Higher education Ministry
Baghdad University
College of Pharmacy
Department clinical Laboratory science

Laboratory of Medical Physics

Laboratory of Medical Physics
Second Semester
1st Stage
2015 /2016

Exp.1

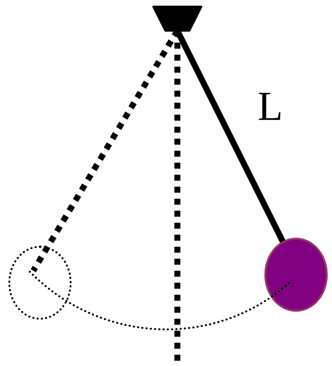
The Simple pendulum

Purpose :

To determine the acceleration of free fall by means of simple pendulum.

Apparatus :

1. Pendulum bob (a metal sphere with a hook attached or with a hole bored through its center.
2. Stopwatch .
3. meter scale .
4. Stand and clamp .



Procedure :

1. Tie a meter length of the cotton to the pendulum bob and suspend the cotton from the jaws of the improvised vice , such as two small plates held in a clamp , or any other method of suspension .
2. Place a piece of paper with a vertical mark on it behind the pendulum so that when the latter is at rest it hides the vertical mark from the observer standing in front of the pendulum .
3. Set the pendulum bob swinging through a small arc of about 10° . with a stop-watch measure the time for 20 complete oscillation , setting the watch going when the pendulum passes the vertical mark and stopping it 20 complete later when it passes the mark in the same direction . Repeat the timing and record both times .

4. Measure the length (L) of the cotton from the point of suspension to the middle of the bob .
5. Shorten the length of the pendulum by successive amounts of 5 or 6 cm by pulling the cotton through the vice and for each length take two observation of the time for 20 oscillations .

Theory :

The periodic time T is given by

$$T = 2\pi\sqrt{L/g}$$

Where g is the acceleration of free fall .

Therefore ,
$$\boxed{g = \frac{4\pi^2 L}{T^2}\ \text{cm . s}^{-2}}$$

Readings and calculation :

1.Tabulate the reading as follows :

The length of pendulum L (cm)	Time for 20 oscillations (sec)			Time for one oscillation, periodic time T (sec)	T^2 (sec^2)	g ($cm.s^{-2}$)
	t_1	t_2	t_{mean}			

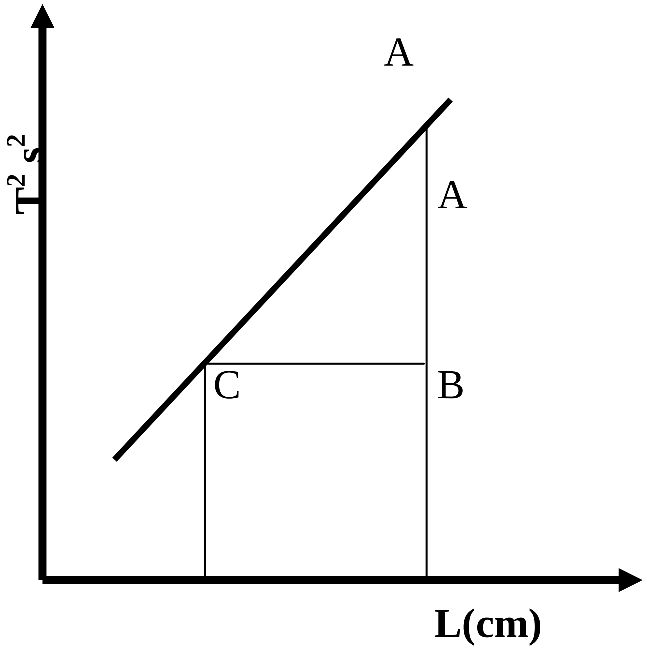
2. Plot a graph with the values of **T^2 sec^2** as ordinates against

the corresponding values of L cm as abscissa .
from which it is seen that the graph of T^2 against L will be straight line whose slope is (AB/BC) , measured from two convenient and will-separated points A & C on the line , is numerically equal to $4\pi^2/g$.

Thus :

$$\frac{AB \ \ s^2}{BC \ \ cm} = \frac{4\pi^2}{g}$$

$$\boxed{g = \frac{4\pi^2\, BC}{AB}\ cm\,.\,s^{-2}}$$



3. from the table find **g´** where **g´ = (∑ g_i)/n .**

4. calculate the variance from the formula :

$$\mathbf{V = \left(\sum (g' - g_i) \right) / n}$$

Then find the standard deviation :

$$\mathbf{S = \sqrt{V}}$$

5. the final value of the Acceleration is :

$$g = \mathbf{g' \pm S}$$

Questions

1. is the Acceleration depend of the weight of pendulum .
2. What is the effect of displacement to the time of vibration
3. What is the relation between L and T .

Exp.No. :
Name of exp. :

Reading & Calculation

The length of pendulum L (cm)	**Time for 20 oscillations (sec)**			**Time for one oscillation, periodic time T (sec)**	**T^2 (sec^2)**	**g ($cm.s^{-2}$)**
	t_1	**t_2**	**t_{mean}**			
100						
90						
80						
70						
60						
50						

Exp.2

The density of liquid

Purpose :

To determination the density of liquid by a loaded test tube

Apparatus :

1. test tube or boiling tube wide enough to allow weights to be placed inside .
2. millimeter graph paper cut to make a scale.
3. 1 gm , 2 gm , and 5 gm weight .
4. a liquid , e.g. water or methylated spirit .
5. calipers , beaker , sand , and lead shot .

Theory :

From fig (1) , assuming the test tube to have uniform cross-section , each additional 1 gm load will produce the same increment in the depth of the immersion . The extra weight of the tube is balanced by the upward thrust due to the extra weight of liquid displaced .

Area of cross-section of tube $= \dfrac{\pi d^2}{4}$

where d= diameter of the test tube ,measured in m.

If an additional load **m** produces an additional immersion depth **x** in a liquid of density **ρ**,

The extra volume of liquid displaced $= \dfrac{\pi d^2 x}{4}$

and the extra mass of liquide displaced $= \dfrac{\pi d^2 \rho x}{4}$

Hence, by Archimedes principle $= \dfrac{\pi d^2 \rho x}{4}$

therefore , $\rho = \dfrac{4m}{\pi d^2 x}$ ……………………… (1)

by plotting a graph of depth of immersion , **x** against additional load in fig. (2) . the mean value of **m/x** is obtained from the graph and is equal to :

$$\frac{QN x 10^{-3}\ kg}{PN x 10^{-3}\ m} \quad or \quad \frac{QN}{PN} \quad (kg\ .\ m^{-1})$$

Substituting the value of **d** (in **m**) and the calculated value of **m/x** in equation (1) , the value of **ρ** is obtained ,

$\rho =$ $kg.m^{-3}$

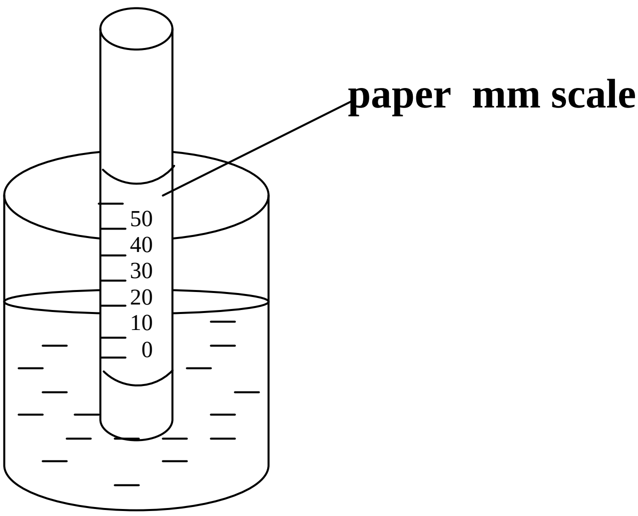


Fig (1)

Procedure :

1- cut and fold the graph paper as a lining to the inside of the test tube to serve as a suitable scale .
2- load the test tube with sand or lead short so that it floats vertically in the liquid with the zero mark just immersed .
3- Note the depth of immersion **h_o** of the zero mark .
4- Add a 1gm weight to the test tube and record the new depth of immersion **h** of the zero mark .
5- Continue to add a 1gm weight to the test tube and measure the new depth of immersion each time .
6- Tabulate the recorded reading as shown in the table below:
7- Plot a graph with values of **x** (mm) as ordinates against corresponding values of the additional load **m (gm)** as abscissa .

