Chemistry Unit 10 Standards-Based Worksheet

District of Columbia Public Schools — Science

STANDARD

C.9.1. Explain the kinetic molecular theory and use it to explain changes in gas volumes, pressure, and temperature.

Concepts:
- kinetic molecular theory
- gas volume
- pressure
- temperature

Skills:
- explain

Big Ideas:
- The behavior of gases have a direct effect on our daily lives.
- There is a fundamental relationship between volume, temperature, and pressure.

Essential Questions:
- How do the properties of gases affect our daily lives?
- What is the relationship between gas volume, pressure, temperature, and molecules?
- How do the differences between the behaviors of liquids, solids, and gases affect our world?

Engaging Scenario:
You are the owner of a SCUBA diving academy. In order to keep your divers safe, you need to make your students aware of the gas laws that affect diving. You will use this information to prevent your divers from experiencing diving-related illnesses. It will be very beneficial to put together a tri-fold pamphlet about safe diving to distribute to your students. The pamphlet should contain all of the information that a diver needs to understand how gases work, how gases act in our bodies, and what happens to those gases when a person goes diving.

PERFORMANCE TASKS	THINKING SKILLS (LOT → HOT)*	PERFORMANCE TASK ASSESSMENT (PROFICIENT CRITERIA)
Students identify real life situations in which they encounter the effects of gas laws.	identify (knowledge) LOT	Students correctly identify at least three real life manifestations of gas laws. For example, changes in tire size/pressure at different times of the year (different temperatures), changes in soda bottle size at different temperatures, etc.
Students identify the gas laws affecting these situations and apply them to solve related problems.	identify (knowledge) LOT apply & solve (application) LOT	Students correctly identify and state most of the relevant laws (including Boyle's, Charles', and Gay-Lussac's Laws) and use them to solve mathematically-based chemistry problems (see Supplemental Resources for sample problems).
Students research scuba diving as a real life activity involving gas laws and the various medical problems that can result. Students then correlate how diving-related illnesses and conditions are related to the laws of gases.	correlate (analysis) HOT	Alone or in small groups, students use available resources to research diving and diving-related illnesses. Students then illustrate relationships between the gas laws and scuba diving (e.g., Boyle's law illustrates what can happen to a diver who holds his/her breath and descends or ascends: pressure changes can cause gas in lungs to expand and rupture lungs).
Students combine gathered information to create a pamphlet about safe scuba diving.	combine & create (synthesis) HOT	Students create their safe diving pamphlets. At a minimum, students include the following sections: 1) introduction to SCUBA, 2) a description for each of three gas-related diving illnesses (e.g., "the bends," air embolisms, oxygen toxicity), and 3) an explanation of the condition using the appropriate gas law, physiology, symptoms, and treatment.

Students complete their pamphlets by predicting other situations in which this information may apply.	predict (synthesis) HOT	In the final section of their pamphlet, students show their readers that these laws and conditions can apply in other situations that humans face (e.g., spaceflight, pressurized airplanes, submarines, etc.).

*See Bloom's Taxonomy of Thinking Skills to determine higher order thinking skills (HOT) or lower order thinking skills (LOT). The goal is to create tasks that employ higher order thinking skills.

Standard Assessment:

1) A tank of nitrogen has a volume of 14.0L and a pressure of 760.0mm Hg. Find the volume of the nitrogen when its pressure is changed to 400.0 mm Hg while the temperature is held constant.

2) You are now wearing scuba gear and swimming under water at a depth of 66.0ft. You are breathing air at 3.00atm and your lung volume is 10.0L. Your scuba gauge indicates that your air supply is low so, to conserve air, you make a terrible and fatal mistake: you hold your breath while you surface. What happens to your lungs? Why?

Resources:

Textbook Materials:

Holt Chemistry, Thomas Myers, Keith Oldham, Salvatore Tocci (Holt, Rinehart and Winston, 2004), Chapters 10 & 12.

Chemistry, 9th ed., Raymond Chang (McGraw-Hill Higher Education, 2007), Chapters 5 & 13.

Supplementary Materials:

DAN Pocket Guide to First Aid for Scuba Diving, Dan Orr, Bill Clendenen (Pocket Guides Publishing, 1997) (Information about diving illnesses and treatment from the Diver's Assistance Network.)

Shadow Divers, Robert Kurson (Random House, 2004) (Non-fiction account of identification of sunken German U-boat; includes stories of diving-related illnesses.)

