महाराष्ट्र राज्य तंत्र शिक्षण मंडळ.

(स्वायत्त) (ISO: ९००१:२००८) (ISO/IES : २७००१-२०१३)

शासकीय तंत्रनिकेतन इमारत, चौथा मजला, ४९, खेरवाडी, बांद्रा (पूर्व), मुंबई - ४०० ०५१.

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परिपत्रक

प्रति,

प्राचार्य,

मंडळाशी संलग्न AICTE अभ्यासक्रम चालविणा-या संस्था

विषय:- Applied Science (Physics & Chemistry) (२२२०२) विषयाचे Lab Manual संकेत स्थळावर प्रसिद्ध करण्याबाबत.

उपरोक्त विषयाच्या अनुषंगाने AICTE Approved अभ्यासक्रमाचे व्दितीय सत्र सुरु झालेले आहे. Applied Science (Physics & Chemistry) (२२२०२) या व्दितीय सत्रातील विषयाच्या प्रात्यक्षिकाचे Load ०२ वरुन ०४ करण्यात आल्याने Lab Manual मध्ये Experiment ची संस्था वाढवून एकुण बारा Experiment करण्यात आलेले आहेत. तथापी Applied Science (Physics & Chemistry) (२२२०२) या विषयाचे Lab Manual पूर्वीच प्रिन्ट झाल्यामुळे विद्यार्थ्यांच्या हिताकरिता या विषयाच्या ९ ते १२ Experiment मंडळाच्या संकेत स्थळावर Download करण्याकरिता प्रसिद्ध करण्यात आले असून सदर बाब विद्यार्थ्यांच्या निदर्शनास आणून देण्याची जबाबबदारी संस्थेची राहील याची नोंद घ्यावी.

(बाळासाहेब मा. कर्डीले)
प्र. सचिव
महाराष्ट्र राज्य तंत्र शिक्षण मंडळ,
मुंबई-५१

प्रत:-

१. संचालक, महाराष्ट्र राज्य तंत्र शिक्षण मंडळ, मुंबई यांना माहितीस्तव सादर.

२. उपसचिव, म. रा. तंत्र शिक्षण मंडळ, विभागीय कार्यालय पुणे, नागपूर, औरंगाबाद व मुंबई यांना माहिती व आवश्यक कार्यवाहीसाठी.

INDEX

Practical No. 9: Chloride content of water sample

I Practical Significance

Boiler is an important equipment for various industrial processes to produce steam using water. Nature of water plays important role in terms of efficiency of boiler and various problems caused to the boiler. Water is also used in different industries such as textile, paper, sugar, pharmaceuticals etc. for various industrial processes. At high temperature and pressure, chloride of calcium and magnesium reacts with water forming hydrochloric acid. Hence water becomes acidic and causes boiler corrosion.

Diploma engineers has to deal with the different uses of water during their course of work and also have to deal with the problems caused by hard water like boiler corrosion, caustic embrittlement, scales and sludge formation. This experiment will help diploma engineers to determine the magnitude of chloride content which is required to control corrosion and helps in selection of water supplies for human use.

II Relevant Program Outcomes (POs)

- **Basic knowledge**: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
- **Experiments and practice:** An ability to plan and perform experiments and practices and to use the results to solve engineering problems.
- **Engineering tools:** Apply appropriate technologies and tools with an understanding of the limitations.
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse/multidisciplinary teams.
- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of engineering industries.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply principles of advanced physics and chemistry to solve broad based engineering problems'***.

i. Measurement
ii. Calculation

IV Relevant Course Outcome(s)

Select relevant water treatment process for various applications.

V Practical Outcome

Determine chloride content in the given water sample.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VII Minimum Theoretical Background

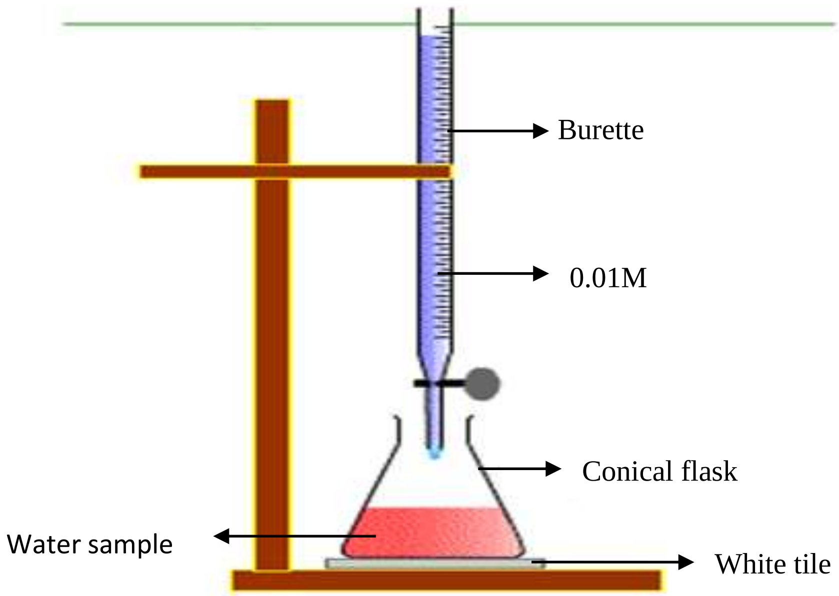
Water contains dissolved chloride salts of calcium, magnesium and sodium. These salts ionize to give chloride ions in water. If water contains chloride ions above 250 ppm is not suitable for drinking or industrial purposes.

When sample of water is titrated against silver nitrate solution, using potassium chromate indicator. The chloride present in water is precipitated as AgCl. As soon as all the chlorides are precipitated out , then even a single drop of $AgNO_3$ added in excess gives a red precipitate of silver chromate.

$AgNO_3 + Cl^- \longrightarrow \downarrow AgCl + NO_3^-$

$AgNO_3 + K_2CrO_4 \longrightarrow \downarrow AgCrO_4 + KNO_3$

VIII Practical set-up / Circuit diagram / Work Situation



IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Burette	Borosil glass , Capacity 25 ml /50 ml	One per group
2.	Conical flask	Borosil glass, Capacity 250 ml/100 ml	One per group
3.	Beaker	Borosil glass, Capacity 250 ml/100 ml	One per group
4.	Pipette	Borosil glass, Capacity 25ml / 10 ml	One per group
5.	Silver nitrate	0.01M	As per Requirement
6.	Potassium chromate indicator		
7.	Water sample		

X Precautions to be Followed

1. All the glass apparatus should wash thoroughly with distilled water before use.
2. Before use, the burette and pipette should rinse properly. Remove an air bubbles if
   present in the nozzle of the burette before taking an initial reading.
3. Place the conical flask on white tile to identify the color change at the end point.
4. Volume of indicator should be same in all titrations.
5. Shaking of the titration flask should be continuous during addition of the solution from burette.

XI Procedure

1. Wash the burette with water.
2. Rinse the burette with 0.01 M $AgNO_3$solution. Fill it with 0.01 M $AgNO_3$solution.
3. Remove air bubble if present, and adjust zero level correctly.
4. Rinse the pipette with sample water. Take 25 ml of sample water in conical flask with the help of pipette.
5. Add 2-3 drops of potassium chromate indicator into the water sample in conical flask. Color of the solution becomes yellow.
6. Add 0.01 M $AgNO_3$ solution from burette into the conical flask very slowly, till yellow color changes to brick red.
7. Note down the reading, repeat the procedure to get constant reading.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
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XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

1. ……………………………………………………………………………………
2. ……………………………………………………………………………………

XIV Observations and Calculations (use blank sheet provided if space not sufficient)

Color of water sample changes from yellow to brick red.

Sr. No.	Burette Reading	Constant Burette Reading (Volume of 0.01M $AgNO_3$)
1.		Z =
2.		
3.		

Calculation:

Step 1:

1000 ml of 1 M $AgNO_3$ $\equiv$ 35.5 g of Cl^-

'Z' ml of 0.01 M $AgNO_3$ $= \dfrac{(35.5 \times Z \times 0.01)}{1000}$

= ……. …..(y) g Cl^-

Step 2:

25 ml water sample contain --------------- (y) g Cl^-
1000 ml water sample contain ------------- (y × 40) g Cl^-
i.e. 1000 ml water sample contain -------------- (y × 40) × 1000 mg of Cl^-
i.e. 1000 ml water sample contain -------------- mg of Cl^-

XV Results

Chloride content in given water sample = -------------

XVI Interpretation of Results

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions

1. Name the salts which produce Cl^- ions in water sample.
2. Write the color of change at the end point.
3. Write the reaction of between indicator and $AgNO_3$ solution.

