

# AP Chemistry Unit 9

Content Area: **Science**  
Course(s): **Chemistry AP**  
Time Period: **April**  
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Status: **Published**

## Title Section

## Department of Curriculum and Instruction



Belleville Public Schools

Curriculum Guide

AP Chemistry 11,12

UNIT 9 - APPLICATIONS OF  
THERMODYNAMICS

Belleville Board of Education

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Board Approved:

## **Unit Overview**

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Topics include:

Introduction to Entropy

Absolute Entropy and Entropy Change

Gibbs Free Energy and Thermodynamic Favorability

Thermodynamic and Kinetic Control

Free Energy and Equilibrium

Galvanic (Voltaic) and Electrolytic Cells

Cell Potential and Free Energy

Cell Potential Under Nonstandard Conditions

Electrolysis and Faraday's Law

## **Enduring Understanding**

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### Enduring Understandings:

1. In these lessons students learn what the science of chemistry means and how will we approach learning chemistry through a combination of didactic and practical exercises. A learning schedule and procedures are imperative to create a safe, structured, and enthusiastic learning environment. In this first unit students will receive necessary information from instructor regarding applicable classroom and lab policies of the school.
2. All our surroundings and every object solid, liquid, and gas is matter. Matter can be classified and identified by their properties whether extensive properties or intensive properties. Extensive properties are dependent upon how much matter is present while intensive are dependent on type of material. We can classify matter by their physical properties and can then explore physical changes where matter changes phase although the chemical composition remains the same.

## **Essential Questions**

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### Essential Questions:

1.
  1. Are heat and temperature synonyms?
  2. Are enthalpy, entropy, and free energy state functions?
  3. What is enthalpy of formation?
  4. What is bond energy?
  5. How is the spontaneity of a process measured?

## **Exit Skills**

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## Skills Checklist:

1. Predict and calculate the change of entropy.
2. Calculate free energy.
3. Compare and contrast free energy and spontaneity.
4. Compare and contrast free energy and equilibrium constant.
5. Assign the oxidation numbers.
6. Balance challenging redox reactions.
7. Identify elements that are oxidized and reduced.
8. Identify oxidizing and reducing agents.
9. Sketch a galvanic cell.
10. The role of the salt bridge.
11. Direction of the flow of electrons.
12. Use the Standard Reduction Potentials.
13. Calculate cell potential under nonstandard conditions.
14. Compare and contrast charge and amount of product in electrolysis

## **New Jersey Student Learning Standards (NJSL-S)**

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### [NextGen Science Standards](#)

SCI.HS-PS1	Matter and Its Interactions
SCI.HS.PS2.B	Types of Interactions
SCI.HS.PS1.A	Structure and Properties of Matter
	Developing and Using Models
SCI.HS-PS1-6	Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
SCI.HS-PS1-8	Develop models to illustrate the changes in the composition of the nucleus of the atom

	and the energy released during the processes of fission, fusion, and radioactive decay.
SCI.HS.PS1.C	Nuclear Processes
SCI.HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity.
SCI.HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems.
SCI.HS-ESS3-5	Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
SCI.HS.ESS2.D	Weather and Climate
SCI.HS.ESS3.D	Global Climate Change
SCI.HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
SCI.HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
SCI.HS.ETS1.B	Developing Possible Solutions

## Interdisciplinary Connections

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LA.RH.11-12	Reading History
MA.N-RN.A	Extend the properties of exponents to rational exponents.
MA.N-RN.B	Use properties of rational and irrational numbers.
MA.N-Q.A	Reason quantitatively and use units to solve problems.
LA.RST.11-12	Reading Science and Technical Subjects
LA.WHST.11-12	Writing History, Science and Technical Subjects

