

PROJECTS

BACKGROUND INFORMATION ABOUT INVESTIGATORY PROJECTS

INTRODUCTION

The expansion of scientific knowledge and consequently the change in the system of education has led to a modification in the methods of instruction. Today the stress is laid on inquiry approach and discussion method instead of the age-old lecture method of teaching. A new dimension in the teaching of science has been added by including the project-work at the higher secondary level. Teaching through project work is an individualized instructional technique. It provides an opportunity to the student to define a problem, to plan his/her work, to search appropriate resources, to carry out his/her plans, and to draw conclusions. This way, students are exposed to the fundamental scientific principles, methods and processes and get a first hand knowledge about the various phases involved in a scientific investigation. Thus the project work helps to: (a) stimulate interest in science; (b) arouse scientific curiosity; (c) develop independent critical thinking; (d) provide experience of using various tools and techniques in the field of science and (e) develop self-confidence. The modern trend in the teaching of science therefore encourages more project work.

Any kind of investigation; formulated, designed and carried out in the library, laboratory, in the field, or at home constitutes an investigatory project. A project may be as simple as collection of samples of minerals and it may be as difficult as developing an original indigenous process for the production of a chemical. Some of the projects can be completely theoretical and involve only the library work. Others may involve the experimental work to be carried out in the laboratory. The experimental work in science exposes the students to a number of scientific instruments, tools, techniques and intellectual skills.

SELECTION OF PROJECTS

Projects should usually be selected by the students. The idea of a project originates from studying a subject in the classroom, reading the reports of various projects, science news, popular science articles from science journals etc. Sometimes the idea of a science project may strike during classroom discussion on topics, which may require testing, quantifying and interpreting. Some of the science journals for getting the ideas for a project are : (a) Journal of Chemical Education; (b) Chemistry Education; (c) Education in Chemistry; (d) New Scientist; (e) School

Science; (f) School Science Review; (g) Science; (h) Scientific American; (i) School Science Resource Letter, etc. Once the project work begins, it might provide new titles and ideas.

In spite of the availability of the above listed scientific literature, it should not be assumed that students can begin the work on projects spontaneously. Since majority of the science journals listed above are not available in Indian Schools. Students need the help and guidance from the teacher. If some student does not get an idea for the project, the teacher may provide a list of suggested projects or take the students to science fairs and exhibitions to show what other students are doing. A format for working on the projects is given below:

1. Title of Project
2. Objectives and importance of Project
3. A brief outline of work on Project

The title of the project should be written in such a manner that the objectives and importance of the project is clearly defined. In other words a project title and its objectives should create an interest and curiosity. A 'brief outline of working on a project' helps the student to initiate the work.

It may be debatable that this approach of suggesting ideas for the projects defeats one of the basic objectives of project work, namely originality, but providing guidelines to the students is completely scientific and desirable to encourage every student to begin and aim at something in the first attempt.

MANAGING TIME

Central Board of Secondary Education has allocated ten periods for the project work. A student can start the project right in the beginning of the academic year and can carry it out in phases and submit the report of the project at the end of the year.

TECHNICAL AND ACADEMIC GUIDANCE

This is an important factor in the smooth running of the project work. The student should plan for the project well in advance and discuss its design with the teacher. If improvisation of the apparatus or some instrument is needed or a chemical is not available in the laboratory. The help of teacher may be taken. If some technical or academic guidance is required help may be taken not only from the concerned teacher of chemistry but also from physics from and other science teachers as well.

LABORATORY FACILITIES

The selection of the project should be such that as far as possible, the material (apparatus, instruments, chemicals, etc.) needed for the project-work is easily available. Student may purchase the affordable chemical or an apparatus (improvised or original) if it is not available in the laboratory, and the student is very curious to take up the project and wants to do it. The students should be discouraged from taking highly expensive projects. An effective project-work requires an integrated approach rather than a subject specific approach.

