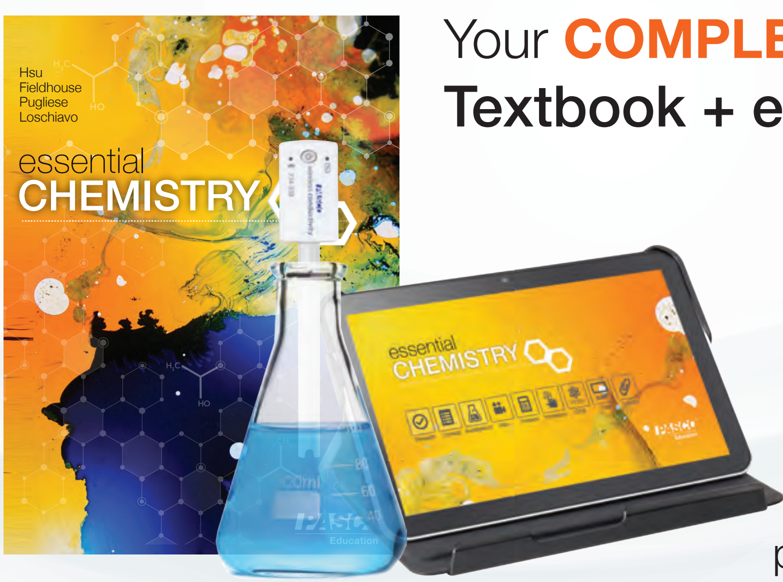
PASCO
Education

essential CHEMISTRY

Program Overview



Your **COMPLETE** Chemistry Solution
Textbook + e-Book + Equipment

Available with
PASCO's award-winning
science equipment

pasco.com/essentialchemistry

A Complete and Affordable Chemistry Solution
that includes Textbook, e-Book, Digital Teacher Edition, and Equipment

Program Components

About the Author

Dr. Tom Hsu, former research physicist at MIT, is author of seven science textbooks including *Essential Chemistry* and *Essential Physics*. His teaching methods have been used successfully across the United States since 1991. He also develops physics apparatus that promotes discovery through active hands-on investigations.

The *Essential Chemistry* curriculum **covers 100% of your standards**.

- Rigorous yet accessible design
- Interactive simulations
- Lessons follow the 5E design
- Chemical equation solver
- 3D molecular modeling
- Works seamlessly with your LMS and Google Classroom

Multiplatform

iOS, Android™, Chrome™, Windows®, PC, and Mac®

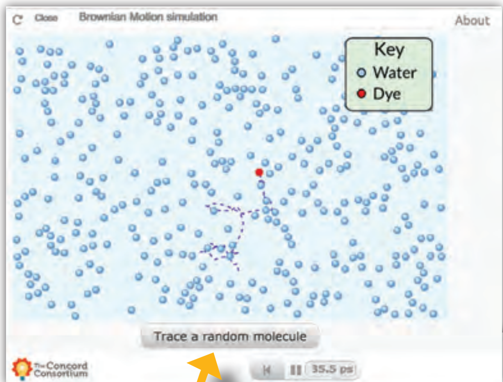
- *24/7 online/offline access*
- *No Internet required*

A textbook and an e-Book

for all your students...

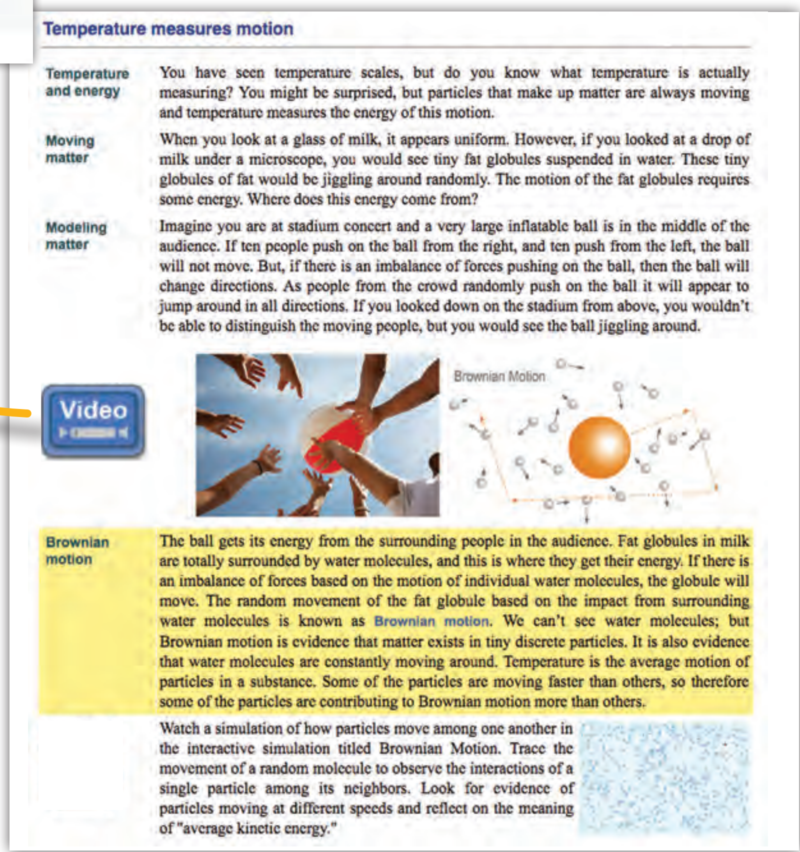
Rigorous and accessible!

Textbook and e-Book



Videos

Embedded animations show real-world applications.



Temperature measures motion

Temperature and energy You have seen temperature scales, but do you know what temperature is actually measuring? You might be surprised, but particles that make up matter are always moving and temperature measures the energy of this motion.

Moving matter When you look at a glass of milk, it appears uniform. However, if you looked at a drop of milk under a microscope, you would see tiny fat globules suspended in water. These tiny globules of fat would be jiggling around randomly. The motion of the fat globules requires some energy. Where does this energy come from?

Modeling matter Imagine you are at stadium concert and a very large inflatable ball is in the middle of the audience. If ten people push on the ball from the right, and ten push from the left, the ball will not move. But, if there is an imbalance of forces pushing on the ball, then the ball will change directions. As people from the crowd randomly push on the ball it will appear to jump around in all directions. If you looked down on the stadium from above, you wouldn't be able to distinguish the moving people, but you would see the ball jiggling around.

