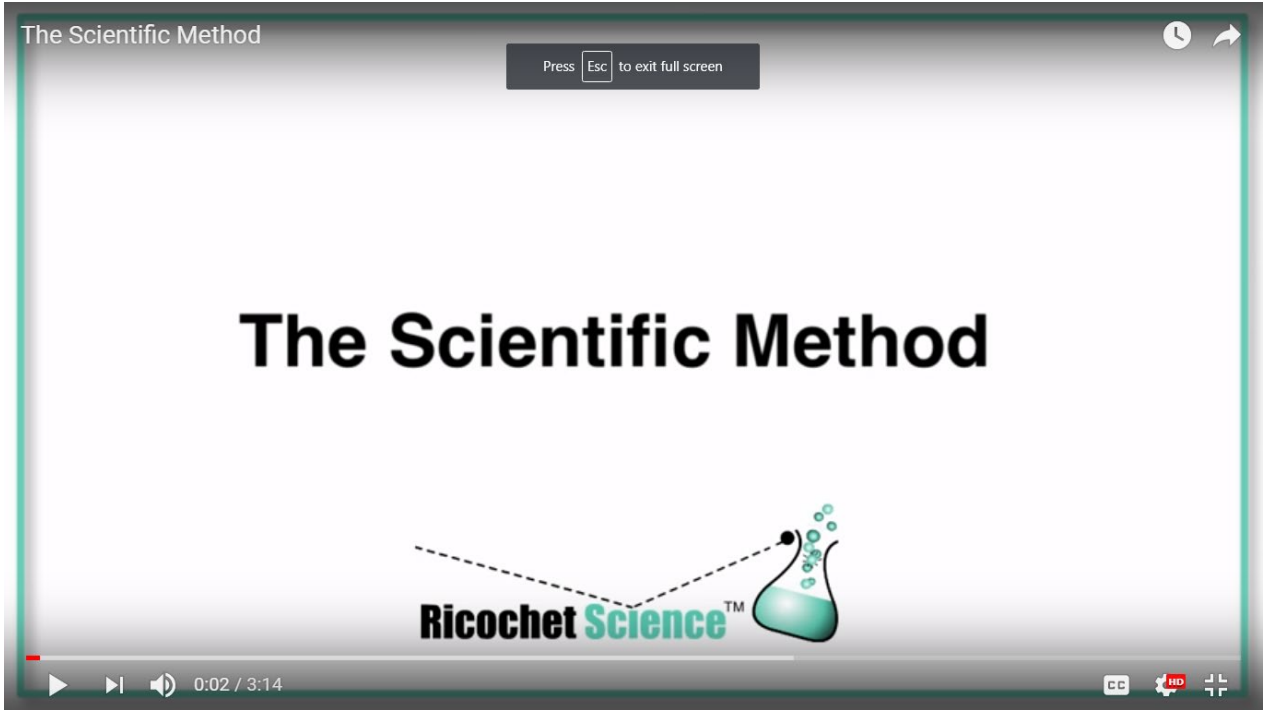
1. What **observations** did they make and collect as **evidence** that were different from the original scene?