Into Thin Air, John Krakauer (Reprint, 1999) (Non-fiction account of attempts to climb Mt. Everest; includes discussion of effects of decreasing air pressure on human body.)

http://www.safetycenter.navy.mil/media/fathom/issues/JulSep01/nitrogen.htm ("Diving 102: Nitrogen Narcosis," article from July-Sept 2001 issue of *Fathom,* journal produced by U.S. Navy Safety center.)

http://www.nmrc.navy.mil/nmrc_ccc_oum.htm (Possible speakers from National Medical Research Center, Undersea Medicine Department website.)

http://www.chemtutor.com/gases.htm (ChemTutor Web page providing additional information about gas laws.)

http://www.scuba-doc.com/ (Information about wide range of diving-related illnesses.)

http://www.howstuffworks.com/question101.htm (Student-friendly information about "The Bends".)

http://home.flash.net/~table/gasses/laws.htm ("Scuba Physics," how gas laws apply to scuba diving.)

http://misterguch.brinkster.net/gaslawworksheets.html (Free worksheets and problems about gas laws and kinetic molecular theory from Cavalcade Publishing.)

Chemistry Unit 10 Standards-Based Worksheet

District of Columbia Public Schools — Science

STANDARD
C.9.3. Solve problems using the Ideal Gas law, $pV = nRT$, and the combined gas law, $p_1V_1/T_1 = p_2V_2/T_2$.

Concepts:
- ideal gas (law)
- gas volume
- pressure temperature

Skills:
- solve

Big Ideas:
- The behavior of gases can be described mathematically.
- In science, one set of laws is often used to prove another.
- The behavior of a gas is dependent on several factors.

Essential Questions:
- Why are gases important to everyday life?
- What relationship exists between gas volume, pressure, and temperature?
- What is the difference between an ideal gas and a real gas?

Engaging Scenario:
You are a new research scientist working with the safety division of the Ford Motor Company. Your first assignment is to give the factory employees a presentation that explains how they use the gas laws every time they build and install an automobile airbag.

PERFORMANCE TASKS	THINKING SKILLS (LOT → HOT)*	PERFORMANCE TASK ASSESSMENT (PROFICIENT CRITERIA)
Students identify the gas laws and combine them into the Combined Gas Law.	identify (knowledge) LOT	Students recall their knowledge of Boyle's and Charles' laws to identify the equation of the Combined Gas Law.

Students identify the Combined Gas Law equation and apply it to solve related problems.	identify (knowledge) LOT apply & solve (application) LOT	Students correctly state the Combined Gas Law (which is pV = nRT) and use it to solve mathematically-based chemistry problems (for sample problems, see Supplemental Resources).
Students formulate the Ideal Gas Law equation by drawing an analogy to the combined gas law.	formulate (synthesis) HOT	Students correctly formulate the Ideal Gas Law (which is $p_1V_1/T_1 = p_2V_2/T_2$).
Students identify the relationship between the Ideal Gas Law, Dalton's Law of Partial Pressures, and Graham's Law of Diffusion. Students apply their knowledge to solve related problems.	connect (analysis) HOT apply & solve (application) LOT	Students relate the gas laws to Dalton's Law of Partial Pressures and Graham's Law of Diffusion and use them to solve mathematically-based chemistry problems (see Supplemental Resources for sample problem sources).
Students research the implosion of airbags in an automobile and then correlate the implosion to the chemical reactions that occur. Students explain the relationship to the gas laws.	correlate (analysis) HOT	Alone or in small groups, students research and correlate the use and function of airbags to the gas laws that make them work. Explanations are logical and thorough.
Students create a presentation to explain the use of airbags and their relationship to the gas laws. Classmates ask questions about advantages and disadvantages of air bags.	create (synthesis) HOT explain (evaluation) HOT	Student presentations may be on Power Point, posters, etc. At minimum, presentations should include the following: 1) a title, 2) an introduction to airbags including the pros and cons of the use of airbags, 3) a description of the chemical reactions that occur when airbags implode, and 4) a discussion of the relationship to the gas laws.

*See Bloom's Taxonomy of Thinking Skills to determine higher order thinking skills (HOT) or lower order thinking skills (LOT). The goal is to create tasks that employ higher order thinking skills.

Standard Assessment:

1) State the equation for the Combined Gas Law and the Ideal Gas Law. What does the R represent in the Ideal Gas Law?