Video

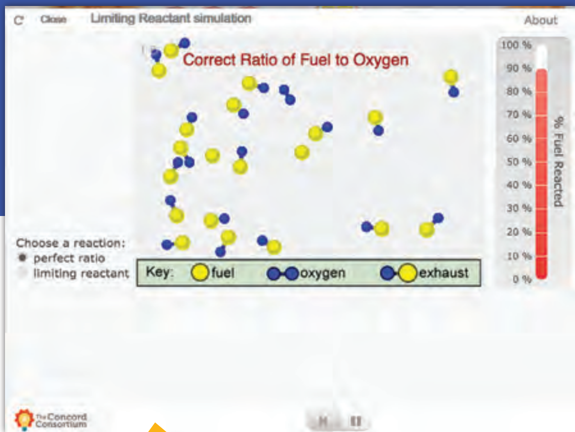
Brownian Motion

Brownian motion The ball gets its energy from the surrounding people in the audience. Fat globules in milk are totally surrounded by water molecules, and this is where they get their energy. If there is an imbalance of forces based on the motion of individual water molecules, the globule will move. The random movement of the fat globule based on the impact from surrounding water molecules is known as **Brownian motion**. We can't see water molecules; but Brownian motion is evidence that matter exists in tiny discrete particles. It is also evidence that water molecules are constantly moving around. Temperature is the average motion of particles in a substance. Some of the particles are moving faster than others, so therefore some of the particles are contributing to Brownian motion more than others.

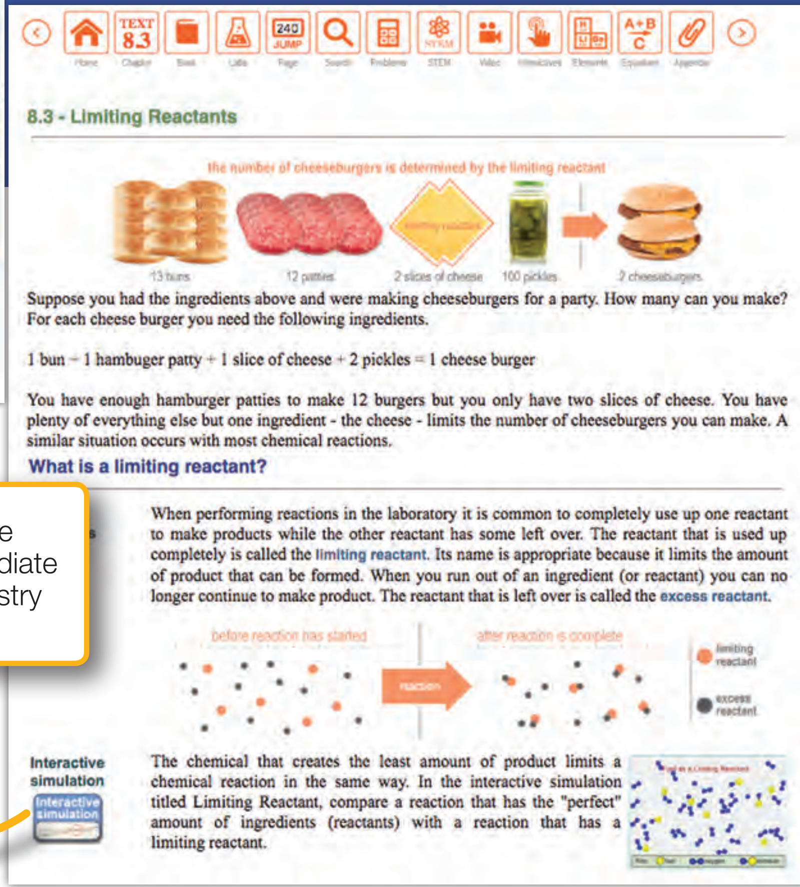
Watch a simulation of how particles move among one another in the interactive simulation titled Brownian Motion. Trace the movement of a random molecule to observe the interactions of a single particle among its neighbors. Look for evidence of particles moving at different speeds and reflect on the meaning of "average kinetic energy."

The Interactive Equation Solver
Learn to balance any chemical equation with this powerful chemistry tool.

Textbook and e-Book



Fully interactive simulations challenge students to explore chemistry ideas. Immediate feedback reinforces learning of core chemistry concepts.



8.3 - Limiting Reactants

the number of cheeseburgers is determined by the limiting reactant

13 buns 12 patties 2 slices of cheese 100 pickles 2 cheeseburgers

Suppose you had the ingredients above and were making cheeseburgers for a party. How many can you make? For each cheese burger you need the following ingredients.

1 bun + 1 hambuger patty + 1 slice of cheese + 2 pickles = 1 cheese burger

You have enough hamburger patties to make 12 burgers but you only have two slices of cheese. You have plenty of everything else but one ingredient - the cheese - limits the number of cheeseburgers you can make. A similar situation occurs with most chemical reactions.

What is a limiting reactant?

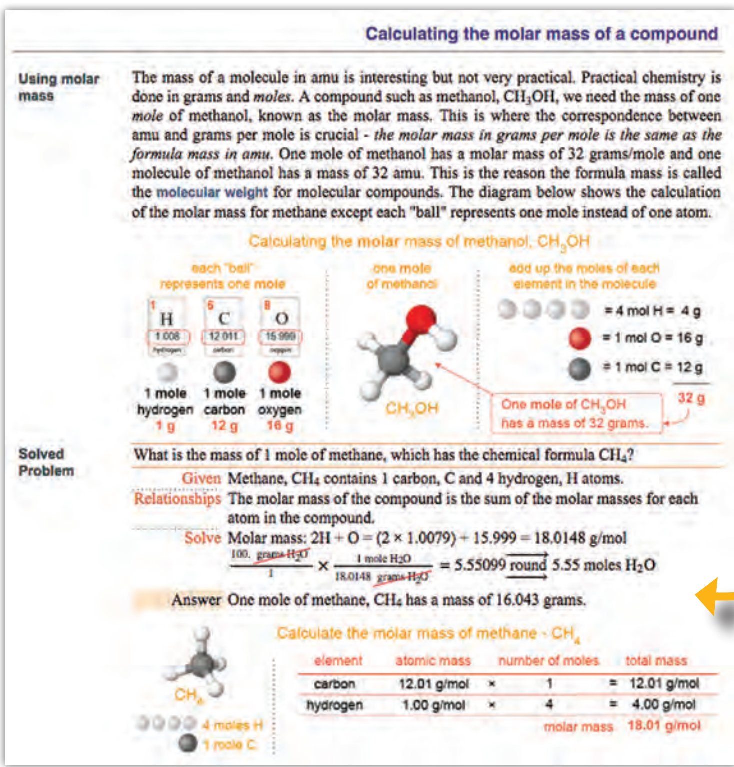
When performing reactions in the laboratory it is common to completely use up one reactant to make products while the other reactant has some left over. The reactant that is used up completely is called the **limiting reactant**. Its name is appropriate because it limits the amount of product that can be formed. When you run out of an ingredient (or reactant) you can no longer continue to make product. The reactant that is left over is called the **excess reactant**.

before reaction has started — reaction — after reaction is complete; limiting reactant; excess reactant

Interactive simulation

The chemical that creates the least amount of product limits a chemical reaction in the same way. In the interactive simulation titled Limiting Reactant, compare a reaction that has the "perfect" amount of ingredients (reactants) with a reaction that has a limiting reactant.

