White Paper

Science in Imagine Edgenuity Courses

Principles and Practices

The Next Generation Science Standards (NGSS) were released in 2013 as a new framework and associated standards to present science content. Twenty states and Washington D.C. have adopted the standards in their entirety, and another 24 states have adopted a modified version of the framework. The primary aim of NGSS is to engage students with the concepts and skills needed to approach problems and solve real-world issues like a scientist or engineer. The standards provide educators with built-in learning tools to increase interest and curiosity.

Imagine Edgenuity offers science courses aligned to NGSS. The courses provide students with opportunities to apply the concepts and skills they learn in meaningful ways. NGSS standards move students away from rote memorization and focus on skills such as asking questions, creating models, investigating, and communicating findings. Students learn how to apply their knowledge of key concepts to explore and make connections between each of the scientific disciplines. This is called three-dimensional learning.

Three-Dimensional Learning

The NGSS framework is composed of three dimensions of scientific learning. The dimensions are 1) Science and Engineering Practices (SEP), Cross-cutting Concepts (CCC), and Disciplinary Core Ideas (DCI). These components help students build a comprehensive understanding of science. Imagine Edgenuity courses aligned to the NGSS incorporate these dimensions throughout the curriculum.

1. Science and Engineering Practices (SEP)

Science and Engineering Practices focus on methods that scientists and engineers use in their careers daily. For example, students may be asked to plan and carry out an investigation, use data to support a hypothesis, or design a solution to an engineering problem. Mastery of the SEPs (Science and Engineering Practices) requires students to demonstrate their knowledge of a concept by “doing”. NGSS courses include the following eight practices:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

NGSS SEPs are evident throughout Imagine Edgenuity courses. Science courses include real-world connections which help students connect science concepts to their everyday lives. Short writing assignments provide opportunities for students to write clearly and concisely on a variety of important scientific topics. For example, students are asked to explain why the structure of DNA is important in the synthesis of different kinds of proteins. Students complete projects in which they model important structures or concepts, such as illustrating cell differentiation, modeling the carbon cycle, and revising a simulation that demonstrates human impact on the environment. Performance tasks ask students to conduct research and analyze their findings. For example, in one project, they research the speciation of the Galapagos Islands finches and construct explanations based on the information gathered. Most units include a virtual lab, with an option for teachers to engage students in an associated wet lab activity for hands-on learning that requires students to obtain, evaluate, and communicate their findings. Reading assignments expose students to models for scientific and technical writing. An emphasis on analyzing and interpreting figures and data helps students read and understand information the way scientists present it.

2. Crosscutting Concepts (CCC)

Crosscutting concepts are ideas that interweave and appear throughout the STEM (Science, Technology, Engineering & Mathematics) disciplines, and they provide students with "an organizational framework for connecting knowledge from the various disciplines". The seven Cross Cutting Concepts (CCC) are:

1. Patterns
2. Cause and effect
3. Scale, Proportion, and Quantity
4. Systems and System Models
5. Energy and Matter
6. Structure and Function
7. Stability and Change

When a student takes an Imagine Edgenuity science course, they learn how the various science disciplines are linked through CCC. Students make connections across content areas as they apply concepts from physical science to areas of biology, including the human body and ecology. A variety of graphic organizers help students understand relationships between and among concepts.

3. Disciplinary Core Ideas (DCI)

NGSS Disciplinary Core Ideas (DCI) are the underlying scientific ideas within any NGSS-aligned curriculum. DCIs are the foundation of an NGSS-aligned course. DCIs cover four domains: Physical Science, Life science, Earth and Space Science, and Engineering, Technology, and Applications of Science.

DCIs are used throughout Imagine Edgenuity courses to help students build a foundation for learning more complex science concepts. Students engage in science practice to enhance their understanding of core ideas when they evaluate new research, examine cause-and-effect relationships, and pose scientific questions about the world around them.

Collectively, the three dimensions provide students with a variety of scenarios and experiences that scientists and engineers would encounter in the real world. Through engaging content and activities in Imagine Edgenuity courses, students gain a greater understanding and appreciation of the world around them.

Examples

NGSS three-dimensional instruction is found throughout current Imagine Edgenuity science courses. Units correspond to NGSS topics, so one way to see this is at the unit level.

