Course: Lab Organization, Management and Safety Method (8629)
Semester: Autumn 2018
Level: B.Ed (1.5 Years)

ASSIGNMENT No. 2

Q.1 Write Aims and Objectives of Laboratory work in Pakistani context.(20)

AIMS AND OBJECTIVES

- To promote higher studies and research on pure and applied sciences in Pakistan and to disseminate scientific knowledge;
- To formulate standards of scientific effort and achievement in Pakistan and to recognize outstanding contributions to the advancement of science;
- To publish and assist in the publication of Scientific Proceedings, Journals, Transactions, Monographs, Books and other scientific literature;
- To establish and maintain association and relations between Pakistani scientists and the international groups, meetings and unions of scientists, and between Pakistani scientific activities and the activities of scientists in other countries;
- To award grants, scholarships, fellowships, prizes and medals for scientific research;
- To undertake such scientific work of national or international importance as the Academy may be called upon to perform by the Government;–to have the advisory and consultative status with the Ministries and Divisions of Government dealing with scientific and technical matters, and to represent internationally the scientific work of Pakistan;
- To secure and administer funds, endowments and other grants for the promotion and development of scientific research or projects of a scientific nature, and for the attainment of the aims and objectives of the Academy;
- To correlate and assist in correlating the efforts of other scientific bodies;
- To do all other lawful things that the Academy may consider conducive to, or necessary for, the attainment of its aims and objects.