Interactive simulations



Calculating the molar mass of a compound

Using molar mass

The mass of a molecule in amu is interesting but not very practical. Practical chemistry is done in grams and *moles*. A compound such as methanol, CH_3OH, we need the mass of one *mole* of methanol, known as the molar mass. This is where the correspondence between amu and grams per mole is crucial - *the molar mass in grams per mole is the same as the formula mass in amu.* One mole of methanol has a molar mass of 32 grams/mole and one molecule of methanol has a mass of 32 amu. This is the reason the formula mass is called the **molecular weight** for molecular compounds. The diagram below shows the calculation of the molar mass for methane except each "ball" represents one mole instead of one atom.

Calculating the molar mass of methanol, CH_3OH

each "ball" represents one mole — 1 mole hydrogen 1 g; 1 mole carbon 12 g; 1 mole oxygen 16 g. One mole of methanol. Add up the moles of each element in the molecule: = 4 mol H = 4 g; = 1 mol O = 16 g; = 1 mol C = 12 g. One mole of CH_3OH has a mass of 32 grams. 32 g

Solved Problem

What is the mass of 1 mole of methane, which has the chemical formula CH_4?

Given: Methane, CH_4 contains 1 carbon, C and 4 hydrogen, H atoms.

Relationships: The molar mass of the compound is the sum of the molar masses for each atom in the compound.

Solve: Molar mass: 2H + O = (2 × 1.0079) + 15.999 = 18.0148 g/mol

$\frac{100.\ \text{grams } H_2O}{1} \times \frac{1 \text{ mole } H_2O}{18.0148 \text{ grams } H_2O} = 5.55099 \text{ round } 5.55 \text{ moles } H_2O$

Answer: One mole of methane, CH_4 has a mass of 16.043 grams.

Calculate the molar mass of methane - CH_4 (4 moles H, 1 mole C)

element	atomic mass		number of moles		total mass
carbon	12.01 g/mol	×	1	=	12.01 g/mol
hydrogen	1.00 g/mol	×	4	=	4.00 g/mol
			molar mass		18.01 g/mol

Embedded solved problems with practice provide point-of use opportunities for students to comprehend mathematical applications.

Solved problems

Textbook and e-Book

Differentiation for advanced, below-level, and ELL students

One main idea per page includes Cornell Note topics.

Each paragraph topic is called out.

Glossary words highlighted on first usage.

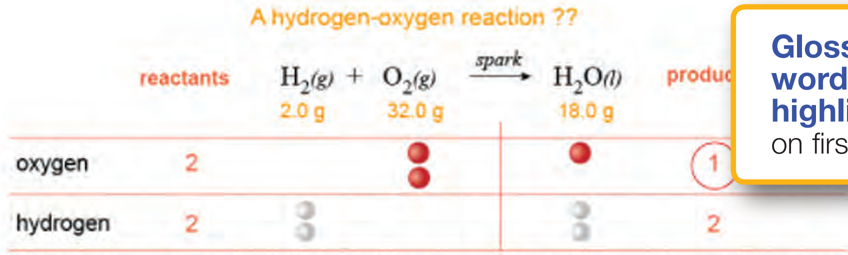
Quality illustrations enhance learning experience.

Example calculations apply concepts.

Balanced chemical equations

Why an unbalanced equation is inaccurate

Consider a reaction that combines hydrogen gas with oxygen to make water. This reaction occurs in a hydrogen fuel cell and releases a great deal of energy. Many companies are trying to make hydrogen powered cars because the product is water and this would greatly lessen air pollution and carbon dioxide emissions that contribute to climate change.



Why this equation is wrong

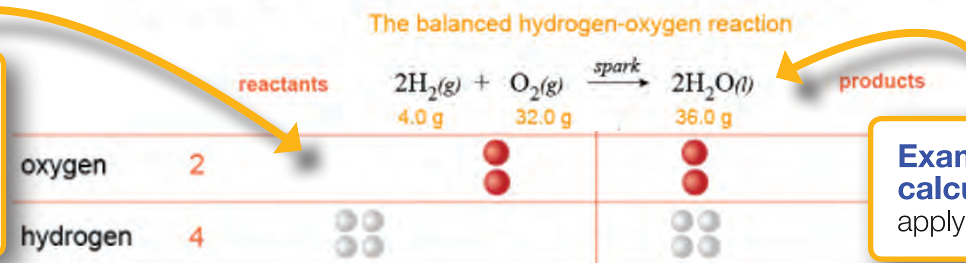
One problem with the equation $H_2 + O_2 \rightarrow H_2O$ is that if you mixed one mole of oxygen and one mole of hydrogen you would NOT get one mole of water molecules. You would actually get one mole of water molecules and 0.5 moles of leftover oxygen molecules. You get leftover oxygen molecules because there are more oxygen atoms in the reactants than there are in the products. The chart below summarizes the reaction by counting the type of each atom on the reactant and product side.

Unbalanced chemical equation

The chemical equation $H_2 + O_2 \rightarrow H_2O$ is an **unbalanced chemical equation**. unbalanced equation tells you what substances are involved in the reaction but it does *not* correctly account for how *much* of each are involved. In order to make it balance, we need to adjust the number of hydrogen molecules, oxygen molecules, and water molecules until there are the same type and number of each atom on both sides of the chemical equation.

The balanced equation

The **balanced chemical equation** adds a coefficient of 2 to the hydrogen molecule on the reactant side and the water molecule on the product side. The coefficient tells you that there are two moles of hydrogen molecules reacting with one mole of oxygen molecules to produce two moles of water molecules. The chart below shows that the number of atoms of each type are now the same on the reactant and product sides of the equation.



Balanced equations are correct

Chemical equations are balanced by adjusting the coefficients in front of each compound until the total number of each type of atom is the same on both sides of the equation. Only the properly balanced chemical equation tells us the correct relationship between the quantities of reactants and products.