The project work in the laboratory requires a bigger and separate space. Arrangements should be made in such a way that at a given time all the students are not involved in doing the laboratory work. Some students should carry out the work of collecting references in the library while others should design experiments.

Problems may arise in carrying out the long term experiments like corrosion, fermentation etc. in the laboratory. It is suggested to have a separate bench in the laboratory, where long term experiments can be set up. For storing the samples of certain chemicals and apparatuses relevant to the project-work, cardboard boxes, with student's name written on them can be used. Empty bottles, if available, can also serve the purpose of storing the chemicals.

RECORDING THE PROJECT WORK

Recording the actual observation in the project work is very essential. Students should be encouraged to record the negative results also. A general format for writing the project report is suggested below. It should involve the following points :

1. Title of project reflecting objectives
2. Principles used for Investigation
3. Apparatus and Chemicals required
4. Improvisation, if any
5. Procedure
6. Observations and Calculations
7. Conclusions and the logic upon which the conclusions are based
8. Precautions
9. Suggestions for further investigations, if any

To illustrate the format outlined above, a 'sample project' report is presented in the end. It may further be noted that sample project report serves merely as a guideline to the

students while writing their projects. It is by no means exhaustive and is open to further improvements. Brief outline of some projects is given below.

PROJECT 1

Title

To test the contamination of water by bacteria by checking the sulphide ion concentration and find out the cause of contamination.

Objective

To check the bacterial contamination in samples of water collected from different sources by determining sulphide ion concentration.

Background Information

Sulphide ions are present in water when anaerobic bacteria decompose organic matter or reduce sulphates. These are found in stagnant water. Generally pollutants from paper mills, gas works, tanneries, sewage works and other chemical plants are responsible for the growth of such bacteria.

Brief Procedure

Collection of Samples

Sulphides are readily oxidised, therefore care should be taken at the time of sampling to exclude air by flushing it with nitrogen or carbon dioxide. But the best way is to 'fix' the sample immediately after collection. This can be done by adding small volume of cadmium-zinc acetate solution. For this take 80 mL of water and add cadmium-zinc acetate solution 20 mL to obtain a total volume of about 100 mL. To make Cd-Zn acetate solution dissolve 50 g cadmium acetate and 50 g zinc acetate in 1.0 L of water. If collected sample is acidic in nature, then first neutralize it with little excess of alkali.

Titration of Fixed Solution

Take 100 mL fixed solution in a titration flask, add 20 mL 0.025 M iodine solution and immediately add 15 mL, (1:1) HCl and mix. Titrate the excess iodine against 0.05 M $\text{Na}_2\text{S}_2\text{O}_3$, adding starch solution as indicator towards the end point. Calculate the amount of sulphide ions in the original samples from the amount of iodine used in the reaction with H_2S . Subtract the values of blank titration if available from the calculated values.

PROJECT 2**Title**

To study the methods of purification of water.

Objectives

- To study level of purity achieved by using different methods of purification.
- To study advantages and disadvantages of using different method for purification.
- To know about specific uses of pure water.

Background Information

Purity of water obtained from different natural sources is different. The type of contamination and impurity present depends upon the source from which water is obtained. Besides drinking purposes, we require pure water for various other purposes e.g. in chemical analysis. There are various methods for the purification of water. These remove impurities and contamination to different extent. There are some advantages and disadvantages in using these methods. Comparison of various methods of purification will provide an idea about obtaining water of specific purity for a specific purpose.

Brief Procedure

Students may find out level of purity achieved by various techniques in use, for the purification of drinking water. They can survey the literature and visit industries etc. to find out uses of water of specific purity. Students may work in groups for the study of various aspects of the project.

Note : Another aspect of the project may be to study different methods of purification of water taken from different sources such as river, well, bore-well, municipality etc.

PROJECT 3**Title**

Testing the hardness, presence of iron, fluoride, chloride etc. in drinking water obtained from different regions and a study of the cause of presence of these ions above permissible limits.

