Physics Investigation 8 Teacher Manual

Observation

When compressing an air balloon, a girl finds it harder and harder to do so. She also finds that the balloon explodes when heated.

Problem

What property of air was responsible for these changes?

Hypothesis

The changes in the gas pressure from varying volume and temperature are responsible for the observations.

Aim

a) To study how the air pressure of a fixed mass of air varies with its volume at the same temperature.

b) To study how the air pressure of a fixed mass of air varies with its temperature at the same volume.

Principle

Matter consists of three states - solid, liquid and gas. Gas has no definite shape and volume. It just fills up the space of a container in which it occupies. Usually the behaviour of air is explained in terms of its pressure, temperature, volume and mass.

Pressure of air is the force per unit area the air exerts on a surface.

Volume of air is just the volume of the container in which it occupies.

In this investigation, the following variables are involved :

independent variables - volume and temperature

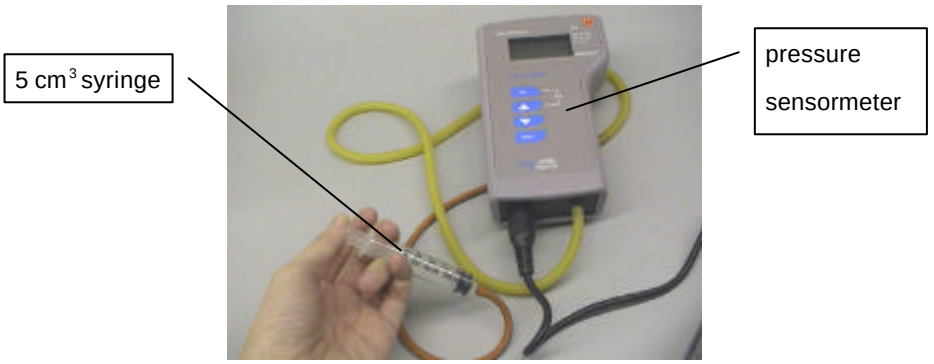
dependent variable - air pressure

Equipment and materials

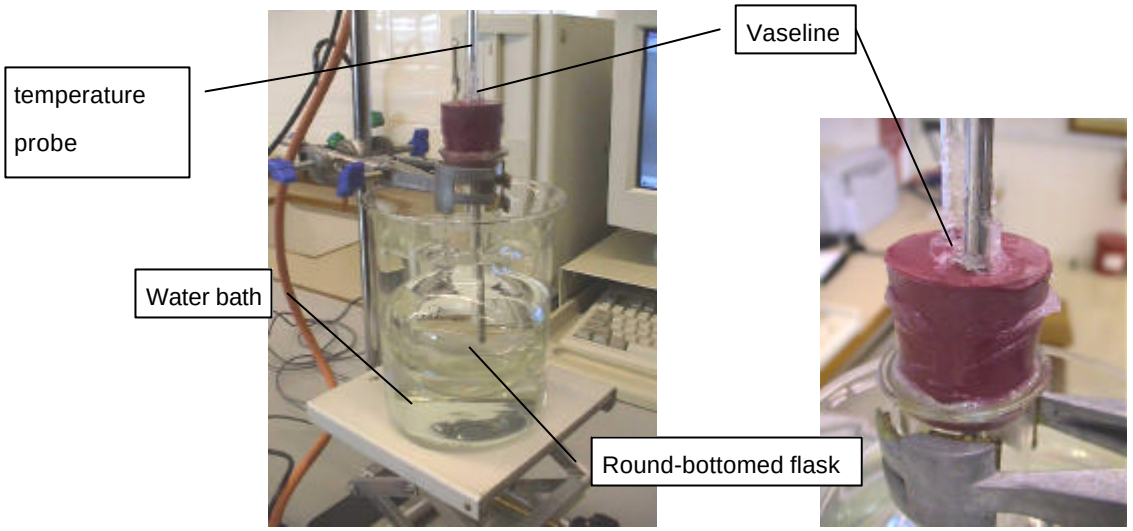
- desktop computer x 1
- datalogging interface x 1
- pressure sensormeter x 1
- temperature sensormeter x 1
- round-bottomed flask x 1
- syringe x 1
- lab jack x 1
- water bath x 1
- stirrer x 1
- Clamps
- Rubber tubings

