Interactive Chemistry Multimedia Courseware

An Introduction to Chemistry
Program Supplement

An Introduction To Chemistry
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Scenes 1-8

Introduction, The Atom and Matter

Scene Number

Scene 1

“What is chemistry and why should you study it?” This program will address this question and in the process expand on the importance of chemistry in our everyday lives. The study of what things are made of and how matter behaves or reacts under various conditions is the science of chemistry. Chemistry helps to explain the world we live in by describing the changes that matter undergoes as a result of chemicals interacting. How our bodies convert the food we eat to energy our cells can use, what fuels the sun and why oranges taste sour can all be understood by the science of chemistry. It is important to study chemistry because it plays a major role in our lives; from pesticides and acid rain to the medicine we need when we get sick. Chemical reactions, such as fire that converts the mass and energy in a log into carbon dioxide gas, water vapor and heat, are responsible for life in living organisms and determine the properties of non living substances. This program will further explore “what” chemistry is; while future programs in this series will explain “why” chemicals act the way they do.

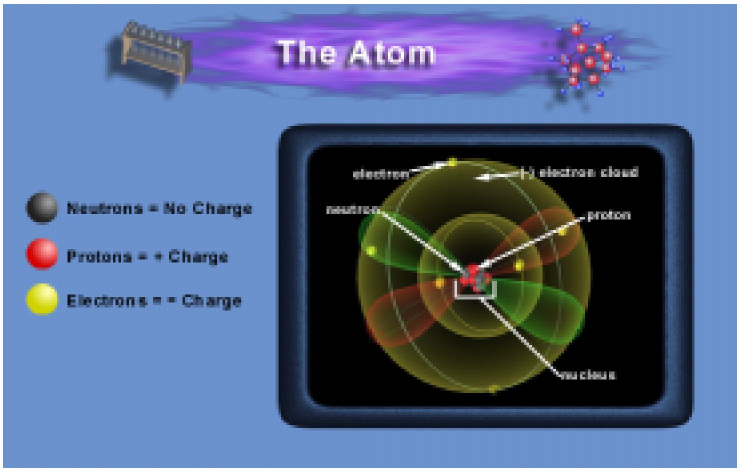
Scene 2

Chemistry is a central science, meaning the principles of chemistry overlap many other scientific endeavors and are used in so many professions. Chemistry is fundamental in professions such as medicine, engineering and agriculture that analyze and work with matter. People that study and do chemistry are called chemists. Chemists may choose to work for a government agency or in the private sector. Many professionals trained in chemistry enter the business world or act as consultants for law firms. Many chemists seek rewarding careers in teaching and research.

Linus Pauling is the only person to ever receive two unshared Nobel Prizes. Pauling received the Nobel Prize for Chemistry in 1954 and the Nobel Prize for Peace in 1962. By combining his knowledge of both chemistry and physics, Pauling was the first to determine and report the nature of the chemical bond. Later, his application of physics to solve chemical problems was applied to biochemistry. Among his numerous contributions Pauling was instrumental in determining the structure of proteins, the nature of DNA, and the role of vitamin C in regards to human health.

Scene 3

Almost all chemistry relates to the structure and behavior of the atom. Although it has long been suspected that matter is composed of atoms, only recently has the structure of the atom been determined. Atoms are made up of three subatomic particles. The core of an atom, known as the nucleus, is composed of positively charged protons and uncharged neutrons. The nucleus is surrounded by a negatively charged electron cloud. These electrons are in constant motion around the nucleus.

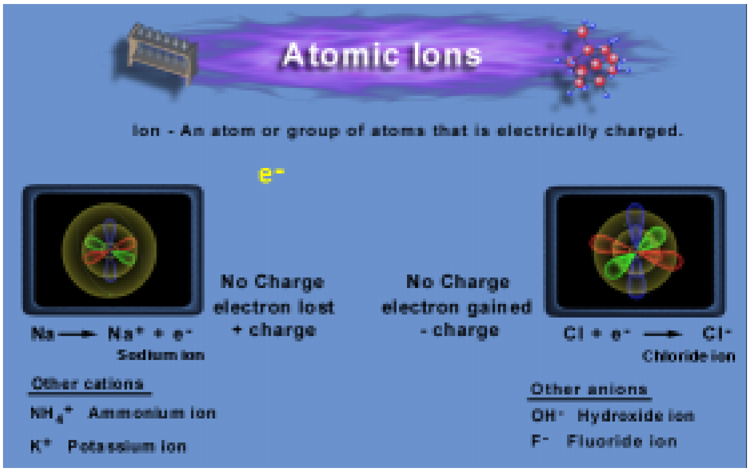


Scene 4

Electrons can be shared with, or even transferred to other nearby atoms. The interactions between atoms of different elements are called chemical reactions. Atoms of different types of elements such as hydrogen, helium or carbon, differ in the number of protons in the nucleus. Therefore, an element is simply a collection of atoms with the same number of protons. The atomic number of an element is equal to the number of protons in the nucleus, and is frequently indicated with the element's symbol. The number of protons in the nucleus identifies the element, while the number and arrangement of electrons is responsible for the properties of an element.

