

# I. Introduction

## *Ward's Science – All You Need for High School Chemistry*

Save prep time in your laboratory while ensuring student safety with pre-organized activities for the most popular introductory chemistry topics.

Ward's Science products and services provide you with:

- **Bi-lingual Chemical Labels – English and French**  
Affords a safer learning experience for your ESL students. Labels are GHS-compliant and WHMIS 2015-compliant.
- **Comprehensive Laboratory Manual for Teachers**  
Written by certified chemistry safety specialists for today's teaching challenges, the Ward's Science manual has indispensable information on acquiring chemicals; interpreting labels; storing, using, and disposing of chemicals; lab safety and spill control; government regulations; regulatory resources; and more.
- **GHS-Compliant, Industry-Standard Chemical Storage System**  
No more cross-referencing your chemicals to a catalog storage guide! Color-coded storage information right on the bottles lets you visually segregate the chemicals on your storage shelves.
- **Package Sizes That Reduce Waste and Expense**  
"Right-sized" packaging lowers hazardous shipping charges and disposal quantities.
- **Chemical Inventory and Management Software**  
Easy-to-use software for all your school's labs. Track, add, and deduct quantities for the most efficient and safe use of chemicals.
- **Expert Technical Service**  
Contact the Ward's Science Plus Us team for one-on-one support, from our science lab to yours.  
Live Chat: Go to [wardsci.com](http://wardsci.com)  
Phone: (866) 260-0501  
Email: [sciencehelp@vwr.com](mailto:sciencehelp@vwr.com)  
Video-chat or in-person: call or email to schedule.

### ***Purpose of This Laboratory Manual***

The purpose of the Ward's Science Laboratory Manual is to provide the science teacher with comprehensive support and a beneficial resource towards managing usage of chemicals in chemistry education. There are thousands of chemicals available. Understanding the chemical qualities and using the chemicals safely is essential in preventing accidents. Following the policies and resources found in this laboratory manual wisely, will assist you and your students in enjoying a stimulating, educational and safe classroom experience.

The layout of the laboratory manual precisely follows the process experienced by a chemistry teacher throughout the school year, from the first step of budgeting to the final step of disposing of chemical waste. Depending upon the phase of your chemical use, the Ward's Science Teachers Laboratory Manual is designed so that you can readily reference the laboratory manual appropriate to your immediate need.

### ***Responsibilities and Regulations***

The following are the primary regulatory agencies that mandate safe chemical use and are referenced throughout this laboratory manual. As a science teacher, you are an employee of the school district. The science teacher and the school are responsible for complying with and enforcing these regulations. The description of each of the following associations was taken from the introduction or mission statement found on the association's website.

Regardless of mandated compliance issues and regulations, it is up to the individual to be aware of the hazards involved and in maintaining a safe working environment when managing the use of chemicals in the laboratory and classroom. Forms and checklists are provided within this laboratory manual to assist you in providing a safe chemical work environment.

For specific regulatory requirements, please refer to the regulatory websites listed in *Section XVIII. Internet Resources and Addresses*.

### **Occupational Safety and Health Administration (OSHA)**

The mission of the Occupational Safety and Health Administration (OSHA) is to save lives, prevent injuries, and protect the health of America's workers. To accomplish this, federal and state governments must work in partnership with the more than 100 million working men and women and their six and a half million employers who are covered by the Occupational Safety and Health Act of 1970.

OSHA and its state partners have approximately 2100 inspectors, plus complaint discrimination investigators, engineers, physicians, educators, standards writers, and other technical and support personnel spread over more than 200 offices throughout the country. This staff establishes protective standards, enforces those standards, and reaches out to employers and employees through technical assistance and consultation programs. The intent of the Occupational Safety and Health Act is to enforce safe practices on the employer (school district) where the employer is required to provide safe working conditions, safety policies, information and training regarding safety and health. As an employee, safety and health regulations apply to the science teacher and to the school facility regarding safe use and storage of chemicals. OSHA makes neglect of safety precautions a criminal offense. There have been cases where teachers have been prosecuted as a result of blatantly disregarding common-sense safety precautions. OSHA regulations do not directly apply to students, but negligence on the part of teachers has been ruled to be actionable at law.

An overview of some regulatory standards regarding school science rooms and laboratories.