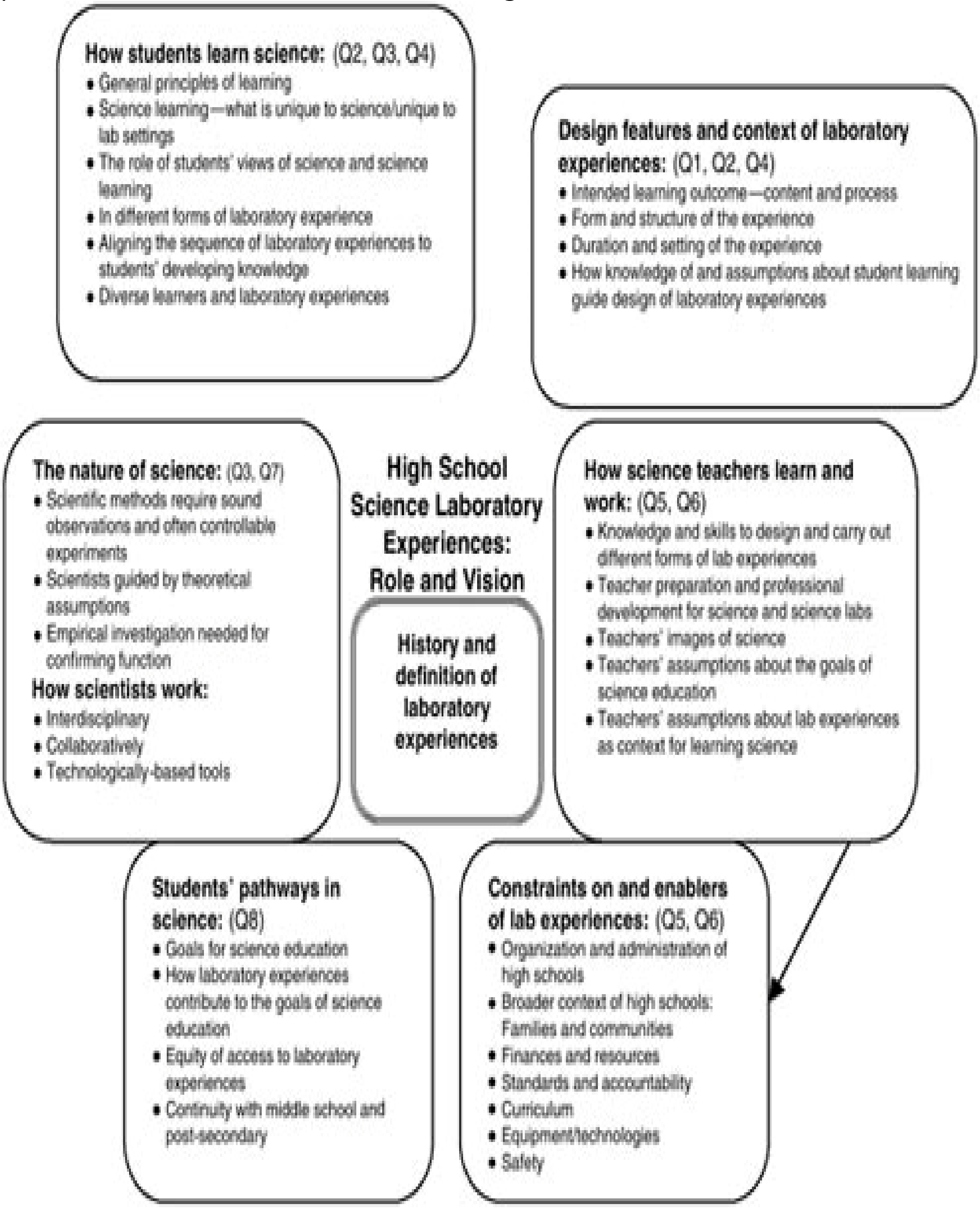
SCOPE OF THE STUDY

The committee carried out its charge through an iterative process of gathering information, deliberating on it, identifying gaps and questions, gathering further information to fill these gaps, and holding further discussions. In the search for relevant information, the committee held three public fact-finding meetings, reviewed published reports and unpublished research, searched the Internet, and commissioned experts to prepare and present papers. At a fourth, private meeting, the committee intensely analyzed and discussed its findings and conclusions over the course of three days. Although the committee considered information from a variety of sources, its final report gives most weight to research published in peer-reviewed journals and books.

At an early stage in its deliberations, the committee chose to focus primarily on "the role of high school laboratories in promoting the teaching and learning of science for all students." The committee soon became frustrated by the limited research evidence on the role of laboratories in learning. To address one of many problems in the research evidence—a lack of agreement about what constitutes a laboratory and about the purposes of laboratory education—the committee commissioned a paper to analyze the alternative definitions and goals of laboratories.

The committee developed a concept map outlining the main themes of the study and organized the three fact-finding meetings to gather information on each of these themes. For example, reflecting the committee's focus on student learning ("how students learn science" on the concept map), all three fact-finding meetings included researchers who had developed innovative approaches to high school science laboratories. We also commissioned two experts to present papers reviewing available research on the role of laboratories in students' learning of science.

At the fact-finding meetings, some researchers presented evidence of student learning following exposure to sequences of instruction that included laboratory experiences; others provided data on how various technologies



Q.2 a) How computers can be used for controlled exercises in science laboratories?

Science laboratory activities pose many barriers to students with disabilities. This session will demonstrate several ways that high school or college level chemistry and physics laboratory activities can be made accessible to students with physical or visual disabilities. Computer-controlled lab equipment can be combined with assistive technology to provide a means for students to make scientific measurements. This equipment, along with other assistive technology and alternative techniques, was used to design a set of accessible chemistry and physics experiments for high school and college level classes.

APPROACH

Computer-controlled laboratory equipment is becoming incorporated into more high school and college chemistry and physics courses. A sensor, such as a temperature probe, is connected to the computer, and specialized software controls the timing of measurements and the recording and display of data. Even without any other accommodations, the larger display and pull-down menu controls of these systems can make data acquisition easier for some students with disabilities. Dr. David Lonny of East Carolina University has achieved even greater accessibility for students with disabilities by adapting laboratory computers with assistive technology. However, his work has focussed on specialized computer systems. Our approach is to combine the relatively inexpensive computer interfaces and software Technologies more commonly found in introductory labs with common alternative computer access methods so that students with disabilities can conduct experiments themselves.

For example, a computer can record measurements from a light sensor, and the readings can be magnified or spoken by a synthesizer for students with visual impairments. A student who has difficulty using his or her hands can control the timing and recording of measurements through voice commands.