Lessons follow the **5E Design**.

Textbook and e-Book

Engage
Essential questions referencing real-world scenarios stimulate students' curiosity and uncover prior knowledge.

Explore
Guided inquiry steps give students the opportunity to satisfy their curiosity.

Explain
Guided inquiry questions help students form explanations based on their observations.

Extend
Extension activities encourage students to apply what they have learned to discover new concepts.

Evaluate
Students test new predictions to evaluate their understanding.

4.3 - Heat of fusion

INQUIRY

Why does the temperature of an ice/water mix stay the same as the ice melts?

4. Measure about 50 grams of ice in a foam cup. Dry the ice with a paper towel before adding it to the cup. Record the exact mass in Table 1.

5. In a second cup, measure 70 - 75 grams of hot water. Record the exact mass in Table 1.

6. Start collecting data and measure the temperature of the hot water. Record the temperature in Table 1. Keep the temperature sensor in the hot water.

---

2. Use the thermal energy equation (below) to calculate the amount of joules that the hot water initially contributed to the system.

   Thermal energy (J) = [mass (g)] × [specific heat capacity of water (4.18 J/g·°C)] × [temperature (°C)]
   $E_{Th} = m \times Cp \times T$

3. What was the total amount of thermal energy in the system before the ice melts?

4. After the ice melts, the entire system is made of liquid water. What is the total mass of the water?

5. Use the thermal energy equation to determine the total thermal energy in the system based on the total mass of water.

---

4. How does your answer compare to the actual value for the heat of fusion of water, which is 334 J/g? What is your percent error for your experiment? The equation for percent error is:

   $$\text{Percent Error} = \left|\frac{\text{accepted value - experimental value}}{\text{accepted value}}\right| \times 100$$

5. If energy must be added to melt ice, what must occur when water freezes?

Purchasing Options

Below are a *few* representative package options for you to choose from. Ask your Education Specialist for more details.

SELECT a Textbook Package

Premium Package

- 75 Student Editions (print)
- 75 Digital Student Editions
- Digital Teacher Edition
- 10 Student Flash Drives
- Teacher Guide (print)
- SPARKvue datalogging software site license (for school and home use)

Class Set Package

- 25 Student Editions (print)
- 75 Digital Student Editions
- Digital Teacher Edition
- Teacher Guide (print)
- 10 Student Flash Drives
- SPARKvue datalogging software site license (for school and home use)

Digital Package

- 75 Digital Student Editions
- Digital Teacher Edition
- Teacher Guide (print)
- 10 Student Flash Drives
- SPARKvue datalogging software site license (for school and home use)

AND select a PASCO Equipment Kit:

Basic Equipment Kit

Includes 6 each of the following:

- Wireless Temperature Sensor
- Wireless pH Sensor
- Wireless Conductivity Sensor
- Molecular Model Kit
- Periodic Trends Card
- Spectrum Cards
- Periodic Table
- Electrode Support
- Storage Cases
- USB Charger
- Extra Coin Cell Batteries

30 labs are designed to use this equipment set.

Standard Equipment Kit

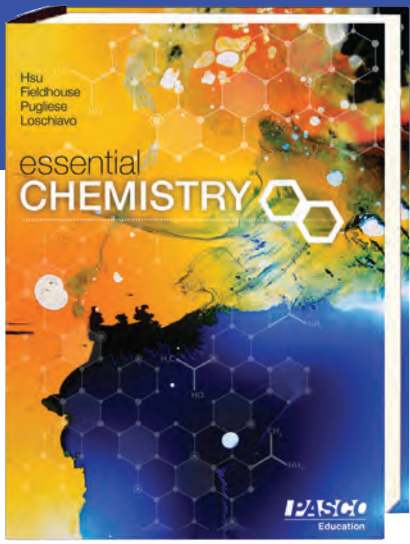
Includes 6 each of the following:

- Wireless Temperature Sensor
- Wireless pH Sensor
- Wireless Conductivity Sensor
- Wireless Pressure Sensor
- Wireless Voltage Sensor
- Wireless Colorimeter and Turbidity
- Molecular Model Kit
- Periodic Trends Card
- Spectrum Cards
- Periodic Table
- Electrode Support
- Storage Cases
- USB Charger
- Extra Coin Cell Batteries

42 labs are designed to use this equipment set.

Get a textbook, e-Book,
<u>and</u> equipment
for the price of
most textbooks!

Equipment



Textbook and e-Book

Basic Equipment Kit (includes 6 of each)

Not shown but included:

- Periodic Trends Card
- Spectrum Cards
- Periodic Table
- USB Charger
- Extra Coin Cell Batteries

Standard Equipment Kit (includes 6 of each)

Not shown but included:

- Periodic Trends Card
- Spectrum Cards
- Periodic Table
- USB Charger
- Extra Coin Cell Batteries

Assessment tools: PASCO students score well on data analysis.

Assessment

No curriculum is complete without a comprehensive suite of tools for assessing student learning. *Essential Chemistry* includes a variety of formative and summative assessment options, in both the textbook and e-Book.

