Chemistry, Quarter 4, Unit 4.1

Earth Processes

Overview

Number of instructional days: 5 (1 day = 55 minutes)

Content to be learned

- Explain how internal and external sources of heat (energy) fuel the rock cycle.
- Explain how chemical processes have altered earth's crust.

Processes to be used

- Examine physical models (e.g., rock and mineral samples).
- Make and interpret diagrams (e.g., diagramming the rock cycle and the element cycle).

Essential questions

- How does the chemical structure of a mineral undergo transformation during the rock cycle?
- What processes create the heat that serves as fuel for the rock cycle?

Written Curriculum

Grade Span Expectations

ESS1 - The earth and earth materials as we know them today have developed over long periods of time, through continual change processes.

ESS1 (9-11) SAE+ POC–3

Explain how internal and external sources of heat (energy) fuel geologic processes (e.g., rock cycle, plate tectonics, sea floor spreading).

ESS1 (9-11)–3 Students demonstrate an understanding of processes and change over time within earth systems by …

3d explaining how the ~~physical and~~ chemical processes of the Earth alter the crust (e.g. seafloor spreading, hydrologic cycle, weathering, element cycling).

Clarifying the Standards

Prior Learning

In grades K–4, students learned how wind, water, and ice have shaped the land. Students identified sudden and gradual changes that affect the earth.

In grades 5 and 6, students represented the processes of the rock cycle in words, diagrams, and models.

In grades 7 and 8, students evaluated fast processes and slow processes to determine how the earth changes and will continue to change over time.

Current Learning

During this unit of study, students will learn to explain how internal and external sources of heat (energy) drive the rock cycle. Students demonstrate an understanding of processes and change over time within earth systems by explaining element cycling. They learn how heat and pressure change the crystal structure of minerals and how the process of subduction, erosion, etc., result in rock being returned to the crust and re-emerging due to weathering processes.

In order to gain the most from this unit of study, students need to know the dynamic nature of the mantle and the earth's cross-sectional structure. They also need to understand ionic bonding and how the ions determine the structure of the crystal. They will need to understand heat transfer and understand that different rocks have different melting points and viscosities.

Students compare crystal structure and relate it to chemical formulas. They may research their birthstones and analyze hardness, luster, refractive index, color, clarity, and origin of minerals.

This unit will require students to examine how chemical formulas can be used to determine crystal structure and rock composition.

Future Learning

Students will use this unit's information in the context of chemical reaction types that will be addressed in the next unit. Students electing to take ocean science or environmental science will further investigate the physical and chemical processes of chemical composition.

Additional Research Findings

This content must be modeled for students because these processes are not readily seen. "Perhaps the most important reason for students to study the Earth repeatedly is they take years to acquire the knowledge that they need to complete the picture. The full picture requires the introduction of such concepts as temperature, the water cycle, gravitation, states of matter, chemical concentration, and energy transfer" **(***Benchmarks of Science Literacy* p. 66).

Studies indicate that students do not associate minerals with rocks. They are more likely to think of mineral water, minerals, and vitamins or mineral resources (*Making Sense of Secondary Science* p. 112).

"By the end of the 12th grade students should know that the formation, weathering, sedimentation, and reformation of rock constitute a continuing, "rock cycle" in which the total amount of material stays the same as its forms change."(*Benchmark of Science Literacy* p.74).

Chemistry, Quarter 4, Unit 4.2

Chemical Equations

Overview

Number of instructional days: 10 (1 day = 53 minutes)

Content to be learned

- Write simple balanced chemical equations to represent chemical reactions.
- Demonstrate the conservation of matter through balanced chemical equations.
- *Students will be given specific reactants (e.g., $Ba + Cl_2$) and write the balanced equation and predict the products.

**This extension covers content that may be more appropriate for advanced chemistry students.*

Processes to be used

- Use and write word equations for chemical reactions.
- Translate word equations for chemical reactions into formulas.
- Use and write common symbols for chemical equations.
- Identify the driving forces in chemical reactions.

Essential questions

- How are atoms rearranged in a chemical reaction?
- How could you differentiate between the five basic chemical reaction types?
- What forces drive chemical change?
- What steps are involved in writing a balanced chemical equation?

