

# Chemistry

## Laws of gases



### ■ C12 - Determination of R: constant of perfect gases

#### ■ Theoretical notes and objectives

The law of perfect gases shows that the pressure  $P$  of a gas, the volume  $V$ , the quantity of matter  $n$  and the absolute temperature  $T$  are related by the equation:

$$P V = n R T$$

Where  $R = \frac{PV}{nT}$

The relation between the temperature  $t$  expressed in  $^{\circ}\text{C}$  and the absolute temperature  $T$  is written as:

$$T = 273.15 + t$$

Value of  $R$ : 8.32

#### Aim of the experiment:

Study the law linking the pressure  $P$  and the volume  $V$ , the quantity of matter  $n$  and the absolute temperature  $T$ . Obtain an estimate of the constant  $R$

#### ■ Experimental procedure

Preparation of the experiment

Weigh about 0.5g to 1g of solid carbon dioxide and place it in the flask.

Close the flask, placing the two probes of temperature and pressure connected to the VTT interface.





#### ■ Setting the apparatus



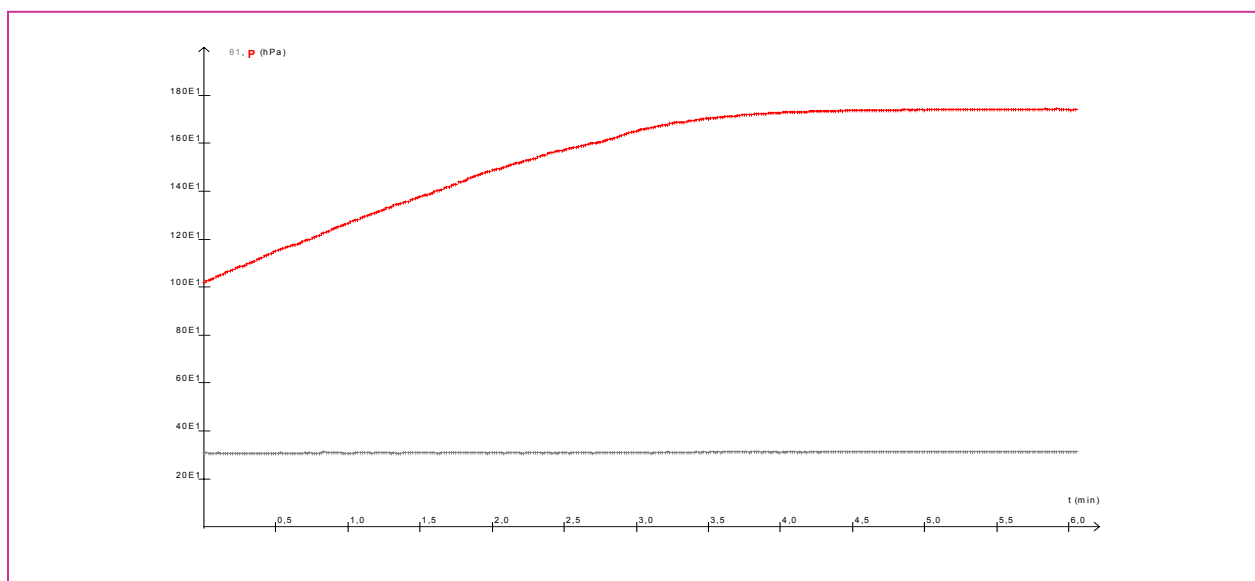
#### ■ Material

VTT console	ref 477000
VTT pressure sensor	ref 472010
VTT temperature sensor	ref 472004
A 500 ml glass flask	ref 713621
Stopper for the flask	ref 253082
Round wash bottles (pack of 6)	ref 723208
Distilled water (1L)	ref 107340
Solid carbon dioxide	
Balance	ref 701276
Generis 5+ software	ref 000720




## ■ Settings required before the experiment

Work to be done	How to do it?
<p>Connect the VTT interface to the computer. Calibration of the sensors.</p> <p>Launch Generis</p> <p>Put the adapters in ordinate. Give a name to the magnitude.</p> <p>Pressure sensor in channel /.</p> <p>Temperature sensor in channel //.</p> <p>Time in abscissa. Duration: 360 s</p> <p>Start the acquisition. The reaction is completed when the pressure has reached its maximum value.</p> <p>Save the file corresponding to this graph <math>P = f(t)</math> under the name <b>Determination of R.lab</b>.</p>	<p>Refer to the sensors' instruction manuals. Start, Programmes, Science Studio, Generis 5+</p> <p>Drag-drop the <b>pressure sensor</b>  on one of the channels in ordinate and name the magnitude P.</p> <p>Drag-drop the <b>temperature sensor</b>  on one of the channels in ordinate and name the magnitude <math>\theta</math>. (use the F12 key for the Greek alphabet). Unit: °C</p> <p>Drag-drop the <b>icon time</b>  in abscissa. Name the magnitude t. Duration: 360 s</p> <p>Click on </p> <p>Go to File, Save as... Select the destination folder and give the name <b>Determination of R</b>.</p>

