08 Fluids

Content Area:	**Science**
Course(s):	**AP Physics 1**
Time Period:	**Semester 2**
Length:	**10 periods**
Status:	**Published**

Standards

SCI.HS.PS2.A	Forces and Motion
SCI.HS.PS3.A	Definitions of Energy
SCI.HS.PS3.B	Conservation of Energy and Energy Transfer
SCI.HS.ETS1.A	Defining and Delimiting Engineering Problems
	Newton's second law accurately predicts changes in the motion of macroscopic objects.
	The availability of energy limits what can occur in any system.
	Patterns
	Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.
	Scale, Proportion, and Quantity
	Cause and Effect
	Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
	Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
	Analyzing and Interpreting Data
	Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.
	Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.
	If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.
	Using Mathematics and Computational Thinking

Enduring Understandings

The internal structure of a system determines many properties of the system.

Materials have many macroscopic properties that result from the arrangement and interactions of the atoms and molecules that make up the material.

All forces share certain common characteristics when considered by observers in inertial reference frames.

Classically, the acceleration of an object interacting with other objects can be predicted by using a = F/m

At the macroscopic level, forces can be categorized as either long-range (action-ata-distance) forces or contact forces.

The energy of a system is conserved.

Classically, the mass of a system is conserved.

Essential Questions

1. Why do some objects float while others sink?

2. Why is an object's ability to float an important characteristic?

3. What implications to our lives would there be if nothing floated?

4. Why don't we feel the miles of air above us pushing us down?

Knowledge and Skills

Knowledge

Internal Structure and Density

- Distinguishing properties of solids, liquids, and gases stem from the varying interactions between atoms and molecules.
- A fluid is a substance that has no fixed shape.
- Fluids can be characterized by their density. Density is defined as a ratio of mass to volume.
- An ideal fluid is incompressible and has no viscosity

Pressure

- Pressure is defined as the magnitude of the perpendicular force component exerted per unit area over a given surface area, as described by the equation
- Pressure is a scalar quantity.
- The volume and density of a given amount of an incompressible fluid is constant regardless of the pressure exerted on that fluid.
- The pressure exerted by a fluid is the result of the entirety of the interactions between the fluid's constituent particles and the surface with which those particles interact.
- The absolute pressure of a fluid at a given point is equal to the sum of a reference pressure P0, such as the atmospheric pressure Patm, and the gauge pressure Pgauge.
- The gauge pressure of a vertical column of fluid is described by the equation

Fluids and Newton's Laws

- Newton's laws can be used to describe the motion of particles within a fluid.
- The macroscopic behavior of a fluid is a result of the internal interactions between the fluid's constituent particles and external forces exerted on the fluid.
- The buoyant force is a net upward force exerted on an object by a fluid.
- The buoyant force exerted on an object by a fluid is a result of the collective forces exerted on the object by the particles making up the fluid.
- The magnitude of the buoyant force exerted on an object by a fluid is equivalent to the weight of the fluid displaced by the object.

Fluids and Conservation Laws

- A difference in pressure between two locations causes a fluid to flow.
    - The rate at which matter enters a fluid-filled tube open at both ends must equal the rate at which matter exits the tube.
    - The rate at which matter flows into a location is proportional to the cross-sectional area of the flow and the speed at which the fluid flows.
- The continuity equation for fluid flow describes conservation of mass flow rate in incompressible fluids.
- A difference in gravitational potential energies between two locations in a fluid will result in a difference in kinetic energy and pressure between those two locations that is described by conservation laws.
- Bernoulli's equation describes the conservation of mechanical energy in fluid flow.
- Torricelli's Theorem relates the speed of a fluid exiting an opening to the difference in height between the opening and the top surface of the fluid and can be derived from conservation of energy principles.

Skills

- Create quantitative graphs with appropriate scales and units, including plotting data.
- Calculate or estimate an unknown quantity with units from known quantities, by selecting and following a logical computational pathway.
- Compare physical quantities between two or more scenarios or at different times and locations in a single scenario.

- Create experimental procedures that are appropriate for a given scientific question.
- Justify or support a claim using evidence from experimental data, physical representations, or physical principles or laws
- Create qualitative sketches of graphs that represent features of a model or the behavior of a physical system.
- Calculate or estimate an unknown quantity with units from known quantities, by selecting and following a logical computational pathway.
- Compare physical quantities between two or more scenarios or at different times and locations in a single scenario.
- Justify or support a claim using evidence from experimental data, physical representations, or physical principles or laws.
- Create diagrams, tables, charts, or schematics to represent physical situations.
- Derive a symbolic expression from known quantities by selecting and following a logical mathematical pathway.
- Predict new values or factors of change of physical quantities using functional dependence between variables.
- Apply an appropriate law, definition, theoretical relationship, or model to make a claim
- Create quantitative graphs with appropriate scales and units, including plotting data.
- Derive a symbolic expression from known quantities by selecting and following a logical mathematical pathway.
- Compare physical quantities between two or more scenarios or at different times and locations in a single scenario.
- Create experimental procedures that are appropriate for a given scientific question.
- Apply an appropriate law, definition, theoretical relationship, or model to make a claim

Transfer Goals

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

Energy and Matter: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

Structure and Function: The way an object is shaped or structured determines many of its properties and functions.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

Assessments

https://docs.google.com/document/d/1wR7bQF-8AQoRrt0g4C3hKja0yjwDjC9_BiAmONWbTcI/edit?usp=sharing

Modifications

https://docs.google.com/document/d/1ODqaPP69YkcFiyG72fIT8XsUIe3K1VSG7nxuc4CpCec/edit?usp=sharing