Written Curriculum

Grade Span Expectations

PS 2 - Energy is necessary for change to occur in matter. Energy can be stored, transferred, and transformed, but cannot be destroyed.

PS2 (9-11) INQ+SAE -6

Using information provided about chemical changes, draw conclusions about and explain the energy flow in a given chemical reaction (e.g., exothermic reactions, endothermic reactions).

PS2 (9-11) –6
Students demonstrate an understanding of physical, chemical, and nuclear changes by …

6a writing simple balanced chemical equations to represent chemical reactions and illustrate the conservation of matter.

PS1 - All living and nonliving things are composed of matter having characteristic properties that distinguish one substance from another (independent of size or amount of substance)

PS1 (9-11) MAS+ FAF – 4

Model and explain the structure of an atom or explain how an atom's electron configuration, particularly the outermost electron(s), determines how that atom can interact with other atoms.

PS1 (Ext)– 4
Students demonstrate an understanding of the structure of matter by …

4bb given specific reactants (e.g., $Ba + Cl_2$) write the balanced equation and determine the products, type of compound formed (ionic or molecular), and the properties of the compound (e.g., solubilities, electrolytic, etc.).

Clarifying the Standards

Prior Learning

In grades K–4, students described that heat can be produced in many ways, such as burning.

In grades 5–6, they identified examples of heat energy transfer and distinguished between mixtures and pure substances (i.e., pure compounds and elements).

In grades 7–8, students interpreted formulas of simple chemical equations and used symbols of chemical formulas to show simple chemical rearrangements that produced new substances. Students also explained that when substances undergo chemical change to form new substances, the properties of the new combinations may be different from those of the old.

Current Learning

During this unit of study, students learn to balance representative chemical equations from the basic reaction types (synthesis, decomposition, combustion, single and double replacement). Students will also learn the symbols for phase notation (solid, liquid, gas, aqueous) and for various catalysts and illustrate

the law of conservation of matter. Previously, students have written and balanced simple chemical equations. This expands their experience with different types of chemical reactions.

Chemical equations will be more complicated than those used in previous courses and students will now be required to identify reaction types.

Students need to know how to balance chemical ionic charges to create correct chemical formulas and the correct chemical symbols of elements in order to correctly write chemical formulas.

They need to practice balancing chemical equations and practice writing formula equations from word equations. Students learn to classify reactions as one of the five basic types. They engage in a laboratory activity that illustrates all reaction types and identify the driving forces involved, such as gas production, precipitation formation, etc.

Future Learning

Advanced students will use these skills to solve stoichiometric problems. In addition, students will identify the type of compounds formed in chemical reactions (ionic or molecular), and the properties of the compound (e.g., solubilities, electrolytic, etc.). In biology, students will use chemical equations in studying photosynthesis and respiration.

Additional Research Findings

It will be important to make sure that students know that no matter how substances within a closed system interact; the total mass of the system stays the same. Make sure they understand that an atom's electron configuration determines how the atom can interact with other atoms and that different energy levels are associated with different configurations of atoms and molecules. Some changes of configuration require a net input of energy, whereas others cause a net release (*Atlas of Science Literacy*, pp. 55, 57, 61).

Students find it difficult to understand chemical combination of elements until they interpret this combination at the molecular level (*Making Sense of Secondary Science*, p. 86).

A large proportion of average students predicted a loss of mass on the combustion of steel wool. Their reasons included that iron is lost through burning, that air or moisture is lost from the steel wool, and that powder weighs less (*Making Sense of Secondary Science*, p. 88).

"No matter how substances with in a closed system interact with one another or how they combine or break a part, the total weight of the system remains the same. The idea of atoms explains the conservation of matter: if the number of atoms stays the same no matter how they are rearranged, then their total mass stays the same." (*Benchmarks of Science Literacy*, p.79)

Chemistry, Quarter 4, Unit 4.3

Energy of Chemical Reactions

Overview

Number of instructional days: 10 (1 day = 53 minutes)

Content to be learned

- Provide information about a chemical reaction, identify whether the chemical reaction is endothermic or exothermic.
- *Use quantitative heat flow or calorimetric investigations to determine the energy released or consumed in the process of chemical reactions.

