Unit 8: Newtonian Mechanics – Fluid Mechanics

OBJECTIVES:

Big Idea 1: Objects and systems have properties such as mass and charge. Systems may have internal structure.

Enduring Understanding 1.E: Materials have many macroscopic properties that result from the arrangement and interactions of the atoms and molecules that make up the material.

Essential Knowledge 1.E.1: Matter has a property called density.

Learning Objective 1.E.1.1: The student is able to predict the densities, difference in densities, or changes in densities under different conditions for natural phenomena and design an investigation to verify the prediction.

Learning Objective 1.E.1.2: The student is able to select from experimental data the information necessary to determine the density of an object and/or compare densities of several objects.

Big Idea 3: The interactions of an object with other objects can be described by forces.

Enduring Understanding 3.C: At the macroscopic level, forces can be categorized as either long-range (action-at-a-distance) forces or contact forces.

Essential Knowledge 3.C.4: Contact forces result from the interaction of one object touching another object, and they arise from inter-atomic electric forces. These forces include tension, friction, normal, spring (Physics 1), and buoyant (Physics 2).

Learning Objective 3.C.4.1: The student is able to make claims about various contact forces between objects based on the microscopic cause of those forces.

Learning Objective 3.C.4.2: The student is able to explain contact forces (tension, friction, normal, buoyant, spring) as arising from inter-atomic electric forces and that they therefore have certain directions.

Big Idea 5: Changes that occur as a result of interactions are constrained by conservation laws.

Enduring Understanding 5.B: The energy of a system is conserved.

Essential Knowledge 5.B.10: Bernoulli's equation describes the conservation of energy in fluid flow.

Learning Objective 5.B.10.1: The student is able to use Bernoulli's equation to make calculations related to a moving fluid.

Learning Objective 5.B.10.2: The student is able to use Bernoulli's equation and/or the relationship between force and pressure to make calculations related to a moving fluid.

Learning Objective 5.B.10.3: The student is able to use Bernoulli's equation and the continuity equation to make calculations related to a moving fluid.

Learning Objective 5.B.10.4: The student is able to construct an explanation of Bernoulli's equation in terms of the conservation of energy.

Enduring Understanding 5.F: Classically, the mass of a system is conserved.

Essential Knowledge 5.F.1: The continuity equation describes conservation of mass flow rate in fluids. Examples should include volume rate of flow and mass flow rate.

Learning Objective 5.F.1.1: The student is able to make calculations of quantities related to flow of a fluid, using mass conservation principles (the continuity equation.)

PROCEDURE:

1. Phase 1: Mass Density & Hydrostatic Pressure, including Pressure Gauges and Pascal's Principle
    - Notes: Roman numeral I
    - Homework: *Please note that on page 322 is a handy dandy table of the densities of common materials.* Chapter 11 Conceptual Problems 3-9 and Problems 1, 2, 4, 7 (1 gallon = 3.785E-3 m^3), 11, 13, 15, 19, 23, 32, 33, 35, 80 (also give absolute pressure, and leave in Pa), 82, 98
2. Phase 2: Archimedes' Principle, Buoyancy
    - Notes: Roman numeral II
    - Homework: Chapter 11 Conceptual Problems 11-16 and Problems 38- 42
    - Develop and solve multiple practice problems.
3. Phase 3: Fluid Flow Continuity and Bernoulli's Equation
    - Notes: Roman numerals III and IV
    - Homework: Chapter 11 Conceptual Problems 18-27 and Problems 50-52, 56-60, 78, 100 (conceptual only)

LABORATORY COMPONENT:

- Lab: Mass Density
- Lab: Bernoulli's Equation