Physics 12

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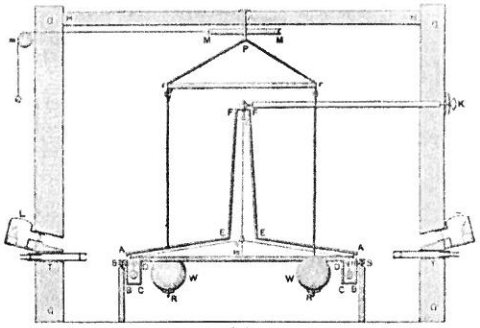


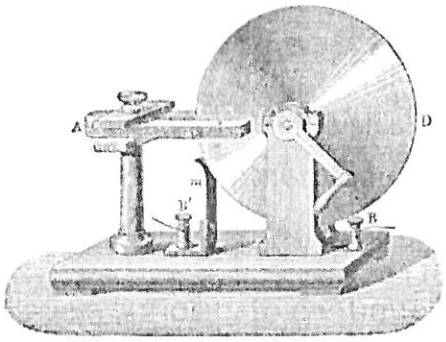
Cavendish's Experiment

What are the **Big Ideas** in Physics 12?

- **Measurement of motion** depends on our frame of reference.
- Forces can cause **linear and circular motion.**
- Forces and energy interactions occur within **fields.**
- **Momentum** is conserved within a closed and isolated system.

Hello, and welcome to Physics 12. In the coming semester, we will be exploring these Big Ideas together, learning the habits of mind with "doing" science, and gaining the **Core Competencies** of:

- Have a curiosity to continually learn more about something of interest.
- Communicate scientific ideas and information, and a suggested course of action.
- Make an argument based on evidence.
- Contribute to care for self, others, community, and the world.



Faraday's disk

Classroom Expectation

- Regular attendance is mandatory. Please come to the class on time.
- If you are going to miss class, please talk to me ahead of time.
  For sudden illness or emergency, please email me at your earlier convenience.
- Assignments are due at the beginning of the class on the due date.
  Late assignments may result in penalties.
- You will be working with other students in different experiments and projects. You might start with the same data or observation, but you will still have to do individual work in your own words.
  Copying will result in no mark on the assignment.
- Respect your teacher and classmates by not using your cellphone in class.

Assessment

The process of your learning will be evaluated in various ways.

10% Classroom Participation

- Self-assessment and reflections
- Providing and receiving peer feedbacks
- Homework checks

45% Experiments, Simulations and Inquiry Project

- Experiments and laboratory reports
- Inquiry projects with design, analysis and building components

45% Tests and Final Exam

- The midterm exam will cover contents in the first half of the course and the final exam will cover contents in the second half of the course.
- A better result in the midterm exam will also replace the overall test mark in the first half of the course. A better result in the final exam will also replace the overall test mark in the second half of the course.

Week	Unit	Big Ideas
1 – 2	1. Forces and Equilibrium	**Measurement of motion** depends on our frame of reference. Forces can cause **linear and circular motion.**
3 – 5	2. Energy and Momentum	**Momentum** is conserved within a closed and isolated system.
5 – 7	3. Circular Motion and Gravitation	Forces can cause **linear and circular motion.** Forces and energy interactions occur within **fields.**
8 – 9	4. Electrostatics	Forces and energy interactions occur within **fields.**
10 – 12	5. Electromagnetism	Forces and energy interactions occur within **fields.**
13 – 14	6. Special Relativity	**Measurement of motion** depends on our frame of reference.

Big Ideas:

- Measurement of motion depends on our frame of reference.
- Forces can cause linear and circular motion.

Question to Support Inquiry:

How can a seesaw be kept parallel to the ground in a variety of ways?

How to build a deadfall trap that could be used in a survival situation?

Why does high jumper jump with their back to the bar?

Core Competencies:

Communication
- I contribute during group activities, cooperate with others, and listen respectfully to their ideas. I can work with others for a specific purpose.

Critical Thinking
- I use observation and data to draw conclusions, make judgments, and ask new questions.

Personal Awareness and Responsibilities
- I can take action toward meeting my own wants and needs and finding joy and satisfaction, and work toward a goal or solving a problem.