Example 1 – Chemistry

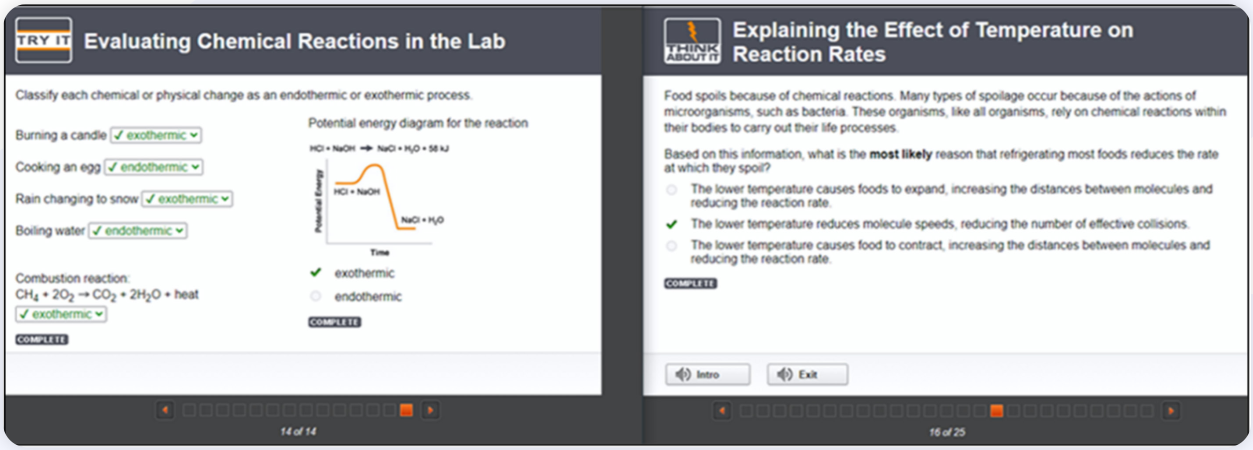
For example, the CCCs, DCIs, and SEPs corresponding to performance expectation HS-PS1-4 are part of the NGSS Chemistry Unit “Energy in Chemical Reactions”.

Performance expectation: HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

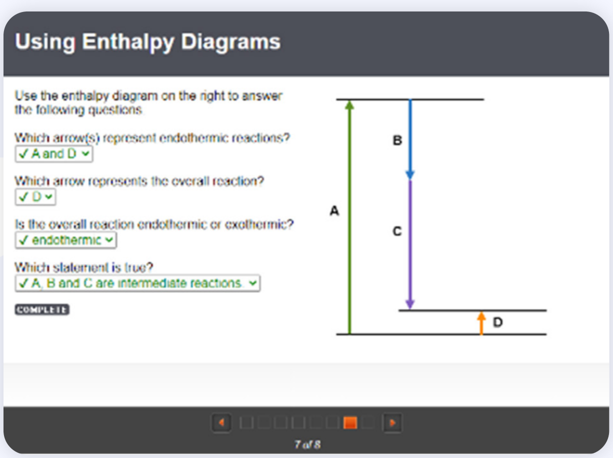
Content supporting HS-PS1-4 can be found in the unit “Energy in Chemical Reactions”. Alongside this Performance Expectation (PE), the corresponding SEP on developing and using models, DCI PS1.A on structure and properties of matter and PS1.B: on chemical reactions, and CCC on energy and matter are addressed in many activities throughout the lessons making up the unit.

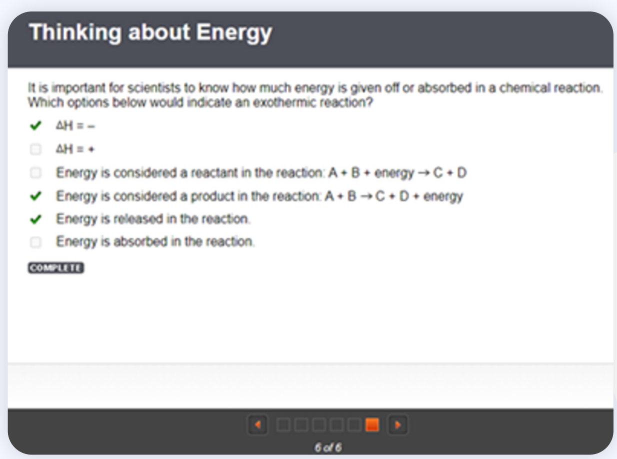
In the lesson, “Enthalpy of Reactions” students explore the absorption and release of heat in chemical reactions using the real-life example of smog as the introduction. The use of phenomena is present in many of the instructional videos and examples to give the students a real-world example of science in action. During instruction, the content addresses the DCIs for the performance expectation. The performance expectation is not confined to one lesson.