## ■ Results obtained








## ■ Analysis of results

Work to be done	How to do it?
<p>Magnify the curves: use the automatic scales</p> <p>Using the relative pointer, determine the increase of pressure and the rise in temperature.</p> <p>Save the work completed</p>	<p>Click on the icon </p> <p>Right click on the graph and select <b>Pointer</b>. Click on the first summit and without dropping go to the next summit. The value of the increase of temperature can be read in the caption bar.</p> <p>Change the axis for reading the second value: icon </p> <p>Click on the icon  or Menu File, Save.</p>

## ■ Interpretation of results

The increase of pressure is due to the appearance of gaseous  $\text{CO}_2$ .  
Calculate the number of moles of carbon dioxide used. Knowing the pressure of the  $\text{CO}_2$ , gas its temperature (expressed in K) and the volume of the flask: 500 mL, calculate the constant R.  
Compare with the theoretical value. Explain the difference between the two results.

## ■ Drafting of report

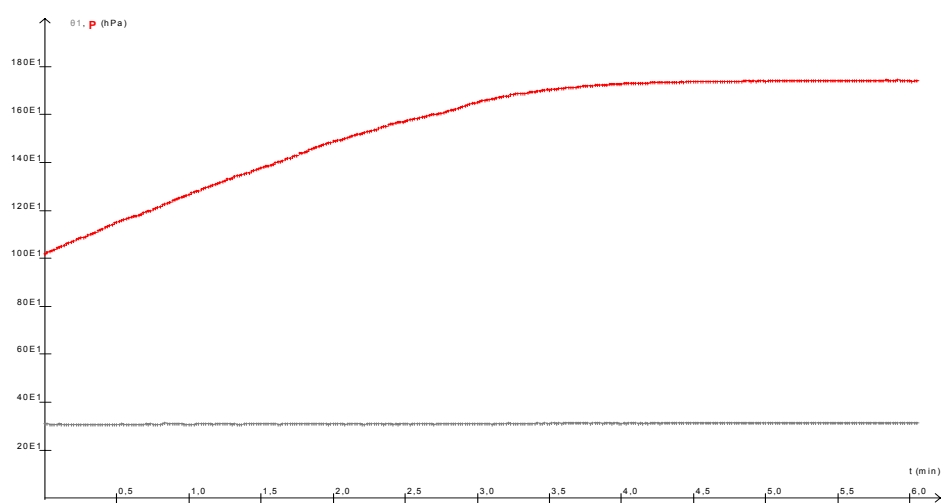
Work to be done	How to do it
<p>Click on the tab Report</p> <p>Enter the title</p> <p>Insert the graph <math>P(t)</math> and <math>\theta(t)</math>: a single graph</p> <p>Answer the questions asked.</p> <p>Go to Print preview and if required, modify the elements of the report.</p>	<p></p> <p>Click on the icon  and define a rectangle Enter the title</p> <p>Open the dialog box  and click on the curves to be inserted <math>P(t)</math> and <math>\theta(t)</math>. Define a rectangle containing the curves.</p> <p>Click on the icon  and define a rectangle for the answers.</p> <p>Click on the icon </p>

# Chemistry

## Laws of gases



### ■ Determination of R: constant of perfect gases – Correction sheet



The increase in pressure is due to the appearance of gaseous carbon dioxide  $\text{CO}_2$ .

Number of moles of carbon dioxide used: 0.014 mol

Increase in the pressure of  $\text{CO}_2$  gas: 726 hPa

Temperature  $t = 23^\circ\text{C}$  therefore,  $T = 273.15 + 23 = 296.15 \text{ K}$

and the volume of flask:  $V = 500 \text{ mL} = 5 \cdot 10^{-4} \text{ m}^3$ ,

Calculate the constant R: 
$$R = \frac{PV}{nT} = \frac{72600 \cdot 0,0005}{0,015 \cdot 296,15} = 8.75.$$

The value obtained is greater than the theoretical value. During weighing, the solid carbon dioxide evaporates. In the time necessary for placing the product in the flask and closing it, a small part of the carbon dioxide has certainly evaporated. This explains that the value obtained is greater than the real value  $R = 8.32$ .