

Chemistry 2

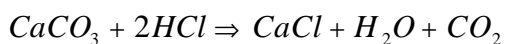
Assessable Prac

THE UNIVERSAL GAS CONSTANT "R"

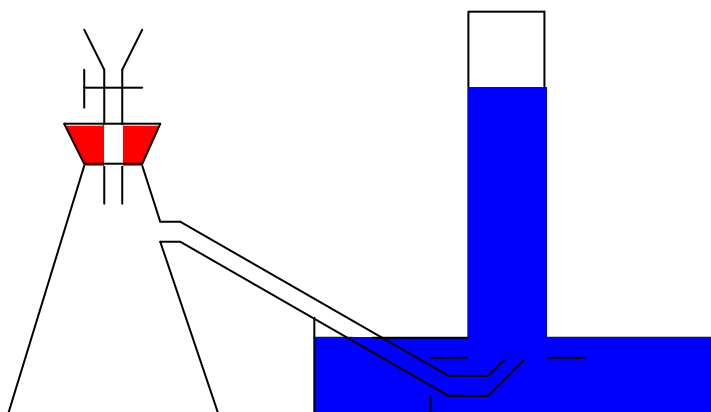
Aim: To calculate the universal gas constant R , given $PV = nRT$.

Conclusion: The calculated universal gas constant that was determined experimentally given the formula $PV = nRT$, is $0.083126 \text{ L ATM K}^{-1}\text{mol}^{-1}$. The actual value for the universal gas constant is $0.0820 \text{ L ATM K}^{-1}\text{mol}^{-1}$; the experimentally determined value is a 1.355% difference from the actual value for R .

Background: The general gas equation $PV = nRT$. P = pressure, V = volume, n = number of moles, R = universal gas constant, T = temperature in Kelvin. The universal gas constant changes depending on which units you use for the pressure and the volume. If you use Atmospheres and volume in litres then the universal gas constant will be $0.0820 \text{ LatmK}^{-1} \text{ mol}^{-1}$, however if you use the pressure in pascals and the volume in m^3 then the universal gas constant will be $8.314 \text{ JK}^{-1} \text{ mol}^{-1}$. Number of moles = mass / molar mass, $n = m / MM$.



Method: Approximately 1.5g of CaCO_3 powder was weighed and poured into a dry conical flask with sidearm. Stopper with glass tubing and rubber hose and clamp was placed firmly in flask. A beehive shelf was placed in a big plastic container and covered with water. A 500 ml measuring cylinder was filled with water. The cylinder was placed upside down in the water on top of the beehive shelf. Rubber hose was connected to the sidearm of the flask and the other end of the hose was placed under the beehive shelf so that any released gas was directed into the cylinder. 50 ml of 2M HCl was measured in a measuring cylinder. A funnel was connected to the flask with a rubber hose. Holding the funnel above the flask, a little acid was poured in and the clamp opened long enough for the acid to run through. This was repeated until there was no more acid left. Water level was adjusted so that the inside and outside levels were equal. The volume occupied by the gas was measured.



Data:

Pressure	Temp	Volume	CaCO_3 mass
713mmHg	293.5k	382 ml	1.47g
713mmHg	293.5k	340 ml	1.46g

Analysis: For the equation $PV = nRT$:

$P = 713 \text{ mmHg}$

$V = 382 \text{ ml}$

$T = 293.5 \text{ k}$

$$\text{Mass} = 1.47\text{g}$$

To get n you use the formula $n = \text{mass} / \text{molar mass}$

Molar mass for CaCO_3 is $40.08 + 12.01 + 16 * 3 = 100.01$

$$N = 1.47 / 100.01 = 0.0686$$

$$PV = nRT$$

$$P = 713\text{mmHg} = 0.938 \text{ ATM}$$

$$V = 0.382\text{L}$$

$$0.938 * 0.382 = 0.686 * R * 293.5$$

$$0.3583 = 4.3103 * R$$

$$R = 0.3583 / 4.3104$$

$$R = 0.083126 \text{ L ATM K}^{-1}\text{mol}^{-1}$$

The experimentally determined universal gas constant is $0.083126 \text{ L ATM K}^{-1}\text{mol}^{-1}$

Errors: Possible errors in the experiment are the fact that some of the carbon dioxide gas will dissolve in the water and therefore not be counted in the pressure of the gas. Also the amount of gas in the measuring cylinder will not be the same as the amount of carbon in the calcium carbonate. There could be parallax errors when looking at the measuring cylinder. Some of the carbon dioxide may escape from under the beehive shelf. Not all the calcium carbonate may have reacted and thus causing a problem.