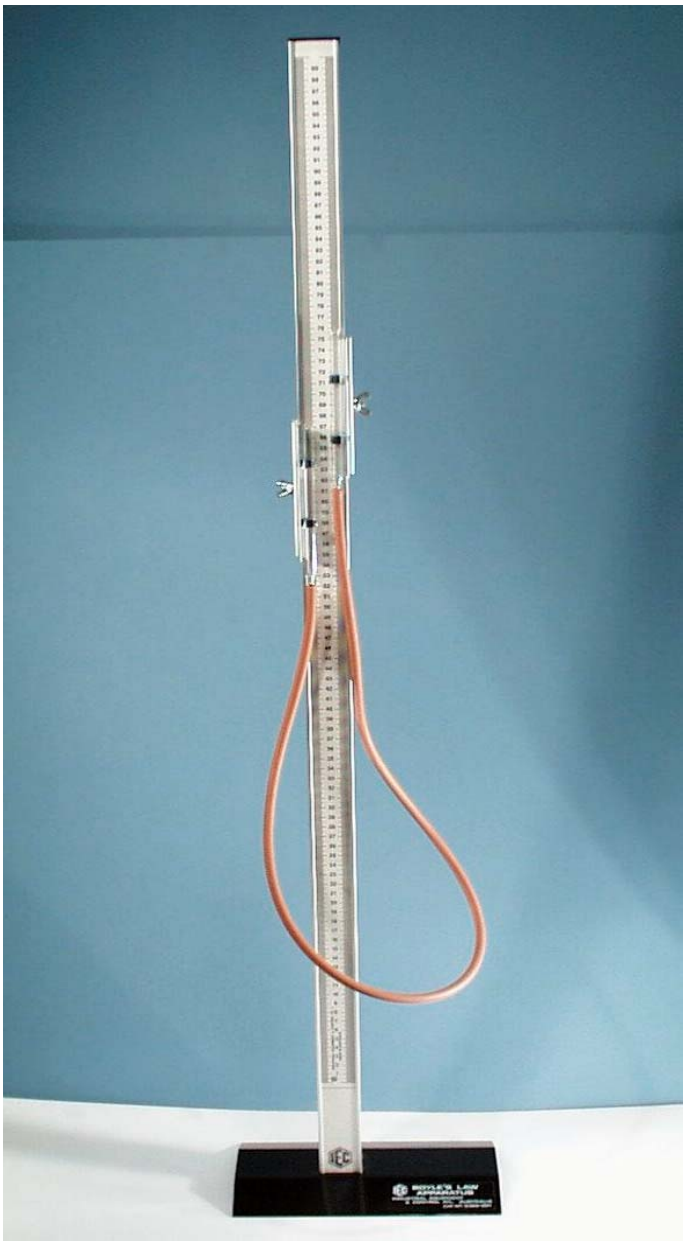
BOYLE'S LAW APPARATUS - glass pattern

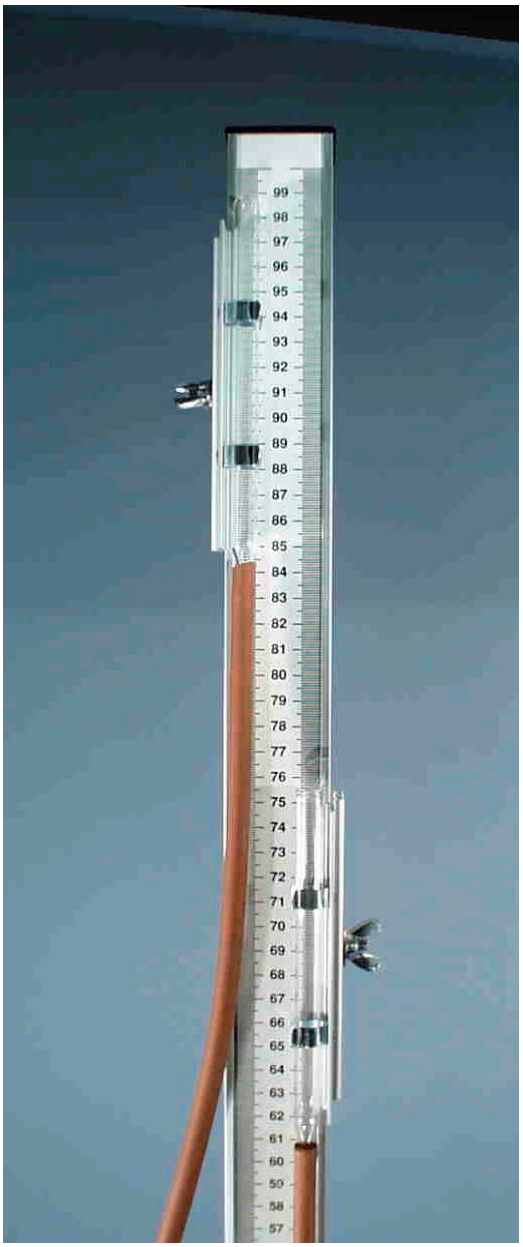
Cat: MF0340-001 Boyle's Law (without mercury)

DESCRIPTION:

The IEC **Boyle's Law** apparatus is a high quality instrument designed to perform the standard experiments relating gas volume to gas pressure. The unit requires approx. 150gm of distilled mercury (not supplied in the kit). By applying several additional components, the instrument can be converted to be the IEC **Constant Volume Thermometer**.