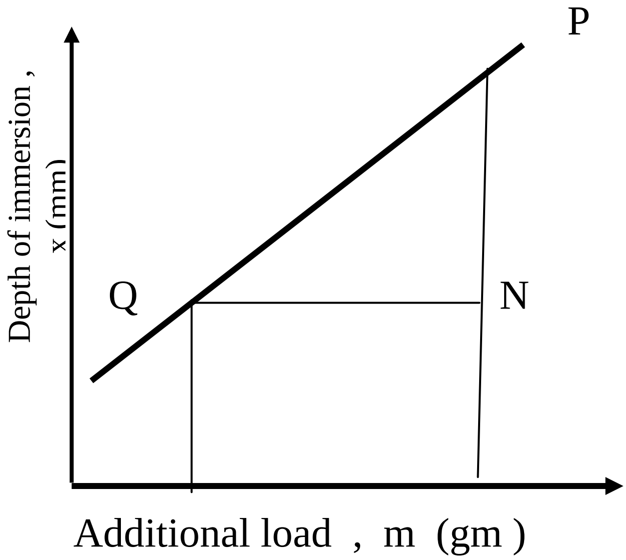


Fig (2)

8- With the calipers , after checking and recording the zero error if any , measure the external diameter of the test tube in two perpendicular directions at one place and two other places along the test tube , and deduce the mean diameter ,**d**(in mm) of the test tube .
9- Repeat the procedure steps (1 to 7) for a different liquid then obtain the ratio of the two densities as calculated .

Exp.3

The focal length of the convex lens

Purpose :

To determine te focal length of the converging lens by using:

1. A plane mirror .
2. A graphical method.

Apparatus :

1. Converging lens.
2. Holder.
3. Plane mirror.
4. Meter scale.
5. Mounted pin (object).
6. Screen.

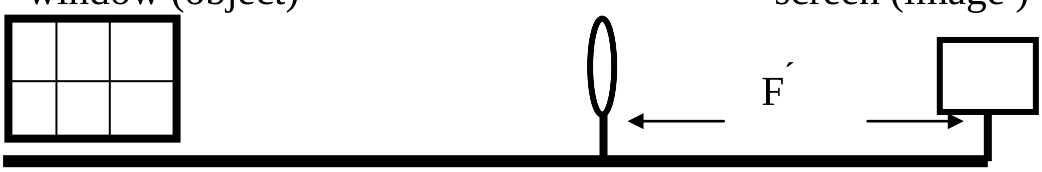
Procedure :

Part 1

1. Obtain a rough value F' for the focal length of the lens by focusing the image of the window on a screen.
2. Measure the distance between the lens and the image (F')
3. Repeat two times at different places along the optical bench or scale and take the mean of the results.

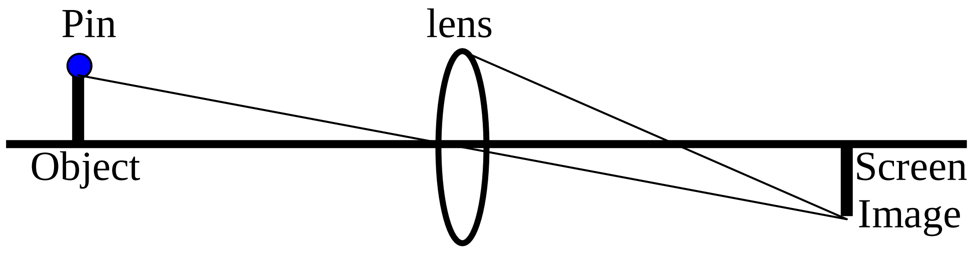
F' = rough value for the focal length of the lens .

window (object) screen (image)



Part 2

1. place an object pin at a distance from the lens equal to 2 F´. Measure the distance between the object and lens , which is called (U).
2. Locate the position of is real image on the other side of the lens, by using a screen .Measure the distance between the image and lens , Which is called (V) .
3. Move the object to other position both nearer to and farther away from the lens , locating the new position of the image each time .



Reading :

Distance of object from lens (U) cm	Distance of image from lens (V) cm	1/U (cm^{-1})	1/V (cm^{-1})

1. Plot a graph of 1/U against 1/V .
2. Drow the straight line through the pointed and produce it to intersect both axes .

Theory and calculation :

$1/F = 1/U + 1/V$

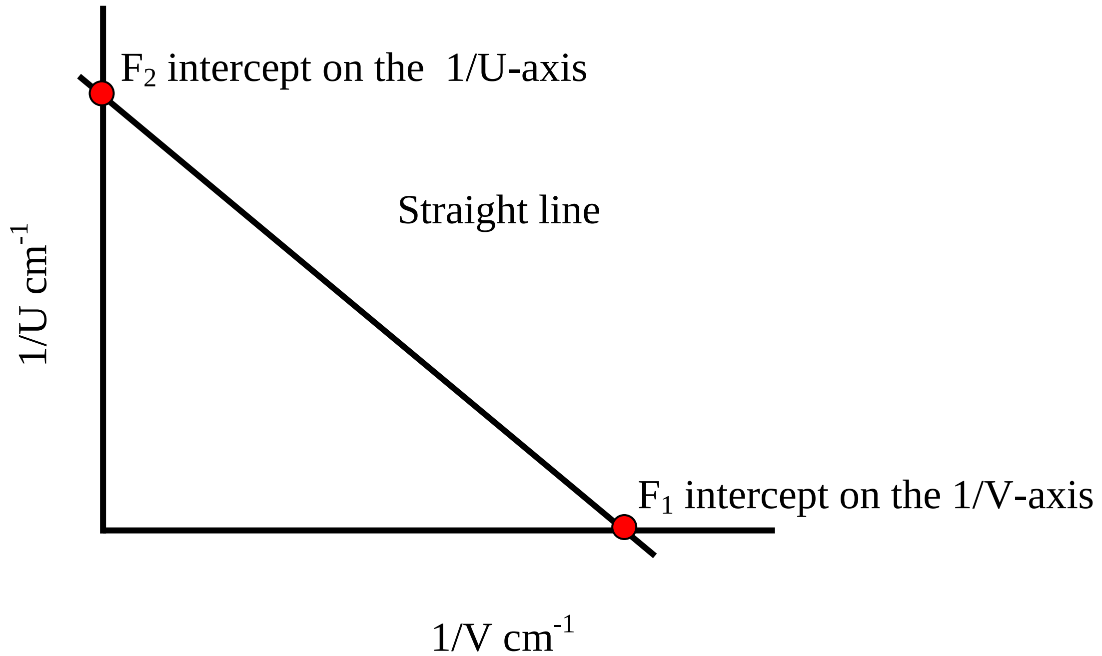
1. A straight line inclined at 45° o each axis is obtained.
2. The intercept on the 1/V axis is the numerical value for which $1/U = 0$.

$$1/F_1 = 1/U + 1/V = 0 + 1/V$$

$$\longrightarrow F_1 = V \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

3. Similarity for the intercept on the 1/V axis . $F_2 = U$
4. Take the mean value of the two intercepts .

$$F = \frac{F_1 + F_2}{2} = (\ \ldots\ldots) \quad \text{cm}$$



Question

Plot the shape for every case in the procedure .

Exp.4

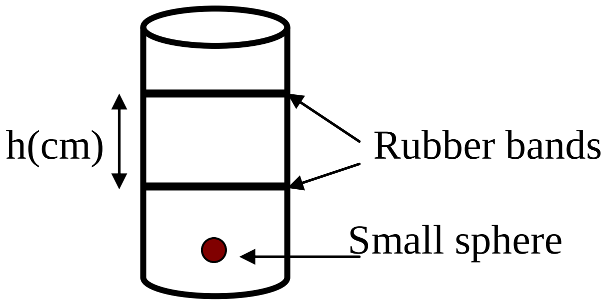
Viscosity of liquid

Purpose :

To determine the viscosity of the medium by using a small sphere falls with constant terminal velocity.

Apparatus :

1. A long glass tube about 50 cm long closed at one end .
2. Oil .
3. Meter scale .
4. Small sphere .
5. Rubber bands .
6. Magnet .
7. stop watch



Theory:

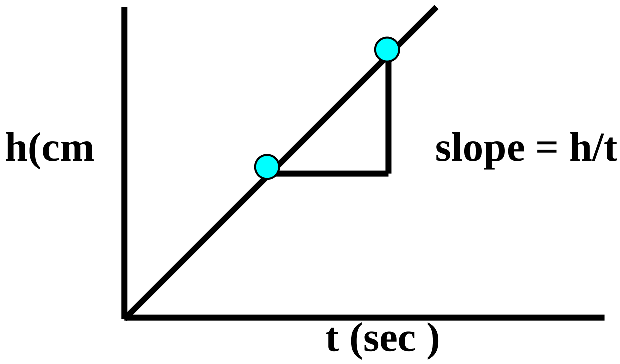
The following equation use to deduce the viscosity (η) for liquid :

$$\eta = \frac{g\,(\rho - \sigma)\,d^2}{18\,v} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

ρ = density of sphere **σ = density of liquid**

d= diameter of sphere **v = velocity (slope)**

g = 980 m/sec^2 **slope = h/t**



Procedure :

1. Adjust the distance between the rubber band .
2. Record the distance (h) between them . (about 30 cm).
3. Drop a sphere centrally down the jar & with stop-watch find the time it take to traverse the distance between the rubber band .
4. Obtain two values of the time of fall.
5. Repeat the experiment for different value of (h) & obtain two values of the time of fall for each new distance apart .