Scene 5

An ion is a chemical species that is electrically charged. Ions can be either positively or negatively charged. Positively charged ions are called cations and indicate a species has lost one or more electrons. The sodium ion and ammonium ion are good examples of cations. Negatively charged ions are called anions and indicate that a species has gained one or more electrons. Chloride ion and hydroxide ion are common examples of anions.



Scene 6

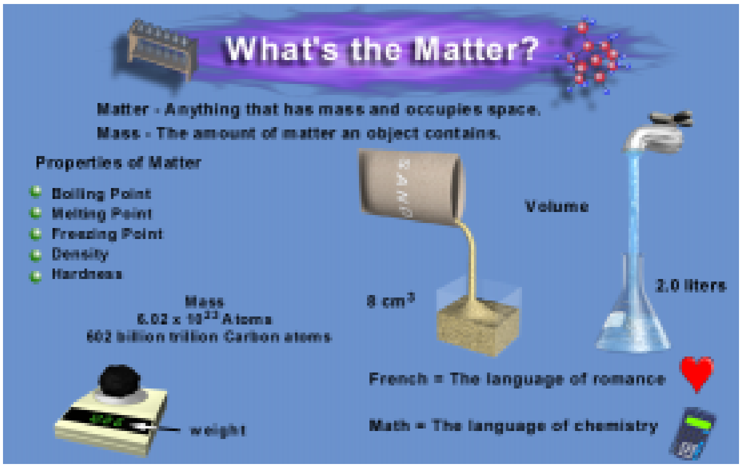
Like individual bricks in a brick wall, atoms are the building blocks of matter. Matter is anything that has mass and takes up space. Mass is a measure of the quantity of matter present which is proportional to the number of atoms in an object. Take an aluminum can for example, the can is simply a collection of trillions and trillions of atoms each atom having 13 protons in its nucleus. An atom with 13 protons in its nucleus is known as the element, aluminum. The mass of the aluminum can is due to the number of aluminum atoms in the can. A larger aluminum can would have more mass because it contains more atoms of aluminum. The can could be most generally categorized as matter, because it has mass and takes up space.

Scene 7

Although units of weight are often used to describe mass, weight and mass are different concepts, and the distinction between the two should be understood. Mass is related to the number of atoms in an object. Weight describes the pull of gravity on those atoms. The following comparison should help distinguish between weight and mass. Suppose an astronaut on a space mission is wearing a gold ring. Let's say the ring is composed of 60 billion trillion gold atoms. A ring composed of 60 billion trillion gold atoms would weigh about 20 grams on Earth. Weight is a measurement of the pull of Earth's gravity upon the mass of an object. In space, the ring is weightless because Earth's gravity is not pulling on the ring. However, the ring still has mass and the mass would be the same whether in space or on Earth because the number of gold atoms in the ring remains constant. Since most scientific measurements involving mass are taken on Earth's surface, the measurements are relative to each other so scientists most often use the terms weight and mass interchangeably.

Scene 8

If a friend asks you what you did in chemistry class today you may reply "I learned about a bunch of stuff and did some calculations." As strange as it may seem, you could not have responded with a more correct answer. Chemistry is the study of "stuff" or matter and its properties. The properties of matter are determined by the atoms that compose it. Mass is a measure of the quantity of matter in an object and is conveniently expressed in units of weight such as grams or pounds. Objects that occupy space are said to have volume. Volume can be described in units such as cubic centimeters, gallons or liters. Chemists use numbers and equations to describe the properties of matter, therefore mathematics may be thought of as the language of chemistry.



Scenes 9-14

Chemical Substances

Scene Number

Scene 9

Elements are composed of only one kind of atom. Atoms of the same element all have the same number of protons. They all have the same atomic number. Carbon for example has six protons in its nucleus, an atomic number of 6 and is known as the 6th element. Elements cannot be separated into simpler substances or converted into other elements by chemical processes. Medieval chemists, known as alchemists, tried to convert elements, such as lead, into other more valued elements such as gold but met with no success. Some elements that people are most familiar with include metals such as gold and iron, oxygen gas required by living organisms and neon gas which fills red neon lights.