## Learning Objectives

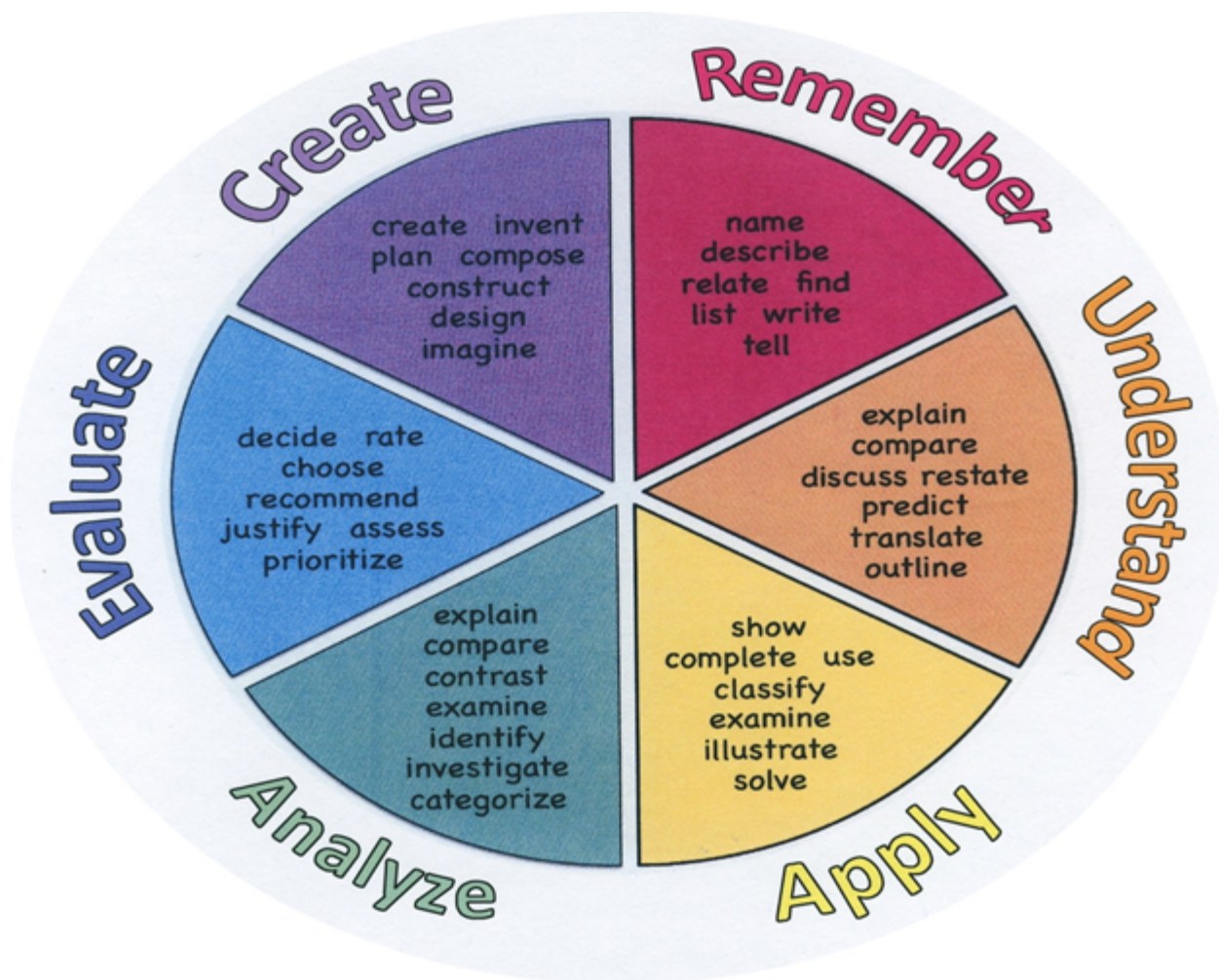
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1. Explain why heat is not the only driving force in a chemical/physical change
2. Predict and calculate the change of entropy
3. Use the free energy change to determine the tendency of a reaction to occur
4. Calculate the free energy under nonstandard conditions
5. Calculate the voltage of a Galvanic Cell.
6. Calculate the amount of gas produced in an electrolytic cell.
7. Why did climate change in the last two centuries?
8. What are the effects of climate change?
9. Propose LOCAL (BELLEVILLE, NJ) solutions to climate change.