Reading :

Distance between rubber bands H(cm)	Time of fall		
	T_1(sec)	T_2(sec)	T_{mean}(sec)

Plot a graph with values of (h) cm as ordinates against the corresponding values of t(sec) as abscissa .
From the graph calculate the terminal velocity .

Slope = h / t = velocity (cm / sec)

Calculate the viscosity from equation (1)

Exp.5

Boyle´s Law

Purpose :
Verify Boyle´s Law by measurement the pressure of the atmosphere .

Apparatus :
Glass tube containing mercury as shown .

Theory:
He equation used to find the atmosphere pressure is :

$$\boxed{H = \frac{C}{K} * \frac{1}{L} - B} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where   C&K = constants .
h & L the length as shown in fig (1) .
B =atmosphere pressure .

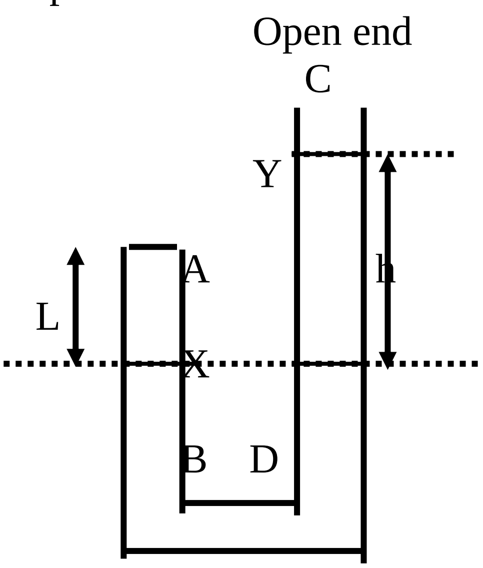


fig (1)

Procedure :

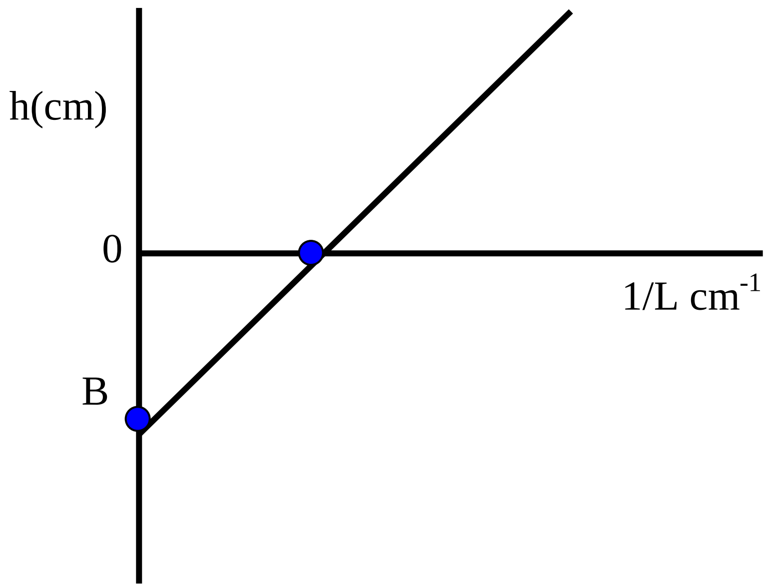
1. keep the mercury levels X and Y in the same position . Record the scale reading of these levels and also the scale reading of (A) , the inside of the closed end of the tube (AB). This is the balance point (i.e. X=Y) .
2. Rising the tube CD (above the balance point) , and recored the scale reading of X and Y levels .
3. Take about four sets of reading over the balance point .
4. Now, lowering the tube CD below the balance point , and record the scale reading of X and Y levels .
6. Take about four sets of reading below the balance point .

Readings and calculation :

1. Make the following table :

Scale reading / cm			**A-X=L**	**Y-X=h**	**1/L**
A	**X**	**Y**	**Cm**	**Cm**	**cm^{-1}**

2. Plot a graph for the values of h(cm) as ordinates against the corresponding values of 1/L (cm^{-1}) as abscises .
3. If the plot of h against 1/L yields a straight line , Boyles law is verified and the negative intercept on the h-axis is numerically equal to B (atmospheric pressure ~ Barometric height =76 cm)
4. from the graph ; if h=0 , find the value of 1/L =? B=76 cm .find the value of C/K from equation (1).



Exp.6

Speed of sound

Purpose :
To determine the speed of sound from the sound waves set up in the closed resonance tube .

Apparatus :

1. Closed A tube of variable length .
2. Meter scale .
3. Tuning forks of different frequencies .
4. Rubber bad .
5. Thermometer .

Theory:
The formula using to find the speed of sound at 0° C is :

$$C = C_0 \sqrt{\frac{273 + t}{273}} \quad \text{.................. (1)}$$

t = room temperature . C = the speed of sound in laboratory .

where $C = 2F\ (L_2 - L_1)$ (m/s) .... (2)

F = the frequency of fork L_2 & L_1 is the length of air in the tube (as shown in fig (1)) .

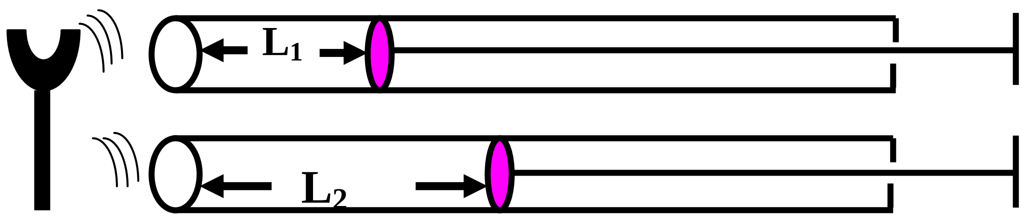


Fig (1)

Procedure :

1. select the fork of highest frequency
2. Strike it smartly on a rubber pad and hold it over the mouth of the tube .
3. Adjust the length of the resonance column until resonance occurs .
4. Measure the length of the air in the tube .
5. Repeat the measurement two or three times and take the mean (L_1) .
6. Now , find the second and different position of resonance using the same fork , but with about three times the length of air and again take the mean (L_2) of several readings of the length when resonance occurs .
7. Obtain different values of L_1 and L_2 using other forks.
8. Record the room temperature .

Readings and calculation :

Frequency F (HZ)	**First resonance position length of air column L_1 (cm)**	**Second resonance position length of air column L_2 (cm)**	**Speed of sound (C) $C=2F(L_2 - L_1)$**

1. find the speed of sound in laboratory (C) for each frequency from equation (2).
2. Find the mean value of C :

$$C = \frac{C_1 + C_2 + C_3}{3} \quad (m/s)$$

3. Find the speed of sound at 0˚ C by using equation (1).

Exp.7

Ostwald´s Viscometer

Purpose :
To compare the viscosities of two liquids.

Apparatus :

1. ostwald´s viscometer .
2. stop-watch .
3. thermometer .
4. two liquids of different viscosity .

Theory:

The rate of flow v/t of the liquid through capillary is directly proportional to the applied hydrostatic pressure hpg and inversely proportional to the coefficient of viscosity η .
Since the volume of the two liquids in the apparatus are the same so are the corresponding values of h at all the various stages in the descent of the level from X to Y .

Hence ,

$$\frac{V}{t_A} = K \frac{h p_A g}{\eta_A} \quad \text{and} \quad \frac{V}{t_B} = K \frac{h p_B g}{\eta_B}$$

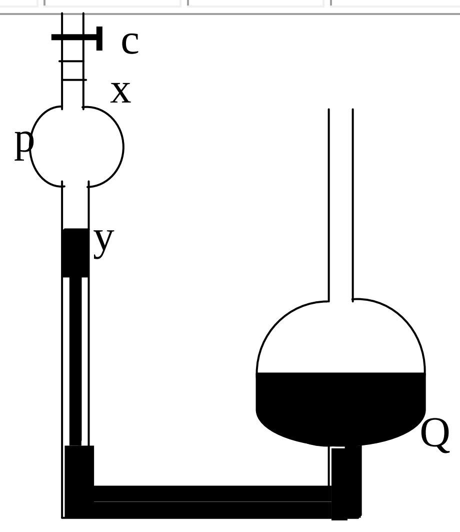
$$\boxed{\frac{\eta_A}{\eta_B} = \frac{t_A p_A}{t_B p_B}} \quad \ldots\ldots\ldots\ldots \quad (1)$$

where K is constant , the densities p_A and p_B of the two liquids are obtained from tables .