Experiment: procedure or test carried out under controlled conditions

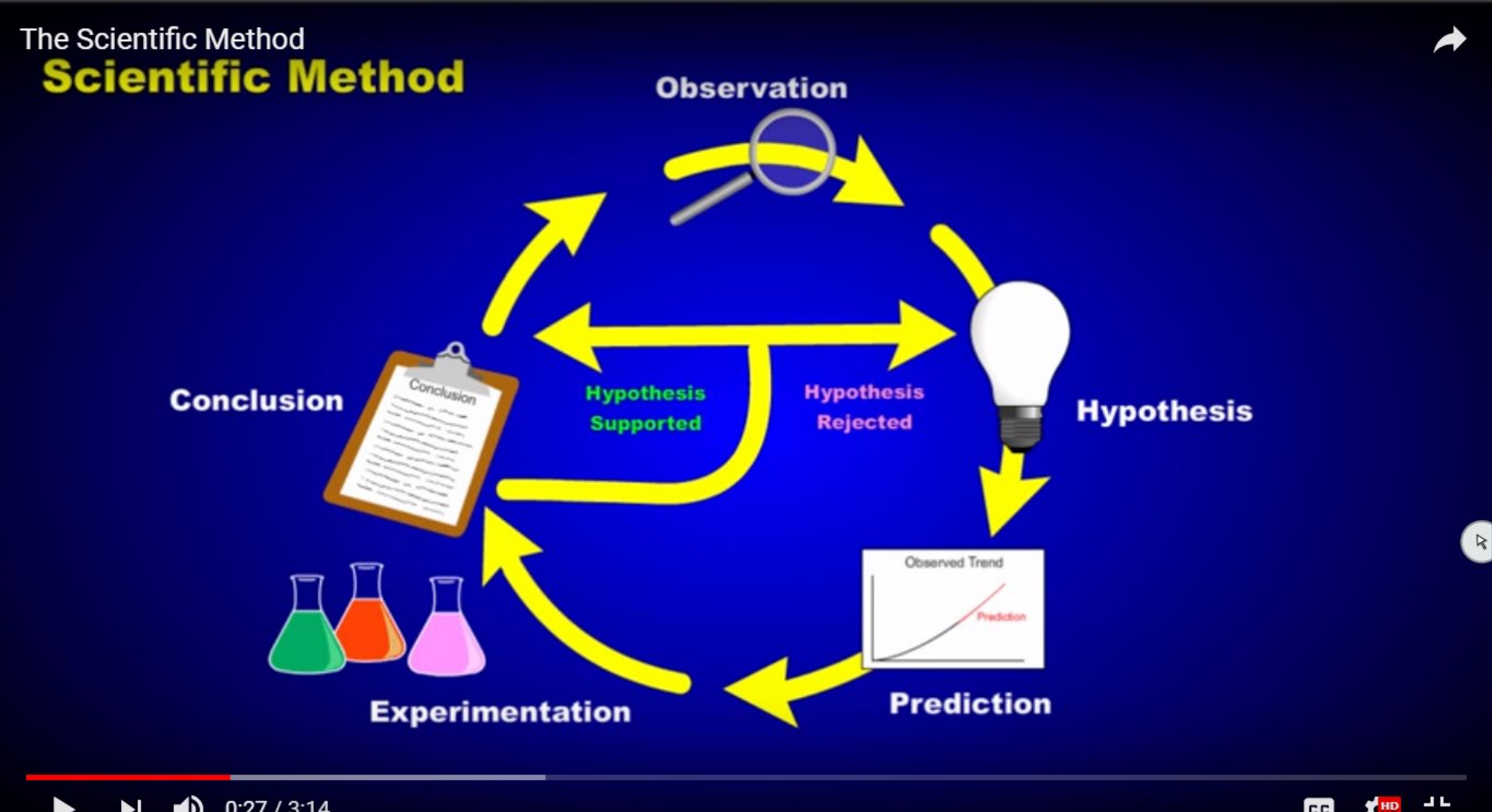


The Scientific Method

https://www.youtube.com/watch?v=H21xs1p0VTc



The Scientific Method



The Scientific Method

Scientific Method

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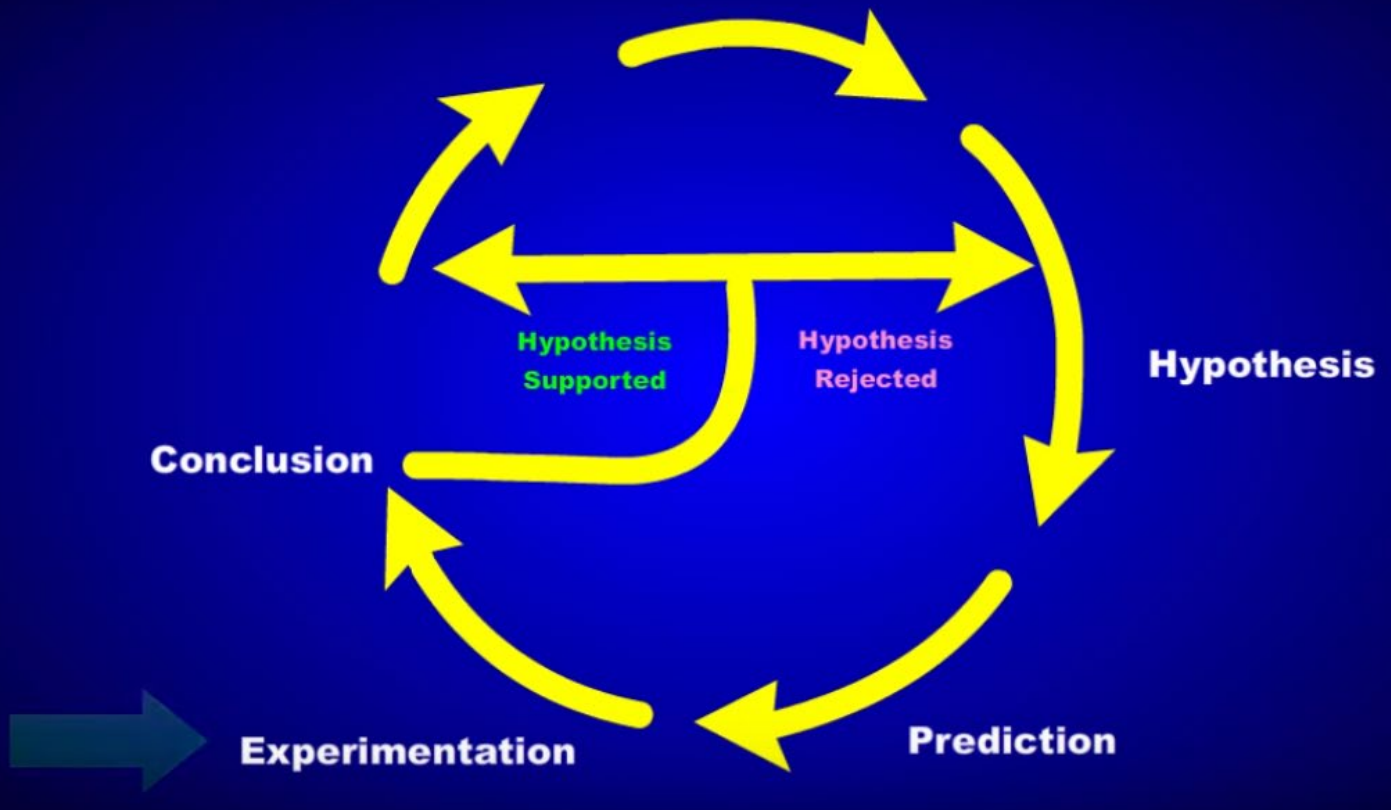

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The Scientific Method

Scientific Method

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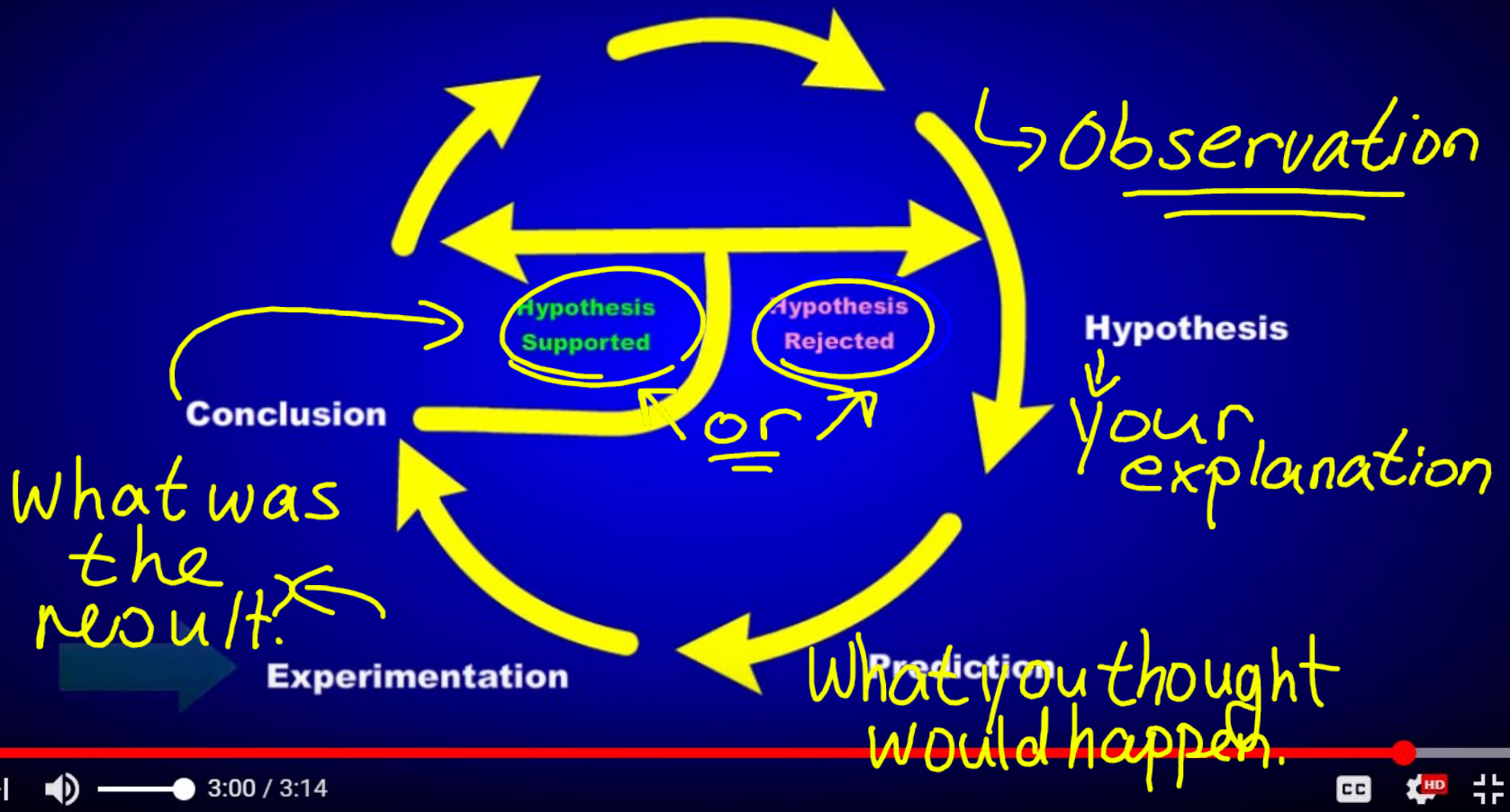