We are developing detailed instructions for science teachers on how to add assistive software to computer-controlled lab software to make it fully accessible. Two lab control systems, Venire Software's Universal Lab Interface and SCI Technology's Lab Works II are presently being tested on IBM and Macintosh computers with access software. A variety of sensors are available for each system, and basic set of interface hardware, software, and a couple of sensors cost $300-1200. The access software includes keyboard access utilities (e.g., Sticky Keys), on-screen keyboards with mouse emulators, voice input programs, magnification programs, and voice output programs.

We have discovered, for example, that the more standard DOS software for the Venire lab interface will not run simultaneously with other software (such as MouseKeys). Students who need software-based assistive technology would need to use the new Windows 95 interface software (which has shown to be compatible). As the combinations of technology are being tested, project personnel are developing configuration files and customizing the software as needed to permit access to the information displayed by the computer. We will complete the testing and customization in the next few months, and a panel of students with disabilities will test the software combination for usability.

Many laboratory tasks cannot be replaced easily with computerized sensors and require additional assistive technology or techniques. Existing assistive technology is being identified and other approaches are being developed. For example, solvents can be measured out via the standard graduated cylinder or pipette, but might also be measured with liquid measuring spoons, a syringe, or by weight.

The information on using computer-controlled lab software, computer access technology, and other assistive technology is being combined to create a series of twelve sample accessible chemistry and physics experiments. Some of the chemistry experiments include Conductivity of Electrolytes and Non-Electrolytes (using a conductivity meter or voltage probe), Gas Laws (using pressure and temperature probes), and Chemical Equilibrium (using a colorimeter). The physics experiments include Force and Motion (using accelerometers, force sensors, and photo gates), Electrical Measurements (using voltage measurement leads), and Properties of Light (using a light sensor). These experiments use a variety of measurements and related laboratory techniques.

Although this project focussed on chemistry and physics, teachers of other science disciplines should note that barometers, carbon dioxide gas sensors, dissolved oxygen probes, heart rate monitors, and Geiger counters can also be interfaced to these computer systems. Thus, similar access could be provided in Biology or Earth Science classes.

The experiments and accommodations developed for this project are being compiled into a resource guide. The guide is also available to the public via the Internet site Barrier Free Education.

b) Give at least two examples of investigation from science subjects.(20)

Scientific investigation is the way in which scientists and researchers use a systematic approach to answer questions about the world around us. Read on to find out more. A quiz is provided to test your understanding.

Scientific Investigation

Some time ago, I was asked to be a judge at a local school science fair. I went to the school to do my judging duty and there were the usual projects: Alaina had a volcano that erupted a vinegar and baking soda mixture; Phillip displayed a three-dimensional mobile of the solar system; and Mariah discussed a potato in a jar of water with a plant growing out of it.

But I was looking for something more. Was there a kid there that really wanted to conduct a scientific investigation? Then I found it. Back in the corner of the gym was a small table and an even smaller boy with a rather crudely made poster. It read, 'How does the angle of a ramp affect how fast a toy car will roll down?' I quickly made my way over to the boy's station and saw that he had an experimental setup with a long wooden ramp and a way to measure the angle of the ramp. He also had a toy car and a stopwatch. Perfect!

Intrigued, I asked him a number of questions. What is your hypothesis? How would you describe your experimental setup? What were your results? Did they support your hypothesis? What about errors in your measurements? Calmly, the boy answered each question and then showed me this table with results scrawled in:

Angle (°)	Length (ft)	Time (sec)	Average Speed (ft/sec)
5	8.0	3.2	2.5
10	8.0	2.1	3.8
15	8.0	1.6	5.0
20	8.0	1.3	6.2
25	8.0	1.1	7.2
30	8.0	1.0	8.0
35	8.0	1.0	8.0
40	8.0	0.9	8.9
45	8.0	0.9	8.9
50	8.0	0.9	8.9

Experimental data from the car and ramp

After a long discussion with the lad, I came to the conclusion that he had conducted a thorough scientific investigation and had learned much from this experience. I voted for an 'A' grade! Let's find out more about what constitutes good scientific investigation.

Scientific investigation is a quest to find the answer to a question using the scientific method. In turn, the **scientific method** is a systematic process that involves using measurable observations to formulate, test or modify a hypothesis. Finally, a **hypothesis** is a proposed explanation for some observed phenomenon, based on experience or research. Scientific investigation is what people like you and me use to develop better models and explanations for the world around them.

