Honors Chemistry 2017 Summer Assignment

Name________________________________ Date____________ Period ____Score ____/50 pts

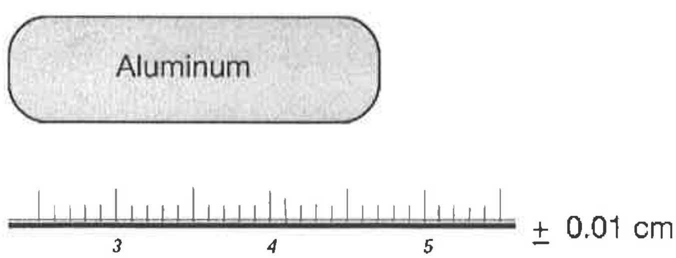
This Honors Chemistry Summer Assignment will review mathematical concepts necessary when performing mathematical calculations and laboratory experiments focus on laboratory safety. This assessment will be assessed 25 points towards laboratory and 25 points towards homework for a total of 50 earned points.

An important part to chemistry is making numeric measurements are limited by the accuracy of our measuring tools and performing calculations to analysis chemical experimentation. However, all measurements have some inherent uncertainty. This uncertainty is a result of the measurement device. The first part of this assignment will review significant figures (digits), significant figures in calculations, scientific notation, the metric system and precision and accuracy. Before reading information provided in this packet, watch the **Unit Conversions & Significant Figures** video located at Khan Academy Unit Conversions and Significant Digits (link on the last page of packet) and answer question regarding the video on page 6 of this packet. Then read packet pages 1-4 and answer questions on pages 7-8.

The second part of this assignment will focus on laboratory safety. In laboratory, accidents can happen; therefore, understanding the safety of being in a laboratory setting is important. First watch, Khan Academy Laboratory Safety (link on the last page of packet). Then read, **Assessing Safety in Each Experiment** on page 5. Before reading **ChemMatters Safety Data Sheets: Information that Could Save Your Life** article (this article in linked as Part II of the summer assignment), complete the table as specified on page 9. In the first column, write "A" or "D," indicating your agreement or disagreement with each statement. As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas. On page 10, summarize what you learned and investigate an actual Safety Data Sheet for a substance found in your household. For instance, you could type into a search engine "Safety Data Sheet Windex" or a chemical in a specific product "Safety Data Sheet ammonium chloride".

Significant Figures

When you use a piece of laboratory equipment, read and record the measurement to one decimal place beyond the smallest marking on the piece of equipment. The length of the aluminum placed along the centimeter stick is 4.75 cm long. There are no graduation markings to help you read the last measurement as 5. This is an estimate. As a result this digit is uncertain. Another person may read this as 4.76 cm. This is acceptable, since it is an estimation.



There is error (uncertainty) built into each measurement that cannot be avoided. If the measurement is reported as 4.75 cm, scientists accept the principle that the last digit has an uncertainty of ±0.01 cm. In other words, the length might be as small as 4.74 cm or as large as 4.76 cm. It is understood by scientists that the last digit recorded is an estimation and contains some uncertainty.

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Guidelines for Determining Significant Figures

1. All digits recorded from a laboratory measurement are called significant figures (or digits).

2. The measurement of 4.75 cm has three significant figures. NOTE: If you use an electronic piece of equipment, such as an electronic balance, you should record the measurement exactly as it appears on the display.

Measurement	Number of Significant Figures
123 g	3
46.54 mL	4
0.33 cm	2
3,500,000 nm	2
0.0325 g	3

3. All non-zero digits are considered significant. There are special rules for zeros. Zeros in a measurement fall into three types: leading zeros, trailing zeros, and middle zeros.
4. A middle zero is always significant.

303 mm a middle zero—always significant

5. A leading zero is never significant. It is only a placeholder; not a part of the actual measurement.

0.0123 kg a leading zero—never significant

6. A trailing zero is significant when it is to the right of a decimal point. This is not a placeholder. It is a part of the actual measurement.