Space for Answer:

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XIX References / Suggestions for further reading

1. Engineering chemistry, Shashi Chavla, S. Chand publication New Delhi 2013 ISBN: 1234567155036
2. Laboratory manual on Engineering Chemistry, Dr.Sudha Rani,Dhanpat Rai Publishing Company, ISBN-9788187433132

XX Suggested Assessment Scheme

	Performance indicators	Weightage
Process related: 15 Marks		**60%**
1	Cleaning and filling burette	10 %
2	Measurement of water sample	10%
3	Burette reading when potassium chromate changes color	20 %
4	Working in team	20 %
Product related: 10 Marks		**40%**
5	Chloride content (Cl^-)	20 %
6	Answer to sample questions	10 %
7	Submission of report in time	10 %
Total		**100 %**

Names of Student Team Members

1. …………………………
2. …………………………
3. …………………………
4. …………………………
5. …………………………

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 10: Calcium content of lime sample

I Practical Significance

The word lime originates with its earliest use as building mortar and has the sense of sticking or adhering. Limestone products, cement, concrete, and mortar materials are still used in large quantities as building and engineering materials as chemical feedstock, and for sugar refining, among other uses. Lime is extensively used for wastewater treatment along with ferrous sulphate. Because of adhesive property with bricks and stones, lime is often used as binding material in masonry works. It is also used in whitewashing as wall coat to adhere the whitewash onto the wall.

Lime used in building materials is broadly classified as "pure", "hydraulic", and "poor" lime; can be natural or artificial; and may be further identified by its magnesium content such as dolomitic or magnesium lime. Uses include lime mortar, lime plaster, lime render, lime-ash floors, tabby concrete, whitewash, silicate mineral paint, and limestone blocks which may be of many types. The qualities of the many types of processed lime affect how they are used.

Poor quality in hydrated lime can be due to either or all of three causes:

- The original limestone had a relatively low level of calcium carbonate ($CaCO_3$) and there were other components containing magnesia (MgO), silica (SiO_2), iron, alumina, etc.
- The limestone was poorly burned so that the lime contains some of the original limestone still as $CaCO_3$.
- The lime has been left exposed to the atmosphere so that carbon dioxide has converted the calcium hydroxide, $Ca(OH)_2$, back to calcium carbonate, $CaCO_3$. Diploma engineers has to deal with the different uses of lime, hence it is necessary to determine the calcium content and to identify the type of lime.

II Relevant Program Outcomes

- **Basic knowledge**: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
- **Experiments and practice:** An ability to plan and perform experiments and practices and to use the results to solve engineering problems.
- **Engineering tools:** Apply appropriate technologies and tools with an understanding of the limitations.
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse/multidisciplinary teams.
- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of engineering industries.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***‘Apply principles of advanced physics and chemistry to solve broad based engineering problems’***.

i. Measurement
ii. Calculation

IV Relevant Course Outcome(s)

Select relevant metallurgical process and properties related to industrial application of iron and copper.

V Practical Outcome

Determine the percentage of calcium in given lime and identify the type of lime.

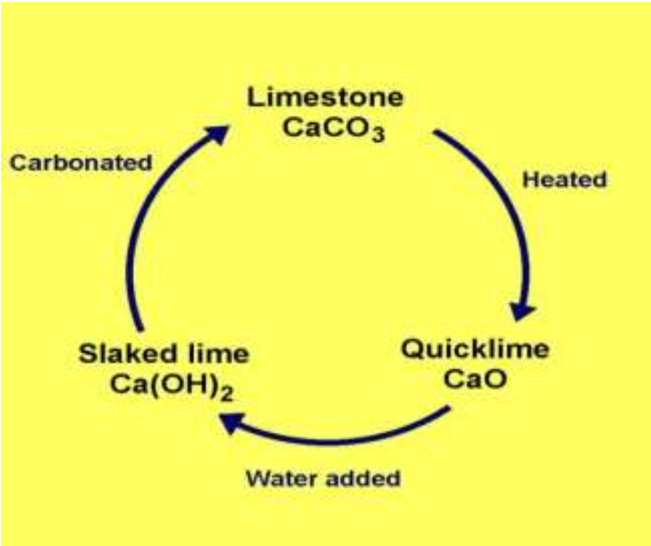
VI Relevant Affective domain related Outcome

- Practice energy conservation.
- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Practice good housekeeping.

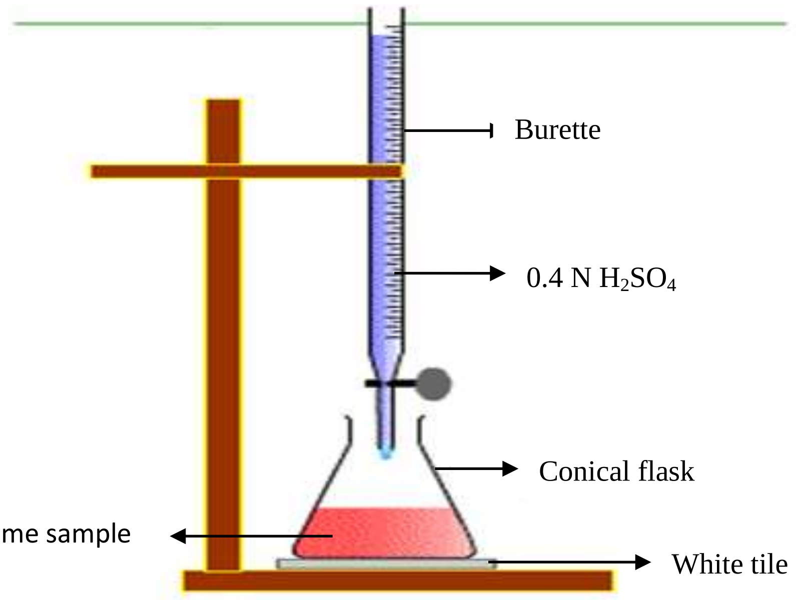
VII Minimum Theoretical Background

The most commonly used masonry lime is Type S hydrated lime which is intended to be added to Portland cement to improve plasticity, water retention and other qualities. The S in type S stands for special which distinguishes it from Type N hydrated lime where the N stands for normal. The special attributes of Type S are its "...ability to develop high, early plasticity and higher water retentivity and by a limitation on its unhydrated oxide content." The term Type S originated in 1946 in ASTM C 207 Hydrated Lime for Masonry Purposes. Type S lime is almost always dolomitic lime, hydrated under heat and pressure in an autoclave, and used in mortar, render, stucco, and plaster. Type S lime is not considered reliable as a pure binder in mortar due to high burning temperatures during production.

Both quicklime and hydrated lime are slightly soluble in water, but calcium carbonate is hardly soluble. So washing a small quantity (say 5 to 10 gm) with excess warm sugar solution (the sugar helps the lime to dissolve quicker) for a few minutes would allow quick or hydrated lime to dissolve away.



VIII Practical set-up / Circuit diagram / Work Situation



IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Burette	Borosil glass , Capacity 50 ml /100 ml	One per group
2.	Conical flask	Borosil glass, Capacity 250 ml	
3.	Beaker	Borosil glass, Capacity 250 ml/100 ml	
4.	Pipette	Borosil glass, Capacity 25ml	
5.	Volumetric flask	Borosil glass, Capacity 250 ml	
6.	Whatman paper	Number 1	
7.	Silver nitrate	0.4 N Sulphuric acid	As per Requirement
8.	Sucrose/ Sugar	20 % in water	
9.	lime sample	Any lime sample	
10.	Phenolphthalein	As per requirement	

X Precautions to be Followed

1. All the glass apparatus should wash thoroughly with distilled water before use.
2. Before use, the burette and pipette should rinse properly. Remove an air bubbles if present in the nozzle of the burette before taking an initial reading.
3. Place the conical flask on white tile to identify the color change at the end point.
4. Volume of indicator should be same in all titrations.
5. Shaking of the titration flask should be continuous during addition of the solution from burette.

XI Procedure

1. Take 2.5 g of lime in 250 ml conical flask.
2. Add 35–45 ml of CO_2 -free water and boil for 3 minutes.
3. Cool the solution to room temperature. Add 20 g of sucrose /sugar in 20 ml of water (20g sugar in 20 ml water)
4. Add this solution to the lime in the 250 ml volumetric flask and shake for 30 minutes.
5. Dilute the solution to 250 ml using distilled water.
6. Filter the solution through a No.1 Whatman filter paper.
7. Discard the first 15–30 ml of filtrate.
8. Wash the burette with water.
9. Rinse the burette with 0.4 N H_2SO_4 solution. Fill it with 0.4 N H_2SO_4.
10. Remove air bubble if present, and adjust zero level correctly.
11. Rinse the pipette with lime sample solution.
12. Take 25 ml of sample in conical flask with the help of pipette.
13. Add 5 drops of phenolphthalein indicator.
14. Titrate the sample solution against 0.4 N sulphuric acid, till the pink colour disappears.
15. Take three constant burette readings.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
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2.					
3.					
4.					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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2. ………………………………………………………………………………………
3. ………………………………………………………………………………………
4. ………………………………………………………………………………………

XIV Observations and Calculations (use blank sheet provided if space not sufficient)

Colour of lime sample changes from pink to colourless.

Sr. No.	Burette Reading	Constant Burette Reading (Volume of 0.4N Sulphuric acid)
1.		Y =
2.		
3.		

Calculation:

The available lime, as CaO, = ……….(Y) ml of 0.4N sulphuric acid, on the burette, x 4.

$= Y \times 4 =$ ………g

XV Results

1. Calcium content in given lime sample = -------------

XVI Interpretation of Results

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions

1. Explain the role of sugar/ sucrose solution in this practical.
2. Write the color of change at the end point.
3. Lime has been left exposed to the atmosphere. Explain.

