BIOZONE

CLASSROOM GUIDE

CHEMISTRY IN THE EARTH SYSTEM

NGSS | INTEGRATING CHEMISTRY AND EARTH SCIENCE

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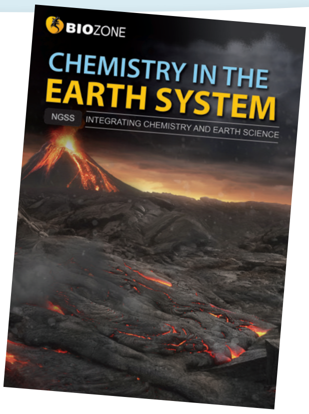
CLASSROOM GUIDE

FAQs ABOUT CHEMISTRY IN THE EARTH SYSTEM



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Summary of BIOZONE's 3D Approach By Chapter

Science and Engineering Practices (SEPs), Crosscutting Concepts (CCCs), Disciplinary Core Ideas (DCIs), and Performance Expectations (PEs) for Instructional Segments 1-6 of the CA NGSS (Three Course Model): *Chemistry in the Earth System*. A skills chapter, which covers some of the background for Science and Engineering Practices, is also included. Performance Expectations are met within activities and/or the **Summative Assessments** concluding each Instructional Segment (IS).

IS1: COMBUSTION AND ENERGY TRANSFER

Page		Activity	Hub	SEP	DCI	CCC	PE
2	1	Boil 'em in Oil		Anchoring phenomenon			
3	2	Working in the Lab Environment	✓	3			
6	3	Everyday Chemistry	✓	1, 2, 3, 4	PS1.A	1, 2, 5	HS-PS1-3, HS-PS1-4
10	4	Observing Reactions	✓	2, 3, 5	PS1.B	2, 5	HS-PS1-4, HS-PS1-7
15	5	Energy in Food	✓	1, 2, 3, 4, 5	PS1.B, PS3.D	2, 4, 5, 7	HS-PS1-3, HS-PS1-4 HS-PS1-7, HS-PS3-1
23	6	Boil 'em in Oil Revisited					
24	7	Summative Assessment		2, 5	PS1.A, PS1.B	1, 5	HS-PS1-3, HS-PS1-4, HS-PS1-7

IS2: HEAT AND ENERGY IN THE EARTH SYSTEM

Page		Activity	Hub	SEP	DCI	CCC	PE
27	8	On the Move		Anchoring phenomenon			
28	9	Energy	✓	2, 3, 6	PS3.A	2, 3, 5, 7	HS-PS3-2
34	10	Order and Disorder	✓	2, 3, 6	PS3.A, PS3.B	3, 5, 7	HS-PS3-4
38	11	Kinetic Theory of Matter	✓	2, 5, 6	PS3.A, PS3.B	2, 4, 5	HS-PS3-1, HS-PS3-2
42	12	Modeling Energy Flow	✓	2, 3, 5	PS3.A, PS3.B, ETS1.B	2, 3, 4, 5	HS-PS3-1, HS-PS3-2, HS-ETS1-4
48	13	Energy in the Earth	✓	2, 4, 7	ESS2.A, ESS2.B	2, 3, 5	HS-ESS2-3
52	14	Evidence for Earth's Structure	✓	2, 4, 5, 7	ESS2.A, ESS2.B, PS4.A	1, 5	HS-ESS2-3
60	15	Energy Drives Plate Tectonics	✓	2, 7, 8	ESS2.B ESS2.C	1, 2, 3, 5	HS-ESS2-3
69	16	On the Move Revisited					
70	17	Summative Assessment		2	ESS2.A	5	HS-ESS2-3

IS3: ATOMS, ELEMENTS, AND MOLECULES

Page		Activity	Hub	SEP	DCI	CCC	PE
75	18	Burp!	✓	Anchoring phenomenon			
76	19	Properties and Patterns	✓	1, 2, 4	PS1.A	1	HS-PS1-1
80	20	The Atom	✓	2, 8	PS1.A	1, 2	HS-PS1-1
88	21	The Periodic Table	✓	2, 6	PS1.A	1, 2	HS-PS1-1
95	22	The Mole	✓	2, 3, 5, 6	PS1.A, PS1.B	1, 3, 5	HS-PS1-2, HS-PS1-7
108	23	Aqueous Reactions	✓	2, 3, 5	PS1.A, PS1.B	1, 3	HS-PS1-7
113	24	Burp! Revisited					
114	25	Summative Assessment		2, 5, 6	PS1.A, PS1.B	1, 5	HS-PS1-1, HS-PS1-2, HS-PS1-7

IS4: CHEMICAL REACTIONS

Page		Activity	Hub	SEP	DCI	CCC	PE
120	26	Hot! Too Hot!	✓	Anchoring phenomenon			
121	27	Molecular Structure	✓	2, 6	PS1.A, PS2.B	1, 2	HS-PS1-1, HS-PS1-2, HS-PS1-7
125	28	Properties of Matter	✓	2, 3, 4, 5, 6	PS1.A, PS2.B, PS3.C	1, 2	HS-PS1-3, HS-PS3-5, HS-PS2-4
135	29	Energy and Changes of State		2	PS1.B	2, 5, 7	HS-PS1-4

137	30	Energy and Chemical Reactions	✓	2, 3, 4, 5, 6	PS1.B	5, 7	HS-PS1-4
147	31	Reaction Rates	✓	2, 3, 4, 5, 6	PS1.B	1, 5, 7	HS-PS1-5
152	32	Hot! Too Hot! Revisited	✓				
153	33	Summative Assessment	✓	2, 5, 6	PS1.A, PS1.B, PS2.B	1, 5	HS-PS1-2, HS-PS1-4, HS-PS1-5, HS-PS2-4

IS5: CHEMISTRY OF CLIMATE CHANGE

Page		Activity	Hub	SEP	DCI	CCC	PE
158	34	It's Heating Up	✓	Anchoring phenomenon			
159	35	Combustion and Hydrocarbons	✓	5	PS1.B, PS3.D	2, 4, 5, 6	
162	36	Fuels and People	✓	2, 4, 5, 7	PS1.B, PS3.D, ESS3.A	2, 5	HS-ESS3-2
170	37	Atmospheric Chemistry	✓	1, 2, 4	ESS2.A, ESS2.D	2, 4, 5, 7	HS-ESS2-6, HS ESS 3-6
176	38	Global Warming and Climate Change	✓	2, 4	PS3.B, PS4.B, ESS2.A, ESS2.D, ESS3.D	2, 4, 5, 7	HS-ESS2-2, HS-ESS2-4, HS-ESS3-5
185	39	Soil Chemistry and Its Role in Climate Change	✓	7	ESS3.A, ETS1.C	2	HS-ES3-2, HS-ETS1-2
191	40	Living with Limited Resources	✓	7	ESS3.A, ETS1-C	2	HS-ESS3-2, ETS1-2
194	41	It's Heating Up Revisited					
195	42	Summative Assessment		2, 4, 7	ESS2.D, ESS3.A, ESS3.D, ETS1-C	2, 7	HS-ESS2-4, HS-ESS3-2, HS-ESS3-5, HS-ETS1-2

IS6: REACTION DYNAMICS AND OCEAN ACIDIFICATION

Page		Activity	Hub	SEP	DCI	CCC	PE
200	43	Seashells by the Seashore	✓	Anchoring phenomenon			
201	44	Reversible Reactions	✓	2, 3, 6	PS1.B	2, 4, 7	HS-PS1-5, HS-PS1-6, HS-PS1-7
209	45	Industrial Chemistry	✓	6	PS1.B, ETS1.C	7	HS-PS1-5, HS-PS1-6, HS-PS1-7
218	46	Ocean Chemistry	✓	3, 4, 5, 6	PS1.B, ESS2.A, ESS2.D, ESS3.D	2, 7	HS-PS1-5, HS-ESS2-2, ESS3-5, HS-ESS2-6
224	47	Seashells by the Seashore Revisited	✓	6	ESS2.D	2, 7	
225	48	Summative Assessment		4, 6	PS1.B, ESS2.A, ESS2.D	7	HS-PS1-5, HS-PS1-6, HS-ESS2-2, HS-ESS2-6

SEPs: BASIC SKILLS FOR CHEMISTRY STUDENTS

Page		Activity	Hub	SEP	DCI	CCC	PE
229	49	Nature of Science	✓	1, 6, 7, 8	NA	4	NA
231	50	Systems and System Models	✓	2	NA	4	NA
233	51	Observations and Assumptions	✓	1	NA		NA
235	52	Useful Concepts in Chemistry	✓	5	NA		NA
236	53	Standard Chemistry Equipment	✓	2, 3, 6	NA		NA
238	54	Experimenting in Chemistry	✓	3	NA		NA
239	55	Accuracy and Precision		3	NA		NA
240	56	Measurement and Quantitative Analysis	✓	2, 3, 6	NA		
242	57	Working With Numbers		5	NA		NA
243	58	Ratio and proportion in Chemistry	✓	5	NA	3	
245	59	Logbooks and Tables		3	NA		NA
246	60	Drawing and Interpreting Graphs		4, 5	NA	1, 2	
248	61	Describing the Data	✓	4, 5	NA	1	
250	62	Periodic Table	✓		NA	1	

Identifying CA CCSS Connections

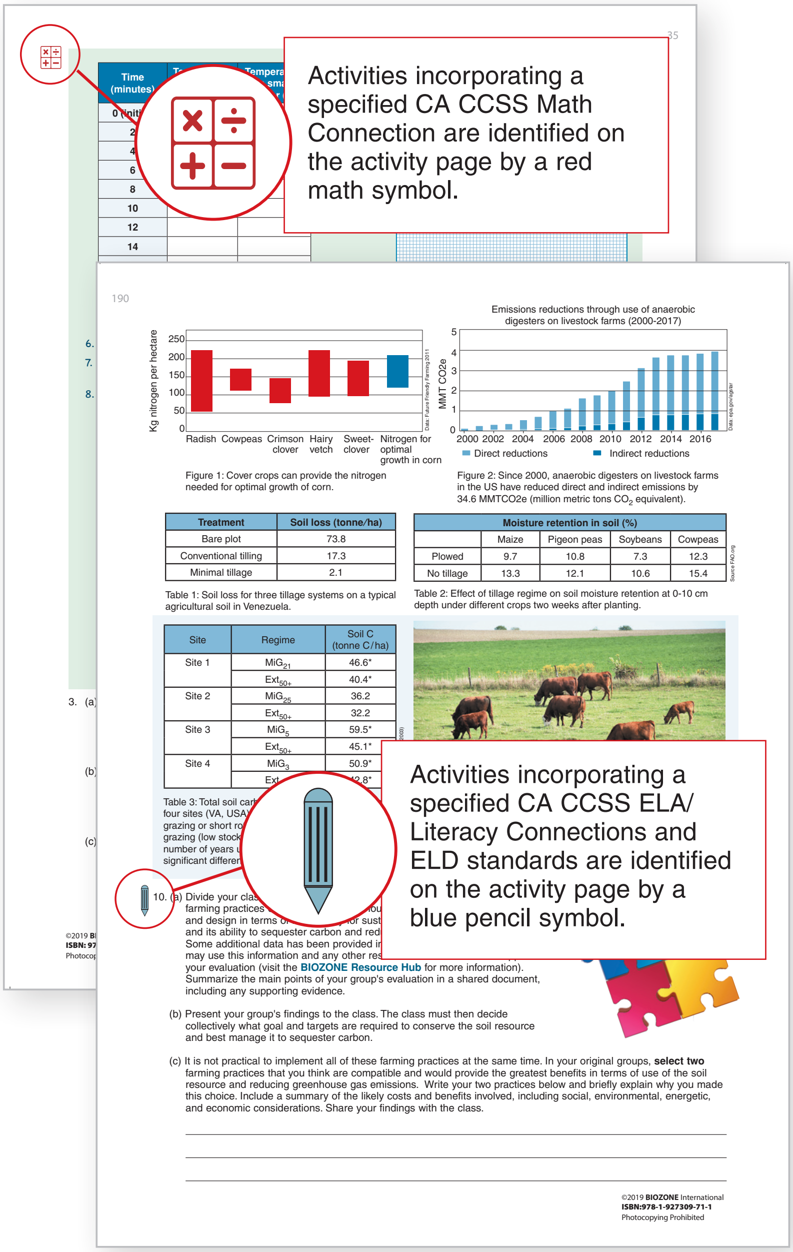
The activities in *Chemistry in the Earth System* provide many opportunities to address the California Common Core State Standards (CA CCSS) for numeracy, literacy, and English language development. The incorporation of these standards provides students with numerous opportunities to practice and develop these key skills while exploring science.

Activities incorporating the CA CCSS Math Connections, ELA/ literacy, and ELD Connections specified in the California Science Framework are identified by codes (right) in the Teacher's Edition and on the Teacher's Digital Edition (TDE).

- A red calculator indicates a math connection.
- A blue pencil indicates an ELA/literacy or ELD connection.

A list of the specific Math Connections, ELA/ Literacy Connections and ELD Standards addressed in the CA NGSS framework can be found in the tables at the bottom of this page and on the following page.

BIOZONE recognizes that CA ELD Standards are not to be used in isolation, and are intended to be implemented in conjunction with ELA/ Literacy and other academic content standards. This is why you will see them appearing along with the relevant ELA/literacy connection in the following tables.