Scene 10

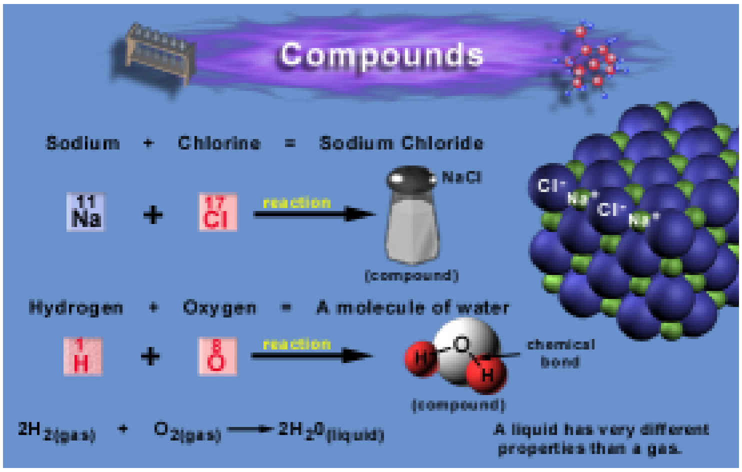
Some elements such as einsteinium are named after famous scientists, other elements such as californium are named after the place in which they were discovered or created. Many elements such as bromine retain their historical names: “bromos” means stench in Greek and describes this element’s foul odor. Elements are organized according to their properties on a chart called the periodic table. Currently there are 100 known elements, 92 of them occur naturally and the rest were created by scientists. Because chemistry is the study of matter and its properties it should be obvious that knowing how to use the periodic table is essential while learning chemistry.

Scene 11

The periodic table shows chemical symbols or abbreviations for the names of the elements. Chemical symbols save space when writing chemical formulas. The symbol is always derived from the name of the element, but it may be the name in a foreign language. Some symbols are direct English or Germanic translations of the element’s name, such as O for oxygen and Al for aluminum. Others such as Pb are abbreviations of the Latin term for the element. In this instance Plumbum is Latin for lead. In chemical abbreviations the first letter is capitalized and the second, if there is one, is always lower case..

Scene 12

When two or more different elements combine in a chemical reaction they form compounds. When electrons are shared or transferred between atoms during a chemical reaction the properties of the resulting compound may be very different from that of the original elements. Elements in a compound are arranged in a fixed proportion or ratio. Table salt is a white crystalline solid composed of trillions and trillions of sodium and chloride ions. These crystals have a fixed ratio of one sodium ion for every chloride ion. Another example of a compound is water. Water molecules are composed of two hydrogen atoms bound to one oxygen atom. Although there are trillions of water molecules in a glass of water, each molecule consists of the same proportion: Two hydrogens to one oxygen.

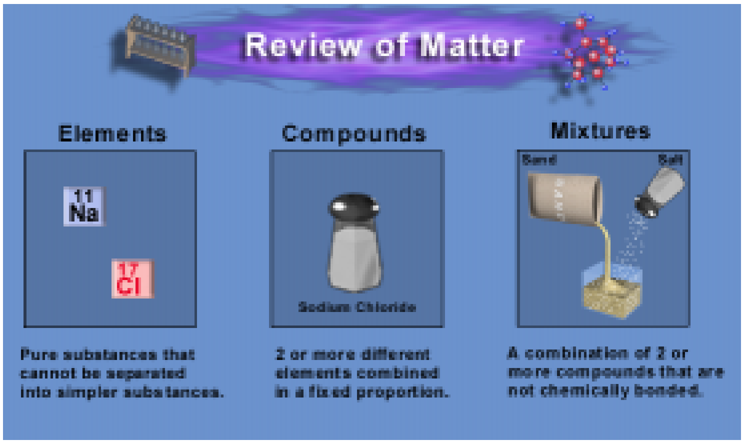


Scene 13

The term molecule describes two or more atoms bound together to make a distinct entity. Examples include a molecule of oxygen which is composed of two oxygen atoms. A molecule can also describe a substance consisting of two different elements such as a molecule of water and a molecule of carbon dioxide.

Scene 14

Mixtures are combinations of two or more substances. Because the components in a mixture are not bonded to each other they can be separated by purely physical means. Ordinary dirt is an example of a mixture composed of many different chemical substances. Many soils contain high concentrations of metals such as nickel, zinc or iron. The use of a magnet is a physical means of separating iron from soil. The air we breathe is another example of a common mixture. Air is mostly composed of the elements nitrogen, oxygen and argon gases. These gases are not bonded to one another but are simply mixed together like the ingredients in a tossed green salad. Let's review the different forms of matter, elements are composed of specific types of atoms and are the building blocks of all matter. Combining two or more elements together through chemical bonding forms compounds and mixtures such as air and soil are simply materials composed of two or more of these compounds.