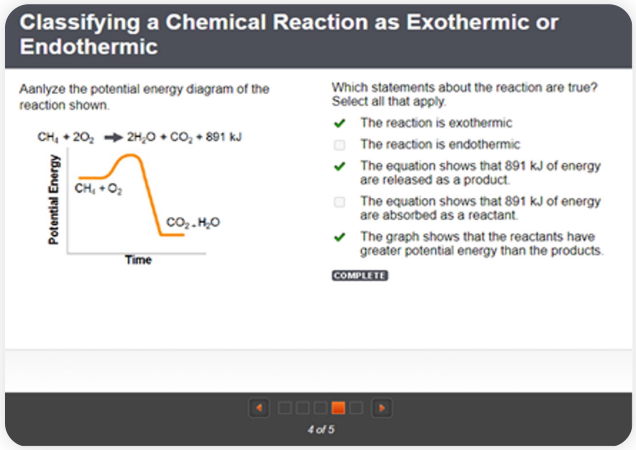
The units are designed to revisit the DCIs, CCCs and SEPs throughout study, providing scaffolding if needed and extending the students' knowledge and practice. As part of the instructional modules, students are required to answer multiple choice questions to practice and apply the concepts they have learned. The following examples are taken from lessons: "Heat" and "Reaction Rates".



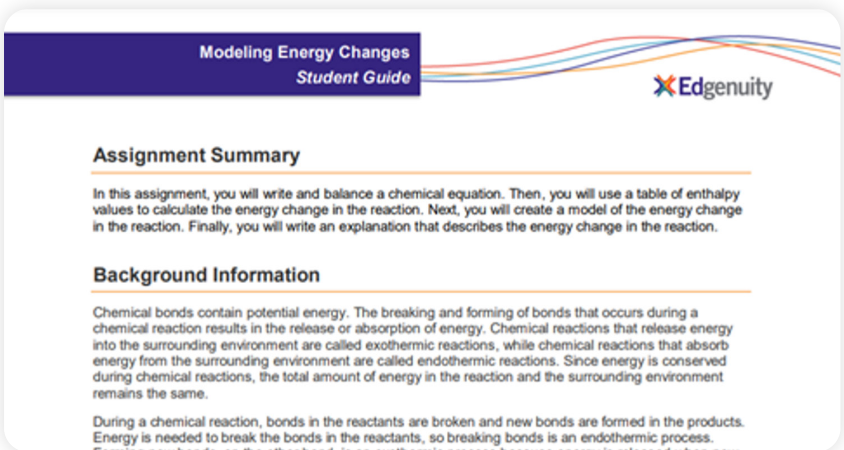
In the assignment modules of the lessons, the students are asked to explore the concept of energy in a reaction and to interpret diagrams representing reactions through multiple choice questions. These questions cover the DCI and CCC for HS-PS1-4. The following examples are taken from lessons: "Heat", "Thermochemical Equations," and "Enthalpy of Reactions".







The SEP for the performance expectation HS-PS1-4 is included in the culminating project for the lesson “Thermochemical Equations”. The students have practiced understanding models in the instructional module. In the project, the students are asked to look at a reaction, calculate the energy change and then create a model to represent the change in a graphical form. The final part of the project asks the students to describe the changes in energy within and around the system. This part of the project directly targets the CCC for the performance expectation.


Modeling Energy Changes
Student Guide
Edgenuity

Assignment Summary

In this assignment, you will write and balance a chemical equation. Then, you will use a table of enthalpy values to calculate the energy change in the reaction. Next, you will create a model of the energy change in the reaction. Finally, you will write an explanation that describes the energy change in the reaction.

Background Information

Chemical bonds contain potential energy. The breaking and forming of bonds that occurs during a chemical reaction results in the release or absorption of energy. Chemical reactions that release energy into the surrounding environment are called exothermic reactions, while chemical reactions that absorb energy from the surrounding environment are called endothermic reactions. Since energy is conserved during chemical reactions, the total amount of energy in the reaction and the surrounding environment remains the same.

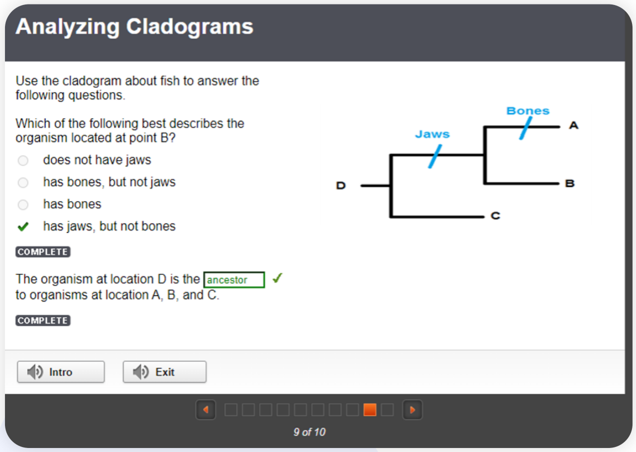
During a chemical reaction, bonds in the reactants are broken and new bonds are formed in the products. Energy is needed to break the bonds in the reactants, so breaking bonds is an endothermic process.