2) What is the difference between an ideal gas and a real gas?

Resources:

Textbook Materials:

Holt Chemistry, Thomas Myers, Keith Oldham, Salvatore Tocci (Holt, Rinehart and Winston, 2004), Chapter 12.
Chemistry, 9th ed., Raymond Chang (McGraw-Hill Higher Education, 2007), Chapter 5.

Supplementary Materials:

http://misterguch.brinkster.net/gaslawworksheets.html (Free worksheets and problems about gas laws and kinetic molecular theory from Cavalcade Publishing.)

http:www.miramar.sdccd.cc.ca.us/faculty/fgarces/zCourse/Fall03/Ch100/Ch100_Lab/Lab_B_Home/AtHomeLab/d_expt/Ex09_GasDemo/GasDemo_OL03.html (Quick time movies showing gas laws at work: Egg in a Bottle, rising water, and imploding soda can.)

http://www.chemistry.wustl.edu/~edudev/LabTutorials/Airbags/airbags.html (Tutorial explaining the chemical reactions that occur when airbags implode and discussing the relationship to the gas laws.)

http://www.chm.davidson.edu/ChemistryApplets/GasLaws/DaltonsLaw.html (Tutorial and simulation explaining the concepts behind Dalton's Law of Partial Pressures.)

Chemistry Unit 10 Standards-Based Worksheet

District of Columbia Public Schools — Science

STANDARD

C.1.10. Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data. (The focus is on manual graphing, interpreting graphs, and mastery of metric measurements and units, with supplementary use of computers and electronic data gathering when appropriate.)

Concepts:

- tools
- technology
- tests
- data
- relationships
- graphs
- metric measurements

Skills:

- select
- use
- perform
- collect
- analyze
- display

Big Ideas:

- Efficient data gathering is essential to scientific observation and analysis.
- Scientists use data to make informed decisions and communicate their reasoning in oral and written forms.
- The use of appropriate tools and technology are essential to reaching valid data in science.

Essential Questions:

- How do scientists collect and analyze data?
- How do scientists display data? Why is this important?
- How can a computer or other technology be used to assist data collection and analysis?
- How can the tools or technology used to perform an experiment affect accuracy and outcome of the experiment?
- How have advances in technology affected scientific observation and analysis?
- Why would a scientist use the metric system instead of another system of measurement?

Engaging Scenario:
You are an air quality specialist with the Environmental Protection Agency, with a special interest in the air quality of the District of Columbia. You have been asked to prepare a Public Service Announcement (PSA) to explain the current status of the air quality to the local residents. This announcement will emphasize the importance of air quality and the role citizens can play in improving the quality of the air.

PERFORMANCE TASKS	THINKING SKILLS (LOT → HOT)*	PERFORMANCE TASK ASSESSMENT (PROFICIENT CRITERIA)
Students identify the different types of graphs that can be used to display data.	identify (knowledge) LOT	Students correctly identify at least four types of graphs that can be used to display data.
Students complete an exercise to reinforce choosing the appropriate graph to represent data and practice reading graphs.	complete (application) LOT	Students successfully choose the appropriate graphs to use to display provided data and correctly analyze the data presented in graphs. (See Supplemental Resources for sources of raw data that may be used.) Data provided should be metric; if not, students perform conversions into metric measurements.
Students collect relevant data about air quality in the D.C. region, with emphasis on atmospheric gas.	collect (knowledge) LOT	Students examine indoor or outdoor air quality within and surrounding the District. The five major pollutants that should be examined include: • ground-level ozone, • carbon monoxide, • sulfur dioxide, • nitrogen dioxide, and • particulate matter. Data provided should be in metric form; if not, students perform conversions into metric measurements. Students also research the effects of poor air quality on human health, and current attempts to remediate air quality.

Students assess the data and compile it into appropriate tables and graphs.	assess (evaluation) HOT compile (synthesis) HOT	Students construct at least two different types graph (depending on data collected, students may wish to only create one large inclusive table). Data gathered includes variables such as location, EPA-allowed amounts of particular contaminants, and levels of contaminant at each location, etc. Other factors may include incidences of contaminant-related health issues at each location, remediation procedures, effectiveness of procedures, etc. A statistical program may also be applied. Data provided should be in metric form; if not, students perform conversions into metric measurements. Tables and graphs effectively display that collected metric data.
Students summarize their findings and design an informational Public Service Announcement to broadcast to the community members.	summarize (evaluation) HOT design (synthesis) HOT	Students design their air quality Public Service Announcements. Announcements can be in the form of video presentation, live presentation, Power Point, or poster. At minimum the PSA includes the following: 1) introduction, 2) an explanation of each of the quality aspects examined, 3) tables and graphs displaying the data, 4) an explanation of what the data means to the community and the measures that need to be taken to improve air quality in the D.C. area.