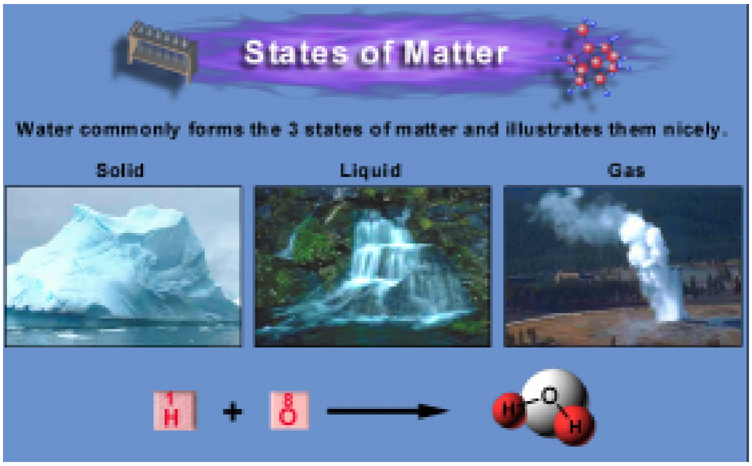
Scenes 15-24

States of Matter and Measurements

Scene Number

Scene 15

There are only 3 states of matter: solids, liquids and gases. Water commonly forms the three states of matter and these states are well known. Solid water forms ice, liquid water flows from faucets and gaseous water is commonly referred to as steam. Water is composed of the elements oxygen and hydrogen which form bonds resulting in molecules of water. In addition, water molecules attract each other forming weak bonds amongst themselves. The strength of the attraction between adjacent water molecules determines the state of matter that water will assume. Energy can be added to water in the form of heat. Heat energy is called thermal energy. The amount of thermal energy added to the water molecules directly effects the physical state of water. Increased thermal energy weakens the attraction between water molecules.



Scene 16

At low temperatures water assumes the solid state. Solids have a fixed shape and a definite volume. You can think of ice cubes in a tray. At low temperatures the water molecules are constantly moving, but they are moving so slowly that the relatively weak attractive forces between them remain intact and the molecules are locked in a crystal like structure. A frozen farm pond holds its shape and structure well enough to support the weight of several ice skaters, but watch out as the pond begins to thaw and resume its liquid state!

Scene 17

You are probably most familiar with water in its liquid state. In contrast to solids, a liquid does not hold its own shape but readily conforms to the shape of its container. When liquids are placed in a container such as an Erlenmeyer flask, their volume can be easily determined. At higher temperature, the molecules of water are more energetic and this increased motion, or kinetic energy, overcomes the attractive forces that bind them together in the solid state. The molecules in a liquid are closely associated and the weak bonds between adjacent molecules are constantly being formed, broken, and reformed.

Scene 18

Unlike solids and liquids, gases have no definite shape or volume but expand to fill the available volume of a container. With the addition of energy in the form of heat, molecules in a liquid gain enough energy to overcome the attractive forces that hold them together, thus giving rise to a gas. To produce the gaseous state of water called steam, energy must be added in the form of heat. Steam engines are designed to harness the energy of gas molecules to do work.

Scene 19

Chemists rely on measurements to conduct experiments and to communicate their findings. A measurement always consists of a number and a unit. Imagine you are approached to buy a ring for one hundred dollars. This description means very little, the ring may or may not be worth the money. A proper description might include the element, and the weight in proper units as in a 20 gram gold ring. In science, neither numbers nor units are valuable by themselves, they must be expressed together to make sense. Remember, including units with all measurements is fundamental to chemistry and all other scientific work.

Scene 20

One of the most useful properties of matter is its density. Density is the ratio of the mass of an object to its volume. Each has it's own unique density. For example, if someone gave you an object such as a ring composed of pure metal, you could easily determine what the ring was made of by determining its density. By measuring the ring on a scale you can determine its mass, keep in mind that mass and weight are equivalents on Earth. To determine the volume of the ring simply drop it into a pre measured volume of water and measure the change in volume. To calculate density, divide the mass of the ring in grams by its volume in cubic centimeters. Our answer indicates that each cubic centimeter of the ring has a mass of 10.5 grams. To determine the identity of our metal we need to compare our calculated answer with a table that lists the elements and their corresponding known densities. How about that, the ring is made of silver!

Scene 21

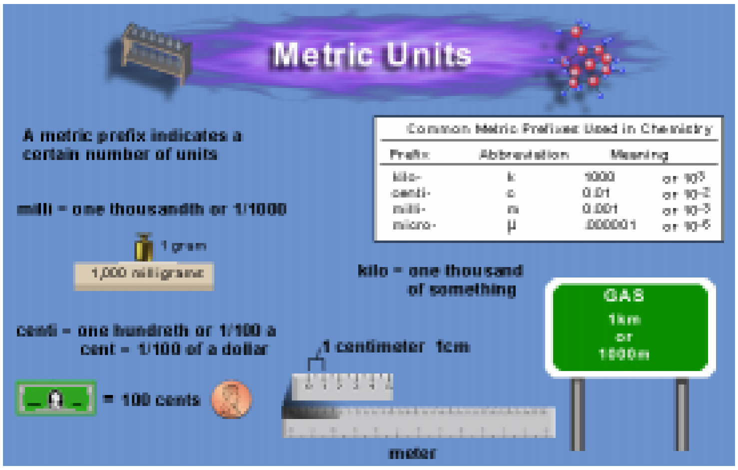
Earlier in this program we discussed the three states of matter and showed how water in its various forms can be used as an example of the solid, liquid and gaseous states. Each state of water has a unique density. Liquid water has a density of 1g./cm^3 and by this standard all other substances are compared. The molecules in liquid water move about, combining and separating but still remain attracted to one another. Ice has a density which is a little lower than the liquid, this is why ice cubes float. Gaseous water is the least dense of the three states,as highly energized water molecules completely separate occupying more space or volume.