Steps for Scientific Investigation

As you can imagine, there are several phases to a good scientific investigation. These may vary a bit in the literature, but they generally include five steps.

Step one - Observe something of interest

The young man at the science fair obviously enjoyed playing with toy cars and had noticed that when he increased the pitch of the ramp, the cars went faster. He wondered what the relationship was between the steepness of the ramp and the speed of the car, beyond just the obvious fact that it went faster as the slope increased. People who engage in a scientific investigation usually do so because they don't know or are unsure of some aspects of the observation or because they want to confirm a hunch about the observation.

Step two - Formulate a question that can be answered in a measurable way

It's important to ask the question so that it can be answered in a measurable way. Beginning the question with 'what,' 'how' or 'why' is a good start. The question should also be focused. Many researchers make the mistake of trying to 'boil the ocean' with a question that is too general. For example, 'Why do people get sick?' would not lend itself to a good scientific investigation in anyone's lifetime, even though it's a pertinent question. Remember, boiling the ocean is quite a bit more difficult than boiling a pot of water.

Step three - Formulate a hypothesis that answers the question based on experience or research

You may be wondering, 'Why come up with a hypothesis about something we're trying to discover?' It's much easier to analyze data and compare it to an existing theory than to try to develop a theory from scratch. There are already good models for much of what we observe, so we can usually find the seeds of an answer to our question through research. Many times, scientific investigation is used just to make incremental improvements to a theory, process or product. In short, the hypothesis brings to bear all that is already known about the question; it gives us context for what we're studying.

When I asked the young boy about his hypothesis, he said, 'When I play with my cars, I notice that when I start increasing the slope of the ramp, the speed of the car seems to change a lot. Later on, at the higher slopes, the car goes fast but each change seems to have less effect. My dad's a teacher and when I talked to him about this, he said that the force of gravity goes straight down. So the part of gravity that is affecting my car changes with the angle, but it changes less at the higher angles. He said it has something to do with trigonometry. I don't know what that is. Anyway, that's what I am expecting to happen.'

Q.3 Write difference between sequence and organization. What is the role of Organization in Laboratory work? (20)

Serial and Sequential files

A **serial file** is one in which the records have been stored in the order in which they have occurred. They have not been sorted into any particular order.

An **example** of a serial file is an **unsorted transaction file**.

A **shopping list** is an example of a non-computerized serial file. Items are appended to the list when that item runs low.

Serial files can be stored on tape, disc or in memory.

A **sequential file** is one in which the records are stored in **sorted** order of one or more key fields.

An **example** of a sequential file is a **sorted transaction file**.

A **class register** is an example of a non-computerized sequential file sorted on surname.

Serial File

-in serial file, the records do not follow each other in any particular order, so if another record needs to be added, it just can be added in the end of the file.

Sequential File

Sequential file are just like serial files except that the records are held in certain sequence. For instance, you might decide to order the student file in admission number sequences...

Lab Assistant: Job Duties, Career Outlook, and Education Requirements

Lab assistants collect and process samples from various sources and use lab equipment to analyze them. Lab assistants must have at least a high school diploma, but most employers require a certificate and/or an associate's degree. Continue reading for an overview of a lab assistant career. Schools offering Clinical Laboratory Science degrees can also be found in these popular choices.

Lab assistants must ensure that all necessary materials are at hand when needed. Thus, restocking materials and reagents as well as cleaning equipment and laboratory instruments are also part of the typical daily routine. Keeping track of the data obtained and accurately recording the various analyses performed are important roles for the lab assistant. The following skills and qualities are helpful when performing these duties:

- Attention to detail
- Dexterity
- Physical stamina
- Technical savvy

What is the Career Outlook?

There were 164,200 medical and clinical lab technicians in 2016, according to the U.S. Bureau of Labor Statistics. The job growth is forecasted to be 14% for the period of 2016-2026, which is faster than the national average. This job growth equates to about 22,900 new jobs. Job growth is partly due to an aging population that needs more diagnostic medical tests, some of which require laboratory analysis, as well as increased medical insurance coverage that allows people to get the tests they need.