<i>OSHA 29CFR 1910</i>	<i>General Industry</i>
<i>OSHA 29CFR 1910.1450</i>	<i>Occupational exposure to hazardous chemicals in laboratories.</i>
<i>OSHA 29CFR 1910.1200</i>	<i>Hazard Communication / Right-to-Understand Laws</i>
<i>OSHA 29CFR 1910.120</i>	<i>HAZWOPER - Hazardous waste operations and emergency response.</i>

### **Health Canada - Workplace Hazardous Materials Information System (WHMIS)**

Health Canada has established the *Occupational Health and Safety Act* and the intention of this act is the same as found under OSHA above. Health Canada's *Workplace Hazardous Materials Information System (WHMIS)*, updated in 2015, is Canada's hazard communication standard. WHMIS is now aligned with the Globally Harmonized System (GHS) of Classification and Labeling of Chemicals.

WHMIS is implemented through coordinated federal, provincial, and territorial legislation. Supplier labeling and SDS requirements are set out under the *Hazardous Products Act (HPA)* and associated *Controlled Products Regulations*. The *Hazardous Products Act* and its regulations are administered by the Government of Canada Department of Health, commonly referred to as Health Canada.

Each of the thirteen provincial, territorial, and federal agencies responsible for occupational safety and health has established employer WHMIS requirements within their respective jurisdiction. These requirements place an onus on employers to ensure that controlled products used, stored, handled, or disposed of in the workplace are properly labeled, SDS's are made available to workers, and workers receive education and training to ensure the safe storage, handling, and use of controlled products in the workplace.

WHMIS balances workers' right-to-know with industry's right to protect confidential business information and includes a mechanism for ruling on claims for exemption from disclosure of confidential business information as well as appeals to these rulings.

OCCUPATIONAL HEALTH  
AND SAFETY ACT

*Regulation 857 – Teachers  
Regulation 860 - Workplace Hazardous  
Information System (WHMIS)*

### **National Fire Protection Association (NFPA)**

NFPA is an international nonprofit membership organization founded in 1896 as the National Fire Protection Association. Today, with more than 75,000 members representing nearly 100 nations and 320 employees around the world, NFPA serves as the world's leading advocate of fire prevention and is an authoritative source on public safety. In fact, NFPA's 300 safety codes and standards influence every building, process, service, design, and installation in the United States, as well as many of those used in other countries.

NFPA codes and standards, including those for labeling and placarding, have helped save lives and protect property around the world. The volunteers and staff of NFPA are dedicated to the single mission of continually enhancing public safety. From Dallas to Dusseldorf, that dedication can be seen in the codes and standards that are adopted – documents developed through NFPA's commitment to creating a true consensus among those interested in safety.

### **Department of Employment and Social Development Canada (ESDC)**

The Fire Prevention staff, as the federal government's technical authority on fire protection, is responsible for the administration and enforcement of standards, codes, and regulations that cover fire protection under the Canada Labour Code. The mandate of the Fire Prevention Unit is to ensure the protection, conservation, and minimization of risks to life, property, and the Government's financial position.

The Labour Program provides specialized fire protection engineering and inspection services for major public band buildings in First Nation communities. These services assist First Nations to protect, conserve, and minimize fire risks to life and property. The services are provided with the approval or at the request of the Chief and Band Council or their designates. The services cover everything related to preventing, detecting, containing, and extinguishing fires, and alerting people to a fire.

### **U.S. Department of Transportation (USDOT)**

*Consult State DOT for specific local requirements*

The United States Department of Transportation touches the public through its mission of ensuring that our various modes of transportation operate safely on an individual basis and together as an interlinked transportation system.

An overview of the major regulatory standards applicable to shipment and handling of chemicals.

### ***TITLE 49--TRANSPORTATION***

PART 171	GENERAL INFORMATION, REGULATIONS, AND DEFINITIONS
PART 172	HAZARDOUS MATERIALS TABLE, SPECIAL PROVISIONS, HAZARDOUS MATERIALS COMMUNICATIONS, EMERGENCY RESPONSE INFORMATION, TRAINING REQUIREMENTS, AND SECURITY PLANS.
PART 173	SHIPPERS--GENERAL REQUIREMENTS FOR SHIPMENTS AND PACKAGINGS
PART 174	CARRIAGE BY RAIL
PART 175	CARRIAGE BY AIRCRAFT
PART 176	CARRIAGE BY VESSEL
PART 177	CARRIAGE BY PUBLIC HIGHWAY
DOT HM 181	HAZARDOUS MATERIALS SHIPPING REQUIREMENTS

### **Transport Canada**

Transport Canada works to help ensure that Canadians have the best transportation system by developing and administering policies, regulations and programs for a safe, efficient and environmentally friendly transportation system; contributing to Canada's economic growth and social development; and, protecting the physical environment. The department employs approximately 5400 people at headquarters in Ottawa and in locations across Canada.