23.20 mL a trailing zero—significant to the right of a decimal point

7. All significant figures include units since they are a result of a measurement. A number without units has little significance. Numbers resulting from measurements made using instruments have a finite number of significant figures. Exact numbers include numbers derived from counting (12 eggs) and definition (1 kg = 1000 g), and they have an infinite number of significant figures. When performing calculations, these values will not be used to determine the amount of significant figures in the final answer.

Examples:

- Amount of items: 25 desks in a room
- A conversion factor 100 cm = 1 meter

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Using Significant Figures in Calculations

Addition and Subtraction

The number of decimal places in the answer should be the same as in the measured quantity with the smallest number of decimal places.

smallest number of decimal places

1259.1 cm + 1252.365 cm + 1215.34 cm = 3726.805 cm   Final answer: 3726.8 cm

Multiplication and Division

The number of significant figures in the answer should be the same as in the measured quantity with the smallest number of significant figures.

$\frac{13.356g}{10.42mL} = 1.281765835g/mL$ Final answer: 1.282 g/mL

smallest number of significant digits

Using Scientific Notation in Calculations & Final Answers

In chemistry, we deal with very small and very large numbers. It is easier to assess the magnitude of and to perform operations with numbers written in scientific notation. It is also easier to identify the proper number of significant figures. The number is rewritten as the product of a number between 1 and 10 and an exponential term—10^n, where n is a whole number. Example, the distance between New York City and San Francisco = 4,741,000 meters or 4.741×10^6 m.

Addition/Subtraction Using Scientific Notation (Use a calculator or the following procedure)

1. Convert the numbers to the same power of ten.
2. Add (subtract) the non-exponential portion of the numbers.
3. The power of ten remains the same.
   Example: $(1.00 \times 10^4) + (2.30 \times 10^5)$
   A good rule to follow is to express all numbers in the problem to the highest power of ten.

   Convert (1.00×10^4) to (0.100×10^5). $(0.100 \times 10^5) + (2.30 \times 10^5) = \mathbf{2.40 \times 10^5}$

Multiplication Using Scientific Notation (Use a calculator or the following procedure)

1. The numbers (including decimals) are multiplied.
2. The exponents are added.
3. The answer is converted to scientific notation—the product of a number between 1 and 10 and an exponential term.

   Example: $(4.24 \times 10^2) \times (5.78 \times 10^4)$ $(4.24 \times 5.78) \times (10^{2+4}) = 24.5 \times 10^6 = \mathbf{2.45 \times 10^7}$

Division Using Scientific Notation (Use a calculator or the following procedure)

1. Divide the decimal parts of the number.
2. Subtract the exponents.

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Using Significant Figures in Calculations

Addition and Subtraction

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Division Using Scientific Notation (Use a calculator or the following procedure)

1. Divide the decimal parts of the number.
2. Subtract the exponents.

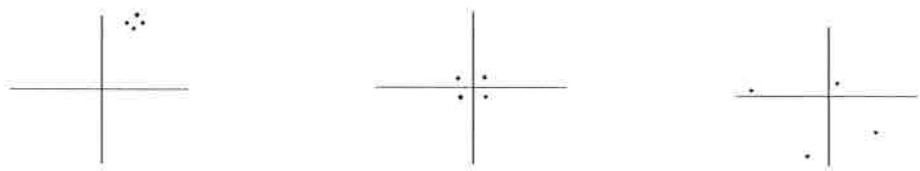
3. Express the answer in scientific notation.

Example: $(3.78 \times 10^5) / (6.2 \times 10^8)$ $(3.78 \times 6.2) \times (10^{5-8}) = 0.61 \times 10^{-3}$ $= \mathbf{6.1 \times 10^{-4}}$

Accuracy and Precision

Chemistry experiments often require a number of different measurements, and there is always some error in making measurements. How much error can depend on several factors, such as the skill of the experimenter, the quality of the instrument, and the design of the experiment? The reliability of the measurement has two components: precision and accuracy. Precision refers to how closely measurements of the same quantity agree. A high-precision measurement is one that produces very nearly the same result each time it is measured. Accuracy is how well measurements agree with the accepted or true value. It is possible for a set of measurements to be precise without being accurate. Figure 1 demonstrates different possible combinations of precision and accuracy in an experiment designed to hit the center of the target.

