MIPER

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IV SEMESTER (II-B.PHARM)

PHYSICAL PHARMACEUTICS - II

PRACTICAL LAB MANUAL

CONTENTS

PHYSICAL PHARMACEUTICS-II

(PRACTICAL MANUAL) SECOND YEAR (IV- SEMESTER)

PHYSICAL PHARMACEUTICS-II

(PRACTICAL MANUAL) SECOND YEAR (IV- SEMESTER)

1. DETERMINE THE ANGLE OF REPOSE AND INFLUENCE OF LUBRICANT ON ANGLE OF REPOSE

AIM

To determine the effect of glidants on lubricants of angle of repose

REQUIREMENTS

- Lactose powder
- Starch paste
- Talc
- Mortar and pestle
- Funnel, stand

PRINCIPLE

Lubricants are glidants of friction during tablet, ejection between the starch of the tablet and the walls of the die cavity. The most widely used lubricants have been steric acid and steric acid derivatives such as calcium and magnesium stearate and talc. Glidants are intended to produce flow of the tablet granulation of powder materials by reducing friction between the particles. The most widely used glidants have been derivation of talc and corn starch.

PROCEDURE

- Select a glass funnel which has a round shape of 15-30mm of diameter with flat edge
- Fix the funnel with a clamp (on the ring)
- Place the glass plate on the ring and arrange it below the glass funnel
- Keep on graph paper on the glass funnel
- Weigh approximately 100gm of granules
- Pour the granules while blocking the orifice of the funnel be thumb
- Remove the thumb the granules load at flow down into the graph paper and form a cone shaped

- Adjust the thumb the funnel clamp so that the gap between the bottom of the funnel peak of the powder pile is about 3mm
- Repeat the 5-7 steps and approximate graph is maintained
- Finally pour the granules back into funnel and allow to flow
- Mark four points which are opposite to each other on the circular base on the graph paper
- Record the readings in table, this value is the diameter calculate the radius in ®
- Measure the height of the pile using two rulers
- Keep one ruler vertically and another horizontally to touch the peak of the pile, then read the value for the vertical scale.
- Substitutes the value in equation to obtained the angle of repose, generally the (h/r) measure is the angle of repose data were plotted semi-long paper and copies of curves made available for the purpose of calculating angle
- Repeat the procedure 2 more time and take on average

REPORT

The angle of repose of the given granules (without glidant) = **22º 93'**

The concentration is **2%**

The effect of glidants of lubricants of angle of repose is = **22º69'**

Inference is that the flow of granules **"Excellent"**

TRIAL	**HEIGHT (cm)**	**RADIUS (r) (cm)**	**h/r**	**Angle of Repose $\theta = \tan^{-1} h/r$**
I	1.2	2.9	0.413	22º47'
II	1.4	2.9	0.47	25º20'
Average angle of Repose = 23º93'				

2. DETERMINATION OF BULK DENSITY, TRUE DENSITY AND PERCENTAGE POROSITY

AIM

To determine the bulk density, true density and percentage porosity of the given granules

PRINCIPLE

- It is defined mathematically as

  Bulk density = /

- When particles are packed loosely lots of gaps between the particles are observed. Hence the bulk volume increases by making the powder light based on bulk volume powder are classified as light and heavy
- light powder have high bulk volumes on the other hand smaller particles the powder assume low bulk volume or high bulk volume density such powder are called heavy powder. The bulk density depends on particle size distribution, shape, and cohesiveness of particles.
- True density is the density of the powder itself

  True density= /

- The density depend on the type of atom in a molecular rearrangement of atoms in a molecule and arrangement of molecule in the sample volume occupied by voids and the intra particle pores are not included in the most common method used in the determination of true density or gas displacement or liquid displacement method.
- This method is used to select a solvent in which the powder is insoluble

PROCEDURE:

- ✓ Approximately 20gm of powder is transformed to a 500ml cylinder and tap mechanically or by tapping device until a constant volume is obtained thus volume is bulk volume and the void space among powder particle

True density:

Determination of true density of the material by solvent displacement method

- ➢ Weigh accurately a clean and dry density bottle
- ➢ Take the weight of density bottle with small quantity of powder sample
- ➢ Now fill the density bottle by solvent without removing the powder material
- ➢ Calculate the true density of given powder sample