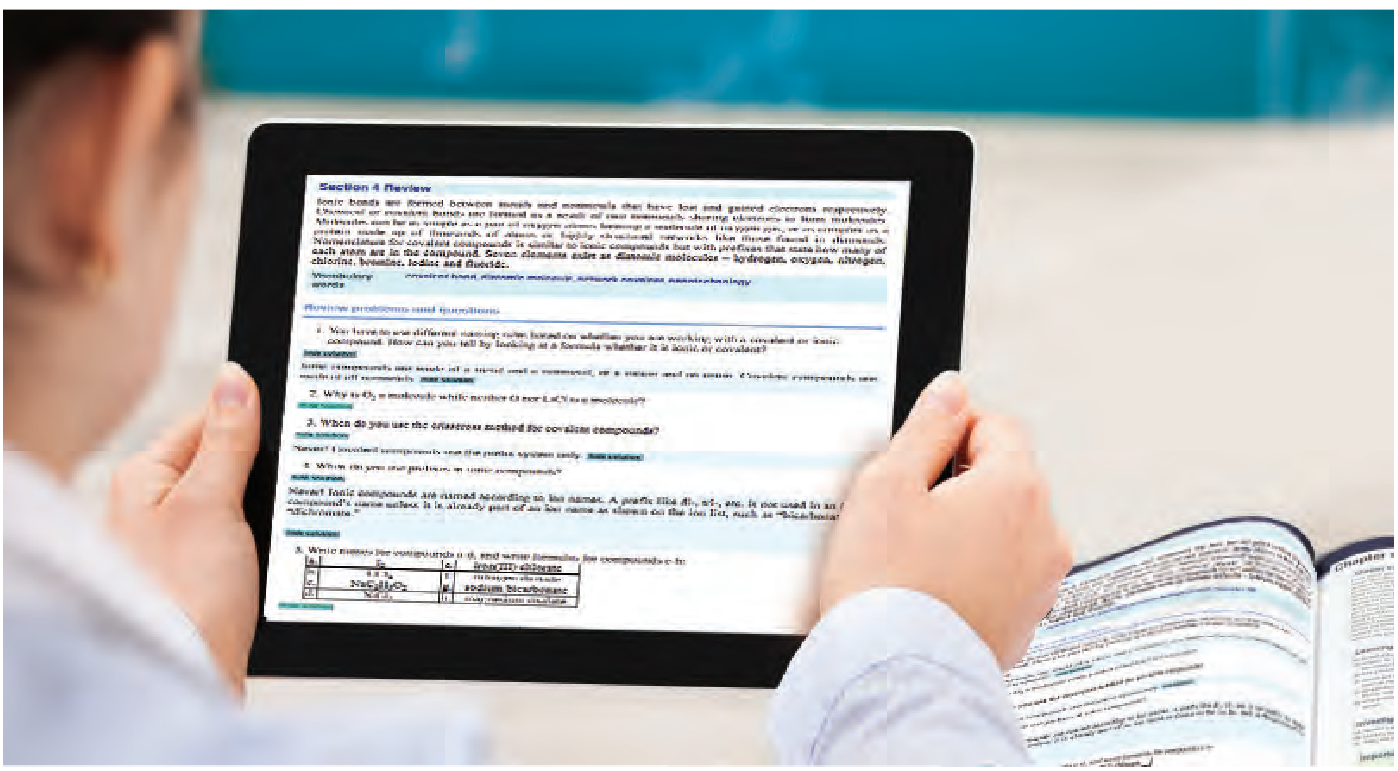
Textbook and e-Book

Chapter Reviews

Over 2000 questions and problems are included in the *Essential Chemistry* chapter reviews. Questions are divided by type, including vocabulary, conceptual, quantitative, and standardized test practice.

Section Reviews

There is a section review at the end of each section in a chapter. When using the e-Book, **students can have the questions and responses read aloud**, as well as answers checked.



Includes hints, repeated attempts, and solutions for *ALL* problems!

Assessment

e-Book only

Formative assessment by section

An infinite number of random 5-question, self-check quizzes and responses are available for every section of the book.

Section 3-1
Position and displacement
Name:
Score New Print Show solution

Self Quiz
Questions: 1 2 3 4 5
Attempts: 0 Score: 0%

1. Which compound would evaporate the fastest under the same atmospheric conditions?

Compound	Boiling point (°C)
Benzene	80.1
Ethanol	78.3
Gasoline	82.78
Water	100.0
Acetone	56.1

a) Gasoline
b) Ethanol
c) Acetone
d) Water
e) Benzene

Formative assessment by main idea

Point-of-use formative **self-check assessment questions allow students to assess their understanding** of each main idea as they are learning it.

Test your knowledge

1. Name the following compound: KNO_3.
a) Kadium nitrite
b) Potassium nitrogen oxygen
c) Potassium nitrate
d) Potassium nitrite
e) Potassium nitrogen oxide

Infinite Test Bank: summative assessment

Making customized tests for all or any part of *Essential Chemistry* is a breeze! Choose the section, the number of questions, and the level of difficulty, and you can create your own customized tests. In addition, you can **automatically generate unlimited versions** of the same test along with a full solution answer key as an aid for student learning.

Section 14-2
Natural frequency and resonance
Name:
Score New Print Show solution

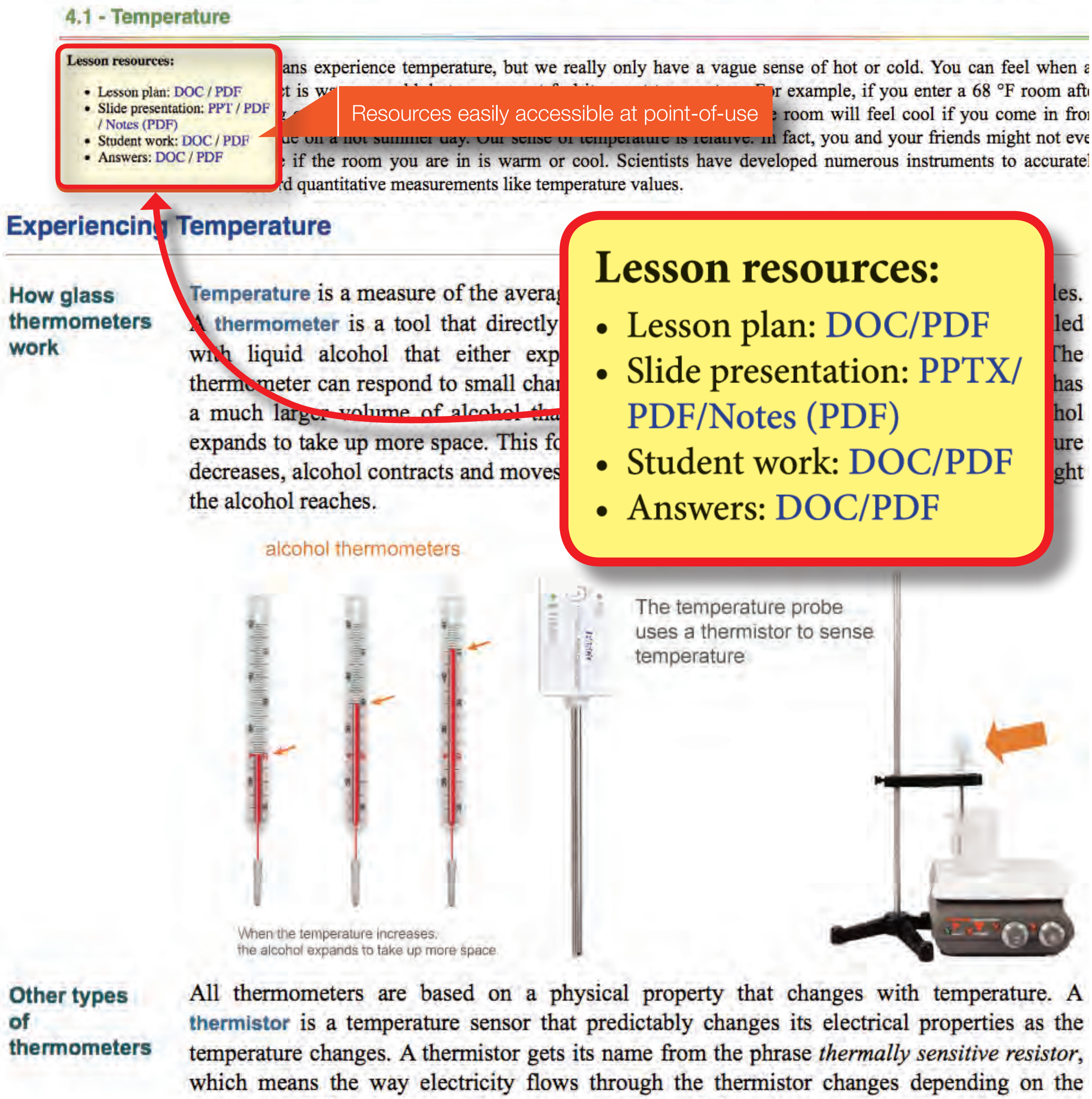
Self Quiz
Questions: 1 2 3 4 5
Attempts: 0 Score: 0%