Curricular Competencies:

Planning and Conducting
- Use appropriate SI units and appropriate equipment, including digital technologies, to systematically and accurately collect and record data

Processing and Analyzing Data and Information
- Seek and analyze patterns, trends, and connections in data, including describing relationships between variables, performing calculations, and identifying inconsistencies

Evaluating
- Evaluate their methods and experimental conditions, including identifying sources of error or uncertainty, confounding variables, and possible alternative explanations and conclusions

Content:

Static Equilibrium
- translational: sum of all forces equals zero (vertical and horizontal)
- rotational: sum of all torques equals zero, location of centre of gravity of a uniform body

First Peoples knowledge and applications of forces
- Deadfall traps

Graphical methods
- graphing a linear, exponential, and inverse relationship given a physical model
- determining the linear regression that results from exponential and inverse relationships
- calculating the slope of a line of best fit, including significant figures and appropriate units

First Peoples Principles of Learning:

- Learning is holistic, reflexive, reflective, experimental, and relational (focused on connectedness, on reciprocal relationships, and a sense of place)
- Learning involves patience and time.

Learning Targets:

1. Collaboratively determine the acceleration due to gravity using a dropping object tracked by ticker tape timer.
2. Construct distance vs time and distance vs time square graphs by hand. Use best-fit line to calculate the slope. Use graphing technology to do regression on data.
3. Use Newton's Laws to find net force or acceleration.
4. Analyze translational equilibrium using vector components.
5. Predict the rotation of objects due to torque.
6. Analyze rotational equilibrium using net torque.
7. Collaboratively determine the mass of an object by balancing it with known masses, strings and pulleys.
8. Collaboratively determine the mass of a beam by balancing it with a known mass and strings.
9. Plan, design, build a deadfall trap while analyzing the static equilibrium.

Assessments:

Formative:

- Homework checks and review
- Teacher signature to provide oral feedback during data measurement for both experiments
- Peer review of deadfall trap made by other groups
- Self-reflection of deadfall trap project

Summative:

- Acceleration due to gravity lab report
  - full write-up assessment
- Translational and rotational equilibrium lab report
  - data collection, calculation and analysis assessment
- Deadfall trap construction and analysis

Big Ideas:

- Momentum is conserved within a closed and isolated system.

Question to Support Inquiry:

How does a ballistic pendulum measure the speed of a projectile?

How does sloped armors provide increased protection?

How does an athlete minimize the impact during collisions?

Core Competencies:

Communication
- I listen and respond to others. I can consider my purpose when I am choosing a form and content. I can communicate clearly about topics I know and understand well.

Critical Thinking
- I can use what I know and observe to identify problems and ask questions.

Social Awareness and Responsibilities
- I can interact with others and my surroundings respectfully.

Curricular Competencies:

Planning and Conducting
- Use appropriate SI units and appropriate equipment, including digital technologies, to systematically and accurately collect and record data

Processing and Analyzing Data and Information
- Construct, analyze, and interpret graphs, models, and/or diagrams

Evaluating
- Evaluate the validity and limitations of a model or analogy in relation to the phenomenon modelled

Communicating
- Formulate physical or mental theoretical models to describe a phenomenon

Content:

Impulse:
- relation to Newton's second law
- in a closed and isolated system

Collisions:
- elastic, inelastic, and completely inelastic
- multiple objects in 1D and 2D
- ballistic pendulums

Graphical methods
- interpolating and extrapolating data from a constructed graph
- calculating and interpreting area under the curve on a constructed graph (e.g., impulse)

First Peoples Principles of Learning:

- Learning involves patience and time.

Learning Targets:

1. Identify and compare momenta of common objects.
2. State the law of conservation of momentum.
3. Determine whether a collision is elastic or inelastic.
4. Solve problems related to collisions or explosions.
5. Analyze conservation of momentum in two dimensions.
6. Give examples of situations involving momentum and impulse.
7. Collaboratively determine the mass of an object by collision with an object with a known mass on an air track.
8. Collaboratively analyze the momentum in a 2D collision between two objects and determine if momentum is conserved.

Assessments:

Formative:

- Homework checks and review
- Teacher signature to provide oral feedback during data measurement for both experiments
- Group discussion of inquiry questions

Summative:

- Collision on an air track lab report
  - data collection, calculation and analysis assessment
- Translational and rotational equilibrium lab report
  - data collection, calculation and analysis assessment
  - analysis of the effects of uncertainties
- Unit test

Big Ideas:

- Forces can cause linear and circular motion.
- Forces and energy interactions occur within fields.