*See Bloom's Taxonomy of Thinking Skills to determine higher order thinking skills (HOT) or lower order thinking skills (LOT). The goal is to create tasks that employ higher order thinking skills.

Standard Assessment:

1) Explain the difference between displaying data in a table and a graph.

2) Name three types of graphs and provide an example of each.

Resources:

Textbook Materials:

Standard is application-based.

Supplementary Materials:

http://www.fodoweb.com/erfora/readtext.asp?txtfile=communications/charts.toc (A website to practice choosing the appropriate graph, analyzing graphs, and preparing graphs.)

http://doh.dc.gov/doh/cwp/view,a,1374,q,599532,dohNav_GID,1809.asp (A website that provides links to the branches of the Air Quality division of the D.C. Department of Environmental Health Department.)

http://www.mwcog.org/environment/air/ (Website that provides data on current air quality conditions and forecasts the future status.)

The Inside Story: A Guide to Indoor Air Quality (Washington, D.C.: U.S. Environmental Protection Agency, Office of Air and Radiation, 1995) (Handbook that discusses indoor air quality.)

http://www.sedl.org/afterschool/toolkits/science/pdf/ast_sci_line_graphs_sample.pdf (Sample data to create a line graph.)

http://standards.nctm.org/document/eexamples/chap5/5.5/part2.htm (Sample temperature and precipitation data for bar, scatter and line graphs; from the National Council of Teacher of Mathematics.)

http://nd.water.usgs.gov/cgibin/devils_lake/result.pl?station=all&constituent=P00300&byear=2000&eyear=2003 (Dissolved oxygen scatter plots with option to get data from USGS.)

http://www.undeerc.org/watman/FMRiver/index.html (Provides an Excel spreadsheet containing data on several different water quality characteristics.)

Chemistry Unit 11 Standards-Based Worksheet

District of Columbia Public Schools — Science

STANDARD
C.10.1. Explain how equilibrium is established when forward-and-reverse reaction rates are equal.

Concepts:
- equilibrium
- reaction rates

Skills:
- explain

Big Ideas:
- The state of equilibrium is a balance between two opposing forces.
- Living organisms rely on their body's ability to maintain equilibrium to stay alive.
- Some reactions can occur in both the forward and reverse directions.

Essential Questions:
- How can chemical equilibrium be defined?
- How does the concept of reversibility explain the establishment of equilibrium?
- How does the principle of equilibrium affect living organisms?
- How have people translated their understanding of equilibrium into different goods and services?

Engaging Scenario:
You have been hired by *Beginning Gardener* magazine to write an article explaining the process by which ammonia is created. Your editors have asked you to explain how fertilizers are made, with a specific focus on the chemistry behind this process. Your article provides beginning gardeners with the information that will give them an understanding of where their products might be coming from when using fertilizer.

PERFORMANCE TASKS	THINKING SKILLS (LOT → HOT)*	PERFORMANCE TASK ASSESSMENT (PROFICIENT CRITERIA)
Students define the term equilibrium in a group discussion.	define (knowledge) LOT	Students correctly define equilibrium. Students may define equilibrium based on mechanical, chemical, and/or physical examples.

Students then identify "real-life" manifestations of chemical equilibrium.	identify (knowledge) LOT	Students "real-life" examples of equilibrium may come from any field of science (e.g., the feedback loop of the human body maintaining blood sugar levels).
Students take part in demonstrations in order to determine when equilibrium has been established.	determine (application) LOT	After watching and participating in various reaction experiments, each student is able to identify how he/she would predict when equilibrium has been established (see Supplemental Resources for reaction demonstrations) and how it was established (equal rates of forward/reverse reactions).
Students research ammonia to identify its uses and discover the process by which ammonia is created.	identify (knowledge) LOT discover (application) LOT	Students successfully research the use of ammonia for agricultural purposes and the process by which it is created. Students include a discussion of equilibrium and reversible reactions in the production of ammonia.
Students prepare an outline from their research to aid in writing their articles.	outline (analysis) HOT	Outlines include agricultural uses of ammonia, manufacturing process, chemical principles involved, and definitions of any unfamiliar terms.
Students rewrite their research outlines as a magazine article explaining the use of ammonia for agricultural purposes and how it is created.	rewrite (synthesis) HOT explain (analysis) HOT	Students successfully write a magazine article discussing ammonia. At a minimum, the article includes an introduction discussing ammonia's uses, brief history of the use of ammonia in agriculture, a discussion of the chemical reaction that creates ammonia, and an explanation of chemical equilibrium. Articles are written in a format appropriate to a general-audience magazine.

