BIRZEIT UNIVERSITY
Physics Department

Physics 111

Experiment No. 8

Half-Life of a Draining Water Column

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Date:17/11/2008

– Abstract:

1) The aim of the experiment: to measure the decay constant and the half-life of a draining column of water.

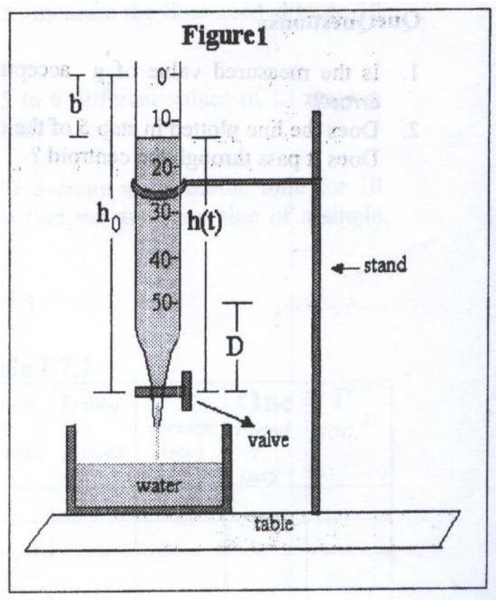
2) The method used: - the Burette method.

3) The main results are:

$t_{1/2}$= 67 ± 5 sec (h vs. t graph)

$t_{1/2}$= 69 sec (Ln (h) vs. t graph)

-Theory:- We consider a tube having water in it of a height (h_0) at time (t_0). When we open the valve water drains from it at some rate.



The rate of the decay of the water column is proportional to its height (h) that is:

$$\frac{-dh}{dt} \propto h(t$$

λ is a constant:

$$\frac{-dh}{dt} = \lambda\, h(t)$$

Multiplying the last equation by
dt and dividing by h(t) we get

$$\frac{dh}{h} = -\lambda\, dt$$

$$\int_{h0}^{h(t)} \frac{dh}{h} = \int_0^t \lambda\, dt$$

$$Ln\, h(t) - Ln\, h_0 = -\lambda\, t$$

$$h(t) = h_0 e^{-\lambda t}$$

So that λ is the decay constant.

When h(t) $= \frac{h_0}{2}$ then:

$$\frac{h_0}{2} = h_0\ \ e^{-\lambda t_1/}$$

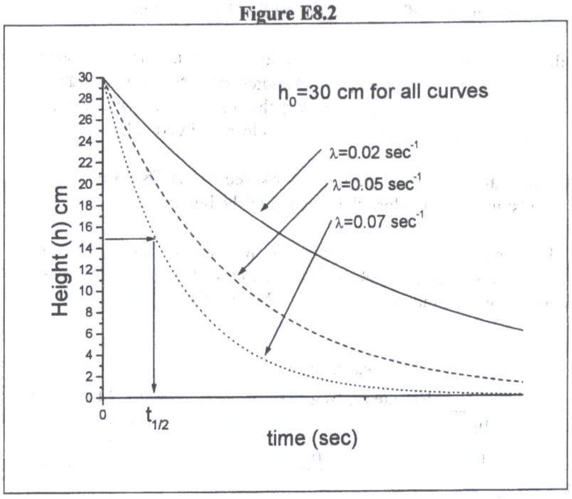
$$\frac{1}{2} = e^{-\lambda t}$$

$$-\lambda\, t_{\frac{1}{2}} = -Ln2$$

$$t_{\frac{1}{2}} = \frac{Ln2}{\lambda}$$

When λ is greater then $t_{1/2}$ is smaller:

Figure E8.2



- **Procedure:**

– The total burette length h0 was measured in burette units which is (h0= 50 units + D {in burette units} , D was measured in cm's then was converted into burette units , then the burette was filled with water using the funnel , the valve was adjusted such the water will drain in about 3 minutes during the experiment the valve setting wasn't changed and the burette was clean and vertical , the reading of the burette (b) was measured every 10 second , the opening of the burette was closed using my finger then the burette was filled again with water to same initial height without changing the setting of the valve and taking measurements were repeated for two more times and written down in the table that is shown in the next page .

Data:

Total burette length h_0 = 58 u in burette units (u)

Time (sec.)	Burette reading (u)			$\bar{b}$	h = $h_0-\bar{b}$	Ln (h)
	b_1	b_2	b_3			
0	0	0	0	0	58.0	4.1
10	4.5	3.7	3.7	4.0	54.0	4.0
20	8	7.5	7.5	7.7	50.3	3.9
30	11.5	11.0	10.9	11.1	46.9	3.8
40	15.3	14.5	14.5	14.8	43.2	3.8
50	18.5	17.7	17.8	18.0	40.0	3.7
60	21.5	20.9	20.7	21.0	37.0	3.6
70	25.0	26.1	23.7	24.2	33.8	3.5
80	28.0	26.8	26.6	27.1	30.9	3.4
90	30.5	29.7	29.6	29.9	28.1	3.3
100	33.3	32.2	32.4	32.6	25.4	3.2
110	35.7	34.8	35.1	35.2	22.8	3.1
120	38.5	37.4	37.5	37.6	20.4	3.0
130	40.5	39.6	40.0	40.0	18.0	2.9
140	4307	41.8	42.0	42.	15.7	2.8
160	46.8	46.0	46.0	46.3	11.7	2.5
170	48.6	48.0	47.7	48.1	9.9	2.3

– **Calculations:**

1) From h vs. t graph paper (Obtain 6 values for $t_{1/2}$)

$t_{1/2}$ (sec)	**82**	**73**	**60**	**65**	**56**	**66**

The average value of $t_{½}$ is:

$t_{½}$ = **67 sec.**

$\Delta t_{½} = \sigma_m(t_{½}) = 3.8$ sec

2) From ln (h) vs. t graph:

Slope = $-\lambda$ = - 0.01006 sec^{-1}

$t_{½} = Ln(2) / \lambda = 69$ sec

– Results and conclusion:

$t_{½}$= 67 ± 5 sec (h vs. t graph)

$t_{½}$= 69 sec (Ln (h) vs. t graph)

According to Range test the practical value of the half life of a draining water column equals 69 sec , according to the graph of (Ln) vs. t but our Range of experiment 62<t<72 so it's included in our range and our result is accepted and our experiment succeeded ,so it succeeded too and the systematic errors were due to period reaction time and how to deal with the stop watch and how to estimate the length of the burette before the experiment .