INSTRUCTION SHEET

BOYLE'S LAW APPARATUS - high pressure

Cat: MF0360-001

DESCRIPTION: The apparatus consists of::

- 1x Base, tank and column assembly.
- 1x Bottle of coloured fluid for half-filling the tank.
- 1x Small pump as used for pumping automotive tyres.
- 1x Short rubber hose with pinch clip and fitting for the attachment of the pump.

MF0360-001

Physical size: 160x160x730mm LxWxH Weight: 1.55 kg Packed wt: 2.2 kg.

Designed and manufactured in Australia by Industrial Equipment and Control Pty Ltd

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USING THE APPARATUS:

Boyle's law states that the relationship between the pressure of a gas and its volume while it is held at a constant temperature is '**PV=k' pressure by volume is a constant.** Most Boyle's law instruments operate at very low pressures and a mercury column is used to compress the gas volume and also to measure the pressure created.. This instrument proves Boyle's law at a higher pressure than normal and the use of mercury is not required..

A small metal reservoir is connected to a vertical glass tube which is sealed at the upper end. This heavy wall high pressure glass tube is placed inside a plastic tube so that if the glass tube breaks during an experiment it is contained. A metric scale is fitted behind the glass tube so the volume of the air space can be measured. The metal reservoir contains colored fluid and, when the reservoir is pressurised by a small air pump, the fluid is forced up the glass tube and can be seen to compress the air inside the tube.

The reservoir is fitted with filling hole, a sealing cap and a small pressure gauge. It is also provided with a short hose with a shut-off clip and a fitting for connecting the high pressure air source. The coloured fluid is poured into the filling hole and the sealing cap is screwed on firmly. The pump is connected to the fitting provided at the end of the short hose. As the pump is operated, the pressure gauge indicates the rise in pressure and the colored fluid will be seen to rise up the glass tube and compress the residual air.

When the air pressure is sufficient, the shut-off clip can be screwed to pinch the small rubber hose tightly closed to form a perfect leak-free seal.

CAUTION: The reservoir must not be pressurised beyond the maximum reading on the pressure gauge.

INITIAL FILLING OF FLUID RESERVOIR

To prepare a new instrument for operation, unscrew the knurled cap on the top of the reservoir, pour in the colored fluid supplied and replace the cap securely.

CAUTION: The fluid should NOT completely fill the reservoir. Any level exceeding half full is sufficient for the equipment to operate correctly.

THE SCALE

The scale should be positioned so that the zero line is level with the ***UNDERSIDE*** of the metal sealing pin that protrudes into the glass tube at the upper end.

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PERFORMING AN EXPERIMENT:

- Attach the pump hose to the connection fitting provided on the short hose. Open the pinch clip so that the air can pass up the hose.
- Operate the pump so that the pressure in the reservoir is increased to near maximum on the gauge. The fluid should be seen to rise in the glass tube as the pressure increases. Screw the pinch clip so that the short hose is pinched off to make a perfect seal and remove the pump from the fitting.
- Using the scale provided, measure the length of the air column from the underside of the metal sealing pin in the upper end of the glass tube to the surface of the liquid. Note also the pressure of the system as indicated on the pressure gauge. By slightly unscrewing the pinch clip, release the air very slowly from the reservoir to reduce the pressure by about 40kPa and again take readings of air column and pressure. Repeat until the pressure is finally zero on the gauge.

THE 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 the 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) and the gauge will be reading zero kPa. Therefore any gauge reading must have 100kPa added to it to be the true gas pressure.

Increase the initial gas pressure to 400kPa on the gauge (add 100kPa to call it 500kPa in your data). Shut the sealing pinch clip and remove the pump. Very slowly open the clip to reduce the pressure in 40kPa intervals. Make note of the air column length (which is proportional to air volume). When the pressure is exhausted and the gauge shows zero kPa, call this 100kPa and note the air column length for your data.

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

The X axis should read from 0.002 (which is the reciprocal of 500kPa. which is 400kPa + the initial 100kPa), up to 0.01 (which is the reciprocal of 100kPa initial gas pressure). The Y axis should read from zero up to 700mm.

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 gauge 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.

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