Space for Answer:

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XX References / Suggestions for further reading

1. Boynton, Robert S. *Chemistry and Technology of Lime and Limestone*. Interscience Publishers, New York and London, 1966
2. Laboratory manual on Engineering Chemistry, Dr.Sudha Rani,Dhanpat Rai Publishing Company, ISBN-9788187433132
3. Website: http://www.gtz.de/basin

XX Suggested Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks:

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Cleaning and filling burette	10 %
2	Measurement of water sample	10%
3	Burette reading at the end point	20 %
4	Working in team	20 %
Product related: 10 Marks		**40%**
5	Accurate final result	20 %
6	Answer to sample questions	10 %
7	Submission of report in time	10 %
Total		**100 %**

Names of Student Team Members

1. …………………………
2. …………………………
3. …………………………
4. …………………………

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 11: Dissolved oxygen in water sample

I Practical Significance

Total dissolved gas concentrations in water should not exceed 110 percent. Concentrations above this level can be harmful to aquatic life. Fish in waters containing excessive dissolved gases may suffer from "gas bubble disease"; however, this is a very rare occurrence. The bubbles or emboli block the flow of blood through blood vessels causing death. External bubbles (emphysema) can also occur and be seen on fins, on skin and on other tissue. Aquatic invertebrates are also affected by gas bubble disease but at levels higher than those lethal to fish. Adequate dissolved oxygen is necessary for good water quality. Oxygen is a necessary element to all forms of life. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As dissolved oxygen levels in water drop below 5.0 mg/l, aquatic life is put under stress. Oxygen levels that remain below 1-2 mg/l for a few hours can result in large fish kills.

Dissolved Oxygen test is the basis for BOD test which is an important parameter to evaluate organic pollution potential of a waste. It is necessary for all aerobic biological wastewater treatment processes to control the rate of aeration. Dissolved Oxygen can be measured either by titrimetric or electrometric method.

II Relevant Program Outcomes

- **Basic knowledge**: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
- **Experiments and practice:** An ability to plan and perform experiments and practices and to use the results to solve engineering problems.
- **Engineering tools:** Apply appropriate technologies and tools with an understanding of the limitations.
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse/multidisciplinary teams.
- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of engineering industries.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***‘Apply principles of advanced physics and chemistry to solve broad based engineering problems’***.

i. Measurement
ii. Calculation

IV Relevant Course Outcome(s)

Select relevant water treatment process for various applications.

V Practical Outcome

Determine the dissolved oxygen in given water sample.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Practice good housekeeping.

VII Minimum Theoretical Background

Dissolved oxygen is absolutely essential for the survival of all aquatic organisms. Moreover, oxygen affects a vast number of other water indicators, not only biochemical but aesthetic ones like the odour, clarity and taste. Consequently, oxygen is perhaps the most well-established indicator of water quality.

The experiment is based on oxidation of potassium iodide. The liberated iodine is titrated against standard hypo solution using starch as a final indicator. Since oxygen in water is in molecular state and not capable to react with KI, an oxygen carrier manganese hydroxide is used to bring about the reaction between KI and O_2.Manganous hydroxide is produced by the action of potassium hydroxide and manganous sulphate.

Chemical reactions:

$2KOH + MnSO_4 \longrightarrow Mn(OH)_2 + K_2SO_4$

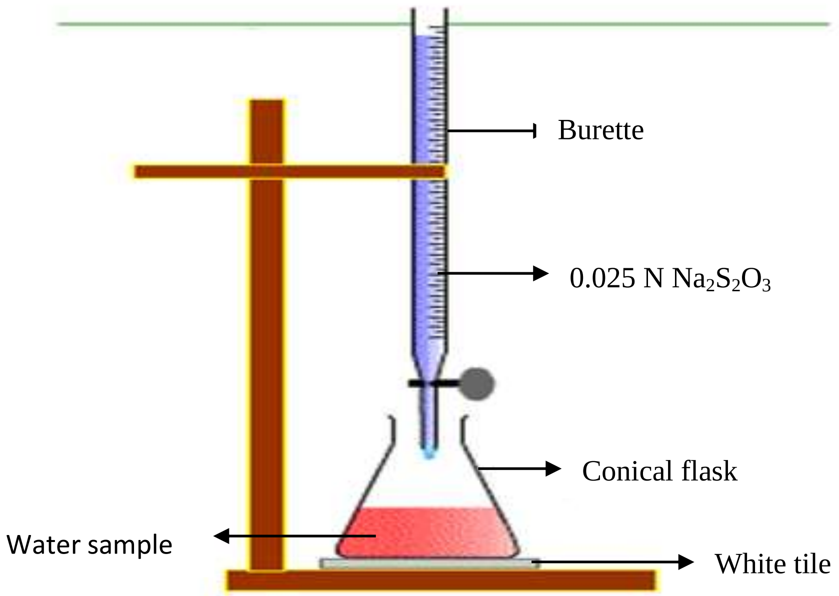
$2Mn(OH)_2 + O_2 \longrightarrow 2\ MnO(OH)_2$

$MnO(OH)_2 + H_2SO_4 \longrightarrow MnSO_4 + 2H_2O + [O]$

$2KI + H_2SO_4 + [O] \longrightarrow K_2SO_4 + H_2O + I_2$

$I_2 + 2Na_2S_2O_3 \longrightarrow 2NaI + \underbrace{Na_2S_4O_6}_{\text{Sodium tetrathionate}}$

VIII Practical set-up / Circuit diagram / Work Situation



IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Burette	Borosil glass , Capacity 50 ml	One per group
2.	Conical flask	Borosil glass, Capacity 250 ml	
3.	Beaker	Borosil glass, Capacity 250 ml	
4.	Pipette/Measuring flask	Borosil glass, Capacity 25ml / 100ml	
5.	Stopper bottle	Glass bottles, Capacity 500 ml	
6.	Sodium thiosulphate	0.025 N	As per Requirement
7.	Alkaline Iodine Azide (AIA)	15g KI + 70 g KOH dissolve and diluted to 100 ml + 4 g NaN_3 dissolved in 4ml distilled water	
8.	Manganese sulphate	400 g $MnSO_4$ in 1 lit. distilled water	
9.	Water sample		
10.	Sulphuric acid	Concentrated	
11.	Starch indicator		

X Precautions to be Followed

1. All the glass apparatus should wash thoroughly with distilled water before use.
2. Before use, the burette and pipette should rinse properly. Remove an air bubbles if present in the nozzle of the burette before taking an initial reading.
3. Place the conical flask on white tile to identify the color change at the end point.
4. Volume of indicator should be same in all titrations.
5. Shaking of the titration flask should be continuous during addition of the solution from burette.

XI Procedure

1. Take 500 ml of water in a stopper bottle.
2. Add 10 ml of alkaline KI and 10 ml of $MnSO_4$ into it.
3. Stopper the bottle and shake it well
4. Wash the burette with water.
5. Keep the bottle in dark for 5 min and add conc. H_2SO_4 till the brown precipitates are dissolved.
6. Take 100 ml of the above solution in a conical flask.
7. Rinse the burette with 0.025 N sodium thiosulphate, and fill it.
8. Titrate the water sample against 0.025 N sodium thiosulphate solution till the colour changes to light yellow.
9. Add 3-4 drops of starch in to it and the colour changes to blue.
10. Continue titration till blue colour disappears.
11. At the end point blue colour changes to colourless.
12. Repeat this process till to get three constant reading.

$$\text{Starch} + I_2 \longrightarrow \text{Starch iodide complex (Blue colour)}$$

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

1. ………………………………………………………………………………………
2. ………………………………………………………………………………………
3. ………………………………………………………………………………………
4. ………………………………………………………………………………………

XIV Observations and Calculations (use blank sheet provided if space not sufficient)

Colour of water sample changes from blue to colourless.

Sr. No.	Burette Reading	Constant Burette Reading (Volume of 0.025 N $Na_2S_2O_3$)
1.		V =
2.		
3.		

Calculation:

1000 ml of 1N $Na_2S_2O_3$= 8 gm of O_2

V ml of 0.025 N $Na_2S_2O_3$ = $\dfrac{V \times 0.025 \times 8}{1000}$ gm of O_2 per 100 mL of water sample

= V × 0.025 × 8 mg oxygen per 100 mL water sample

= V × 0.025 × 8 × 10 mg oxygen per 1000 mL water sample

XV Results

Dissolved oxygen in given water sample = ……….ppm

XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions

1. Solution turns blue after addition of starch. Explain.
2. Write the colour of change at the end point.

3. Write the balanced chemical reaction between alkaline KI and Manganese sulphate.
4. Write the balanced chemical reaction between liberated iodine and sodium thiosulphate. Give the name of product.