1. What is the formula for sodium bromide?
a) $NaBr_2$
b) NaBr
c) Na_2Br_2
d) SoBr
e) Na_2Br
Hint: Use the crisscross method to determine the formula for the compound.

All Teacher Resources are easily accessible at point-of-use in the Digital Teacher Edition.

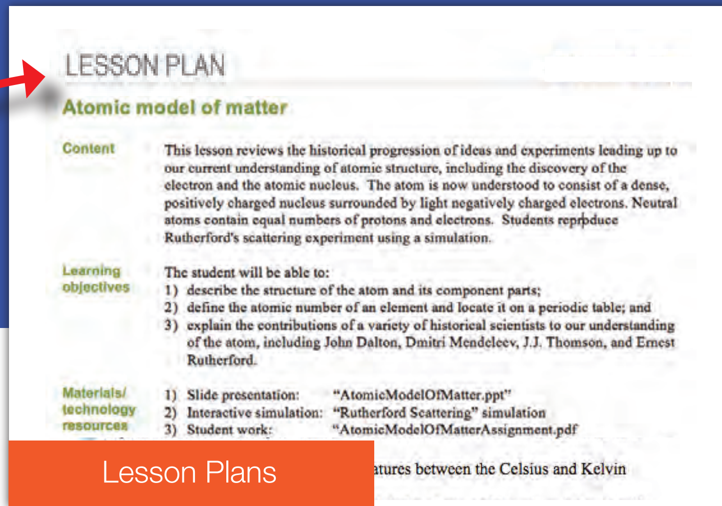
The Online Teacher Edition

All Teacher Resources are easily accessible at point-of-use in the Digital Teacher Edition. The Teacher Resources (below) are included.



Lesson resources:

Lesson plan: DOC/PDF
- Slide presentation: PPTX/ PDF/Notes (PDF)
- Student work: DOC/PDF
- Answers: DOC/PDF



LESSON PLAN

Atomic model of matter

Content	This lesson reviews the historical progression of ideas and experiments leading up to our current understanding of atomic structure, including the discovery of the electron and the atomic nucleus. The atom is now understood to consist of a dense, positively charged nucleus surrounded by light negatively charged electrons. Neutral atoms contain equal numbers of protons and electrons. Students reproduce Rutherford's scattering experiment using a simulation.
Learning objectives	The student will be able to: 1) describe the structure of the atom and its component parts; 2) define the atomic number of an element and locate it on a periodic table; and 3) explain the contributions of a variety of historical scientists to our understanding of the atom, including John Dalton, Dmitri Mendeleev, J.J. Thomson, and Ernest Rutherford.
Materials/ technology resources	1) Slide presentation: "AtomicModelOfMatter.ppt" 2) Interactive simulation: "Rutherford Scattering" simulation 3) Student work: "AtomicModelOfMatterAssignment.pdf"

...atures between the Celsius and Kelvin

Lesson Plans

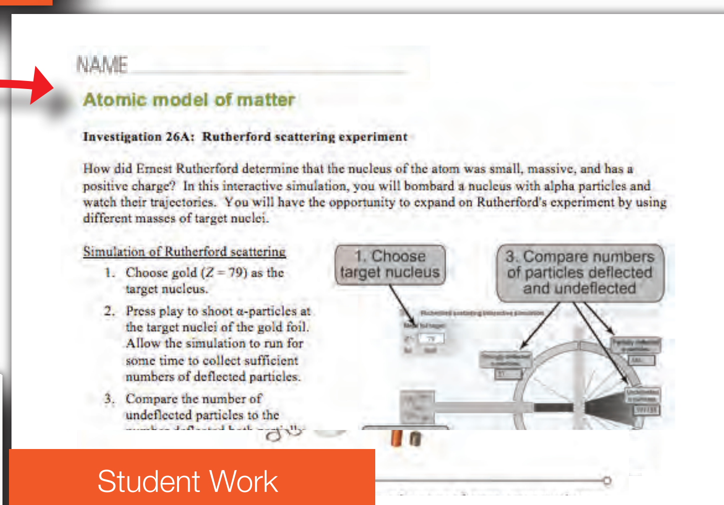
Slide Presentations

Lesson resources:
- Lesson plan: DOC/PDF

Slide presentation: PPTX/ PDF/Notes (PDF)
- Student work: DOC/PDF
- Answers: DOC/PDF

Lesson resources:
- Lesson plan: DOC/PDF
- Slide presentation: PPTX/ PDF/Notes (PDF)

Student work: DOC/PDF
- Answers: DOC/PDF



NAME

Atomic model of matter

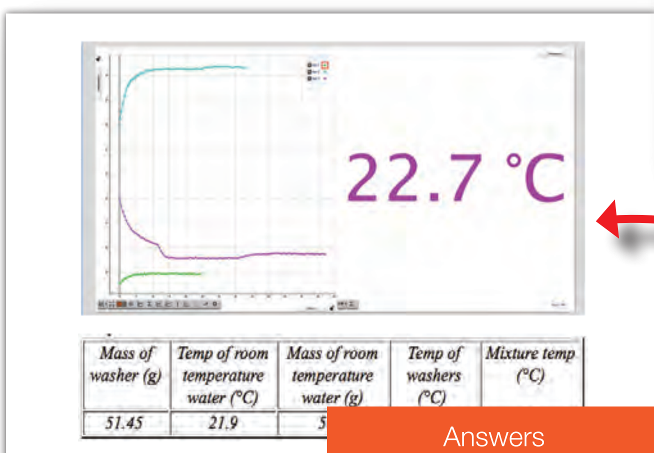
Investigation 26A: Rutherford scattering experiment

How did Ernest Rutherford determine that the nucleus of the atom was small, massive, and has a positive charge? In this interactive simulation, you will bombard a nucleus with alpha particles and watch their trajectories. You will have the opportunity to expand on Rutherford's experiment by using different masses of target nuclei.