Question to Support Inquiry:

How do we produce weightless environments to train astronauts?

What is the requirement for a geosynchronous satellite?

Core Competencies:

Communication
- I can identify and apply roles and strategies to facilitate groupwork. I am an active listener and speaker

Critical Thinking
- I consider more than one way to proceed and make choices based on my reasoning and what I am trying to do.

Positive Personal & Cultural Identity
- I can identify my individual characteristics and explain what interests me.

Curricular Competencies:

Questioning and Predicting
- Make observations aimed at identifying their own questions, including increasingly abstract ones, about the natural world

Planning and conducting
- Assess risks and address ethical, cultural, and/or environmental issues associated with their proposed methods

Processing and Analyzing Data and Information
- Experience and interpret the local environment

Evaluating
- Evaluate the validity and limitations of a model or analogy in relation to the phenomenon modelled

Content:

Uniform circular motion:
- both horizontal and vertical circles

Changes to apparent weight:
- vertical and horizontal circles

First Peoples knowledge and applications of forces
- salmon wheel

Gravitational field
- vector field, interacts with mass through gravitons, attractive only

Gravitational dynamics and energy relationships:
- satellite motion, orbit changes, launch velocity, escape velocity

First Peoples Principles of Learning:

- Learning involves patience and time.
- Learning involves recognizing the consequences of one's actions.

Learning Targets:

1. Describe the velocity of an object moving in uniform circular motion at any point in that motion.
2. Explain how the acceleration of an object may result in a change in direction with no change in speed.
3. Analyse the forces acting on objects in circular motion, using free-body diagrams.
4. State Newton's law of universal gravitation.
5. Describe the gravitational field strength of a body in terms of an inverse square relationship.
6. Solve problems for satellites in circular orbits, in terms of gravitational and centripetal forces.
7. Compare the difference between using conservation of energy and circular motion to model motion in a circular track.
8. Predict the characteristics of ISS and compare to the actual measurements.

Assessments:

Formative:

- Homework checks and review
- Teacher signature to provide oral feedback during data measurement for experiment
- Observed astronauts on the ISS doing experiments from Science off the Sphere and develop inquiry questions as a group

Summative:

- Motion on a circular track lap report
  - data collection, calculation and analysis assessment
- Unit test
- Observations and reflections from Gravity and Orbits simulation from PhET

Big Ideas:

- Forces and energy interactions occur within fields.

Question to Support Inquiry:

How is the concept of fields different from the representations in science fiction movies?

Why is there a strange feeling when you touch the screen of an old TV when it is in use?

Core Competencies:

Communication
- I can communicate clearly about topics I know and understand well, using forms and strategies I have practiced. I gather the basic information I need and present it.

Creative Thinking
- I can use my imagination to get new ideas of my own, or build on other's ideas, or combine other people's ideas in new ways.

Critical Thinking
- I can assess my own efforts and experiences and identify new goals. I give, receive, and act on constructive feedback.

Curricular Competencies:

Questioning and Predicting
- Make observations aimed at identifying their own questions, including increasingly abstract ones, about the natural world

Processing and Analyzing Data and Information
- Analyze cause-and-effect relationships

Evaluating
- Exercise a healthy, informed skepticism and use scientific knowledge and findings to form their own investigations to evaluate claims in primary and secondary sources

Content:

Electric field:
- vector field
- interacts with positive/negative elementary charge
- attractive or repulsive
- single point charges (non-uniform field) and parallel plates (uniform field)

Electrostatic dynamics and energy relationships:
- relationships between force, charge, and distance on a single point charge:
- 1D and 2D with other charges
- in orbits
- between parallel plates
- application of law of conservation of energy and the principle of work and energy

First Peoples Principles of Learning:

- Learning involves patience and time.

Learning Targets:

1. Use Coulomb's law to solve problems that deal with two point charges.
2. Describe and illustrate the electric field lines for simple charge distributions.
3. Recognize the relationship between electric force, electric field, and charge.
4. Define electric potential and electric potential difference (voltage).
5. Recognize that electric potential energy is the product of charge and electric potential.
6. Explain what causes static charge.
7. Explain how charges are generated from a Faraday's disk and estimate the voltage.
8. Relate the potential difference to the voltage of a battery.