MF0340-001 Boyle's Law (low pressure)





Physical size: 250x140x1140mm LxWxH **Weight: 1.7 kg**

KIT COMPONENTS LIST: FOR BOYLE'S LAW:

- 1 pce Long aluminium rail complete with 1m scale and end cap. The scale has a transparent cover to permit marking and wiping clean by students.
- 1 pce Steel base.
- 1 pkt 2x Screws, washers & nuts for sliders. 4 x Screws to mount rail to base.
- 2 pcs Aluminium sliders complete with clips for glass.
- 1 pce Glass tube with open end.
- 1 pce Glass tube with closed end.
- 1 pce Rubber hose for mercury to join glass tubes, 1m long x 3mm bore.

SUPPLIED WITHOUT MERCURY. Approx. 150g of distilled mercury required.

ASSEMBLY INSTRUCTIONS - BOYLE'S LAW:

- Unpack containers and check all parts are correct. Insert the two large headed screws into the two aluminium slider plates with the screw head on the same side of the plate as the spring clips. Place the large washer over the thread and fit the wing nut to the thread. Do not tighten the wing nuts.
- Lay the long aluminium rail on the table with the plastic end cap at the far end and fit the two aluminium sliders to the rail by sliding the large screw heads into the slots provided in the rail. The square shape on the screw will slide in the slot in the rail and will prevent the screw from rotating. Be sure that the spring clips are on the same side of the rail as the metric scale. Move the sliders along the rail to about the mid-position and tighten the wing nuts gently.
- Attach the steel base plate to the end of the long rail with the 4 small screws provided. If the plastic scale protection strip protrudes from the end of the rail, cut the excess with scissors or a sharp knife. Tighten the screws firmly and stand the unit upright on the table.
- Take the two glass tubes (1x open end and 1x closed) and fit the rubber hose firmly to the small end of the OPEN tube ONLY. To make the rubber fit more easily, wet the end of the glass. Do not wet the inside of the glass tube or the rubber hose.
- Take this open end glass tube and clip it into the spring clips of the right hand slider so that the rubber is about level with the bottom edge of the slider.
- Adjust the slider so the open end of the rubber hose is level with the upper end of the open glass tube clipped to the right hand slider.
- Take the other (open) end of the RUBBER HOSE and temporarily clip it into the spring clips of the left hand slider whilst the mercury is being loaded into the open end glass tube.
- ***FILLING: IMPORTANT NOTE:*** Mercury is an expensive, dangerous and very poisonous substance. Take care when filling the unit so that mercury is not spilled. Avoid contact with the skin.
- Take distilled mercury in a plastic dropper bottle and, very carefully, squeeze the mercury into the right hand glass tube and the rubber hose until the level is visible about two thirds of the way up the glass tube. Wriggle the rubber hose gently with the hand to permit any trapped air to rise into the glass tube and escape.

- Carefully lower the rubber hose and slider until the mercury is JUST visible approaching the end of the hose. DO NOT ALLOW THE MERCURY TO ESCAPE OUT THE END OF THE HOSE. Fit the small end of the closed glass tube into the end of the rubber hose. Remove the hose from the clips and clip the closed glass tube into its position.
- Adjust the two sliders so they are opposite each other and add mercury to the open tube until it is again about two thirds full. Mercury should be seen beginning to enter the closed tube. As the open tube is raised and lowered by its slider, the air in the closed tube is compressed and the pressure rises in the closed tube. Use the vertical scale to measure the air volume change and the pressure (difference in height of the two mercury levels).
- Finally, transfer a little air from the closed tube to the open tube so the mercury is about 25mm up the closed tube when the sliders are level. This can be done by unclipping and inverting the closed tube so that a little air runs backwards through the mercury to the open tube.

NOTE: When filled with mercury, do not knock over or invert the unit or mercury spillage will occur. During storage only, a rubber stopper fitted to the open glass tube may prevent spillage.

BOYLE'S LAW CALCULATIONS:

Boyle's Law states that gas **Pressure x Volume = a constant (k)** **PV=k or V=k/P**

Therefore, volume varies in proportion to the inverse of the pressure. Thus a graph of gas volume directly to pressure will be a curve but the graph of gas volume (Y axis) to the **inverse of the pressure** (X axis) should be a straight line with a slope of 'k'.

Remember that air pressure around us already is pressurised to 100kPa (one atmospheric pressure), therefore any reading must have 100kPa added to it to be the true gas pressure. The added pressure on the air is created by the difference in height of the mercury columns. When the mercury levels are exactly level, the added air pressure is zero and the air is at standard atmospheric pressure (actually 100kPa). Move the mercury in the open ended glass tube upwards to exert pressure on the air. Take 6 or 8 different volume readings at different column heights.

Plot a graph of **air column length** (Y axis) to **inverse of air pressure** (X axis).

The graph of the gas volume plotted against the inverse of the total gas pressure should be a straight line and should prove the linear relationship between volume and the inverse of pressure as stated in 'Boyle's Law' of gases. The slope of the line (dY/dX) should be the value of the constant 'k'.

A different approach: Boyle's law states that $V_1P_1=V_2P_2=k$, so therefore $V_1/V_2=P_2/P_1$.

Take two different pressures (add the 100kPa initial atmospheric pressure in each case) and take the two corresponding volumes or lengths of air columns. See if the law is true.

Designed and manufactured in Australia