Transport Canada's policy is to develop, recommend, and coordinate modal and multi-modal policies. To provide advice, analysis, and intelligence on transportation issues, system performance, and stakeholder positions. Advice on policy options is based on efficiency, competitiveness, safety and security, environmental sustainability, and inter-modal integration. This role is fulfilled through a multi-modal program of policy analysis, briefings, coordination, consultations, evaluation, and economic analysis, which develops and utilizes necessary data, forecasts, models, research, and intelligence.

An overview of the major regulatory standards applicable to shipment and handling of chemicals.

*Transportation of Dangerous Goods Act*

### **Environmental Protection Agency (EPA)**

EPA provides leadership in the nation's (USA) environmental science, research, education, and assessment efforts. EPA works closely with other federal agencies, state and local governments, and Indian tribes to develop and enforce regulations under existing environmental laws. EPA is responsible for researching and setting national standards for a variety of environmental programs and delegates to states and tribes responsibility for issuing permits, and monitoring and enforcing compliance. Where national standards are not met, EPA can issue sanctions and take other steps to assist the states and tribes in reaching the desired levels of environmental quality. The Agency also works with industries and all levels of government in a wide variety of voluntary pollution prevention programs and energy conservation efforts.

### **Environment Canada**

Environment Canada's mandate is to preserve and enhance the quality of the natural environment, including water, air, and soil quality; conserve Canada's renewable resources, including migratory birds and other non-domestic flora and fauna; conserve and protect Canada's water resources; carry out meteorology; enforce the rules made by the Canada - United States International Joint Commission relating to boundary waters; and coordinate environmental policies and programs for the federal government (*Department of Environment Act*).

## When Things Go Wrong!

As a science teacher your objective is providing your students with an educational and enlightening class year. Science teachers have access to an abundant number of chemicals, many of which if handled incorrectly can be hazardous to you and your students. This Ward's Science Laboratory Manual is designed to provide you with a piece of mind in chemical use. If followed closely and in conjunction with standard practices and regulations, the Ward's Science Laboratory Manual will provide you with the necessary information to safely use these chemicals and provide you and your students with an enjoyable and rewarding educational experience. Education in safe use of chemicals is mandatory for a science teacher. Complacency and, to a fair degree, ignorance of the potential hazards involved in using chemicals can be disastrous. The following are three separate demonstrations, under similar conditions, that required the chemical methanol to be ignited to show a specific reaction and examples of where each variation led to an undesirable outcome. The Ward's Science Laboratory Manual is dedicated to preventing these types of accidents.

### Explosion Rocks Science Class

Filed: *August 31, 1999*

By AMANDA GAUTHIER and KERRY CAVANAUGH

Tuesday was just the second day of class at East Bakersfield High School when teacher John McCormick began his science experiment, which had always been exciting but safe. That day, however, a 5-gallon glass water cooler bottle shattered, sending shards of glass flying across the room and 22 students to local emergency room. No one suffered major injuries in the 8:25 a.m. explosion, but it shook up students, parents, and school officials on campus.

The Tuesday morning lesson for 33 students at East Bakersfield High was supposed to be about observation and inference, a demonstration the 10-year veteran teacher had performed for years. A few milliliters of methanol, also known as wood alcohol, sat in the bottom of the glass bottle. McCormick turned the lights off, lit a match, and lifted the lid off the bottle. The students heard a crack before a flame shot out of the top and the bottle exploded — shooting bits of glass around the room. Glass flew in every direction, breaking a plastic ceiling light cover, hitting the back wall cabinets, and piercing the vinyl drapes.

Igniting methanol is a common lab demonstration, said Roy LaFever, a professor of chemistry at Cal State Bakersfield. "It's used in a variety of experiments because it burns clean and, under normal circumstances, is quite controllable."