IS1: COMBUSTION AND ENERGY TRANSFER

Activity number	Activity	CA CSS Math connection	CA CCSS ELA/Literacy & ELD connection
3	Everyday Chemistry	N-Q.1, MP.4	
5	Energy in Food	N-Q.1, MP.4	SL.11-12.5, ELD. PI.11-12.1, 5, 6, 9, 10
7	Summative Assessment	N-Q.1, MP.4	

IS2: HEAT AND ENERGY IN THE EARTH SYSTEM

Activity number	Activity	CA CSS Math connection	CA CCSS ELA/Literacy & ELD connection
10	Order and disorder	N-Q.1, MP.4	
11	Kinetic Theory of Matter	MP.2	
12	Modeling Energy Flow	MP.2	SL.11-12, 4, 5, WHST.9-12.7, 9 ELD PI.11-12.1, 5, 9, 10, 11
13	Energy in the Earth	N-Q.1, MP.4	
14	Evidence for Earth's Structure	N-Q.1, MP.4	
15	Energy Drives Plate Tectonics	N-Q.1	
17	Summative Assessment	N-Q.1	

IS3: ATOMS, ELEMENTS, AND MOLECULES

Activity number	Activity	CA CSS Math connection	CA CCSS ELA/Literacy & ELD connection
20	The Atom		SL.11-12.4, ELD PI.11-12.5, 6
21	The Periodic Table	N-Q.1-3, MP.4	
22	The Mole	N-Q.1-3, MP.2	WHST.11-12.2
23	Aqueous Reactions	MP.2	
25	Summative Assessment	MP.2	

IS4: CHEMICAL REACTIONS

Activity number	Activity	CA CSS Math connection	CA CCSS ELA/Literacy & ELD connection
28	Properties of matter	A-SSE.1a-b, 1a-b, N-Q.1, MP.2	
30	Energy and Chemical Reactions	MP.2, MP.4	WHST.11-12.7, 8, 9, ELD PI.11-12.6
31	Reaction Rates	N-Q.1, MP.4	
33	Summative Assessment	A-SSE.1a-b	

IS5: CHEMISTRY OF CLIMATE CHANGE

Activity number	Activity	CA CSS Math connection	CA CCSS ELA/Literacy & ELD connection
34	It's Heating Up		SL.9-10.1c-d, ELD PI.9-10.1, 2, 3, 11
35	Combustion and Hydrocarbons		SL.9-10.4, WHST.9-10.4, 9, 10 ELD PI.9-10.1, 3, 5
36	Fuels and People	N-Q.1, MP.4	WHST.9-10.4 ELD PI.9-10.11, PII.9-10.1
37	Atmospheric Chemistry	N-Q.1, F-LE.1b, MP.1, MP.4	
38	Global Warming and Climate Change	N-Q.1, S-ID.6, MP.1, MP.4	WHST.9-10.9 ELD PI.9-10.11, PII.9-10.1
39	Soil Chemistry and Its Role in Climate Change		SL.11-12.1c-d, ELD PI.9-10.1, 2, 3, 6
40	Living With Limited Resources		WHST.9-10.4, ELD PI.9-10.11
41	It's Heating Up Revisited		WHST.9-10.4, 6 ELD PI.9-10.2, 1, PII.9-10.1
42	Summative Assessment		WHST.9-10.4, ELD PI.9-10.6, 11

IS6: REACTION DYNAMICS AND OCEAN ACIDIFICATION

Activity number	Activity	CA CSS Math connection	CA CCSS ELA/Literacy & ELD connection
47	Seashells By the Seashore Revisited		SL.11-12.5, RST.11-12,1, 2

BASIC SKILLS FOR CHEMISTRY STUDENTS

Activity number	Activity	CA CSS Math connection	CA CCSS ELA/Literacy connection
49	The Nature of Science		SL.11-12.1, 3, 4, WHST.11-12.2 ELD PI.11-12.1, 3, 5, 6
56	Measurement and Quantitative Analysis	A-REI.2	
60	Drawing and Interpreting Graphs	N-Q.1, S-ID.7, MP.4	
61	Describing the Data	N-Q.1, S-ID.2-3	

The Contents: A Planning Tool

The contents pages are not merely a list of the activities in the student edition. Encourage your students to use them as a planning tool for their program of work. Students can identify the activities they are to complete and then tick them off when completed. The teacher can also see at a glance how quickly the student is progressing through the assigned material.

Contents

CODES: **Activity** is marked: to be done

The teacher can see at a glance how this student is progressing through this unit of work. Any concerns with progress can be addressed early.

Ticking off the activities as they are completed gives students a sense of progression and helps them to be more personally organized in their work.

Students can mark the check boxes to indicate the activities they should complete. This helps them to quantify the work to be done and plan their work.

IS2 Heat and Energy in the Earth System

Student Questions ... 26
8 ANCHORING PHENOMENON
On the Move ... 27
9 Energy ... 28
10 Order and Disorder ... 34
11 Kinetic Theory of Matter ... 38
12 Modeling Energy Flow ... 42
13 Energy in the Earth ... 48
14 Evidence for Earth's Structure ... 52
15 Energy Drives Plate Tectonics ... 60
16 On the Move Revisited ... 69
17 Summative Assessment ... 70

Identifying Learning Intentions and Goals

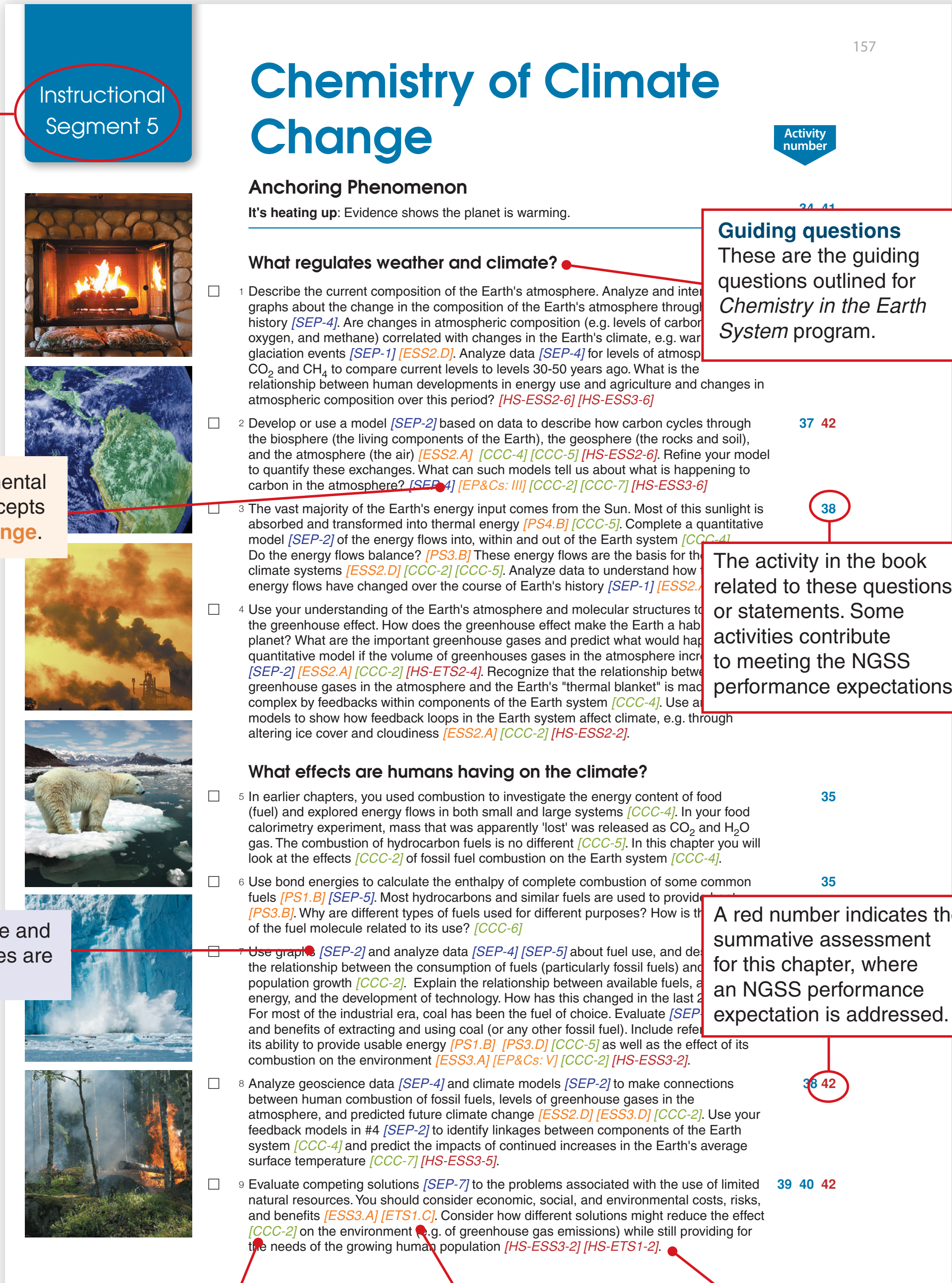
In developing *Chemistry in the Earth System*, we have embraced the three dimensions of the CA NGSS framework, emphasizing the application of ideas and skills to new scenarios. The activities in *Chemistry in the Earth System* have been specifically designed to address the **Disciplinary Core Ideas, Science and Engineering Practices**, and **Crosscutting Concepts** in a way that helps students to meet specific performance expectations.

In the Teacher's Edition and Teacher's Digital Edition all dimensions are embedded in the text and are color coded for easy identification (below). The performance expectations and California Environmental Principles and Concepts are also identified. It is important to note that this coding is a tool for the teacher and is not present in the Student Edition.

This identifies the Instructional Segment to which this chapter applies.

California Environmental Principles and Concepts are indicated in **orange**.

The relevant science and engineering practices are indicated in **blue**.



Instructional Segment 5

157

Chemistry of Climate Change

Activity number

Anchoring Phenomenon

It's heating up: Evidence shows the planet is warming. 34 41

What regulates weather and climate?

- ☐ 1 Describe the current composition of the Earth's atmosphere. Analyze and inter graphs about the change in the composition of the Earth's atmosphere throug history *[SEP-4]*. Are changes in atmospheric composition (e.g. levels of carbor oxygen, and methane) correlated with changes in the Earth's climate, e.g. war glaciation events *[SEP-1] [ESS2.D]*. Analyze data *[SEP-4]* for levels of atmosp CO_2 and CH_4 to compare current levels to levels 30-50 years ago. What is the relationship between human developments in energy use and agriculture and changes in atmospheric composition over this period? *[HS-ESS2-6] [HS-ESS3-6]*
- ☐ 2 Develop or use a model *[SEP-2]* based on data to describe how carbon cycles through the biosphere (the living components of the Earth), the geosphere (the rocks and soil), and the atmosphere (the air) *[ESS2.A] [CCC-4] [CCC-5] [HS-ESS2-6]*. Refine your model to quantify these exchanges. What can such models tell us about what is happening to carbon in the atmosphere? *[SEP-4] [EP&Cs: III] [CCC-2] [CCC-7] [HS-ESS3-6]* — 37 42
- ☐ 3 The vast majority of the Earth's energy input comes from the Sun. Most of this sunlight is absorbed and transformed into thermal energy *[PS4.B] [CCC-5]*. Complete a quantitative model *[SEP-2]* of the energy flows into, within and out of the Earth system *[CCC-4]*. Do the energy flows balance? *[PS3.B]* These energy flows are the basis for th climate systems *[ESS2.D] [CCC-2] [CCC-5]*. Analyze data to understand how energy flows have changed over the course of Earth's history *[SEP-1] [ESS2.* — 38
- ☐ 4 Use your understanding of the Earth's atmosphere and molecular structures t the greenhouse effect. How does the greenhouse effect make the Earth a hab planet? What are the important greenhouse gases and predict what would ha quantitative model if the volume of greenhouses gases in the atmosphere incr *[SEP-2] [ESS2.A] [CCC-2] [HS-ETS2-4]*. Recognize that the relationship betw greenhouse gases in the atmosphere and the Earth's "thermal blanket" is mac complex by feedbacks within components of the Earth system *[CCC-4]*. Use a models to show how feedback loops in the Earth system affect climate, e.g. through altering ice cover and cloudiness *[ESS2.A] [CCC-2] [HS-ESS2-2]*.

What effects are humans having on the climate?

- ☐ 5 In earlier chapters, you used combustion to investigate the energy content of food (fuel) and explored energy flows in both small and large systems *[CCC-4]*. In your food calorimetry experiment, mass that was apparently 'lost' was released as CO_2 and H_2O gas. The combustion of hydrocarbon fuels is no different *[CCC-5]*. In this chapter you will look at the effects *[CCC-2]* of fossil fuel combustion on the Earth system *[CCC-4]*. — 35
- ☐ 6 Use bond energies to calculate the enthalpy of complete combustion of some common fuels *[PS1.B] [SEP-5]*. Most hydrocarbons and similar fuels are used to provide *[PS3.B]*. Why are different types of fuels used for different purposes? How is th of the fuel molecule related to its use? *[CCC-6]* — 35
- ☐ 7 Use graphs *[SEP-2]* and analyze data *[SEP-4] [SEP-5]* about fuel use, and de the relationship between the consumption of fuels (particularly fossil fuels) and population growth *[CCC-2]*. Explain the relationship between available fuels, a energy, and the development of technology. How has this changed in the last 2 For most of the industrial era, coal has been the fuel of choice. Evaluate *[SEP* and benefits of extracting and using coal (or any other fossil fuel). Include refe its ability to provide usable energy *[PS1.B] [PS3.D] [CCC-5]* as well as the effect of its combustion on the environment *[ESS3.A] [EP&Cs: V] [CCC-2] [HS-ESS3-2]*.
- ☐ 8 Analyze geoscience data *[SEP-4]* and climate models *[SEP-2]* to make connections between human combustion of fossil fuels, levels of greenhouse gases in the atmosphere, and predicted future climate change *[ESS2.D] [ESS3.D] [CCC-2]*. Use your feedback models in #4 *[SEP-2]* to identify linkages between components of the Earth system *[CCC-4]* and predict the impacts of continued increases in the Earth's average surface temperature *[CCC-7] [HS-ESS3-5]*. — 38 42
- ☐ 9 Evaluate competing solutions *[SEP-7]* to the problems associated with the use of limited natural resources. You should consider economic, social, and environmental costs, risks, and benefits *[ESS3.A] [ETS1.C]*. Consider how different solutions might reduce the effect *[CCC-2]* on the environment (e.g. of greenhouse gas emissions) while still providing for the needs of the growing human population *[HS-ESS3-2] [HS-ETS1-2]*. — 39 40 42

Guiding questions
These are the guiding questions outlined for *Chemistry in the Earth System* program.