Processes to be used

- Analyze data from tables and charts.
- Analyze formulas and equations to determine if energy is consumed or released.

Essential questions

- How can the information in a table of energy values for reactants and products be used to determine if a chemical reaction is endothermic or exothermic?
- How can the information in an energy diagram be used to determine if a chemical reaction is endothermic or exothermic?
- *How can the enthalpy of reactions be used to determine the energy released or consumed in a chemical reaction or chemical process?

**Covers content that may be more appropriate for advanced chemistry students.*

Written Curriculum

Grade Span Expectations

PS 2 - Energy is necessary for change to occur in matter. Energy can be stored, transferred, and transformed, but cannot be destroyed.

PS2 (9-11) INQ+SAE -6

Using information provided about chemical changes, draw conclusions about and explain the energy flow in a given chemical reaction (e.g., exothermic reactions, endothermic reactions).

PS2 (9-11) –6 Students demonstrate an understanding of physical, chemical, and nuclear changes by …

6b identifying whether a given chemical reaction or a biological process will release or consume energy (endothermic and exothermic) based on the information provided (e.g. given a table of energy values for reactants and products or an energy diagram).

PS2 (Ext)– 6 Students demonstrate an understanding of physical, chemical, and nuclear changes by…

6bb using quantitative heat flow or calorimetric investigations to determine the energy released or consumed in the process.

Clarifying the Standards

Prior Learning

In grades K–4, students identified the sun as a source of heat energy. They described that heat can be produced in many ways, such as electricity, friction, and burning. They understood that some materials are good conductors and some are good insulators.

In grades 5–6, students differentiated among the properties of the various forms of energy. They identified real world applications where heat energy is transferred and showed the direction that the heat energy flowed.

In grades 7–8, students modeled the motion of molecules for a material in a warmer and cooler state. Students explained that while energy may be stored, transferred, or transformed, the total amount of energy is conserved.

Current Learning

During this unit of study, students identify whether a chemical reaction will release energy (exothermic) or absorb energy (endothermic). Advanced students also learn the quantitative aspects of heat of formation.

Students are already aware that energy changes occur in chemical and physical reactions. This unit extends this to include graphic representations and measurement. They are asked to quantify energy changes in chemical reactions.

They demonstrate an understanding of the energy flow in a chemical reaction. Students need to be able to read and interpret a data table of energy values. Students are able to recognize and identify exothermic and endothermic energy graphs with corresponding activation energy.

They are engaged in laboratory activities requiring them to monitor temperature changes in chemical reactions. A representative investigation would be sodium bicarbonate and citric acid (endothermic) and low molar (0.1M) hydrochloric acid and low molar (0.1M) sodium hydroxide (exothermic).

Suggested link:

http://www.chemteam.info/Thermochem/Thermochem.html

Future Learning

In future courses such as biology, students will apply energy concepts when studying photosynthesis, respiration, and energy diagrams. In advanced chemistry courses, students will deepen their understandings in calculating heats of reaction, enthalpy, entropy, and Gibbs free energy.

Additional Research Findings

Students often fail to distinguish between heat and temperature when describing a chemical change (*Making Sense of Secondary Science*, p. 90).

To help students make sense of their experiences, it has been suggested that teachers develop five conceptual areas: the meaning of energy, energy transformation, and the storage of energy in chemicals, the degradation of energy, and the conservation of energy during transformation (*Making Sense of Secondary Science*, p. 90).

It is suggested that in order to promote learning about energy, students should explain the physical conservation of energy in their own words and time should be devoted to qualitative questions (*Making Sense of Secondary Science,* p. 147).

It is difficult for students to understand that energy changes can occur only in fixed amounts. This concept is even more difficult to demonstrate (*Benchmarks for Science Literacy*, p. 85).

Students need to understand that if no energy leaks in or out across boundaries of a system, the total energy will not change, but energy does tend to leak across boundaries. This happens especially in the form of heat, which leaks away by radiation or conduction and cannot be completely prevented **(***Science for All Americans*, p. 50).

