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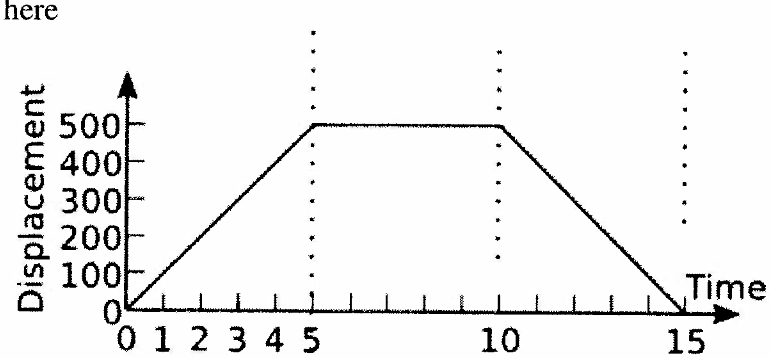
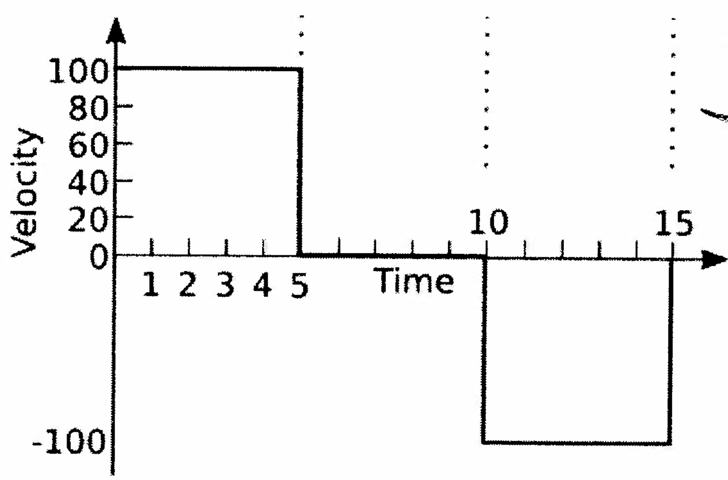
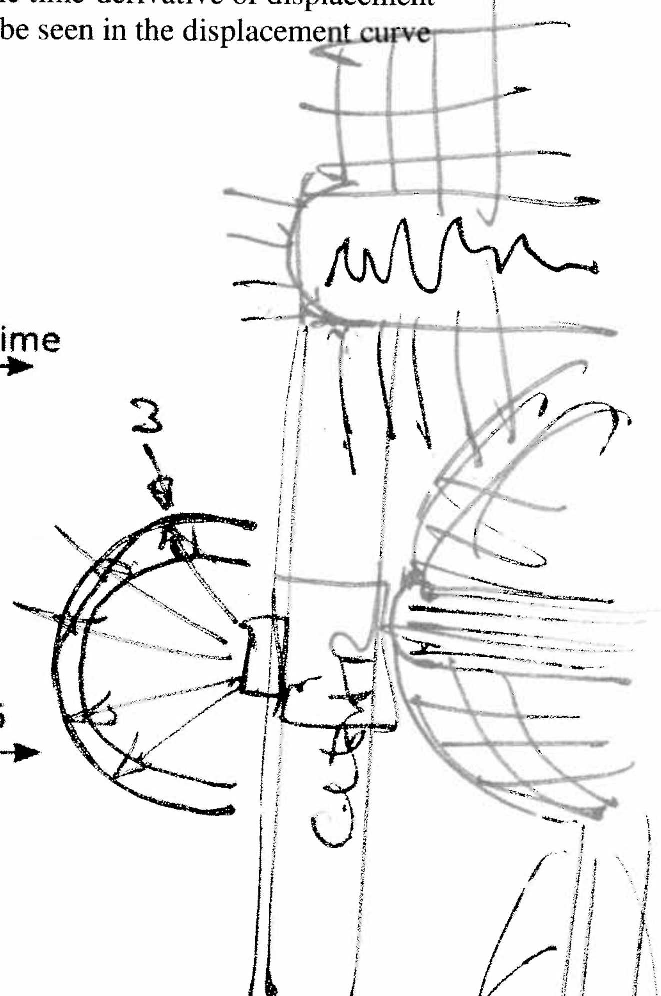
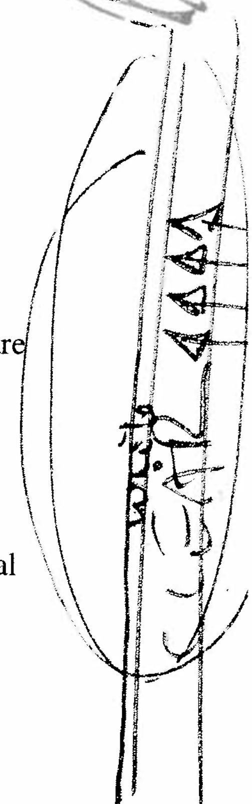
Hydraulophone Absement Theory

