Extension Activity – Water

Title of Activity – Contents Under Pressure

Concepts/Principles Covered -

Hydrostatic force is exerted by a fluid at rest against a vertical plate. Because the hydrostatic pressure of the fluid varies by depth, the pressure felt by the side of a container filled with fluid is not constant, but instead varies continuously along its height.

Hydrostatic pressure is the force per unit area on a horizontal plate in a fluid at rest, exerted by the volume of fluid that lies above that plate. Since the volume, mass and force of the fluid above a horizontal plate increases with depth from the surface, the hydrostatic pressure also increases with depth.

Hydrostatic pressure can be calculated by knowing the depth (d) and density (ρ) of the fluid, $P = \rho g d$, where g is the acceleration constant due to gravity and ρ is the density of the fluid. If a fluid starts to move, static pressure changes to dynamic pressure. The velocity of the fluid increases with depth. When a fluid leaves a tank through an orifice, the fluid stream cannot change direction immediately, resulting in a decrease in the velocity of the fluid. The Hoover Dam is a gravity dam shaped like a trapezoid to counteract the increase hydrostatic pressure with increasing depth, and the resulting increase in total hydrostatic force. It is also curved rather than flat, and thicker at greater depths, to counteract the hydrostatic forces at increasing depths.

Short Description –

Demonstrate how hydrostatic pressure varies with the height of a water column. Because the hydrostatic pressure of the fluid varies by depth, the pressure felt by the side of a container filled with fluid is not constant, but instead varies continuously along its height.

Standards Covered -

5.MD.C.5: Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.

HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas, choose and interpret the scale and the origin in graphs and data display

HSN.Q.A.2: Define the appropriate quantities for the purpose of descriptive modeling

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities

Length - 1hour

Age Group - Grades 6-12

Materials and Supplies -

- Tall rectangular container
- Thumbtacks
- Water
- Stopwatch
- Tray to catch water

Step-by-step Instructions -

- Pierce a tall rectangular container with thumbtacks to create three holes along the same vertical line.
- Plug holes and fill container with fluid.
- Remove one tack and carefully capture and measure the volume of water that escapes in a given time period (e.g., 3 seconds). Make note of the path of the water. Replace thumbtack.
- Refill the bottle to repeat experiment for each thumbtack.
- Refill again, but this time pull out all the thumbtacks at the same time.
- Note the differences in the trajectories of the water.