Determination of percentage porosity

- ➢ Porosity is defined as the void volume to the bulk volume of the granules

Porosity=1- /

REPORT

- ✓ The bulk density of the given sample of granules was found to be = g/cm^3
- ✓ The true density of a given powder was found to be = g/cm^3
- ✓ The percentage porosity of the a given powder is =%

3. DETERMINATION OF VISCOSITY OF LIQUID USING OSTWALD'S VISCOMETER

AIM:

To determine the viscosity of the unknown liquid by using Ostwald's viscometer

REQUIREMENTS:

- Ostwald's viscometer
- Stop clock
- Specific gravity bottle
- Sample
- Distilled water

PRINCIPLE:

The force of friction with one part of a liquid offers to another part of the liquid is called viscosity. For measuring the viscosity coefficient Ostwald's viscometer method is used which is based on poiseuilles's law. According to this law, the rate of flow of liquid through a capillary tube having viscosity coefficient (n)

$$\eta = \frac{\quad}{\quad}$$

Where,

V= volume of liquid (ml)

T= flow of time in seconds through capillary (in second)

R= radius of capillary (cm)

η= viscosity coefficient (poise)

p= hydrostatic pressure

- Since the hydrostatic pressure (driving force) of the liquid is given by

$$\eta = dgh$$

Where,

h= height of the column

d= density of the liquid

PROCEDURE:

- Wash the relative density bottle with distilled water and dried.
- Take the weight of empty bottle and filled given liquid
- Clean and rinse the viscometer properly with distilled water
- Fix the viscometer vertically in the stand and filled the specific amount of given unknown liquid in viscometer
- Time of flow recorded when the liquid starts to flow from the mark c and d above and below the bulb a. the experiment repeated 3-4 times to get viscosity of the given unknown liquid.

LIQUID	**FLOW TIME IN (SEC)**			**AVERAGE (SEC)**	**DENSITY (g/ml)**
	1	2	3		
distilled water	120	120	120	120	0.9976g/ml
given sample	180	180	180	180	1.0325g/ml

REPORT:

The viscosity of the unknown liquid is = centipoise

4. DETERMINATION OF SEDIMENTATION VOULME WITH EFFECT OF DIFFERENT SUSPENDING AGENT

AIM:

To determine the sedimentation volume with effect of different suspending agent.

PRINCIPLE:

SUSPENSION

Pharmaceutical suspension may be defined as a coarse dispersion in which insoluble solids are suspended in liquid medium. It is also known as heterogeneous system (or) more precisely biphasic system. The insoluble solids may have size range from 10-10000µm and liquid medium is normally water or a water based vehicle.

SUSPENDING AGENT

Suspending agent is defined as physiologically inert substance which increases the viscosity when added to suspensions. It helps in the keeping the dispersed particles. Suspended thus there enhanced the physical stability and re-dispersion of the sediment or shaking.

PHYSICAL STABILITY

Physical stability may be defined as a condition in which particles remain uniformly distributed throughout the dispersion with any signs of sedimentation.In practice Physical stability may be defined as a condition in which particles should be easily re-suspended by a moderate shaking. If they settle suspensions when kept aside. The solids tends to settle at the bottom of the container due to gravitational pull on the particles of higher size. It is not possible to prevent the sedimentation volume and its case of re-dispersion are the common evaluation procedure for assessing the physical stability. The two sedimentation parameters are employed such as

1. Sedimentation volume
2. Degree of flocculation

SEDIMENTATION VOLUME:

- Sedimentation volume is defined as

  F= ——————————————

- When a suspension is taken in a measuring cylinder volume and height is proportional and height can be conveniently measured through the term volume is included in the terminology sedimentation volume "F" is a dimension less number. Most pharmaceutical suspension has an "F" value less than one. If f=1 the product has no sediment and no clear supernatant on standing which is an ideal condition. Normally "F" value lies between 0 and 1. Sometimes the network of flow is loose and fluffy and ultimate volume of sediment increase. In this situation "F" value will be greater than one.

PROCEDURE:

1. Weigh 5gm of calcium carbonate and place in a mortar and add small quantity of water and triturate the sample. After suspending the powder uniformly transfer the suspension into a 100ml measuring cylinder makeup the volume to 100ml with distilled water.
2. Separately prepare 5% w/v of calcium carbonate suspension with 1% of different suspending agent such as bentonite, methyl cellulose, respectively in different vessel add small quantity of water and triturate well. After powder is uniformly suspended transfer the suspension into separate 100ml measuring cylinder.
3. Makeup the volume to 100ml with distilled water
4. Shake the suspension simultaneously and kept aside
5. Note the volume of sediment at time periods 0,10,20,30,…60 minutes. Calculate the sedimentation volume
6. Draw the plot by taking "F" values on "Y" axis and the time on "X" axis.