Figure 1: Precision and Accuracy



Precise and accurate | Precise and not precise | Not precise and not accurate

A second example of accuracy and precision is given in Figure 2. The table lists the results of temperature measurements of a beaker of boiling water. The standard temperature of boiling water is 100 °C. The data in the table illustrates the different possible combinations of precision and accuracy in an experiment.

Figure 2: Measured Temperature of 100 mL of Boiling Water

Reading	Thermometer 1	Thermometer 2	Thermometer 3	Thermometer 4
1	99.9 °C	97.5 °C	98.3 °C	97.5 °C
2	100.1 °C	102.3 °C	98.5 °C	99.7 °C
3	100.0 °C	99.7 °C	98.4 °C	96.2 °C
4	99.9 °C	100.9 °C	98.7 °C	94.4 °C
Average	100.0 °C	100.1 °C	98.5 °C	97.0 °C
Range	0.2 °C	4.8 °C	0.4 °C	5.3 °C

The average value for each set is taken as the best value. The accuracy of each set is determined by how close the average value is to the standard temperature of boiling water (100°C). The range, the difference between the largest and smallest values, is the measure of the agreement among the individual measurements. The data taken with Thermometer 1 is accurate and precise, since the average agrees with the accepted value and the range is small. Thermometer 2 provided data that is accurate but not precise since the range is relatively large. The data from Thermometer 3 is precise but not accurate. One explanation for the deviance from the accepted value could be that Thermometer 3 was not calibrated properly. Thermometer 4 provides data that is neither precise nor accurate.

Percent error is a measurement of the accuracy of the measurement. The theoretical value is the same as actual or true value. Experimental value is the amount determined through experimentation. Percent error equation:

Percent error = |(theoretical value - experimental value)/theoretical value| x 100 %

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Assessing Safety in Each Experiment

It is essential for teachers to spend time planning and preparing for each experiment and each demonstration for you. They should assess each experiment carefully before, during and after its execution. Below are some guidelines for assessing a given experiment:

Before the experiment:

1. Know what you are working with. You should always identify the substances you are working with.
2. Find and evaluate hazard information using the information found in the Safety Data Sheets.
3. Ensure the proper concentrations were prepared.
4. Ensure the bottles were properly labeled.

During the experiment:

1. Students should be closely and carefully supervised in the laboratory at all times.
2. During the pre-laboratory lecture, discuss potential hazards of the chemicals, safety considerations of the lab, proper use of personal protective equipment (chemical splash goggles and aprons or lab coats), methods of disposal of waste, and emergency procedures specific to the experiment.
3. Students and instructors must wear goggles, aprons, closed toed shoes and appropriate clothing. Long hair and dangling clothing must be pulled back.
4. Be aware of students' handling of chemicals, use of equipment and good housekeeping procedures.

After the experiment:

1. Students should return any chemicals to the appropriate location or dispose of them according to the instructions. They should clean any used glassware and wipe down the lab table.
2. The Instructor should return glassware and equipment. Ensure that: all reagent containers are clean, closed and stored properly; disposal of chemicals is correctly handled; and the laboratory is left clean and dry.

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Name______________________________ **Date**____________ **Period** ____**Score** ____**/50 pts**

Honors Chemistry 2017 Summer Assignment Answers
Crash Course: Unit Conversions & Significant Figures Video Questions: (9 pts)

1. What is the IPK?____

____

2. The International System of Units includes: __________________________

____

3. What are derived units?______________________________________

____

4. What is a unit conversion? How does flipping a conversion help solve a problem?

____

____

____

5. Distinguish between exact numbers vs. measured numbers.

____

____

6. What are place holders? What value is typically used for placeholders? ______________

____

7. Write 60 in scientific notation. ____________________________________

8. Explain how to use addition of significant figures. __________________________

____

____

9. Explain how to use multiplication of significant figures._______________________

____

____

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Summary Questions:

1. How many significant figures are in each of the following? (2 pts)

451 000 m	______	6.626 cm	______	0.0065 g	______	2300 g	______
4056 mg	______	0.0540 mL	______	2.2 L	______	12 test tubes	______

2. Solve the following problems using the correct number of significant figures. (6 pts)

   a. 16.27 m + 16.463 m + 16.1 m = ____________________

   b. 36.4 mg - 0.02 mg = ____________________

   c. 15.1 cm × 0.032 cm = ____________________

   d. 13.36 g /0.0468 cm³ = ____________________

   e. 1.45 g x 4 marbles = ____________________

   f. 7.895 g / 12 test tubes = ____________________

Remember Include units

3. Convert the following numbers to exponential notation. (4 pts)

a. 0.0369 cm ____________________

b. 0.0452 g ____________________

c. 4,520,000 atoms ____________________

d. 365,000 s ____________________

Remember Include units

4. Carry out the following operations. (4 pts)

a. $(3.00 \times 10^{8}\ m/s) \div (2.4 \times 10^{2}\ m)$ ____________________

b. $(1.75 \times 10^{-1}\ cm) - (4.6 \times 10^{-2}\ cm)$ ____________________

c. $(6.63 \times 10^{-34}\ J{\cdot}s) \times (4.5 \times 10^{15}\ 1/s)$ ____________________

d. $(6.02 \times 10^{23}\ atoms) + (6.02 \times 10^{23}\ atoms)$ ____________________

Units are used to check whether calculations are correct

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Percent Error *(5 pts)*

1. Comment on the precision and accuracy of the following sets of measurements.

   a. A group of students was determining the density of an unknown liquid. They obtained the following values: 1.34 g/cm^3, 1.32 g/cm^3, 1.36 g/cm^3. The actual value is 1.34 g/cm^3.

   b. Another group obtained the following values: 1.66 g/cm^3, 1.28 g/cm^3, and 1.18 g/cm^3. The actual value is 1.34 g/cm^3.

   c. Another group obtained the following values: 1.60 g/cm^3, 1.50 g/cm^3, and 1.70 g/cm^3. The actual value is 1.34 g/cm^3.

2. Determine the percent error if the theoretical (actual) value for density is 1.40 g/cm^3 and the obtained average data (experimental value) is 1.38 g/cm^3.

3. During an experiment, a student measured the temperature of boiling water as 97.5 degrees Celsius. Determine the percent error of this measurement if water should boil at 100 degree Celsius.

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Safety Data Sheets: Information that Could Save Your Life

Directions: *Before reading*, in the **first** column, write "A" or "D," indicating your agreement or disagreement with each statement. As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas. (10 pts)

Me	Text	Statement
		In the first two months of school in 2014, more than 20 students were injured in the United States by a teacher demonstration involving methanol.
		Safety Data Sheets include safety precautions as well as potential health hazards.
		The United Nations developed safety pictograms which are used on products worldwide.
		Safety Data Sheets include information about hazards as chemical reactions occur and the concentration of chemicals change.
		Liquid methanol burns.
		You can easily see a methanol flame in good light.
		The flash point and the fire point are the same temperature for most flammable liquids.
		All fire extinguishers can be used on any type of fire.
		Substances require a flame to ignite.

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***Safety Data Sheets: Information that Could Save Your Life Summary** (10 pts)*

3	New things you learned about chemical safety	
2	Things to remember about the flash point and/or the fire point	
1	Question you have about Safety Data Sheets	
Contact!	What would you like to tell others about the dangers of methanol?	
Explore!	Now, investigate a chemical product in your home inspect a cleaning product used in your home. Find a Safety Data Sheet for the main ingredient in the product. From the SDSs, report out the physical and chemical properties of the substances, their hazards and decide if the warning on the label of the product is sufficient, based on the SDS.	