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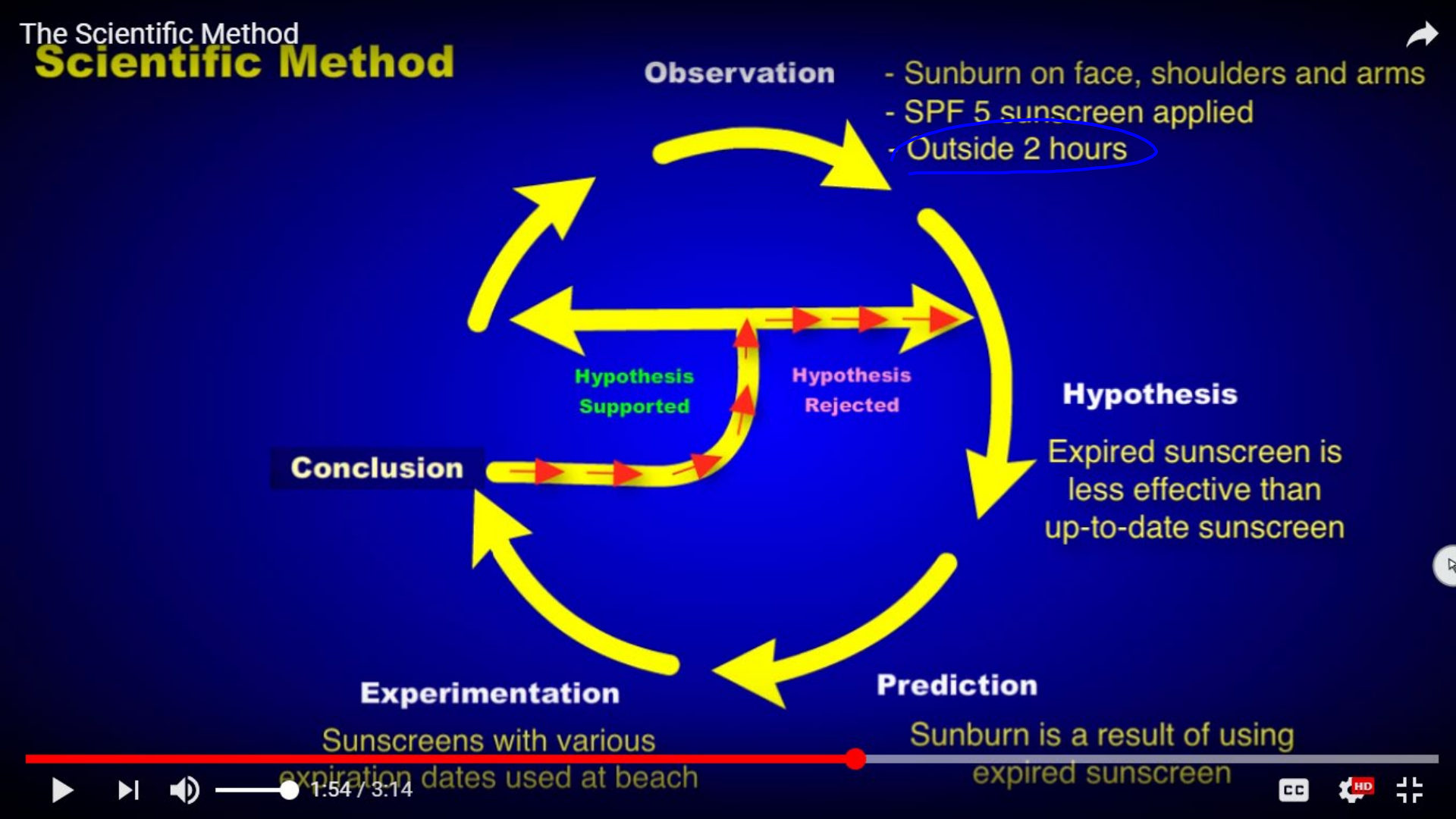
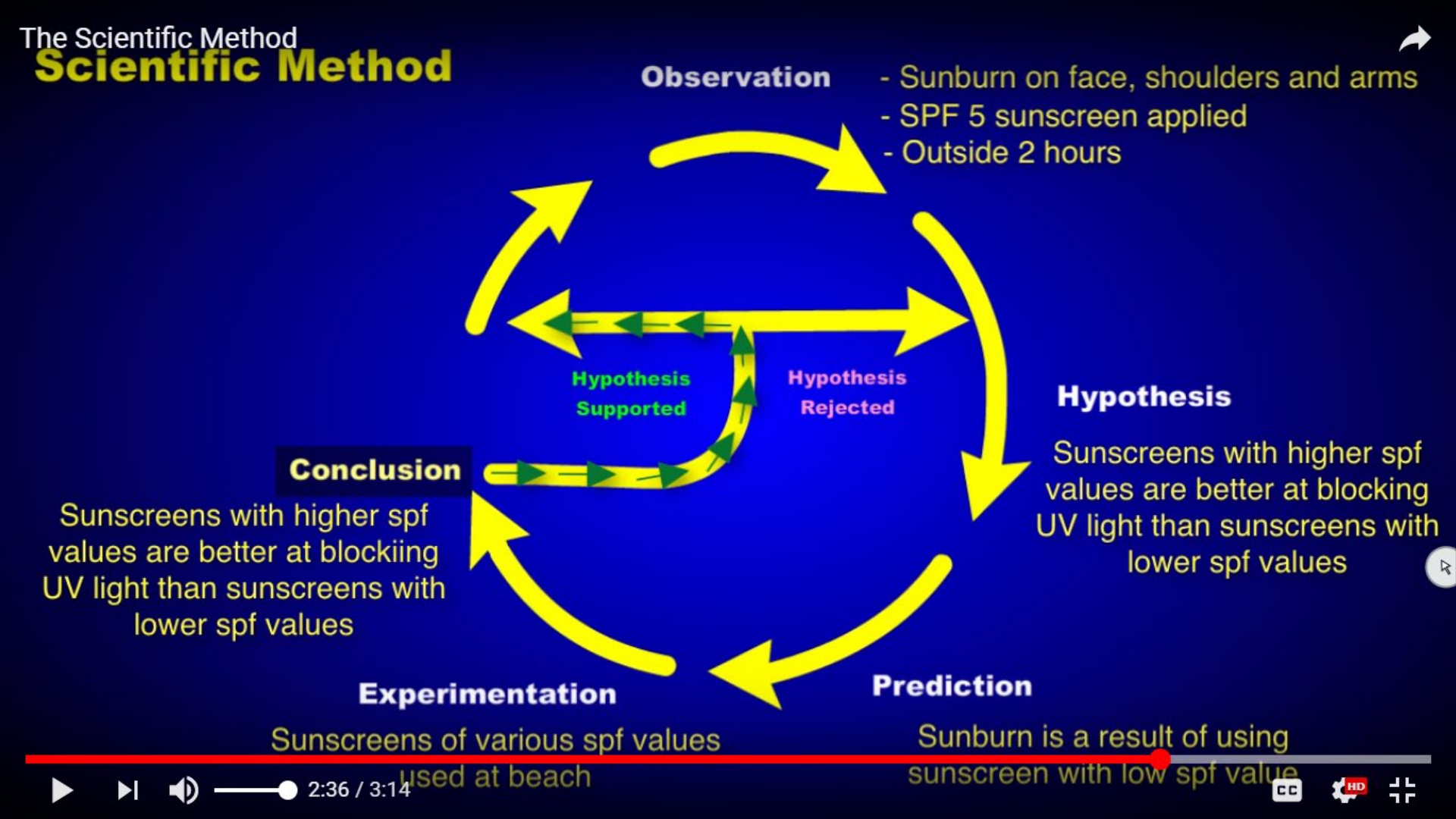