Officials quickly determined that the explosion was simply an unfortunate accident.

Mary Martinez, 39, expressed concern about McCormick when she came to pick up her son, Erik Martinez, from San Joaquin Hospital. While Erik wasn't seriously injured, Mary Martinez was concerned about the safety of the science lab experiments. She said she was upset that McCormick was wearing protective goggles, gloves and earplugs while the students were not. "If he (Erik) had lost his eyesight over this" she said, and stopped. "An accident isn't really an accident. It's someone else's mistake."

## **Students Recount Chemistry Accident**

**November 8, 2000**

By Lisa O'Neill Hill and Monique Henderson

The Press-Enterprise

RIVERSIDE

One minute, Josh Ramirez was watching a chemistry experiment give off blue, red, and green flames. The next minute, the 16-year-old high school junior was patting out fire from the right leg of his jeans. Josh, a Martin Luther King High School honors student and athlete, was one of two students injured in an experiment gone awry. He suffered burns to his shin and face. His friend Minh Vuong, also 16, was hospitalized.

"There was a big whoosh and it happened like in a split second," Josh said from his home. "I just tried to get out of the way and I noticed my leg was kind of burning and so I put it out with my hand."

The accident occurred while the teacher demonstrated an experiment called a flame test for her Advanced Placement chemistry class. The purpose of the flame test, a common science activity that has been conducted for decades, is to identify distinct elements. With the classroom lights turned off, the chemistry students were instructed to look for the different flame colors coming from seven dishes containing a variety of chloride salts and methyl alcohol, fire officials said.

One by one, the teacher lighted each dish on fire. When one dish failed to light, she added extra methyl alcohol. A dish that was already lighted ignited the methyl alcohol and there was a small flash of fire.

Minh stood up and jumped up and down to try to extinguish the flames, while her teacher threw a fire-retardant blanket around her. She was burned on her forearms, chest, hands, and face, fire officials said. Hospital officials estimated the burns cover 4 percent to 5 percent of her body. A hospital spokesman said it was too early to say whether the burns will leave the honor student with scars.

Sandra S. West, an associate professor of biology at Southwest Texas State University, said little research has been done on safety in high school science labs. She said some studies have shown there are more accidents in classrooms when there is less than 41 square feet for each student, when there are more than 22 students in the class, and when teachers have had insufficient safety training.

Josh, a member of numerous campus clubs and a school baseball and football player, said he believes everything happens for a reason. "Thank God it was just what it was and not anything more serious. I guess it just goes to show you how fast your life can be taken away," he said.

## **Chemical Ignites During Science Class**

*November 25, 1999*

Detroit News

One student was in critical condition and 13 others were treated for respiratory problems Wednesday after a chemical ignited during a science class at Waverly High School.

Christina Jurus, a junior, was being treated for burns at Sparrow Hospital in Lansing. School officials said she was in critical condition. The other 13 students were treated and released from another Lansing-area hospital.

The accident happened at 9:50 a.m. at the end of a second-hour advanced chemistry class. The demonstration used methanol gas to blow a cork from a plastic bottle. An electric coil attached to one of two nails in the bottle's sides creates a spark that jumps between them, igniting the vapor and blowing the cork out of the bottle. When the chemistry teacher was performing the experiment for the second time, some of the gas in the

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bottle might still have been burning, fire officials said. Jurus was closest to the flame; the other students were injured by breathing vapors.

Ryan said the teacher of the college preparatory chemistry class wasn't doing anything unusual. "I have high confidence that he was in command of that situation and doing the good job he normally does," Ryan said.

## **What Went Wrong?**

You may never know the exact conditions that led to each of these accidents. Did the teacher use too much of a certain chemical? Were the demonstration materials cleaned thoroughly enough, and prepared properly for the demonstration? Was the procedure followed exactly as specified?

These teachers most likely performed the same demonstrations numerous times previous to these accidents. It does not take much deviation from the specified demonstration procedure to get a different result than intended.

The demonstrations provided in this laboratory manual have been used numerous times and are designed to be safe. They must be followed as written to maintain safe conditions. Understand the chemical that is being used and the full process of the demonstration. Whether it is being used in a demonstration, transported, stored, or being disposed of, know the right way to handle the chemical. Be clearly aware, at all times, of your next step – not complacent with your last.