Procedure :

1. record room temperature
2. Allow the two liquids to attain room temperature .
3. Wit the pipette pour a known volume of the first liquid in to the side Q of the viscometer .
4. Drop the liquid through the capillary tube until it appears above the mark X above P and hold it by closing the clip C .
5. Open clip C , then measure the time for the liquid level to fall from the upper mark X to the lower mark Y . Repeat the timing two more times .
6. Repeat the experiment with the second liquid .
7. Tabulate the readings as follows :

Time of fall of level from X to Y							
Liquid A				**Liquid B**			
t_1 (sec)	**t_2 (sec)**	**t_3 (sec)**	**Mean t_A (sec)**	**t_1 (sec)**	**t_2 (sec)**	**t_3 (sec)**	**Mean t_B (sec)**



Part II

Viscosity

Viscosity means resistance to flow under apply stress (pressure) if you have capillary and have water and glycerin , water flow faster but it is less viscous . The more viscosity is the more the force required to make it flow at a certain rate .

gm . Cm^{-1} . Sec^{-1}= poise =dyne . Sec .cm^{-2}
Dyne =gm .Cm . Sec^{-2}
Poise = gm .Cm . Sec^{-2}. Sec .cm^{-2}
.. poise = gm . Cm^{-1} . Sec^{-1}
poise = 100 centipoises
Viscosity of water =1 centipoises = 0,01 poise .
It measures by capillary viscometer , by measure the time required for the liquid to flow between two mark through a vertical capillary tube of certain diameter .

$$\frac{\eta_{unknown}}{\eta_w} = \frac{\rho_{unknown} \cdot t_{unknown}}{\rho_w \cdot t_w}$$

$$\boxed{\eta = \eta(1= 2.5\ \theta\ )}$$ Einstein equation

θ = vol. fraction of particle related directly to conc.
Θ is a vol. of particle divided by a total vol of disposion (also equal conc.)

$$\frac{\eta}{\eta^\circ} = \eta_{relative} = 1 + 2.5\ \theta$$

<u>Apparatus</u> : Distilled water , glycerin pure , viscometer

<u>Objective</u> : In order to determine the viscosity (Relative of a liquid (glycerin) in different conc. By using a capillary viscometer .

Procedure : Prepare different conc. of glycerin in water such as 2% , 5% , 10 % , 15 % , 20 % , 25 % (w/w)

To prepare 50 gm of 5% w/w
2.5 gm pure glycerin + 47.5 gm of water
Density of pure glycerin = 1.26 gm/cm^3

So 2.5/1.26 = 1.984 ml of glycerin Aethal to 47.5 ml of water to get 50 gm of 5% w/w and shake well Lρ = 1.005

$$V= \frac{\omega}{\rho}$$

To prepare 50 gm of each conc. %

%w/w	Glycerin (gm)	Glycerin (ml)	Water (ml=gm)
2%	1	.793	49
5%	2.5	1.984	47.5
10%	5	3.96	45
15%	7.5	5.95	42.5
20%	10	7.93	40
25%	12.5	9.93	37.5

Use one of conc. As unknown .
Then measure the viscosity of each conc. By using viscometer (measure the time required for a liquid to flow between 2 mark through vertical capillary tube . also measure the time of water by a viscometer (also for unknown).

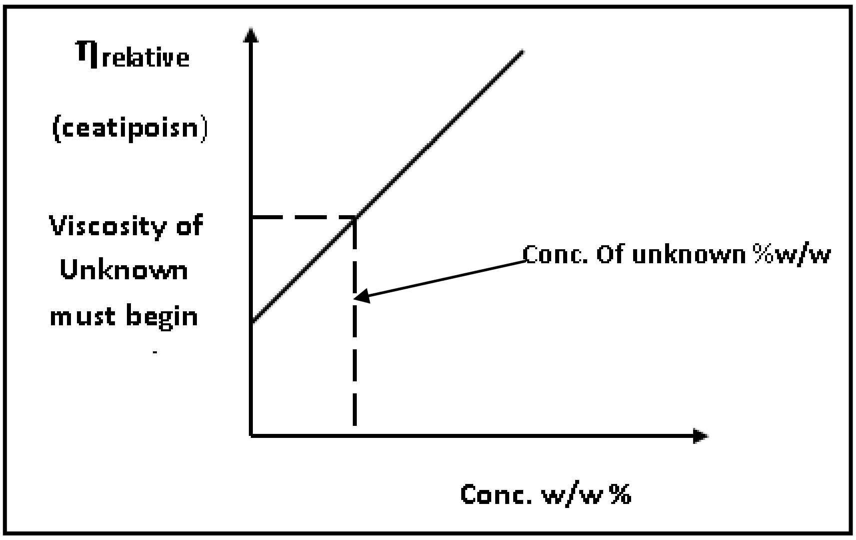
$$\frac{\eta_{unknown}}{\eta_w} = \frac{\rho_{unknown} \cdot t_{unknown}}{\rho_w \cdot t_w}$$

$$\frac{\eta_{unknown}}{\eta_{water}} = \eta_{relative}$$

Result

Conc. w/w%	ρ	time	$\eta_{centipoises}$	$\eta_{relative}$
2%	1.003			
5%	1.005		1.148	
10%	1.018		1.198	
15%	1.03		1.324	
20%	1.037		1.48	
25%	1.044		1.789	

By divided η by η_w what ever a medium here . i.e the η is relative toη of water



Conclusion

From The curve we can find the concentration of unknown :

- concentration increase the time measured to flow will increase also .
- the viscosity is increased

$$Viscosity = \frac{F.dr}{A.dr}$$

Where

F = Force applied (dyne) (gm.cm/sec^2)

dv = different in the distance between parallel plate of a liquid (cm)

A = area of the block of water (cm ^{2}) .

η= ( ) gm.cm^{-1}.Sec^{-1} = Poise

A- To determine the M.wt of gelatin

From Exist equation :-

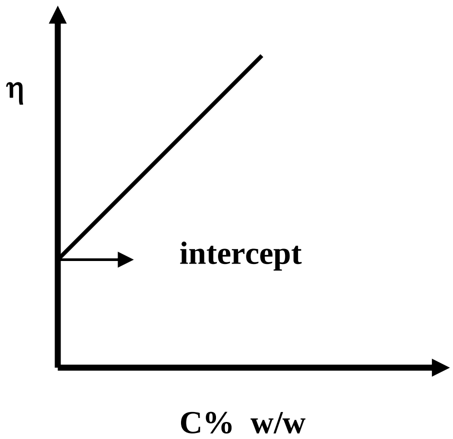
$\eta = \eta_o (1 + 2.5\ \theta)$

$\frac{\eta}{\eta^\circ} = \eta_{relative} = 1 + 2.5\ \theta$

$\theta\ \alpha$ Conc.

$\frac{\eta specific}{C\%\ w/w} = \eta_{reduced} = K_1 = 2.5$

η_{int} = intercept



$[\eta]_{int} = KM^\alpha$

K = 1.7 × 10^{-5} constant

α = 1

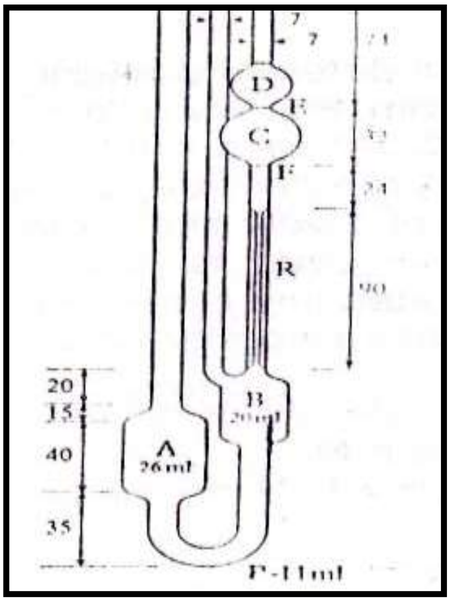
M = Molecular weight .

Objective

To determined the Mint of a polymer such as gelatin

Apparatus

- gelatin 1% w/w .
  20 gm gelatin .
  1980 gm water = 1980 ml water
- Viscometer



Procedure

Prepare different Conc. Of gelatin solution from 1 % w/w gelatin solution (density equal 1.3 gm /cm^3)

Conc. % w/w	Density	Water 1%	ml of 1%	Gm/ml of water
0.2	1.05	10	7.6	40
0.4	1.08	20	15.3	30
0.6	1.11	30	23.7	20
0.8	1.2	40	30.76	10
1	1.3	50	38.46	

To prepare 50 gm of 0.2% w/w from 1% w/w

$1\% \times w = 0.2 \times 50$ gm

w = 10 gm of 1% w/w

$\frac{10}{1.3}$ = 7.6 ml of 1% w/w + 40 ml .gm water .

- measure the viscosity of each Conc. by using capillary viscometer by measuring the time required for liquid to flow between two marks through vertical capillary tube , (also water) .

