

Science Department Guide ChemCom (College Prep) Overview

Course Description: ChemCom (College Prep)

ChemCom is a yearlong course built around the following eight societal issues as they relate to chemistry. These issues include 1) Water quality and supply, 2) use and conservation of resources, (3) use of petroleum as both a fuel and chemical feedstock, (4) chemistry of food and nutrition, (5) nuclear chemistry, (6) air and climate, (7) chemistry and health, and (8) role of the chemical industry in our society. Each unit is laboratory oriented and helps students to develop the skills necessary for problem solving such as the ability to identify problems, to consider and evaluate possible alternative solutions, to weigh their risks and benefits, to separate fact from opinion, to verify information and evaluate their worth and objectivity of sources, to interpret quantitative information such as tables, charts, and graphs, and to formulate and reach decisions logically. This course will help the student relate chemical knowledge to the problems and issues of modern society. Laboratory experiments are performed regularly. Evaluation of the student will be based upon tests, quizzes, laboratory reports, cooperative group work, and class participation

Prerequisite: Minimum grade of “C” in Biology and Algebra I

Major Course Objectives

When students have completed ChemCom (College Prep), they will have an understanding of:

1. Metric measurements
 - a. practice metric manipulations and conversions with reasonable accuracy and precision.
 - b. develop familiarity with and use terms associated with metric measurements.
 - c. develop an awareness of metric use in their everyday lives.
 - d. recognize why scientists prefer metric measurements over U.S. customary units.
2. Chemical laboratory safety
 - a. demonstrate a knowledge of the location and use of the various pieces of laboratory safety equipment.
 - b. learn and habitually follow the basic lab safety rules.
 - c. identify and correctly use the basic lab equipment pertinent to lab investigations.
3. Water quality
 - a. explore the role of water in their own lives.
 - b. develop an awareness of the quantity of water routinely used by themselves and their families.
 - c. develop an awareness of the quantity of water used in the manufacturing of goods.

- d. collect and discuss data about the lack of adequate water in drought stricken areas of the world.
- e. learn more about the chemistry of water and how substances interact with it.
- f. recognize the observable properties of matter and how they relate to water.
- g. develop an understanding of the molecular idea of matter based on atoms and molecules.
- h. become familiar with the terms: symbol, formula, equation, element, and compound.
- i. become familiar with the naming, structure, and chemistry of ionic and molecular substances.
- j. develop an understanding of the concepts related to solubility: solute, solvent, solution, saturation, and solubility curves.
- k. develop an understanding of the necessity of water purification and treatment in our society.
- l. recognize the use of chemistry as it applies to real world problems.

4. Chemical resources

- a. develop familiarity with the law of conservation of matter through the use of balanced equations.
- b. engage in balancing chemical equations.
- c. recognize the difference between exothermic and endothermic reactions.
- d. distinguish between renewable and nonrenewable resources.
- e. recognize the importance of organizing chemical knowledge through the study and use of the periodic table.
- f. recognize the difference between physical and chemical properties of matter.
- g. distinguish between metallic and nonmetallic elements by use of some physical and chemical characteristics.
- h. demonstrate an understanding that patterns and regularities in nature are used to organize chemical information through the use of activities associated with the periodic table of elements.
- i. explore the reactivity of elements and question what causes differences in reactivity.
- j. explore the Earth's chemical supplies, where they are located, how society uses them, how nature conserves them, and what conservation means in human terms.
- k. evaluate the economic, political, and environmental effects of recycling and decide which resources are better candidates for recycling.
- l. investigate the concepts of the mole, molar mass, and molarity.

5. Petroleum chemistry

- a. develop an awareness of the wide array of everyday items made from petroleum that we rely on
- b. investigate the properties and chemistry of petroleum and carbon based chemistry.
- c. investigate the fractional distillation of petroleum and realize that boiling points are important in distillation.

- d. develop a familiarity with the terms covalent bond and ionic bond and realize that hydrocarbon molecules form as a result of covalent bonding.
- e. develop an understanding that organic chemistry is so extensive relative to inorganic chemistry because of the unique bonding capability of carbon.
- f. recognize that lifestyles were very different before the use of petroleum and that the Industrial Revolution brought accelerated use of petroleum.
- g. identify the sun as the primary source of energy.
- h. trace the growth of energy use and associate it with economic factors and with the availability of particular types of energy sources.
- i. explore the chemical energy stored in molecules through the use of exothermic and endothermic chemical reactions.
- j. construct models of hydrocarbons and explore common petroleum based molecules and their typical reactions.
- k. explore the alternatives we can turn to if we run out of oil.