**Action Verbs:** Below are examples of action verbs associated with each level of the Revised Bloom's Taxonomy.

Remember	Understand	Apply	Analyze	Evaluate	Create
Choose Describe	Classify Defend	Choose Dramatize	Categorize Classify	Appraise Judge	Combine Compose

Define	Demonstrate	Explain	Compare	Criticize	Construct
Label	Distinguish	Generalize	Differentiate	Defend	Design
List	Explain	Judge	Distinguish	Compare	Develop
Locate	Express	Organize	Identify	Assess	Formulate
Match	Extend	Paint	Infer	Conclude	Hypothesize
Memorize	Give Examples	Prepare	Point out	Contrast	Invent
Name	Illustrate	Produce	Select	Critique	Make
Omit	Indicate	Select	Subdivide	Determine	Originate
Recite	Interrelate	Show	Survey	Grade	Organize
Select	Interpret	Sketch	Arrange	Justify	Plan
State	Infer	Solve	Breakdown	Measure	Produce
Count	Match	Use	Combine	Rank	Role Play
Draw	Paraphrase	Add	Detect	Rate	Drive
Outline	Represent	Calculate	Diagram	Support	Devise
Point	Restate	Change	Discriminate	Test	Generate
Quote	Rewrite	Classify	Illustrate		Integrate
Recall	Select	Complete	Outline		Prescribe
Recognize	Show	Compute	Point out		Propose
Repeat	Summarize	Discover	Separate		Reconstruct
Reproduce	Tell	Divide			Revise
	Translate	Examine			Rewrite
	Associate	Graph			Transform
	Compute	Interpolate			
	Convert	Manipulate			
	Discuss	Modify			
	Estimate	Operate			
	Extrapolate	Subtract			
	Generalize				
	Predict				



## **Primary Resources & Materials**

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Chemistry - The Central Science: AP Edition; 12th Edition.

Pearson: Brown, Lemay, Bursten, Murphy, and Woodward 2012

Albert.io

AP Collegeboard

## **Suggested Activities & Best Practices**

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- What situations in ordinary life could help to master this unit?

Given a problem pertaining to thermodynamic favorability, have students think through how enthalpy and/or entropy is driving the thermodynamic favorability of the reaction. Have them pair up and explain their reasoning for whether or not the reaction is thermodynamically favorable and what is driving that favorability. After the pairs have discussed their responses, have them share with other pairs to get feedback on their rationale.

Construct a simple battery by submerging two electrodes (Mg and Cu) into orange juice and attaching it to the battery compartment of a quartz clock. Instruct students to ask as many questions as they can while the clock is running. Allow the clock to run for as long as possible and then examine the magnesium anode after a day to see if it corrodes away. As a class, examine the table of standard reduction potentials and discuss where the electrons are coming from and going to in order to power the clock

Have students mass a new penny with an analytical balance. They attach the penny to the negative electrode, which is attached to a 9-volt battery. A zinc strip is attached to the positive electrode. The penny is submerged for 10 minutes in a 1.0 M NaOH solution with zinc dust and the zinc electrode. Students dry the penny and mass it again. Using Faraday's laws, have them calculate the current that must have been delivered to plate the zinc onto the penny. Then have student pairs share and peer review each other's reasoning.

- Atmospheric concentration of Carbon Dioxide (ppm) and consequences on climate change.

### **Assessment Evidence - Checking for Understanding (CFU)**

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Student must be able to graph Free Energy and Temperature. (Formative)

Students must be able to read a Standard reduction potential chart. (Formative)

Students must be able to convert different types of units for free energy, enthalpy, and entropy. (Formative)

Unit Test/Quiz (Summative)

Benchmark #3 (Benchmark)

## "Do Now/Exit Ticket" Activity (Formative)

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- Admit Tickets
- Anticipation Guide
- Common Benchmarks
- Compare & Contrast
- Create a Multimedia Poster
- DBQ's
- Define
- Describe
- Evaluate
- Evaluation rubrics
- Explaining
- Fist- to-Five or Thumb-Ometer
- Illustration
- Journals
- KWL Chart
- Learning Center Activities
- Multimedia Reports
- Newspaper Headline
- Outline
- Question Stems
- Quickwrite
- Quizzes
- Red Light, Green Light
- Self- assessments
- Socratic Seminar
- Study Guide
- Surveys
- Teacher Observation Checklist
- Think, Pair, Share
- Think, Write, Pair, Share
- Top 10 List
- Unit review/Test prep
- Unit tests
- Web-Based Assessments

- Written Reports

## **Ancillary Resources**

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1. Teacher and Publisher supplied powerpoints, notes, laboratory guides, and worksheets
2. Textbooks
3. Resource Manuals
4. Internet Resources
5. Computer and smartboard Activities

## **Technology Infusion**

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Use a Voltmeter to measure Cell Potential.