REPORT:

5% calcium carbonate suspension 1% carboxy methyl cellulose as suspending was found to be more physically stable compared with other suspending agent.

5. DETERMINATION OF SEDIMENTATION VOLUME WITH EFFECT OF DIFFERENT CONCENTRATION OF SINGLE SUSPENDING AGENT

AIM:

Determination of Sedimentation volume With Effect of Different Concentration of Single Suspending Agent

PRINCIPLE:

SUSPENSION

Pharmaceutical suspension may be defined as a coarse dispersion in which insoluble solids are suspended in liquid medium. It is also known as heterogeneous system (or) more precisely biphasic system. The insoluble solids may have size range from 10-10000µm and liquid medium is normally water or a water based vehicle.

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PROCEDURE:

1. Separately prepare 5% w/v of calcium carbonate suspension with0.5%, 1%, 1.5%, 2 % of single suspending agent such as (bentonite) in different vessel. Add small quantity of water and triturate well. After powder is uniformly suspended transfer the suspension into separate 100ml measuring cylinder.
2. Makeup the volume to 100ml with distilled water
3. Shake the suspension simultaneously and kept aside
4. Note the volume of sediment at time periods 0, 10, 20, 30,…60 minutes. Calculate the sedimentation volume
5. Draw the plot by taking "F" values on "Y" axis and the time on "X" axis.

REPORT:

- Increase the concentration of suspending agent and also increase the viscosity so lower the sedimentation volume
- The concentration of single suspending agent bentonite has more physical stable.

Sedimentation volume of 5% calcium carbonate suspension with 5% bentonite

S.NO	TIME (MIN)	$F= V_U/V_0$
1	0	1
2	10	0.34
3	20	0.31
4	30	0.28
5	40	0.25
6	50	0.24
7	60	0.23

6. DETERMINATION OF PARTICLE SIZE DISTRIBUTION BY SIEVING METHOD

AIM:

To determine the average particle size and find out their distribution pattern for the given granules by sieve analysis method.

PRINCIPLE:

Sieve method gives sieve diameter, sieve diameter is defined as the diameter of the sphere that possess through the sieve aperture as the asymmetric particle sieve method directly give weight distribution. Particles having size range from 50 and 1500μm are estimated by sieving method. In this method, the size is expressed as d_{sieve}. The sieving method finds application in dosage and development of tablets and capsules. Normally 15 percent of fine powder (passed through mesh 100) should be present in granulated material to get a proper flow of material and achieve good compaction in tableting. Therefore, percent of coarse and fine can be quickly estimated. Sieves for pharmaceutical testing are constructed from wire cloth with square meshes, woven from wire of brass, bronze, stainless steel or any other suitable material.

Designations and Dimensions of I.P specification sieves

Sieve Number	Aperture Size Micrometer	Sieve Number	Aperture Size Micrometer
10	1700	44	325
12	1400	60	250
16	1000	85	35
22	710	100	36
25	600	120	34
30	500	150	36
36	425	170	35

Advantages of sieving method

1. It is in expensive, sample and rapid with reproducible results.
2. Sieving method is useful when particles are having size range between 50 and 1500µm.

Disadvantage of sieving method

1. Lower limit of the particle size is 50 µm.
2. If the powder is not dry, apertures become clogged with particles leading to improper sieving.
3. During shaking, attrition occurs causing size reduction of particles. This leads to errors in estimation.

Factors influencing the sieving method

Factors influencing sieving are weight of sample, duration of shaking and type of motion. The types of motion influencing sieving are vibratory motion, (most efficient), side tap motion, bottom pat motion, rotary motion with tap and rotary motion. The type of motion standardized. Care should be taken in order to get reproducible results.

PROCEDURE:

1. Standard sieves set is selected (sieve no: 10, 22, 36, 44, 65, 80, 100,120) arrange them in such manner that the coarsest remains at the top and finest at the bottom.