"By the end of the 12th grade, students should know that whenever the amount of energy in one place or form diminishes, the amount in other places or forms increases by the same amount." (*Benchmarks for Science Literacy* p.86)

Chemistry, Quarter 4, Unit 4.4

Stoichiometry

Overview

Number of instructional days: 10 (1 day = 53 minutes)

Content to be learned

- Prepare and complete the performance portion of the comprehensive course assessment.
- If time permits, students will qualitatively and/or quantitatively predict reactants and products in a prescribed investigation.
- If time permits, students will identify measure, calculate, and analyze qualitative and quantitative relationships associated with energy transfer and energy transformation.

Processes to be used

- Use chemical equations.
- Calculate mole and mass quantities.
- Calculate theoretical yields
- Compute percent error

Essential questions

- How could you use the information you have obtained about your chemical reaction to explain the energy flow and classify the reaction as endothermic or exothermic?
- How do you predict how much product will be produced in a chemical reaction?
- What are the steps in solving a mass/mass stoichiometry problem?

Written Curriculum

Grade Span Expectations

PS 2 - Energy is necessary for change to occur in matter. Energy can be stored, transferred, and transformed, but cannot be destroyed.

PS2 (9-11) INQ+SAE -6

Using information provided about chemical changes, draw conclusions about and explain the energy flow in a given chemical reaction (e.g., exothermic reactions, endothermic reactions).

PS2 (Ext)– 6 Students demonstrate an understanding of physical, chemical, and nuclear changes by…

6bbb qualitatively and/or quantitatively predicting reactants and products in a prescribed investigation. (e.g. Acid-base. Redox).

PS2 (9-11) POC+SAE -5

Demonstrate how transformations of energy produce some energy in the form of heat and therefore the efficiency of the system is reduced (chemical, biological, and physical systems).

PS2 (Ext)– 5 Students demonstrate an understanding of energy by…

5aa Identifying, measuring, calculating and analyzing qualitative and quantitative relationships associated with energy transfer and energy transformation.

Clarifying the Standards

Prior Learning

In grades K–4, students learned positive fractional numbers and rational numbers. They developed a conceptual understanding of mathematical operations involving addition, subtraction, multiplication, and division.

In grades 5 and 6, students demonstrated conceptual understanding of algebraic expressions by using letters to represent unknown quantities.

In grades 7 and 8, students learned how change in the value of one variable relates to the change in a second variable. They also learned to evaluate and simplify algebraic expressions.

Current Learning

All students complete the performance portion of the comprehensive course assessment and prepare for the objective portion of the CCA.

Advanced students or students who have completed the performance portion of the CCA learn to compute mole-to-mole quantities from a balanced chemical equation. They also learn to compute mass-to-mass quantities from a balanced equation and gas volumes. Students need to be able to convert units using dimensional analysis. They need to be able to write and balance chemical equations as well as predict reactants or products. They practice problems at all levels described above. They engage in a quantitative

laboratory activity that involves predicting the quantity of a product and compare it to the actual product obtained (percent yield/percent error). As an extension, students can calculate energy changes that occur in the reaction process using tables of enthalpy of formation.

This unit adds the quantitative extension to the chemical equation unit taught previously. This unit combines all skills learned in the gas laws unit, chemical equations unit, and chemical formulas unit.

A suggested link for practice is: http://www.chemteam.info/Stoichiometry/Stoichiometry.html

Future Learning

In advanced chemistry classes, this foundation will be used to predict product amounts in acid/base reactions and oxidation/reduction reactions.

Additional Research Findings

Symbolic statements can be manipulated by rules of mathematical logic to produce other statements of the same relationship, which may show some interesting aspect more clearly (*Atlas of Science Literacy*, p. 27).

A common misconception held by students is that there is one best mathematical model for any science and technology problem. Opportunities should be provided in which more than one mathematical description seems equally appropriate (*Benchmarks for Science Literacy*, p. 38).

According to the *Benchmarks for Science Literacy*, "By the end of 12th grade, any mathematical model, graphic or algebraic, is limited in how well it can represent how the world works. The usefulness of a mathematical model for predicting may be limited by uncertainties in measurements, by neglect of some important influences or may be requiring too much computation"(p. 220). Furthermore, "When calculations are made with measurements, a small error in the measurements may lead to a large error in the results. The effects of uncertainties in measurements on a computed result can be estimated" (p.214).