The activity in the book related to these questions or statements. Some activities contribute to meeting the NGSS performance expectations.

A red number indicates the summative assessment for this chapter, where an NGSS performance expectation is addressed.

The relevant crosscutting concepts are indicated in **green**.

The relevant disciplinary core are indicated in **orange**.

The relevant performance expectation is indicated in **red**

Scaffolded Learning

In developing *Chemistry in the Earth System* we have utilized the 5Es instructional model as a basis for developing materials to address all three dimensions of the CA NGSS framework: **disciplinary core ideas** (DCIs), **science and engineering practices**, and **crosscutting concepts**. By successfully completing the activities, students can demonstrate competence in all three dimensions. This is central to meeting the performance expectations for *Chemistry in the Earth System* with confidence.

BIOZONE encourages the development of the NGSS learner profile using the 5 Es model

The Five Es

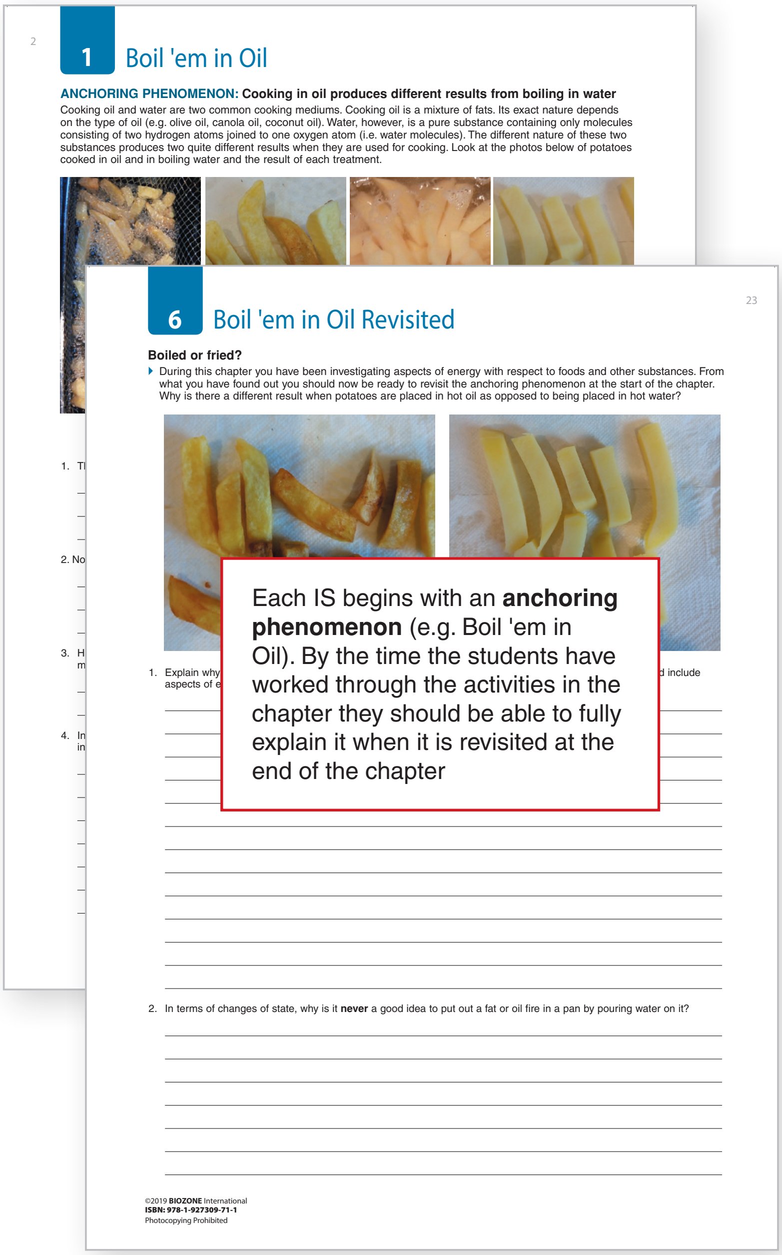
Engage:	make connections between past and present learning experiences.
Explore:	become actively involved in the activity.
Explain:	communicate the learning experience.
Elaborate:	expand on the concepts learned.
Evaluate:	assess understanding of the concepts.

BIOZONE's series for CA-NGSS is **phenomenon-based**. Students engage with phenomena through their own investigations and observations, through modeling and data analysis, and through collaborative work and discussion.

Using phenomena to drive inquiry promotes discussion and the sharing of ideas. The iterative approach presents opportunities to look at phenomena from several different perspectives. This allows students of all abilities to widen their thinking and understanding, increasing understanding each time the phenomenon is revisited.

Each IS begins with an **anchoring phenomenon** (right). In each instance, we have chosen a phenomenon that the student is probably familiar with, but which they cannot explain (or cannot explain fully). Teachers can use this activity to find out what the students already know (or think they know) before delving into the content more fully.

The subsequent activities in a chapter take the students, step by step, through phenomena that explore the ideas inherent in the anchoring phenomenon. By the time students revisit the anchoring phenomenon, they should be able to fully explain it.



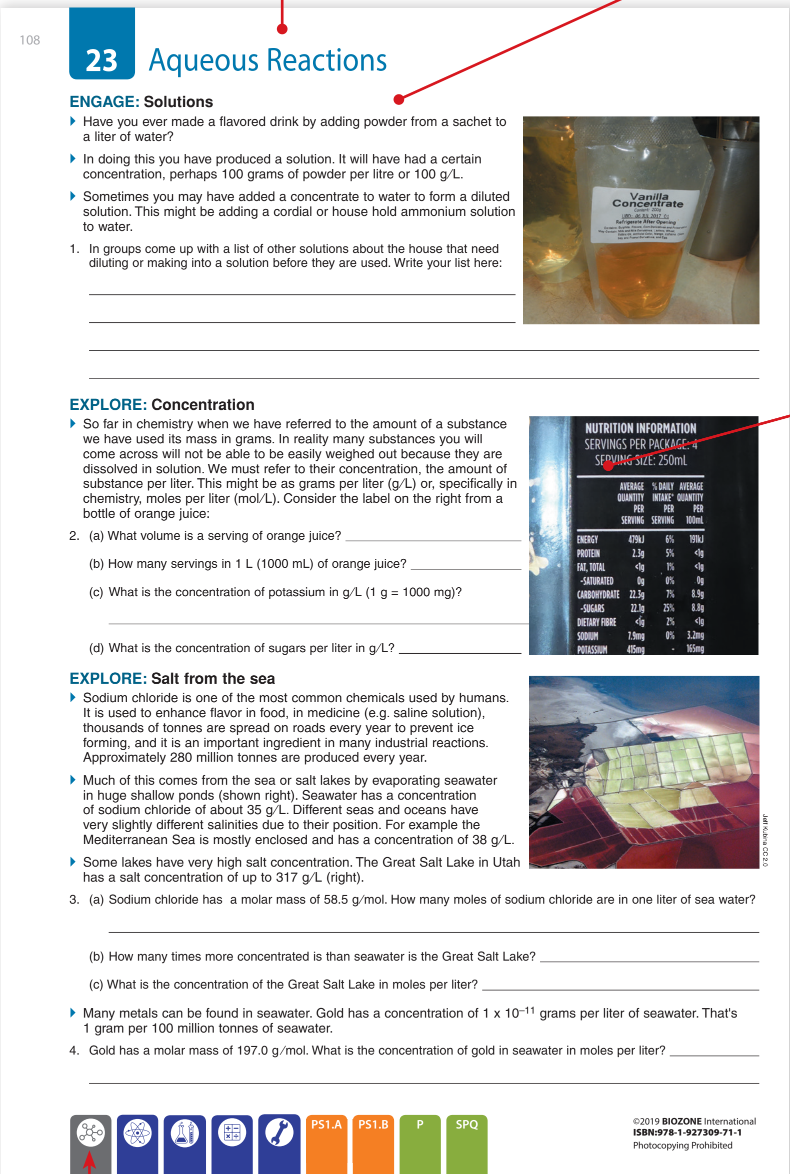
Scaffolding with the 5Es

The content of the *Chemistry in the Earth System* is organized into 7 chapters, corresponding to the six Instructional Segments (IS) and one chapter addressing basic skills. Each Instructional Segment begins with an introduction outlining learning goals and is immediately followed by the Anchoring Phenomenon. Engaging activities make up the bulk of each chapter, with each activity focusing on the student investigating and developing understanding of a phenomenon, applying that understanding to new scenarios, and/or developing a skill or essential science practice, such as graphing, data analysis, modeling, or evidence-based explanation.

Annotated diagrams and photographs are a major part of most activities and the student's understanding of the information is evaluated through questions and/or tasks involving data handling and interpretation. Tabs at the bottom of the page identify crosscutting concepts, science and engineering practices, and disciplinary core ideas as appropriate. Tabs also indicate if the activity is supported via **BIOZONE's Resource Hub**, which provides online teacher and student support for specific aspects of the activity.

Each activity is presented as a logical sequence, in which understanding of an everyday or investigative phenomenon is developed progressively through exploration and explanation.

ENGAGE with phenomena
Each activity begins with a task to engage student thinking, asking them to review their current understanding of a phenomenon, or providing an interesting (if not yet fully explained) piece of information and setting the scene for the content to follow. Prior knowledge can also be assessed using the ENGAGE material.



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23 Aqueous Reactions

ENGAGE: Solutions

- Have you ever made a flavored drink by adding powder from a sachet to a liter of water?
- In doing this you have produced a solution. It will have had a certain concentration, perhaps 100 grams of powder per litre or 100 g/L.
- Sometimes you may have added a concentrate to water to form a diluted solution. This might be adding a cordial or house hold ammonium solution to water.

1. In groups come up with a list of other solutions about the house that need diluting or making into a solution before they are used. Write your list here:

EXPLORE: Concentration

- So far in chemistry when we have referred to the amount of a substance we have used its mass in grams. In reality many substances you will come across will not be able to be easily weighed out because they are dissolved in solution. We must refer to their concentration, the amount of substance per liter. This might be as grams per liter (g/L) or, specifically in chemistry, moles per liter (mol/L). Consider the label on the right from a bottle of orange juice:

NUTRITION INFORMATION
SERVINGS PER PACKAGE: 4
SERVING SIZE: 250mL

	AVERAGE QUANTITY PER SERVING	% DAILY INTAKE* PER SERVING	AVERAGE QUANTITY PER 100mL
ENERGY	479kJ	6%	191kJ
PROTEIN	2.3g	5%	<1g
FAT, TOTAL	<1g	1%	<1g
-SATURATED	0g	0%	0g
CARBOHYDRATE	22.3g	7%	8.9g
-SUGARS	22.1g	25%	8.8g
DIETARY FIBRE	<1g	2%	<1g
SODIUM	7.9mg	0%	3.2mg
POTASSIUM	415mg	-	165mg

2. (a) What volume is a serving of orange juice?
(b) How many servings in 1 L (1000 mL) of orange juice?
(c) What is the concentration of potassium in g/L (1 g = 1000 mg)?
(d) What is the concentration of sugars per liter in g/L?

EXPLORE: Salt from the sea

- Sodium chloride is one of the most common chemicals used by humans. It is used to enhance flavor in food, in medicine (e.g. saline solution), thousands of tonnes are spread on roads every year to prevent ice forming, and it is an important ingredient in many industrial reactions. Approximately 280 million tonnes are produced every year.
- Much of this comes from the sea or salt lakes by evaporating seawater in huge shallow ponds (shown right). Seawater has a concentration of sodium chloride of about 35 g/L. Different seas and oceans have very slightly different salinities due to their position. For example the Mediterranean Sea is mostly enclosed and has a concentration of 38 g/L.
- Some lakes have very high salt concentration. The Great Salt Lake in Utah has a salt concentration of up to 317 g/L (right).

3. (a) Sodium chloride has a molar mass of 58.5 g/mol. How many moles of sodium chloride are in one liter of sea water?
(b) How many times more concentrated is than seawater is the Great Salt Lake?
(c) What is the concentration of the Great Salt Lake in moles per liter?

- Many metals can be found in seawater. Gold has a concentration of 1 x 10^{-11} grams per liter of seawater. That's 1 gram per 100 million tonnes of seawater.

4. Gold has a molar mass of 197.0 g/mol. What is the concentration of gold in seawater in moles per liter?

PS1.A PS1.B P SPQ

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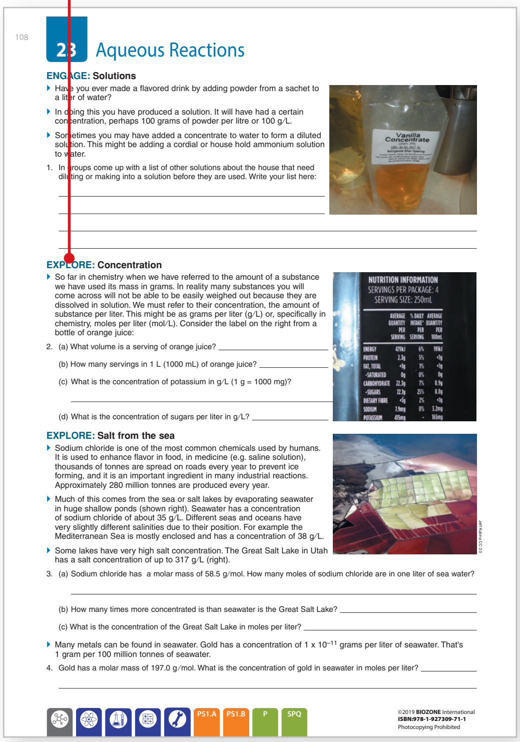
Annotated diagrams, photographs, and graphs explain the content of the page, providing the information necessary to complete the activity.