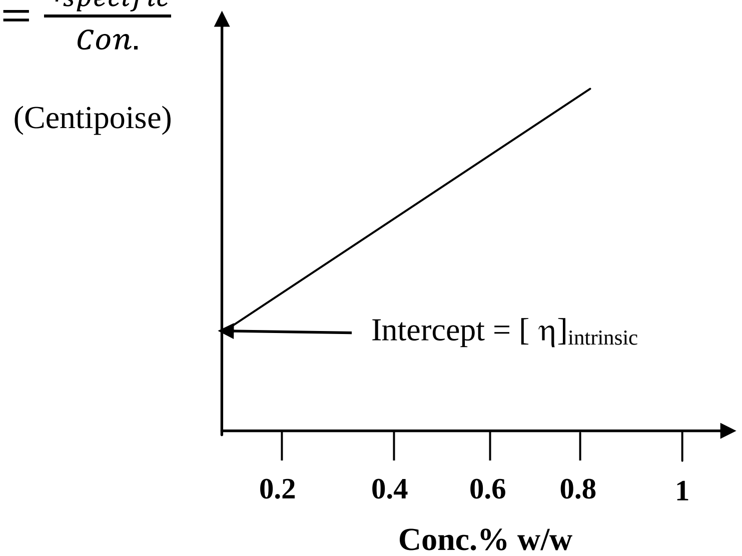
Result

Conc. % w/w	Density	Time (sec)	$\eta_{cettipoise}$
0.2	1.05		
0.4	1.08		
0.6	1.11		
0.8	1.2		
1	1.3		

$$\frac{\eta_{unknown}}{\eta_w} = \frac{\rho_{un}t_{un}}{\rho_{w}t_{w}}$$

$$\frac{\eta_{speafi\mapsto}}{C\%_{w/w}} = \eta_{reduced}$$ (reducing viscosity)

$$\eta_{reducing} = \frac{\eta_{specific}}{Con.}$$



$[\eta]_{int} = KM^{\alpha}$

M = 40670 gm / mole for gelatin

K and α are constant characteristic of the particle polymer solvent system .which are approximately independent of M_{wt} from the curve we determine the intrinsic viscosity and the $M._{wt}$.

B- To determine the radius of Particle by Plotting η_{rel} against molar concentration

Objective

For determination of radius of particle of glycerin

Apparatus

20% w/v glycerin solution

$$20 \text{ gm} \xrightarrow{\text{To}} 100 \text{ ml}$$

$$\underbrace{\frac{20}{1.26}}_{\text{Density of glycerin}} = 15.87 \text{ ml glycerin} \xrightarrow{\text{To}} 100 \text{ ml water}$$

$\boxed{\times 20}$ $\boxed{\times 20}$

$$317.4 \text{ ml glycerin} \xrightarrow{\text{To}} 2\text{l water}$$

Procedure

Prepare different Conc. of glycerin from 20% w/v such as 3% ,6% ,9%,12%,15% w/v .

$c_1v_1 = c_2v_2$

$20\% \times v = 3\times 50\text{ml}$

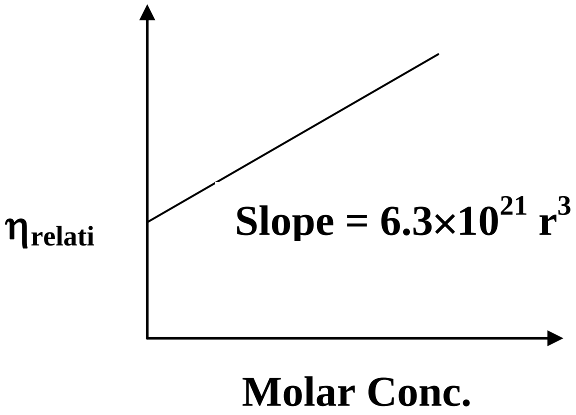
$V = \frac{3\times 50}{20} = 7.5$ ml of 20% w/v $\xrightarrow{\text{Complete}}$ to 50 ml to obtain 50ml of 3% w/v .

- measure the viscosity of each Conc. by viscometer by measuring the time required for the liquid to flow between 2 mark through vertical capillary tube , also for water .

$$\frac{\eta_{un}}{\eta_w} = \frac{\rho_{un} t_{un}}{\rho_w t_w}$$

Conc. % w/w	Density	$Time_{(sec)}$	$\eta_{c.p.}$	$\eta_{relative}$	Molar Conc.
3	1.003				0.326
6	1.006				0.652
9	1.016				0.978
12	1.025				1.304
15	1.03				1.630

- find radius from slope .



Exp.8

The surface tension

Purpose :

To calculate the surface tension of water by the capillary tube method

Apparatus :

1. Set of three capillary tubes .
2. Traveling microscope or glass scale .
3. Beaker .
4. stand and clamp .
5. thermometer .

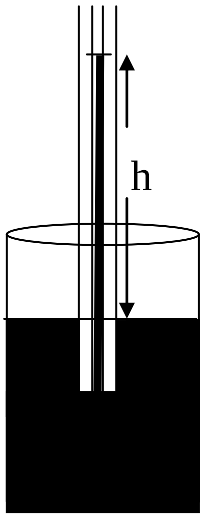


Fig (1)

Theory:

In fig (1) , r is the radius of the capillary tube , Then the liquid touch the tube along line length of it is (2π r) , and the total force in the upper direction effect to the cylinder of liquid (y) is :

$$\mathbf{F = 2\pi\, r\, \gamma \cos\theta}$$

Where γ is the coefficient of surface tension .

θ is the contact angle .

and the total force in the down direction is the weight of te cylinder W

$$\mathbf{W = \rho\, g\, \pi\, r^2\, y}$$

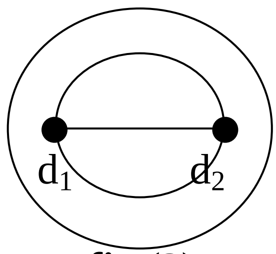


fig (2)

ρ = the density of liquid , **g** = the Acceleration

but the liquid in the capillary tube is in balance

therefore: $\mathbf{2\pi\, r\, \gamma \cos\theta = \rho\, g\, \pi\, r^2\, y}$

$$\gamma = \frac{\rho g r y}{2 \cos \theta}$$

if the liquid is water then the contact angle is θ , and we take the shadow area (see fig (3)) in the calculation then :

$$\boxed{\gamma = \frac{\rho g r}{2}\left(y + \frac{1}{3} r \right)}$$

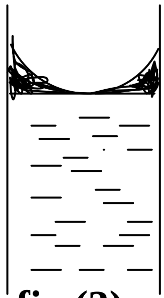


fig (3)

Procedure :

1. Fill the beaker to overflowing with water so that the water level stands up above the glass , as shown in fig (1) .
2. Hold the capillary tube in a clamp with its lower end immersed in water .
3. Measure the height (h) to which the water level rises in the capillary tube above the level of the water in the beaker
4. Also , measure the internal diameter of the capillary tube by using a traveling microscope , ($d = d_1 - d_2$) (show fig (2)) .
5. Repeat all the measurement with the other capillary tubes .
6. Record the temperature of the water , because the surface tension changes with change in temperature .

Readings and calculation :

Tabulate the reading as follows :

	Capillary tube diameter d (cm)			Height h(cm)	Surface tension (γ)
	(1)	(2)	mean		
1^{st} tube					
2^{nd} tube					
3^{rd} tube					
					Mean= Nm^{-1}

Calculate the surface tension from the relation (1) .

The mean value of the measured surface tension ,

$$\gamma = \ldots\ldots\ldots\ldots\ldots\ (N\ m^{-1}) \quad \text{at} \quad \ldots\ldots \quad ^{\circ}C$$

Questions

1. What is the effect of change the length of tube input liquid .
2. What is the relation between change the radius and height of liquid in the capillary tube .
3. What is the effect of temperature to the surface tension .

Exp.9

The density of liquids

Purpose :

To compare between the density of two liquids by used hare´s apparatus .

Apparatus :

1. glass tube as shown in fig (1) .
2. two beakers .
3. stand and clamp .
4. scale meter .
5. two different liquids.

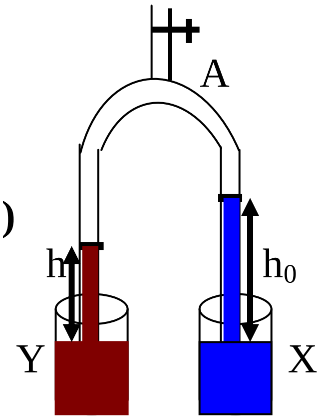


fig (1)

Theory:

hare´s apparatus used to compare between the density of two liquids without merge them with the other .

if the pressure of air in the curve part of the tube to the surface of the two liquids = P, then ,

the pressure in X is $\mathbf{P_X = P + \rho_0\, g\, h_0}$

the pressure in Y is $\mathbf{P_y = P + \rho\, g\, h}$

but $\mathbf{P_X}$ & $\mathbf{P_y}$ = the pressure of atmosphere (P_0) then :

$$\mathbf{P + \rho_0\, g\, h_0 = P + \rho\, g\, h}$$

Or

$$\frac{\rho}{\rho_0} = \frac{h_0}{h}$$

if the water is one of the two liquids then **ρ_0 = 1 gm/cm^3** and we can calculate the density of the other liquid .