2. Weigh approximately 50g of sample place the sample on the coarsest sieve no.10.

3. Fix the above sieves set on hand sieve shaker and shaken for 20 minutes.

4. Collect the Sample retained on each sieve into a paper, weigh all the ample.

5. Report the weights retained on each sieve in the table against corresponding sieve number.

REPORT:

The average diameter of the given granules was found to be 493.47µm.

7. CALIBRATION OF EYE PIECE MICROMETR

STANDARD STAGE MICROMETER:

- ✓ Standard stage micrometre is used to calibration of eye piece micrometre. Eye piece micrometre is a glass slide (7.5cm into 2.5cm) which has the scales engraved in the scale usefully 0.1mm is length. 1mm divided into 100 divisions. Thus smallest division least count of the stage micrometre represents 0.01mm or 10µm length.
- ✓ In this experiment in the optical combination of 10x eye piece and 45x objective is used
- ✓ The stage micrometre is least on the stage of the microscope. The objective is position to the centre of objective
- ✓ Initially disc focus low power the scale of stage micro meter observed (100 divisions)
- ✓ Now the objective is focus to high power (45x)
- ✓ Two points were selected one point on the left side where divisions both scales coincide and another point on the right side
- ✓ The number of small division that is eye piece were counted and big division stage micrometre were counted and recorded

1 eye piece = y/x × 0.01mm

1 eye piece = y/x × 10 µm

PROCEDURE:

Counting of the sample

1. A small portion of given sample transfer to a clean slide
2. One (or) two drops of liquid paraffin is added to the slide
3. The sample is dispersed uniformly with help of brush and particles should be in depended and distribution should be uniform
4. The cover slip is placed carefully entrancement of air bubbles is avoided
5. The slide is placed the stage of microscope

Measurement of particle size:

- The slide is focus in low power (10x) the presence of individual particle is absorb (if aggregation or lumps are present the sample should be mounted again)
- The size of the each particles measure is terms of eye piece division
- A total 300 particles should be considered for size distribution analysis. Ideally 625 particles measure according to BPC.

REPORT:

From the graph it was found the particles were distributed uniformly from size range of 0-400µm.

Size Range (µm)	Mean Size (D) µm	Number Of Globules In Each Size Range	% Number Of Globules	Cumulative % Number Of Globules	Number Size
0-50					
50-100					
100-150					
150-200					
200-250					

8. DETERMINATION OF REACTION RATE CONSTANT FIRST ORDER

AIM:

To determine the reactant rate constant and half-life and the ester (methyl acetate or number of globules) at 0.5M HCL at room temperature.

APPARATUS AND CHEMICALS REQUIRED:

- Conical flask (250 ml)
- 10 ml volumetric pipette
- Burette
- Ethyl acetate or methyl acetate
- Test tube
- 0.5 N HCL solution
- 0.25 N NAOH solution
- Phenolphthalein indicator
- Ice cold water

PROCEDURE:

Preparation of hydrochloric acid solution (0.5N) IP:

Solutions of any normality XN may be prepared by diluting 85 x ml of HCL to 1000ml with water. Measure 850 ml of distilled water into a 1000ml volumetric flask. Add 42.5 ml of conc.HCL and slowly added. Finally make up the water in 1000ml.

Preparation of NAOH solution (0.25 N) IP:

Solutions of any normally XN may be prepared by dissolving 40 x gm of NAOH in water and diluting to 1000ml. weigh 10gm of NAOH and transferd into 1000ml volumetric flask. Add water slowly with stirring finally makeup the water into 1000ml.

PROCEDURE:

KINETIC METHOD

- 100ml of 0.5N HCL solution is measured and transferred into a 250ml conical flask
- It should be kept in the water bath for equilibrium (do not heat)
- 10ml of the given ester it transfer into the test tube and kept in the water bath for equilibrium. Normally it takes 10minutes
- The acid solution its mix ester sample thoroughly and kept in water bath
- Immediately after mixing 5ml of the mixer is withdrawn using the pipette and transferred in to a conical flask containing 10ml ice water (0 time)
- The few drops of phenolphthalein indicator is added to the mixture
- The reaction mixer is titrated against 0.25N NAOH solution. This value of alkali consumed represents $V_{0.}$
- 5ml samples by periodically at 10, 20, 30, 40, 50, 60, 75minutes. the volume consumed at each time interval represent V_t
- The reaction mixture is heated at water bath at the 60^0c at 20 minutes
- The mixture cooled to room temperature
- 5ml of sample by withdrawn at transfer into the conical flask containing 10 ml ice cold water. The titration is repeated and this value represents Vα.