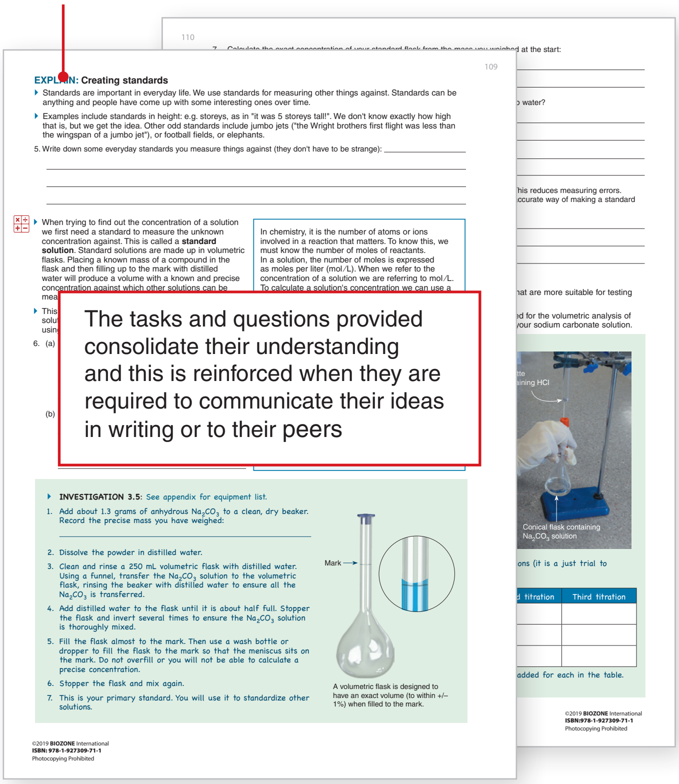
Students are given enough information to complete the activity's tasks. To progress through the activity they may need to apply knowledge and information developed earlier in the activity. Answers to questions are not always directly available on the page. Students may need to analyze data or information and draw conclusions to answer the questions and progress to the next part of the activity. Students are sometimes asked to do further research or carry out their own research or investigation.

Related content is identified through the tab system. This activity also has supporting resources on **BIOZONE's Resource Hub** assigned to it.

EXPLORE sections encourage students to be independent learners and seek the answers to questions posed by the activity. They do this through investigation and by creating their own models, analyzing data, or interpreting diagrams. In this example students use an everyday example (food labels) to explore concentrations in a familiar context. They also explore a second example (salt production).

EXPLAIN sections deepen student understanding of phenomena by building on what they discovered through exploration. They are encouraged to use scientific principles and reasoning to construct explanations and devise solutions to the problems presented to them. Here students look at the importance of using standard solutions in chemistry. An investigation provides an opportunity to practice making standards. Through the investigation, students explain why it is important to adhere to certain rules and demonstrate use of c = n/v.

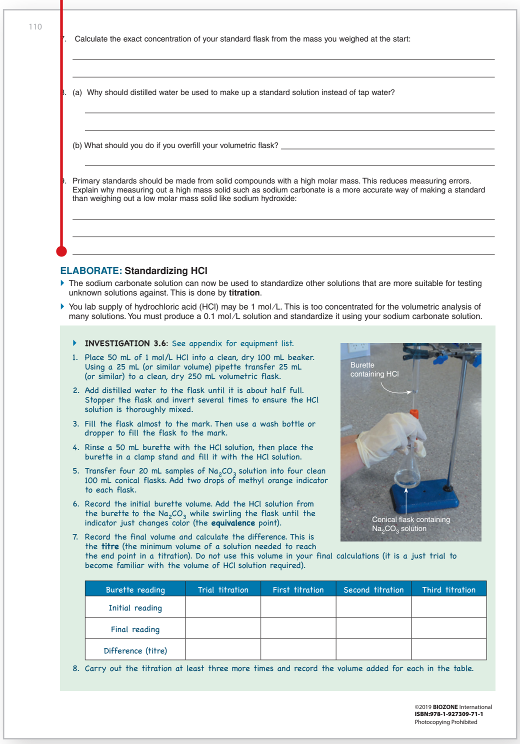


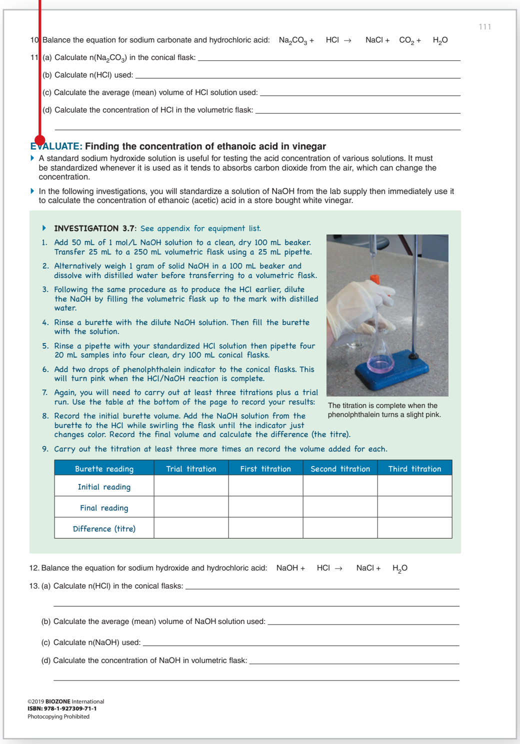


The tasks and questions provided consolidate their understanding and this is reinforced when they are required to communicate their ideas in writing or to their peers

ELABORATE sections provide opportunities for students to demonstrate deeper understanding by elaborating on new phenomena or using their experience to refine engineering solutions to relevant problems. Here students use the standard solution of sodium carbonate they have made to determine the concentration of a solution of HCl.

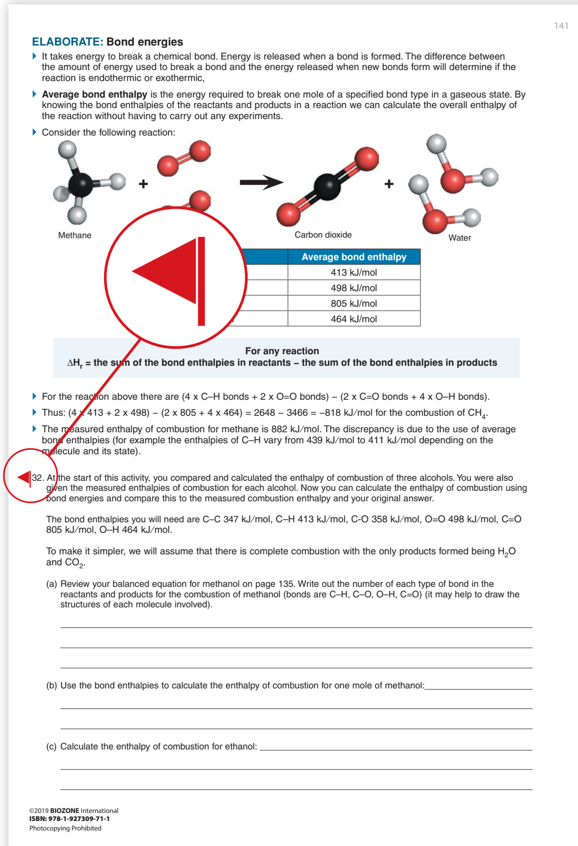
EVALUATE sections provide opportunities for **formative assessment** (if you wish). In this example, students standardize their sodium carbonate solution and apply what they have learned in previous sections to determine the concentration of ethanoic acid in a sample of vinegar via titration.

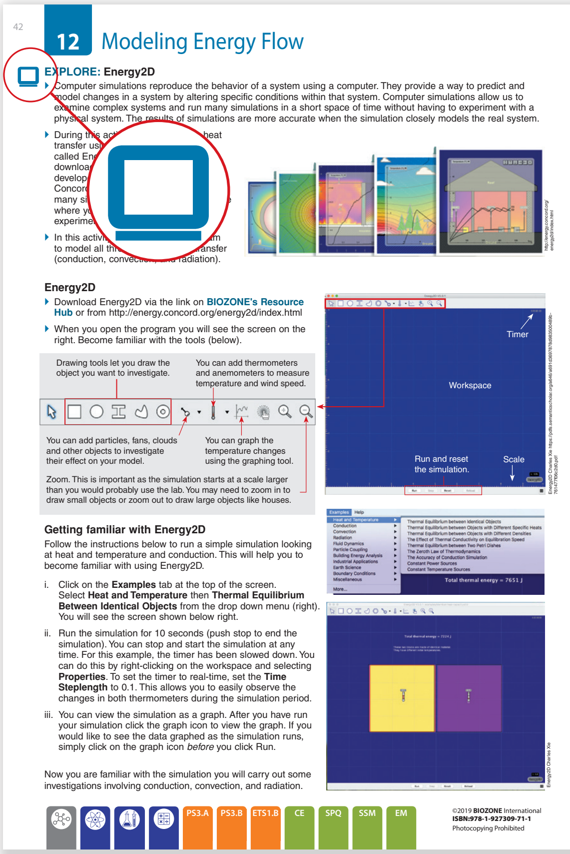




The structure of Chemistry in the Earth System promotes differential instruction, and has been designed to cater for students of all abilities. BIOZONE's collaborative approach to science inquiry encourages students of all abilities to share their ideas and knowledge with their peers while at the same time broadening their own understanding of phenomena.
There are several ways you can use Chemistry in the Earth System to implement differential instruction in your classroom:

- **BIOZONE's Resource Hub** contains support materials for students of all abilities. The Resource Hub provides:
    - **Short animations and videos**: Another way to approach the material covered in *Chemistry in the Earth System*. Students can view short videos (often with Spanish subtitles) to help them understand concepts or procedures. This approach is helpful to all students, but can be especially valuable for striving students.
    - **Interactive spreadsheets**: These support activities requiring more complex data handling or modeling. Students can manipulate the data and see the consequences of these actions directly. These modeling activities can be utilized by all students, but gifted students may find the freedom of exploration particularly valuable as they can manipulate the spreadsheet more widely and explore to a deeper level if they wish.
    - For teachers and more able students we have included the **source material** used to develop some activities. Capable or inquisitive students can view this material and develop a deeper understanding of the material covered.
- **Red flag codes** beside a section or question (on the Teacher's Edition or Teacher's Digital Edition) indicate that students may need extra guidance from the teacher to complete them. They may also indicate questions that can be used as extension material to challenge gifted students. These activities are also identified in the extended contents of this guide.
- **ELD support** is provided throughout *Chemistry in the Earth System*. English language learners progress through the ELD continuum while accessing high-quality science content the same time. It is worth noting that BIOZONE's scaffolded, inquiry-based approach, with an emphasis on collaboration, is in keeping with recommendations outlined in Chapter 4 of the ELD standards. In particular teachers can carefully structure collaborative learning practices that promote small-group discussion among students about, for example, the scientific information they read. Such practices foster comprehension and promote acquisition of vocabulary and understanding of language structure. *Ref: Heller and Greenleaf 2007; Klingner et al. 2004; Kosanovich, Reed, and Miller 2010; Short, Echevarría, and Richards-Tutor 2011; Vaughn et al. 2011*.





A red flag beside a section or question indicates that students may need some extra guidance from the teacher to complete this material. It may also highlight questions that can be used as extension material to challenge gifted students. These activities are also identified in the extended contents of this guide (CG3-CG4).

A computer monitor indicates an activity where a device will be needed to carry out part or all of an activity. The activity may require access to online simulations (e.g. Energy2D), the interactive spreadsheets on **BIOZONE's Resource Hub**, or specific external websites suggested by BIOZONE as part of a student investigation. Computer models can be used by students to explore, elaborate and evaluate content.

A Phenomenon Based Approach

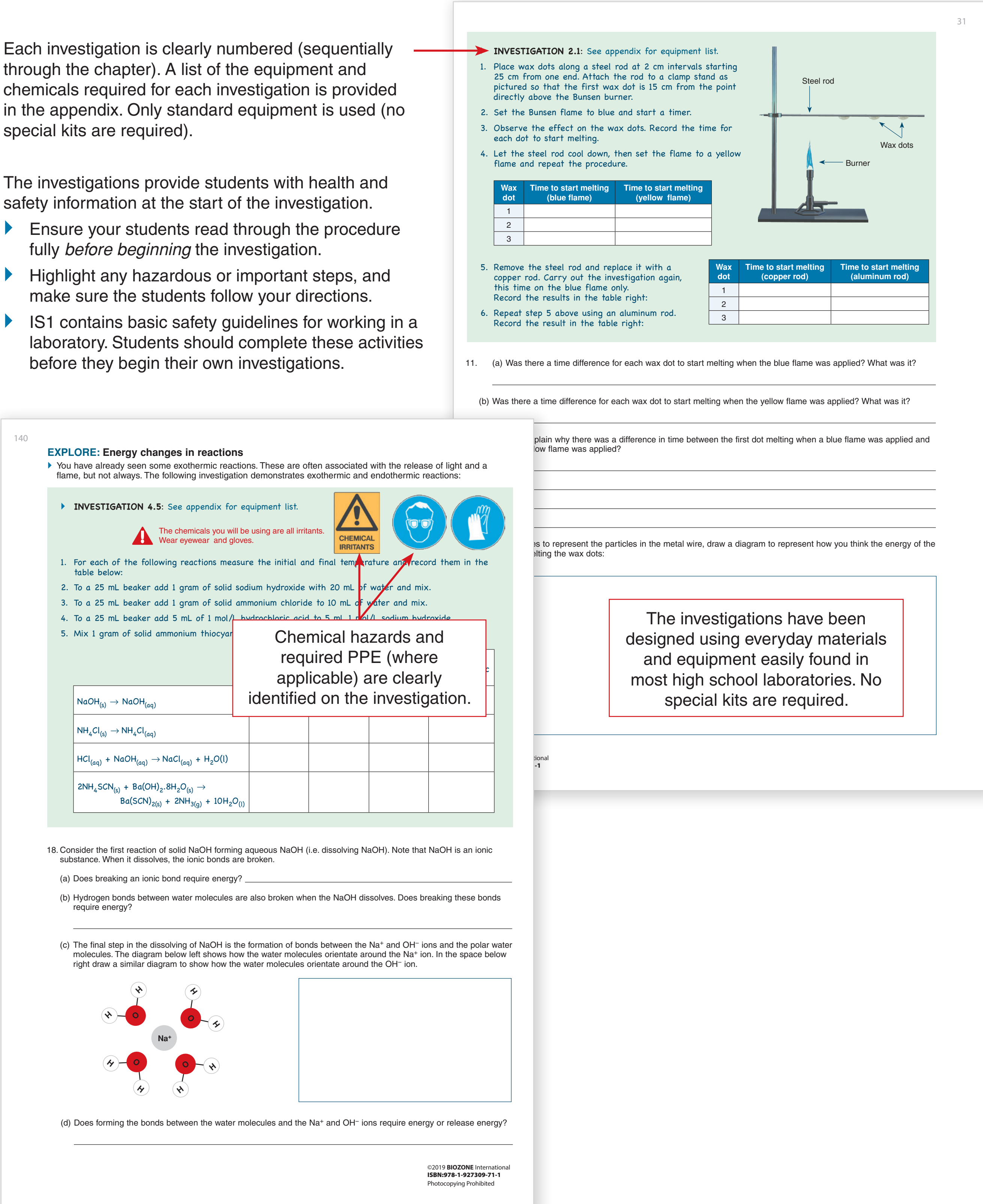
Throughout Chemistry in the Earth System, students are given opportunities to explore phenomena through simple experiments. These **investigative phenomena** are opportunities for students to develop competency in laboratory procedures, to practice and refine skills in observation and analysis, and to manipulate data. Some investigations act as stimulus material while others require students to take what they have already learned and apply their knowledge to a more complex scenario.