6. Food chemistry

- a. compare the uses of food in terms of “building” and “burning”.
- b. distinguish malnutrition from undernutrition, and identify parts of the world where these problems are most acute.
- c. define calorie and joule, and calculate energy changes from calorimetry data
- d. correlate weight gain or loss with caloric intake and human activity.
- e. compare and contrast mono-, di, and poly- saccharides in terms of structural formulas and properties.
- f. distinguish between saturated and unsaturated fats, and relate the consumption of each to health.
- g. describe how functional groups in amino acids interact in protein formation.
- h. describe five functions of proteins in the body.
- i. explain the concepts of essential amino acids, complete protein, and complementary protein with respect to a balanced diet.
- j. distinguish water-soluble from fat-soluble vitamins, and discuss the implications of these differences in terms of dietary needs.
- k. analyze the vitamin C content of foods by performing titrations.
- l. recognize the relative risks and benefits of various food additives in terms of their purposes, and provide specific examples.
- m. explain the role of the Food and Drug Administration and federal regulations in ensuring food safety.
- n. compare and contrast menus from several cultures in terms of calories and nutritional balance, and analyze the nutritional quality of food recorded in a personal food diary.

7. Nuclear energy

- a. list at least three examples of nuclear technology and/or natural radioactivity that affect dairy life.
- b. explain the general properties of electromagnetic radiation and specific properties of various regions of the electromagnetic spectrum

- c. describe the experiments of Roentgen, Becquerel, the Curies, and Rutherford, and explain how they led to modifications in the atomic model.
- d. describe the properties and locations of the three major subatomic particles.
- e. define the term isotope and interpret nuclear isotope notation.
- f. balance nuclear equations and use them to describe natural radioactive decay.
- g. explain the concept of half-life and discuss the implications of half-life for natural radioactivity and nuclear waste disposal.
- g. describe radiation detectors and their operating principles.
- h. define nuclear transmutation using a nuclear equation to illustrate the process.
- i. distinguish nuclear fission from nuclear fusion.
- j. use the equation $E=mc^2$ to compare the energies produced by nuclear fission and by typical exothermic chemical reactions.
- k. explain the energy effects of a chain reaction and compare a controlled and an uncontrolled reaction.
- l. identify the main components of a nuclear power plant.
- m. assess relative risks and benefits of various nuclear technologies.
- n. list and briefly explain factors that determine the amount of biological radiation damage.
- o. compare the ionizing radiation produced by various sources, including radon, that are encountered by a typical United States citizen.
- p. explain the problems and possible solutions associated with nuclear waste generation and disposal.

8. Chemistry of our atmosphere

- a. describe common physical and chemical properties of air.
- b. compare the chemical properties of nitrogen, oxygen, and carbon dioxide.
- c. identify the major components of the troposphere and indicate their relative concentrations.
- d. describe with words and equations the interrelationships among amount, temperature, volume, and pressure (Avogadro's, Charles', and Boyle's laws), and list one practical application of each law.
- e. define and apply in appropriate situations the terms molar volume, standard temperature and pressure (STP), Kelvin temperature scale, and absolute zero.
- f. sketch or graph the relationship between altitude and air pressure.
- g. discuss air pressure and explain how to measure it.
- h. compare the various components of solar radiation.
- i. describe how reflection, absorption and re-radiation of solar radiation account for the Earth's energy balance.
- j. explain how differing heat capacities and reflectivity of various land covers and water can influence local climates.
- k. describe the greenhouse effect, its natural incidence and causes, and the significance of industrial contributions.
- m. compare the production of carbon dioxide from combustion with that from respiration.
- n. describe the function of the ozone layer and how human activities may be affecting it.

o. list the major categories of air pollutants and discuss the relative contributions of various human and natural factors to each category.

p. describe the major general strategies for controlling pollution and specific strategies for particulates.

q. describe chemical reactions and geographic and meteorological factors which contribute to photochemical smog.

r. interpret graphs and tables related to automotive induced air pollution.

s. describe the role of catalytic converters in reducing automotive emissions of unburned hydrocarbons, carbon monoxide, and nitrogen oxides.

t. describe sources and consequences of acid rain.

u. define the terms acid and base, give examples of each, describe their formation with balanced ionic equations, and relate hydrogen ion concentration to the pH scale.

v. discuss air pollution in terms of the trade off between control cost and damage cost.