REPORT:

The reaction rate constant (k) of the given data (methyl acetate or ethyl acetate) in 0.5N HCL acid is

From graphical method= minutes

From substitution method= minutes

The half -life ($t_{1/2}$) of the given ester (methyl acetate or ethyl acetate) in 0.5N HCL acid is

From graphical method=

From substitution method=

9. DETERMINATION OF VISCOSITY OF SEMISOILD BY USING BROOKEFIELD VISCOMETER

AIM:

To determine the viscosity of semisolid by using Brooke field viscometer

PRINCIPLE:

Newton was the first to study the flow properties of liquids in quantitative terms liquids that obey newton's law of flow are called as Newtonian fluids

$$F = \eta G$$

Shear stress- shear rate

Relationship is normally in the form of a curve rheogram or consistency curve. When data are plotted by taking "F" on x-axis and "G" on y-axis, a flow curve is obtained. The rheogram passes through the origin and the slope given the coefficient of viscosity system that follow this linear relationship are called as Newtonian fluids. This class includes liquids such as water, glycerine, chloroform, solutions of syrups, very dilute colloidal solution. Simple liquids exhibit Newtonian flow. Rheological properties of heterogeneous dispersions such as emulsions, suspensions and semisolid are more complex and do not obey newton's equation of flow based on the pattern of consistency curve, Non-Newtonian fluids are categorized as

- Plastic flow
- Pseudo plastic flow
- Dilatant flow

PROCEDURE:

- Prepare bentonite magma (5%w/v), methyl cellulose (2%w/v) and mineral oil. They show Non-Newtonian rheological profile
- Measure the viscosity of these liquids using a Brookfield viscometer and observe the thixotrophy phenomenon

- Place the spindle with the correct number listed in the data sheet in each liquid and rotate the spindle at the speeds indicated. Once the dial reading has stabilized, record the values of viscosity in (cps).

CALCULATION:

Viscosity in cps= dial reading x factor

S. No	Spindle Speed	Factors	Dial Reading	Viscosity (F × Dr)
1.	6	1000		
2.	12	500		
3.	30	200		
4.	60	100		
5.	30	200		
6.	12	500		
7.	6	1000		

REPORT:

The viscosity of the given sample was found to be= centipoise (cps)

10. DETERMINATION OF REACTION RATE CONSTANT SECOND ORDER

AIM:

To determine the reaction rate constant and half-life period of ethyl acetate in 0.025N sodium hydroxide solution at room temperature.

Principle:

The alkaline hydrolysis of an ester (ethyl acetate) is irreversible and follows the second order kinetics.

$$CH_3COOC_2H_5 + NaOH \longrightarrow CH_3COONa + C_2H_5OH$$

Ethyl acetate sodium hydroxide Sodium acetate ethyl alcohol

The molecularity of the reaction is two and the order is also two. Second order reaction is defined as the reaction in which the rate of reaction depends upon the concentration of two reactants with each term raised to the first power.

Apparatus and chemicals:

- Conical flask (250 ml)
- Water bath
- Pipette
- Burette (50 ml)
- Ethyl acetate solution (0.05N)
- Hydrochloric acid solution
- Ice cold water
- Phenolphthalein indicator

PROCEDURE:

Preparation of ethyl acetate solution (0.05N)

The molecularity weight of ethyl acetate is 88.10 density is 0.90g/ml. percentage purity is 99%. Measure 50 ml of Ethyl acetate and transfer into 1000ml volumetric flask dilute to 1000ml with distilled water.

Preparation of hydrochloric acid solution (0.02N)

Solutions of any normality XN may be prepared by diluting 85 xml of hydrochloric acid to 1000ml with water. Measure 850 ml of distilled water into 1000ml volumetric flask. Add 1.7ml of concentrated hydrochloric acid slowly and shake. Finally make up the volume to the mark.

Preparation of sodium hydroxide solution (0.05N)

Weigh 2.0gm of sodium hydroxide in water and transfer into 1000ml volumetric flask. Add water slowly with continuous stirring, while cooling the flask under running tap water. Add sufficient water to make 1000ml. allow it to stand overnight and pour off the clear liquid into a bottle. This clear solution is used.