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Links:

Khan Academy Unit Conversions and Significant Digits:

https://www.khanacademy.org/partner-content/crash-course1/crash-course-chemistry/v/chem02-unit-conversion-sig-digits

Khan Academy Laboratory Safety:

https://www.khanacademy.org/partner-content/crash-course1/crash-course-chemistry/v/chem21-lab-safety

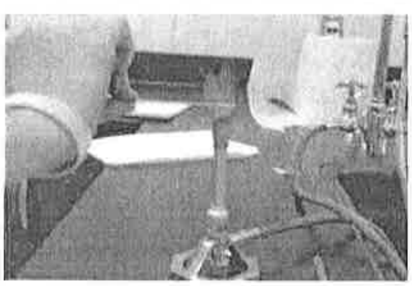
Safety Data Sheets

Information that Could Save Your Life

By Brian Rohrig

ON SEPTEMBER 15, 2014, a high school chemistry teacher in Colorado intended to demonstrate the characteristic emission spectra of metal ions with a flame test large enough for the entire classroom to watch. The different colored flames produce the so-called rainbow effect, which would certainly impress the students. Unfortunately, in this instance, four students were injured. All four suffered burns, one seriously.

Methanol flame tests are typically performed by placing 5 to 7 grams of a metal chloride in a glass Petri dish and then adding 7 to 10 milliliters (mL) of methanol. After turning down the lights, the instructor lights the mixture, and the class observes the flame test color. But demonstrators are cautioned not to add more methanol to the Petri dish after starting the demonstration—the mistake this teacher made.



When conducting a flame test, soaking wooden splints in salt solutions and then placing the splints in a Bunsen burner is considered a safer alternative than working directly with flammable liquids, such as methanol, which is not recommended anymore.

The flame quickly traveled back up into the bottle and ignited the rest of the methanol. Pressure built up within the bottle, as the temperature of the gases produced in this chemical reaction quickly increased, and the bottle spewed a fiery stream of methanol at a distance of 12 feet (3.6 meters), hitting a student in the chest.

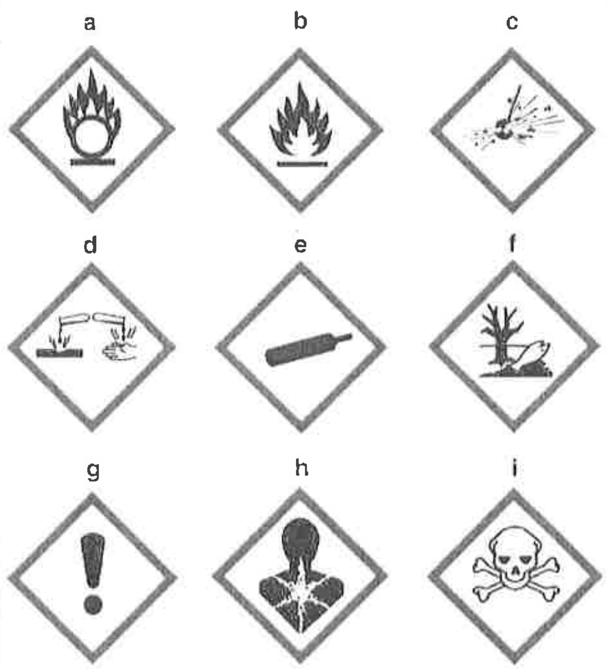
In September and October 2014, a total of 22 students and two adults were injured throughout the United States in four separate incidents involving methanol used in rainbow demonstrations.

Could these accidents have been prevented? Where can teachers (and students) find the type of information needed to use chemicals in a safe and responsible fashion? Fortunately, there is a system in place to provide ready access to this type of information. Every chemical has its own Safety Data Sheet (SDS), formerly known as a Material Safety Data Sheet (MSDS), containing a wealth of information in a simple, easy-to-read format. Especially prominent within each SDS are safety precautions needed to handle the chemical properly, as well as any potential health hazards.

Understanding the hazards of chemicals

If you ever read the labels of chemical products, you may have noticed a lot of symbols. The use of these symbols is a direct result of recent efforts to modernize and standardize the way chemicals' potential hazards are labeled. One update is the adoption of a uniform set of pictograms developed by the United Nations, which is used throughout the world. Quiz yourself on p. 6 to see if you can match these symbols with their warnings.