Procedure :

1. put Hare´s apparatus vertically by stand and clamp , and place the meter scale behind it (see fig (1) .
2. put the two end of the tube in two beakers ,one of them contain a water and the other contain the liquid have to measure it density .
3. pull some of air in the curve part from point A then close it very well , and measure h & h_0 .
4. Repeat the last point (2) several times to get a group of reading by change the pressure of air (P) in the apparatus .

Readings and calculation :

1. tabulate your reading as shown :

$\frac{\rho}{\rho_0} = \frac{h_0}{h}$	**Height of water(h_0)**	**Height of water (h)**
Mean h_0/h=		

2. Plot a curve between h_0 against h , then calculate slope ,

Where **slope = h_0 / h = ρ / ρ_0**

$$\boxed{\rho = \rho_0 \text{ (slop)}}$$

Questions :

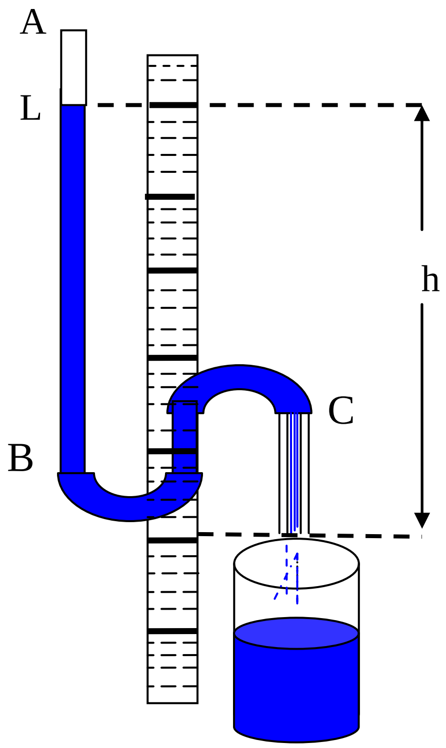
1. is it necessary put the level of surface of liquids in the beaker in the same horizontal level .
2. is the radius of the two tube of hare´s apparatus must be equal each other .

Exp.10

The flow of water through a capillary tube as an introduction to decay curves and the study of half-life

Purpose :
study decay curves and the of half-life .

Apparatus :
Bureite of 50cm length of 1cm diameter glass tubing AB joined by rubbr tubing to about 10-15 cm of 1mm diameter capillary tubing CD and set up with a verticalscale as shown in the diagram , Stop watch , Beakers .



Theory:

Wherever the rate of decay of any quantity is proportional to the quantity itself , as the rate of fall of h in this experiment is proportional to h , the head of liquid , this can be expressed mathematically by :

$$-\frac{dh}{dt} \quad \alpha \quad h$$

Rearranging $$\frac{dh}{h} \quad \alpha \quad -dt$$

$$\frac{dh}{h} = -\lambda dt \quad \text{(where } \lambda \text{ is a constant)}$$

integrating $$\int_{h0}^{h} \frac{dh}{h} = -\lambda \int_{0}^{t} dt$$

$$\log_e \frac{h}{h_0} = -\lambda t$$

changing the base of the logs :

$$\therefore \log_{10} \frac{h}{h_0} = -k t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where k is another constant $= (\lambda \log_{10} e)$

The equation may be written

$$\log_{10} h = \quad -k t \quad \log_{10} h_0$$

and therefor represents a straight line of negative slope k .

From this straight line the half-life $T_{1/2}$ may be calculated by letting $T_{1/2}$ be the value of t when $h = ½ h_0$

Substitution of these values in (1) gives

$$\log_{10} (1/2) = \quad -k T_{1/2}$$

Or half-life $T_{1/2} = \dfrac{\log_{10} 2}{K}$

$$\boxed{\mathbf{T_{1/2} = \dfrac{0.301}{\text{Slope } \dfrac{PN}{QN}}}}$$

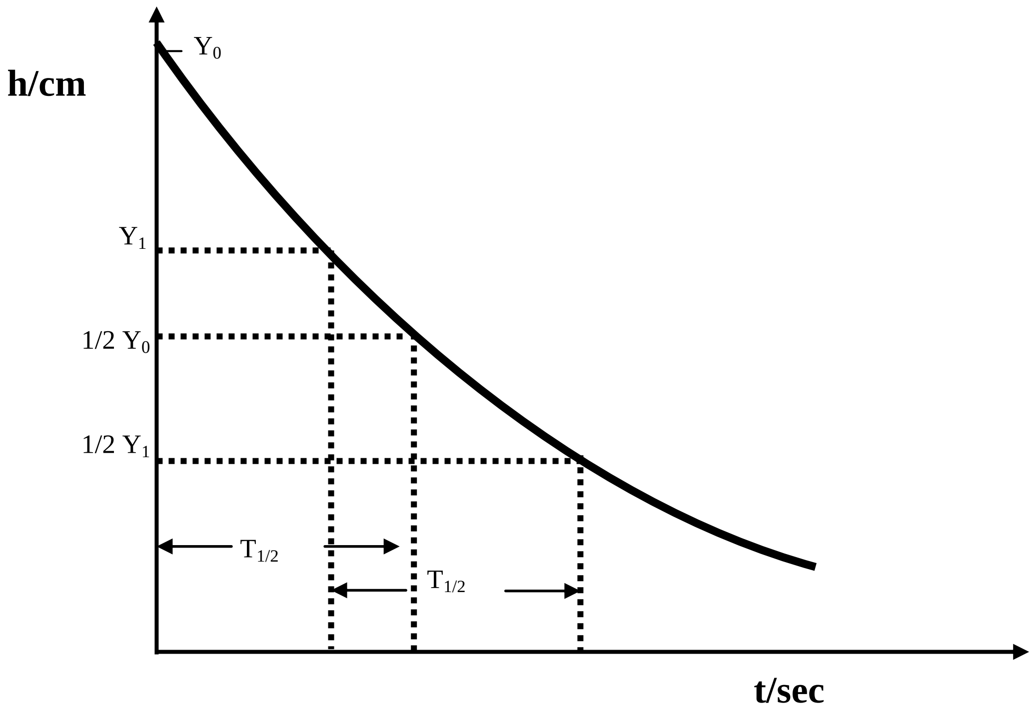
Procedure :

Adjust the exit level D of the water to a convenient mark on the scale (e.g. Zero)
Fill the large tube with water to within 1cm of the top , and when water is flowing freely from the capillary tube record the level of the water L , and hence the head of water h at 15- seconed intervals and recored the level of water . Repeat the experiment twice to obtain two additional confirmatory readings for each value of h taking care to start the timings when the same initial level for L is reached each time .
Tabulate the readings :

Time (sec)	**Head of water**			**Log $_{10}$ h/cm**
	h1 (cm)	h2(cm)	Mean h/cm	
0				
15				
30				
45				
…..				

Plot two graph :

1- Plot values of h/cm as ordinates againest corresponding values of t/s as abscissae .

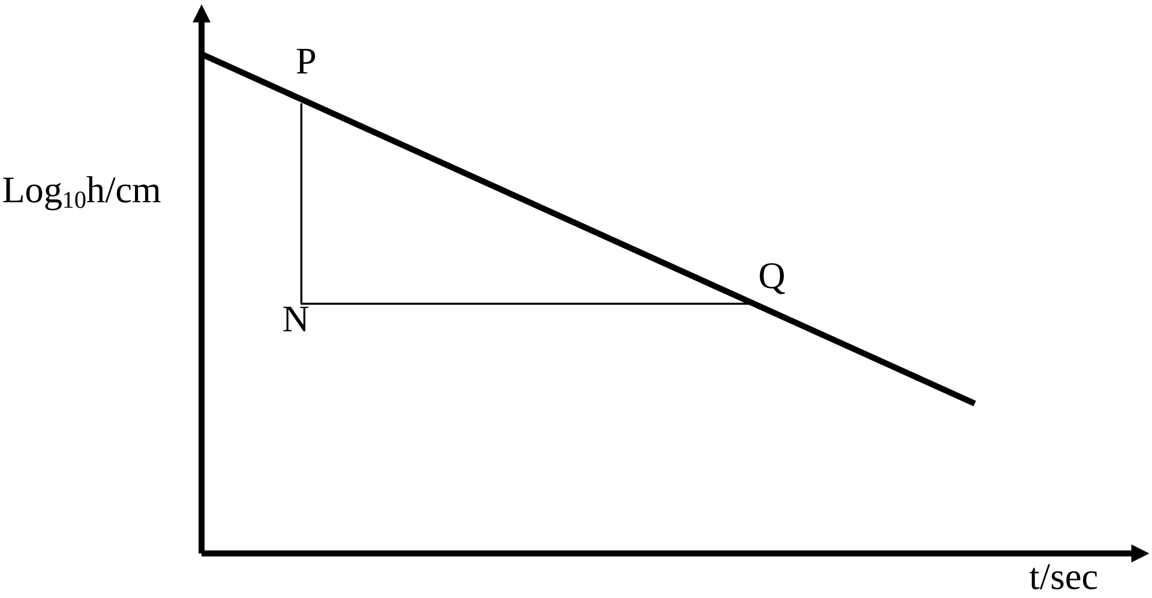


Take any two ordinates , one of wich is half the other (e.g. in the fig. above Y_0 and ½ Y_0) and deduce the correspnding distance between these pairs of ordinates , Note that it is reasonably costant , This value in seconed is the half-life $T_{1/2}$ (i.e. The time in which any value of h is halved) .