The Scientific Method
Scientific Method
Observation
- Sunburn on face, shoulders and arms
- SPF 5 sunscreen applied
- Outside 2 hours
Hypothesis
Expired sunscreen is less effective than up-to-date sunscreen
Prediction
Sunburn is a result of using expired sunscreen
Experimentation
Sunscreens with various expiration dates used at beach
Conclusion
Hypothesis Supported
Hypothesis Rejected
1:54 / 3:14


The Scientific Method
Scientific Method
Observation
- Sunburn on face, shoulders and arms
- SPF 5 sunscreen applied
- Outside 2 hours
Hypothesis
Sunscreens with higher spf values are better at blocking UV light than sunscreens with lower spf values
Prediction
Sunburn is a result of using sunscreen with low spf value
Experimentation
Sunscreens of various spf values used at beach
Conclusion
Sunscreens with higher spf values are better at blockiing UV light than sunscreens with lower spf values
Hypothesis Supported
Hypothesis Rejected
2:36 / 3:14

Testing the hypothesis

- Testing a hypothesis often involves designing an experiment.
- Whenever possible, a hypothesis should be tested by a **controlled experiment**—an experiment in which only one variable (the **independent variable**, or manipulated variable) is changed.

Testing the hypothesis

- The variable that can change in response to the independent variable is called the **dependent variable**, or responding variable.
- The **control group** is exposed to the same conditions as the experimental group except for one independent variable.

In an experiment – what is the difference between an independent and dependent variable?

- Independent – a person is controlling it
- Dependent – the response that is measured or described

INDEPENDENT VARIABLE

manipulated
controlled/changed

What I CHANGE

in an experiment.

DEPENDENT VARIABLE

measured
response
described

What I OBSERVE

→ constants

CONTROLLED VARIABLE

What I KEEP THE SAME

Line Graph

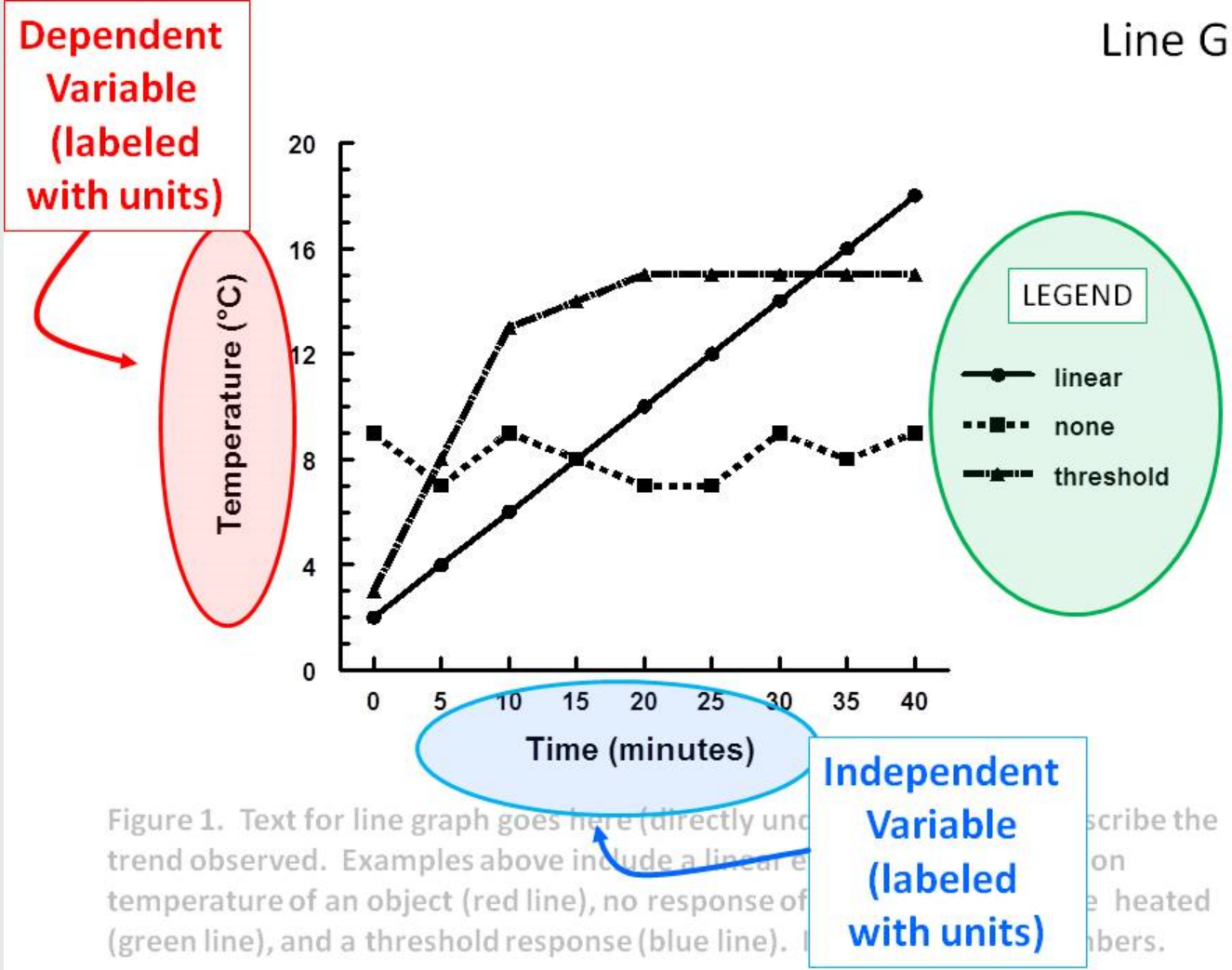


Figure 1. Text for line graph goes here (directly unc scribe the trend observed. Examples above include a linear e on temperature of an object (red line), no response of e heated (green line), and a threshold response (blue line). I bers.

Types of Variables

Independent

The one thing you change. Limit to only one in an experiment.

Example:
The liquid used to water each plant.