Use a barometer to measure external pressure.

Use a ammeter to measure electric current.

Albert.io

AP Collegeboard

What **Technology Infusion** and/or strategies are integrated into this unit to enhance learning? Please list all hardware, software and strategies. Please find a technology pedagogy wheel for assistance while completing this section.

# Win 8.1 Apps/Tools Pedagogy Wheel

Podcasts  
 Photostory 3  
 Kid Story Builder  
 Music Maker Jam  
 Paint A Story  
 Office 365  
 MS PowerPoint  
 Stack 'Em Up  
 NqSquared Numbers  
 Physamajig  
 Xylophone 8

Wikipedia  
 Skydrive  
 Lync  
 SkyMap  
 Skype  
 Office 365  
 Puzzle Touch  
 Easy QR  
 Memorylage  
 Life Moments  
 Word Cloud Maker

Where's Waldo?  
 MS Excel  
 Flipboard  
 Office 365  
 Nova Mindmapping

Ted Talks  
 Record Voice Pen



Originally taken from <http://www.coetail.com/vzimmer/files/2013/02/iPadagogy-Wheel.001.jpg>  
 And adapted for Windows 8.1 devices by Charlotte Beckhurst @CharBeckhurst

## Alignment to 21st Century Skills & Technology

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Mastery and infusion of **21st Century Skills & Technology** and their Alignment to the core content areas is essential to student learning. The core content areas include:

- English Language Arts;
- Mathematics;
- Science and Scientific Inquiry (Next Generation);
- Social Studies, including American History, World History, Geography, Government and Civics, and Economics;
- World languages;
- Technology;
- Visual and Performing Arts.

CS.9-12.8.1.12.AP.3	Select and combine control structures for a specific application based upon performance and readability, and identify trade-offs to justify the choice.
CS.9-12.8.1.12.AP.7	Collaboratively design and develop programs and artifacts for broad audiences by incorporating feedback from users.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ETW.3	Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution.
WRK.9.2.12.CAP.2	Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
WRK.9.2.12.CAP.3	Investigate how continuing education contributes to one's career and personal growth.
WRK.9.2.12.CAP.10	Identify strategies for reducing overall costs of postsecondary education (e.g., tuition assistance, loans, grants, scholarships, and student loans).
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.DC.2	Compare and contrast international differences in copyright laws and ethics.

## 21st Century Skills/Interdisciplinary Themes

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Upon completion of this section, please remove all remaining descriptions, notes, outlines, examples and/or illustrations that are not needed or used.

Please list only the **21st Century/Interdisciplinary Themes** that will be incorporated into this unit.

- Communication and Collaboration
- Creativity and Innovation
- Critical thinking and Problem Solving
- ICT (Information, Communications and Technology) Literacy
- Information Literacy
- Life and Career Skills
- Media Literacy

## **21st Century Skills**

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Upon completion of this section, please remove all remaining descriptions, notes, outlines, examples and/or illustrations that are not needed or used.

Please list only the **21st Century Skills** that will be incorporated into this unit.

- Civic Literacy
- Environmental Literacy
- Financial, Economic, Business and Entrepreneurial Literacy
- Global Awareness
- Health Literacy

## **Differentiation**

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### **Differentiations:**

- Small group assignments (to prepare a unit 1 review of key concepts )
- Extra time to complete assignments (completed at home)
- Pairing oral instruction with visuals (College Board videos of Unit 1 Review)
- Repeat directions (Rephrase the problem on mixtures giving real-life examples)
- Use manipulatives (building atoms)
- Multisensory approaches (youtube videos on Unit 1)
- Preview content & concepts (percent composition of students in AP chem class)
- Student(s) work with an assigned partner (Complete a lab on flame test)
- Visual presentation (flame test lab video)

