APPLIED SCIENCE LAB MANUAL (105)

CHEMISTRY LAB MANUAL (105)

VOLUMETRIC ANALYSIS

It is a method of quantitative chemical analysis. It involves the determination of concentration of a solution by making use of another suitable solution whose concentration is accurately known. The reactants in the form of solutions are made to react.

MOLARITY OF A SOLUTION : It is the number of gram moles of solute present in one litre of solution.

NORMALITY OF A SOLUTION: It is the number of gram equivalents of solute present in one litre of solution.

STANDARD SOLUTION: The solution whose concentration is known is called a standard solution. A standard solution contains a known weight of a substance in a known volume of the solution.

TITRATION AND END POINT : It is the process of finding out the exact volume of a solution required to react completely with a known volume of standard solution. *The exact stage at which a reaction is just complete is called the end point of the titration.*

INDICATORS : These are the substances used in volumetric analysis to point out the end point of a chemical reaction by change of colour. The common indicators used for acid-base titration are methyl orange and phenolphthalein.

PHENOLPTHLALEIN: It is a colourless weak acid with pH range 8 — 9.8. This indicator appears as colourless in acid and pink in alkali solution.

METHYL ORANGE : It is a weak base with pH range of 3.1 — 4.5. This indicator appear golden yellow colour in basic medium and red orange colour in acid medium. *The choice of indicators of a titration depends upon the nature of the acid and base.* If both acid and base are strong either phenolphthalein or methyl orange can be used. in titrations of strong base against weak acid only phenolphthalein can be used and if base is weak and acid is strong, only methyl orange can be used as indicator.

PRINCIPLES OF VOLUMETRIC ANALYSIS: Let V_1 and V_2 be the volume of solutions reacting. If N_I and N_2 are the Normality's of the two solutions respectively, then by normality formula , $N_1V_1 = N_2V_2$

ACIDIMETRY AND ALKALIMETRY: Estimation of alkali solutions using standard acid solution is called acidimetry.

In reactions between acid and alkali, indicators commonly used are phenolphthalein and methyl orange. Phenolphthalein is pink in alkali solution but colourless in acid solution. When one or two drops of the indicator are added to an alkali solution, the whole solution turns pink. But when acid is carefully added to the pink solution, the solution turns from pink to colourless when alkali is completely neutralized by the acid. The end point is reached when the colour just changes from pink to colourless.

PERMANGANOMETRY : Estimation of substances using potassium permanganate is known as permanganometry. Potassium permanganate $KMn0_4$) is a strong oxidizing agent. It is largely used as a titrant for the estimation of various reducing agents such as oxalic acid, ferrous sulphate, Mohr's salt etc. The titration is carried out in acidic medium. The solution is made sufficiently acidic so as to prevent the formation of manganese dioxide or potassium manganate. The oxidizing action of KMn04 is due to the following reaction.

$$2\ KMnO_4 + 3\ H_2SO_4 \rightarrow K_2SO_4 + 2\ MnSO_4 + 3\ H_20 + 5\ [0]$$

This oxygen oxidizes reducing agents such as oxalic acid, ferrous sulphate etc. During the reaction, KMn04 undergoes reduction to form colourless potassium sulphate and Manganous sulphate.

Using a standard solution of potassium permanganate, solutions of reducing agents can be estimated. Potassium permanganate solution is pink in colour and when reduced, changes into potassium and manganous salts which are colourless in solution. Therefore reducing agents decolourise the pink solution. So no other indicator is required to denote the end point in the titrations with potassium permanganate. Potassium permanganate acts as a self indicator. KMn04 solution should always be taken in the burette. The upper meniscus burette reading to be taken.

PREPARATION OF STANDARD SOLUTIONS

In volumetric analysis, the amount of a substance (acid, base or salt) is estimated using a standard solution. A solution of known concentration (Normality or Molarity) is called a standard solution. Some of the standard solutions are prepared by weighing out accurately and dissolving the weighed solute in a suitable solvent and making up the solution to a known volume. Standard solutions of oxalic acid, sodium carbonate, ferrous ammonium sulphate (Mohr's salt) etc. are prepared in this way. These substances are available in the pure form and are called primary standard substances. Their solutions of known concentrations are called primary standard solutions as other solutions are standardized against them. A primary standard substance must have the following characteristics:

(1) It should be easily available in the pure state, (2) It should be stable and unaffected by the atmosphere

(3) It should not decompose on storage, (4) It should be readily soluble in water.

Substances which do not meet the above requirements are called secondary standard substances. Standard solutions of these substances cannot be prepared by dissolving their known amount in a solvent. For the preparations of standard solutions of such substances, as HCl, H_2SO_4, $KMnO_4$, NaOH etc. solutions of approximate concentration are prepared and then standardized by titratin.g against a suitable primary standard solution.

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Expt. No : 1

Date: ....

PREPARATION OF STANDARD Na_2CO_3 SOLUTION

AIM: To prepare 250 ml of 0.5 N Na_2CO_3 solution.

CALCULATIONS:

Molecular weight of Na_2CO_3 = 106

Equivalent weight of Na_2CO_3 = Molecular weight / acidity = 106/2 = 53

Weight of Na_2CO_3 required to prepare 1000 ml of 1 N Na_2CO_3 solution = 53 g

Weight of Na_2CO_3 required to prepare 1000 ml of 0.5 N Na_2CO_3 solution = 53/2 = 26.5 g

Weight of Na_2CO_3 required to prepare 250 ml of 0.5 N Na_2CO_3 solution = 26.5/4 =6.625 g

APPARATUS REQUIRED: Standard flask, beaker, watch glass, glass rod, funnel etc.

PROCEDURE: 6.625 g of Na_2CO_3 is accurately weighed in a watch glass by using a chemical balance. Sodium carbonate is transferred from the watch glass to a 250 nil beaker carefully. Sticking particles from it are removed with a fine spray of distilled water from a wash bottle in such a way that washing should fall in the beaker. The entire solution is transferrc:d into 250 ml standard flask with distilled water. The interior of the beaker is washed several times with distilled water and the washings transferred into the measuring flask. Now, more distilled water is added from a wash bottle taking care not to fill upto the mark but a little below the mark. Finally a few drops of distilled water is added with a pipette until the lower level of the meniscus just coincides the graduated mark on the standard flask: The measuring flask i then stoppered and shaken vigorously for a few minutes to make the solution homogenious.

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Expt. No : 2

Date: ....

PREPARATION OF STANDARD OXALIC ACID SOLUTION

AIM: To prepare 250 ml of 0.1 N oxalic acid solution

CALCULATIONS

Molecular weight of crystalline oxalic acid ($H_2C_2O_4 . 2H_20$) = 126 Equivalent weight of oxalic acid = Molecular weight /Basicity = 126/2 = 63

Weight of oxalic acid required to prepare 1000m1 of 1N oxalic acid solution. = 63 g

Weight of oxalic acid required to prepare 1000 ml of 0.1 N oxalic acid solution. = 63/10 = 6.3 g

Weight of oxalic acid required to prepare 250 ml of 0.1N oxalic acid solution. = 6.3/4 = 1.575 g

APPARATUS REQUIRED: Standard flask, beaker watch glass, glass rod, funnel etc.