*See Bloom's Taxonomy of Thinking Skills to determine higher order thinking skills (HOT) or lower order thinking skills (LOT). The goal is to create tasks that employ higher order thinking skills.

Standard Assessment:

1) What characteristics define a system at equilibrium?

2) Describe an equilibrium in everyday life that illustrates a state of balance between two opposing processes. *(Chemistry, p. 590)*

Resources:

Textbook Materials:

Holt Chemistry, Thomas Myers, Keith Oldham, Salvatore Tocci (Holt, Rinehart and Winston, 2004), Chapter 14.

Chemistry, 9th ed., Raymond Chang (McGraw-Hill Higher Education, 2007), Chapter 14.

Supplementary Materials:

http://www.iit.edu/~smile/chbi1800.htm (This website provides a sample lesson plan for introduction to equilibrium – includes demonstrations and discussion topics.)

http://www.iit.edu/%7Esmile/ch9116.html (This website provides a sample lesson plan for equilibrium – demonstrations only.)

http://www.wpbschoolhouse.btinternet.co.uk/page04/4_74revNH3.htm#3 (A website that explains reversible reactions and the Haber process used to create ammonia.)

http://www.ausetute.com.au/haberpro.html (A website that discusses the Haber process and uses of ammonia.)

http://www.ammonia.com/ammoniainfo.html (A website that describes the uses, making, and toxicology problems of ammonia.)

Chemistry Unit 11 Standards-Based Worksheet

District of Columbia Public Schools — Science

STANDARD

C.10.2. Describe the factors that affect the rate of a chemical reaction (temperature, concentration) and the factors that can cause a shift in equilibrium (concentration, pressure, volume, temperature).

Concepts:
- factors
- rate
- chemical reaction
- temperature
- concentration
- shift
- equilibrium
- pressure
- volume

Skills:
- describe

Big Ideas:
- Chemical reactions are influenced by numerous external factors.
- Chemical equilibrium is easily shifted.

Essential Questions:
- How do the temperature and the concentration of the reactants and products affect the rate of a chemical reaction?
- Why do chemical reactions play a role in our lives?
- What purpose does changing chemical equilibrium have?

Engaging Scenario:
You were recently hired by a major educational publishing company to be a writer for a new high school Chemistry textbook. You have been assigned the chapter dedicated to chemical reactions; your specific role is to design a lab procedure that will allow students to investigate how changing the conditions of a reaction can dramatically affect the outcome of that reaction. Before being paid for your efforts, a group of chemists will have to evaluate your proposed experiment to make sure it is valid.

PERFORMANCE TASKS	THINKING SKILLS (LOT → HOT)*	PERFORMANCE TASK ASSESSMENT (PROFICIENT CRITERIA)
Students observe an example of a chemical reaction and identify specific characteristics of the reaction.	identify (knowledge) LOT	Students correctly identify the products and reactants of the reaction. Students discuss ways of describing the rate of the reaction and ways to identify when chemical equilibrium has been reached. *Note: See Supplemental Resources for examples of simple reaction demonstrations.*
Students compose a list of factors that affect the rate or equilibrium of chemical reactions.	compose (synthesis) HOT	Students successfully conduct a teacher-provided lab and/or complete library research to create a list of factors affecting rates of reactions and levels of equilibrium within chemical reactions (see Supplemental Resources for sample laboratories). At a minimum, student lists identify temperature and concentration as factors that affect the rate of chemical reactions, and identify concentration, pressure, volume, and temperature as factors that can cause shifts in equilibrium.
Students outline ideas for a high-school textbook laboratory procedure.	outline (analysis) HOT	Using knowledge from previous tasks, as well as their classroom experiences, students outline a textbook laboratory procedure that would allow students to investigate factors that affect chemical reaction rates and/or levels of equilibrium. Proposed labs investigate at least one of the factors discovered in the above task. Students should not attempt to paraphrase an experiment that they have done or found through research, but develop an original experiment. Ideas are appropriate for a high-school classroom setting.

