Verifying PV=NkT

Apparatus

400 kPa absolute pressure sensor

Bicycle inner tube with Schrader valve.

Tyre pump with Schrader connector and pressure gauge,

Barbed T connector to match inside diameter of pump hose.

Tube adaptor (unequal barbed)

Female Luer lock connector

Flexible connector tube (e.g. high pressure silicon).

Vernier caliper

Safety glasses

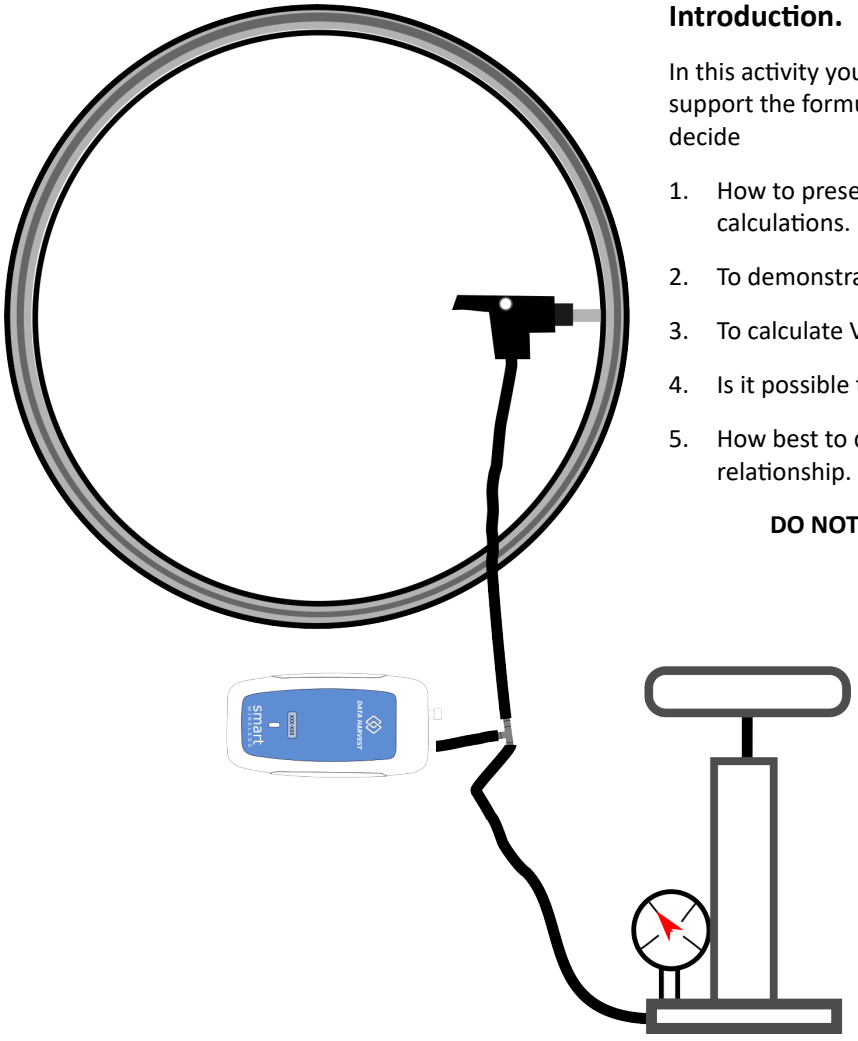
Data recording setup.

Graph and table two panel layout

Recording setup

Snapshot

Prompt for value on each sample active (inner tube diameter)



Introduction.

In this activity you will take measurements to support the formula PV = NkT. It will be up to you to decide

1. How to present the data and conduct the calculations.
2. To demonstrate the relationship PV = NkT.
3. To calculate V for various readings of P.
4. Is it possible to quantify N in any way?
5. How best to demonstrate the validity of the relationship.

DO NOT OVER INFLATE THE TYRE

Method

Your teacher may give more local guidance based upon the apparatus supplied.

1. Turn on and connect the pressure sensor to the apparatus and the software.
2. Use the details in the data recording setup (on the first page) to set the software up.
3. Use the pump to inflate the tyre until it just retains its shape. Make a note of how many pumps you used.
4. Use the vernier calipers to measure the tube diameter, click on the software to record the pressure and enter the tube diameter measurement.
5. Measure the diameter of the inner and the outer edge of the tube. Take several measurements as it is more than likely the tube will not form a natural circle.
6. Pump another volume of air into the tube and measure the new tube diameter. Collect the pressure reading using the software and enter the diameter data when prompted. Make a note of the total number of pumps used.
7. Repeat - how many repeats will depend upon the inner tube, but for a 24" tube 10 - 12 are possible.
8. Tabulate the raw data and any necessary calculated data.
9. Plot a suitable graph in the form of y = mx + c

Practical notes.

Before data collection starts it might be useful to lightly inflate the tube and use a simple graph log to check the inflation and pressure hold.

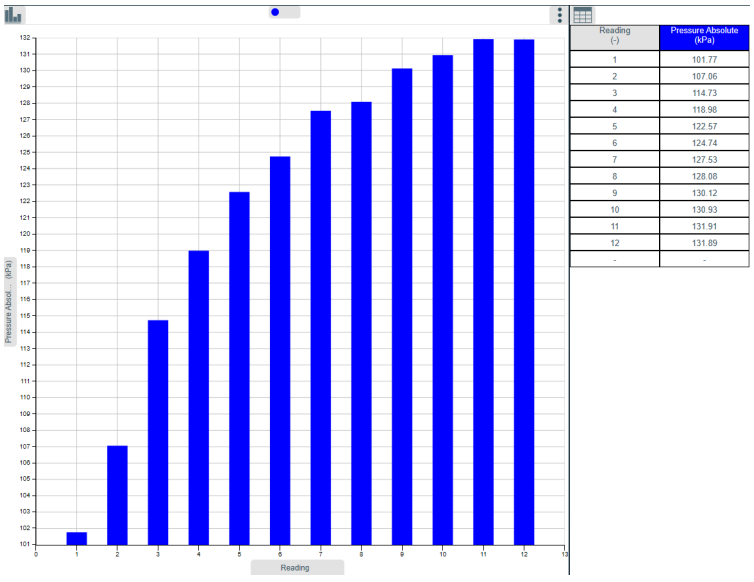
You are advised to create a protocol for measurement, for example

1. Pump
2. Count to 10
3. Collect pressure reading
4. Measure tyre diameter

The rationale behind this is that the elasticity of the tube, small leaks in the connections and within the pump means that pressure as measured by the pressure sensor is slowly decreasing.

If using the software only to record pressure data save the data often.

An alternative is to use a Numeric display in the software and simply use the apparatus as an accurate gauge.



Reading (-)	Pressure Absolute (kPa)
1	101.77
2	107.06
3	114.73
4	118.98
5	122.57
6	124.74
7	127.53
8	128.08
9	130.12
10	130.93
11	131.91
12	131.89
-	-

Example of snapshot data.

This was from an uncontrolled test of the work.

Example table of results.

Pump	Pressure	Tube diameter	Cross section area of tube	Volume of tube	PV ratio

Data can be transferred to a spreadsheet if required.

Use File > Export CSV

(If you are not sure CSV is a universal file transfer format that removes proprietary information, each piece of data is separated by a comma. Most spreadsheets have and import CSV data function)