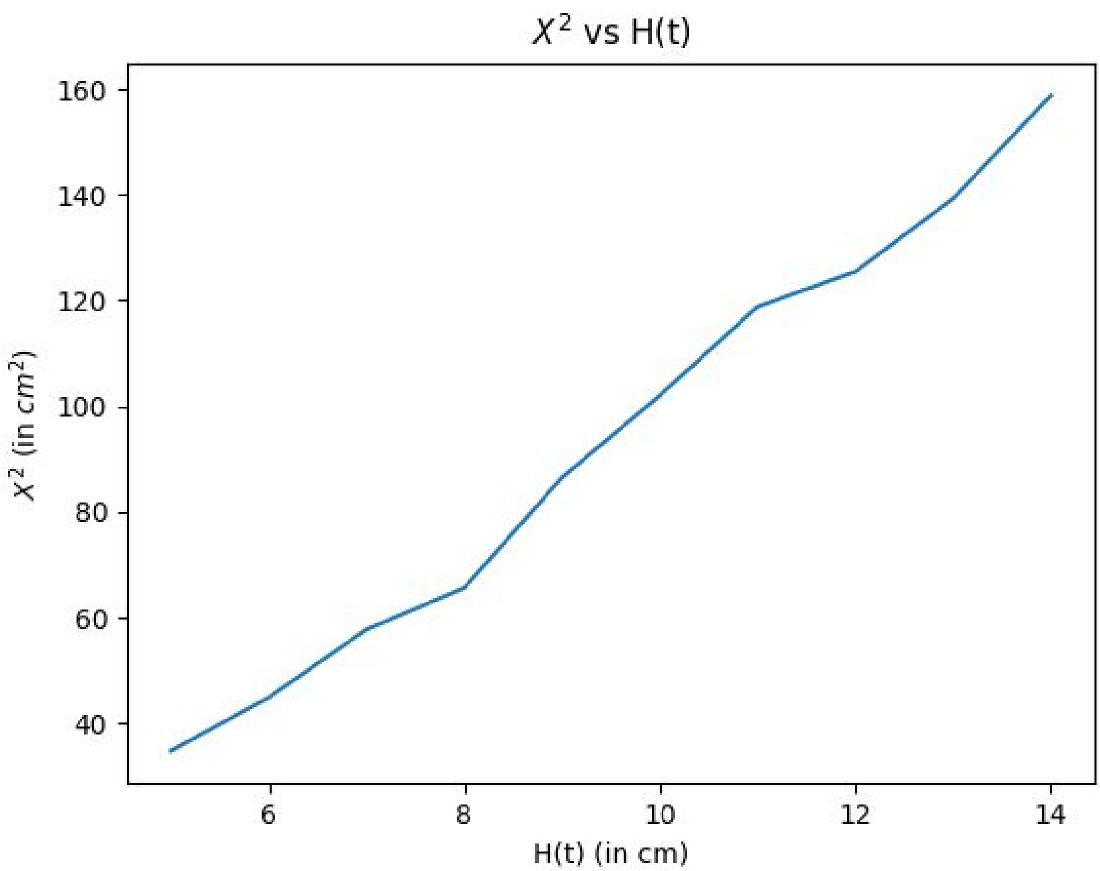
Observations and Calculations(IMT2019084)

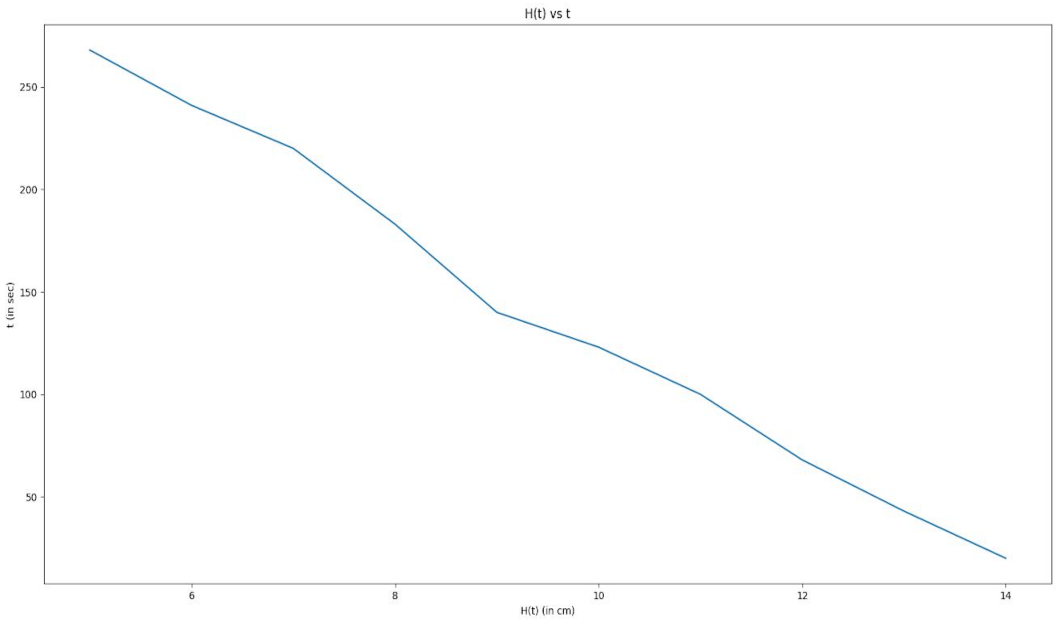
- The flow of water through an orifice at the bottom of a cylindrical bottle has been explored in this experiment.
- The height of water level inside the bottle has been measured with a meter scale (eg. *14cm, 13cm* etc.)
- The range of efflux of water from the orifice at the bottom of the bottle has been measured using a meter scale (eg. *12.6cm, 11.8cm* etc.)
- Time has been measured in seconds manually using a stopwatch, at different height levels (eg. *height = 14cm* at *time elapsed = 20sec*, *height = 13cm* at *time elapsed = 43sec*, and so on)