Kinetic method:

- ✓ Measure 50ml of 0.05N sodium hydroxide solution and transfer into a conical flask. Keep it in a water bath for equilibrium at room temperature.
- ✓ Measure 50ml of 0.05N of the given ester and transfer into a conical flask. Keep it in above water bath for equilibrium. Normally it takes about 10 minutes.
- ✓ Mix the alkali and ester solution thoroughly and keep in same water bath.
- ✓ Immediately after mixing, withdrawn a 10ml sample of the mixture with pipette and transfer into a conical flask containing 10ml ice cold water
- ✓ Add few drops of Phenolphthalein indicator
- ✓ Titrate against 0.02N hydrochloric acid. This titter value times t=0 corresponds to the original concentration “a” report the results

- ✓ Periodically withdrawn samples at 5, 10, 15, 20, 25, 30 minutes time periods. Repeat the steps 4 to 6. These titter values denote the amount of sodium hydroxide or ethyl acetate remain unreacted ie, (a-x) at time. Record the results
- ✓ Substitute the values in integral equation and calculate the reaction rate constant (K_2). These values will more or less constant
- ✓ Calculate the average of the reaction rate constant (K_2)
- ✓ Draw a plot by taking x/a (a-x) on y-axis and time on x-axis
- ✓ Estimate the slope. This slope same as K_2 value.

Calculation:

time (min)	**volume of HCL consumed**		**volume of HCL (ml)**	**concentration in mol/liter a or (a-x)**	**x= a(a-x)**	**x/a(a-x)**	**K_2= x/at (a-x) liter/mol**
	initial (ml)	final (ml)					
00							
5							
10							
15							
20							
25							
30							

REPORT:

The reaction rate constant (K_2) of the given ester (methyl acetate or ethyl acetate) in 0.025N NAOH at room temperature

From graphical method= minutes

From substitution method= minutes

The half -life ($t_{1/2}$) of the given ester (methyl acetate or ethyl acetate) in 0.025N NAOH at room temperature

From graphical method=

From substitution method=

11. ACCELERATED STABILITY STUDIES

AIM:

To determine the shelf-life of the product. If stored at 25^0C from the given data.

- A pharmaceutical product needs to be physically, chemically, therapeutically, toxicologically and microbiologically stable throughout its shelf-life. The pharmaceutical companies do stability testing for estimating the shelf-life and based on this the expiry date is given for the product.
- The real time syudies at recommended condition are ideal method for predicyting shelf-life often the studies are designed to increase the rate of chemical degradation or physical change of pharmaceutical products by using exaggerated storage conditions. This is known as accelerated stability testing. The pharmaceutical products are subjected to higher temperatyre and humidity conditions for accelerating the degradation. However the results of accelerated testing are not always predictive of physical changes and potency.
- The pharmacopoeia specifies certain storage conditions. The following table gives the details as specified in Indian pharmacopoeia.

Storage Condition	Meaning
Cold	any temperature not exceeding 8^0C (2-8^0C)
Cool	any temperature between 8-25^0C
Warm	any temperature between 30-40^0C
Excessive Heat	any temperature above 40^0C

PRINCIPLE:

Though the medicinal products needs to be physically, chemically, therapeutically, toxicologically and microbiologically stable. The chemical instability is most often the main consideration for detrmining the shelf-life or expiry date. The medicinal products are stored at higher teperature conditions to accelerate the degradation rate. This is known as accelerated stability taesting. The rate of chemical reaction increases by 2-3 folds for every rises in 10^0C at room temperature. The Arrhenius equation plot (log k vs 1/t) from the equation

$$\text{Log}k = \log A - K/2.303\ RT$$

Where,

K= rate constant

R= gas constant

T= absolute temperature

E= energy of activation is used to find out the reaction rate constant at 25^0C.

PROCEDURE:

- The order of drug decomposition reaction is determined first by plotting curve. Percent potency retained VS time. Here it is first order
- The k value is determined for each temperature curve.
- The Arrhenius plot is drawn log k vs 1/t
- The value at desired temperature is determined by extrapolating Arrhenius equation
- The value of k is placed in the first order rate equation and is calculated.

Three drug products were kept at 4^0C ± 2^0C/ 75% RH ± 5% RH

Storage Period In Months	Potency Retained Product-I	Potency Retained Product-II	Potency Retained Product-III
0			
3			
6			

REPORT:

The shelf-life of the medicinal product is

Product-I K=

Product-II K=

Product –III K=

The best product is=