Sene 22

Scientists use the metric system for most measurements they make. The metric system has several benefits over traditional systems of measurements. Today more than ever, science is conducted on an international basis, just like manufacturing and other commerce. The metric system allows research to be conducted in any country regardless of language with the same scale of measurement, therefore results obtained from scientists around the world can be combined and compared. In many ways, the metric system can be thought of as an international language of measurement. Another and perhaps primary reason why the metric system is so popular with the scientific community is the ease with which measurements and calculations can be converted and manipulated as the following examples will illustrate.

Scene 23

The metric system expresses units in powers of ten, as indicated by a specific prefix. A metric prefix is a mathematical adjective that denotes a number of units. For example, a kilo means a thousand. A kilogram would therefore equal 1,000 grams and a kilometer would be 1,000 meters. Some prefixes indicate a fraction of a unit. The prefix cent- for example means one one-hundredth of a unit. A centimeter would therefore mean one-hundredth of a meter. The prefix milli- means one thousandth of something. Therefore a milligram would equal 1 thousandth of a gram; in other words it would take 1000 milligrams to equal the weight of one gram.



Scene 24

An International System of measurements has been derived from the metric system. Standard international units, known as SI units, denote mass, length, time, volume and temperature. The standard units for these measurements are the meter for length, the kilogram for mass, seconds for time, and Kelvins for temperature. The liter, though not an S.I. Unit, is most commonly used for measuring liquid volumes. A liter is equivalent to one thousand cm^3 of water. Though Kelvins are the SI unit for temperature, the Kelvin can be easily converted to degrees Celsius or degrees Fahrenheit.

Scenes 25-38

The Mathematics of Chemistry, Summary and Conclusion

Scene Number

Scene 25

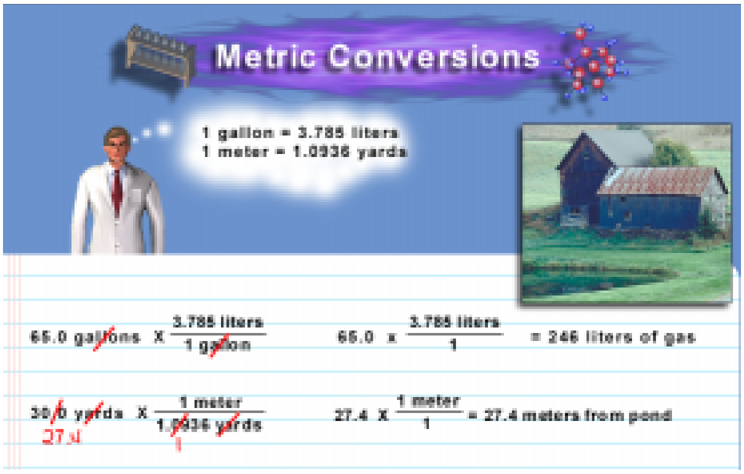
It will often be necessary to convert from one unit to another when solving chemistry problems. The process known as cross canceling is used for conversions when equalities are known. A known equality means that it is known how many of one unit equals some other unit. Let's practice with some familiar examples before moving on to metric conversions. Suppose we have 20 quarters and want to convert these coins into units of dollars. This conversion will first be written as an fraction then the units and equalities will be cross canceled. The units we have, 20 quarters, is the first component of the equation. The unit we want to express in our answer, in this case dollars, occupies the numerator or top portion of the fraction. The dollar's equivalent is 4 quarters and occupies the denominator or bottom portion of the fraction. Next, cancel the units to be converted along with their values. This is where the process known as cross canceling gets its name. After the units have been crossed out nothing is left but simple arithmetic and we see that 20 quarters converts to 5 dollars.

Scene 26

It is often necessary to convert English units to metric units and vice versa. Metric-English equivalents charts are provided in most textbooks, but it would be beneficial to memorize a few of the more common conversions. Some of the easier conversions involve weight. Say you weigh 150 pounds on a scale and want to know your weight in kilograms. One kilogram is equivalent to 2.2 pounds. In order to cancel out the pounds unit, it must be placed in the denominator of the fraction. The units and numbers cross cancel and the final answer appears as 68.2 kilograms. Let's now see how 50 kilometers can be expressed in units of miles.

Scene 27

Many word problems involve unit conversions. Consider the following situation: A farmer's fuel tank is punctured in an accident and he reports that 65 gallons of diesel fuel was spilled 30 yards from a pond. Environmental scientists interested in the effects the fuel may have on the animals' drinking water need to report their findings in standardized units. Therefore, they need to analyze the amount spilled in liters in relation to the distance in meters from the pond. How would the scientists go about converting these numbers?



Scene 28

Our scientist is aware that 1 gallon equals 3.785 liters. To arrive at an answer in liters requires cross canceling the units of gallons, therefore gallons must be in the denominator position of a fraction when multiplying and cross canceling. After carrying through the arithmatic we see that 65 gallons equals 246 liters. Now to tackle the distance problem in the same fashion. Knowing that 1 meter equals 1.0936 yards and knowing that we want our answer in meters we must place yards in the denominator position. Cross cancelling units and multiplying across results in an answer of 27.4 meters.