Space for Answer:

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XXI References / Suggestions for further reading

1. Engineering chemistry, Shashi Chavla, S. Chand publication New Delhi 2013 ISBN : 1234567155036
2. Laboratory manual on Engineering Chemistry, Dr.Sudha Rani,Dhanpat Rai Publishing Company, ISBN-9788187433132
3. Website : https://www.lenntech.com/why_the_oxygen_dissolved_is_important.htm
4. Website :file:///C:/Users/User/Desktop/Lab%206%20Dissolved%20Oxygen.pdf

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Cleaning and filling burette	10 %
2	Measurement of water sample	10%
3	Accurate burette reading	20 %
4	Working in team	20 %
Product related: 10 Marks		**40%**
5	Dissolved oxygen in water sample	20 %
6	Answer to sample questions	10 %
7	Submission of report in time	10 %
Total		**100 %**

Names of Student Team Members

1. …………………………
2. …………………………
3. …………………………
4. …………………………
5. …………………………

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 12: Calcium content of Cement sample

I Practical Significance

Cement is used as a basic binding material, is a very important building material. Almost every construction work requires cement. Cement contains ingredients as lime (CaO), silica (SiO_2), alumina (Al_2O_3), iron oxide (Fe_2O_3), magnesia. (MgO), Sulphur trioxide (SO_3), Soda (Na_2O), Potash (K_2O). By altering the amount of an ingredient during the production of cement desired quality of cement is produced. Different types of cement like white cement, water proof cement, high alumina cement, quick setting cement etc. are used for various purposes as in construction of bridges, pavements, sidewalks, dams, in foundation work, marine construction etc. Cement is also used to cover hairline cracks on concrete. It is a very important material used.

II Relevant Program Outcomes (POs)

- **Basic knowledge**: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
- **Experiments and practice:** An ability to plan and perform experiments and practices and to use the results to solve engineering problems.
- **Engineering tools:** Apply appropriate technologies and tools with an understanding of the limitations.
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse/multidisciplinary teams.
- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of engineering industries.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply principles of advanced physics and chemistry to solve broad based engineering problems'***.

i. Measurement
ii. Calculation

IV Relevant Course Outcome(s)

Select relevant metallurgical process and properties related to industrial application of iron and copper.

V Practical Outcome

Determine the percentage of calcium in given cement sample.

VI Relevant Affective domain related Outcome

- Practice energy conservation.
- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Practice good housekeeping.

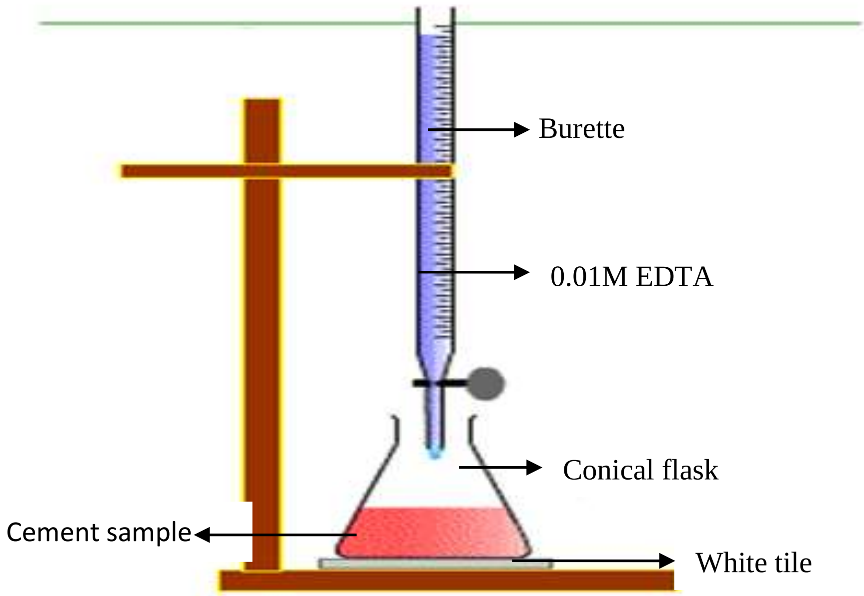
VII Minimum Theoretical Background

Cement is a mixture of calcium silicate and aluminate which has property of setting and hardening in presence of water. Cement is chemically analyzed in terms of percentage of oxides of calcium, silicon, aluminium, iron, magnesium etc. Determination of calcium content in cement is based on the fact that when indicator (Eriochrome Black T) is added to cement solution in alkaline medium, it forms a wine red colour unstable complex with Ca^{++} and Mg^{++} ions.

Ca^{++} + Eriochrome Black T -------------> Ca^{++} Chrome Black T
(Wine red unstable complex)

When Sodium salt of EDTA is added, Ca^{++} and Mg^{++} ions form a stable colourless complex with EDTA and indicator (Eriochrome Black T) becomes free which turns the solution light blue.

VIII Practical set-up / Circuit diagram / Work Situation



IX Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Burette	Borosil glass , Capacity 50 ml /100 ml	One per group
2.	Conical flask	Borosil glass, Capacity 250 ml	
3.	Beaker	Borosil glass, Capacity 250 ml/100 ml	
4.	Pipette	Borosil glass, Capacity 25ml	
5.	Volumetric flask	Borosil glass, Capacity 250 ml	

6.	Watch Glass		
7.	Wire Gauge		
8.	Burner		
9.	Glass rod		
10.	Filter paper		
11.	Test Tube		
12.	Weighing balance		
13.	EDTA (Disodium salt)	0.01 M solution	As per Requirement
14.	Concentrated HCl		
15.	Concentrated HNO_3		
16.	Ammonium chloride		
17.	1:1 Ammonia solution		
19.	Eriochrome Black T indicator		
20.	Distilled water		

X Precautions to be Followed

1. All the glass apparatus should wash thoroughly with distilled water before use.
2. Before use, the burette and pipette should rinse properly. Remove an air bubbles if present in the nozzle of the burette before taking an initial reading.
3. Place the conical flask on white tile to identify the color change at the end point.
4. Volume of indicator should be same in all titrations.
5. Shaking of the titration flask should be continuous during addition of the solution from burette.

XI Procedure

Part I: Dissolution of Cement Sample

1. Weigh about 1 g of cement using watch glass transfer it to 250 ml beaker.
2. Add 10 ml of concentrated HCl and 2 ml water.
3. Heat the content on wire gauge using low flame with stirring till it dissolve.
4. Cool it to get clean solution and filter it using ordinary filter paper.
5. Collect the filtrate in 250 ml volumetric flask and dilute it upto 250 ml using distilled water. This is stock solution.
6. Pipette out 50 ml of stock solution in a beaker.
7. Add 1 ml concentrated HNO_3 and boil the solution. Then add about 1 g of NH_4Cl and one test tube 1:1 ammonia with constant stirring.
8. Aluminum and iron will precipitate in the form of their hydroxide, filter the solution to remove ppt.
9. Collect filtrate in 250 ml volumetric flask and dilute it to 250 ml shake the solution to make it homogenous (Solution A).

Part II: Estimation of Calcium Volumetrically.

1. Pipette out 25 ml of solution A in conical flask.
2. Add 5 ml of buffer solution (PH 10) and 5 drops of EBT as an indicator.
3. Fill the burette with 0.01 M EDTA solution adjust zero mark.
4. Titrate it against standard EDTA solution till wine red colour changes to sky blue.
5. Note down the reading. Take three more readings and find out constant burette reading.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

1. ………………………………………………………………………………………
2. ………………………………………………………………………………………
3. ………………………………………………………………………………………
4. ………………………………………………………………………………………
5. ………………………………………………………………………………………

XIV Observations and Calculations (use blank sheet provided if space not sufficient)

Colour of cement sample changes from wine red to sky blue.

Sr. No.	Burette Reading	Constant Burette Reading
1.		X =
2.		
3.		

Calculation:

Step I: Quantity of Ca in 25 ml of solution A

1000 ml of 1 M EDTA = 40 g of Ca

$$1 \text{ ml of } 1 \text{ M EDTA} = \frac{40}{1000} \text{ g of Ca}$$

$$1 \text{ ml of } 0.01 \text{ M EDTA} = \frac{40 \times 0.01}{1000} \text{ g of Ca}$$

$$X \text{ ml of } 0.01 \text{ M EDTA} = \frac{40 \times 0.01 \times X}{1000} \text{ g of Ca}$$

$$X \text{ ml } 0.01 \text{ M EDTA} = 4.0 \times 10^{-4} \times X \text{ g of Ca}$$

X ml 0.01 M EDTA = $4.0 \times 10^{-4} \times$ ………….. g of Ca

X ml 0.01 M EDTA = ………………(y)g of Ca/25 ml of Solution A

Step II :

Quantity of Ca in 250 ml of stock solution (1 g cement)

Since 25 ml of solution A contains = (y) g of Ca

250 ml of solution A contains = $\frac{y \times 250}{25}$ g of Ca

250 ml of solution A contains = $y \times 10$ g of Ca

250 ml of Solution A contains =…………× 10 g of Ca

250 ml of Solution A contains =…………..(y) gm of Ca

But 250 ml of solution A prepared by dilution of 50 ml stock solution.

50 ml stock solution contains = (z) g of Ca

250 ml of stock solution contains = $\frac{z \times 250}{50}$ g of Ca

250 ml of stock solution contains = $\frac{\ldots\ldots\ldots \times 250}{50}$ g of Ca

250 ml of stock solution (1 g cement) contains = ------------(w) g of Ca

Step III: Percentage of Ca in cement

Since 1 g of cement contains = w g of Ca

100 g of cement contains = $\frac{w \times 100}{1}$

100 g of cement contains = $\frac{\ldots\ldots\ldots\ldots \times 100}{1}$

100 g of cement contains = …………..% of Ca

XV Results

The percentage of calcium content in given cement sample = -------------

XVI Interpretation of Results (Give meaning of the above obtained results)

…………………………………………………………………………………………
…………………………………………………………………………………………

XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

…………………………………………………………………………………………
…………………………………………………………………………………………

XVIII Practical Related Questions

1. Name the acid used for dissolution of cement sample.
2. "Disodium EDTA is used for titration" justify.
3. State the components which are insoluble in concentrated HCl.
4. State the concentration (molarity) of EDTA solution.

