Step 2 Chemistry at work

Here is a review of the main concepts of this step!

1 What chemists do

Chemists study chemicals, their properties, and interactions. They work in labs conducting experiments, on computers developing theories, and in the field providing expert advice. Key branches of chemistry include biochemistry (chemical processes in living organisms), organic chemistry (carbon compounds), inorganic chemistry (non-carbon substances), analytical chemistry (examining and measuring materials), and physical chemistry (matter and energy changes).

Chemistry is linked to many fields like medicine, biology, and engineering. The fastest growth is in biotechnology and pharmaceuticals, with other expanding areas including food science and materials science. Chemistry offers diverse career opportunities across various industries.

2 Getting down to work

A degree in chemistry opens up various career paths in different fields such as industry, education, government, and more. Chemists are involved in a range of tasks depending on their role.

Chemical Industry: Research chemists develop new technologies and study chemical structures, which production chemists then scale up for manufacturing. Quality control chemists ensure that materials meet standards during production.

Education: In schools and universities, chemists teach and guide students in research projects. Lab technicians support this work by maintaining equipment and assisting in research.

Government and Forensics: Chemists in government roles might analyze evidence in legal cases as forensic scientists or test substances for safety as toxicologists. They also evaluate products like drugs and cosmetics.

Food, Health, and Cosmetics: Pharmacologists study drugs for safety and effectiveness, while chemists in cosmetics work on new treatments and products.

Environmental Science: Environmental chemists study the impact of chemicals on the environment, monitor water quality, and manage hazardous waste to ensure safety and compliance with regulations.

Overall, a chemistry degree offers diverse opportunities to work in various industries, solving problems and contributing to advancements in multiple fields.

3 The lab, a chemist's workplace

In a chemistry lab, students apply what they've learned in lessons and lectures through practical exercises. A well-equipped lab includes essential measuring and analytical tools to study various branches of chemistry.

Safety in the Lab: Working in a lab involves handling chemicals and conducting experiments, which can be dangerous. Safety procedures are crucial to prevent accidents. Experiments should always be supervised by a teacher or lab instructor. Safety rules are displayed prominently, and everyone must follow them.

Precautions: Proper handling and disposal of chemicals, using appropriate protective equipment, and storing reagents and glassware correctly are essential. Chemicals should be labeled, and waste must be disposed of in designated containers.

Lab Equipment: Labs are equipped with work benches, washable surfaces, and essential safety features like water taps, safety eyewash stations, fume hoods, fire extinguishers, and emergency shutoff systems for gas and electricity. Scientists should remain standing during experiments for quick movement in emergencies.

4 Safety rules for students attending lab classes

Access to labs is restricted to authorized individuals who must follow safety rules. Visitors should familiarize themselves with safety equipment locations, such as showers, eyewash stations, fire extinguishers, and emergency exits.

Students must adhere to several key safety procedures in the lab:

- **No games**: Avoid games and jokes.
- **Eye Protection**: Wear appropriate eye protection, not contact lenses.
- **Protective Gear**: Use screens, face shields, and proper clothing for potentially hazardous operations.

- **Footwear and Clothing**: Wear closed shoes and non-flammable lab coats. Avoid baggy clothes and jewelry.
- **No Smoking or Eating**: Smoking, eating, and drinking are not allowed.
- **Gloves**: Use gloves when necessary, check for damage, and remove them before touching other items. Wash hands thoroughly after removing gloves.
- **Cleanliness**: Keep the workspace tidy, dispose of chemicals properly, and avoid touching your face with gloves. Wash contaminated clothing separately.
- **Safety Maintenance**: Ensure all equipment and materials are stored properly, and keep the work area free from hazards.

Lab safety during a pandemic: Extra precautions include wearing face masks, maintaining distance, limiting lab movement, practicing good hand hygiene, and regularly disinfecting surfaces. If someone contracts Covid-19, areas they used must be closed off and decontaminated.

5 Laboratory equipment

Glassware

- **Beakers**: Large containers with a pouring edge, used for making solutions.
- **Burettes**: Narrow tubes with a tap at the base for precise liquid dispensing in titrations.
- **Erlenmeyer flasks**: Also known as conical flasks, used for mixing and heating.
- **Graduated cylinders**: Measuring cylinders for liquid volumes.
- **Pipettes**: Glass tubes for measuring or transferring small liquid quantities, available in various types like micropipettes and Pasteur pipettes.
- **Test tubes**: Designed for heating samples.

Tools

- **Bunsen burner**: Produces an open flame for heating, sterilization, and combustion.
- **Centrifuge**: Spins samples to separate materials based on density, used in various scientific fields.
- **Water bath**: Maintains stable temperatures by surrounding a vessel with heated water.

Measurement equipment

- **Microscope**: Allows viewing of very small objects.
- **Thermometer**: Measures temperatures, often with digital displays now.
- **pH meter**: Measures acidity or alkalinity with electrodes.
- **Colorimeter**: Measures the concentration of colored compounds by analyzing light absorption.
- **Refractometer**: Measures how much light is bent as it passes through a liquid, helping determine substance concentration.

6 Glassware cleaning procedures

Lab glassware should be cleaned immediately after use to prevent impurities from affecting experiment results. The cleaning process varies based on the type of chemicals used.

Before washing

- **Remove stoppers**: Take out any stoppers or plugs.
- **Determine solution**: Rinse water-soluble solutions with de-ionized water. For strong acids or bases, rinse first with tap water in a fume hood, then with de-ionized water.
- **Safe disposal**: Ensure the solution is safe to pour down the drain. If unsure, collect it in a large glass container for proper disposal.

Washing procedures

- Use detergents specifically designed for lab glassware.
- Rinse with the appropriate solvent, then with distilled water, and finish with de-ionized water.

De-ionized water should form a smooth sheet when poured through clean glassware. If not, When cleaning glassware, always wear heavy-duty gloves to prevent cuts. Hand washing involves using plastic tubs for acid or base washes, and proper disposal of acids and bases afterward. To remove grease, you can boil the glassware in a weak sodium carbonate solution or use acetone or other fat solvents.

After washing

- **Drying**: Hang glassware to dry on a rack or place it in an oven. Avoid hand drying or using paper towels, as they can leave fibers that interfere with experiments.
- **Quick use**: If you need the glassware immediately, rinse with acetone for quick drying.
- **Avoid blowing Air**: Do not blow air into the glassware to dry it; instead, use a vacuum if available to evaporate solvents.

7 How to write a lab report

A lab report details an experiment and its results. It typically includes:

1. **Title**: A brief and clear description of the experiment.
2. **Abstract**: A summary of the experiment's purpose, methods, results, and conclusions.
3. **Introduction**: Outlines the experiment's objective, hypothesis, and background.
4. **Materials and methods**: Details the experiment's procedures, materials, and data analysis.
5. **Results and discussion**: Presents findings with visual aids and discusses if they support the hypothesis, noting any biases.
6. **References and appendices**: Lists sources used and additional relevant information.