Dependent

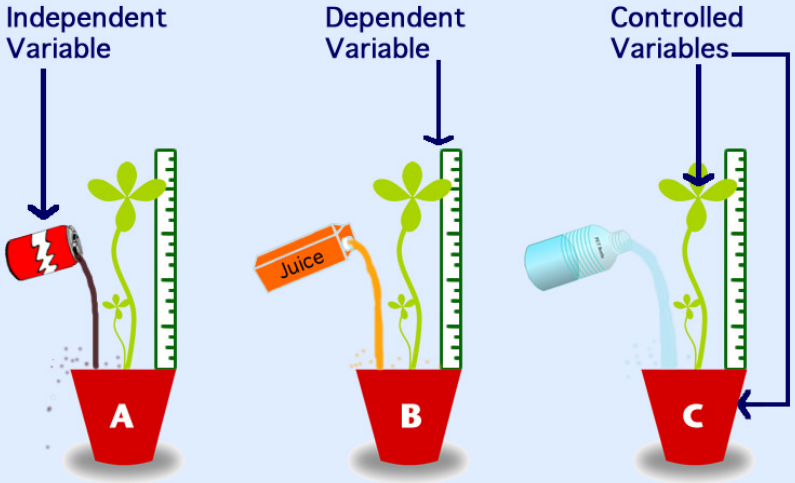
The change that happens because of the independent variable.

Example:
The height or health of the plant.

Controlled

Everything you want to remain constant and unchanging.

Example:
Type of plant used, pot size, amount of liquid, soil type, etc.



Types of Variables

Independent

The one thing you change. Limit to only one in an experiment.

Example:
The liquid used to water each plant.

Fluid

Independent Variable

Dependent

The change that happens because of the independent variable.

Example:
The height or health of the plant.

measuring height

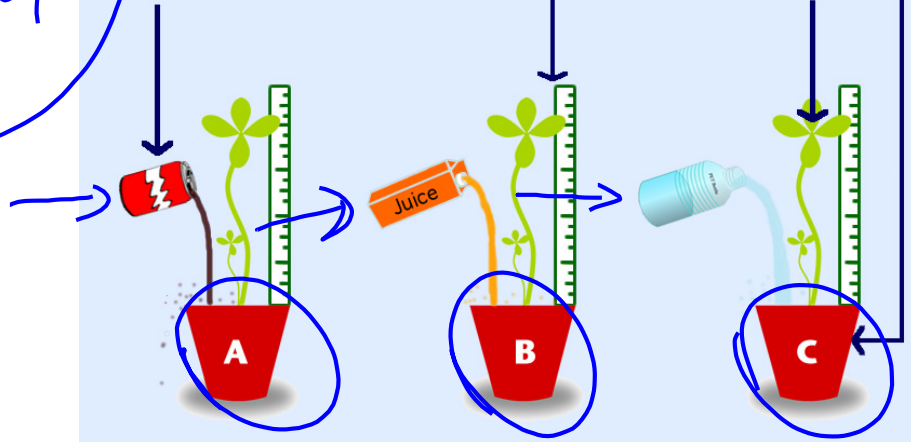
Dependent Variable

Controlled

Everything you want to remain constant and unchanging.

Example:
Type of plant used, pot size, amount of liquid, soil type, etc.

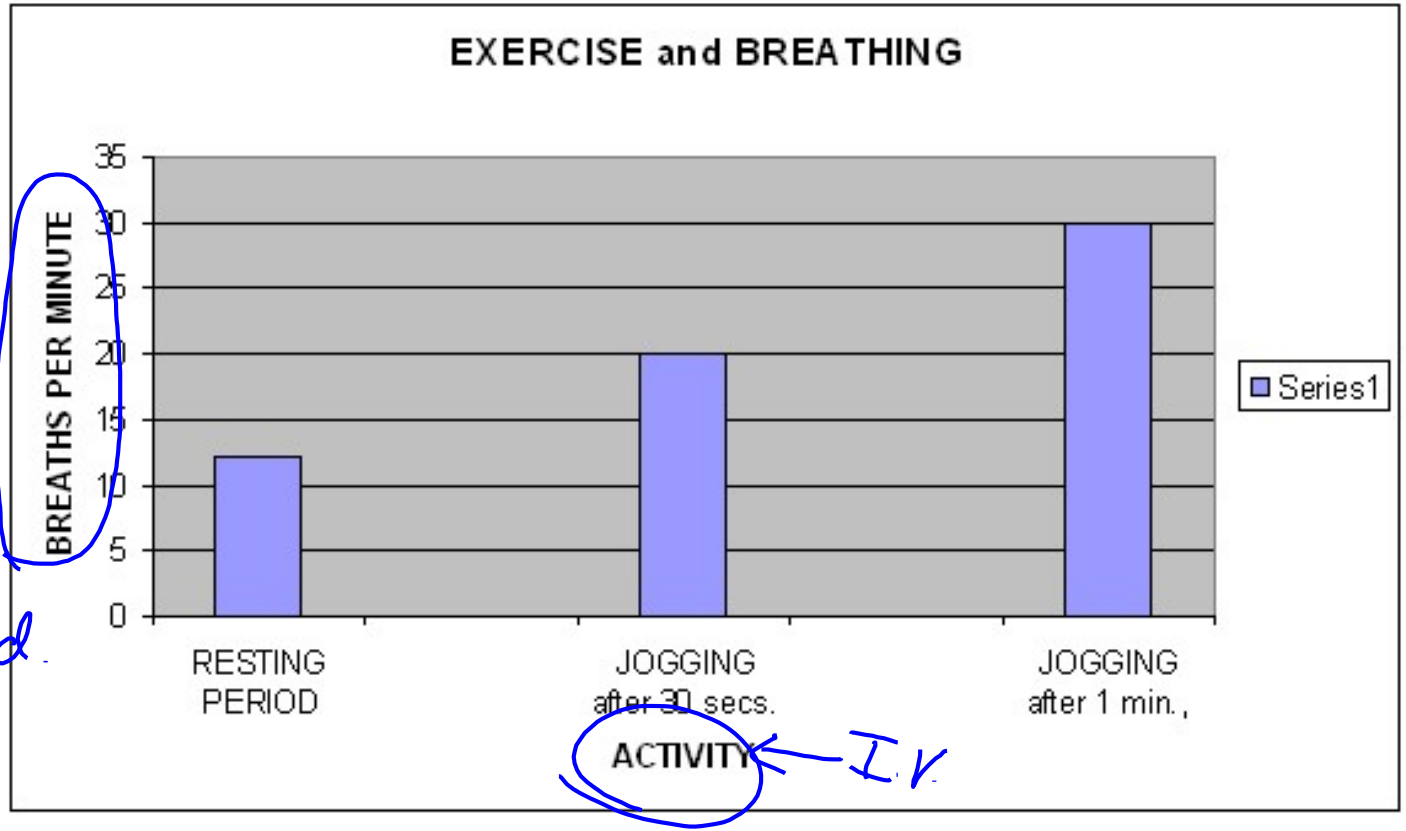
Controlled Variables



what you control

what you measure

Name the independent and dependent variables:



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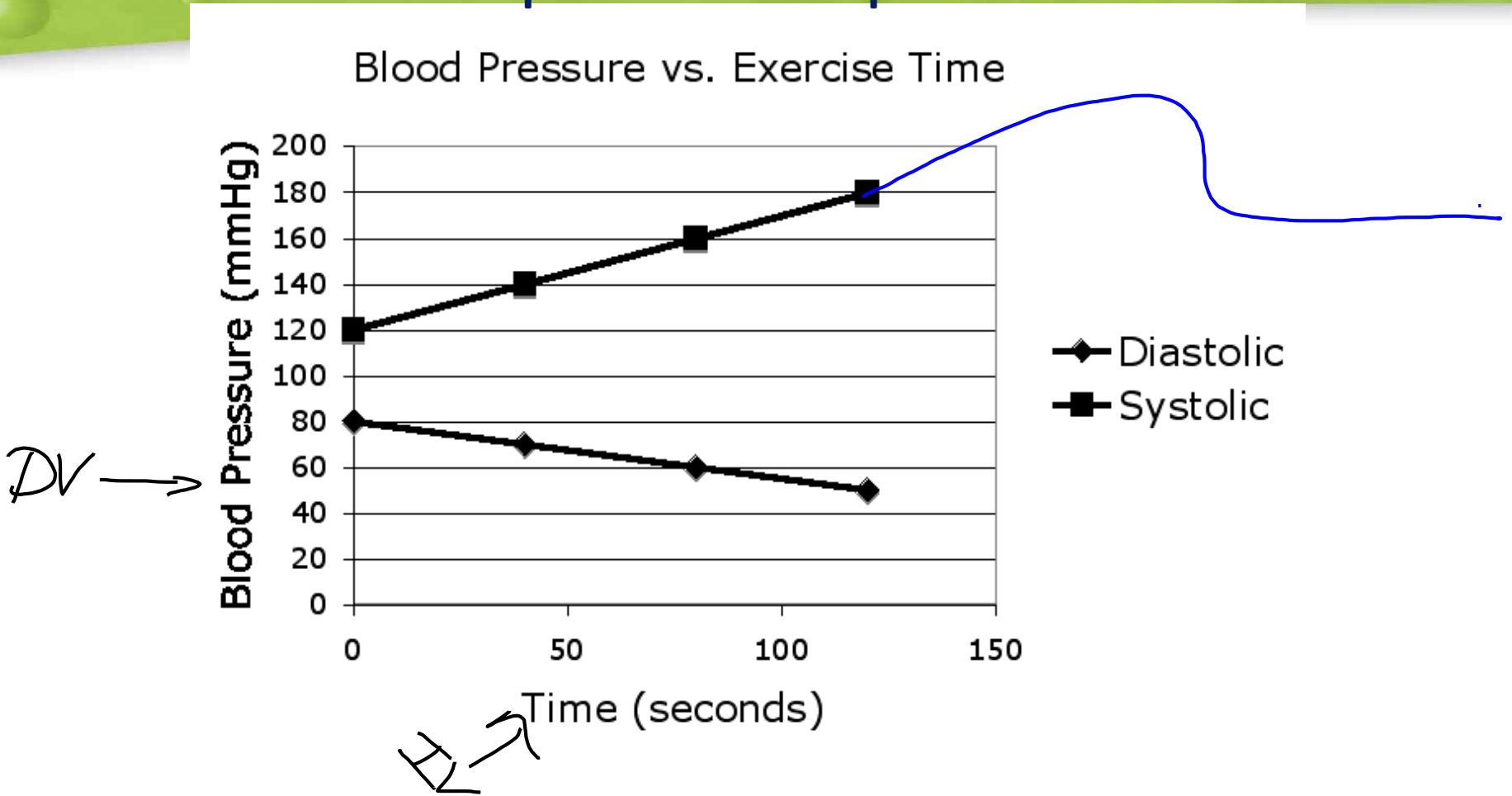

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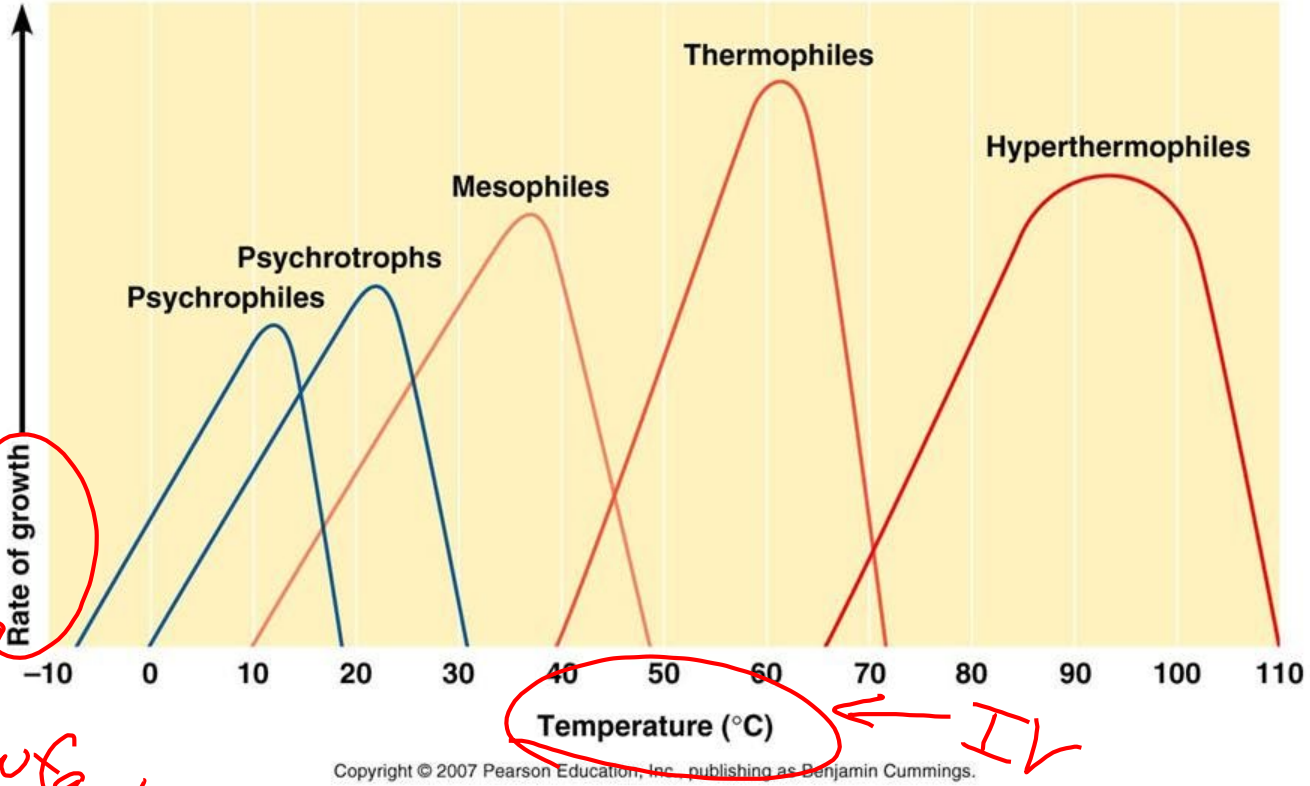


D.V.

How fast

I.V.

Figure 6.1

Gathering Data

Did You Know? *Gulls are protected by the Migratory Bird Treaty Act, and government agencies like the U.S. Fish and Wildlife Service continually collect data on seagull populations and habitats.*

- Scientists test predictions by gathering evidence in the form of data.
  - If data match predictions, **hypothesis is supported**.
  - If data do not match predictions, **hypothesis is rejected**.
- Data can come from an experiment or observational studies; ideally experiments and studies are **controlled** and **repeated**.

Data

- **Qualitative data**: word descriptions

- **Quantitative data**: counting and measuring (numbers)

Data

Analyze: to take a close look, examine carefully

"to break apart"

"look at details"

Conclusion

idea, statement, judgment based on information gathered from research and/or experiment

final or ending explanation for something

- A conclusion must be objective.
- **Objective: based upon facts and what is observed by the 5 senses,** not based on opinion or preferences

subjective

Science and Technology

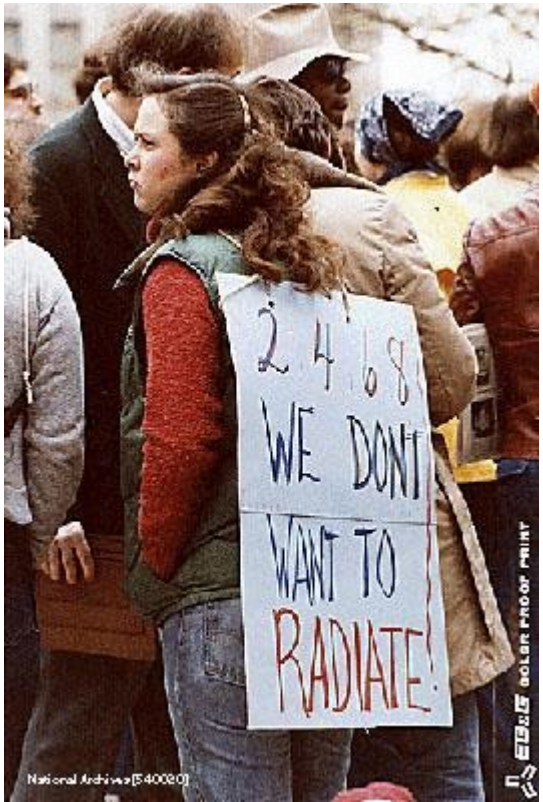
Technology – applying science to produce methods and material things for use by people

What Is Environmental Science?

National Marine Fisheries Service scientists studying whether commercial boats are harming endangered killer whales

- Study of our planet's natural systems and how humans and the environment affect one another
- Understanding interactions between humans and the environment: for solving environmental problems.

Environmental Science vs. Environmentalism

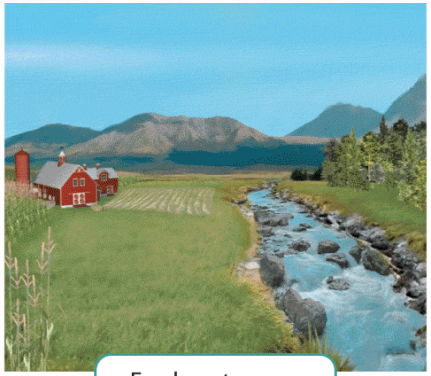


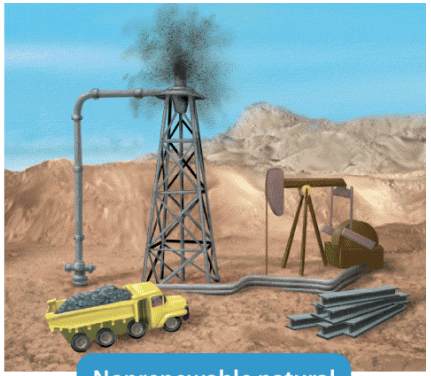
- **Environmental Science:** **Objective**, unbiased pursuit of knowledge about the workings of the environment and our interactions with it
- **Environmentalism:** Social movement

Environmentalists protesting the use of nuclear power

Natural Resources

Natural resources are materials and energy sources found in nature that people need to survive.





geo= earth

Renewable natural resources

- Sunlight
- Wind energy
- Wave energy
- Geothermal energy

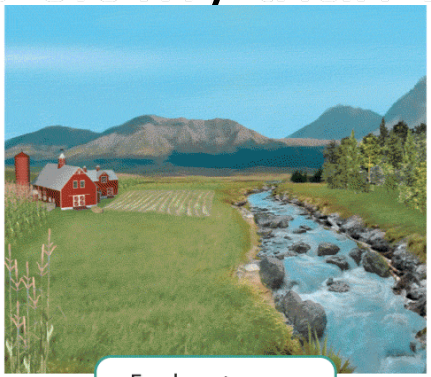
- Fresh water
- Forest products
- Agricultural crops
- Soils

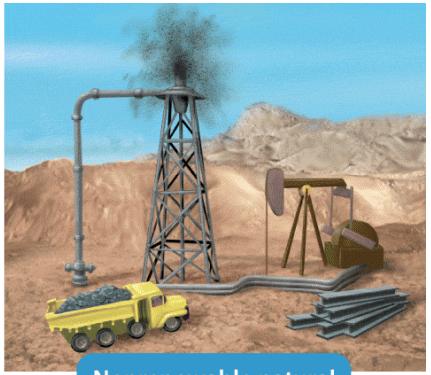
Nonrenewable natural resources

- Crude oil
- Natural gas
- Coal
- Copper, aluminum, and other metals

Natural Resources

- **Renewable resources:** Naturally replenished over short periods
- **Nonrenewable resources:** Naturally formed more slowly than we use them.





Renewable natural resources

- Sunlight
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Nonrenewable natural resources

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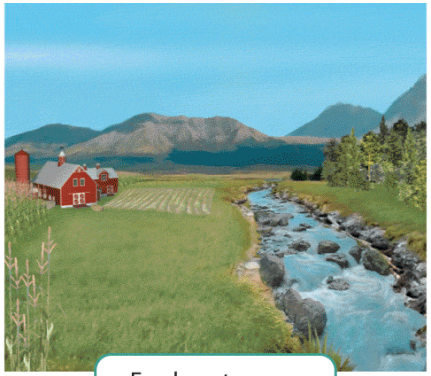
Natural Resources

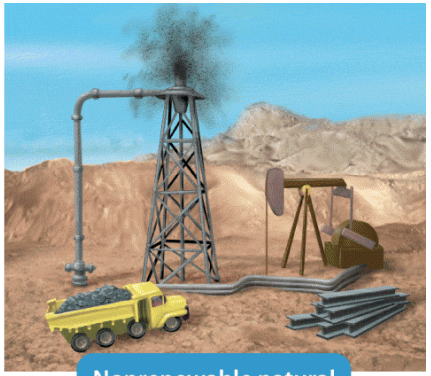
Renewable resources can become **nonrenewable** if used faster than they are replenished.