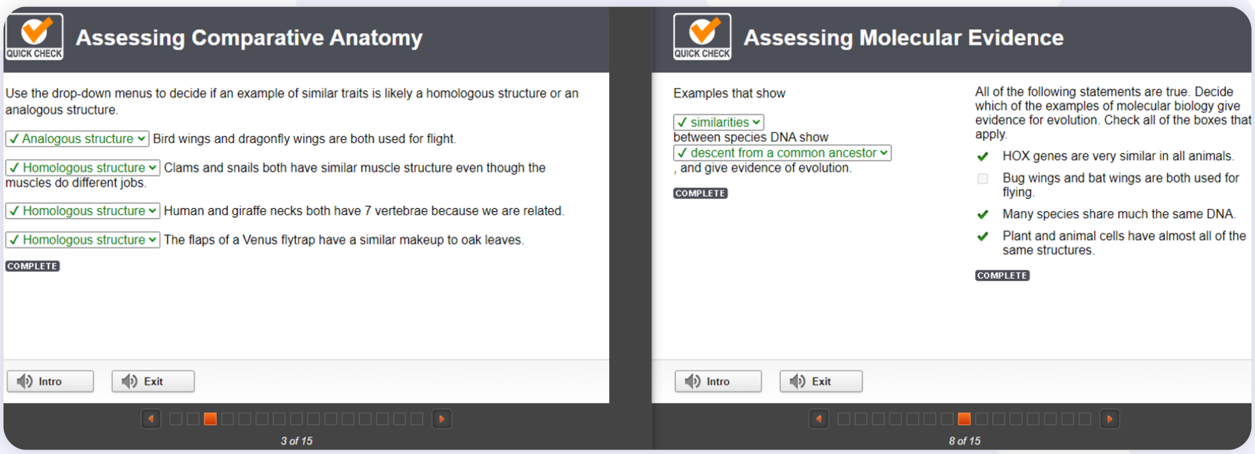
Example 2 – Life Science

Another example, the CCCs, DCIs, and SEPs corresponding to performance expectation HS-LS4-1 are part of the NGSS Biology unit “Evolution of Life”.

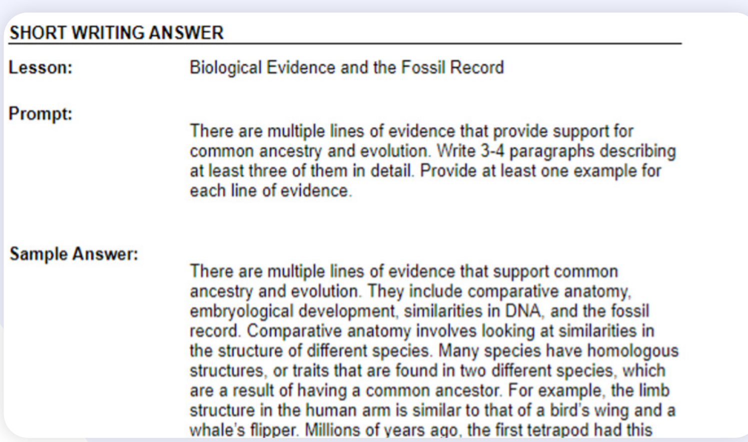
Performance Expectation HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

Within the lessons “Biological Evidence and the Fossil Record” and “Evolutionary Relationships”, the instructional modules cover many examples of evidence as covered in the DCI (LS4.A: Evidence of Common Ancestry and Diversity). Students are given multiple-choice questions in the instructional and assignment modules to check their understanding of the concepts.





In a culminating activity, students are asked to respond to a short writing prompt using the knowledge gained by completing the lesson content. By completing the writing prompt, students meet the needs of the SEP: Obtaining, Evaluating, and Communicating Information. Students will address the CCC: Patterns by citing evidence of embryological development, comparative anatomy, DNA similarities and the fossil record.



SHORT WRITING ANSWER

Lesson: Biological Evidence and the Fossil Record

Prompt: There are multiple lines of evidence that provide support for common ancestry and evolution. Write 3-4 paragraphs describing at least three of them in detail. Provide at least one example for each line of evidence.

Sample Answer: There are multiple lines of evidence that support common ancestry and evolution. They include comparative anatomy, embryological development, similarities in DNA, and the fossil record. Comparative anatomy involves looking at similarities in the structure of different species. Many species have homologous structures, or traits that are found in two different species, which are a result of having a common ancestor. For example, the limb structure in the human arm is similar to that of a bird's wing and a whale's flipper. Millions of years ago, the first tetrapod had this

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