### **Hi-Prep Differentiations:**

- Alternative formative and summative assessments (debating atomic trends exceptions)
- Leveled rubrics (writing rubric with siblings that took a science class in college)

- Project-based learning (propose a new project for low prep students)
- Problem-based learning (design solution for climate change)

#### **Lo-Prep Differentiations**

- Choice of books or activities (choose an article on Newsela on global warming)
- Cubing activities (apply the cubic method to atomic trends)
- Reading buddies (pair Lo-prep and Hi-prep students)
- Varied supplemental materials (Youtube videos on electron configuration)

### **Special Education Learning (IEP's & 504's)**

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Please identify the **Special Education Learning** adaptations that will be employed in the unit, using the ones identified below.

Find Standard Potential of a Cu/Zn galvanic Cell.

- behavior management plan (Cubing activities (apply the cubic method to the periodic table)
- computer or electronic device utilizes (Varied supplemental materials (Youtube videos on climate change)
- modified assignment format (Reading buddies (pair Lo-prep and Hi-prep students)
- student working with an assigned partner (Students must be able to build atomic models)
- Use open book, study guides, test prototypes (choose an article on Newsela on global warming)

### **English Language Learning (ELL)**

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Please identify the **English Language Learning** adaptations that will be employed in the unit, using the ones identified below.

Students are provided with a glossary in their native language of climate change.

Spanish-speaking students may utilize the Spanish Edition of a Textbook to solve Unit 9 problems.

Find Standard Potential of a Cu/Fe galvanic Cell.

- using videos, illustrations, pictures, and drawings to explain or clarify (Students are provided with videos in their native language on climate change.)
- allowing the use of note cards or open-book during testing (Students are provided with glossary in their native language)
- providing study guides (Students are provided with a glossary in their native language on climate change)

## **At Risk**

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Please identify Intervention Strategies that will be employed in the unit, using the ones identified below.

Find Standard Potential of a Li/Ag galvanic Cell.

- teaching key aspects of a topic. Eliminate nonessential information ((electron configuration exceptions are omitted))
- allowing the use of note cards or open-book during testing
- decreasing the amount of work presented or required (electron configuration exceptions are omitted)
- having peers take notes or providing a copy of the teacher's notes (videos from College Board provided)
- tutoring by peers (climate change discussed by peers)
- using videos, illustrations, pictures, and drawings to explain or clarify (Students provided access to virtual labs)

## **Talented and Gifted Learning (T&G)**

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Please identify the **Talented and Gifted** adaptations that will be employed in the unit, using the ones identified below.

Find Standard Potential of a combustion galvanic Cell.

- Advanced problem-solving ( Students must be able to analyze Schrodinger Equation)
- Allow students to work at a faster pace (Princeton Review problems are solved)
- Cluster grouping (to propose original solutions of climate change)
- Complete activities aligned with above grade level text using Benchmark results ( Students must be able to analyze Schrodinger Equation)
- Higher order, critical & creative thinking skills, and discovery (exceptions of electron configuration are underlined and discussed)
- Using atomic models to identify the shape, the bond angle and the hybridization of molecules.

## Sample Lesson

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Unit Name: Application of Thermodynamics.

NJSLS: SCI.HS-PS1 &2 &3 & 4; SCI.HS.ESS3.D

Interdisciplinary Connection: Vocabulary and algebra contents

Statement of Objective: Students will demonstrate the ability to propose how to assemble a galvanic cell with 90% accuracy.

Anticipatory Set/Do Now: What do you know about electricity?

Learning Activity: Lecture - compare and contrast Galvanic Cells and electrolysis cells..

Small groups activities: to assemble a galvanic cell .

Final review: units in electrochemistry

Student Assessment/CFU's: Survey, written report, Exit ticket

Materials: Chromebook, lab equipments and chemicals.

21st Century Themes and Skills: Critical thinking and Problem Solving

Differentiation/Modifications:

Students must be able to to assemble a galvanic cell and an electrolytic cell. (Gifted and Talented)

Students must be able to to assemble an electrolytic cell I. (Special Ed)

Integration of Technology: Chromebook PowerPoint Presentation