Space for Answer:

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XXII References / Suggestions for further reading

1. Boynton, Robert S. *Chemistry and Technology of Lime and Limestone*. Interscience Publishers, New York and London, 1966
2. Laboratory manual on Engineering Chemistry, Dr. Sudha Rani,Dhanpat Rai Publishing Company, ISBN-9788187433132
3. Website: http://www.gtz.de/basin

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Dissolution of cement sample	20%
2	Filling of burette	10 %
3	Measurement of sample	10%
4	Burette reading when colour changes	10 %
5	Working in team	10 %
Product related: 10 Marks		**40%**
6	Calcium content	20 %
7	Answer to sample questions	10 %
8	Submission of report in time	10 %
Total		**100 %**

Names of Student Team Members

1. …………………………
2. …………………………
3. …………………………
4. …………………………
5. …………………………

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

INDEX

Sr. No.	Name of the experiment	Page No.	Date of Performance	Marks out of 25	Dated signature of the teacher
1.	Use Searle's method to determine Young's modulus of given wire.				
2.	Apply Archimedes principle to determine the buoyancy force on a solid immersed in liquid.				
3.	Determine the coefficient of viscosity of given liquid by Stoke's method				
4.	Find downward force, along an inclined plane, acting on a roller due to gravity and its relationship with the angle of inclination.				
5.	Predict the range of the projectile from the initial launch speed and angle.				
6.	i) Find the dependence of stopping potential on the frequency of the light source in photoelectric effect experiment ii) Find the dependence of stopping potential on the intensity of the light source in photoelectric effect experiment				
7.	Determine the I-V characterises of photoelectric cell and LDR				
8.	Determine the divergence of LASER beam				
9.	Determination of Force Constant using Helical Spring				
10.	Comparison of terminal velocities by Stoke's method.				
11.	Compare Young's modulii of the material of a given wires by using Searle's apparatus				
12.	To determine coefficient of viscosity of a low viscous liquid- Capillary flow method.				

Experiment No. 9: Determination of Force Constant Using Helical Spring

I Practical Significance

Hooke's Law states that the force needed to compress or extend a spring is directly proportional to the distance you stretch it. As an equation, Hooke's Law can be represented as **F = kx**, where F is the force we apply, k is the spring constant, in Newton's per meter (N/m) and x is the displacement of the spring from its equilibrium position. The spring constant, k, is representative of how stiff the spring is. Stiffer (more difficult to stretch) springs have higher spring constants.

II Relevant Program Outcomes (POs)

PO1- Basic knowledge
PO3- Experiments and practice
PO8- Individual and teamwork
PO9- Communication
PO10- Lifelong learning

III Relevant Course Outcomes

(a) Select relevant material in industry by analyzing its physical properties.
(b) Apply laws of motion in various applications.

IV Practical Outcome

To calculate the force constant of a helical spring by plotting m -T^2graph using method of Oscillation.

V Competency & Practical Skills

a. Measurement Skills.
b. Drawing skills.

VI Relevant Affective domain related Outcomes

a. Handle tools and equipment carefully.
b. Practice energy conservation.
c. Function as a team leader / a team member.

VII Minimum Theoretical Background

Elasticity is a property of a material which allows it to return to its original shape or length after being distorted. Some materials are not at all elastic - they are brittle and will snap before they bend or stretch. Others, like rubber, for example, will stretch a long way without significant warping or cracking. This is because the materials contain long chain molecules that are wrapped up in a bundle and can straighten out when stretched. The spring constant is a number that represents how much force it takes to stretch a material -- materials with larger spring constants are stiffer.

The helical spring, is the most commonly used mechanical spring in which a wire is wrapped in a coil that resembles a screw thread. It can be designed to carry, pull, or push loads. Twisted helical (torsion) springs are used in engine starters and hinges.

Helical spring works on the principle of Hooke's Law. Hooke's Law states that within the limit of elasticity, stress applied is directly proportional to the strain produced.

i.e. **Stress α Strain**

$$\frac{Stress}{Strain} = \text{Constant}$$

When a load 'F' is attached to the free end of a spring, then the spring elongates through a distance 'l'. Here 'l' is known as the extension produced. According to Hooke's Law, extension is directly proportional to the load.

This can be represented as:

$$\mathbf{F \propto l}$$

$$\mathbf{F = kl}$$

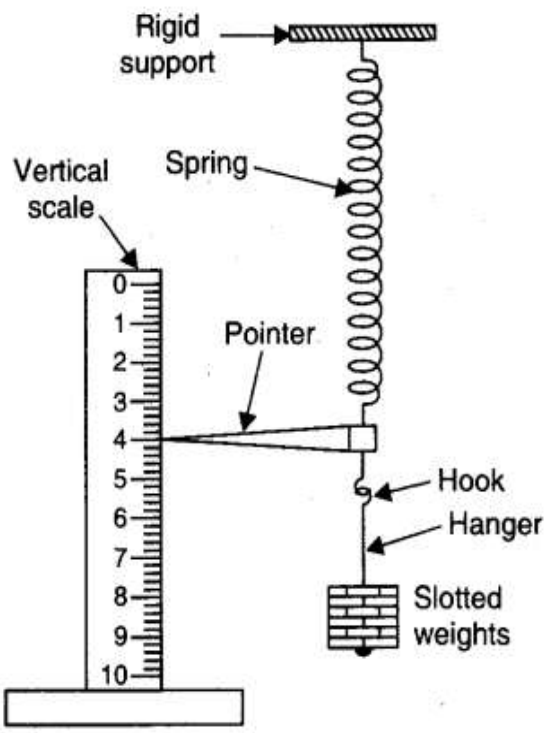
where ‘k’ is constant of proportionality. It is called the force constant or the spring constant of the spring.

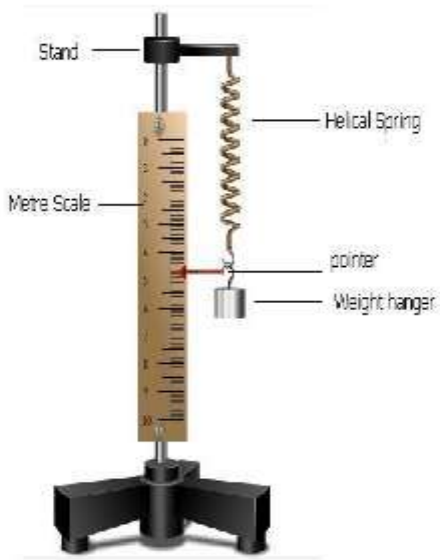
A graph is drawn with load M in kg wt along X axis and extension, l in metre along the Y axis. The graph is a straight line whose slope will give the value of spring constant, k.

Formula to find the Force constant is; $T = 2\Pi\sqrt{\frac{M}{K}}$; i.e.

$$\mathbf{K = \frac{4\,\Pi^2\,M}{T^2}}$$

VIII Circuit diagram / Experimental set-up / Work Situation





IX Resources required

Sr. No.	Instrument/Object	Specifications	Quantity
1	Meter Scale		1
2	Weight Hanger		1
3	50g to 500g slotted weights		1 each
4	Fine Pointer		1

X Procedure

1. Suspend the spring form a rigid support. Attach a pointer and a hook form its lower free end (as shown in the diagram above).
2. Attach a load of M gm at end hook of the helical spring.
3. Set the vertical wooden scale such that the tip of the pointer comes over the divisions on the scale but does not touch the scale.
4. Note the reading of the position of the tip of the pointer on the scale.
5. Wait for few minutes till the pointer tip comes to rest.
6. Now gently move the spring so that it starts oscillating.
7. Note the time taken (T_1) for 20 oscillations.
8. Repeat the same procedure to note time taken as T_2.
9. Find the mean Time period (T sec) and hence calculate the value of T^2 sec^2.
10. Calculate the value of Force Constant K.
11. Repeat the same procedure by adding 50 gm weights and complete the observation table.
12. Find the value of Mean K.
13. Plot a graph of Mass suspended M kg verses Time period T^2 sec^2
14. Calculate the slope and hence calculate the value of the Force constant K.
15. Compare the value of Force constant by experiment and from graph.

