

SUGGESTED SKILLS

1.B

Create quantitative graphs with appropriate scales and units, including plotting data.

2.B

Calculate or estimate an unknown quantity with units from known quantities, by selecting and following a logical computational pathway.

2.C

Compare physical quantities between two or more scenarios or at different times and locations in a single scenario.

3.A

Create experimental procedures that are appropriate for a given scientific question.

3.C

Justify or support a claim using evidence from experimental data, physical representations, or physical principles or laws

TOPIC 8.1

Internal Structure and Density

Required Course Content

LEARNING OBJECTIVE

8.1.A

Describe the properties of a fluid.

ESSENTIAL KNOWLEDGE

8.1.A.1

Distinguishing properties of solids, liquids, and gases stem from the varying interactions between atoms and molecules.

8.1.A.2

A fluid is a substance that has no fixed shape.

8.1.A.3

Fluids can be characterized by their density. Density is defined as a ratio of mass to volume.

Relevant equation:

$$\rho = \frac{m}{V}$$

8.1.A.4

An ideal fluid is incompressible and has no viscosity.

TOPIC 8.2

Pressure

Required Course Content

LEARNING OBJECTIVE

8.2.A

Describe the pressure exerted on a surface by a given force.

8.2.B

Describe the pressure exerted by a fluid.

ESSENTIAL KNOWLEDGE

8.2.A.1

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

$$P = \frac{F_{\perp}}{A}.$$

8.2.A.2

Pressure is a scalar quantity.

8.2.A.3

The volume and density of a given amount of an incompressible fluid is constant regardless of the pressure exerted on that fluid.

8.2.B.1

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.

8.2.B.2

The absolute pressure of a fluid at a given point is equal to the sum of a reference pressure P_0 , such as the atmospheric pressure P_{atm} , and the gauge pressure P_{gauge} .

Relevant equation:

$$P = P_0 + \rho gh$$

8.2.B.3

The gauge pressure of a vertical column of fluid is described by the equation

$$P_{\text{gauge}} = \rho gh.$$

SUGGESTED SKILLS

1.C

Create qualitative sketches of graphs that represent features of a model or the behavior of a physical system.

2.B

Calculate or estimate an unknown quantity with units from known quantities, by selecting and following a logical computational pathway.

2.C

Compare physical quantities between two or more scenarios or at different times and locations in a single scenario.

3.C

Justify or support a claim using evidence from experimental data, physical representations, or physical principles or laws.

SUGGESTED SKILLS

1.A

Create diagrams, tables, charts, or schematics to represent physical situations.

2.A

Derive a symbolic expression from known quantities by selecting and following a logical mathematical pathway.

2.D

Predict new values or factors of change of physical quantities using functional dependence between variables.

3.B

Apply an appropriate law, definition, theoretical relationship, or model to make a claim.

TOPIC 8.3

Fluids and Newton's Laws

Required Course Content

LEARNING OBJECTIVE

8.3.A

Describe the conditions under which a fluid's velocity changes.

8.3.B

Describe the buoyant force exerted on an object interacting with a fluid.

ESSENTIAL KNOWLEDGE

8.3.A.1

Newton's laws can be used to describe the motion of particles within a fluid.

8.3.A.2

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.

8.3.B.1

The buoyant force is a net upward force exerted on an object by a fluid.

8.3.B.2

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.

8.3.B.3

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.

Relevant equation:

$$F_b = \rho V g$$

TOPIC 8.4

Fluids and Conservation Laws

Required Course Content

LEARNING OBJECTIVE

8.4.A

Describe the flow of an incompressible fluid through a cross-sectional area by using mass conservation.

ESSENTIAL KNOWLEDGE

8.4.A.1

A difference in pressure between two locations causes a fluid to flow.

8.4.A.1.i

The rate at which matter enters a fluid-filled tube open at both ends must equal the rate at which matter exits the tube.

8.4.A.1.ii

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.

Derived equation:

$$\frac{V}{t} = Av$$

8.4.A.2

The continuity equation for fluid flow describes conservation of mass flow rate in incompressible fluids.

Relevant equation:

$$A_1v_1 = A_2v_2$$

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3.A

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3.B

Apply an appropriate law, definition, theoretical relationship, or model to make a claim.

LEARNING OBJECTIVE**8.4.B**

Describe the flow of a fluid as a result of a difference in energy between two locations within the fluid–Earth system.

ESSENTIAL KNOWLEDGE**8.4.B.1**

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.

8.4.B.2

Bernoulli's equation describes the conservation of mechanical energy in fluid flow.

Relevant equation:

$$P_1 + \rho g y_1 + \frac{1}{2} \rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2} \rho v_2^2$$

8.4.B.3

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.

Derived equation:

$$v = \sqrt{2g\Delta y}$$

BOUNDARY STATEMENT

All fluids will be assumed to be ideal, and all pipes are assumed to be completely filled by the fluid, unless otherwise stated.