Fluid Flow Exponential Decay.

Experiment 4 was the study of exponential decay and how closely a fluid flow follwed the half-life trend. The experiment was carried out by filling a tall cylinder with water to a known height. The water is then allowed to flow out of a small capillary tube at the bottom.

The first part of the experiment tested **how the height of the water column affected the pressure exerted by air on the water, which in turn affected the rate of the water flow**, the height of the water was kept constant for each event. By comparing the amount of time needed to collect roughly 100ml of water at varying heights of water, it was found that **the higher the column of water the faster the rate of water flows**. This is explained by the equation [pressure] = [density of water] x [acceleration due to gravity] x [height of water], since [density of water] and [acceleration due to gravity] are constant, the only variable in the experiment was the height of the water. This meant that the greater the height of the water, the more pressure acted upon the water and thus increased the rate of water flow or Q. To find the value of Q, we used the equation $\mathbf{Q = \rho(diameter/2)^2\pi h}$. Experimentally, the data collected fit together very well graphically. In both graphs of [$\Delta Q/\Delta T$ vs P] and [$\Delta Q/\Delta T$ vs Q], the data collected fit the linear fit line very well. Because the data fit very well onto the linear best fit line, we can see that the rate of change of Q over time is directly proportional to both Q, the initial amount of water, and P, the pressure exerted on the water. This proportional relationship between [$\Delta Q/\Delta T$ vs Q] was found to be **0.00235** and the proportional relationship between [$\Delta Q/\Delta T$ vs P] was found to be **0.12219**.

The second part of the experiment involved **testing how the rate of water flow changed as the height changed**. This part involved recording the quantity of water that flowed out every five without keeping the height constant. This allowed us to see the relationship of how Q varies with time. By using the relationship **$Q = Q_o$e^-kt**, where Q is the amount of water at a certain time, Q_o is the initial amount of water 510.45g, k is the decay constant, and t is the time, we find that the decay constant, k, is **–0.000287**. The value of Q used in the equation was 382.8g and t was 100.3 s. This point was chosen because of it's position on the quadratic fit line of the Q vs Time graph. Using this found decay constant, we are able to calculate the theoretical half-life **T = 241.5s** using the computed equation **kT = -0.693**. According to the data collected the experimental half-life is **237.06s**, the amount of time that passed before Q was half that of the Q_o. The % difference of these two values came out to **1.82%**. This percent error could be attributed to the coordination between the reading of the time and the reading of the height of the water. From the collected data, it is found that for the fluid flow experiment, the formula relating Q and Time was found to be

$Q = Q_o$e^-0.693t.