

State Examination Commission – Physics Higher Level, 2011

Question 2

During an experiment to verify Boyle's law, the pressure of a fixed mass of gas was varied. A series of measurements of the pressure p and the corresponding volume V of the gas was recorded as shown. The temperature was kept constant.

p/kPa	325	300	275	250	200	175	150	125
V/cm^3	12.1	13	14.2	15.5	19.6	22.4	26	31.1

Draw a labelled diagram of the apparatus used in the experiment.

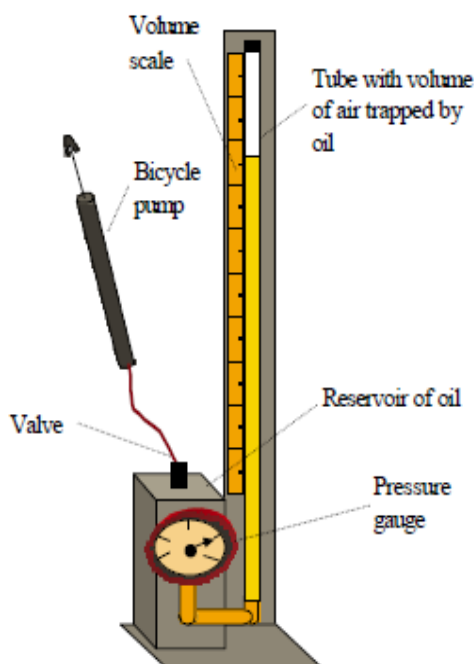
How was the pressure of the gas varied during the experiment?

Describe how the pressure and the volume of the gas were measured.

Why should there be a delay between adjusting the the pressure of the gas and recording its value? (22)

Draw a suitable graph to show the relationship between the pressure and the volume of a fixed mass of gas. Explain how your graph verifies Boyle's law. (18)

Draw a labelled diagram of the apparatus used in the experiment.



How was the pressure of the gas varied during the experiment?

Using the pump, increase the pressure on the air in the tube, making sure not to exceed the safety limit indicated on the pressure gauge. Reduce the pressure by opening the valve slightly.

Describe how the pressure and the volume of the gas were measured.

The value of atmospheric pressure, obtained from a barometer, was added to the pressure reading on the gauge to get the pressure of the air in the tube.

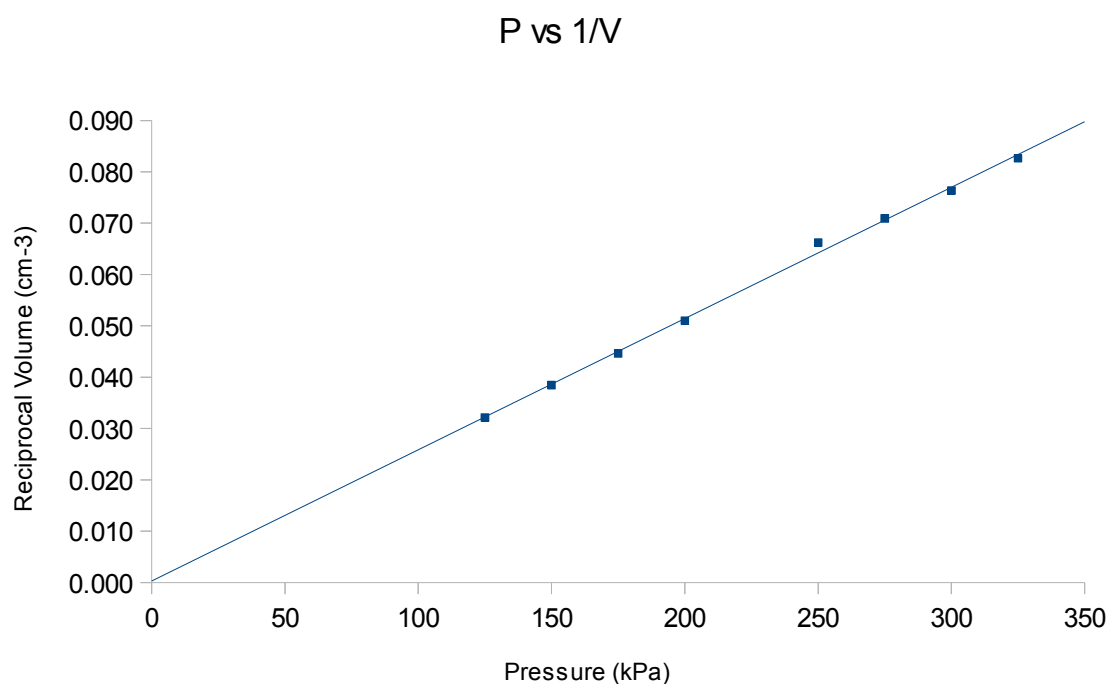
The volume was obtained by reading the volume scale at the side of the glass tube.