Scene 29

Accurate measurements require skill and a knowledge of the equipment used to perform the measurement. As strange as it may sound, accurate measurements always involve some uncertainty. Measurements are always uncertain for two reasons: First, measuring instruments are not always perfect and second, making measurements requires estimation. In making estimates on a scale such as the line scale found on a graduated cylinder, you must first become acquainted with the units on the scale. This graduated cylinder is marked in 1-milliliter increments. You can see that the volume of water in the cylinder is greater than 65 milliliters but less than 66 milliliters. It is up to the scientist to estimate the volume of water in the cylinder. The volume of water in the cylinder is approximately 65.5 milliliters but that is an estimation. Since the uncertain digit occupies the tenths position past the decimal, the uncertainty is measured as ± 0.1 and the volume of liquid in the beaker would be given as 65.5 ± 0.1 ml.

Scene 30

Determining uncertainty in single measurements is relatively easy. Uncertainty becomes more difficult when many numbers are combined, multiplied or divided. To adjust for uncertainty in a calculation it is necessary to understand the rules governing what are known as significant figures. Significant figures in a measurement include all the digits that are known precisely plus one last digit that is estimated. All non zero numbers in a measurement are significant and zeros sandwiched between nonzero digits are significant. Zeros appearing in front of non zero digits act as placeholders and are never significant. Zeros at the end of a number are always significant. When counting, the number of significant figures is unlimited as are numbers involving defined quantities such as 12 eggs in a dozen.

Scene 31

The concept of significant figures can be confusing, but here is a helpful trick that should help you learn them. You need to keep in mind the location of the Atlantic and Pacific oceans in relation to the United States. If a decimal point is present in a number begin counting from the Pacific or left side of the number. Begin counting significant figures with the first non zero digit and include all numbers from there to the end as significant. If a decimal point is absent in a number begin from the right or Atlantic side. Again begin counting with the first non zero number and include all numbers encountered as significant figures.

Scene 32

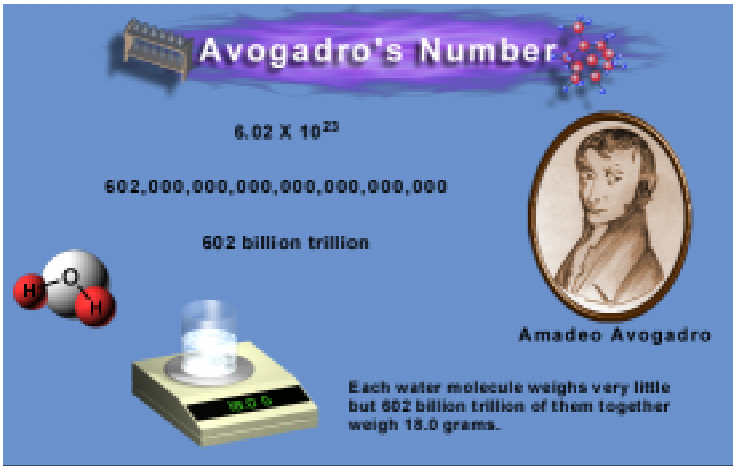
No calculation can be more accurate than its least accurate factor; in other words no mathematical chain can be stronger than its weakest link. When multiplying or dividing numbers, the measurement with the least number of significant digits determines how many digits are reported in the final answer. In the following example, the volume of a hypothetical box is calculated as 9.0006092 cm^3. The measurement in the equation with the least amount of significant figures contains only 3 significant figures. Therefore, the final answer is limited to 3 significant figures and must be reported as 9.00 cm^3. When a calculation is performed in several steps, extra digits are carried through to the final result which is usually displayed on a calculator. Only after the final answer is calculated is the answer rounded to the proper number of significant digits. To round off a final answer, look at the digit following the last significant digit to be reported in the answer. If that digit is less than 5, round down. If the digit is 5 or more, round up.

Scene 33

Remember, no calculation can be more precise than its least precise factor. Suppose several students weighed the contents of their pockets at home and added up all their measurements at school the next day. A list of items and their weights might look like this. When adding or subtracting values, the least precise value limits the precision of your result. As you can see, the least precise measurement is the weight of the keys. The weight of the keys was determined to the nearest gram, this value is less precise than the others obtained. A variance such as this could occur if several different measuring devices were used. The weight of the keys could be written as 165 ± 1 g. Since the measurement is uncertain in the ones place, the final answer would be rounded off to the nearest whole gram and given as 206 ± 1 g.

