Activity Template

Subject Area(s) Measurement, Physics

Activity Title Fluid Flow Rate with LEGO NXT

Header

Image 1

ADA Description: Flow rate apparatus

Caption: Flow rate apparatus

Image file name: AMPS_Experiment_Ryan.jpg

Source/Rights: Copyright © Ryan Caeti 2010

Grade Level 5 (4-6)

Activity Dependency

Time Required 45

Group Size 6

Expendable Cost per Group US$4

Summary

This activity will introduce students to the concepts of flow rate and its dependency on pipe diameter. By attaching pipe fitting of various orifice diameters to a simple flow system, students discover what effects the differences in diameter have on the flow rate of the system. While the

effects are readily seen by mere observation, students will learn to quantitatively measure the flow rate via the use of LEGO sensors to determine the time it takes to fill a container between two discrete points.

Engineering Connection

Controlling the flow of a fluid is crucial to the design of workable fluid system. One of the main engineering concepts involved in this control is the flow rate (mass or volumetric) of the system. While sophisticated tools can be employed to measure this flow rate, one of the simplest means is via the using of timing.

Engineering Category

(#3) Provides engineering analysis or partial design.

Keywords

fluid, flow rate

Educational Standards choose from http://www.jesandco.org/asn/viewer/default.aspx

State science:
State math:

Pre-Requisite Knowledge

A basic understand of how to time events. i.e. How to use a stopwatch

Learning Objectives

After this activity, students should be able to:

- Test the effects of pipe diameter on flow rate
- Quantitatively discover the flow rate of a system.

Materials List

Each group needs:

- Water bottle assembly
- Nozzles
- Lego NXT kit with preloaded timer program

Introduction / Motivation

There are many applications in everyday life that involve the control of flow rate. One of the simplest examples is the common household faucet. When filling up pots with water or even washing your hands, you adjust the flow of water to your liking. What you normally don't think about however, is how the flow of water is adjusted. You turn a valve and like magic, the rate of flow changes. The principles behind this control are not magic however and simply depend on one property – the area of the pipe.

Fluid flowing through a pipe is similar to people walking in a hallway. If the hallway is small, only a few people can fit through. When the hallway is made larger, more and more people are able to fit through. If you think of the fluid traveling through the pipe in the same manner, the concept is the same. That is to say, a larger pipe will allow more fluid to flow

through than a smaller pipe would. Using the faucet as an example, as the valve opens the area inside of the pipe is increases. As this area increases, more fluid is able to flow through the opening.

Vocabulary / Definitions

Word	Definition
fluid	A liquid or a gas; such as water or steam
flow rate	The rate of fluid flow in the system. It can be given in two quantities – volumetric flow rate, and mass flow rate.
volumetric flow rate	The rate at which a volume of fluid flows in a system.
mass flow rate	The rate at which a mass of fluid flows in a system.

Procedure

1. Affix the LEGO assembly to the table so that it cannot move
2. Place the beaker next to the LEGO assembly such that the light sensors are touching the surface of the beaker
3. With no nozzle affixed to the spout, place a finger over the bottom and fill the water bottle to the top with water.
4. Start the LEGO timing program and then remove the finger from the spout.
5. Record the time it took to fill up the bottle.
6. Repeat steps 3-5 for the other two nozzle assemblies.

Before the Activity

- 1. Explain the concept of time keeping
- 2. Assign tasks to each student. i.e. time keeper, button presser, water releaser/pourer, etc.
- 3. Explain the use of the photogate to tell time.

Safety Issues

- 1. Water spilling

Assessment

1. Ask students what they discovered about the nozzle diameter and how it affects flow rate
2. Ask them to explain how the program calculated the time for them.

Post-Activity Assessment

1. What is one way to measure how fast a fluid is moving?
2. If you want the fluid to move faster/slower, how would you set up the system?