PROCEDURE: 1.575 g of oxalic acid is accurately weighed in a watch glass by using a chemical balance. Oxalic acid is transferred from the watch glass to a 250 ml beaker carefully. Sticking particles form it are removed with a fine spray of distilled water from a wash bottle in such a way that washings should fall in the beaker. The entire solution is transferred into 250 ml standard flask with distilled water. The interior of the beaker is washed several times with distilled water and the washings transferred into the measuring flask.

Now, more distilled water is added from a wash bottle taking care not to fill up to the mark but a little below the mark. Finally a few drops of distilled water is added with a pipette until the lower level of the meniscus just coincides the graduated mark on the standard flask. The measuring flask is thenstoppered and shaken vigorously for a few minutes to make the solution homogenous.

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Expt. No : 3

Date: ....

ESTIMATION OF HYDROCHLORIC ACID

Aim:- (1)To determine the Normality of the given HC1 solution using a standard solution of NaOH containing 4 g of NaOH per litre. (2)To calculate the amount of HC1 present in 500 ml of the solution.

Apparatus required: 50 ml burette, 20 ml pipette, 250 ml conical flask etc.

Principle:- Standardisation of HCl is based on the neutralization of HCl by NaOH solution.

$HCl + NaOH \rightarrow NaCl + H_20$

A known volume of standard NaOH solution is titrated against HC1 using phenolphthalein as indicator. Since we know the volume and normality of NaOH and the volume of HCl required to neutralize the NaOH, the normality of HCl can be calculated.

Procedure:- A burette is washed with water and rinsed with the given HCl solution. The burette is filled with the HC1 solution, the tap is opened and the nozzle of the burette also is filled with the acid. After air bubbles have escaped, the level of the acid is brought to the zero mark and te reading of the burette is noted Clamped the burette in the burette stand. A pipette is washed with water and rinsed with the NaOH solution. Pic^{s}etted out 20 ml of NaOH solution into a clean conical flask. Added one or two drops of phenolpththalein to the solution in the conical flask. The solution turned pink. Hydrochloric acid from the— burette is added to the NaOH solution in the conical flask, little by little. Meanwhile the flask is kept gently shaking. The addition of the acid is stopped when the pink colour is just discharged. This is the end point of the titration. The final reading of the burette is noted and the titration is repeated to get concordant values.

Result :-

1. Normality of the given HCl solution = ... N
2. Weight of HCl in 500 ml of the solution = ... g

Observation

Std NaOH Vs HCl (Phenolphthalein)

Trial No	Burette Reading(in ml)		Volume HCl Used(in ml)
	Initial	Final	

Titre Value=……….ml

$N_1V_1=N_2V_2$

N_1= Normality of NaOH solution= (Wt per litre) / (Eqvt wt) =4/40= 0.1N

V_1= Vol of NaOH sol^n = 20ml

V_2= Vol of HCl sol^n = ……….ml

N_2= Normality of HCl solution=(N_1V_1) / V_2 =(0.1N x 20) / (………) =….N

Normality = (Wt per litre) / (Eqvt wt)

(Wt per litre) = Normality x Eqvt wt

Wt of HCl in 1L sol^n , w = Normality of HCl x Eqvt wt of HCl = N_2 x 36.5 = ……..x 36.5 = …………g

Wt of HCl in 500ml sol^n = w/2 =……….g

Expt. No : 4

Date: ....

ESTIMATION OF H_2SO_4

Aim: - (1)To determine the normality of the given sulphuric acid solution using standard solution of Na_2CO_3 containing 5.6 g per litre (2) To calculate the weight of H_2SO_4 in 250 ml of the solution.

Principle :- The experiment is based on the neutralization of H_2SO_4 with Na_2CO_3

$Na_2CO_3 + H_2SO_4 \rightarrow 4\ Na_2SO_4 + H_20 + CO_2$

A definite volume of the standard sodium carbonate solution is titrated against the H_2SO_4 solution using methyl orange indicator. Methyl orange is golden yellow in alkali solution and orange red in acid solution. From the titre value, thenormality of the H_2SO_4 solution and the weight of H_2SO_4 per litre can be calculated knowing that the equivalent weight of H_2SO_4 is 49.

Procedure : A pipette is washed with water and rinsed with the given Na_2CO_3 solution. 20 ml of the Na_2CO_3 solution is pipetted out into a clean conical flask. One or two drops of methyl orange indicator is added to the solution so as to impart to it a golden yellow colour. A burette is washed with water and rinsed with the H_2SO_4 solution and filled with it. After air bubbles have escaped, the level of the acid is brought to the zero mark and the reading of the burette is noted. The solution in the conical falsk is titrated against H_2SO_4 taken in the burette. The addition of the acid is stopped when the golden yellow colour just changes to orange red. The Titration is repeated till concordant values are obtained. From the titre value, the noimality and weight of H_2SO_4 per litre can be calculated.

Result :- 1. Normality of the H_2SO_4 solution = ...N

2. Weight of H_2SO_4 in 250 ml of the solution = g

Observation

Std Na_2CO_3 Vs H_2SO_4 (Methyl orange)

Trial No	Burette Reading(in ml)		Volume H_2SO_4 Used(in ml)
	Initial	Final	

Titre Value =…………………..ml

Calculation:

$$N_1V_1=N_2V_2$$

N_1= Normality Na_2CO_3 of solution= (Wt per litre) / (Eqvt wt) =5.6/53= 0.1056N

V_1= Vol of Na_2CO_3 sol^n = 20ml

V_2= Vol of H_2SO_4 sol^n = ……….ml

N_2= Normality of H_2SO_4solution=(N_1V_1) / V_2 =(0.1056N x 20) / (………) =…. N

Normality = (Wt per litre) / (Eqvt wt)

(Wt per litre) = Normality x Eqvt wt

Wt of H_2SO_4 in 1L sol^n , w = Normality of H_2SO_4 x Eqvt wt of H_2SO_4 = N_2 x 49 = ……..x 49 = ………….g

Wt of H_2SO_4 in 250ml sol^n = w/4 =……….g

Expt. No : 5

Date: ....

ESTIMATION OF NaOH

Aim:- (1)To determine mine the normality of the given NaOH solution using a standard solution of Na_2CO_3 containing 5.4 g per litre of solution and a link solution of H_2SO_4 (2) To calculate the amount of NaOH present in 250 ml of solution

Principle:- The experiment involves double titration. First titration is standardization of the link solution H_2SO_4 using a. standard solution of Na_2CO_3

$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_20 + CO_2$$

The second titration involves estimation of NaOH using standard H_2SO_4. It is based on the neutralization of the acid with NaOH $2\ NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_20$

Procedure:-

(A) **Standardization of sulphuric acid :** A burette is washed with water and rinsed with the given H_2SO_4 solution. It is filled with the given H_2SO_4 solution, the level of the acid is brought to the zero mark and the reading of the burette is noted.