What Are Some Educational Requirements?

Some lab assistants who hold at least a high school diploma may be trained on the job. However, earning an associate's degree in clinical laboratory science or a related subject is becoming the standard level of education. Some certificate programs are also available, but these are usually targeted to individuals who already have allied health training. You can find training programs at community colleges and vocational schools.

In a clinical laboratory science associate's degree program, you'll take basic science and mathematics courses. Hands-on training with basic laboratory techniques and equipment is generally provided. Some classes you may take are hematology, immunohematology, and bioethics.

What Are Some Credentialing Options?

Some states and employers require laboratory workers to be licensed or certified. Holding certification as a medical laboratory technician can also boost your employment prospects. Typically, you need to graduate from an accredited program and pass one or more examinations to earn a professional designation.

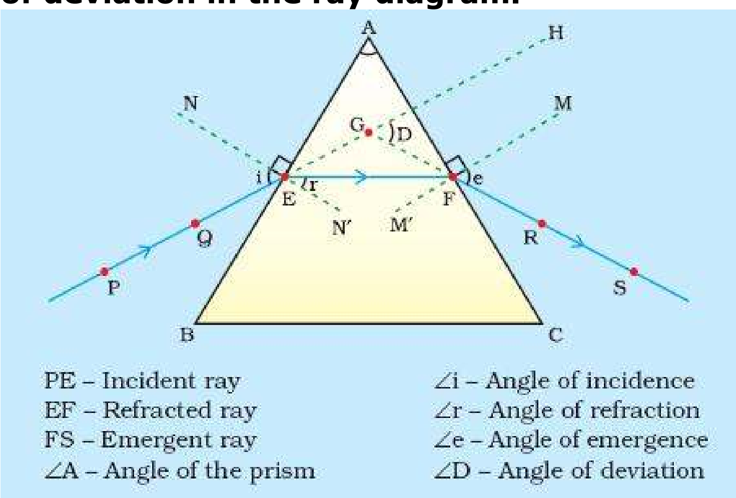
To continue researching, browse degree options below for course curriculum, prerequisites and financial aid information. Or, learn more about the subject by reading the related articles below

Q**.4 Develop an evaluative feedback sheet for the following practicals:**

i. To find path of light through a prism.

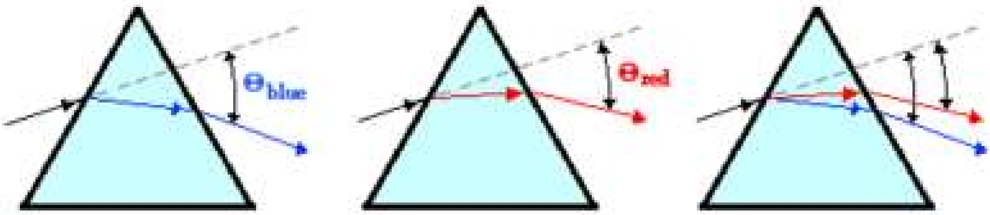
Draw a path of light ray passing through a prism

Draw a path of light ray passing through a prism. Label angle of incidence and angle of deviation in the ray diagram.



A ray of light PQ is incident on one of its faces at point E, making a ∠PEN, also called the angle of incidence ∠i, at the point of incidence. NN' being the normal at the point of incidence.

As the ray of light enters the transparent material, it moves from air, a rarer medium, to a denser medium. Refractive index μ of the material of the block being more than that of air. The ray of light is refracted and bends towards the normal.
The ray of light moves in a straight path through the block and impinges the other face of the block at F. As it emerges out of the block, it moves from a denser to a rarer medium, and therefore, bends away from the normal MM' at point F. Once out of the block it proceeds again along a straight line path RS as the emergent ray.
The Angle of Deviation
The amount of overall refraction caused by the passage of a light ray through a prism is often expressed in terms of the **angle of deviation** (θ). The angle of deviation is the angle made between the incident ray of light entering the *first face* of the prism and the refracted ray that emerges from the *second face* of the prism. Because of the different indices of refraction for the different wavelengths of visible light, the angle of deviation varies with wavelength. Colors of the visible light spectrum that have shorter wavelengths (BIV) will deviated more from their original path than the colors with longer wavelengths (ROY). The emergence of different colors of light from a triangular prism at different angles leads an observer to see the component colors of visible light separated from each other.