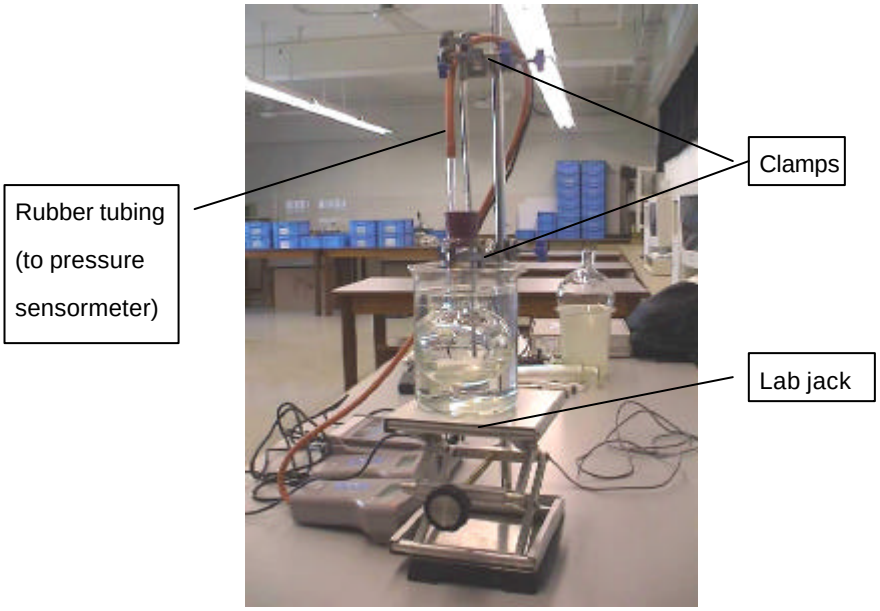
Set-ups

Experiment a



Experiment b





Procedure

Experiment a

1. Set up the computer and the interface. Connect the syringe to the pressure sensormeter as shown above;
2. Load and run the Datadisc 32program;
3. Select the "spacebar" function for recording;
4. Slowly push in or pull out the piston to change the pressure and volume of the air inside;
5. Measure the pressure of the air in the syringe using the pressure sensormeter;
6. Measure the volume of the air by reading the calibrations on the syringe. Record the pressure for every cm^3;
7. Display the pressure-volume graph on the screen.

Experiment b

1. Set up the computer and the interface;
2. Load and run the program;
3. Select the "continuous" function for recording;
4. Connect a round-bottom flask to the pressure sensormeter and temperature sensormeter using rubber tubings as shown above. Vaseline is added to prevent any leakage of air;
5. Put the round-bottom flask in a water bath;
6. Pour hot water (above 50°C) into the water bath and at the same time start the program for datalogging;
7. The pressure and temperature of the air will be displayed on the screen;
8. Leave the set-up unattended for about one hour to allow the air inside the flask to cool down slowly;
9. Display a pressure-temperature graph on the screen.

Precautions

Experiment a

1. The length of the rubber tubing joining the syringe and the sensormeter should be short;
2. The piston is pushed in or pulled out to change the pressure and volume of the air inside the syringe very slowly so as not to heat up the air inside;
3. The temperature of the air should be kept constant.

