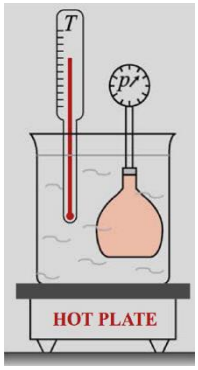
# Linear Algebra: Charles's Law

According to Charles's law for an ideal gas, at constant volume, a linear relationship exists between the pressure, $p$, and temperature, $T$. In the experiment shown in the figure, a fixed volume of gas in a sealed container is submerged in ice water ($T = 0\,°C$). The temperature of the gas is then increased in ten increments up to $T = 100\,°C$ by heating the water, and the pressure of the gas is measured at each temperature.



(Gilat 2013)

The data from the experiment is:

| $T\ (°C)$ | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $p\ (atm)$ | 0.94 | 0.96 | 1.0 | 1.05 | 1.07 | 1.09 | 1.14 | 1.17 | 1.21 | 1.24 | 1.28 |

The data is contained in the `ME2004_CharlesLawData.mat` file for convenience.

a) Load and plot the data.
b) Compute the linear regression coefficients $a_0$ and $a_1$ (intercept and slope, respectively) without using any built-in MATLAB curve fitting or regression functions. This involves solving a linear system of equations. Append the best-fit line to the plot.
c) Compute the $R^2$ without using any built-in MATLAB curve fitting or regression functions. This involves calculating $S_r$ and $S_t$.
d) Using the results of the regression, predict $p$ for $T = 55\,°C$. Append this point to your plot to visually confirm the numerical prediction.