2- Plot values of $\log_{10}h$ /cm as ordinates againest corresponding values of t/s as abscissae . A stright line should be obtained from which the half-life $T_{1/2}$ is equal to :

$$\mathbf{T_{1/2} = \frac{0.301}{\text{Slope } \dfrac{PN}{QN}}}$$

The value of $T_{1/2}$ obtained from this graph should be compared with the values obtained from the first graph .



Questions :

1- what is the relation between rat of flow the liquid and h .
2- define half-life .

Exp.11

Optical Fiber Loss (bend) Measurement

Purpose

To demonstrate the loss (bend loss) occurs in optical fiber .

Theory : -

To consider the propagation of light within an optical fiber utilizing the ray theory model it is necessary to take account of the refractive index of the dielectric medium . The refractive index of a medium is defined as the ratio of the velocity of light in a vacuum to the velocity of light in the medium . A ray of light travels more slowly in a optically dense medium than in one that less dense , and the refractive index gives a measure of this effect . There are many types of losses : -

1- Material absorption losses .
2- Scattering losses .
3- Optical fiber bend loss .

Optical fiber suffers radiation losses at bends or curve on their path . This is due the energy in the evanescent field at the bend exceeding the velocity of light in the cladding and hence the guidance mechanism is inhibited , which , causes light energy to be radiation from fiber . An illustration of this situation is shown in figure 1 . The part of mode which is on the outside of the bend is required to travel faster than that on the inside so that a wave from perpendicular to the direction of propagation is maintained

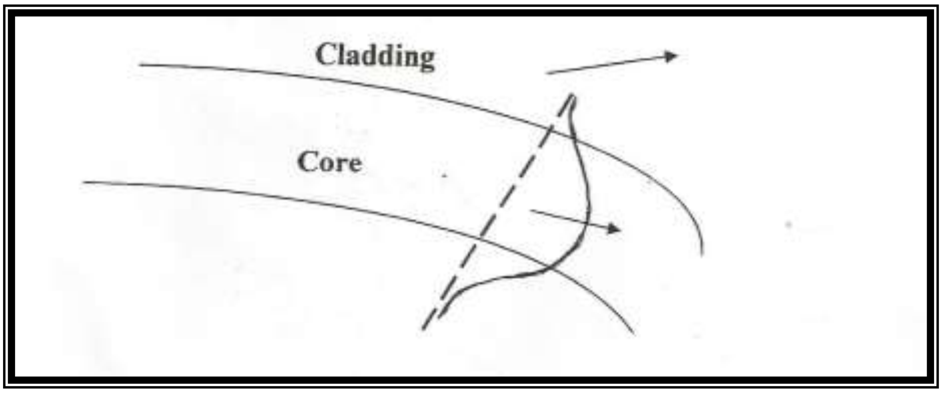


Figure (1) An illustration of the radiation loss at a fiber bends . The part of the mode in the cladding outside the dashed arrowed line may be required to travel faster than the velocity of light in order to maintain a plane wave front . Since it cannot do this . The energy contained in this part of mode is radiated away .

Procedures

1- Connect the fiber terminal on the fiber laser transmitter and the second and on the fiber laser receivers .

2- Bend the fiber on (R_1 =   ) and record the output voltage

R_1 =

N	1	2	3	4	5
V (volt)					

3- Bend the fiber on (R_2 =   ) and record the output voltage .

R_2 =

N	1	2	3	4	5
V (volt)					

4- Bend the fiber on (R_3 =   ) and record the output voltage .

R_3 =

N	1	2	3	4	5
V (volt)					

Exp.12

Spectrophotometer

Introduction

When light falls on a liquid , some is reflected and the rest is partly and partly transmitted . Spectra Photometric method of analysis is usually concerned with measurement of the amount of light absorbed or with comparison of the absorption or transmission of two solution one of which is a standard of known composition .

I = transmitted light

Sample

$$\boldsymbol{A = \frac{I_{\circ}}{I} = -Log\, T}$$

Where t represent transmission .

$$T = \frac{I}{I_{\circ}}$$

The Percentage of transmission % = transmission Light × 100

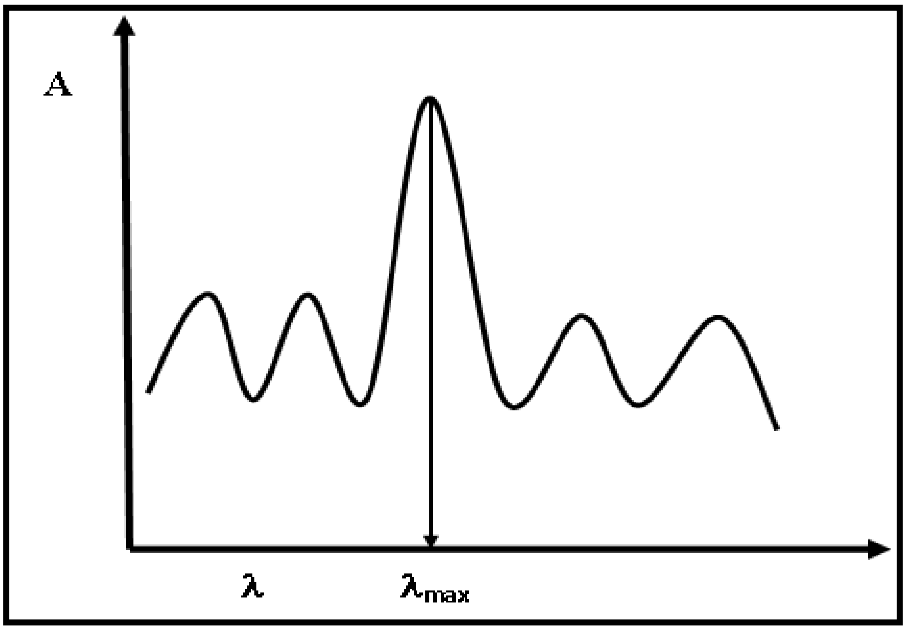
There are two type of spectrophotometer

1- U.v which read absorbance for colorless solution wavelength (λ) 200 – 400 nm .

2- Visible which read absorbance for colored solution wavelength (λ) 400 – 740 nm .

Absorption depend on: -

1- Concentration of sample .
2- Molecular Composition of sample .
3- Frequency of light .



Blank Solution is the medium which contains all the substance in the sample except the active ingredient which required to be measured .

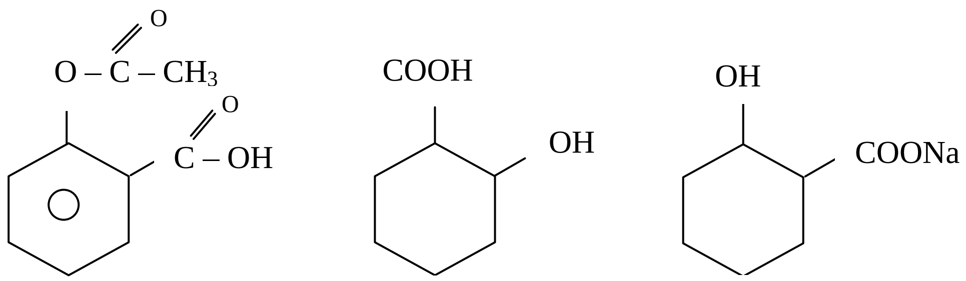
Purpose
To prepare a calibration curve of salicylic acid from a series of standard solution to use it as a reference curve to obtain the concentration of unknown sample .

Note
Salicylic acid is slightly soluble in water so in this experiment we use sod. salicylate which is more soluble in water .

Apparatus
1- Spectrophotometer .
2- Blank Solution .
3- Stock solution .

Procedure

Prepare 250 ml of sod. Salicylic contains the equivalent of 200 mg S.A / 100 ml solution .