1. **Plot of $X^2(t)$ vs $H(t)$**



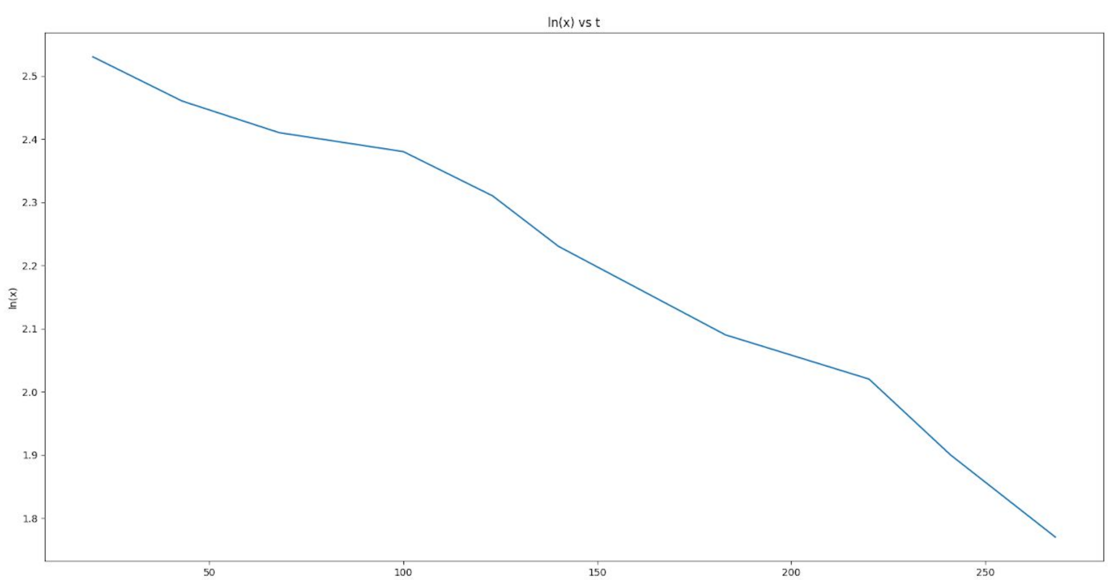
We observe that the plot is almost a straight line, with slope, $m = 13.77$.
And, since $slope = 4Y_0$, we get $\boldsymbol{Y_0 = 3.44}$.

2. *H(t)* vs *t*



We observe that this is an exponentially decaying curve, although that is not much visible because the sample size is very small, but if we had taken a big enough sample size, we would have observed an exponentially decaying curve.

3. *lnX* vs *t*



We observe that in this case too, the plot is almost a linear curve, with **slope $m = -0.0032$ and *intercept* = *0.1535.***

Now, theoretical value of slope = $(\pi \rho g r^4) / (16 l A \eta)$

where r = radius of the cylindrical bottle = $3.5cm$,

η = Viscosity of water

l = Length of the outlet tube = $0.2cm$

$\rho = 1\ gm/cm^3$

$g = 9.8\ m/s^2$

A = Cross-sectional area of the cylindrical bottle = πr^2

Hence, **theoretical value of slope = -0.0029**

And, theoretical value of intercept = $(4 Y_0 H_0) / 2$

where $Y_0 = 3.44$

$H_0 = 15cm$

Hence, **theoretical value of intercept = 0.09**

These values are pretty close to the experimental values.

4. **Viscosity of water:**

We have, $g = 9.8\ m/s^2$

Density of water at room temperature, $\rho = 1\ gm/cm^3$

Now, we know that $k = (\rho g r^4)/(8 \eta l)$,

where r = radius of the cylindrical bottle = $3.5cm$,

η = Viscosity of water

l = Length of the outlet tube = $0.2cm$

$k = - (2 A m)$, where

A = Cross-sectional area of the cylindrical bottle = πr^2

m = Slope of the graph of lnX vs $t = -0.0032$

Hence, we have: $\eta = - (\rho g r^4) / (16 l A m)$

$= - (\rho g r^4) / (16 l \pi r^2 m)$

$= - (\rho g r^2) / (16 l \pi m)$

$= - [(1\ gm/cm^3)(9.8\ m/s^2)(3.5cm)(3.5cm)] / [16 \pi (0.2cm) (-0.0032)]$

$=$ ***0.373 mPas***