Students formulate a hypothesis and the variables for their original laboratory procedure.	formulate (synthesis) HOT	Students formulate a hypothesis that students could test and identify specific variables for their original laboratory procedures.
Students compile materials and design the methods for their laboratory procedure.	compile, design (synthesis) HOT	Students compile a list of the materials they plan to incorporate into their laboratory experiments and design the specific procedures of the experiment. Materials and procedures must be safe and appropriate to the high-school setting. Procedures are clearly written and easy to follow.
Students test the effectiveness of their laboratory procedures by completing the laboratory of another group and evaluating how well it worked.	assess, evaluate (evaluation) HOT	Students follow the procedures of another group's lab to evaluate the overall effectiveness of the procedure. Students report on the effectiveness by following a modified lab report format: hypothesis tested, materials used, data, results, and discussion. The discussion includes student thoughts on why the experiment did or did not address the goal of the activity (investigate factors that affect rate/equilibrium), as well as recommendations to improve the lab.

*See Bloom's Taxonomy of Thinking Skills to determine higher order thinking skills (HOT) or lower order thinking skills (LOT). The goal is to create tasks that employ higher order thinking skills.

Standard Assessment:

1) Describe the effect of changes in temperature on the rate of a reaction.

2) Describe the effect of increasing or decreasing the concentration of reactants on the rate of reaction.

Resources:

Textbook Materials:

Holt Chemistry, Thomas Myers, Keith Oldham, Salvatore Tocci (Holt, Rinehart and Winston, 2004), Chapters 14 & 16.

Chemistry, 9th ed., Raymond Chang (McGraw-Hill Higher Education, 2007), Chapters 13-14.

Supplementary Materials:

Applications of Reaction Rate, Kevin Cunningham (*Journal of Chemistry Education*, 2007 84:430) (This article presents an assignment in which students are asked to research and report on a chemical reaction whose increased or decreased rate is of practical importance.)

http://www.iit.edu/%7Esmile/ch9605.html (This website has a sample lesson plan using vinegar to examine rates of chemical reactions.)

http://www.iit.edu/%7Esmile/cb1498.htm (This website has a sample lesson plan examining temperature, surface area, concentration, and catalyst affects on reactions.)

http://www.chem4kids.com/files/react_rates.html (This website gives a brief, thorough lesson about reaction rates and the factors that can such affect rates; includes a quiz.)

http://biologycorner.com/worksheets/labreport.html (A sample template for a science laboratory report.)

http://biologycorner.com/worksheets/labreport_rubric.html (A sample rubric for a science laboratory report.)

Chemistry Unit 11 Standards-Based Worksheet

District of Columbia Public Schools — Science

STANDARD

C.10.6. Write the equilibrium expression for a given reaction and calculate the equilibrium constant for the reaction from given concentration data.

Concepts:
- equilibrium expression
- reaction
- equilibrium constant
- data

Skills:
- write
- calculate

Big Ideas:
- Some chemical systems move readily towards completion while others have little tendency to react.
- It is possible to determine and predict concentrations of reactants and products in a chemical reaction.

Essential Questions:
- What is the law of chemical equilibrium and why is it important?
- How do you use the chemical equilibrium expression to predict concentrations of reactants and products?
- How can chemical equilibrium be applicable to everyday life?

Engaging Scenario:
An internationally famous investment corporation has been invited to the factory where you are employed as a supervisor. They are thinking about investing money in your manufacturing company and your boss would like you to explain part of the manufacturing process while dazzling them with your understanding and expertise. If they are impressed by what they see and hear, their investment will let your business grow and eventually triple its profits. Your boss has requested that you take them on a tour of the factory and that you explain to them some of what they are seeing. At the end of the tour you will give them a presentation as to why they should invest in your company.

