Pressure demonstrations

Manometers and Siphons

Manometers

A manometer is a U-tube filled with a liquid (water, mercury etc.) The difference in height on each side is the pressure difference in cm of that particular liquid. Water manometers in glass or plastic tubing are read to the bottom of the meniscus. Water manometers cannot normally be used to measure pressure differences of less than 1 mm of water (10 pascals).

An unequal arm manometer

Because pressure depends only on depth the levels in the open manometer shown below are equal.

Fig 1 – an unequal arm water manometer open to the atmosphere.

Note: as with many first approximations in physics the statement above is not strictly true. The two water levels are not *exactly* the same. Surface tension will raise the level in the narrow tube by a small amount. For water in 4 mm aquarium hose the elevation is around one mm and not significant for demonstration purposes. Equal arm manometers do not show this slight reading error.

A second example

The hot water bottle is filled with water and connected to a 4 mm aquarium hose fixed to a pole. The question is … "*How high will water rise in the tube if a person stands on the rubber bottle*?" (When teaching I like to leave students overnight with that question unanswered.)

Fig 2 – Equipment.

Now that they have had time to think about the rubber bottle question, ask again. *Don't expect too much, but hope for an insightful answer*.

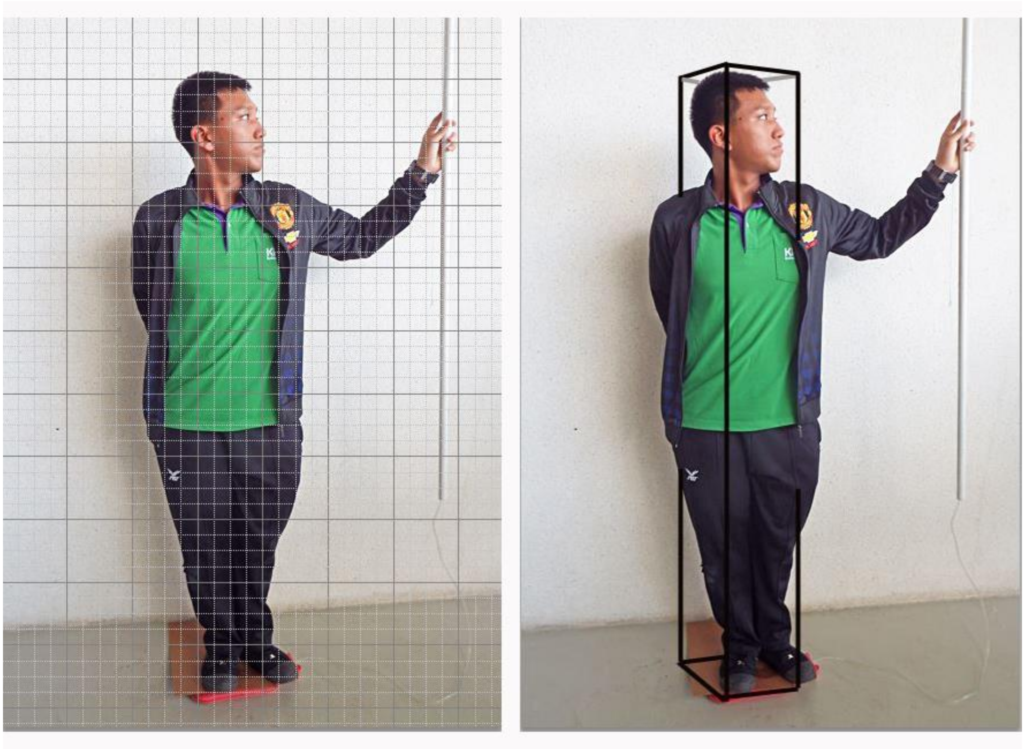

Fig 3 – Standing on the board on the rubber bottle.

The grid looks good but is not helpful**.** An average person has a volume very nearly equal to the volume of the box on the right. Given that the density of the human body is close to that of water we are looking at the equivalent of an unequal-arm manometer. The water will rise to about head-height.

Siphons

Pythagoras is credited with the invention of a self-emptying cup.

Fig 4 – a Pythagoras cup in its original form.

The central pillar conceals a siphon that empties the cup through a hole in the base when the liquid level reaches the top of the pillar. The ceramic cup in its original form is a little clumsy but something of a puzzle when first encountered. The improvised transparent version below makes for easier analysis.

Fig 5 – a Pythagoras cup in modern form.

In figure 5 two transparent plastic cups are nested with a 3 cm space under the inner cup. A hose passes through the base of the inner cup and is bent to end half a cm above the bottom. Once the inner cup is filled to the top of the hose water flows in the syphon and empties the cup through holes in the outer base. The water flow is driven by the pressure difference (ρgh) between the ends of the siphon, in this case 2-3 cm of water.