20 ml of the Na_2CO_3 solution is transfered into a clean conical flask after rinsing a clean pipette with the alkali solution. One or two drops of methyl orange indicator is added to the solution in the conical flask. It is then titrated against the H_2SO_4 solution till golden yellow colour of the solution is changed to orange red. The final reading of the burette is noted. The titration is repeated to get concordant values. From the titre value, the normality of H_2SO_4 can be calculated.

(B) Estimation of NaOH: A pipette is washed with water and rinsed with the given NaOH solution. 20 ml of NaOH solution is pipetted out into a clean conical flask. One or two drops of phenolphthalein indicator is added to the solution in the conical flask so as to get a pink colour to it. It is then titrated against H_2SO_4 solution taken in the burette. The end point is the disappearance of pink colour. The titration is repeated to get concordant values. From the titre value, the normality and weight per litre of NaOH can be calculated.

Result :- 1. Normality of the NaOH solution = ... N

2. Weight of NaOH in 250 ml of the solution = ...g

Observation

Std Na_2CO_3 Vs H_2SO_4 (Methyl orange)

Trial No	Burette Reading(in ml)		Volume H_2SO_4 Used(in ml)
	Initial	Final	

Titre Value =…………………..ml

Calculation:

$N_1V_1=N_2V_2$

N_1= Normality Na_2CO_3 of solution= (Wt per litre) / (Eqvt wt) =5.4/53= 0.1018N

V_1= Vol of Na_2CO_3 sol^n = 20ml

V_2= Vol of H_2SO_4 sol^n = ……….ml

N_2= Normality of H_2SO_4solution=(N_1V_1) / V_2 =(0.1056N x 20) / (………) =…. N

Observation

Std H_2SO_4 Vs NaOH (Phenolphthalein)

Trial No	Burette Reading(in ml)		Volume H_2SO_4 Used(in ml)
	Initial	Final	

Titre Value =…………………..ml

Calculation:

$N_1V_1=N_2V_2$

N_1= Normality of H_2SO_4solution……….N

V_1= Vol of H_2SO_4 sol^n = ……….ml

V_2= Vol of NaOH sol^n = 20ml

N_2= Normality of NaOH solution =(N_1V_1) / V_2 =(…….N x 20) / (………) =…. N

Normality = (Wt per litre) / (Eqvt wt)

Wt of NaOH in 1L sol^n , w = Normality of NaOH x Eqvt wt of NaOH = ……..x 40 = ………….g

Wt of NaOH in 250ml sol^n = w/4 =……….g

Expt. No : 6

Date: ....

ESTIMATION OF HNO_3

Aim:- (i)To determine the strength of the given HNO_3 solution using a standard solution of oxalic acid containing 6.2 g of crystalline oxalic cal in one litre of solution and a link solution of NaOH. (2)To calculate the amount of HNO_3 present in 250 ml of the given solution

Principle:- This experiment involves double titration. First sodium hydroxide solution is standardized using the standard solution of oxalic acid. $H_2C_2O_4 + 2NaOH \rightarrow Na_2C_2O_4 + 2H_2O$

The second titration involves the estimation of HNO_3 using the standardized NaOH

$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$

Procedure:-

1. **Standardization of NaOH:** A burette is washed with water and rinsed with the given standard solution of oxalic acid. The initital reading of the burette is noted. A pipette is washed with water and rinsed with the given NaOH solution. 20 ml of the NaOH solution is pipetted out into a clean conical flask. One or two drops of phenolphthalein indicator is added to the NaOH solution and titrated against oxalic acid from the burette, till the pink colour of the solution is just disappeared. The titration is repeated to get concordant values.

2.Estimation of HNO_3: A burette is washed with water and rinsed with the given HNO_3 solution. It is filled with HNO_3 solution, the level of the acid is brought to the zero mark and the reading of the burette is noted.

20 ml of the solution is transferred into a clean conical flask after rinsing a clean pipette with the alkali solution. One or two drops of phenolphthalein indicator is added to the solution in the conical flask. It is then titrated against the HNO_3 solution till pink colour of the solution is just disappeared. The final reading of the burette is noted. The titration is repeated to get the concordant values. From the titre value, the normality of HNO_3 can be calculated.

Result: 1. Normality of the given HNO_3 solution = ... N

2. Weight of HNO_3 solution in 250 ml of the solution = ...g

Observation

Std Oxalic acid Vs NaOH (Phenolpthalein)

Trial No	Burette Reading(in ml)		Volume Oxalic acid Used(in ml)
	Initial	Final	

Titre Value =…………………..ml

Calculation:

$$N_1V_1=N_2V_2$$

N_1= Normality Oxalic Acid of solution= (Wt per litre) / (Eqvt wt) =6.2/63= 0.0984N

V_1= Vol of Oxalic Acid sol^n = ………ml

V_2= Vol of NaOH sol^n =20ml

N_2= Normality of NaOH solution=(N_1V_1) / V_2 =(……. x ……..) / (20) =… … N

Observation

Std NaOH Vs HNO_3 (Phenolpthalein)

Trial No	Burette Reading(in ml)		Volume HNO_3 Used(in ml)
	Initial	Final	

Titre Value =…………………..ml

Calculation:

$$N_1V_1=N_2V_2$$

N_1= Normality of NaOHsolution ……….N

V_1= Vol of NaOH sol^n = 20ml

V_2= Vol of HNO_3 sol^n = ………ml

N_2= Normality of HNO_3 solution =(N_1V_1) / V_2 =(…….N x 20) / (………) =…. N

Normality = (Wt per litre) / (Eqvt wt)

Wt of HNO_3 in 1L sol^n , w = Normality of NaOH x Eqvt wt of NaOH = ……..x63 = ………….g

Wt of NaOH in 250ml sol^n = w/4 =……….g

Expt. No : 7

Date: ....

ESTIMATION OF $KMnO_4$

Aim: - To determine the Normality and weight of $KMNO_4$ in 500 ml of the given solution. You are provided with 0.1 N Ferrous sulphate solution

Principle:- Potassium permanganate reacts with $FeSO_4$ according to the following equations

$2\ KMnO_4 + 3\ H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_20 + 5\ [0]$

$2\ FeSO_4 + H_2SO_4 + [0] \rightarrow Fe_2(SO_4)_3 + H_20$ A known volume of standard solution of $FeSO_4$ is titrated against $KMnO_4$ solution in presence of dilute sulphuric acid. From the titre value, the strength of $KMn0_4$ can be calculated.

Apparatus required:- Burette, pipette, conical flask, wash bottle etc.