Why should there be a delay between adjusting the the pressure of the gas and recording its value? (22)

Gases give out / take in heat when they are compressed / expanded and have to be allowed to reach equilibrium temperature before readings are taken. The pressure of a gas is dependent on it's temperature also.

Draw a suitable graph to show the relationship between the pressure and the volume of a fixed mass of gas. Explain how your graph verifies Boyle's law. (18)

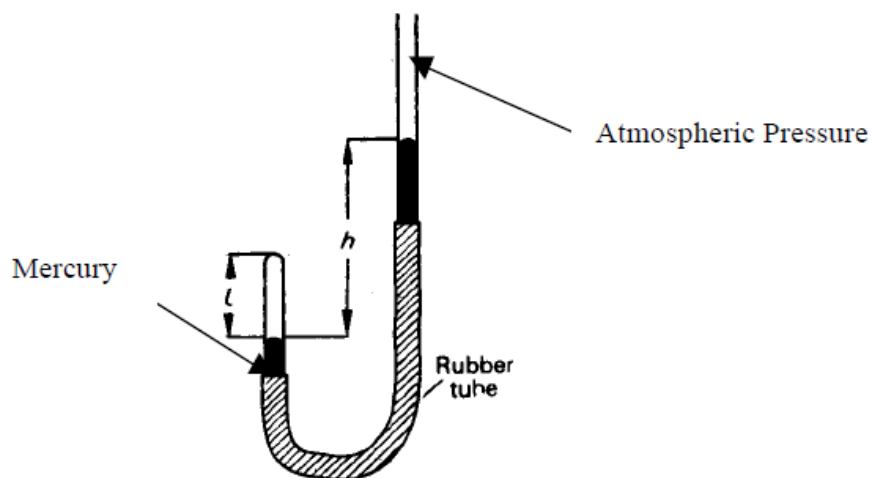
p / kPa	325	300	275	250	200	175	150	125
V / cm^3	12.1	13	14.2	15.5	19.6	22.4	26	31.1
$1/V \text{ cm}^{-3}$	0.083	0.076	0.071	0.066	0.051	0.045	0.038	0.032



The graph shows that the pressure of the fixed mass gas is inversely proportional to it's volume (because of straight line through the origin), once the temperature is kept constant. This is what Boyle stated in his law.

Alternatively,

Draw a labelled diagram of the apparatus used in the experiment.



How was the pressure of the gas varied during the experiment?

By raising the open limb of the J tube, the pressure of the fixed mass of gas in the closed limb was increased by an amount equivalent to the increase in h , the difference between the level of mercury in the open and closed limbs.

Describe how the pressure and the volume of the gas were measured.

The pressure of the gas was obtained by adding the atmospheric pressure (got from barometer) to the pressure due to the height h of mercury.

The volume of the gas was got by multiplying the length of the column of air in the closed limb by πr^2 , where r is the internal radius of the glass tube (half the internal diameter as determined with a calipers).