Scene 34

Scientists work with very large and very small numbers every day. To make these rather cumbersome numbers more convenient to express, they use what is known as scientific notation. Scientific notation is a way of abbreviating numbers. When a number is written in scientific notation it is separated into two parts. Lets take the number 225,000 for example. The first part of the equation is written as a number between 1 and 10 and the rest of the number is continued after the decimal point. The second part is an exponent.. 225,000 would be expressed in scientific notation as 2.25 x 10^5. 10^5 actually represents 10 x 10 x 10 x 10 x 10 or 100,000. Therefore 2.25 x (100,000) = 225,000 and we are back to the original number. Scientific notation can also be used to express very small numbers, for example .000025 can be written as 2.5 x 10^{-5}. 10^{-5} actually represents 1/100,000. Therefore, 2.5 x (.00001) = .000025 and we are back to the original number. A very large number known as Avagodro's number is expressed as 6.02 x 10^{23} which represents 602 billion trillion. If it were possible, you could count 602 billion trillion water molecules in a cup containing 18 grams of water.



Scene 35

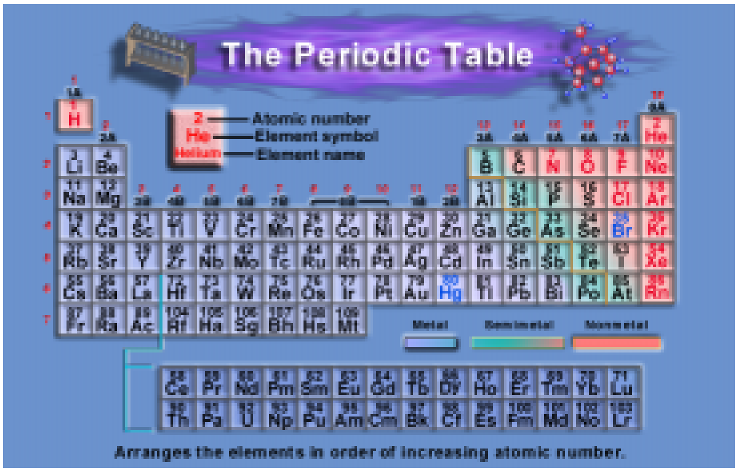
Many comparisons in the study of chemistry are expressed as percents. Percents allow for the quick comparison of data. The quickest way to obtain a percent is to first convert a fraction to a decimal, then multiply the result by 100. A familiar example of percents are test scores given as a percent of correct answers. Let's say you correctly answered 140 problems out of 150 possible on your first chemistry exam. To determine the percent of the questions you answered correctly, first convert the whole numbers to a fraction. Dividing the number correctly answered by the number possible gives you an answer as a decimal. The last step is to multiply the decimal by 100 to report your answer as a percent. Lastly use your common sense to check the answer. Think to yourself "does this make sense?" In our example getting 150 correct out of 150 possible would equal 100% but a couple of mistakes were made so the answer would be a little less than 100%. Thinking about this verifies that an answer of 93% makes sense and "sounds right". What if you didn't study and got 35 answers correct?

Scene 36

A good example of how percentages are used in chemistry is the determination of what's known as percent error. Percent error is used to compare how accurately some measured value is to the actual or accepted value. Let's say a steak is weighed on a less than accurate scale at the supermarket and its weight is recorded as 463 g. When the same piece of meat is weighed on a very accurate electronic balance in your chemistry lab the weight is determined to be 425.56 g. The percent error is calculated as follows: the accepted value 425.56 g is subtracted from the measured value 463.0 g. The resulting number is 37.44 g. This number is then divided by the accepted value 425.56 g. which converts the fraction to a decimal (.088). This answer is then multi plied by 100 which results in a percent error of 8.8% meaning that the butcher's scale is increasing the weight of whatever it weighs by almost 9%. Percent errors are often used in chemistry to determine the accuracy of laboratory techniques, purity of materials and accuracy of equipment.

Scene 37

In this program we have defined chemistry as the study of what things are made of and how they behave or react under various conditions. Elements are the building blocks of matter. There are 112 known elements. An element is composed of only one type of atom. Atoms are identified by the number of protons in their nucleus known as the atomic number. The periodic table is a systematic presentation of all the elements arranged in order of increasing atomic number. Elements can be combined to form compounds. Elements and compounds are collectively called substances. Substances are combined to make mixtures. Mathematics is the language of chemistry and is used to describe the properties of matter such as mass, weight, and density. Other mathematical equations are used to compare the properties of matter or results of scientific research. This program has provided you with the "what" of chemistry, further programs in this series will explore why chemicals behave as they do.



Scene 38

Although chemistry can be complex, understanding the fundamentals of what matter is, and how mathematical expressions are used to describe changes in matter does not have to be difficult. Chemistry keeps you alive, enables computers to function and rockets to fly. Understanding chemistry will allow you to interpret the chemistry of the environment and the biochemistry of your body. The chemistry of drugs determines their effect on the body, and chemical imbalances are responsible for many illnesses. It is certainly possible to live your life without understanding any chemistry at all, but life is a chemical reaction and living life becomes much more fulfilling when you understand it at its most fundamental level.

An Introduction To Chemistry
Exam

1. During his distinguished career this scientist received two unshared Nobel prizes. One for chemistry and one for peace.