Objectives

- To test the total hardness, iron, fluoride and chloride etc. in different samples of water.
- To collect information about local sources of above ions in water.
- To study the effect of these ions on health if present beyond permissible limits.
- To find out whether any such problem exists in the locality and around.

Background Information

Quality of drinking water has direct relationship with the human health and life. If iron, fluoride, chloride etc. are present in water above permissible limits, they may cause several health problems. For example, if fluoride is present above permissible limit, people of the region may suffer from fluorosis. Hardness of water is due to the presence of calcium and magnesium ions. It is well known fact that hard water is not fit for laundry purposes. Thus, it is very important to know the ions and their amount present in water.

Brief Procedure

Students may collect samples of water from different sources. They can detect the presence of different ions by usual methods of analysis. Total hardness of water can be estimated by standard procedure of complexometric titration. Estimation of Cl^- , F^- and Fe^{2+} is difficult at this level. Therefore existing data from approved labs can be taken for the purpose of investigation.

PROJECT 4

Title

Investigation of the foaming capacity of different washing soaps and the effect of addition of sodium carbonate on their foaming capacity.

Objective

To study the foaming capacity of soaps and the effect of addition of sodium carbonate on their foaming capacity.

Brief Procedure

Weigh 1 gram of a sample of soap and dissolve it completely in 100 mL of distilled water. Take 10 mL of the soap solution in a boiling tube close the mouth of the boiling tube with the help of a cork and shake the solution making 20 regular strokes so that foam increases uniformly. Measure the length of the boiling tube up to which the foam rises. Similarly, perform the experiment with other soap solutions.

Dissolve 0.5g of sodium carbonate in 50 mL of each of the above soap solutions separately. Now take 10 mL of a solution in a boiling tube and shake it equal number of times (e.g. 20 regular strokes). Measure the length up to which foam appears. Similarly, perform the experiment with other soap solutions. Record the observations in a tabular form.

Compare the height upto which foam produced rises in different soap solutions with and without the presence of Na_2CO_3 and draw conclusions.

PROJECT 5

Title

Study of the acidity of different samples of tea leaves and reasons for the variation in colour of tea prepared from these leaves.

Objective

To estimate the concentration of acids present in different tea samples and the effect of addition of acids or bases on the colour of tea extract.

Brief Procedure

(a) Estimation of Concentration of Acids Present in Tea

Weigh 10 grams of the sample of tea leaves and prepare the extract of each sample separately in 200 mL of distilled water. For this, boil different samples of tea leaves with distilled water for a fixed time period.

Take 5mL of tea extract in a conical flask and dilute it with 20 mL of distilled water. Shake the solution well for homogenous mixing and then titrate it against M/50 NaOH solution using phenolphthalein as an indicator. Similarly, titrate other tea

extracts with M/50 NaOH solution. Calculate the concentration of acids present in different samples of tea leaves in terms of molarity. If colour of the extract causes problem, then tea extract can be taken in the burette and sodium hydroxide solution in the conical flask. Phenolphthalein may be used as an indicator if sodium hydroxide solution is taken in conical flask. The colour change will be from pink to colourless.

(b) Effect of Acids and Bases on the Colour of Tea Extract

Take five filter paper strips and mark them as A, B, C, D and E. Dip all the strips in any one sample of tea extract and then take them out. Now put two drops of dilute HCl, acetic acid solution, NaOH solution and NH_4OH solution on strips A, B, C and D respectively. Compare the change in colour of these strips with reference to the colour of the strip E. Repeat this experiment with other samples of tea extract.

PROJECT 6

Title

Study the rates of evaporation of different liquids

Objective

To study the relationship between the rates of evaporation of different liquids and their chemical constitution.

Brief Procedure

Take five clean and dry weighing tubes and mark them as A, B, C, D and E. Weigh each weighing tube with its stopper. Now pour 10 mL of different liquids (ethanol, ether, tetrachloromethane, acetone etc.) in different weighing tubes. Weigh each weighing tube again and find the mass of the liquid taken in each weighing tube.