Blue light refracts more than red light due to the difference in wavelength. This causes blue light to deviate from its original path by a greater angle than the red light.

Of course the discussion of the dispersion of light by triangular prisms begs the following question: Why doesn't a square or rectangular prism cause the dispersion of a narrow beam of white light? The short answer is that it does. The long answer is provided in the following discussion and illustrated by the diagram below.
Suppose that a flashlight could be covered with black paper with a slit across it so as to create a beam of white light. And suppose that the beam of white light with its component colors unseparated were directed at an angle towards the surface of a rectangular glass prism. As would be expected, the light would refract towards the normal upon entering the glass and away from the normal upon exiting the glass. But since the violet light has a shorter wavelength, it would refract more than the longer wavelength red light. The refraction of light at the entry location into the rectangular glass prism would cause a little separation of the white light. However, upon exiting the glass prism, the refraction takes place in the opposite direction. The light refracts away from the normal, with the violet light bending a bit more than the red light. Unlike the passage through the triangular prism with non-parallel sides, there is no overall angle of deviation for the various colors of white light. Both the red and the violet components of light are traveling in the same direction as they were traveling before entry into the prism. There is however a thin red fringe present on one end of the beam and thin violet fringe present on the opposite side of the beam.

This fringe is evidence of dispersion. Because there is a different angle of deviation of the various components of white light after transmission across the first boundary, the violet is separated ever so slightly from the red. Upon transmission across the second boundary, the direction of refraction is reversed; yet because the violet light has traveled further downward when passing through the rectangle it is the primary color present in the lower edge of the beam. The same can be said for red light on the upper edge of the beam.

ii. To find the rate of photosynthesis by photometer. (20)

Measuring the rate of photosynthesis

There would be no biology without photosynthesis. Plant biomass is the food and fuel for all animals. Plants are the primary producers. These amazing organisms are capable of capturing the energy of sunlight and fixing it in the form of potential chemical energy in organic compounds. The organic compounds are constructed from two principle raw materials; carbon dioxide and water (which is a source of hydrogen). These compounds are stable and can be stored until required for life processes. Hence animals, fungi and non-photosynthetic bacteria depend on these for the maintenance of life.
But how can we measure the rates at which photosynthesis takes place?
The quantities are mind boggling. A hectare (e.g. a field 100 m by 100 m) of wheat can convert as much as 10,000 kg of carbon from carbon dioxide into the carbon of sugar in a year, giving a total yield of 25,000 kg of sugar per year.
There is a total of 7000 x 10^9 tons of carbon dioxide in the atmosphere and photosynthesis fixes 100 x 10^9tonnes per year. So 15% of the total carbon dioxide in the atmosphere moves into photosynthetic organisms each year.

What are the different methods of measuring the rate of photosynthesis?

There are a few key methods to calculate the rate of photosynthesis. These include:
1) Measuring the uptake of CO_2
2) Measuring the production of O_2
3) Measuring the production of carbohydrates
4) Measuring the increase in dry mass
As the equation for respiration is almost the reverse of the one for photosynthesis, you will need to think whether these methods measure photosynthesis alone or whether they are measuring the balance between photosynthesis and respiration.

Measuring photosynthesis via the uptake of carbon dioxide
Using 'immobilized algae' - It's easy and accurate to measure the rate of photosynthesis and respiration using immobilized algae in hydrogen carbonate indicator solution - known as the 'algal balls' technique. Read the full protocol on using immobile algae to measure photosynthesis.
Using an IRGA - Uptake of CO_2 can be measured with the means of an IRGA (Infra-Red Gas Analyzer) which can compare the CO_2 concentration in gas passing into a chamber surrounding a leaf/plant and the CO_2 leaving the chamber.
Using a CO_2 monitor - More simply, you could put a plant in a plastic bag and monitor the CO_2 concentration in the bag using a CO_2 monitor. Naturally, the soil and roots must NOT be in the bag (as they respire). Alternatively, you could place some Bicarbonate Indicator Solution in the bag with the plant and watch the colour change. This would best be done with a reference colour chart to try to make the end-point less subjective. This could give a comparison between several plants. There are difficulties with this method, as I'm sure you can appreciate. The leaf area of the plants should be measured so you can compensate for plant size. Atmospheric air is only 400ppm CO_2, so there is not much CO_2 to monitor and the plant will soon run out of CO_2 to fix.