9. Basic human body chemistry

a. develop examples of correlation and determine the relationship between the members of a given pair of events.

b. define epidemiology, and describe benefits and limitations of epidemiological studies.

c. define homeostasis and give examples of how it is related to maintaining good health.

d. describe the major elements of the human body and their function in maintaining good health.

e. explain how enzymes work and list several factors that may alter their effectiveness.

f. describe cellular energy production and storage, including the role of ATP

g. define and give examples of acids and bases, and use net ionic equations to describe the neutralization reaction.

h. describe the components of a buffer and explain how it prevents acidosis and alkalosis.

i. describe the concept of "like dissolves like" and apply it to the function of soap.

j. explain the functions of the different skin parts and describe the effect of sunlight on these parts and the effectiveness of sun screens.

k. explain the effect of common drugs on the human body, and the body's chemical defenses against these drugs.

l. discuss the role of antigen-antibody complexes in protecting the body against infectious organisms, and contrast the Aids virus to other viruses.

m. evaluate the products of cigarette smoking and assess personal control of risks to maintain good health and well being.

10. Positive and Negative effects of the Chemistry industry

a. list the functions of the chemical industry and the general categories of industrial products, both present and future.

- b. contrast responsibilities of the public and industry in preserving the quality of life in a community
- c. evaluate the potentially positive and negative impacts of a chemical industry on a community.
- d. compare natural and synthetic products, providing examples of each.
- e. describe the role of chemical engineers in industry.
- f. explain the major divisions and departments of a typical chemical industry, and explain their interrelationships.
- g. analyze a fertilizer sample for its major components, and describe their importance in agriculture.
- h. describe the process of nitrogen fixation in the Haber process.
- i. trace the history and development of explosives, including the contributions of Alfred Nobel.
- j. develop and evaluate voltaic cells, using the activity series of common metals.
- k. demonstrate the charging and discharging of electrochemical cells and the technique of electroplating.
- l. identify key considerations involved in the development of a new chemical process or product.

11. Laboratory

- a. Making observations of chemical reactions and substances
- b. Recording data
- c. Calculating and interpreting results based on the quantitative data obtained
- d. Communicating effectively the results of experimental work

Relationship to the Massachusetts Science Curriculum Framework

Students engage in problem solving, communicating, reasoning as they

- 1. Use chemical and physical properties to classify and describe matter
- 2. Observe the interaction of elements and compounds on a macroscopic scale to understand the atomic model
- 3. Relate the periodicity of physical and chemical properties to atomic structure and the arrangement of the periodic table
- 4. Explain how atoms form chemical bonds
- 5. Balance chemical equations and apply stoichiometry
- 6. Explain the behavior of gases by the Kinetic Molecular Theory
- 7. Describe the solution process
- 8. Apply acid/base theory
- 9. Identify the factors that affect the rate of a chemical reaction and the factors that can cause a shift in equilibrium
- 10. Explain the driving forces in a chemical reaction
- 11. Describe the process of oxidation-reduction

Assessment Tools

Success in ChemCom (College Prep) will be assessed by the following methods:

1. Homework may be checked for completeness, accuracy, and/or understanding.
2. Class work will be evaluated overall by the teacher.
3. Laboratory work/reports will be checked for completeness, accuracy, and/or understanding
4. Formative and summative quizzes are given as needed.
5. Tests are primarily summative, yet various parts may, as needed, be treated as formative.
6. Unit tests may consist of multiple choice, short answer, and/or open response items.
7. Emphasis is put on organization, notation, accuracy and proficiency of student work.
8. The final exam will consist of primarily multiple choice, short answer and open response questions.

Materials and Resources

Heikkinen, Henry, Chemistry in the Community (4th edition), New York, W.H.Freeman and Company, 2002. (This is the primary text for this course. It includes a number of labs used in this course.)

Other labs are derived from a multitude of lab manual resources in the chemistry stockroom.

Journal of Chemical Education

Chem 13 News

Annenberg Chemistry Video Series and other related videos located in the chemistry storeroom.

Relationship to the High School Student Expectations

The members of the Scituate High Science Department will offer to every student the opportunity to:

1. Be an effective reader
2. Be an effective writer
3. Be an effective speaker/presenter/performer
4. Be an effective problem solver
5. Be an effective information seeker/organizer
6. Contribute to the community at large