Procedure:- A burette is washed with water and rinsed with the given $KMn0_4$ solution. The burette is filled withthe solution, the tap is opened and the nozzle of the burette also is filled with the $KMnO_4$ solution. After air bubbles have escaped, the upper meniscus of the solution is brought to the zero mark and the reading of the burette is noted.

A pipette is washed with water and rinsed With the given $FeSO_4$ solution. 20 ml of the $FeSO_4$ solution is pipetted out into a clean conical flask About 25 ml of dilute sulphuric acid solution is added to the solution in the conical flask and titrated against potassium pernianganato solultion. The end point is indicated by the appearance of palepink colour. Titration is repeated till concordant values are obtained. From the titre value, the normality of $KMnO_4$ solution can be calculated.

Result :- (1) Normality of $KMnO_4$ solution =..N

(2) Weight of $KMnO_4$ in 500 ml of solution =.......................... g

Observation

Std $FeSO_4$ Vs $KMnO_4$

Trial No	Burette Reading(in ml)		Volume HCl Used(in ml)
	Initial	Final	

Titre Value =…………………..ml

Calculation: $N_1V_1=N_2V_2$

N_1= Normality of $FeSO_4$ solution= 0.1N

V_1= Vol of $FeSO_4$ sol^n = 20ml

V_2= Vol of $KMnO_4$ sol^n = ……….ml

N_2= Normality of $KMnO_4$ solution=(N_1V_1) / V_2 =(0.1N x ……..) / (………) =….N

Normality = (Wt per litre) / (Eqvt wt)

Wt of $KMnO_4$ in 1L sol^n , w = Normality of $KMnO_4$ x Eqvt wt of $KMnO_4$ = N_2 x 31.6 = ……..x 31.6 = …………g

Wt of $KMnO_4$ in 500ml sol^n = w/2 =……….g

Expt. No : 8

Date: ....

ESTIMATION OF $KMnO_4$

Aim:- (1) To determine the strength of the given potassium permanganate solution using standard solution of ferrous ammonium sulphate (Mohr's salt) containing 39.4 g per litre. (2) To calculate the amount of potassium permanganate present in 100 ml of the solution

Principle:- Mohr's salt is hydrated ferrous ammonium sulphate, $FeSO_4\ (NH_4)_2\ SO_4\ .\ 6\ H_2O$. It is a reducing agent due to the presence of $FeSO_4$ in its Molecule. Potassium permanganate reacts with ferrous sulphate contained in Molar 's salt according to the following equations.

$$2\ KMnO_4 + 3\ H_2SO_4 \rightarrow 4\ K_2SO_4 + 2\ MnSO_4 + 3\ H_20 + 5\ [0]$$

$$2\ FeSO_4 + H_2SO_4 + [0] \rightarrow 4\ Fe_2\ (SO_4)_3 + H_20$$

Procedure:- A pipette is washed with water arid rinsed with the given Mohr's salt solution. 20 ml of the standard Mohr's salt solution is pipetted out into a clean conical flask. About 20 ml of dilute sulphuric acid is added to it. A burette is washed with water and rinsed with the $KMnO_4$ solution and filled with it. After air bubbles have escaped, the level of the acid is brought to the zero mark and the reading of the burette is noted. The solution in the conical flask is titrated against $KMnO_4$ solution taken in the burette. The end point is the appearance of pale permanent pink colour. The titration is repeated to get concordant values. From the titre value, the normality and weight per litre of $KMnO_4$ can be calculated.

Result:- 1. Normality of $KMnO_4$ solution = ...N

2. Weight of $KMnO_4$ in 100 nil of the solution = ...g

Observation

Std Mohr's salt Vs $KMnO_4$

Trial No	Burette Reading(in ml)		Volume HCl Used(in ml)
	Initial	Final	

Titre Value =…………………..ml

$$N_1V_1=N_2V_2$$

N_1= Normality of Mohr's Salt solution= 0.1N

V_1= Vol of Mohr's Salt sol^n = 20ml

V_2= Vol of $KMnO_4$ sol^n = ……….ml

N_2= Normality of $KMnO_4$ solution=(N_1V_1) / V_2 =(0.1N x ……..) / (………) =….N

Normality = (Wt per litre) / (Eqvt wt)

Wt of $KMnO_4$ in 1L sol^n , w = Normality of $KMnO_4$ x Eqvt wt of $KMnO_4$ = N_2 x 31.6 = ……..x 31.6 = …………..g

Wt of $KMnO_4$ in 100ml sol^n = w/10 =……….g

PHYSICS LAB MANUAL(105)

VERNIER CALIPERS

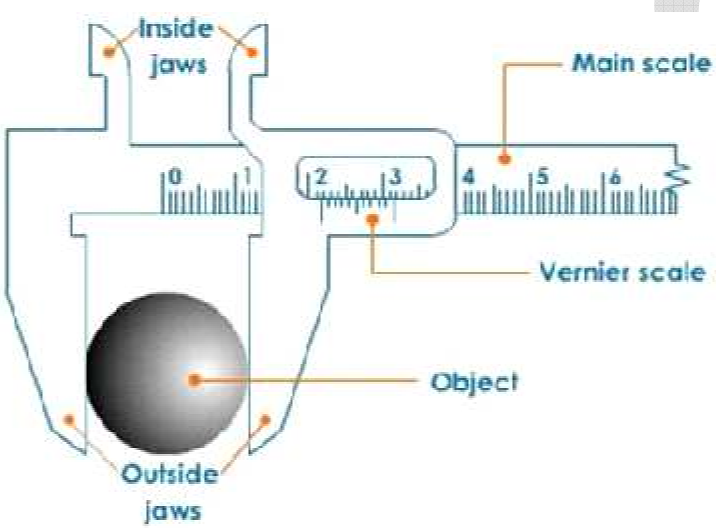
Aim: To determine the volume of the given hollow cylinder.

Apparatus: Vernier calipers, hollow cylinder.

Principle: Least Count = Value of 1 main scale division / No. of divisions on vernier.

Total reading = MSR+(VSR × LC)……

Volume of hollow cylinder = ð h $(R^2 - r^2)$



Procedure: The least count of the apparatus is determined first. The apparatus is then checked to find the zero correction, if any. To check this, the two jaws are kept in contact. If the zero of the main scale coincides with the zero of the vernier, there is no zero error. If the zero of the vernier is on to the right of main scale zero, it is a case of positive zero error and the zero correction is negative, if zero of vernier is on to the left of main scale zero, zero error is negative and zero correction is positive. Now the cylinder is gently gripped in between the jaws to find the length. The reading of the main scale just before the zero of the vernier is noted as the MSR (Main Scale Reading). The vernier scale division coinciding with any division on the main scale is noted as the VSR (Vernier Scale Reading). Now the total reading is calculated using the formula (MSR+ VSR×LC).The procedure is repeated at least 4 times and the mean value is calculated as h.

