Comprehensive Course Syllabus

Course Title: Scientific Inquiries: Physics

Course Description:
Scientific Inquiries – Physics is a one semester course required of all IMSA sophomores who have not taken a high school level physics course and have not passed the IMSA physics placement exam. The course addresses the fundamental principles of classical mechanics including Newton's laws of motion and the conservation laws of momentum and energy. Students learn concepts and skills through a combination of lab activities and experiments, guided inquiry, group discussion, collaborative problem solving and direct instruction.

Instructors:

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Meeting Days, Time and Room(s)
AC or BD days, 100 minutes, B114/116

Text(s) / Materials:
Textbook: Conceptual Physics, Paul Hewitt
Laptop computer
Scientific or graphing calculator
Notebook, folder, and pencils

Instructional Design and Approach:

Students learn the material through a multifaceted approach of classroom discussion, problem-solving, demonstration, laboratory activities and experiments. Both large and small group discussions are used to provide the students the opportunity to learn from each other.

Key to the experience is a student's development of experimental skills and practices fundamental to inquiry based learning. Students work individually and cooperatively to build models and develop mathematical relations from observations and quantitative data and to communicate their conclusions and explanations in written and oral form.

Student Expectations:

1. Students are expected to arrive to class on time. Unexcused tardies in excess of 10 minutes will be treated as unexcused absences. Please refer to the Attendance and Tardiness Procedures section of the handbook.
2. When in class, students are expected to be alert, to listen intently, to actively participate in class activities, and take written notes during class lessons.
3. Students are expected to follow all safety rules as they are working in the laboratory.

4. Each member of the lab group is expected to take an active role in collecting the data and performing the experiment. Raw data may be exchanged between lab partners, but each student is expected to do the analysis individually and answer the analysis questions in their own words. Laboratory reports are submitted on turnitin.com.
5. Students complete problem sets electronically through Quest, an online homework system through the University of Texas.
6. All work should be submitted in a timely manner. Up to 10% per day may be deducted for a late penalty. After two weeks, the assignment may no longer be accepted.
7. Honesty is a key component of scientific work, whether on the forefront of scientific research or in an IMSA course. Consequently any violation of the honesty policy is considered a serious offense. Please see the Academic Integrity section in the student handbook for more specific information.
8. Students are responsible for checking email, Moodle and PowerSchool on a regular basis.
9. Students are expected to get help early. Options include:
    a. Office hours / appointment with instructor
    b. Peer tutor
    c. Physics help session
    d. E-mail

Assessment Practices, Procedures, and Processes:
The students earn grades based on their ability in knowing, understanding and applying the concepts and skills learned in the course. Students have multiple chances to show evidence of their understanding in each concept or skill.

An **A** in the course indicates that the student has exceeded the expectations of the course. The student has a thorough understanding of the concepts in the course and can apply them in familiar and novel situations.

A **B** in the course indicates that the student has met the expectations of the course. The student has a good understanding of the concepts in the course and can apply them in a familiar context.

A **C** in the course indicates that the student has an understanding of the basic concepts in the course.

A **D** in the course indicates that the student has not met the minimum expectations of the course.

Each unit of study includes online homework, laboratory experiences, and a summative assessment. If a student does not submit a lab, complete a problem set, or take an assessment, a zero will be entered for the assignment.

The assignments are grouped by category; the categories are weighted as follows:

55% Tests and Quizzes
20% Labs
10% Quest problem sets
15% Final exam

Sequence of Topics and Activities

Kinematics (7 class periods)

- Unit conversions tutorial and problem set
- Class discussions: Kinematic variables
- Buggy and Sparky lab
- Graphing with detectors
- Derivation of equations
- Kinematics problem sets
- Video analysis lab
- Class discussion: Free Fall
- Free fall problem set

Newton's Laws of Motion (7 class periods)

- Motion exploratory stations and follow-up questions for each of Newton's Laws
- Class discussion
- Free Body Diagram tutorial and worksheet
- Mass vs. weight lab and problem set
- Newton's Second Law Lab
- Vertical Forces, Elevator Lab
- Quest problem sets

Experimental Design (4 class periods)

- Design your own experiment, either to test the relationship between variables or design an apparatus according to specific criteria.