Remove the stoppers of the weighing tubes and keep them at room temperature for one hour. After exactly one hour, close the mouth of all the weighing tubes with their stoppers and weigh them again one by one.

Calculate the loss in mass of each liquid. The temperature and the surface area should be the same for the evaporation of each liquid. Determine the rate of evaporation of each liquid in grams of liquid evaporated per second. Relate the difference in rates of evaporation of liquids with their chemical constitution and variation in intermolecular/intra-molecular interactions.

PROJECT 7**Title**

Study the effect of acids and alkalies on the tensile strength of fibres

Objective

To study the effect of acids on the tensile strength of different types of fibers.

Brief Procedure

The tensile strength of a fibre is measured by noting the minimum weight required just to break the thread. It may be done as follows:

Take a thread of about 20 cm length and tie its one end with a ring fixed on the iron stand and the other end with a hanger which carries the weights. Increase the weight on the hanger and find out the minimum weight required to just break the thread. Repeat the experiment with threads of equal length and thickness but of different materials (eg. cotton, wool, silk, terylene etc.). These weights are the measure of tensile strength of the fibre.

The effect of acids and alkalies on the tensile strength of fibres can be determined by dipping them separately in dilute HCl or dilute NaOH solution of equal strengths for equal intervals of time. After a small but fixed interval of time, the fibres are removed from the solution, washed with water and dried. Then minimum weight required to just break these threads are determined. These weights are the measures of the tensile strengths of fibres after treatment with acid or alkali. Interpret your observations in terms of chemical constitution of the material of fibre.

PROJECT 8**Title**

Study of the acids and mineral contents of vegetables and fruits.

Objective

- (a) To determine the amount of acids present in various vegetables and fruits.
- (b) To detect the presence of iron, carbohydrate, protein and sugar etc. in vegetables and fruits.

Brief Procedure

(a) Acid Content

Take out the juice of a few fruits and vegetables (apple, orange, amla, lemon, raddish, cane sugar etc.) by crushing them. Keep the juice samples in different containers. Determine the pH of different samples of juices. Determine their acid content by titrating a known quantity of juice with M/100 potassium hydroxide solution using phenolphthalein as an indicator. In case of dark coloured juices, dilute them with enough distilled water to get sharp end point during titration.

Compare the acid contents of juices by comparing their acid values. Acid value of vegetables and fruits is the number of milligrams of potassium hydroxide required for neutralizing the acids present in one gram of vegetable/fruit.

(b) Tests for Iron, Carbohydrate (starch and sugar), Protein and Fats

Test the vegetables and fruit juices for the presence of iron. Heat the vegetable juice with concentrated HNO_3 for some time and perform the test for iron. Carbohydrate (starch, sugar), protein and fats can be tested by the usual tests.

SAMPLE PROJECT REPORT

Title

A study of the variation of viscosity of organic compounds of same homologous series with variation in the (a) molecular masses and (b) structures of carbon chains.

Background Information

Some liquids like honey or Mobil oil flow very slowly while others like water or kerosene flow rapidly. Liquids that flow slowly are known as viscous liquids while others that flow rapidly are known as non-viscous liquids. The resistance offered by a liquid to flow is known as viscosity. It is related to intermolecular forces existing in a liquid. Different liquids have different values of viscosity due to the existence of different magnitudes of intermolecular forces. The comparison of viscosities of various homologues and isomers in a particular homologous series would give an idea about the magnitude of intermolecular forces existing in them.

Objectives

The objectives of this project are to establish a relationship between (a) viscosity and molecular masses; and (b) viscosity and nature of carbon chain in organic compounds.

