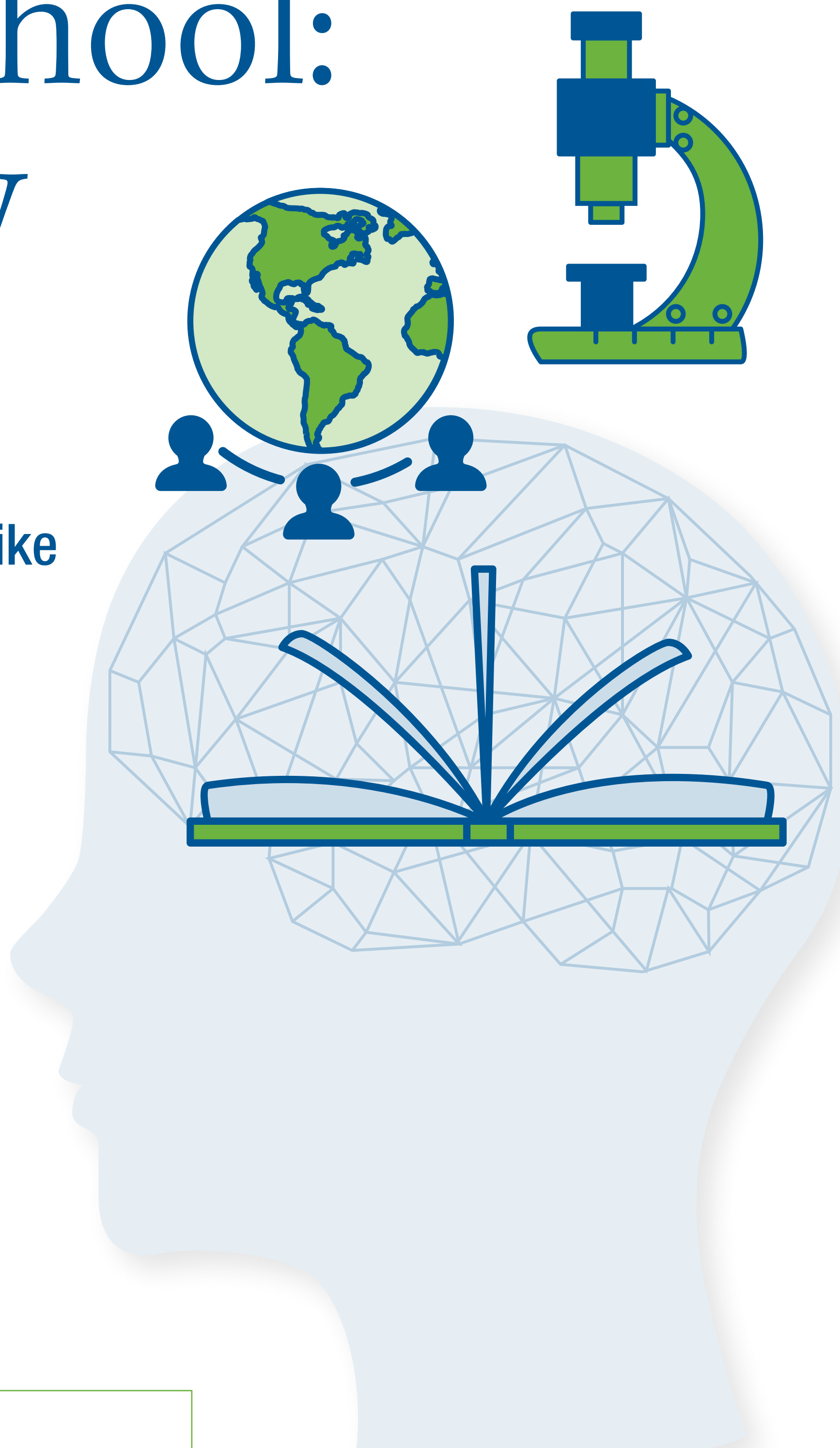
SREB Readiness Courses

Ready for High School: Literacy



Academic Notebook

Science Unit 1

What will the Earth look like in 1 million years?

Informational Text

Name

Unit 1
Table of Contents

Course Overview

Welcome to the first disciplinary literacy science unit of the SREB Readiness Course — Ready for High School: Literacy. What does disciplinary literacy in science mean? According to Shanahan & Shanahan (2012), disciplinary literacy refers to the specialized skills and strategies needed to learn at higher levels in each discipline. That means that how people approach reading and writing in the sciences would differ from how they approach it in history, English, mathematics, or other fields. It also means that students need to learn more than the content in any particular discipline — they also need to learn how reading and writing are used within that field. So, disciplinary literacy in science in this unit will introduce you to the knowledge, skills, and tools used by scientists.

You will learn to "make explicit connections among the language of science, how science concepts are rendered in various text forms, and resulting science knowledge" by learning ways to "develop the proficiencies needed to engage in science inquiry, including how to read, write, and reason with the language, texts, and dispositions of science" (Pearson, Moje, Greenleaf, 2010). These ideas are the principal focus of this unit. While certainly the content covered in this course is important, a primary purpose of this unit is to equip you with the tools necessary to be more successful in your college coursework. You will take part in many reading and writing activities aimed at improving your disciplinary literacy in science. To that end, the creators of the course have developed this Academic Notebook.

More specifically, in this unit you will apply the concepts of disciplinary literacy to science in order to learn how to approach reading and writing as a scientist. You will focus on Earth Science, specifically processes that change the surface of the Earth over time, as you learn skills and strategies that will allow them to access the texts and make meaning of the content. You will recognize how scientists approach vocabulary using Greek and Latin root words. You will access multiple texts in order to gain understanding of a complex scientific process in order to construct an explanation. You will practice transforming information from text to diagram, a skill very important in understanding science texts. You will engage in an inquiry activity in which you model various processes that can alter the surface of the Earth, as well as develop your own model of a process they research.

An important skill in science literacy is the ability to analyze large bodies of data, so you will learn strategies to do that, as well as to look for trends such as cause and effect. