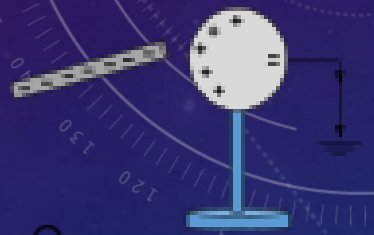
INTRO TO PHYSICS & THE SCIENTIFIC METHOD

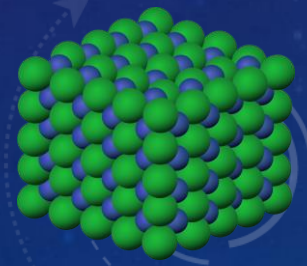
PES 1000 – PHYSICS IN EVERYDAY LIFE

WHAT IS PHYSICS?

- Physics is *the study of the basic nature of matter and the interactions that govern its behavior*
- Physics (and all science) is based on discoveries using the scientific method
- Physics is often considered one of the most fundamental sciences, upon which other sciences are built
- Many areas of physics are well-understood. Many other areas are currently being explored.
- Previous discoveries of physics can be modified if sufficient evidence and theory justify such a change

WHAT IS PHYSICS?





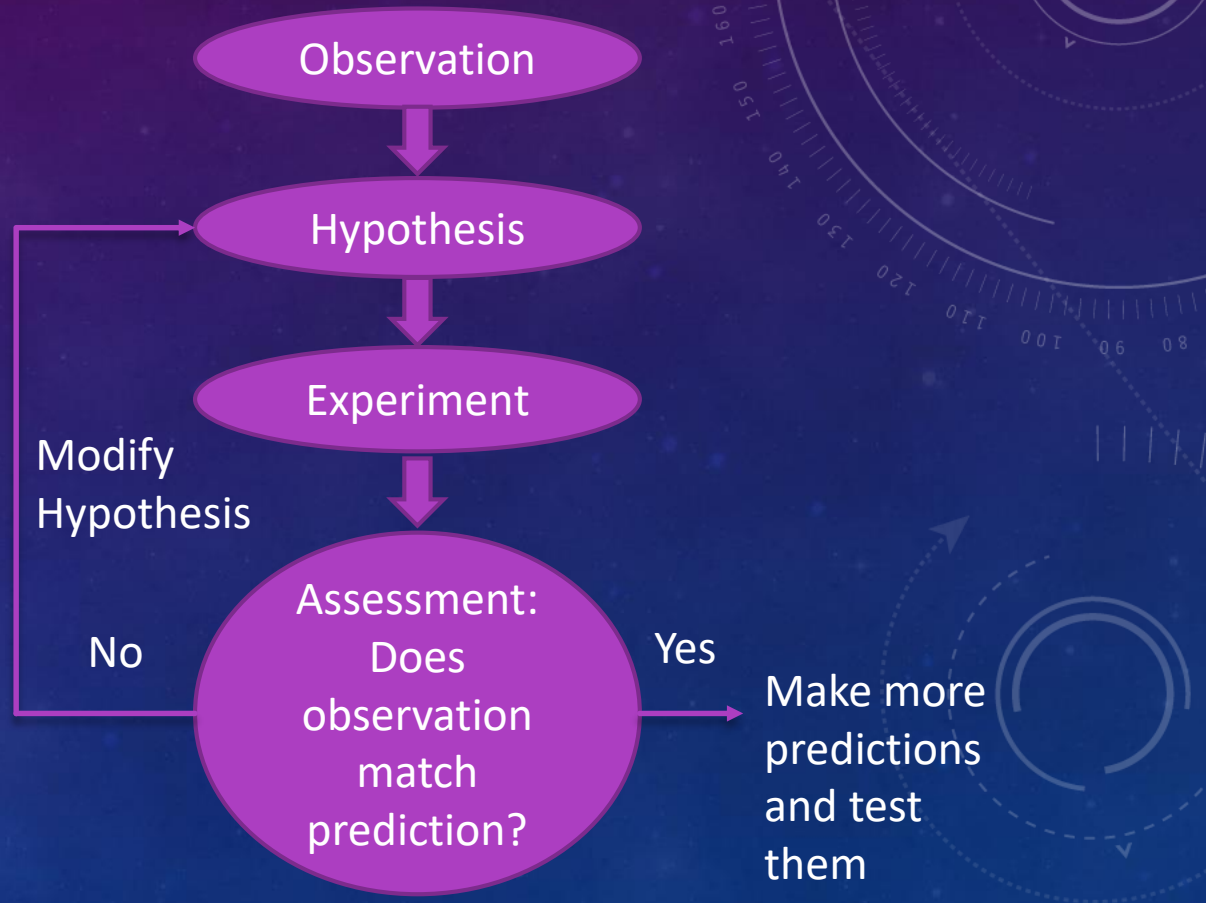
- Some branches of physics that we will explore in this class:
  - Mechanics – the study of forces and motion
  - Electro-magnetism – the study of electric & magnetic forces
  - Optics – the study of light
  - Thermodynamics – The study of temperature, heat, and energy
- Some other branches of physics:
  - Atomic physics – the study of the structure and behavior of atoms
  - Condensed matter physics – the study of matter in solid & liquid states

WHAT IS THE SCIENTIFIC METHOD?

- The scientific method is a methodology that mankind has developed to discover how nature works
- It relies on hypothesis and experiment to come to conclusions
- The hypothesis must be testable and can be found either correct or incorrect
- Experiments must be repeatable by anyone else
- There is no official set of steps to the scientific method, but the conceptual process is similar in all descriptions
  - The following slide is one description of the conceptual process

STEPS OF THE SCIENTIFIC METHOD

- Observation
  - The data you collect and wish to explain
- Hypothesis (model)
  - Your explanation of the data. It must be falsifiable.
- Prediction & Experiment
  - Use your model to predict something you didn't observe, then test it by experiment.
- Conclusion or Assessment
  - Did the observation match the prediction?
    - **If not**, <u>modify</u> or replace the hypothesis. **If so**, <u>keep testing</u> it.



AN EXAMPLE: WHY DO TREES GROW?

Mythology

- We observe that trees are alive and grow
- We hypothesize that a nymph lives in the tree
- If we cut the tree down, it dies because the nymph leaves it, but…
  - We can't test this theory because we can't see the nymph, so it's just an explanation, not science

AN EXAMPLE: WHY DO TREES GROW?

Science

- We observe that trees are alive and grow
- We hypothesize that the tree draws nutrition from the ground through its roots
- We propose an experiment to remove half of the roots and measure its growth. We predict it will grow, but not as well.
- We run the experiment an observe less growth
- We conclude that we may be right, and design other experiments to test our hypothesis

WHAT HAPPENS NEXT?

- A single experiment is just the start of the quest for scientific explanations.
- If the hypothesis works, then it should be tested in a variety of other conditions with other experiments.
- Others should test the hypothesis to verify it.
- The results should be reviewed by other experts for correctness and compatibility with current science.
- If a hypothesis is found to be true in a large variety of situations, it may be elevated to a ***theory.***
- A theory in science is not just a conjecture or wild idea, but a well-tested model that has both explanatory and predictive power.

THEORIES AND LAWS

- A ***law*** in physics is distinct from a ***theory.***
- A law is an observation about nature that appears to be true in practically every case.
- A law is *how* something behaves, a theory is *why* it behaves that way.
- There are very few laws in physics: Examples include: Law of Conservation of Energy, Law of Universal Gravitation, Law of Conservation of Charge, …
- Rarely, a law is updated or improved if sufficient evidence is found to justify that action.

CONCLUSION

- Physics is *the study of the basic nature of matter and the interactions that govern its behavior*
- Its theories are derived from application of the scientific method
  - Observation – Data you which to explain
  - Hypothesis – A falsifiable model used to explain the data
  - Prediction & Experiment – The model makes predictions. Experiments using the model produce actual results.
  - Conclusions – Predictions are compared to results and the model is improved accordingly
- Physics is based on laws (how things work) and theories (why they work that way)