The investigations provide an excellent opportunity for collaborative work and will stimulate discussion and the sharing of ideas. You may wish to pair students of different abilities together. Confident students can guide and encourage less able students and, in this relaxed environment, striving students will be encouraged to share their own observations and thoughts. Collaboration through paired practical work provides an excellent opportunity for English language learners to interact in meaningful ways to extend their English language and scientific vocabulary.

Each investigation is clearly numbered (sequentially through the chapter). A list of the equipment and chemicals required for each investigation is provided in the appendix. Only standard equipment is used (no special kits are required).

The investigations provide students with health and safety information at the start of the investigation.

- Ensure your students read through the procedure fully *before beginning* the investigation.
- Highlight any hazardous or important steps, and make sure the students follow your directions.
- IS1 contains basic safety guidelines for working in a laboratory. Students should complete these activities before they begin their own investigations.

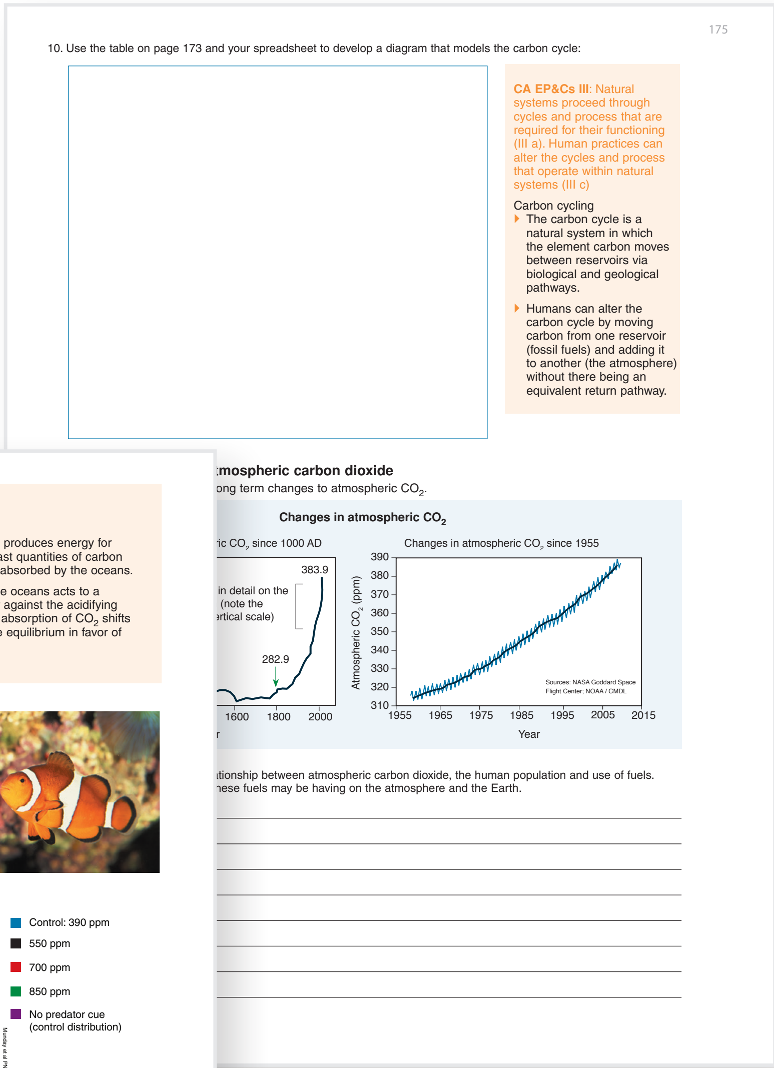


California Environmental Principles and Concepts

The California Environmental Principles and Concepts (EP&Cs) have been incorporated into Chemistry in the Earth System to increase environmental literacy. This in accordance with the requirements of the California Education and the Environment Initiative (EEI). Within *Chemistry and the Earth System*, the EP&Cs material provides examples and context for students to study the relationship between humans and the natural world. For example, how does the carbon dioxide released from burning fossils fuels affect the oceans?

Activities containing EP&Cs are easily identified in Chemistry in the Earth System.

- In the Teacher's Edition (and Teacher's Digital Edition) the EP&Cs are identified in the chapter front in **orange.** For example: Evaluate the costs and benefits of extracting and using coal (or any other fossil fuel). Include reference to its ability to provide usable energy as well as the effect of its combustion on the environment *[EP&Cs: V]*.
- **Orange** boxes within specific activities clearly identify where EP&Cs are covered (see below).
- The specific EP&C code (e.g. EP&C V) is identified on the page so you know exactly which principle is being covered.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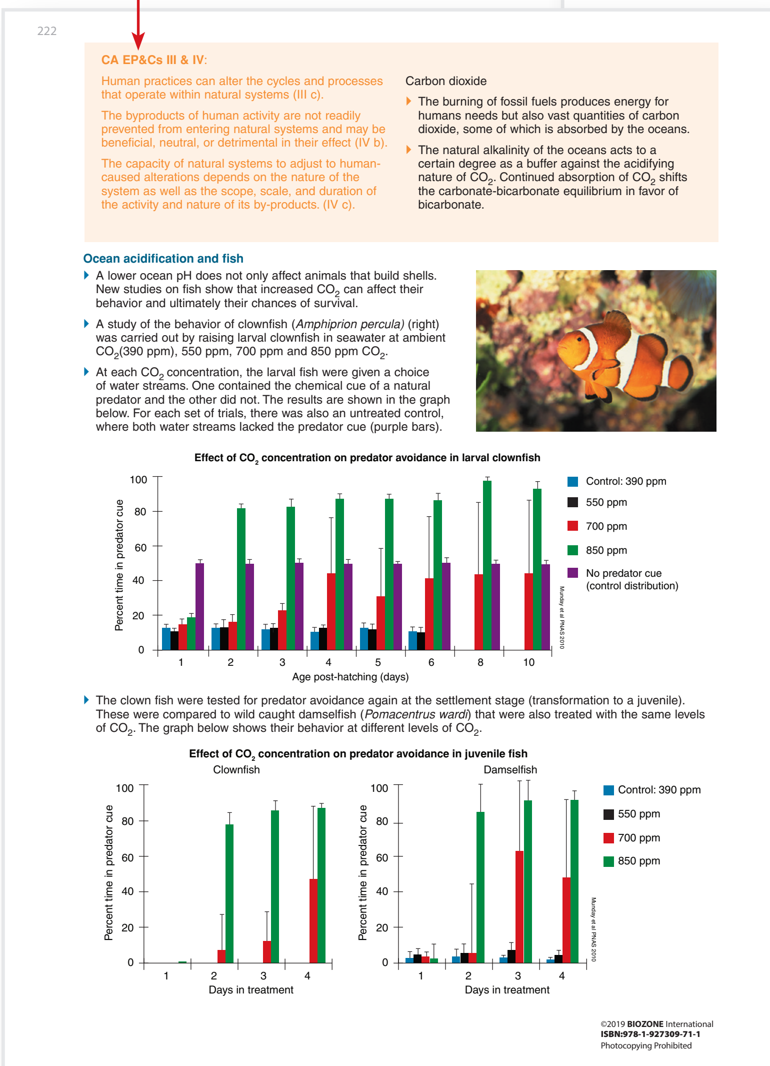
10. Use the table on page 173 and your spreadsheet to develop a diagram that models the carbon cycle:

CA EP&Cs III: Natural systems proceed through cycles and process that are required for their functioning (III a). Human practices can alter the cycles and process that operate within natural systems (III c)

Carbon cycling
- The carbon cycle is a natural system in which the element carbon moves between reservoirs via biological and geological pathways.
- Humans can alter the carbon cycle by moving carbon from one reservoir (fossil fuels) and adding it to another (the atmosphere) without there being an equivalent return pathway.

tionship between atmospheric carbon dioxide, the human population and use of fuels. hese fuels may be having on the atmosphere and the Earth.

The specific EP&C is clearly identified on the page.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CA EP&Cs III & IV:

Human practices can alter the cycles and processes that operate within natural systems (III c).

The byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect (IV b).

The capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity and nature of its by-products. (IV c).

Carbon dioxide
- The burning of fossil fuels produces energy for humans needs but also vast quantities of carbon dioxide, some of which is absorbed by the oceans.
- The natural alkalinity of the oceans acts to a certain degree as a buffer against the acidifying nature of CO_2. Continued absorption of CO_2 shifts the carbonate-bicarbonate equilibrium in favor of bicarbonate.

Ocean acidification and fish
- A lower ocean pH does not only affect animals that build shells. New studies on fish show that increased CO_2 can affect their behavior and ultimately their chances of survival.
- A study of the behavior of clownfish (*Amphiprion percula*) (right) was carried out by raising larval clownfish in seawater at ambient CO_2(390 ppm), 550 ppm, 700 ppm and 850 ppm CO_2.
- At each CO_2 concentration, the larval fish were given a choice of water streams. One contained the chemical cue of a natural predator and the other did not. The results are shown in the graph below. For each set of trials, there was also an untreated control, where both water streams lacked the predator cue (purple bars).

- The clown fish were tested for predator avoidance again at the settlement stage (transformation to a juvenile). These were compared to wild caught damselfish (*Pomacentrus wardi*) that were also treated with the same levels of CO_2. The graph below shows their behavior at different levels of CO_2.

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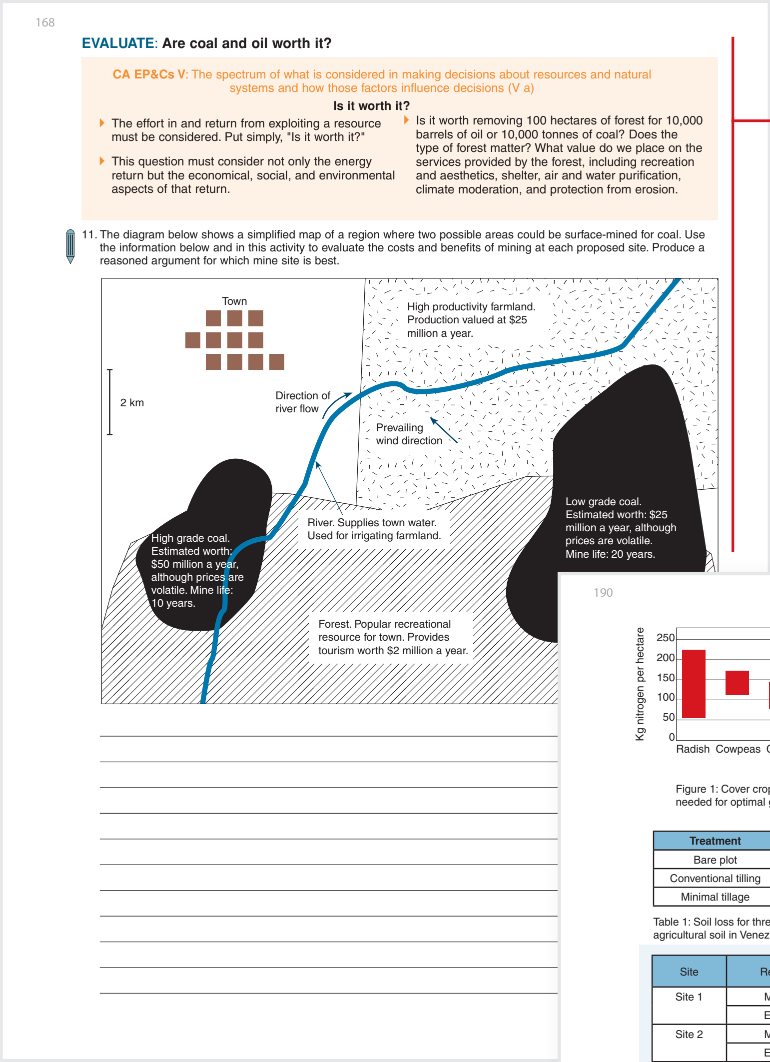
Engineering Design Solutions

ETS SEPs, DCIs, and performance expectations as indicated in the CA-NGSS framework are met through appropriately integrated engineering and design challenges. Typically tasks include analyzing problems, developing solutions using engineering, evaluating a design solution based on costs and benefits, or modeling a design solution.

The three dimensions of the NGSS framework appropriate to each design challenge are indicated in the chapter introduction of the Teacher's Edition (and Teacher's Digital Edition) and indicated through the tab system on the activity itself. Such tasks are usually examples of 'ELABORATE' as they involve the students applying what they learned to solve a problem. As such, they also make good tasks for formative or summative assessment.



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EVALUATE: Are coal and oil worth it?