A derivative is a mathematical term for a slope (rise over run). A time derivative is the slope of a graph where the horizontal axis is time. so the time-derivative of displacement is the slope of a displacement vs. time graph. This can be seen in the displacement curve here









the velocity is the time-derivative of displacement. When the slope of the displacement curve is positive the velocity is positive. When the displacement curve is level the velocity is zero (displacement is not changing so you are not moving)
When the slope is negative the velocity is negative (displacement is decreasing so you are walking backwards)
An integral is the area under the curve over some interval. When its not defined it is usually an interval from time =0 to some point in the curve. For example. the value on the displacement graph at time =2 is equal to the area under the velocity curve over in interval from time=0 to time=2. the value on the displacement graph at time=5 is equal to the area under the velocity curve for the interval time=0 to time=5.

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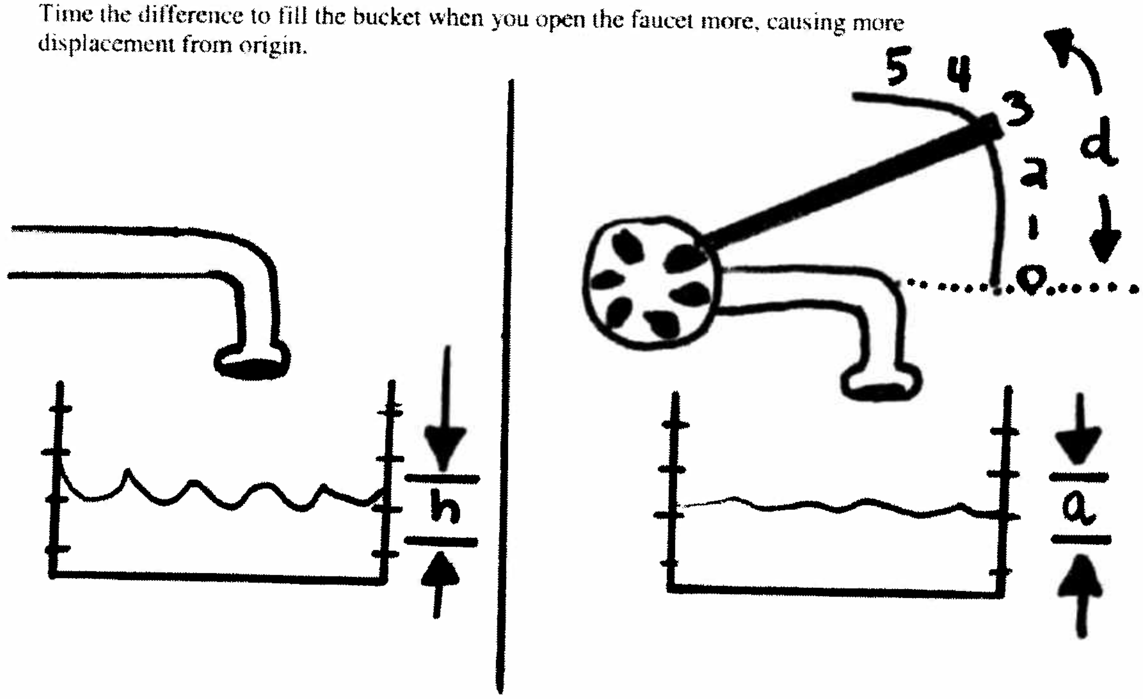
If velocity were the flow of water from a tap then displacement would be the amount of water in your bucket. The time derivative of the amount of water in the bucket (how fast the bucket fills) is the flow rate (Flow Rate similar to velocity). And the integral of the flow rate is the amount of water in the bucket.

Flow Rate is proportional to how far open the tap is. As you open the tap further, the rate of flow increases. Now if we consider the displacement of the faucet's handle from its rest position (see diagram below), then the amount of water in the bucket is approximately proportional to the time-integral of the handle's displacement.
The time-integral of displacement is called "absement". Absement is a measure of how "absent" (how far away and for how long) the handle is from its closed position. Equivalently, displacement is the time-derivative of absement, i.e. the position of the faucet handle is the time-derivative of how full the bucket is.

Activity

Have the kids tape a long stick of straw or something to the handle of the tap (the rotating part) now when they turn the handle the end of the straw will move. now you could say that the water in the bucket is the absement of the displacement of the straw. if you open the tap (move the straw) the bucket starts to fill. if you open the tap more (move the straw more) the bucket fills faster.

Time the difference to fill the bucket when you open the faucet more, causing more displacement from origin.



