MARIOTTE'S BOTTLE

Description:

This apparatus consists of a tall plastic cylinder with three small orifices on one side. It is used to demonstrate hydrostatic phenomena. It is suggested that a tray be provided to collect the water discharged from the orifices.

Material:

one plastic cylinder
one package toothpicks (with which to plug holes)
one rubber stopper
one piece 8 mm plastic tube

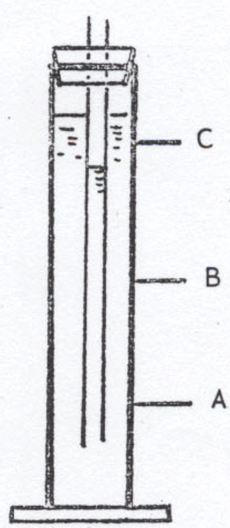
Experiment 1:

Flow requires a pressure difference.

Close the three orifices tightly with toothpicks and fill the cylinder with water to within an inch of the top. Close the top with the stopper and small plastic tube. The plastic tube should extend almost to the bottom of the cylinder and the stopper must be firmly in place. Remove and then replace each toothpick in turn and note whether or not water flows from the orifice. Note also the position of the water level in the plastic tube.

Repeat the experiment, this time placing the bottom end of the plastic tube at a position midway between the top two orifices. Observe both the initial effect and the rest state when the plugs to these two orifices are both removed.

Remember that the top of the water column in the small plastic tube is at atmospheric pressure.



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MARIOTTE'S BOTTLE (Cont.)

Experiment 2:

Water parabolas.

The velocity of a water stream is related to its head – the elevation which causes the flow. In the diagram below, this head is the distance between the water level in the cylinder and the position of the orifice h_1, for a falling body:

$h = \frac{1}{2}gt^2$

Since the velocity of a falling body is g times time we may say $V = gt$ or $t = \frac{V}{g}$

Then h_1 becomes equal to $\frac{1}{2}g(\frac{V}{g})^2$ or $\frac{V^2}{2g}$

The distance the water stream travels horizontally is dependent upon its velocity and the time permitted for it to move. From the above,

$h_1 = \frac{V^2}{2g}$ and $V = \sqrt{2gh}$,

We may solve for the time it takes the stream to fall by remembering that

$h_2 = \frac{1}{2} gt^2$.

Thus,

$t = \sqrt{\frac{2h_2}{g}}$

Combining we get

$d = Vt = \sqrt{2gh}, \circ \sqrt{\frac{2h_2}{g}}$ or $d = 2\sqrt{h_1h_2}$.

It can be shown that the product h_1h_2 is a maximum when h_1 and h_2 are equal.