

## Using the Volume and Temperature sensors

These teachers notes are designed to show:

- How to setup the Volume sensor using Datadisc.
- How to investigate the Charles law using the ScienceScope Volume sensor, a ScienceScope Temperature sensor, Datadisc and a *Logbook* datalogger.

### Setting up the Volume sensor

Before the using the Volume sensor, it is useful to familiarise yourself with the method of operation:

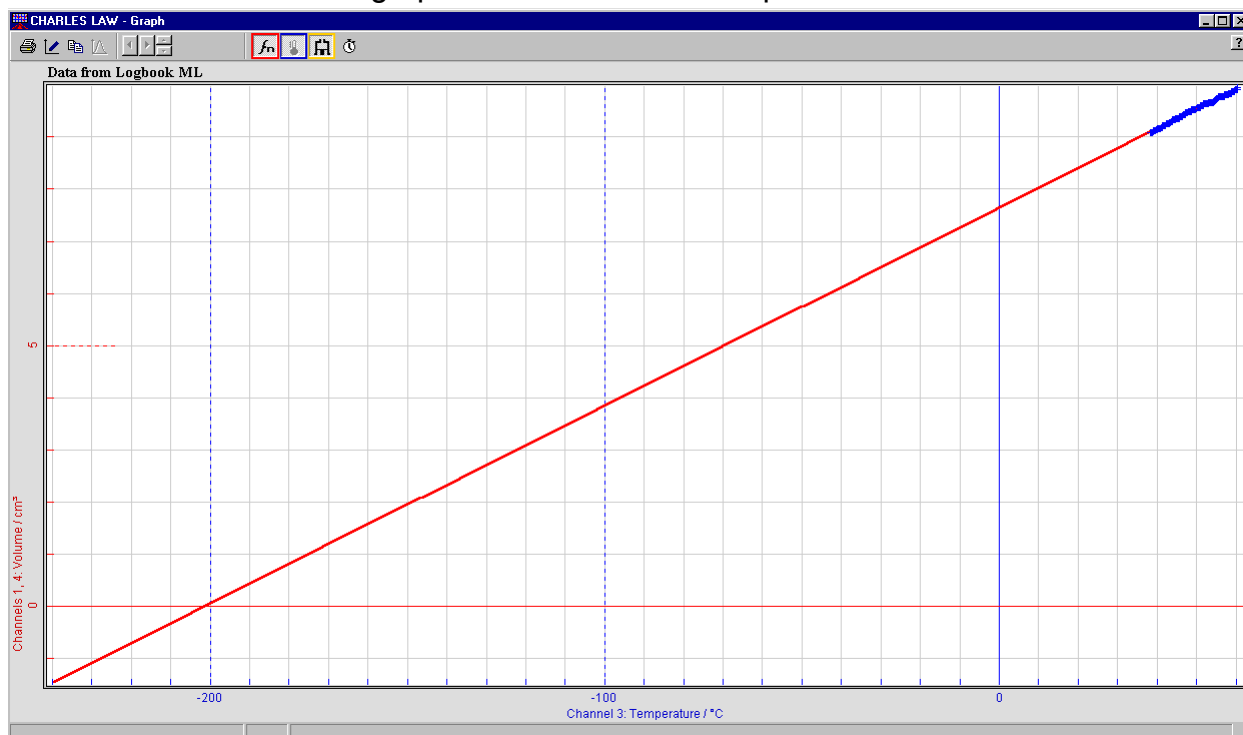
- ✓ The Volume sensor can be used to measure either an amount of material (say an acid solution) delivered into another container such as when a titration is being carried out or to measure the change in volume of the material (say a gas such as air) in the sensor or in a container connected to the sensor.
- ✓ To see how to use the Volume sensor in these two ways connect it to a *Logbook* datalogger. Connect the logger to the computer and run Datadisc, see the Teachers' Guide for help if you need at this stage. Select the meter in Datadisc.
- ✓ You will see that there is an option to zero the sensor. This allows you to set the start point for investigations in which material is being delivered to the experiment. In this investigation this feature is not required.
- ✓ You can also set an offset, which is for use when the volume of the experiment is larger than the volume of material (say a gas) contained in the sensor. In this example, using the 17cc version, the cap should be placed over the end of the syringe with the plunger at about 10ml. The offset for this investigation should be set to  $1\text{cm}^3$
- ✓ Finally you can choose whether the volume measured increases or decreases as the plunger is pushed in. In this investigation the default should be used.

### An investigation of the gas laws using the Volume (17cc) sensor and Temperature sensor

Using Datadisc, the Volume (17 cc) sensor, and the Temperature sensor, it is possible to investigate how the Temperature and Volume of a gas are related. To carry out this simple investigation proceed as follows:

1. Set the Volume sensor at about  $10\text{cm}^3$  and use the cap provided to close the end of the syringe.
2. Prepare a water bath with cold water in it and set up the Volume sensor on a clamp stand so that the syringe is in the water just above the plunger. Place the Temperature sensor in the hole in the Volume sensor so that the tip is near to the part of the syringe containing air. Ensure that the plunger of the Volume sensor is pushed down hard and allowed to relax back to the equilibrium position.
3. Connect the sensors to the logger you are using.
4. To carry out the investigation connected to a PC select the meter and set the offset volume to  $0.6\text{cm}^3$ . This is to allow for the small volume of gas contained in the tip of the sensor. Select an auto recording of Temperature and Volume. If you are doing a recording remotely ensure that the recording type is set to Auto on the logger.
5. Turn on the water bath and set it for a temperature of about  $60^\circ\text{C}$ .
6. Start the recording on the logger or on the PC as appropriate.
7. Datadisc will now record Temperature as the Volume changes so the plunger of the volume sensor will gradually move outwards as the temperature rises.

8. When the temperature reaches 60°C stop the recording. If you have carried out the recording remotely transfer the data to a convenient PC.
9. Select Graph/Set Axes on Datadisc and choose temperature for the X axis and only volume on the Y axis. You should see a straight line graph showing the volume increasing with temperature.
10. Select Data/Fit/Auto on Datadisc and choose a linear fit. Ensure that Temperature is chosen for the X axis and Volume for the Y axis and type in a lower X range of about -300°C. Select calculate.
11. You should obtain a graph like the one we have produced here.



You can see here that an estimate of the value of absolute zero can be obtained. This is done by assuming that the gas is perfect and that when the volume reduces to zero it is impossible for the gas to get any colder. In this case the estimate is that the Volume is zero at -200°C. The estimate has a large error which is due to the fact that we only have a small portion of a straight line which is far from the real value of absolute zero.

#### Equipment List:

- A Logbook, a serial lead to connect to the computer, a PC computer with Datadisc Au software installed.
- A Logbook Volume sensor
- A Logbook Temperature sensor
- A water bath
- A Clamp Stand