PERFORMANCE TASKS	THINKING SKILLS (LOT → HOT)*	PERFORMANCE TASK ASSESSMENT (PROFICIENT CRITERIA)
Students identify the equilibrium constant expression using the law of chemical equilibrium.	identify (knowledge) LOT	Students correctly identify the equilibrium constant expression.
Students apply the equilibrium constant expression to solve practice problems.	apply, solve (application) LOT	Students successfully solve problems using the equilibrium constant expression (see Supplemental Resources for sample problems).
Students identify chemical reactions used in common manufacturing processes and the outcomes of these reactions. Students select one category to focus on within their research.	identify (knowledge) LOT	Students conduct research to identify at least one chemical reactions used in manufacturing (e.g., plastics, rubber, fuels). This reaction allows students to focus on the product/company that the investors are interested in. Students describe what these reactions are used to make and the products and reactants of the specific reaction.
Students write the equilibrium expression and calculate the equilibrium constant equation for the reaction.	write (knowledge) LOT calculate (application) LOT	Students correctly identify the equilibrium expression and solve the equilibrium constant equation. If data cannot be found through research, the teacher should provide concentration data.
Students design a presentation about the reaction for the investment company.	design (synthesis) HOT	Presentations identify the reaction, its equilibrium expression and constant, as well as how the constant was determined. Students explain why this information is vital to the reaction and, in turn, why the reaction is a vital part of the manufacturing process (e.g., what are they making, and how does it help?). Presentations may be made orally, Power Point, etc.; are in layman's language, and is persuasive.

*See Bloom's Taxonomy of Thinking Skills to determine higher order thinking skills (HOT) or lower order thinking skills (LOT). The goal is to create tasks that employ higher order thinking skills.

Standard Assessment:

1) How can an equilibrium system contain small and unchanging amounts of products yet have large amounts of reactants? What can you say about the relative size of K_{eq} for such an equilibrium?

2) Calculate K_{eq} for the following when $[SO_3] = 0.0160$ mol/L, $[SO_2] = 0.00560$ mol/L, and $[O_2] = 0.00210$ mol/l.

$$2SO_3(g) \Leftrightarrow 2SO_2(g) + O_2(g)$$

(Chemistry, p. 590)

Resources:

Textbook Materials:

Holt Chemistry, Thomas Myers, Keith Oldham, Salvatore Tocci (Holt, Rinehart and Winston, 2004), Chapter 14.

Chemistry, 9th ed., Raymond Chang (McGraw-Hill Higher Education, 2007), Chapter 14.

Supplementary Materials:

Applying the Concepts of Equilibrium (SR Publications – Media on Human Development, 2003) (This is a 21-minute video that examines the basic concepts of chemical equilibrium.)

http://www.cerritos.edu/mzewail/111%20worksheets/Worksheet%20Equilibrium.pdf (A website with a practice worksheet on Chemical equilibrium.)

http://www.cerritos.edu/mzewail/111%20Worksheet%20KEY/Worksheet%20Chemical%20Equilibrium%20KEY.pdf (This is the answer key for practice worksheet above.)

http://www.jdenuno.com/APChemistry/Equilibrium.htm (A website that includes helpful links to equilibrium tutorials, practice problems, and lectures.)

http://www.chemguide.co.uk/physical/equilibria/kc.html (A website tutorial that examine homogeneous and heterogeneous equilibria. It provides a good explanation of the chemical equilibrium constant.)

http://people.wcsu.edu/nigroa/CHE%20111/Lectures/Chapter%2013%20Chemical%20Equilibrium.pdf (This is a sample PowerPoint presentation on chemical equilibrium.)

Chemistry Unit 11 Standards-Based Worksheet

District of Columbia Public Schools — Science

STANDARD

C.8.11. Describe the effect of changes in reactant concentration, changes in temperature, the surface area of solids, and the presence of catalysts on reaction rates.

Concepts:
- effect
- reactant
- concentration
- temperature
- surface area
- solid
- catalyst
- reaction rate

Skills:
- describe

Big Ideas:
- Many factors can influence a chemical reaction.
- Reactions are the basis of many biological and industrial processes.
- Chemical reactions are vital to the basic functions of our everyday lives.

Essential Questions:
- Why is it important to understand what influences a chemical reaction?
- How do chemical reactions affect daily life?

Engaging Scenario:
You are a chef who was invited to appear on *Iron Chef America*, a popular Food Network TV show. You were given a mystery ingredient and had 60 minutes to dazzle a panel of judges with an assortment of dishes based on that ingredient. Unfortunately, you lost "Battle Pineapple" to Iron Chef Bobby Flay. You think that this had something to do with your original idea which was to serve a number of gelatin-based pineapple foods, but not one of them came out even remotely edible. You are pretty sure that this had something to do with the reactions involved in making Jell-O. Now that you are back in your own kitchen, you decide to do some investigating and find out why none of your recipes worked.