Gravitation and Circular Motion (5 class periods)

- Lab with tubes and stoppers
- Calculation of linear speed, centripetal acceleration, and centripetal force.
- Problem sets/Quest
- Scientific notation tutorial and problem set
- Class discussion: Newton's Universal Law of Gravitation, Gravitational Field Strength, Acceleration due to gravity
- Gravitation problem set

Momentum (3 class periods)

- Class discussion: Impulse and Momentum
- Impulse-momentum lab
- Class discussion: Conservation of Momentum
- Conservation of Momentum lab Air Track
- Problem sets
- Egg drop challenge

Energy (4 class periods)

- Class discussion: Work, Work-KE theorem, Power

- Lab: Work-energy theorem
- Work-Kinetic energy problem set
- Calculate your power running up the stairs
- Class discussion: Conservation of energy
- Lab: Conservation of energy
- Conservation of energy problem set
- Build roller coaster for marble and accompanied calculations.

Addressing Underrepresentation in Physics (2 class periods)

- Introduction to representation in physics by race and gender.
- Research of a scientist who is underrepresented.
- Presentations to the class.

Learning Objectives:

Kinematics:

1. Understand the difference between scalar and vector quantities.
2. Calculate the change in a quantity (final value – initial value).
3. Define position, distance, displacement, speed, velocity and acceleration.
4. Demonstrate an understanding of the difference between instantaneous and average quantities.
5. Perform unit conversions using dimensional analysis.
6. Interpret and analyze graphical data to understand the motion of an object.
7. Use mathematical equations to solve 1-D kinematics problems.
8. Demonstrate understanding of the motion of a falling body near the surface of the earth.
9. Solve free fall problems using the equations of motion.
10. Understand projectile motion for objects launched horizontally.

Lab skills:

1. Use a spreadsheet to create a properly labeled data tables and graphs with trend lines appropriate to the data. (Buggy/Sparky lab)
2. Insert a formula into a spreadsheet to make calculations. (Buggy/Sparky lab)
3. Interpret graphs and trend lines and utilize equations generated to make predictions. (Buggy/Sparky, and Detector lab)

Newton's Laws of Motion:

1. Draw a Free Body Diagrams using arrows of relative appropriate lengths to indicate the forces acting on an object.
2. Add together the forces acting on an object to determine the net force.
3. Explain everyday phenomena, identify examples, and solve problems with Newton’s laws of motion.
4. Explain Newton’s third law and how the force affects the motion of an object, including identifying the third law pair to a force.
5. Solve problems involving the motion of objects with constant acceleration applying Newton’s second law and the kinematics equations.
6. Differentiate between mass and weight and be able to convert from one to the other.

7. Apply Newton's second law to an object with constant vertical acceleration.

Experimental Design:

1. Design an experiment to test the relationship between two variables and/or design an apparatus to meet specific physical criteria.
2. Collect and organize data into tables and graphs for interpretation.

Circular Motion and Gravitation:

1. Apply Newton's second law to circular motion of an object with constant speed.
2. Calculate linear speed, centripetal acceleration and centripetal force.
3. Show an understanding of and solve problems with Newton's Universal Law of Gravitation.
4. Define and solve problems with gravitational field strength.
5. Use Newton's second law to explain why all objects fall in a uniform gravitational field with the same acceleration.
6. Use centripetal force with Newton's Universal Law of Gravitation to calculate orbital speed.

Momentum and Impulse:

1. Define momentum and impulse, including knowing units for each.
2. Solve problems and explain scenarios conceptually using the impulse-momentum theorem.
3. Solve problems and explain scenarios conceptually using the law of conservation of momentum.
4. Design a physical device to minimize the force of a collision.

Work and Energy:

1. Define work, mechanical energy, kinetic energy, and gravitational potential energy.
2. Know the unit for all of the above is the joule. Define the joule in basic SI units.
3. Define power, know the unit is the Watt, and do calculations with problems.
4. Understand and apply the concept of conservation of energy to solve problems.
5. Determine an appropriate height in the system to label as zero and understand that this choice is arbitrary.
6. Understand and apply the work-kinetic energy theorem to solve problems.
7. Experimentally derive the relationship between distance and final velocity for object with constant acceleration.