XI Precautions

1. Loading and unloading of weight must be done gently.
2. Reading should be noted only when tip of pointer comes to rest.
3. Pointer tip should not touch the scale surface.
4. Loading should not be beyond elastic limit.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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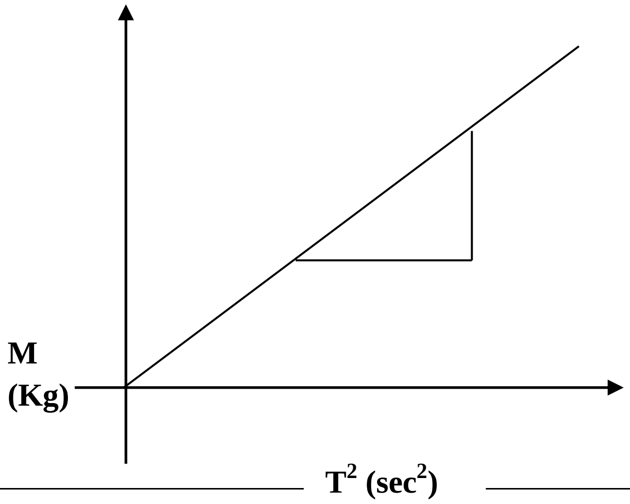
XV Observations and Calculations:

Sr. No.	Load in the hanger = Applied Force F = Mass suspended M (Kg)	Position of the Pointer tip (Extension) (cm)	Time for 20 Oscillations		Mean Time Period T (sec)	Time Period T^2 (sec^2)	Force constant $K = \frac{4\Pi^2 M}{T^2}$
			T_1 (sec)	T_2 (sec)			
01							
02							
03							
04							
05							
06							
Mean Force Constant (K) =							………..…. N/m



XVI Results

1. Value of Force Constant K (by experiment) = …………………………… N/m

2. Value of Force Constant K (from graph) = **……………………………** N/m

XVII Interpretation of results

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XVIII Conclusions and Recommendations

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define Hooke's law.
2. State the formula and unit of force constant.
3. If mass attached to the spring is made 2 times heavier. How many times the period of oscillation changes?
4. Why do we have to wait for some time after adding or removing of weight to the spring?
5. Which law is used in the movement of a helical spring?

a) Pascal's law b) Gravitational law c) Newton's law d) Hooke's law

Space to write answers:

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XX References / Suggestions for further Reading

Laboratory Manual Physics for class XI - Published by NCERT
http://www.wisegeek.com/what-is-a-helical-spring.htm
http://en.wikipedia.org/wiki/Coil_spring
http://sisphysics.weebly.com/uploads/7/9/7/5/797568/experiment_9__10.pdf
http://www.britannica.com/EBchecked/topic/259959/helical-spring
https://www.youtube.com/watch?v=YqnZUodE1yY

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instrument	10
2	Experimental Set - up	20
3	Performance	20
4	Plotting Graphs	10
Product related: 10 Marks		**40%**
5	Timely submission and Neatness	20
6	Conclusions & Recommendations	10
7	Practical related questions	10

Name of Student Team Members

1. ………………………..
2. ………………………
3. ……………………….
4. ……………………….
5. ……………………….

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Scale

X-axis -

Y-axis -

Experiment No. 10: Comparison of terminal velocities by Stoke's method.

I Practical Significance

Viscosity plays vital role in all engineering field. It is useful in bearing operation. As we know bearing is continuously rotating, there will be friction between two rotating surfaces. This friction is reduced by using lubricant of optimum viscosity. This lubricant helps to form viscous layer which creates film between the rotating parts and helps in heat dissipation. Due to viscosity boundary layer is formed which is useful to control flow in turbo-machines. In turbo-machines if we want to extract more power from fluid then fluid should be in control. Viscosity is important in Heat Transfer by convection also. Convection is dependent on Reyonld Number. Reynold Number changes according to viscosity. The knowledge of coefficient of viscosity of organic liquids is used to determine their molecular weights.

II Relevant Program Outcomes (POs)

PO1- Basic knowledge
PO3- Experiments and practice
PO8- Individual and teamwork
PO9- Communication
PO10- Lifelong learning

III Relevant Course Outcomes

Select relevant material in industry by analyzing its physical properties.

IV Practical Outcome

Compare the terminal velocities of spherical balls of different sizes and measure the coefficient of viscosity of the given liquid.

V Competency & Practical Skills

Measurement Skills.

VI Relevant Affective domain related Outcomes

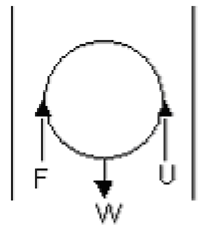
a. Handle tools and equipment carefully.
b. Practice energy conservation.
c. Function as a team leader / a team member.

VII Minimum Theoretical Background

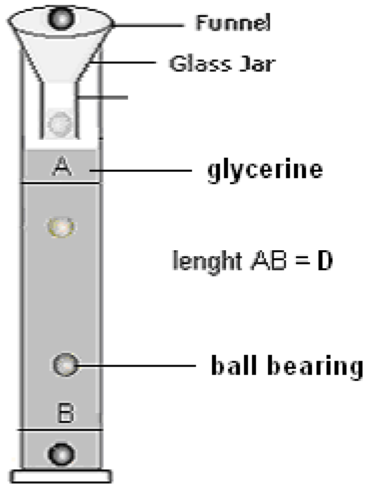
Viscosity is the property of a fluid by virtue of which an internal resistance comes into play when the liquid is in motion, and opposes the relative motion between its different layers. Thus, it is the resistance of a fluid to flow. When liquid flows over flat surface, a backward viscous force acts tangentially to every layer. This force depends upon the area of the layer, velocity of the layer, and the distance of the layer from the surface.

Stoke's Law: Stoke's law was established by an English scientist Sir George G Stokes (1819-1903). When a spherical body moves down through an infinite column of highly viscous liquid, it drags the layer of the liquid in contact with it. As a result, the body experiences a retarding force.

VIII Circuit diagram / Experimental set-up / Work Situation



F = ……………………………
W = …………………………… .
U = ……………………………



(Write the meanings of symbols F, W and U.)

IX Resources required

Sr. No.	Instrument/Object	Specifications	Quantity
1	A long cylindrical glass jar		1
2	Viscous liquid (glycerine)		As per glass jar size
3	Meter scale		1
4	Spherical ball (of different radius)		5 each
5	Screw Gauge		1
6	Stop clock		1

X Procedure

1. Find the least count and zero correction of the given screw guage.
2. Find the diameter (d) of the ball using the screw gauge. Now, the radius(r) of ball can be calculated as ; r = d/2
3. Clean the glass jar and fill it with the viscous fluid.
4. Place a meter scale vertically beside the jar.
5. Mark two reference points A and B on the jar using two threads. The marking A is made well below the free surface of liquid, so that by the time when the ball reaches A, it would have acquired terminal velocity v.
6. Adjust the position the thread B so that the distance between A and B is 50cm.
7. The ball of known diameter is dropped gently in the liquid. It falls down in the liquid with accelerated velocity for about one-third of the height. Then it falls with uniform terminal velocity.
8. When the ball crosses the point A, start the stop watch and the time taken by the ball to reach the point B is noted.
9. If the distance moved by the ball is d and the time taken to travel is t, then velocity $v = \frac{d}{t}$

10. Now repeat the same procedure for three balls having different diameter.
11. Calculate the value of r^2 and plot a graph of r^2 verses terminal velocity ‘v’, to show r^2 is directly proportional to v. ($r^2 \alpha v$).
12. Calculate for the coefficient of the liquid used from known radius of the ball bearing.

XI Precautions

1. Use a funnel to drop the ball bearing inside the liquid column.
2. Be very prompt to note the time taken, as the ball bearing moves very fast inside the liquid column.
3. Carefully note the reading in the stop watch.
4. The distance between the two points on the jar should be marked accurately.

XII Actual procedure followed

………
………
………
………
………
………
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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations

To find the diameter of the sphere using screw gauge:

Pitch of the screw gauge = ... cm

Number of divisions on the circular scale = ...

Least count of the screw gauge (L.C.) =........... cm

Zero correction of the screw gauge (z) = ……... cm

Ball No.	M.S.R (cm)	C.S.D. (div)	C.S.R. = C.S.D.×L.C. (cm)	Diameter of the Ball Total reading = M.S.R. + C.S.R.	Radius of the Ball $r=d/2$ ($\times10^{-2}$ m)
1					
2					
3					

To find the terminal velocity of the sphere:

Density of the liquid, ρ (given) = ………..kg/m^3

Density of the sphere, σ (given) = ……….kg/m^3

Distance travelled by the sphere = AB = ……… x 10^{-2} m

Ball No.	Radius of Ball 'r' (m)	Time taken to travel the distance AB, (s)	Velocity, 'v' = distance AB/t (m/s)	r^2 (m^2)
1				
2				
3				

To find the coefficient of viscosity of the liquid (consider radius of any one ball measured):

Density of the liquid, ρ (given) = ………..kg/m^3

Density of the sphere, σ (given) = ……….kg/m^3

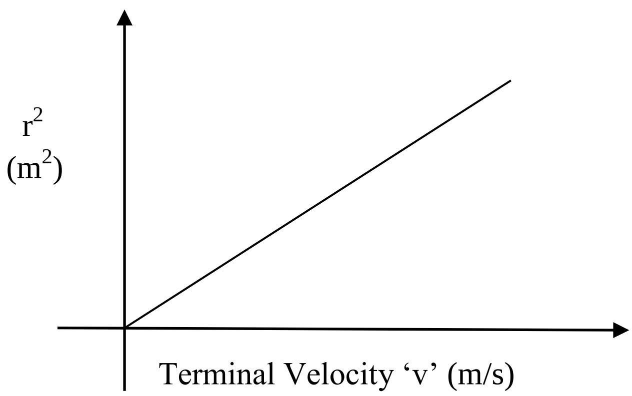
Distance travelled by the sphere =AB = ……… x 10^{-2} m

Radius of the ball, r = ……………… m

Terminal velocity, v = ………….. m/s

$$\eta = \frac{2}{9}\frac{r^2(d-\rho)g}{v}$$

Coefficient of viscosity of ……………… (η) =……….……….. N S/m^2



XVI Results

1. Since the graph between r^2 and v is a ………….. (Straight line / curved), we can say r^2 is ………………… (Directly / inversely) proportional to the terminal velocity.
2. The coefficient of viscosity of the liquid ……… **(η) =………..……….** N S/m^2

XVII Interpretation of results

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XVIII Conclusions and Recommendations

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. What will happen if density of ball bearing is less than density of glycerine oil?
2. List any four applications where viscous property of fluid is used.
3. Why funnel is used for dropping the ball bearing?
4. State the relation between radius of the ball bearing and terminal velocity.
5. Why does the body acquire the terminal velocity?
6. Which property measures the resistance of a liquid to flow?