Aspirin S.A Sad . salicylate

Note

S.A is sparingly soluble in cold water (one part acid in 550 part water) more soluble in hot water one part in 15 parts of boiling water , from which it can re crystallized .

Method to prepare solution

M.wt sod.salicylate	**M.wt.S.A**
160	138
×	2mg

$$X = \frac{200 \times 160}{138} = 231.8 \frac{mg}{100} ml \;\; sad.saliy$$

231.8	100
×	250

$$X = \frac{231 \times 250}{100} = 579.6 \, mg \; of \; sad.$$

Salicylate ⟶ dilute to 250 ml .

2-From the stock solution of sod . salicylate using volum procedure to accurately prepare solution containing the equivalent of 50,40,30,20,10 mg S.A / 100 ml (prepare it 100 ml volumetric flask)

$c_1 v_1 = c_2 v_2$

$\frac{100}{50} \times v_1 = \frac{25}{50} \times 50 \text{ ml}$

$\frac{200mg}{100} \times v_1 = \frac{50mg}{100} \times 100 \text{ ml}$

$$v_1 = \frac{50 \times 100}{200} = 25\, ml\ of\ stock\ solution$$

$\rightarrow dilute\ to\ 100\, ml\ by\ D.W\ to\ contain\ \frac{50mg}{100} ml\ S.A.$

$- \frac{40mg}{100\, ml} \rightarrow 20\, ml \rightarrow dilute\ to\ 100\, ml$

$- \frac{30mg}{100\, ml} \rightarrow 15\, ml \rightarrow dilute\ to\ 100\, ml$

$- \frac{20mg}{100\, ml} \rightarrow 10\, ml \rightarrow dilute\ to\ 100\, ml$

$- \frac{10mg}{100\, ml} \rightarrow 5\, ml \rightarrow dilute\ to\ 100\, ml$

3- Take 1 ml of each solution and add 5ml of colour developing reagent which is composed of

- F colour developing reagent .
- Mercaonc Hcl

Mix well then determine the absorbance in spectrum 20 at 530 nm against a blank at 530 nm

$blank \rightarrow (1ml\ D.W. + 5ml\ C.D.R)$

- A complex will be formed between the hydroxyl group in the salicylate with femcion of C.D.R resulting the violet color seen when both solution are mixed which read the best absorbance at λ_{530nm} " this reaction must be occur in acidic medium).

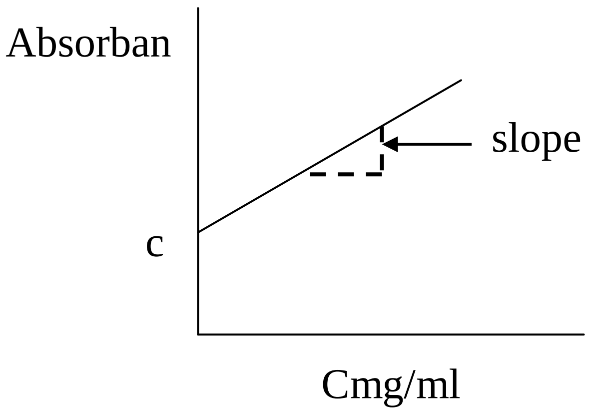
4- Plot the absorbance vs conc. of S.A (eye filling) .

5- Apply the least square method to calculate the b (slope) and C(intersect point). Using regression .

6- Analysis equation to calculate $\bar{y}$.

$\bar{y}$ = c + bx

7- Draw the line of best fit curve result and calculation .



Arrange your result in the table

Conc. mg/ml	Abs
$\frac{10}{100} = 0.1$	
$\frac{20}{100} = 0.2$	
$\frac{30}{100} = 0.3$	
$\frac{40}{100} = 0.4$	
$\frac{50}{100} = 0.5$	

Exp.13

Laser application for measurement of single slit

Aim:-

To study the diffraction of laser by a single narrow slit.

Apparatus:-

Laser source (diode laser) of wavelength λ=(630nm) , Screen , Single slit , Ruler**.**

Theory:-

Laser is an electromagnetic radiation produced by light amplification of stimulated emission of radiation. It has all the characteristics of light and the law, of reflection and refraction are applied on it laser has the following characteristics:

1- It is coherent light i.e. the photons of laser beam has the same frequency, direction and phase.

2- It has very high intensity.

3- It has very low diffraction.

4- It can be used as continuous or pulse wave depending on the kind of source and the required application for exampel pulse wave are normally used in medical applications.

5- It can deliver large energy at very short time.

6- It can be transmitted through optical fibers to minimize the diffraction of laser been i.e. to minimize the waste of laser energy and also it can be transmitted through flexible fibers to different part of the body from different openings like mouth, nose…..ect.

Method:-

1- Switch on the laser apparatus and notice the red beam of laser.
2- Arrange the slit so that the laser will be transmitted through the slit and incident on the screen.
3- Move the screen forward and backward until you get the most clear fringes on the screen.
4- Measure the distance between the center of the central fringe and each of the bright fringes.

1st fringe(X1), 2nd fringe (X2)……………as follows:

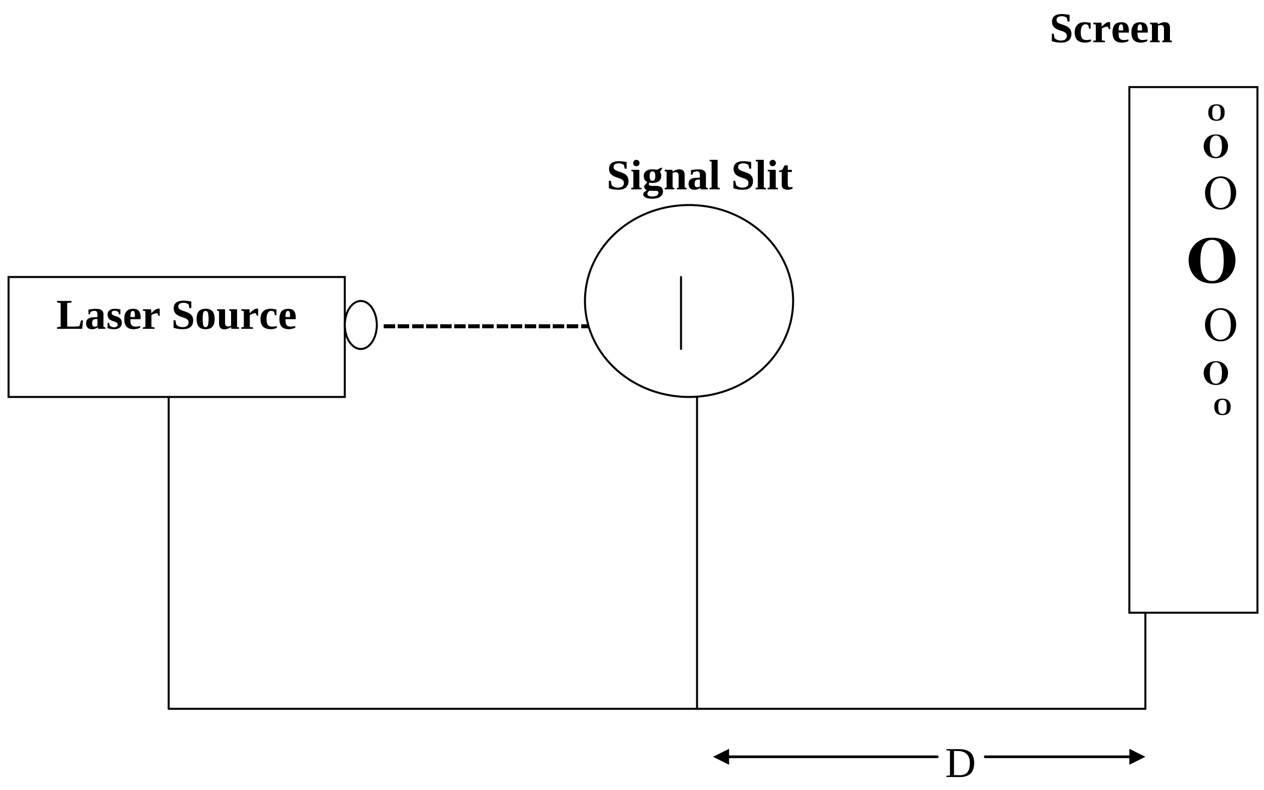
n	**X**
1	**X1**
2	**X2**
3	**X3**

5-Apply Snell law: $n\lambda = d \sin\theta$
but θ is very small therefore $\sin\theta \approx \theta$

$$n\lambda = d\frac{X}{D} \Longrightarrow \frac{n}{x} \quad \lambda = \frac{d}{D}$$

$$\text{Slop} = \frac{n}{X}$$

d=width signal slit.
D=distance between the slit and screen.


Screen
Signal Slit
Laser Source
D