Simulation of Rutherford scattering

1. Choose gold ($Z = 79$) as the target nucleus.
2. Press play to shoot α-particles at the target nuclei of the gold foil. Allow the simulation to run for some time to collect sufficient numbers of deflected particles.
3. Compare the number of undeflected particles to the ...

Student Work



Mass of washer (g)	Temp of room temperature water (°C)	Mass of room temperature water (g)	Temp of washers (°C)	Mixture temp (°C)
51.45	21.9	5		

Answers

Lesson resources:
- Lesson plan: DOC/PDF
- Slide presentation: PPTX/ PDF/Notes (PDF)
- Student work: DOC/PDF

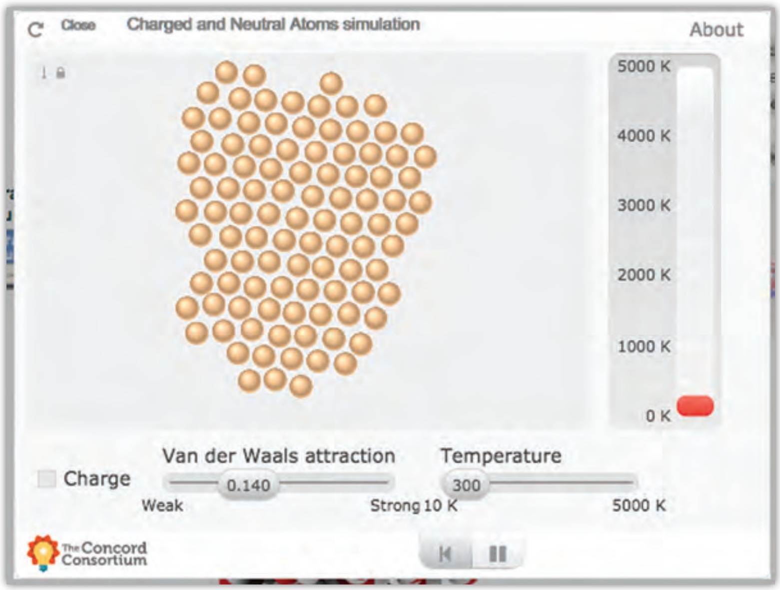
Answers: DOC/PDF

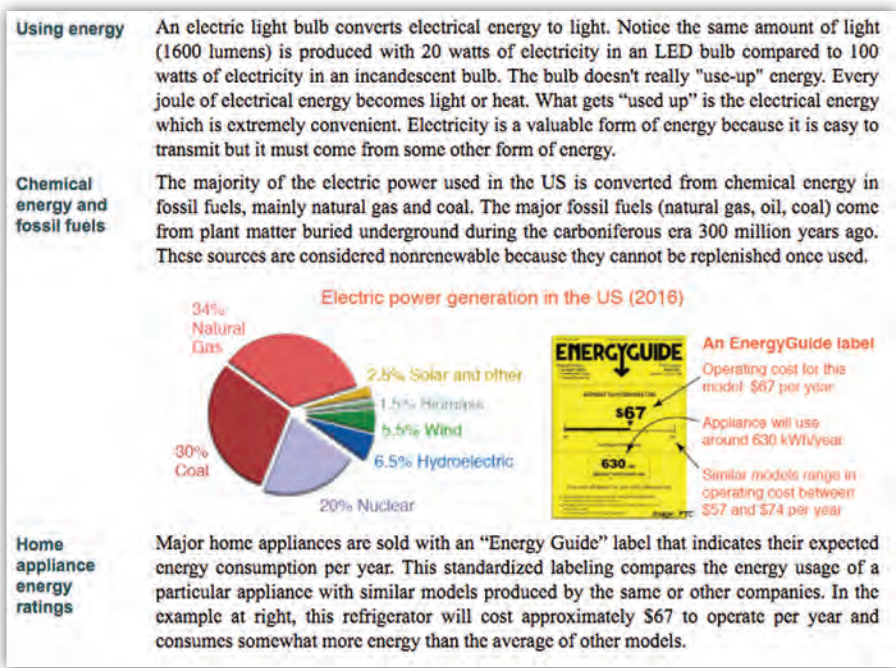
STEM Is Essential to Chemistry.

STEM Education

SCIENCE Interactives

Fully interactive simulations challenge students to explore chemistry ideas. Immediate feedback reinforces learning of core chemistry concepts.





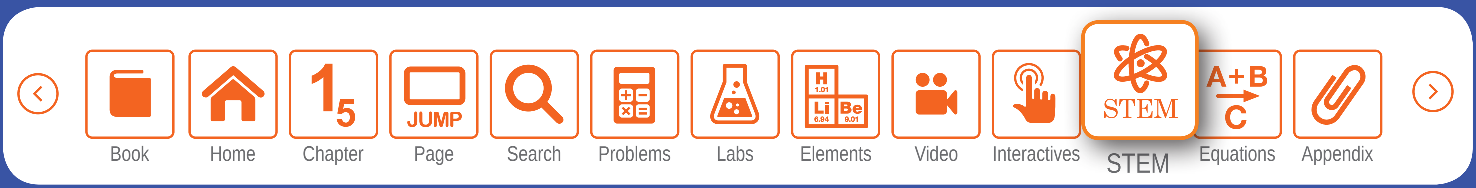
Using energy An electric light bulb converts electrical energy to light. Notice the same amount of light (1600 lumens) is produced with 20 watts of electricity in an LED bulb compared to 100 watts of electricity in an incandescent bulb. The bulb doesn't really "use-up" energy. Every joule of electrical energy becomes light or heat. What gets "used up" is the electrical energy which is extremely convenient. Electricity is a valuable form of energy because it is easy to transmit but it must come from some other form of energy.

Chemical energy and fossil fuels The majority of the electric power used in the US is converted from chemical energy in fossil fuels, mainly natural gas and coal. The major fossil fuels (natural gas, oil, coal) come from plant matter buried underground during the carboniferous era 300 million years ago. These sources are considered nonrenewable because they cannot be replenished once used.