CA EP&Cs V: The spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions (V a)

Is it worth it?

- The effort in and return from exploiting a resource must be considered. Put simply, "Is it worth it?"
- This question must consider not only the energy return but the economical, social, and environmental aspects of that return.
- Is it worth removing 100 hectares of forest for 10,000 barrels of oil or 10,000 tonnes of coal? Does the type of forest matter? What value do we place on the services provided by the forest, including recreation and aesthetics, shelter, air and water purification, climate moderation, and protection from erosion.

11. The diagram below shows a simplified map of a region where two possible areas could be surface-mined for coal. Use the information below and in this activity to evaluate the costs and benefits of mining at each proposed site. Produce a reasoned argument for which mine site is best.

In this ETS example, students are asked to evaluate the costs and benefits of mining coal at two different site. They must evaluate a range of factors and decide which option is best. Cost, productivity, effect on the nearby township and its water supply, and tourism are all considered. The activity provides an excellent example of how ETS can be linked to achieve CA EP&Cs outcomes.

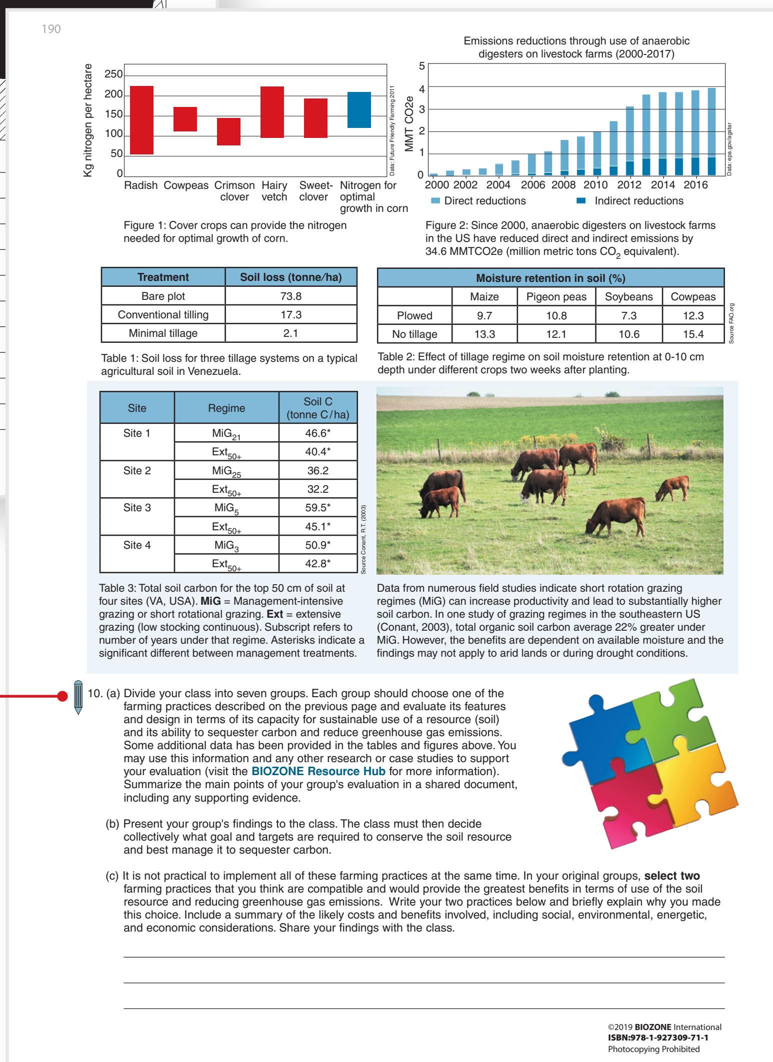

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Figure 1: Cover crops can provide the nitrogen needed for optimal growth of corn.

Figure 2: Since 2000, anaerobic digesters on livestock farms in the US have reduced direct and indirect emissions by 34.6 MMTCO2e (million metric tons CO_2 equivalent).

Treatment	Soil loss (tonne/ha)
Bare plot	73.8
Conventional tilling	17.3
Minimal tillage	2.1

Table 1: Soil loss for three tillage systems on a typical agricultural soil in Venezuela.

Moisture retention in soil (%)				
	Maize	Pigeon peas	Soybeans	Cowpeas
Plowed	9.7	10.8	7.3	12.3
No tillage	13.3	12.1	10.6	15.4

Source FAO.org

Table 2: Effect of tillage regime on soil moisture retention at 0-10 cm depth under different crops two weeks after planting.

Site	Regime	Soil C (tonne C/ha)
Site 1	MiG_{21}	46.6*
	Ext_{50+}	40.4*
Site 2	MiG_{25}	36.2
	Ext_{50+}	32.2
Site 3	MiG_{5}	59.5*
	Ext_{50+}	45.1*
Site 4	MiG_{3}	50.9*
	Ext_{50+}	42.8*

Source Conant, R.T. (2003)

Table 3: Total soil carbon for the top 50 cm of soil at four sites (VA, USA). **MiG** = Management-intensive grazing or short rotational grazing. **Ext** = extensive grazing (low stocking continuous). Subscript refers to number of years under that regime. Asterisks indicate a significant different between management treatments.

Data from numerous field studies indicate short rotation grazing regimes (MiG) can increase productivity and lead to substantially higher soil carbon. In one study of grazing regimes in the southeastern US (Conant, 2003), total organic soil carbon average 22% greater under MiG. However, the benefits are dependent on available moisture and the findings may not apply to arid lands or during drought conditions.

10. (a) Divide your class into seven groups. Each group should choose one of the farming practices described on the previous page and evaluate its features and design in terms of its capacity for sustainable use of a resource (soil) and its ability to sequester carbon and reduce greenhouse gas emissions. Some additional data has been provided in the tables and figures above. You may use this information and any other research or case studies to support your evaluation (visit the **BIOZONE Resource Hub** for more information). Summarize the main points of your group's evaluation in a shared document, including any supporting evidence.

(b) Present your group's findings to the class. The class must then decide collectively what goal and targets are required to conserve the soil resource and best manage it to sequester carbon.

(c) It is not practical to implement all of these farming practices at the same time. In your original groups, **select two** farming practices that you think are compatible and would provide the greatest benefits in terms of use of the soil resource and reducing greenhouse gas emissions. Write your two practices below and briefly explain why you made this choice. Include a summary of the likely costs and benefits involved, including social, environmental, energetic, and economic considerations. Share your findings with the class.

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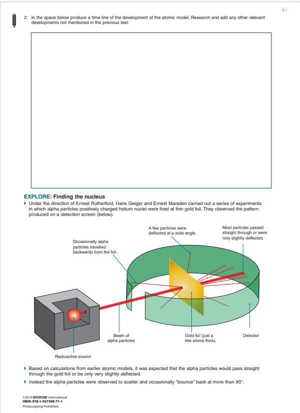
During this activity, students work in groups to evaluate the effects of seven farming practices on soil sustainability and carbon emissions. After presenting their findings to the class, the entire class must debate the merits and limitations of each and collectively set goals to conserve the soil resource, reduce emissions from soil, and increase soil storage of carbon.

This activity not only provides excellent practice in analyzing a real life problem and seeing how a technological solution can help to solve it, but the collaborative nature of the work is beneficial to English language learners.

The Nature of Science

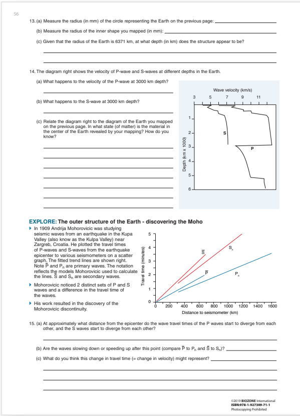
The Nature of Science combines established information with new knowledge to constantly refine what we know about the natural world. Eight Nature of Science understandings are presented in the NGSS document. Four are associated most closely with Science and Engineering Practices, and four with the Crosscutting Concepts. Because the Nature of Science understandings have been incorporated into most activities in *Chemistry in the Earth System*, we have not identified them specifically on the activity page. Some examples of activities relating to the eight Nature of Science understandings are illustrated below. The subheading to which they relate is also given.

Nature of science understandings most closely associated with science and engineering practices



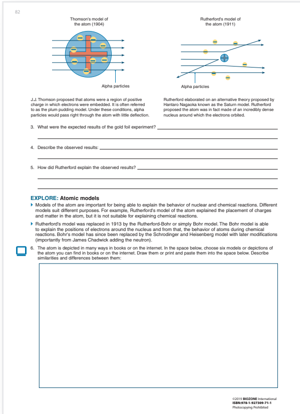
Scientific investigations use a variety of methods.

- Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge



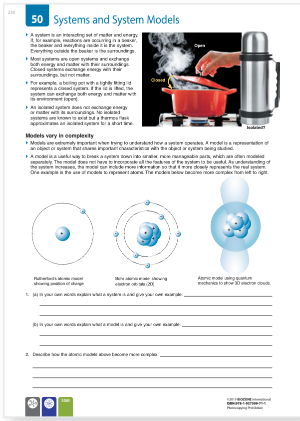
Scientific knowledge is based on empirical evidence.

- Scientific knowledge is based on empirical evidence.



Scientific knowledge is open to revision in light of new evidence.

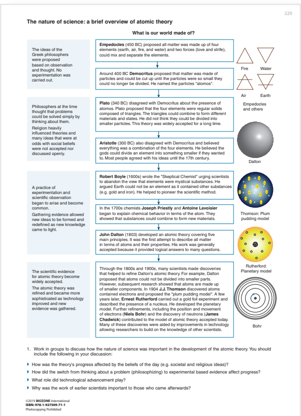
- Most scientific knowledge is quite durable but is subject to change based on new evidence and/or reinterpretations of existing evidence.



Science models, laws, mechanisms, and theories explain natural phenomena.

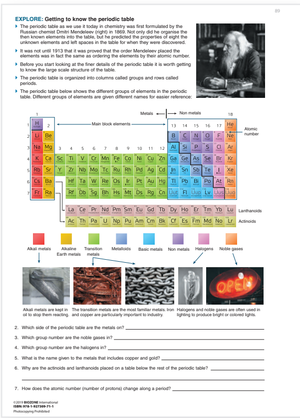
- Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory.

Nature of science understandings most closely associated with crosscutting concepts



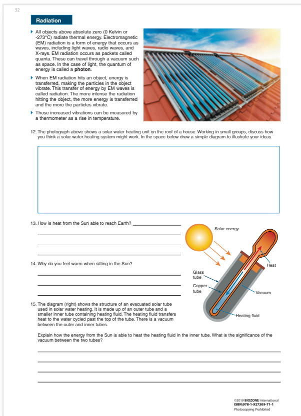
Science is a way of knowing.

- Scientific knowledge has a history that includes refinement of, and changes to, theories, ideas, and beliefs over time.



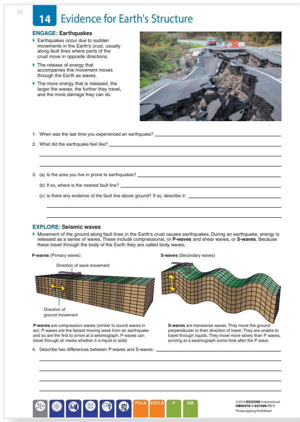
Scientific knowledge assumes an order and consistency in natural systems.

- Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and will continue to do so in the future.



Science is a human endeavor.

- Technological advances have influenced the progress of science and science has influenced advances in technology.



Science addresses questions about the natural and material world.

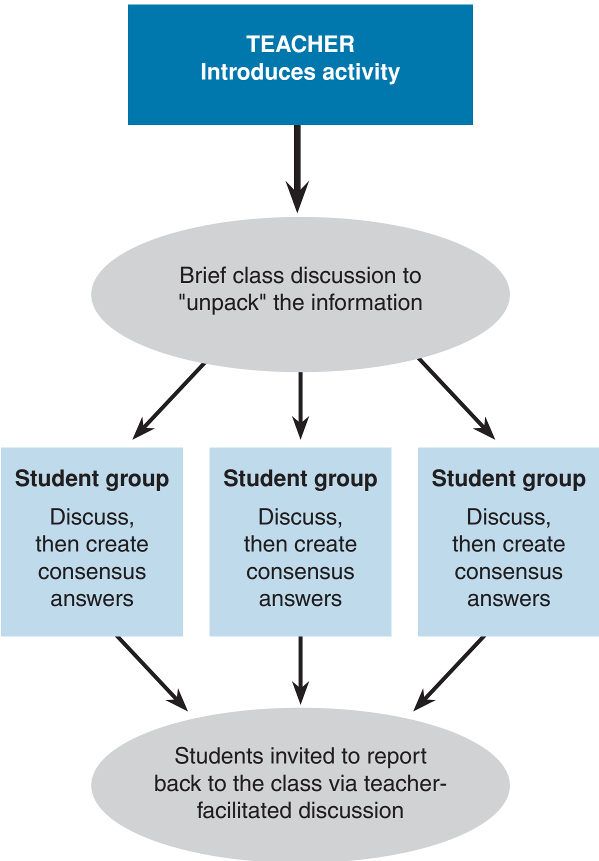
- Scientific knowledge indicates what can happen in natural systems - not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.

Teaching Strategies for Classroom Use

Achieving effective differential instruction in classes is a teaching challenge. Students naturally have mixed abilities, varying backgrounds in the subject, and different language skills. Used effectively, BIOZONE's student books and supporting resources can make teaching a mixed ability class easier. Here, we suggest some approaches for differential instruction.

MAKING A START

Regardless of which activity you might be attempting in class, a short introduction to the task by the teacher is a useful orientation for all students. For collaborative work, the teacher can then divide the class into appropriate groups, each with a balance of able and less able students. Depending on the activity, the class may regroup at the end of the lesson for discussion.