Similarly, the external diameter and the internal diameter of the cylinder are determined. The external radius R and internal radius r are then calculated. The volume is determined using the formula $\pi h (R^2 - r^2)$.

Observations:

Value of 1 main scale division = ……….mm

No. of divisions on vernier = …………..

Least count = value of 1 main scale division / No. of divisions on the vernier = ………….. mm

Zero correction = …………

To find height h

Trial no.	MSR(mm)	VSR	MSR + (VSR×LC)	Corrected Reading
1				
2				
3				

Mean height h = …………mm

To find external diameter D

Trial no.	MSR (mm)	VSR	MSR + (VSR × LC)	Corrected Reading
1				
2				
3				

Mean diameter D = …………mm

External radius R = ………….mm

To find internal diameter d

Trial no.	MSR (mm)	VSR	MSR + (VSR × LC)	Corrected Reading
1 2 3				

Mean diameter d = ………..mm

Mean radius r = ………………..mm

Volume of the hollow cylinder v = $\pi h (R^2 - r^2)$ = ……………………….mm^3

=………………………× 10^{-9} m^3

Result:

Volume of the given cylinder **=** ………………m^3

SCREW GAUGE

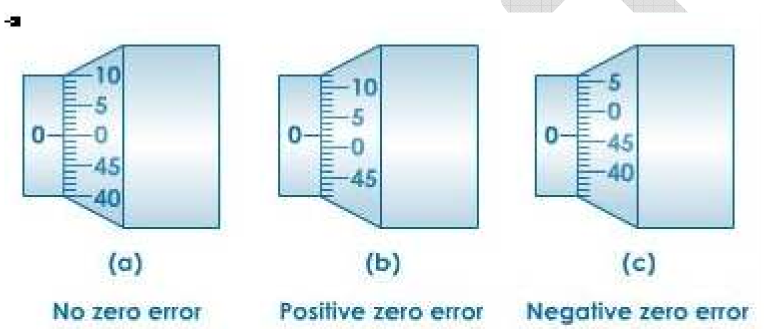
Aim: To determine the volume of the given glass plate.

Apparatus: Screw gauge, glass plate

Principle: Pitch p is the distance advanced by the screw during one rotation. Least count is the distance advanced by the screw as it is rotated through one division.

Least count = pitch / No. of divisions on Head scale Total reading = PSR + Correct HSR × LC

Volume of the glass plate = Area × Thickness.



Procedure: The apparatus is first of all checked to find the zero correction if any. For this, the screw is tightened without keeping any object in between the screw tip and stud. If the zero of the Head scale coincides with the reference line, there is no zero error. No correction is needed in such case. But if the zero of the head scale is above the index line, zero correction is positive. If the zero of the head scale is below the reference line the zero correction is negative.

The pitch of the screw is then found out. For this, the screw is rotated 4 times and the distance moved by the screw due to one rotation (pitch) is calculated. Now, the number of divisions on the vernier is noted and the least count is calculated.

The glass plate is gently gripped in between the screw tip and the stud. The last fully visible reading on the pitch scale is noted as the Pitch Scale Reading (PSR).The reading of the head scale against the reference line is noted as the observed HSR. The zero correction is accounted with this observed HSR and the correct HSR is calculated. Now the total reading is calculated using the formula PSR + (correct HSR × LC). The experiment is repeated by keeping the glass plate at different positions and the mean thickness is determined.

The glass plate is then placed on a graph plate and the area of the glass plate is determined. The volume is then calculated using the formula Area × Thickness.

Observations:

Distance moved for 4 rotations = ………………………..mm

Distance moved for 1 rotation = ……………………..mm

No. of divisions on the head scale =

Least count = pitch / no. of divisions on head scale = ………………..mm

Zero correction = ………..head scale divisions

Trial no.	PSR	Observed HSR	Corrected HSR	PSR+(Corrected HSR× LC)
1 2 3				

Mean thickness t = …………….mm

Area from the graph A = …………….mm^2

Volume of the glass plate A × t = …………mm^3 = ………………. $\times 10^{-9} m^3$

Result:

Volume of the glass plate = …………………m^3

COMMON BALANCE

Aim: To determine the mass of a given body by sensibility method.

Apparatus: Common balance, standard masses

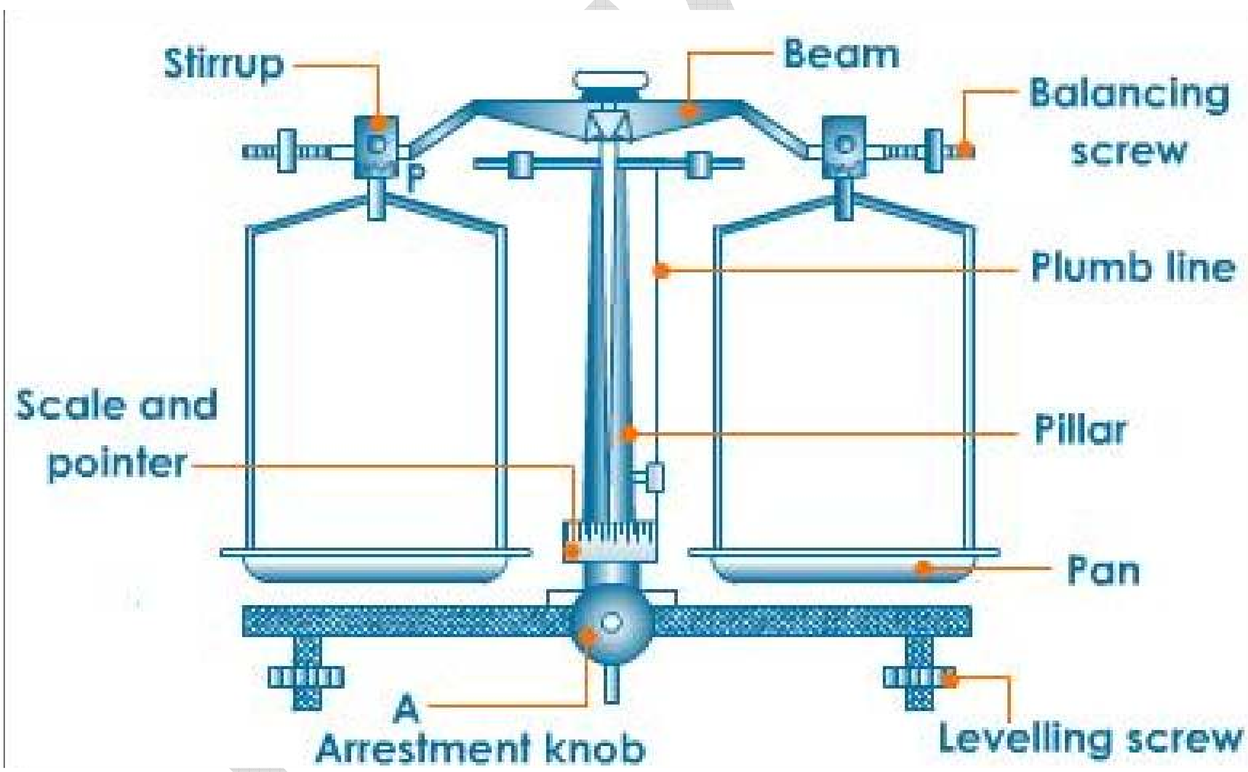
Principle: Resting point is the division against which the pointer comes to rest. Sensibility is the mass required to change the resting point by one division.