An SDS meets the requirements of the **Occupational Safety and Health Administration (OSHA)**, a U.S. federal agency created to ensure a safe work environment for all employees. OSHA mandates that all workers exposed to chemicals have the right to know about the potential hazards of these chemicals.



1. Gases under pressure____
2. Explosive________
3. Irritant________
4. Acute toxicity (severe)________
5. Corrosive________
6. Oxidizer________
7. Environmental toxicity________
8. Flammable________
9. Carcinogen, reproductive or organ toxicity, or respiratory sensitizer________

(Answers on p. 7)

Although OSHA regulations apply only to workers, state laws typically extend similar protections to students. So when your teacher orders chemicals for the lab, each chemical will come shipped with an SDS, either in written or electronic form. Having an SDS on hand for each chemical you use in the lab is not just a good idea—it's the law.

The SDS for any chemical is written by the supplier or manufacturer of that chemical. There is a great deal of motivation for these companies to be thorough and accurate, as any incomplete or false information could lead to serious harm by the user, not to mention a lawsuit. But an SDS does not address the possible hazards that could occur as a chemical reaction moves forward and the constituents and concentrations of the chemicals involved change.

Using methanol safely

Let's look at an example of an SDS for methanol and see if it contains information that could have helped to prevent the tragedies described above. Section 2 of the SDS is labeled "Hazards Identification." A typical listing for methanol under this section may read as shown below (see "Highlights from 'Section 2: Hazards Identification'").

Highlights from "Section 2: Hazards Identification"

DANGER

- Highly flammable liquid and vapor
- Keep away from heat, sparks, open flames, hot surfaces. - No smoking
- Toxic if swallowed, in contact with skin or if inhaled
- Causes damage to organs
- Use only non-sparking tools
- Take precautionary measures against static discharge

By reading the information contained in the SDS, the highly flammable nature of methanol is revealed. It is so flammable that there is a direct warning to avoid open flames and even sparks.

Although the label says that both the liquid and vapor are flammable, the liquid itself does not actually burn. When a liquid is ignited, it is the vapors on top of the liquid that burn. For a liquid to be considered flammable, it needs to evaporate quickly so that enough vapors can form above the surface of the liquid to support combustion. It is these vapors that will ignite, if enough heat is applied.

Many accidents involving methanol occur because it is poured onto an open flame. The same precaution against pouring any substance onto an open flame should be followed.

Even though most people should know better than to pour a flammable liquid onto an open flame, sometimes even trained professionals make this mistake with methanol, with disastrous consequences. Read through section 5 of the SDS (see "Highlights from 'Section 5: Fire-Fighting Measures'" on the right) to see if you can figure out why this mistake may occur.

Highlights from "Section 5: Fire-Fighting Measures"

- Highly flammable liquid and vapor
- Sealed containers exposed to excessive heat may explode
- Vapors may travel back to ignition source
- Flame may be invisible during the day
- Use dry chemical, CO_2, or foam to extinguish
- Avoid using water to extinguish—water may not cool the fire to a temperature below methanol's flash point.
- Water will cause fire to spread if not contained.
- Water and methanol mixtures still flammable at concentrations above 20% methanol

Because methanol burns with a clear, clean flame, it is often difficult to see this flame in the daytime. As stated in the SDS, the flame may appear invisible during the day. If you are performing a demonstration where a methanol flame is produced and then the flame dies down, you might be tempted to add more methanol, thinking that the fire has gone out. This could be a tragic mistake.

Flash point and autoignition temperature

Methanol does not have to be poured directly onto a flame to produce unintended results. On September 3, 2014, a demonstrator at a science museum in Reno, Nev., attempted to conduct a flame tornado demonstration on a rotating platform that makes a vortex composed of flames. He poured some additional methanol onto cotton balls in a dish after the flames had apparently gone out, but the cotton balls were still smoldering and instantly re-ignited when the methanol was added. The flame traveled up into the bottle (as described in the SDS), spraying the flaming liquid into the audience. Thirteen people were injured, mostly children.