Space to write answers:

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XX References / Suggestions for further Reading

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http://epathshala.nic.in/wp-content/doc/book/flipbook/Class%20XI/11087Physics%20Part%20II/ch%2010/index.html
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http://amrita.olabs.edu.in

XXI Suggested Assessment Scheme

Performance indicators		**Weightage**
Process related: 15 Marks		**60%**
1	Handling of the instrument	10
2	Experimental Set - up	20
3	Performance	20
4	Plotting Graph	10
Product related: 10 Marks		**40%**
5	Timely submission and Neatness	20
6	Conclusions & Recommendations	10
7	Practical related questions	10

Name of Student Team Members

1. ………………………..
2. ………………………
3. ……………………….
4. ……………………….
5. ……………………….

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Scale

X-axis -

Y-axis -

Experiment No. 11: Compare Young's modulii of the material of a given wires by using Searle's apparatus

I Practical Significance

The Young's modulus directly Measures the stiffness of the Solid material. It defines the relationship between stress (force per unit area) and strain (proportional deformation) in a material. Young's modulus (E) is a measure of the ability of a material to withstand changes in length when under length wise tension or compression. It predicts how much a material sample extends under tension or shortens under compression. Young's modulus is also used in order to predict the deflection that will occur in a statically determinate beam when a load is applied at a point in between the beam's supports. Young's modulus or Modulus of Elasticity which is material Constant Value. Thus modulus of elasticity always seems to be an important parameter in any field of engineering.

II Relevant Program Outcomes (POs)

PO1- Basic knowledge
PO3- Experiments and practice
PO8- Individual and teamwork
PO9- Communication
PO10- Lifelong learning

III Relevant Course Outcomes

Select relevant material in industry by analyzing its physical properties.

IV Practical Outcome

To calculate and Compare Young's moduli of the material of a given wires.

V Competency & Practical Skills

a. Measurement Skills.
b. Analysis skills.

VI Relevant Affective domain related Outcomes

a. Handle tools and equipment carefully.
b. Function as a team leader / a team member.

VII Minimum Theoretical Background

Elasticity is a property of a material which allows it to return to its original shape or length after being distorted. Some materials are not at all elastic - they are brittle and will snap before they bend or stretch. Others, like rubber, for example, will stretch a long way without significant warping or cracking. This is because the materials contain long chain molecules that are wrapped up in a bundle and can straighten out when stretched.

Hooke's Law states that within the limit of elasticity, stress applied is directly proportional to the strain produced.

i.e. **Stress α Strain**

$$\frac{Stress}{Strain} = \textbf{Constant}$$

The constant is called as modulus of elasticity.

Young's modulus is defined as the ratio of tensile stress to the tensile strain.

Y = (F L) / (A ΔL)

Where Y= Young's modulus

F= M X g

F= Force

M = Mass attached to the wire.
g = Gravitational acceleration = 9.81 m/s^2
A = Area of Cross section of wire
L = Original length
ΔL = Change in length

VIII Circuit diagram / Experimental set-up / Work Situation

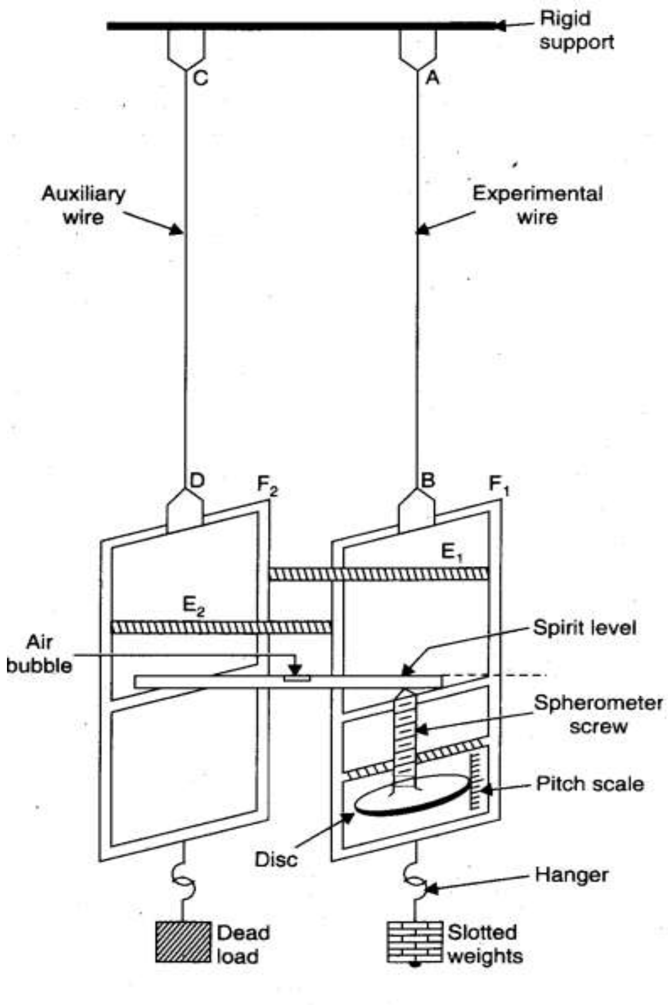

Fig. Searle's apparatus.

IX Resources required

Sr. No.	Instrument/Object	Specifications	Quantity
1	Searl's apparatus		1
2	Slotted weight	0.5 Kg	6
3	Meter scale	1 Meter	1

X Procedure

1. Attach dead load to dummy wire as well as experimental wire so that kinks present in the wire can be removed.
2. Adjust the bubble in the spirit level at its centre using spherometer screw.
3. Observe main scale reading (MSR) shown by spherometer.
4. Observe circular scale division (CSD) shown by spherometer.
5. Calculate circular scale reading (CSR).
   CSR = CSD X LC
6. Calculate total reading (TR) = MSR + CSR
7. Now gradually increase load by 0.5 kg each.
8. Wait for 2-3 minutes till bubble in spirit level shift from centre.
9. Repeat steps from 3 to 8 till weight becomes W0 + 2.5kg
10. Now gradually decrease a load by 0.5kg each.
11. Repeat the steps 3 to 6 for getting TR.
12. Repeat the steps till weight becomes W0.
13. Calculate elongation as shown in observation table.
14. Calculate stress as shown in the table.
15. Calculate Young's modulus Y using the formula.
16. Calculate mean value of Young's modulus.
17. Repeat the steps from 1 to 16 for next wire.

XI Precautions

1. Loading and unloading of weight must be done gently.
2. Avoid backslash error.
3. Loading should not be beyond elastic limit.

XII Actual procedure followed

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XIII Resources used

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XIV Precautions followed

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XV Observations and Calculations:-

Table 1:

Given: 1) Material of wire = Steel

2)Area of the wire = ……………..m^2

3) LC of spherometer = …………cm.

Sr. No	Load (M) Kg	M x g N	Spherometer reading							Elongation (l) X 10^{-2} m	Stress = $\frac{M \times g}{A}$ N/m^2	Strain = l/L	Y = $\frac{Stress}{Strain}$ N/m^2
			Load			Unload			Mean TR cm				
			MSR cm	CSR cm	TR cm	MSR cm	CSR cm	TR cm					
01													
02													
03													
04													
05													
06													
Mean of Young's modulus (Y) =													

Table 2:

Given: 1) Material of wire = Copper

2)Area of the wire = ……………..m^2

3) LC of spherometer = …………cm.

Sr. No	Load (M) Kg	M x g N	Spherometer reading							Elongation (l) X 10^{-2} m	Stress = $\frac{M \times g}{A}$ N/m^2	Strain = l/L	Y = $\frac{Stress}{Strain}$ N/m^2
			Load						Mean TR cm				
			MSR cm	CSR cm	TR cm	MSR cm	cm	R cm					
01													
02													
03													
04													
05													
06													
Mean of Young's modulus (Y) =													

XVII Interpretation of results

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XVIII Conclusions and Recommendations

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define Hooke’s law.
2. If Area of the wire increases, then what affect on Young’s modulus?
3. If mass attached to the wire is made 2 times heavier, then what affect on young’s modulus?
4. Why do we have to wait for some time after adding or removing of weight to the wire?
5. If material of wire change then young’s modulus of wire change or not. give reason.