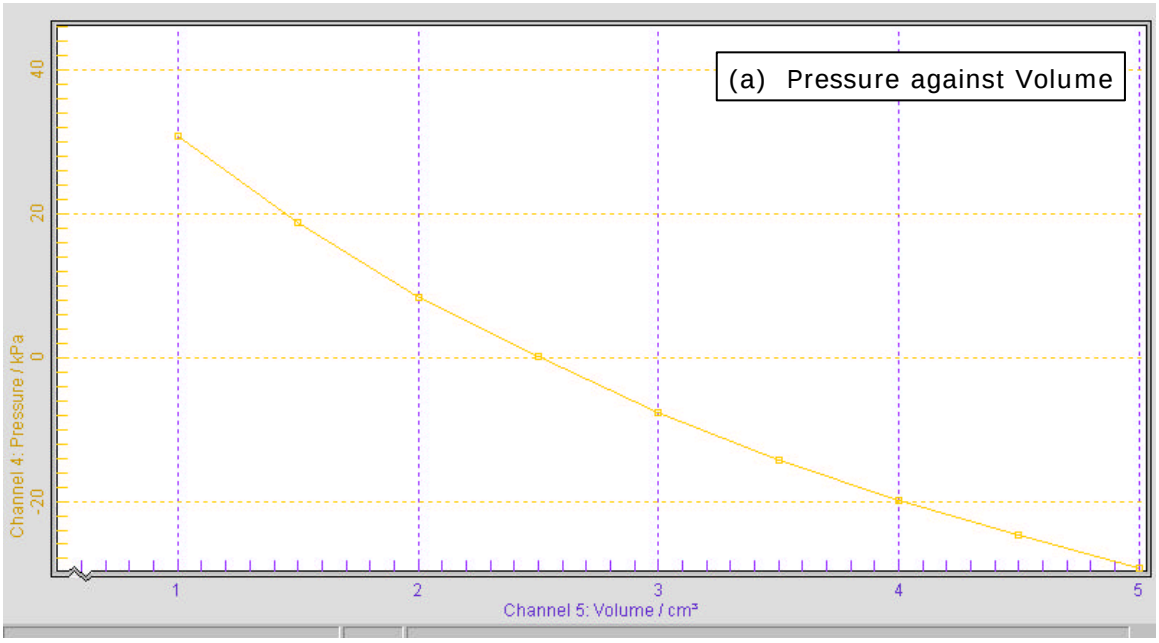
Experiment b

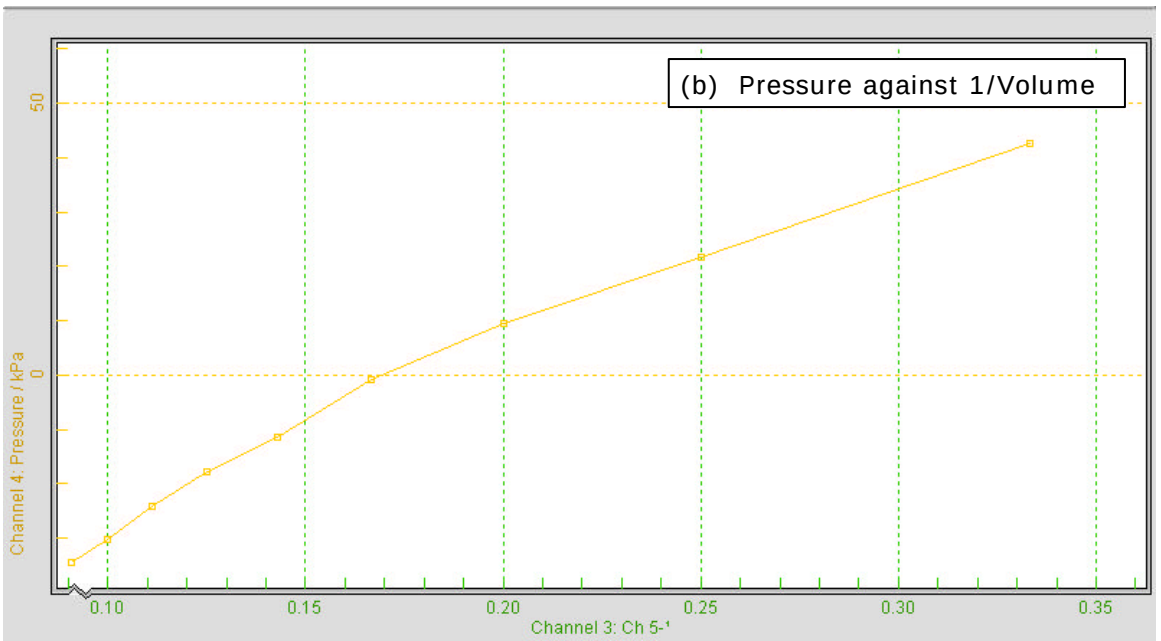
1. Wait for several minutes until the pressure and temperature readings become steady before starting the recording;
2. The length of the rubber tubing joining the syringe and the sensormeter should be short;
3. Cover the joints of the stopper of the flask and the tubings with vaseline to keep the volume of gas constant;
4. The flask should be wholly immersed in water;
5. The air should be cooled very slowly so that the temperature of the air inside the flask is always the same as the water bath.

Results

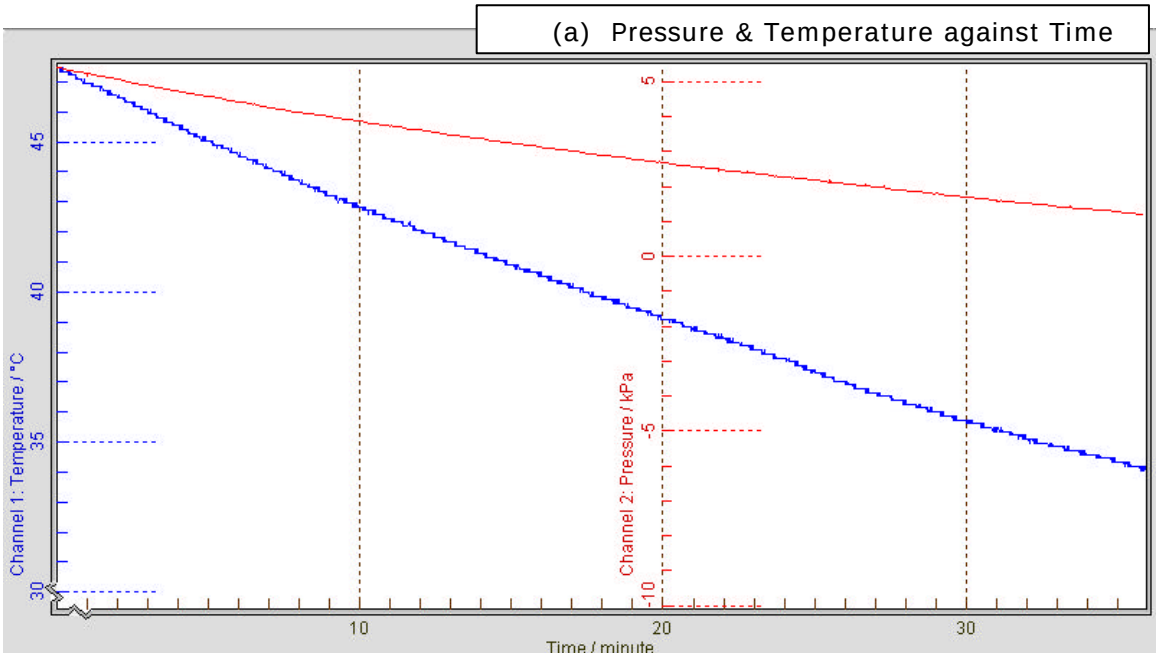
Graphs obtained:

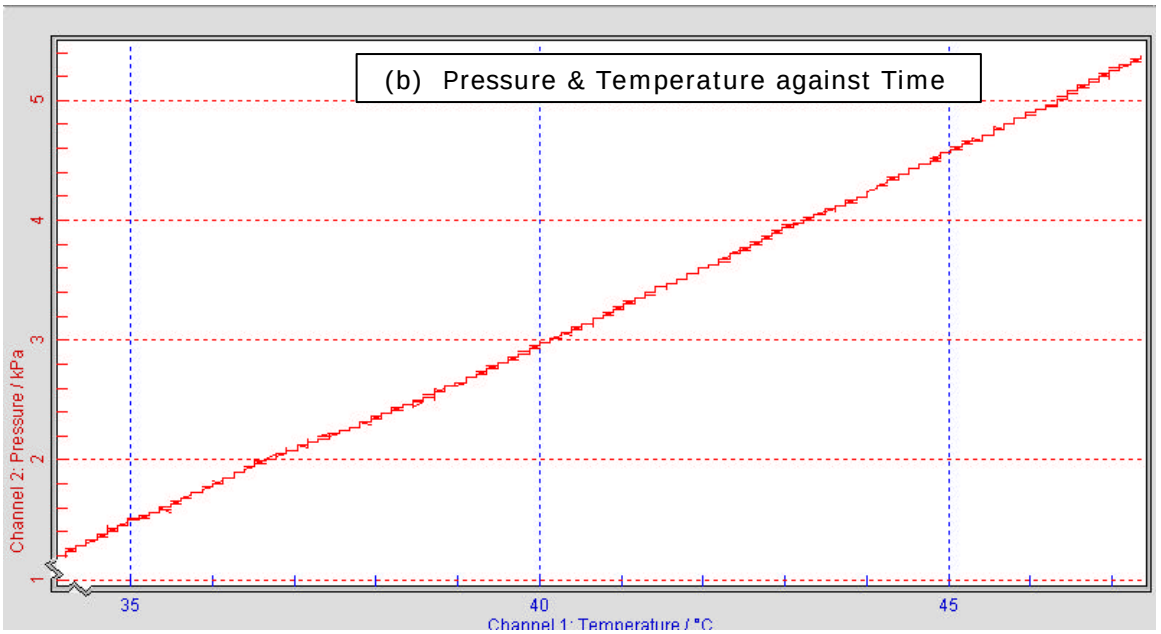
Experiment a





Experiment b





Interpretation

Experiment a

When air was compressed, its pressure increased. From the graph of pressure against 1/volume, the points nearly fitted into a straingt line. It was found that the pressure of air was inversely proportional to its volume.

Experiment b

When the gas was cooled down, its pressure decreased. From the graph of pressure against temperature, it was found that the pressure of air and its temperature were linearly related.

Possible errors

Experiment a

1. The air contained a trace amount of water vapour, which would affect the result;
2. The volume of the air inside the tubing was not measured;
3. There was an error in measuring the volume of the air because of the calibration on the syringe.

Experiment b

1. The air contained a trace amount of water vapour, which would affect the result;
2. The air inside the tubing was not at the same temperature as the air inside the flask;
3. The air inside the flask was not heated uniformly in all directions;
4. The flask expanded slightly on heating.

Improvement :

1. If the syringe can be replaced by one with a finer calibration, the accuracy in measuring the volume will be higher.
2. As glass is a poor conductor, it is better to replace the round-bottomed flask with one having a thinner wall.

Conclusion:

The pressure of air was inversely proportional to the volume at a constant temperature.

The pressure of air increased linearly with its temperature at a constant volume.