   A. Alfred Nobel
   B. Marie Currie
   C. Linus Pauling
   D. Albert Einstein

2. The study of matter and the changes it undergoes describes the science of ______.

   A. physics
   B. mathematics
   C. chemistry
   D. biology

3. The _________ is the fundamental unit of matter.

   A. atom
   B. compound
   C. nucleus
   D. proton

4. The atom is composed of three subatomic particles known as _____, ____ and _______.

   A. neutrals, electives and peeons
   B. quarks, alpha rays and xenons
   C. electrons, protozoans and electricals
   D. protons, neutrons and electrons

5. Protons are _________ charged particles found in the nucleus of an atom.

   A. neutrally
   B. positively
   C. negatively
   D. brighltly

6. Electrons are ________ charged particles that orbit the nucleus of an atom.

   A. negatively
   B. positively
   C. neutrally
   D. brighltly

7. Neutrons are ________ particles found in the nucleus of an atom.

   A. negatively charged
   B. positively charged
   C. uncharged
   D. brightly

8. An ion is an atom or molecule that ___________.

   A. is electrically neutral
   B. is composed of two or more elements
   C. is man made
   D. carries a charge

9. Which of the following chemical species is a cation?

   A. Cl^-
   B. H^+
   C. Au
   D. HCO_3^-

10. The atomic number of an atom or element describes the number of _______.

   A. electrons orbiting the nucleus
   B. neutrons in the nucleus
   C. alpha particles in the nucleus
   D. protons in the nucleus

11. Mass is proportional to the number of _________ that make up an object.

    A. atoms
    B. cells
    C. neutrons
    D. protons

12. Weight is best described as _____________.

    A. the number of atoms in an object
    B. the pull of gravity on matter
    C. the electrical charge on an ion
    D. the number of electons in an atom

13. Atoms of any one type of element, such as gold, all posess the same number of _______.

    A. electrons
    B. neutrons
    C. protons
    D. nuclei

14. There are currently _______ known elements.

    A. 65
    B. 98
    C. 112
    D. 152

15. Element _______ are one or two letter abbreviations for the names of the elements.

    A. mass numbers
    B. atoic numbers
    C. symbols
    D. characters

16. Two or more elements that combine as a result of a chemical reaction form _____.

    A. atoms
    B. ions
    C. mixtures
    D. compounds

17. An example of a mixture would be __________.

    A. a bar of pure gold
    B. the air we breathe
    C. sodium chloride salt
    D. pure water

18. The three states of matter are ________, ________ and _________.

    A. atoms, molecules and compounds
    B. atoms, compounds and mixtures
    C. solids, liquids and gases
    D. solids, gases and steam

19. The least dense and most energetic of the three states of matter is ____.

    A. the gaseous state
    B. the liquid state
    C. the solid state
    D. the elemental state

20. All measurements must consist of both ____________.

    A. a size and a shape
    B. a price and a volume
    C. a number and a unit
    D. a color and a number

21. Density is a physical property that refers to _____________.

    A. the number of atoms in an object
    B. the weight of an object
    C. the mass of an object relative to its volume
    D. the weight of an object relative to its cost

22. A kilogram is equal to ________ grams.

    A. 1
    B. 10
    C. 100
    D. 1,000

23. There are _______ centimeters in a meter.

    A. 1
    B. 10
    C. 100
    D. 1,000

24. Measurements are _________ because of equipment error and human judgment.

    A. useless
    B. uncertain
    C. perfect
    D. inaccurate

25. The number 221.5 contains ______ significant figure(s).

    A. 1
    B. 2
    C. 3
    D. 4

26. The number .001 contains ______ significant figure(s).

A. 1
B. 2
C. 3
D. 4

27. The number 226 would be scientifically noted as ______.

A. 226
B. 2.26×10^{1}
C. 2.26×10^{2}
D. 22.6×10^{1}

28. The figure .005 would be scientifically noted as _______.

A. 5×10^{-1}
B. 5×10^{-2}
C. 5×10^{-3}
D. 5×10^{-4}

29. Elements or atoms are arranged on the periodic table in the order of increasing ________.

A. atomic mass
B. atomic weight
C. atomic number
D. atomic symbols

30. A substance that weighs 10 grams and has a volume of 2 cm^3 would have a density of ______.

A. 5 g/cm^3
B. 10g/cm^3
C. 2g/cm^3
D. 15g/cm^3

31. The terms Kelvin, Celsius and Fahrenheit all correspond to units of ___________.

A. density
B. hardness
C. volume
D. temperature

32. The ________ is the SI standard unit for measurements of length.

A. cetimeter
B. foot
C. meter
D. yard

33. One kilogram is equal to approximately ________ pounds.

A. 1.2
B. 2.2
C. 3.2
D. 4.2

An Introduction To Chemistry
Exam Answer Key

1.	C	17.	B
2.	C	18.	C
3.	A	19.	A
4.	D	20.	C
5.	B	21.	C
6.	A	22.	D
7.	C	23.	C
8.	D	24.	B
9.	B	25.	D
10.	D	26.	A
11.	A	27.	C
12.	B	28.	C
13.	C	29.	C
14.	C	30.	A
15.	C	31.	D
16.	D	32.	C
		33.	B