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XX References / Suggestions for further Reading

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http://www.wisegeek.com/what-is-a-youngs modulus.htm
http://en.wikipedia.org/wiki/Coil_spring
http://sisphysics.weebly.com/uploads/7/9/7/5/797568/experiment_9__10.pdf
http://www.britannica.com/EBchecked/topic/259959/ spring
https://www.youtube.com/watch?v=YqnZUodE1yY

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instrument	10
2	Experimental Set - up	20
3	Performance	20
4	Calculation	10
Product related: 10 Marks		**40%**
5	Timely submission and Neatness	20
6	Conclusions & Recommendations	10
7	Practical related questions	10

Name of Student Team Members

1. ………………………..
2. ………………………
3. ……………………….
4. ………………………
5. ……………………….

Marks Obtained			Dated Signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Experiment No. 12: To determine coefficient of viscosity of a low viscous liquid- Capillary flow method.

I Practical Significance

Measuring viscosity is an effective way of determining the state (properties of matter) or fluidity of a liquid or gas. It plays an important role in the quality control and various research and development stages in lab, process and research environments as well as a wide range of industries and applications including Food, Chemical, Pharmaceutical, Petrochemical, Cosmetics, Paint, Ink, Coatings, Oil and Automotives.

Viscosity is one of the most important properties of a fluid and plays a very prominent role in the petroleum industry. The viscosity of a crude oil affects our ability to pump it out of the ground; the viscosity and volatility of a fuel affect how easy it is to atomize in the fuel injector; the viscosity of a lubricant affects its ability to protect an engine.

Viscosity testing of food is used to find best composition ratios when producing items such a chewing gum, butter, margarine, bread, candy, chocolate, and other food items.

II Relevant Program Outcomes (POs)

PO1- Basic knowledge
PO3- Experiments and practice
PO8- Individual and teamwork
PO9- Communication
PO10- Lifelong learning

III Relevant Course Outcomes

Select relevant material in industry by analyzing its physical properties.

IV Practical Learning Outcome

To determine coefficient of viscosity of a low viscous liquid- Capillary flow method.

V Competency & Practical Skills

Measurement Skills.

VI Relevant Affective domain related Outcomes

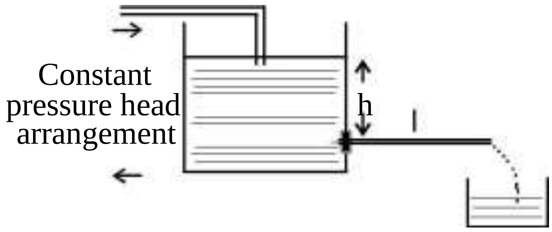
a. Handle tools and equipment carefully.
b. Practice energy conservation.
c. Function as a team leader / a team member.

VII Minimum Theoretical Background

The property by virtue of which the relative motion between the layers of a liquid is maintained is called viscosity. We can also say viscosity is the resistance to flow.

Coefficient of viscosity of a liquid is defined as the viscous force acting between two layers of a liquid having unit area of layers and unit velocity gradient normal to the direction of flow of the liquid.

Poiseuille's formula:



Consider a capillary tube of length 'l' and radius 'r' fixed horizontally to a side of a vessel. Let a liquid be filled in the vessel. The level of the liquid is maintained constant by constant pressure head arrangement. Let 'h' be the height of the liquid and P be the pressure at the capillary tube. Let 'η' be the coefficient of viscosity of the liquid and 'ρ' be the density of the liquid.

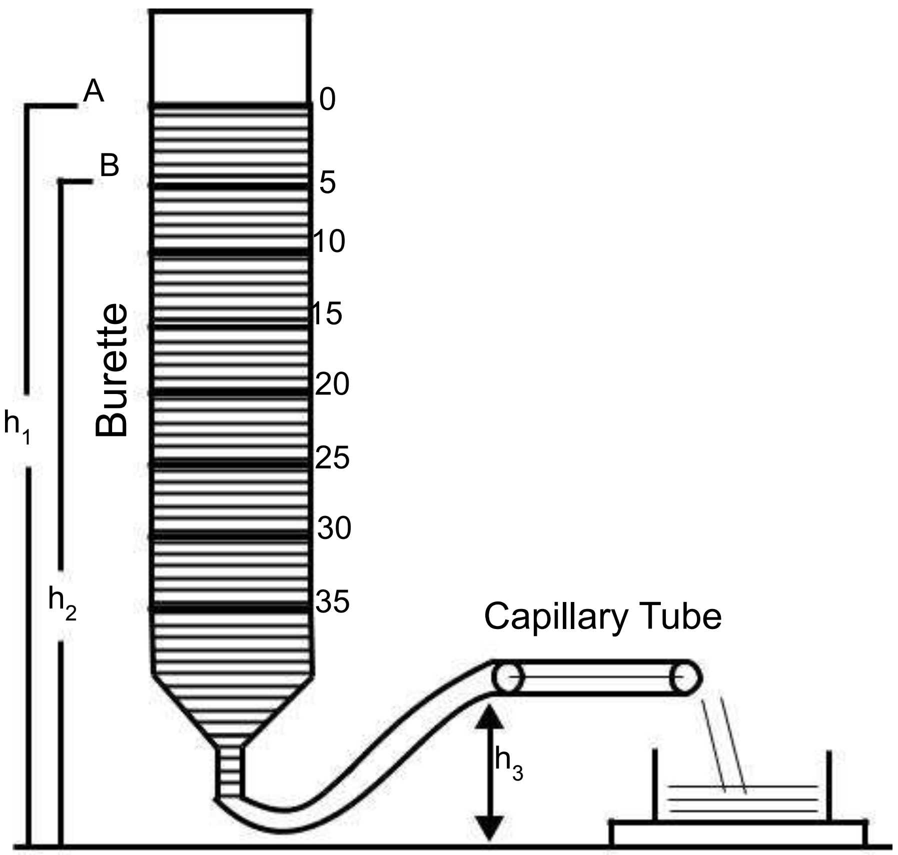
When the liquid is in streamline flow, it is found that, the volume of liquid flowing per second 'v' Is proportional to

some power of pressure gradient $(P/l)^x$
some power of radius of the capillary tube $(r)^y$
some power of coefficient of viscosity of the liquid $(\eta)^z$

i.e. $v \mu (P/l)x(r)y (\eta)z$
$v = K(P/l)x(r)y (\eta)z$ ...(1) Where K is a constant.
The value of K is found to be $\pi/8$ by experiments,

$$v = \frac{\pi P r^4}{8 l \eta} \quad \text{(or)} \quad \eta = \frac{\pi P r^4}{8 l v} = \frac{\pi h \rho g r^4}{8 l v}$$

VIII Circuit diagram / Experimental set-up / Work Situation



IX Resources required

Sr. No.	Instrument/Object	Specifications	Quantity
1	Burette		1
2	Glass capillary tube		1
3	Digital stopwatch		1 each

X Procedure

1. Mount graduated burette without stopper vertically in the stand.
2. Connect rubber tube to the bottom of the burette.
3. To the other end of the tube, an insert capillary tube to the other end.
4. Placed a capillary in a perfectly horizontal position.
5. Poured pure water into the burette using a funnel.
6. Adjust the height of liquid level in the burette such that flow of water is a streamline flow i.e. 5 to 8 drops per minute.
7. Start the stopwatch when the water level in the burette comes to zero mark
8. Record the time when the water level reach to 5 cc, 10 cc, 15 cc, 20 cc and 25 cc mark
9. Record heights of the respective initial levels and final levels
9. Calculate the average pressure head height.
10. Calculate the coefficient of viscosity of water by using given formula.

XI Precautions

1. The burette should be vertically straight..
2. The capillary tube should be in perfectly horizontal position.
3. The water flow through capillary should be streamline flow.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XVI Results

1. Value of coefficient of viscosity pure water (by experiment) = …………… N/m

2. Value of coefficient of viscosity pure water (from graph) = …………… N/m

XVII Interpretation of results

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XVIII Conclusions and Recommendations

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. The intermolecular forces in oil are less than water but still the viscosity of oil is more than water. Justify
2. If the temperature increases, the viscosity of liquid decreases whereas the viscosity of gases increases. Comment.

3. List out the fluids having viscosity less than and greater than that of water.
4. Why is viscous force dissipative?
5. What is effect of pressure on coefficient of viscosity of liquid?

Space to write answers:

XX References / Suggestions for further Reading

Laboratory Manual Physics for class XI - Published by NCERT
http://www.wisegeek.com/what-is-a-helical-spring.htm
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https://www.youtube.com/watch?v=YqnZUodE1yY

XXI Suggested Assessment Scheme

Performance indicators		**Weightage**
Process related: 15 Marks		**60%**
1	Handling of the instrument	20
2	Experimental Set - up	20
3	Performance	20
Product related: 10 Marks		**40%**
4	Timely submission and Neatness	20
5	Conclusions & Recommendations	10
6	Practical related questions	10

Name of Student Team Members

1. ………………………..
2. ………………………
3. ……………………….
4. ………………………
5. ……………………….

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Scale

X-axis -

Y-axis -