Sensibility (s) = $0.01 / (R_0 - R_{10})$

Where R_0 is the zero resting point and R_{10} the resting point after adding 10mg to the right pan.

Correct mass $m = w + s\,(R - R_0)$

Where R is the resting point when a mass of w kept in the right pan is balanced with the body.



Procedure: At the beginning, the beam is released and it is ensured that the pointer makes approximately equal oscillations to both sides. If necessary, the screws at the ends of the beam are adjusted.

By keeping the pans empty, five consecutive turning points are noted beginning from left (3 on left and 2 on right). The average of the left turning points and the average of right turning points are noted. The average of the two averages gives the zero resting point R_0. By keeping 10mg in the right pan, the turning points are noted and the resting point is calculated as R_{10}. Now the sensibility of the balance is

The body is placed in the left pan and standard masses are added to the right an so that the pointer oscillates almost equally from the equilibrium position. The turning points are noted and the resting point R is calculated. The mass w kept in the right pan is noted. Now, the correct mass of the body is calculated using the formula $w + s\,(R - R_0)$.

Body in pans		Turning points		Mean Left	Mean Right	Resting point
Left	Right	Left	Right			
0	0					R_0 =
0	10mg					R_{10} =
Body	W=……….g					R =

Sensibility (s) = $0.01 / (R_0 - R_{10})$ = …………………….. g/ div

Correct mass m = $w + s\,(R - R_0)$ = ……………………g

= ………………….. $\times 10^{-3}$ kg

Result: Mass of the given body = …………………….. Kg

SIMPLE PENDULUM

Aims: 1. To determine the value of acceleration de to gravity g 2. To determine the length of the seconds pendulum.

Apparatus: Simple pendulum, stop watch

Principle: Acceleration due to gravity $g = 4\pi^2 \times l/T^2$

A seconds pendulum is a simple pendulum having period of 2 seconds.

Procedure: The pendulum is set for a length 0.6m. (Length if the pendulum is the distance between the point of suspension and the centre of gravity of the bob). The time for 20 oscillations is noted and the period is calculated. This is repeated and the mean value of period is taken. The experiment is repeated for lengths 0.7m, 0.8m, 0.9m and 1m and in each case the value of l/T^2 is used to determine g.

A graph is plotted with length along the X-axis and T^2 along the Y-axis. A straight line graph is drawn including maximum number of points. From the graph determine the value of length corresponding to T^2 equal to 4.

Observations:

Trial no.	Length l (m)	Time 1	2	Mean t	Period T= t/20	T^2	l/T^2
1	0.6						
2	0.7						
3	0.8						
4	0.9						

Mean l/T^2 = …………………

$g = 4\pi^2 \times l/T^2$ = …………………… m/s^2

Results:

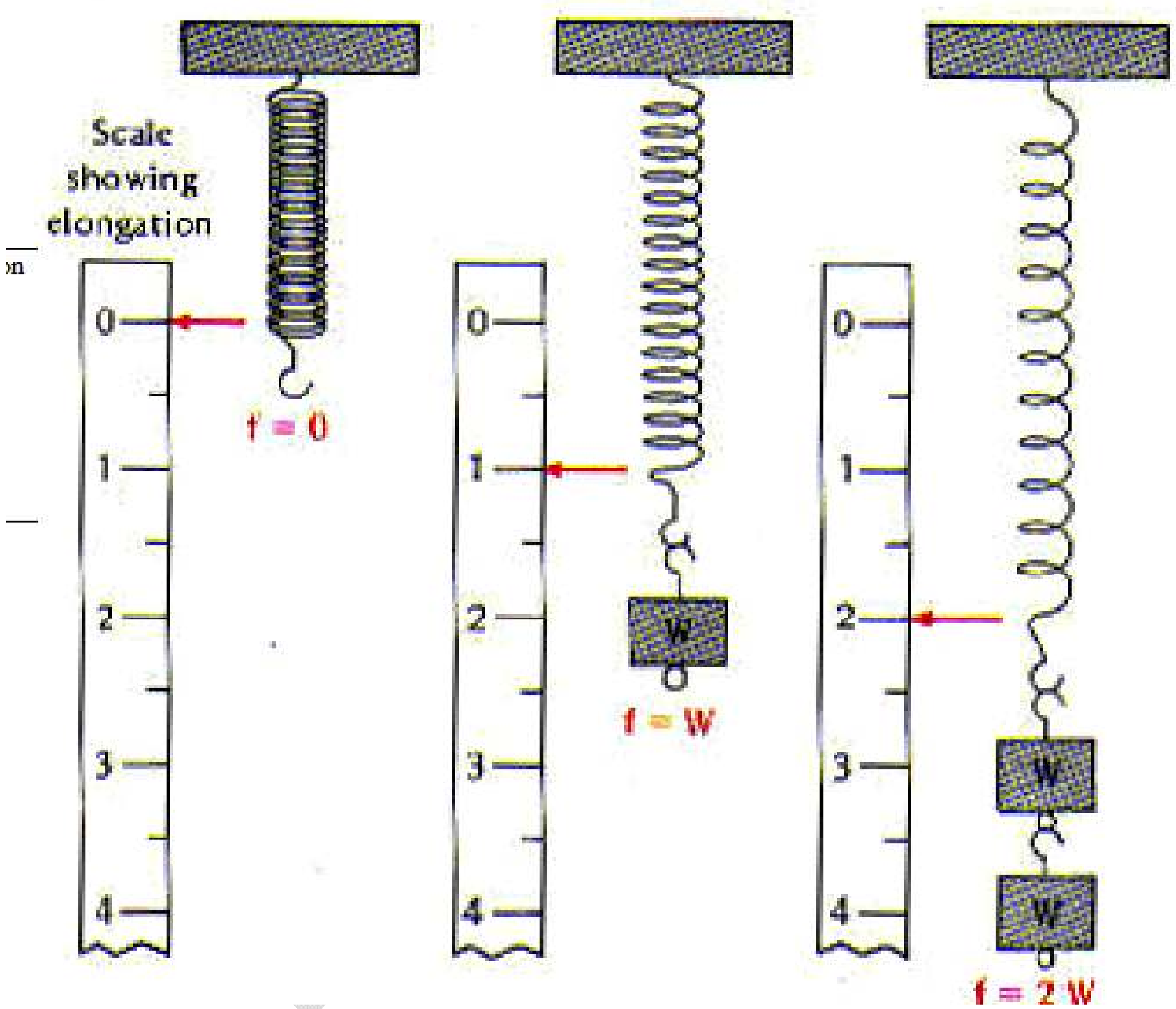
1. Acceleration due to gravity g = …………………… m/s^2
2. Length of seconds pendulum = …………………… m.

