

AQA Physics A-level

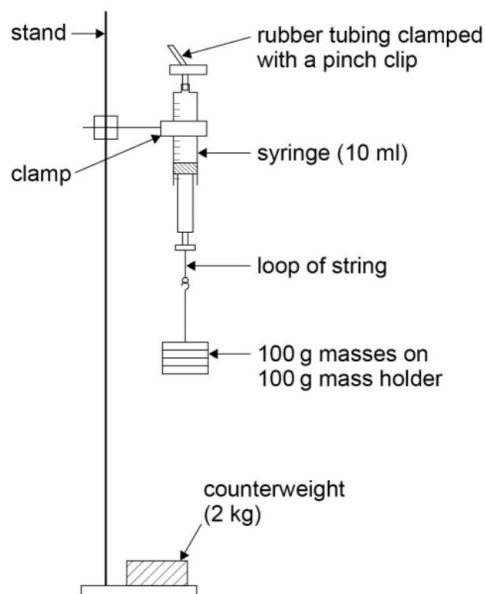
Required Practical 8

Investigation of Boyle's (constant temperature) law and Charles's (constant pressure) law for a gas



Boyle's law

- Equipment:
 - Stand and clamp
 - Syringe
 - Rubber tubing
 - Pinch clip
 - String
 - 100g masses with 100g holder
- Method:
 - With the plunger removed from the syringe, measure the inside diameter d of the syringe using a vernier caliper.
 - Replace the plunger and draw in about 4.0ml of air and record this. Fit the rubber tubing over the nozzle and clamp it with the pinch clip as close to the nozzle as possible.
 - Set up the apparatus as shown in the diagram, with only the 100g holder and one 100g mass suspended.
 - Gently move the plunger up and down to ensure it is not sticking and release it. Record the new volume V on the syringe scale.
 - Add two 100g masses to the holder and repeat this, adding two 100g masses each time until the total mass is 1000g.
 - Repeat the experiment twice more and find and record the mean V for each m .
- Graphs and calculations:
 - Calculate the cross sectional area A of the syringe using $A = \frac{\pi d^2}{4}$
 - Calculate and tabulate the force F exerted by each mass m using $F=mg$.
 - Find the pressure exerted by this force using F/A . Subtract this from standard atmospheric pressure, 101kPa, to obtain the pressure P of the air sample at each V .
 - Plot a graph of $1/V$ against P and draw a line of best fit. A straight line through the origin should be obtained, showing that the pressure is inversely proportional to the volume.
- Safety:
 - The stand could topple over and cause injury so a counterweight can be used if it is deemed unstable.
- Improvements and notes:
 - The clamp should be high enough that it does not distort the syringe barrel and make it more difficult for the plunger to move freely.
 - The syringe can be lubricated to prevent the plunger from sticking.



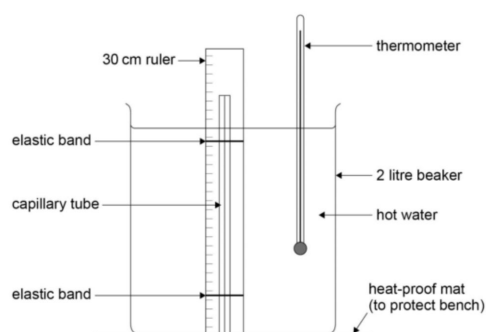
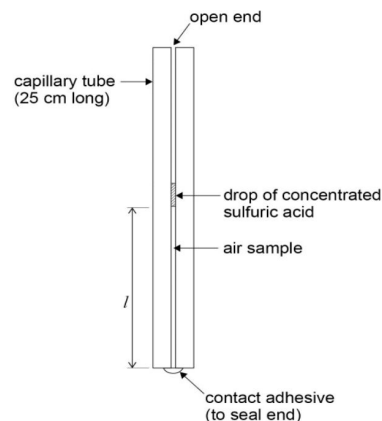
Charles' law

- Equipment:

- Capillary tube
- Sulfuric acid
- 2 litre beaker
- 2 elastic bands
- 30cm ruler
- Thermometer
- Kettle

- Method:

- Set up the apparatus as shown in the diagram with the open end of the capillary tube at the top and add hot water from the kettle. The hot water should cover the air sample.
- Stir the water well using the thermometer and read and record the value of its temperature, θ , and the length of the air sample, l , on the 30cm ruler.
- Allow the water to cool by 5°C and repeat this, taking measurements every 5°C down to room temperature.



- Graphs and calculations:

- Plot a graph of l against θ , draw a line of best fit, and find the gradient m . The value of absolute zero can be found by $\theta_0 = \theta_1 - \frac{l_1}{m}$, where θ_1 and l_1 are pair of values on the line of best fit.

- $l_1 = m\theta_1 + c \Rightarrow c = l_1 - m\theta_1$

At absolute zero, $l=0$, so $0 = m\theta_0 + c \Rightarrow \theta_0 = \frac{-c}{m} = \frac{-(l_1 - m\theta_1)}{m} = \theta_1 - \frac{l_1}{m}$

- Safety:

- Safety goggles must be worn because concentrated sulfuric acid can cause damage to the eyes.
- Boiling water is being used which could cause burns, so care must be taken it does not spill.

- Improvements and notes:

- The tube needs to be perfectly clean with no traces of other chemicals to prevent the thread of sulfuric acid from splitting.