Home appliance energy ratings Major home appliances are sold with an "Energy Guide" label that indicates their expected energy consumption per year. This standardized labeling compares the energy usage of a particular appliance with similar models produced by the same or other companies. In the example at right, this refrigerator will cost approximately $67 to operate per year and consumes somewhat more energy than the average of other models.

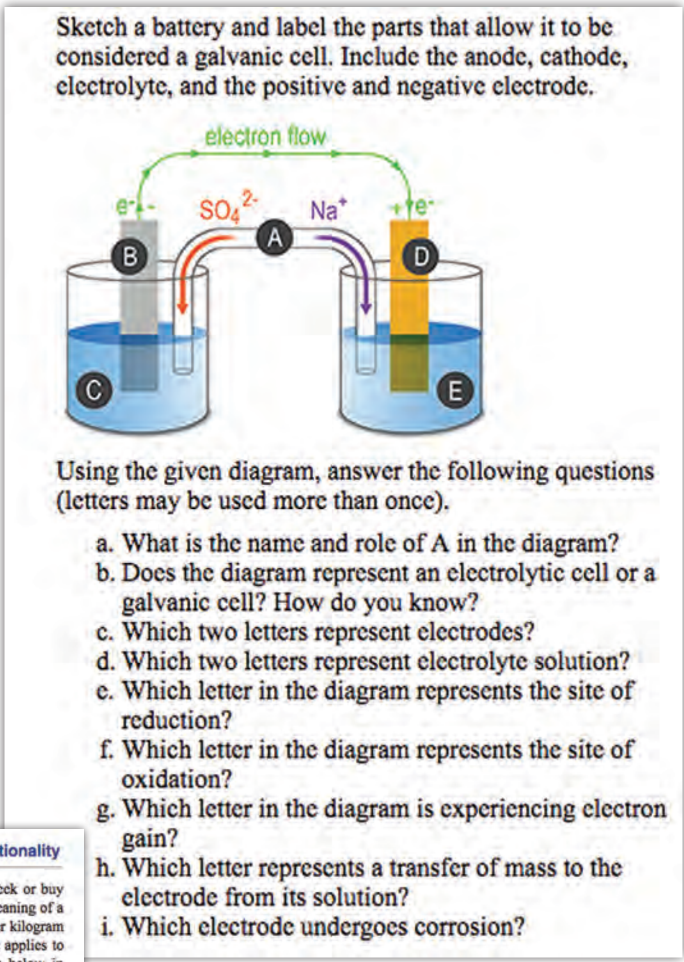
TECHNOLOGY Connections

Technology connections are integrated with the science concepts being taught.



ENGINEERING Design Projects

Engineering projects and applications give students exposure to the Engineering Design Process.

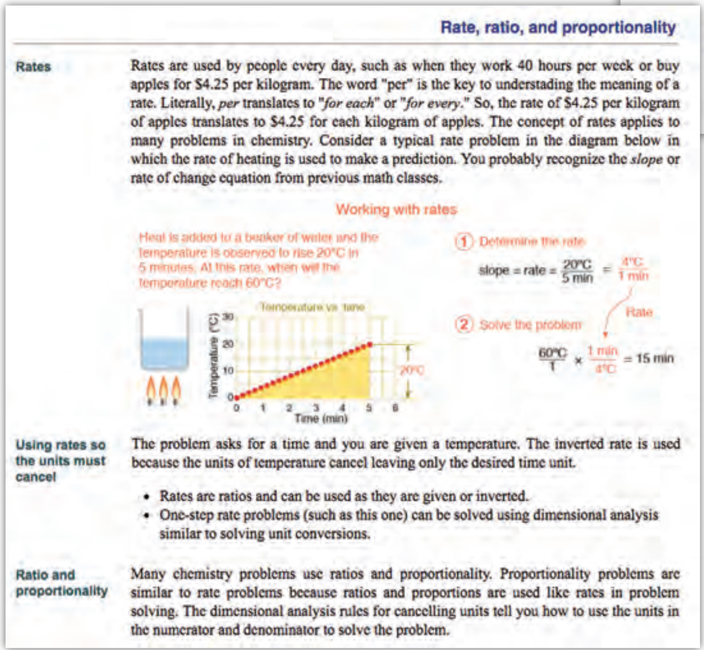

Sketch a battery and label the parts that allow it to be considered a galvanic cell. Include the anode, cathode, electrolyte, and the positive and negative electrode.

Using the given diagram, answer the following questions (letters may be used more than once).

a. What is the name and role of A in the diagram?
b. Does the diagram represent an electrolytic cell or a galvanic cell? How do you know?
c. Which two letters represent electrodes?
d. Which two letters represent electrolyte solution?
e. Which letter in the diagram represents the site of reduction?
f. Which letter in the diagram represents the site of oxidation?
g. Which letter in the diagram is experiencing electron gain?
h. Which letter represents a transfer of mass to the electrode from its solution?
i. Which electrode undergoes corrosion?

MATH Problems

Integrated math support is provided throughout the program.


Rate, ratio, and proportionality

Rates Rates are used by people every day, such as when they work 40 hours per week or buy apples for $4.25 per kilogram. The word "per" is the key to understading the meaning of a rate. Literally, *per* translates to "*for each*" or "*for every*." So, the rate of $4.25 per kilogram of apples translates to $4.25 for each kilogram of apples. The concept of rates applies to many problems in chemistry. Consider a typical rate problem in the diagram below in which the rate of heating is used to make a prediction. You probably recognize the *slope* or rate of change equation from previous math classes.

Using rates so the units must cancel The problem asks for a time and you are given a temperature. The inverted rate is used because the units of temperature cancel leaving only the desired time unit.

- Rates are ratios and can be used as they are given or inverted.
- One-step rate problems (such as this one) can be solved using dimensional analysis similar to solving unit conversions.

Ratio and proportionality Many chemistry problems use ratios and proportionality. Proportionality problems are similar to rate problems because ratios and proportions are used like rates in problem solving. The dimensional analysis rules for cancelling units tell you how to use the units in the numerator and denominator to solve the problem.

essential

CHEMISTRY

PASCO
Education

Essential Chemistry

To evaluate
Essential Chemistry
go to pasco.com/essentialchemistry and select e-Book.

Ask your PASCO Education Specialist for pricing on these packages.

Textbook Package	Equipment	Product Number
Premium	Basic	EC-3331
Premium	Standard	EC-3334
Class Set	Basic	EC-3330
Class Set	Standard	EC-3333
Digital	Basic	EC-3329
Digital	Standard	EC-3332

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