Renewable natural resources

- Sunlight
- Wind energy
- Wave energy
- Geothermal energy



- Fresh water
- Forest products
- Agricultural crops
- Soils



Nonrenewable natural resources

- Crude oil
- Natural gas
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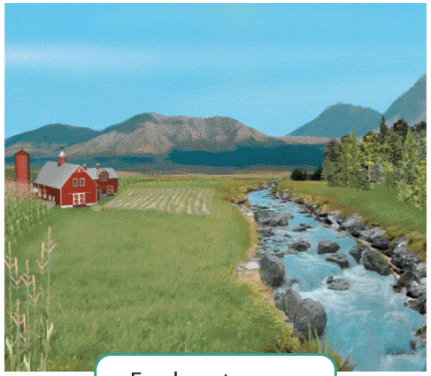
Natural Resources

Sustainable- resources continue to be used at the same rate in which they are naturally renewed

Renewable natural resources

- Sunlight
- Wind energy
- Wave energy
- Geothermal energy



- Fresh water
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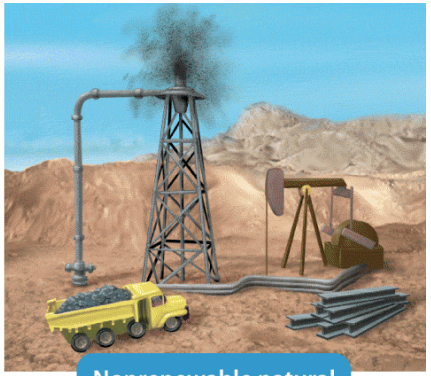

Nonrenewable natural resources

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Ecological Footprints

Ecological footprints include land and water used to grow food at farms hundreds or thousands of miles away.

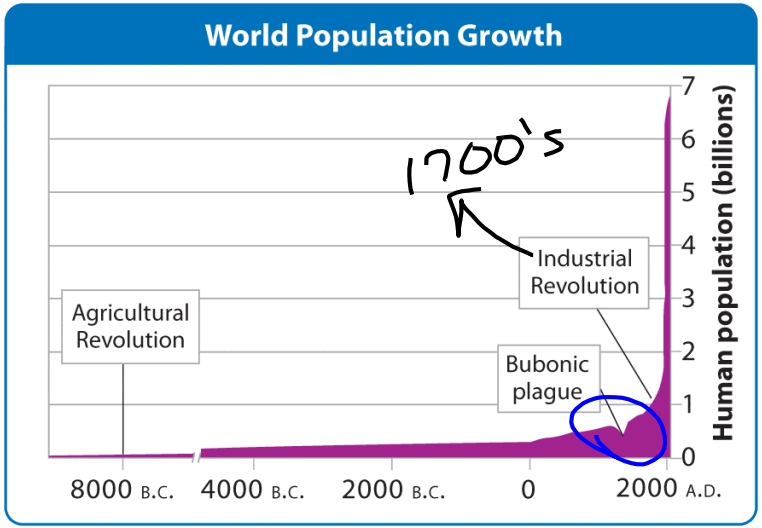
- Total amount of land and water required:
  - to provide raw materials an individual/ population consumes
  - dispose/recycle waste

Conservation

- preservation and protection of a natural resource to prevent exploitation, destruction, or neglect, such as wildlife, water, forests...

Human Population Growth

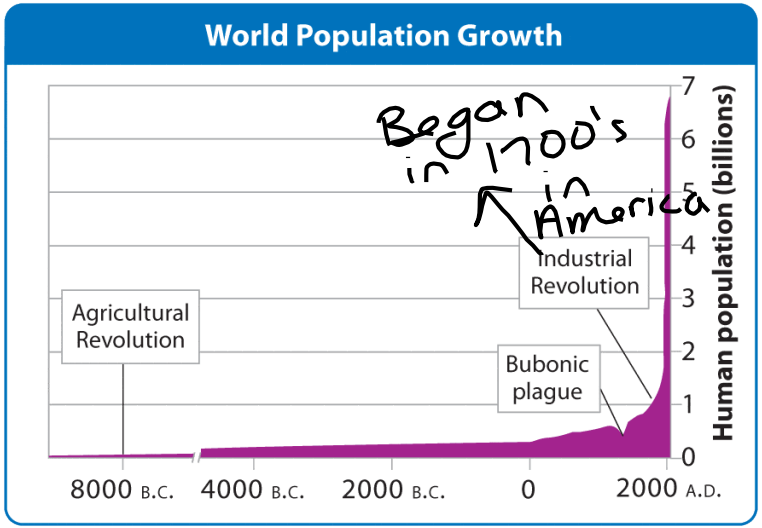
- Tremendous and rapid human population growth:
  - **Agriculture:** About 10,000 years ago; humans began living in villages, had longer life spans, and more surviving children.



Did You Know? The human population increases by about 200,000 people every day.

Human Population Growth

- Tremendous and rapid human population growth:
  - **Industrial Revolution:** Began in early 1700s; driven by fossil fuels and technological advances



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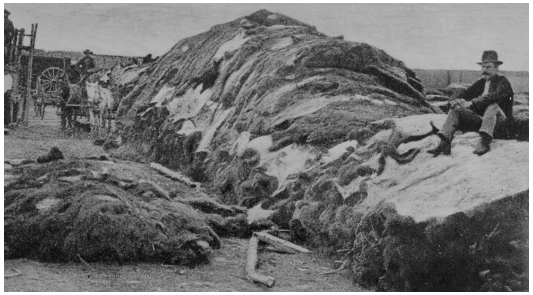
Building on Environmental Science

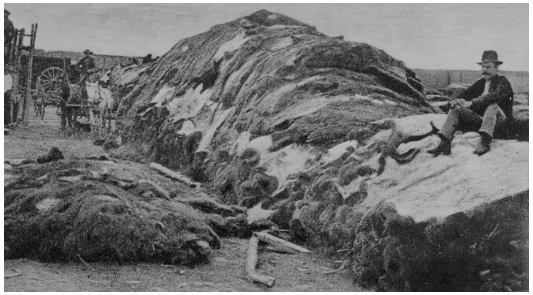


40,000 buffalo hides, 1872

Ducks killed by an oil spill

- More than just understanding the science.
  - **Ethics:** Study of behavior (good and bad, right and wrong), moral principles, and values

Building on Environmental Science



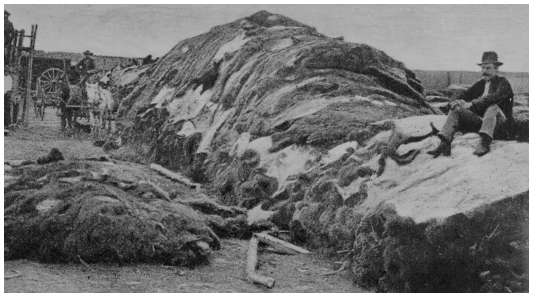
40,000 buffalo hides, 1872

Ducks killed by an oil spill

- More than just understanding the science.

- **Culture:** Knowledge, beliefs, values, and learned ways of life shared by a group of people

Building on Environmental Science



40,000 buffalo hides, 1872

Ducks killed by an oil spill

- More than just understanding the science.
- **Worldview:** Perception of the world and a person's place in it

Environmental Ethics

- Environmental ethics: application of ethical standards to the relationship between humans and the environment.

Environmental Ethics

Anthropocentrism:

↳ "man"

Humans and human welfare most important

Environmental Ethics

Biocentrism

All living things have value; some may be more important than others

Environmental Ethics

Ecocentrism

Well-being of a species or community more important than that of an individual