Using collaboration to maximize learning outcomes

- The structure of *Chemistry in the Earth System* allows for a flexible approach to unpacking the content with your students.
- The content can be delivered in a way to support collaboration, where students work in small groups to share ideas and information to answer and gain a better understanding of a topic, or design a solution to a problem.
- By working together to ask questions and evaluate each other's ideas, students maximize their own and each other's learning opportunities. They are exposed to ideas and perspectives they may not have come up with on their own.
- Collaboration, listening to others, and voicing their own ideas is valuable for supporting English language learners and developing their English and scientific vocabularies.
- Use a short, informal collaborative learning session to get students to exchange ideas about the answer to a question. Alternatively, collaboration may take a more formal role that lasts for a longer period of time (e.g. assign groups to work together for a practical activity, to research an extension question, or design a solution to a problem).

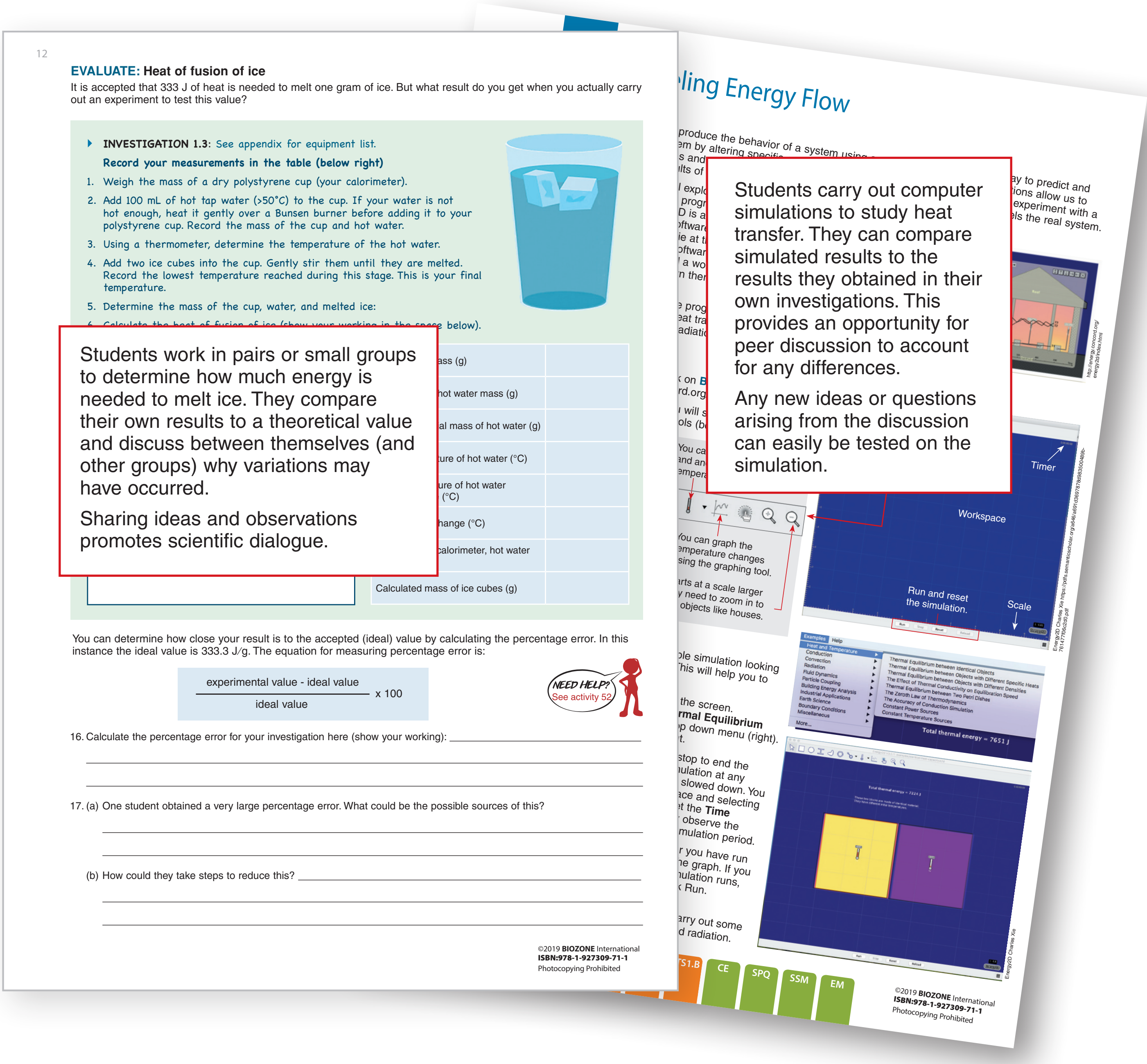
The teacher introduces the topic. They provide structure to the session by providing background information and setting up discussion points and clear objectives. Collaboration is emphasized to encourage participation from the entire group. If necessary, students in a group can be assigned specific tasks.

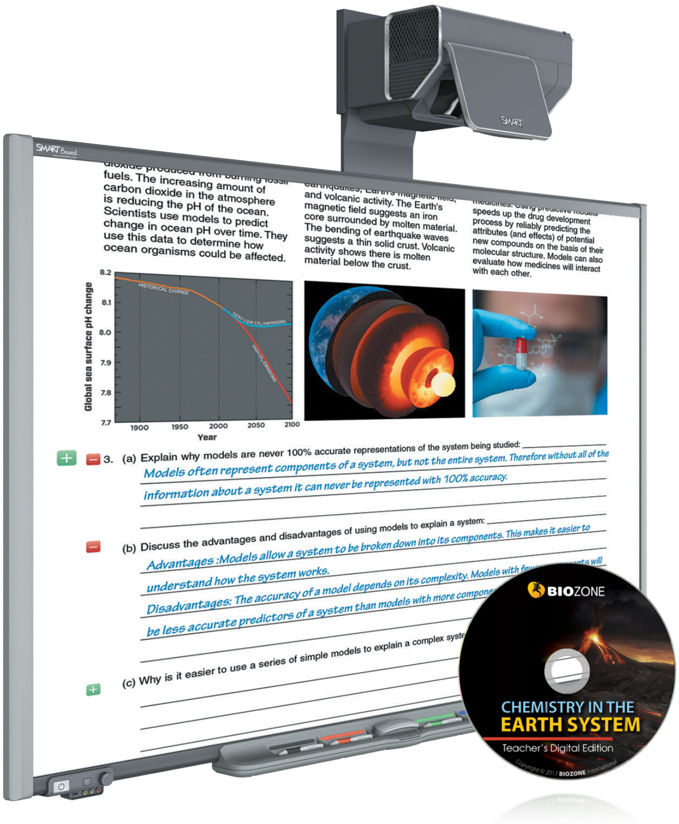
Students work in small groups so everyone's contribution is heard. They collaborate, share ideas, and engage in discourse. The emphasis is on discussing questions and formulating a consensus answer, not just sharing ideas.

At the end of the session, students report back on their findings. Each student should have enough knowledge to report back on the group's findings. Reporting consists primarily of providing answers to questions, but may involve presenting a report, model, or slide show, or contributing to a debate.

Peer to peer support

- **Peer-to-peer (collaborative) learning** can be used for any activities, but is particularly valuable for more challenging activities in which the content is more complex or the questions require students to draw on several areas of their knowledge to synthesize an answer. Examples of such activities include investigative activities, activities with a design component, or activities involving data analysis, graphing, and evaluation.
- Stronger peers can assist weaker students and both groups benefit from verbalizing their thoughts and presenting them to a group. Students for whom English is a second language can ask their peers to explain unfamiliar terms (both scientific and English) and this benefits the understanding of both parties.
- **Practical investigations** are an ideal vehicle for peer-to-peer learning. Students can work in groups or pairs and their results and observations prompt them to voice their questions and think about how they could use the information obtained to describe phenomena or answer specific questions. There are also opportunities for students to collaborate using online simulations (e.g. **Energy2D** shown below).





Interactive revision of tasks in class

- The **Teacher's Digital Edition** provides a digital rights managed (DRM) version of the student book as PDF files. It features useful HIDE/SHOW answers, which can be used to review activities in class using a data projector or interactive whiteboard (left).
- Students benefit from the feedback in class, where questions can be addressed, and teachers benefit by having students self-mark their work and receive helpful feedback on their responses.
- This approach is particularly suited to activities with questions requiring a discussion, as students will be able to clarify some aspects of their responses. Stronger students can benefit by contributing to the explanatory feedback and class discussion.

NGSS as collaboration and discovery

- BIOZONE's *Chemistry in the Earth System* provides multiple chances for collaboration and discovery. By working together and sharing ideas, students are exposed to different perspectives and levels of knowledge about a particular phenomenon.
- NGSS requires deeper student engagement with less emphasis on facts and more on understanding. By exploring principles and concepts within a context students are more easily able to apply these principles to new phenomena.
- BIOZONE's *Chemistry in the Earth System* uses the CA NGSS as a framework to develop student understanding by providing a range of activities. These begin by getting students to think about and share what they already know and then build on this knowledge by providing opportunities to explore and explain phenomena.

Student A is capable. He helps to lead the discussion and records the others ideas in a structured way.

Students B and C are also capable but less willing to lead discussion they will add ideas to the discussion but need a little direction from A to do so.

Student D is less able but gains ideas and understanding from the discussion of students A, B, and C. She may add to the discussion as she gains confidence in the material being studied.

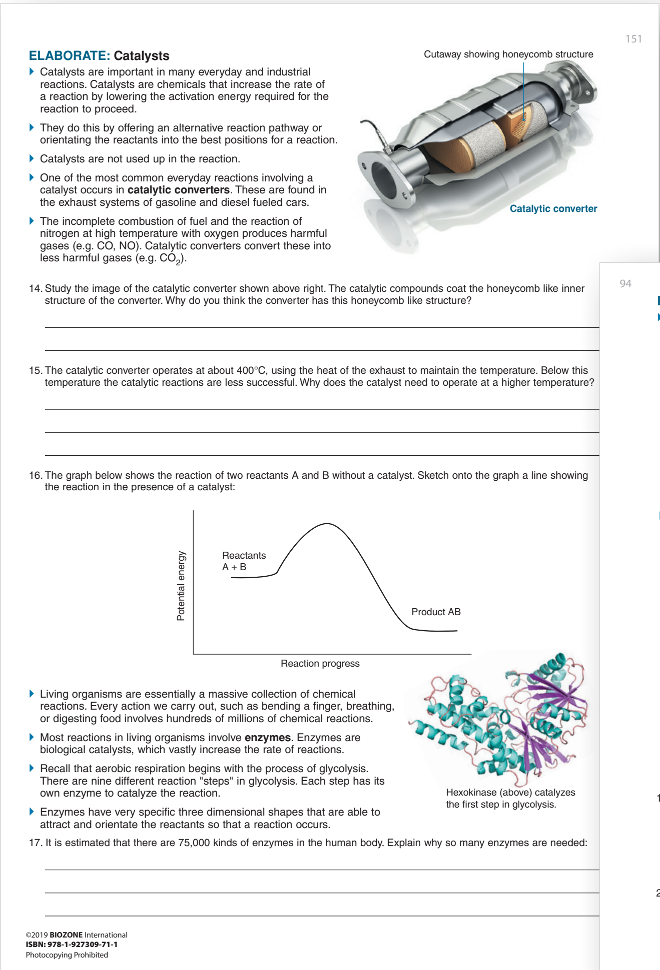
Formative and Summative Assessment

Chemistry in the Earth System provides ample opportunity for students to demonstrate their understanding and proficiency in all three dimensions of the standards. Opportunities for both formative and summative and assessment are provided.

As this series has been written specifically for the CA-NGSS Three Course Model, all activities (including assessments) are three-dimensional in their approach, with the goal to enable achievement of specific performance expectations. Performance expectations (PE) are not always met through completion of one activity or assessment, but through completion of a connected suite of tasks (as intended by the framework).

Assessments involve a variety of tasks as appropriate to a 3D approach, e.g., constructing models, analyzing and interpreting data, explaining, and communicating understanding through short and long answers, drawings, calculations, group work, design, and problem solving. The structure of the tasks is such that students use specific science and engineering practices and apply relevant crosscutting concepts to demonstrate their understanding of disciplinary core ideas.

Formative assessments can be chosen by the teacher to determine how a student's knowledge is progressing within a selected topic. We suggest that 'ELABORATE' and 'EVALUATE' sections of activities be used for formative assessment. These may incorporate some aspect of a performance expectation with the goal being to build confidence. Teachers can revise their instruction, revisit material, or set further tasks if a student is having difficulty with the material. Revisiting the Anchoring Phenomenon near the end of each instructional segment also provides a way to evaluate student understanding.



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ELABORATE: Catalysts

- Catalysts are important in many everyday and industrial reactions. Catalysts are chemicals that increase the rate of a reaction by lowering the activation energy required for the reaction to proceed.
- They do this by offering an alternative reaction pathway or orientating the reactants into the best positions for a reaction.
- Catalysts are not used up in the reaction.
- One of the most common everyday reactions involving a catalyst occurs in **catalytic converters**. These are found in the exhaust systems of gasoline and diesel fueled cars.
- The incomplete combustion of fuel and the reaction of nitrogen at high temperature with oxygen produces harmful gases (e.g. CO, NO). Catalytic converters convert these into less harmful gases (e.g. CO_2).

Cutaway showing honeycomb structure

Catalytic converter

14. Study the image of the catalytic converter shown above right. The catalytic compounds coat the honeycomb like inner structure of the converter. Why do you think the converter has this honeycomb like structure?

15. The catalytic converter operates at about 400°C, using the heat of the exhaust to maintain the temperature. Below this temperature the catalytic reactions are less successful. Why does the catalyst need to operate at a higher temperature?

16. The graph below shows the reaction of two reactants A and B without a catalyst. Sketch onto the graph a line showing the reaction in the presence of a catalyst:

Potential energy | Reactants A + B | Product AB | Reaction progress

- Living organisms are essentially a massive collection of chemical reactions. Every action we carry out, such as bending a finger, breathing, or digesting food involves hundreds of millions of chemical reactions.
- Most reactions in living organisms involve **enzymes**. Enzymes are biological catalysts, which vastly increase the rate of reactions.
- Recall that aerobic respiration begins with the process of glycolysis. There are nine different reaction "steps" in glycolysis. Each step has its own enzyme to catalyze the reaction.
- Enzymes have very specific three dimensional shapes that are able to attract and orientate the reactants so that a reaction occurs.