Measuring photosynthesis via the production of oxygen
Oxygen can be measured by counting bubbles evolved from pondweed, or by using the Audis apparatus to measure the amount of gas evolved over a period of time. To do this, place *Cabimas* pondweed in an upside down syringe in a water bath connected to a capillary tube (you can also use *Elodea*, but we find *Cabimas* more reliable). Put the weed in a solution of $NaHCO_3$ solution. You can then investigate the amount of gas produced at different distances from a lamp. Read a full protocol on how to investigate photosynthesis using pondweed.

Measuring photosynthesis via the production of carbohydrates
There is a crude method where a disc is cut out of one side of a leaf (using a cork borer against a rubber bung) and weighed after drying. Some days (or even weeks later), a disk is cut out of the other half of the leaf, dried and weighed. Increase in mass of the disc is an indication of the extra mass that has been stored in the leaf. This is very simple to do and enables you to

investigate plants growing in the wild. However, you can probably think of several inaccuracies in this method.

Measuring photosynthesis via the increase in dry mass
Dry mass is often monitored by the technique of 'serial harvests' where several plants are harvested, dried to constant weight and weighed - this is repeated over the duration of the experiment. If you harvest several plants and record how much mass they have accumulated you will have an accurate measure of the surplus photosynthesis over and above the respiration that has taken place. As with most methods, you need several plants so you have replicate measurements and you can find an average and a standard deviation if necessary.

Q.5 Write how these chemicals should be handled to avoid any hazard. (Benzene, Mercury, Ninhydrin, Plastics, Potassium, Urea- Methanal Resin, Violent reagents, Hydrogen sulphide, Chlorine & carbon tetrachloride). (20)

Minimize the Risks of the Hazards
Minimizing the risks of hazards requires an evaluation of an entire experiment and a review of the chemicals used and produced, as well as the equipment, procedures, and PPE.
This step-by-step procedure enables you to discover and collect this information for your particular situation while reviewing an experiment.

Before an Experiment
Pre-experiment analysis may be the most important step you can take to minimize the risks in any laboratory setting.
Incidents can happen even in the best-prepared scenario, however, careful attention to detail can minimize the risks.

1. Carefully develop a list of all of the chemicals used and the quantities needed in an experiment:
   - Review the SDS for each chemical and evaluate any risk, keeping in mind the inexperience of your students
   - Determine the minimum quantity of each chemical or solution that will be required for completion of an experiment. Build in a small excess, but avoid having large excesses that will require disposal
   - Review the warnings given in the printed material that will be given to your students to make sure that all hazard information is clear and correct. If necessary, add additional information
   - Identify those warnings that must be reinforced in the pre-laboratory instruction
   - Be certain to fully explain and demonstrate any new procedures or techniques that will be introduced in the experiment
2. Use appropriate containers for chemical distribution in the laboratory:
   - Ensure that all containers used for distribution are clearly and completely labeled with the name, formula, and concentration of the chemical. Safety information, such as signal words and GHS symbols, should also be included. Chemical formulas may be confused by inexperienced students, or even by experienced students who are rushing to complete an assignment
   - Use dispensing bottles for solutions, if possible. Students will then take only the amount needed and will not be left with excess reagent. This procedure also minimizes the risk of contamination of an entire bottle of reagent
   - Use several small bottles rather than one large bottle for solutions, if dispensing bottles are not available. This will minimize the risk of spillage, and the small bottles are also easier to handle and pour. In addition, if a student pours excess reagent back into a small bottle—which, of course, is poor technique because of the risk of pouring into the wrong bottle or adding adulterated chemicals—there is less risk of contaminating the entire stock
   - Use bottles with droppers or attach a test tube with a dropper, if using solutions that require drops rather than larger volumes, such as pH indicators. Disposable droppers may be used but must be carefully discarded after use to prevent cross-contamination