How is it possible to ignite methanol without an actual flame? To answer that question, we need to look at Section 9 of the SDS for methanol (see "Highlights from 'Section 9: Physical Data'" below).

If you examine the data above (which is only a small portion of what is contained in the SDS for this section), you will notice the terms "flash point" and "autoignition temperature." The **flash point** is the temperature at which the vapors above a liquid ignite if an outside ignition source, such as a spark or flame, comes near.

For example, if a beaker of methanol is at a temperature below its flash point, you cannot set it afire, even if you put an open flame to it. So, at 10 °C and below, methanol will not catch on fire. But once it reaches 11 °C—its flash point—you can set it on fire if you light it.

As a liquid warms, the average kinetic energy of its molecules increases. Because more molecules have enough kinetic energy to escape the attractive forces holding them together in the liquid phase, its evaporation rate increases, producing more vapor. The flash point occurs when a sufficient concentration of vapor has accumulated above the liquid, which, in combination with oxygen, will burn if ignited. Remember: Only vapors burn, not liquids.

Highlights from "Section 9: Physical Data"

- Melting point: -97.8 °C
- Freezing point: -97.6 °C
- Boiling point: 64.7 °C
- Flash point: 11 °C
- Auto-ignition temperature: 464 °C

When the flash point is reached, the vapors will ignite, but the fire will not be sustained, because there is not enough vapor present to sustain combustion. This ignition is still very dangerous, as a quick burst of flame can produce severe burns, and if other combustible substances are nearby, they can also catch on fire.

A more useful value is the **fire point,** which is the point at which a flammable liquid will not only catch on fire if lit but will also keep burning for five seconds. The fire point is typically only a few degrees higher than the flash point.

If methanol is at or above its fire point, it will continue to burn when lit. Under most laboratory conditions, methanol will be above its fire point, so when lit, it will continue to burn. Although the fire point is not included on the SDS, it is important to know how it differs from the flash point.

The **autoignition temperature** is the temperature at which a substance will burst into flames *without* an outside ignition source, such as a spark or a flame. At the autoignition temperature, spontaneous combustion occurs. According to the SDS for methanol, the autoignition temperature is 464 °C. So, when the methanol was poured onto the smoldering cotton balls, if they were at a temperature above 464 °C, the methanol would instantly burst into flames on contact. Substances do not need flames to catch on fire—they only need a sufficient amount of heat along with air.

Considering the number of students who take high school chemistry, the number of students who were involved in accidents in a chemistry class is relatively small, and of the accidents that occur, most are relatively minor.

The number of students injured in science labs is smaller than those injured in sports. This good safety record is due to science teachers being vigilant about enforcing safety rules in the laboratory. So, the next time your chemistry teacher tells you to put your goggles on, make sure you comply, as he or she is only looking out for your safety.

While every accident in the chemistry lab cannot be avoided, the recent incidents with methanol likely could have been avoided, had the experimenters familiarized themselves with the safety information contained in an SDS. Anytime chemicals are used in the laboratory, there are risks involved, but these risks can be minimized by understanding the chemicals used in an experiment. It is often said that a little knowledge is a dangerous thing, but when it comes to chemicals, a little knowledge can save your life! CM

In case of a lab fire

If a fire occurs in a lab, it is important to know that different types of fire extinguishers are used for different types of fires. In the United States, fires are classified depending on the materials that catch fire. Methanol combustion is an example of a Class B fire.

Most classroom fire extinguishers should be able to extinguish this kind of fire, but to make sure, read the label on the fire extinguisher.

Classes of Fires	Types of Fires	Picture Symbol
A	Wood, paper, cloth, trash & other ordinary liquids.	
B	Gasoline, oil, paint and other flammable liquids.	
C	May be used on fires involving live electrical equipment without danger to the operator.	
D	Combustible metals and combustible metal alloys.	D

SELECTED REFERENCES

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Answers to quiz on p. 6: 1. e, 2. c, 3. g, 4. i, 5. d, 6. a, 7. f, 8. b, 9. h