Hexokinase (above) catalyzes the first step in glycolysis.

17. It is estimated that there are 75,000 kinds of enzymes in the human body. Explain why so many enzymes are needed:

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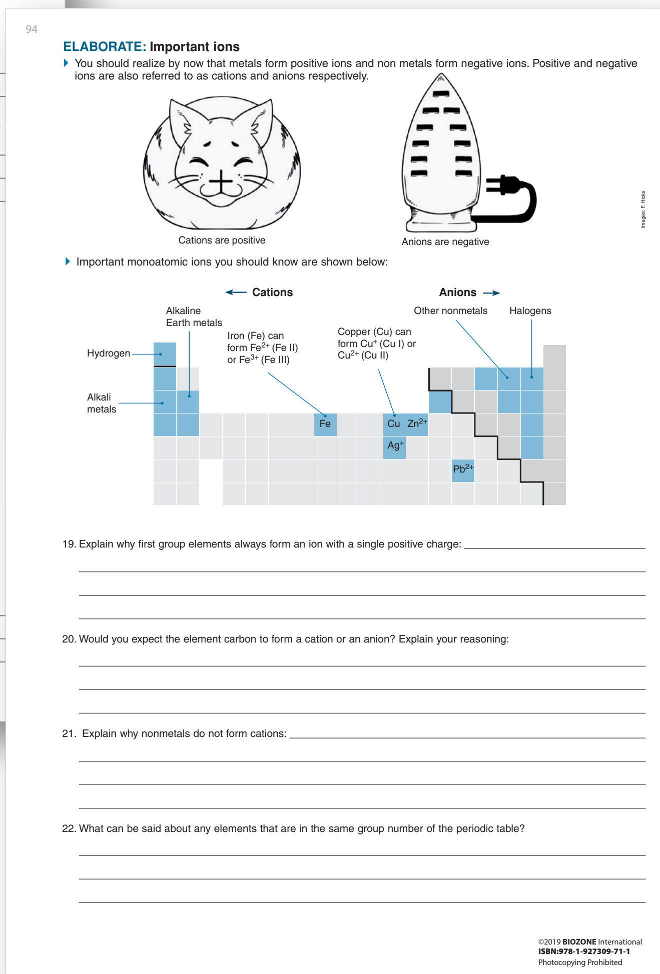

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ELABORATE: Important ions

- You should realize by now that metals form positive ions and non metals form negative ions. Positive and negative ions are also referred to as cations and anions respectively.

Cations are positive

Anions are negative

Images: F. Hicks

- Important monoatomic ions you should know are shown below:

← Cations | Anions →

Hydrogen | Alkali metals | Alkaline Earth metals | Iron (Fe) can form Fe^{2+} (Fe II) or Fe^{3+} (Fe III) | Copper (Cu) can form Cu^{+} (Cu I) or Cu^{2+} (Cu II) | Other nonmetals | Halogens

Fe | Cu | Zn^{2+} | Ag^{+} | Pb^{2+}

19. Explain why first group elements always form an ion with a single positive charge:

20. Would you expect the element carbon to form a cation or an anion? Explain your reasoning:

21. Explain why nonmetals do not form cations:

22. What can be said about any elements that are in the same group number of the periodic table?

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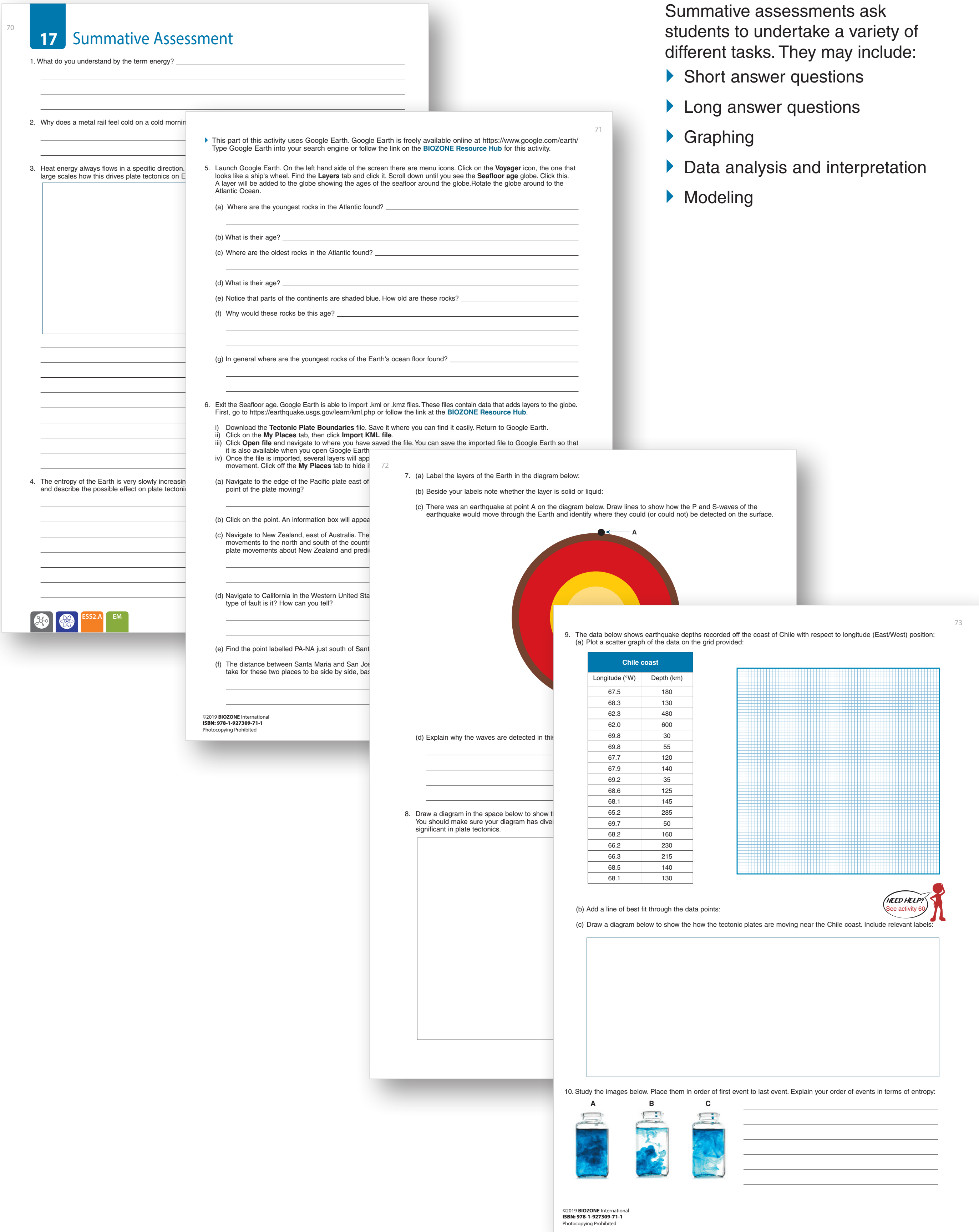
Summative assessments at the close of each instructional segment can be used as a formal testing moment to evaluate student skills, understanding, and application of knowledge of the material covered. They are designed to meet part or all of one or more performance expectations. The performance expectations they cover are identified in the chapter introduction for the instructional segment, and also in the tables summarizing BIOZONE's 3D approach by chapter earlier in this guide (CG5-CG6).

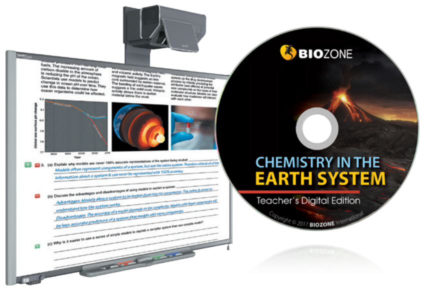


Summative assessments ask students to undertake a variety of different tasks. They may include:

- Short answer questions
- Long answer questions
- Graphing
- Data analysis and interpretation
- Modeling

The Teacher's Digital Edition

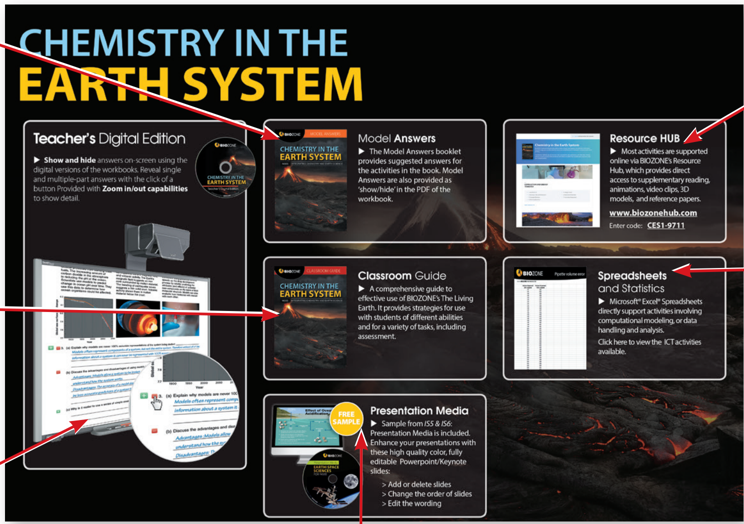
The *Teacher's Digital Edition* is a DRM product, sold separately, and aimed primarily at extending the pedagogical tools at a teacher's disposal. Many of the features of this resource have been developed in response to requests from teachers themselves.



Digital copy of the Model Answers (non-printable). Suggested answers are provided to most activities.

This **Classroom Guide** is provided as a printable PDF.

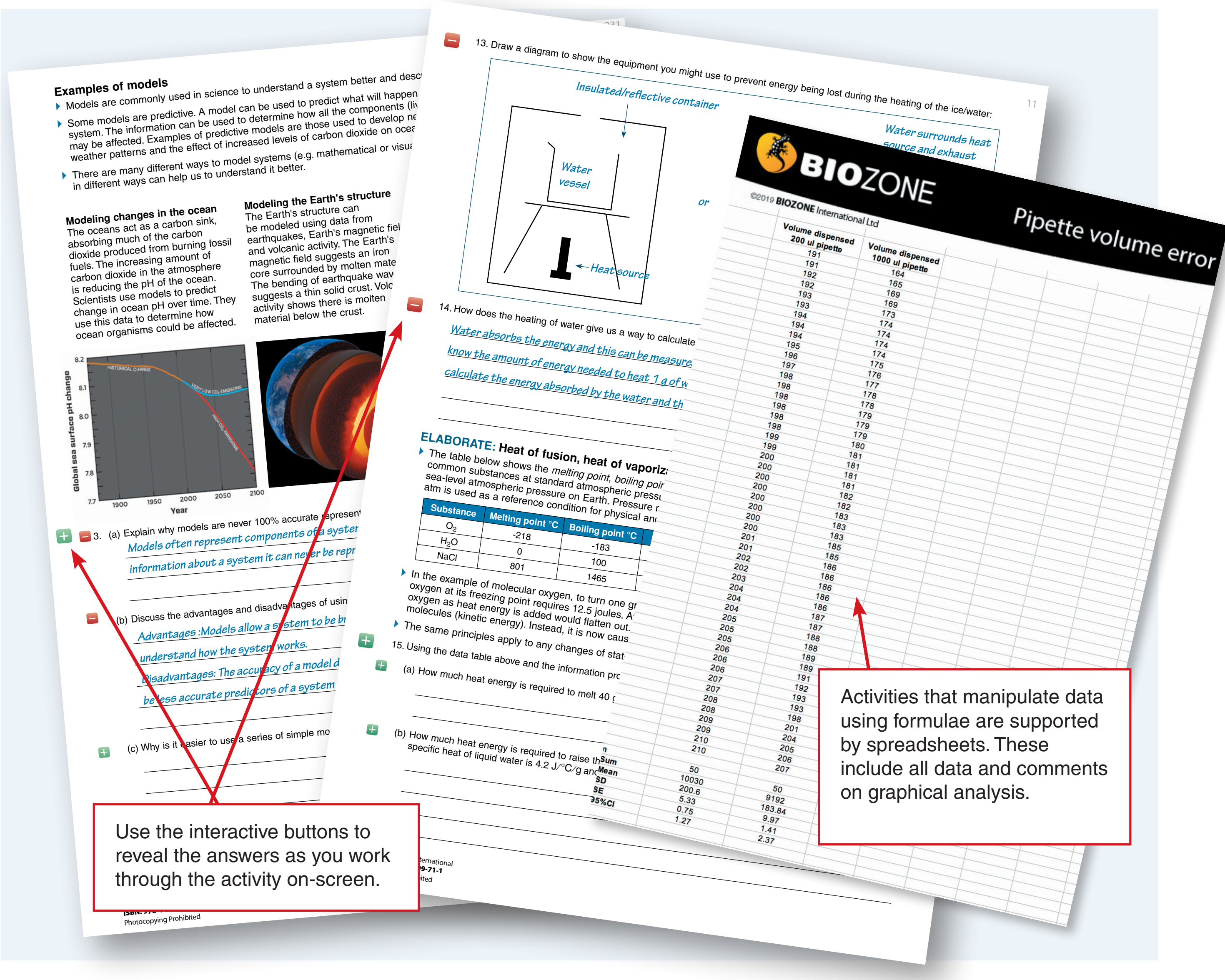
A digital (PDF) version of the student edition (non-printable). Use the interactive buttons to HIDE or SHOW the answers.



Access **BIOZONE's Resource Hub** directly from this link for a range of resources to support the activities.

Link to ***Excel***® **spreadsheets** for all activities with a data analysis component.

A **BONUS** sample copy from the planned presentation media for IS5 and IS6 is included. It is fully editable.



Activities that manipulate data using formulae are supported by spreadsheets. These include all data and comments on graphical analysis.

Use the interactive buttons to reveal the answers as you work through the activity on-screen.