HOOKE'S LAW

Aim: To determine the mass of the given body.

Apparatus: Hooke's law apparatus, standard masses

Principle: According to Hooke's law, the extension produced on a body is directly proportional to the load applied.Hence, mass of the body = Mean (Load/extension)× extension produced.



Procedure: The spring is brought to the elastic mood by loading and unloading it a number of times. Now the spring is loaded in steps of 50gm and in each case the reading of the pointer is taken. The readings are taken in steps of 50gm during unloading also. Now the extension for each load is calculated.

The given body is suspended from the hanger and the extension is noted. From the extension, the mass of the body can be determined.

Observations:

NO.	Load (g)	Pointer Reading			Extension	Load/Extension
		Loading	Unloading	Mean		
1	**0**					
2	**50**					
3	**100**					
4	**150**					
5	**200**					

Mean (Load / extension)=

Extension produced for the body =

Mass of the body = Mean(Load / extension)× extension produced= …………g = ……………..× 10^{-3}kg

Result: Mass of the body = …………….kg

OHM'S LAW

Aim:To verify Ohm's law and to determine the resistance of a conductor.

Apparatus:Battery, voltmeter, Ammeter, Rheostat, Key, Resistor

Principle: At constant temperature, the current through a conductor is directly proportional to the potential difference.

$V/I = R$ where R is the resistance of the conductor.

Procedure: Connections are made as shown in the figure. The rheostat is adjusted to read a potential of 1V.The corresponding ammeter reading is noted. The voltmeter and ammeter readings are taken by increasing the voltages in steps of 0.5V. In each case, the value of V/I is calculated. Its mean value gives the resistance of the conductor.

Observations:

No.	V (volt)	I (ampere)	R= V/I (ohm)

= 1 cm). The parallelogram is drawn with OA representing the force P and OB representing the force Q. The length of the diagonal OC is measured. OC multiplied with the scale factor (OC × 50gm in this case) gives the mass of the given body.

The experiment is repeated with a different set of weights as P and Q and the mass is again determined.

Observation:

Sl. No.	P	Q	OA	OB	OC	OC × scale	Mean
1							
2							

Result: Mass of the given body = …………..kg

MOMENT BAR

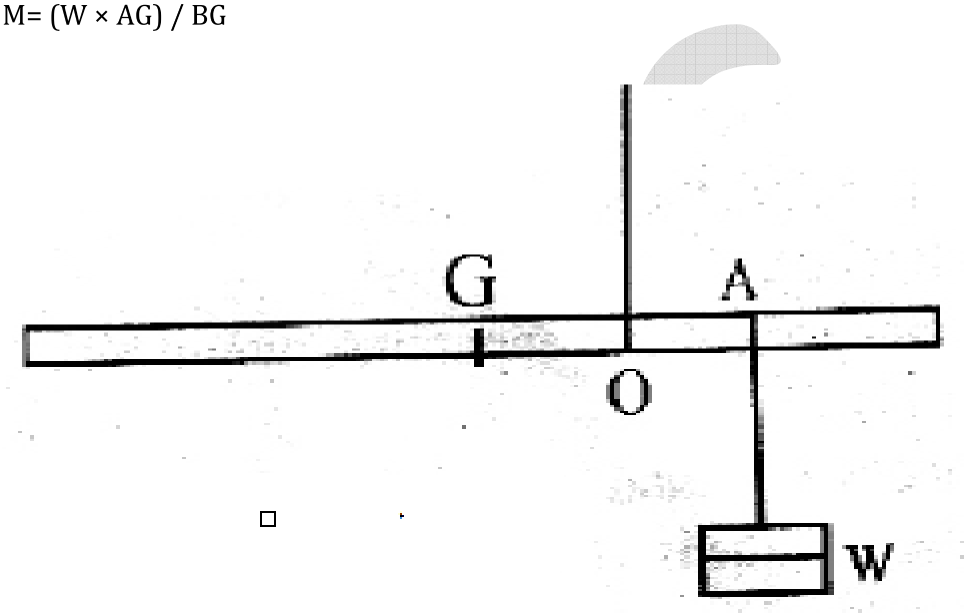
Aim1: To determine the mass of the given body

Apparatus: Moment bar, slotted weights

Principle: For a rigid body supported at its centre of gravity, the anticlockwise moment produced by the weight of the given body is equal to the clockwise moment produced by the slotted weight.

Here, $W \times AG = M \times BG$

Or $M = (W \times AG) / BG$



Procedure: The metre scale is suspended at its centre of gravity G. The given body is suspended on one side at a convenient point B, say at a distance 5cm. Now a standard mass m is suspended on the other side of the string. The position (A) of the standard mass is so adjusted that the scale is in equilibrium keeping the horizontal position. The distance BG is measured and the value of W is calculated. The experiment is repeated for different values of AG and in each case the value of BG is determined.

Observations:

Standard mass W = …………… g

Trial no.	BG (cm)	AG (cm)	$M = (W \times AG) / BG$

Mean m = ………… g = …………… $\times 10^{-3}$ kg

Result: Mass of the given body = ………….kg

Aim2: To determine the mass of the metre scale.

Apparatus: Metre scale, slotted weights

Principle: At the equilibrium position, the anti clockwise moment produced by the weight of the body W is equal to the clockwise moment produced by the slotted weights. Ie, W × AO = m × GO

Or, m= (W × AO) / GO

Procedure: The centre of gravity of the metre scale is located as G using a string. Now, the position of the string is displaced to the right to the position O, let GO= 5cm. The scale will get unbalanced. To counter this, standard mass *W* is suspended from the position A so that the scale is again horizontal. The distance AO is measured, and value of m is calculated. Repeat with different values of GO and the average value is calculated.(the experiment can also be done by changing W).

Observation:

Trial no.	GO (cm)	AO (cm)	m= (W × AO) / GO

Mean m = …………….g = ……………….. × 10^{-3} kg

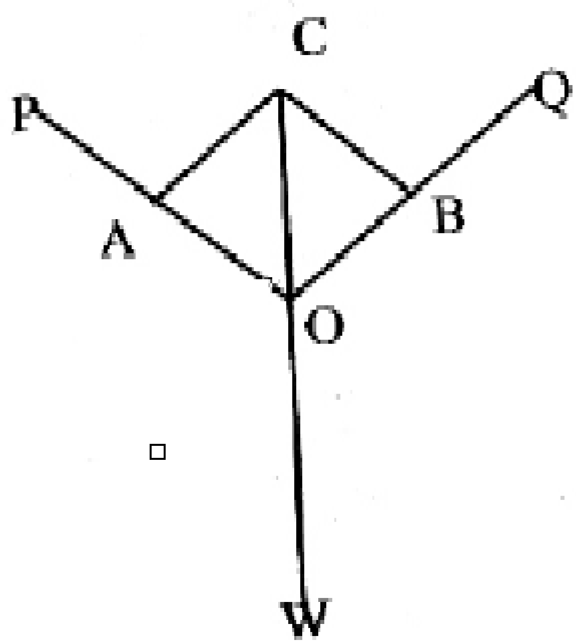
Result: Mass of the given metre scale = ……………… Kg

CONCURRENT FORCES

Aim: To determine the mass of a given body applying parallelogram law.