Principle Involved

The resistance to flow offered by a liquid is measured in terms of coefficient of viscosity which is defined as follows:

‘Coefficient of viscosity of a liquid at a specified temperature is the steady force required to maintain a velocity difference of unity between two parallel layers of a liquid, a unit distance apart and having a unit area of contact’. Coefficient of viscosity is measured by Ostwald viscometer method. For two liquids whose coefficient of viscosity are d_1 and d_2 , η_1 , η_2 the time of flow in seconds are t_1 and densities are d_1 and respectively d_2 then the following relation holds:

$$\frac{\eta_1}{\eta_2} = \frac{d_1 \times t_1}{d_2 \times t_2}$$

Hence if the viscosity of one liquid is known, the viscosity of other can be determined.

Hazard Warning

- Acetone and alcohols are inflammable, do not let the bottles open when not in use.
- Keep the bottles away from flames.
- Wash your hands after use.
- Wear safety spectacles.

Material required

Ostwald viscometer, stop-watch, beaker (250 mL), pipette, graduated cylinder, kerosene, petrol, diesel, methyl alcohol, ethyl alcohol, propyl alcohol, isopropyl alcohol, butyl alcohol, isobutyl alcohol, tert butyl alcohol and amyl alcohol.

Brief Procedure

The viscometer was washed, rinsed with alcohol and dried. 10 mL of the liquid under investigation was filled in it and the time required for the flow of liquid between two marks of viscometer was noted with the help of a stop watch. These observation were recorded in Tables I and II. The viscosities of various liquids were calculated by the formula discussed under the heading principles involved.

Observations and Calculations

Room Temperature = 23°C.

A viscometer of different capacity was used for alcohols.

Table 1 : Data for the time of flow of various compounds

Sl. No.	Name of the compound	Time of flow (seconds)	Density (g/mL)	Viscosity (millipoise)
1.	Water	13.5	1	10.08
2.	Petrol	8.5	0.8	6.4
3.	Kerosene Oil	22.0	1	16.4
4.	Diesels Oil	48.0	1	18.0

Table 2 : Data for the viscosity vs molecular mass relationship of various compounds

Sl. No.	Name of the compound	Molecular mass	Time of flow (Seconds)	Density in (g/mL)	Viscosity (millipoise)
1.	Water	18	180	1	10.08
2.	Methanol	32	136	0.79	7.6
3.	Ethanol	46	258	0.78	14.4
4.	Propan-1-ol	60	391	0.8	21.9
5.	Propan-2-ol	60	546	0.79	30.6
6.	Butan-1-ol	74	612	0.81	34.3
7.	Butan-2-ol	74	686	0.80	38.4
8.	2-Methylpropan-1-ol	74	1406	0.79	78.8
9.	Pentan-1-ol	88	784	0.817	43.9

Note : * If the homologues/isomers of alcohols are not available, other suitable compounds, which are available or are easily manageable can be used for this study.

** Time of flow recorded in the tables are specific for a viscometer and should not be taken as standard values.

Conclusion

As seen from the Table 1, the viscosities of various hydrocarbon fractions, i.e. petrol, kerosene and diesel oil are on an average 6.4, 16.4 and 18.0 respectively. Since the molecular mass of these fractions increases from petrol to diesel oil, this indicates that viscosity increases with increase in molecular mass. The intermolecular attractions tend to increase with increase in molecular mass.

In the case of alcohols, the viscosity of nine alcohols were determined and their values are given in Table-II. The viscosity of alcohols increases with an increase in the molecular mass as can be seen from the viscosities of methanol, ethanol, propan-1-ol, butan-1-ol, the viscosities are 34.3, 38.4 and 78.8 millipoise respectively. This shows that viscosity increases with the increase in molecular mass.

Precaution

The viscometer should be thoroughly cleaned and dried before use.

Suggestions for further investigation

A study of the variation of viscosity with intermolecular forces may be carried out using appropriate compounds.

References

KEENAN, C.W.; WOOD, J.H. *General Chemistry IVth Edition.*, Harper and Row Publishers Inc. New York.