PERFORMANCE TASKS	THINKING SKILLS (LOT → HOT)*	PERFORMANCE TASK ASSESSMENT (PROFICIENT CRITERIA)
Students identify factors that can change reaction rates and select one as the focus their investigation.	identify (knowledge) LOT select (analysis) HOT	Students identify at a minimum: changes in reactant concentration, changes in temperature, the surface area of solids, and the presence of catalysts on reaction rates. Students then select one of these factors to focus their recipe research on. *Note: The first three may be the easiest to test within the bounds of this task and in a classroom; the teacher may choose to direct student attention to these.*
Students create a method that lets them test the effects of their selected factor on the production of Jell-O and write a laboratory procedure for their Jell-O experiment.	create (synthesis) HOT	Using the basic procedure for making Jell-O, students modify the recipe in a way that lets them examine the effects of one factor on the "Jell-O" reaction (e.g., students can investigate the effects of temperature by comparing Jell-O made with fresh vs. canned vs. frozen pineapple?; students can use different sizes of pineapple in their Jell-O, etc.). Students clearly state their hypothesis and variables. Students devise a list of materials that are usable in a classroom and write a procedure that is clear and easy to follow. *Note: See Supplemental Resources for a basic lab that uses pineapple to investigate the effects of temperature on reaction rates.*
Students complete their experiment and make observations.	complete (application) LOT	Students complete their experiment as they have written it. Students make one batch of pineapple Jell-O as directed (e.g., only using canned pineapple) to use as a control. Students make observations about what was and was not successful in making Jell-O.

Students analyze their results to determine what factor in their modified "recipe" had an effect on the outcome of the Jell-O, and why this happened.	analyze (analysis) HOT	Students identify how the variable that they chose affected the Jell-O. Students describe their observations, relate it to their hypothesis, and try to determine why the Jell-O did or did not work. For example, if a student tested temperature and/or catalysts, they would determine that Jell-O does not set with fresh pineapple, Jell-O sets very slowly with frozen pineapple but then disintegrates, and Jell-O works fine with canned pineapple. With research, students would discover that the presence of the enzyme bromelin in fresh pineapple keeps the pineapple from setting, but it has been deactivated during the heating process, so canned pineapple will work with Jell-O.
Students speculate on how the factors that affect reaction rates could change other recipes as well.	speculate (synthesis) HOT	Using a recipe brought from home (or found in a cookbook), students use their new understanding of factors that affect reaction rates to indicate steps or ingredients that should be changed in a recipe because of the effect on the reaction.

*See Bloom's Taxonomy of Thinking Skills to determine higher order thinking skills (HOT) or lower order thinking skills (LOT). The goal is to create tasks that employ higher order thinking skills.

Standard Assessment:

1) What is the relationship between reaction rate and:
   a. reactant concentration
   b. temperature
   c. surface area of solids

2) What do you call a substance that increases the rate of a chemical reaction without being consumed by the reaction?
   (Chemistry, p. 554)

Resources:

Textbook Materials:

Holt Chemistry, Thomas Myers, Keith Oldham, Salvatore Tocci (Holt, Rinehart and Winston, 2004), Chapter 10.
Chemistry, 9th ed., Raymond Chang (McGraw-Hill Higher Education, 2007), Chapter 13.

Supplementary Materials:

The Science of Cooking, Peter Barham (Springer, 2001) (This describes the chemical and physical principles used in cooking and recipes that demonstrate them.)

Applications of Reaction Rate, Kevin Cunningham (*Journal of Chemistry Education*, 2007 84:430) (This article presents an assignment in which students are to research and report on a chemical reaction whose increased or decreased rate is of practical importance.)

http://www.accessexcellence.org/AE/ATG/data/released/0271-RandyllWarehime/ (A lesson plan to show the effects of temperature and catalysts on reaction rate. Fresh pineapple has an enzyme that does not let Jell-O set; in canned/heated pineapple, the enzyme has been deactivated and the Jell-O sets; the enzyme in frozen pineapple is working very slowly, so the Jell-O sets slowly and then disintegrates.)

http://antoine.frostburg.edu/chem/senese/101/consumer/faq/pineapple-jello.shtml ("Why Can't You Put Pineapple Chunks in Jello," from General Chemistry Online.)

http://www.chatham.edu/pti/Kitchen_Chem/abstract_page.htm (Pittsburg Teacher's Institute list of links to units that use cooking to teach chemistry concepts.)