Apparatus: Parallelogram law apparatus, slotted weights

Principle: If two forces acting at a point are represented in magnitude and direction by the adjacent sides of a parallelogram drawn from the point, the diagonal drawn from the point represents the resultant in magnitude and direction. The length of diagonal multiplied by the scale factor gives the mass of the body.



Procedure: Slotted masses, 100g each are suspended from both sides (P&Q) and the body whose mass is to be determined is suspended from the middle (W). A convenient scale is chosen(eg: 50gm = 1 cm). The parallelogram is drawn with OA representing the force P and OB representing the force Q. The length of the diagonal OC is measured. OC multiplied with the scale factor (OC × 50gm in this case) gives the mass of the given body.

The experiment is repeated with a different set of weights as P and Q and the mass is again determined.

Observation:

Sl. No.	P	Q	OA	OB	OC	OC × scale	Mean
1							
2							

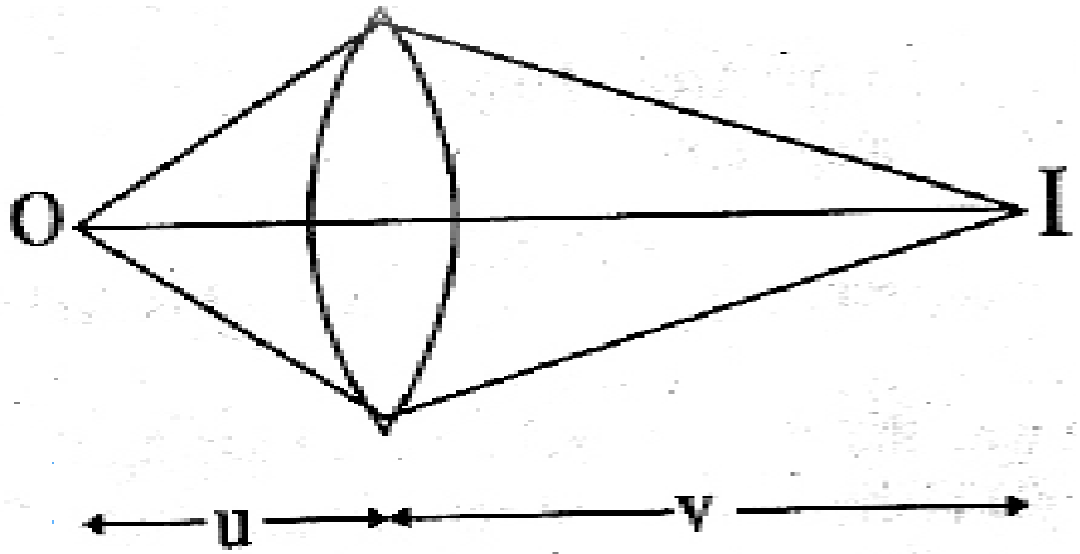
Result: Mass of the given body = …………..kg

CONVEX LENS

Aim: To determine the focal length of the given convex lens.

Apparatus: Convex lens, illuminated wire gauze, screen

Principle: If u is the distance of the object from the lens and v the distance of the image from the lens, then focal length f = uv / (u+v)



Procedure: The convex lens is mounted in front of the object at a convenient distance u. The position of the screen on the other side is so adjusted that a clear image is obtained on it. The distance of the image from the screen is measured as v. Now the focal length is calculated using the formula uv/(u+v). The experiment is to be performed both for magnified and diminished images.

Observations:

Serial no.	U	V	F= uv/(u+v)	Mean f

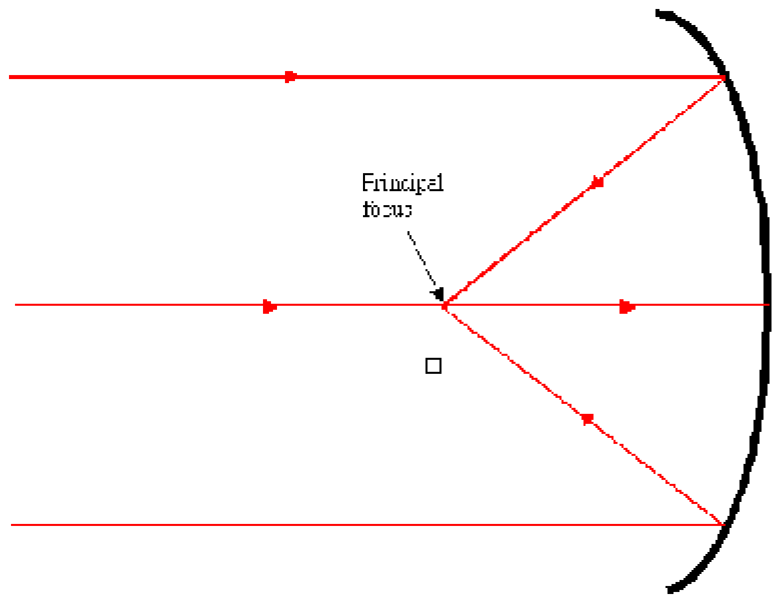
Result: The focal length of the given lens = …………………m

CONCAVE MIRROR

Aim 1: To determine the focal length of the given concave mirror by distant object method.

Apparatus: Concave mirror mounted on a stand, screen

Principle: Image of the distant object is formed at the focus.



Procedure: The mirror is directed towards a distant object and the image is focused on the screen. Distance between the screen and the mirror gives the focal length.

Observation:

	1	2
Distance between the screen and the mirror		

Mean: .... m

Aim 2 : To determine the focal length of the given concave mirror by normal reflection method.

Apparatus: Concave mirror mounted on a stand, illuminated wire gauze

Principle: If an object is placed at the centre of curvature of a concave mirror, the image will be formed at the centre of curvature.

Procedure: The concave mirror is placed in front of the illuminated wire gauze and its position is adjusted till a clear image of the wire gauze is formed by its side. Measure the distance of the wire gauze from the pole of the mirror. This gives radius of curvature. Half of this gives the focal length.

Observations:

	1	2
Distance of the wire gauze from the pole		

Mean R = ………………… m

Focal length f = …………………
m

Result: The focal length of the concave mirror = ………………….. m