- Provide a scoop or spoon to remove the contents of solid materials, again taking care to avoid cross-contamination
- Stress the importance of closing or capping all containers after chemicals are removed
- Review procedures for student disposal of excess reagent

3. Consider the physical arrangement and the facilities available in your laboratory:

- If an experiment involves the production of volatile materials, or if you are using flammable solvents, ensure that there are adequate fume hoods and ventilation to provide a safe environment.
- Determine whether stock reagent requires the use of a fume hood or can be placed in a central location.
- The source of heat for an experiment is an important consideration, particularly if any flammable solvents are used. Common laboratory hot plates are NOT designed for the heating of flammable or combustible chemicals. In no case should a burner be used to heat a flammable or combustible chemical. If flammable materials need to be heated, this should be done in small quantities in a hot water bath and in a fume hood. Never use a burner near a flammable substance. If no flammable materials are present and burners are used, they should be checked to ensure that the hoses and mechanical parts are in good condition.
- If glass apparatus must be assembled (e.g., as in a filtration or distillation), it must be securely held to avoid breakage. Any apparatus assembled by the students must be checked for safety by the teacher before use.
- Check that fire extinguishers, eyewash stations, and safety showers are working and unblocked.
- Remove stools or other equipment that may block aisles.

4. It is possible that one or more of your students have been identified as requiring accommodation because of special needs, either physical or developmental. In planning the experiment, take particular note of these requests for reasonable accommodation and the best and safest way to address any special needs of your students.

During an Experiment

Students should be closely and carefully supervised in the laboratory at all times. The teacher must be physically present during the entire experiment, concentrating on the students the entire time. Even a momentary lack of attention or absence could result in the escalation of an incident or emergency situation. Teachers need to have their full attention on all aspects of the laboratory work at all times.

1. During the pre-laboratory instruction, be sure to point out:

- Potential hazards of the chemicals used;
- Safety considerations in the use of chemicals;
- Proper use of PPE;
- Steps in the procedure that are new to the students or that require particular attention;
- Methods of disposal of excess reagent or the products of a reaction; and
- Emergency procedures specific to the experiment and materials.

2. Students and teachers must wear the appropriate personal protective equipment (PPE) and clothing. The basic requirements are listed here:

- Chemical splash goggles are an absolute requirement in all chemistry laboratories and should be worn at all times
- Laboratory aprons, coats, and gloves should be used to protect clothing and skin
- Gloves must be changed as soon as they are contaminated. Contaminated gloves as well as aprons and coats must be disposed of properly
- Long hair must be pulled back, and clothing must be tucked in
- Jewelry should be removed
- Open-toed shoes or sandals are not allowed in the laboratory

3. Be aware of student handling of chemicals, use of equipment, and good housekeeping procedures:

- At the dispensing center of a reagent, monitor spillage and contamination. Clean up any spillage immediately, using correct procedures and materials.
- Students should take only the amount required of each reagent. If there is excess, it must be disposed of properly and not returned to the reagent container.
- Dry chemicals should never be placed directly on balance pans. Weighing paper, weighing dishes, or small beakers may be used to hold dry chemicals.
- Make sure that all apparatus is properly set up before students are allowed to proceed with an experiment.
- No mixing of chemicals should be allowed, other than that specified in an experimental procedure.
- Chemical products should be turned in or disposed of properly.

After an Experiment

The work is, of course, not completed when the students have finished the experimental procedure.

1. Before the students leave the laboratory, they should:
    - Return any chemicals (excess reagent, product, or waste) to the appropriate location, or dispose of them as instructed;
    - Clean any used glassware and return the items to the appropriate location; and
    - Wipe down the work surfaces

- The teacher should also ensure the following:
    - Returned glassware and equipment are clean and in usable, undamaged condition;
    - Reagent containers are clean, closed, and properly stored;
    - Chemicals requiring disposal are correctly handled;
    - Unforeseen events are completely documented to prevent repetition;
    - Work surfaces are left clean and dry; and
    - All gas outlets are closed, especially (but not only) if burners were used during the experiment.