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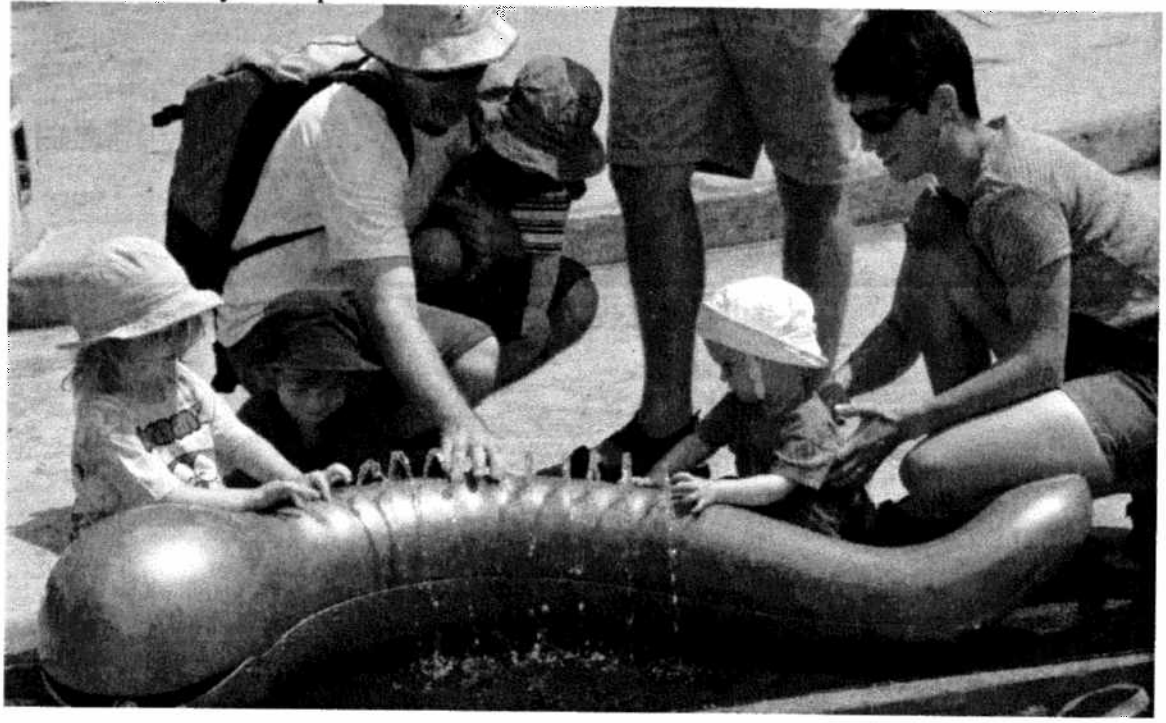
In this case we are looking at the flow let out by a tap and in his case he is looking at the flow inhibited by his finger. In our case the absement of the tap position is related to the amount of water in the bucket. In his case the absement of his finger motion is related to the tone of the hydraulophone.



Pianos tend to respond to velocity (how quickly a key is struck), whereas organs tend to respond to displacement (whether or not a key is pressed down). Hydraulophones tend to respond to absement (the time-integral of displacement), as well as to displacement, velocity, and to some degree jerk and jounce

Relationship to the piano

On a concert hydraulophone, the finger holes are arranged like the keys on a piano, i.e. there is a row of uniformly spaced holes close to the player, and a row of holes that are in groups of 2, 3, 2, 3, ..., a little further from the player. Whereas the piano and organ both have a similar kind of keyboard layout, the response ("key action") is different. Pianos tend to respond to velocity (how quickly a key is struck), whereas organs tend to respond to displacement (whether or not a key is pressed down). Hydraulophones tend to respond to absement (the time-integral of displacement), as well as to displacement, velocity, and to some degree jerk and jounce[1].

The term **hydraulophone** refers to one of:

- an interactive acoustic sound sculpture, typically in the form of a civic centerpiece used in landscape architecture[1]; or
- a musical instrument that is played by direct physical contact with hydraulic fluid (typically water) in which sound is generated or affected hydraulically[2].

- Typically the sound is produced by the same hydraulic fluid that is in direct contact with the player's fingers[3]; or
- an acoustic sound-producing mechanism that is used as an interface or input device involving the monitoring of fluid flow. Examples include hydraulophones for fluid-flow monitoring and measurement applications, such as building automation, equipment monitoring, and the like (e.g. determining which faucet or toilet in a building is operating and how much water it is consuming)[4].

Since humans do not breathe water, the water must be "blown" into the hydraulophone by way of a pump which can be hand-operated, wind operated, water powered, or electric (i.e. an electric pump). Unlike woodwind instruments in which there is one mouthpiece at the entrance to the flute chamber, hydraulophones have mouthpieces at every exit port from the chamber. Whereas flutes have one fipple mechanism for the mouth of the player, along with several finger holes that share the one fipple mechanism, the hydraulophone has a separate mouth/mouthpiece for each finger hole. A typical park-hydraulophone for installation in public spaces has 12 mouths, whereas a concert hydraulophone typically has 45 mouths.

Just as a piano is velocity sensing (i.e. it responds to how fast you hit the keys), hydraulophones are absement sensing (i.e. respond to how far down and for how long you hold the water jet).