Assessments:

Formative:

- Homework checks and review
- Score a goal by shooting a charged puck into the net in Electric Hockey simulation from PhET

Summative:

- Unit test
- Observations and reflections from Electric Hockey simulation from PhET

Big Ideas:

- Forces and energy interactions occur within fields.

Question to Support Inquiry:

What are the social, ethical, and environmental implications of the application of electromagnetic induction technologies?

How did the discovery of the electron and the development of the cathode ray tube (CRT) form the basis of new technologies (e.g., particle accelerators, smartphones)?

Core Competencies:

Communication
- I recognize how my contributions and those of others complement each other. I can plan with others and adjust our plan according to the group's purpose.

Critical Thinking
- I consider alternative approaches and make strategic choices. I take risks and recognize that I may not be immediately successful.

Creative Thinking
- I generate new ideas as I pursue my interests. I deliberately learn a lot about something by doing research, talking to others, or practicing, so that I can generate new ideas.

Curricular Competencies:

Questioning and Predicting
- Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal, local, or global interest

Evaluating
- Connect scientific explorations to careers in science

Applying and innovating
- Co-operatively design projects with local and/or global connections and applications
- Implement multiple strategies to solve problems in real-life, applied, and conceptual situations

Content:

Magnetic force:
- acting on a moving charge or current carrying wire within a magnetic field
- right-hand rules

Electromagnetic induction:
- Faraday's law, Lenz's law
- current induced by a change in magnetic flux
- moving a bar, wire, coil, single charge within a changing magnetic field (strength, polarity, or area)

Applications of electromagnetic induction:
- back electromotive force (EMF), direct current (DC) motors, generators, transformers

First Peoples Principles of Learning:

- Learning involves patience and time.

Learning Targets:

1. Describe and illustrate the direction of the magnetic field lines for a permanent magnet.
2. Use the right-hand rule to determine the magnetic field direction for a current-carrying wire or a solenoid.
3. Use the right-hand rule to determine the magnetic field direction for a current-carrying wire or a solenoid.
4. Describe the path of charged particles moving perpendicular to magnetic fields.
5. Calculate the magnetic flux through a loop or coil placed parallel or perpendicular to a magnetic field.
6. Use Faraday's law to solve problems.
7. Use Lenz's law to determine the direction of the induced current in a loop or coil placed in a perpendicular magnetic field.
8. Qualitatively describe how a generator uses induction to produce an electric current.
9. Design and built a speaker or a motor collaboratively.

Assessments:

Formative:

- Homework checks and review
- Peer review of the speaker or motor made by other groups
- Self-reflection of the speaker or motor project

Summative:

- Unit test
- Construction and analysis of a speaker or a motor

Big Ideas:

- Measurement of motion depends on our frame of reference.

Question to Support Inquiry:

How is kite-boarding, Ultimate Frisbee, or soccer affected by relative motion?

How is the relativistic mass of a particle used in a particle accelerator to determine the radius of curvature needed to keep it within the walls of the device?

Would the age of a sibling who travels to Mars at half the speed of light and returns a few years later with a different age?

Core Competencies:

Creative Thinking
- I can get new ideas or reinterpret others' ideas in novel ways.

Critical Thinking
- I can ask questions and offer judgments, conclusions, and interpretations supported by evidence I or others have gathered.

Positive Personal & Cultural Identity
- I can identify my individual characteristics and explain what interests me. I can describe different groups that I belong to.

Curricular Competencies:

Processing and analyzing data and information
- Use knowledge of scientific concepts to draw conclusions that are consistent with evidence

Communicating
- Communicate scientific ideas and information, and perhaps a suggested course of action, for a specific purpose and audience, constructing evidence-based arguments and using appropriate scientific language, conventions, and representations

Content:

Relativistic effects:
- time dilation
- length contraction
- changes in mass

Gravitational dynamics and energy relationships:
- satellite motion

First Peoples Principles of Learning:

- Learning is embedded in memory, history, and story.

Learning Targets:

1. Explain why simultaneous events for one observer may not be simultaneous for another observer.

2. State the two postulates of the special theory of relativity:
   – the relativity principle
   – the constancy of the speed of light.

3. Describe and give examples of the relativistic effects of time dilation, length contraction, and mass increase.

4. Describe the application of special relativity in GPS.

Assessments:

Formative:

- Homework checks and review
- Group discussion of science fiction ideas with relativity

Summative:

- Assignment on GPS and special relativity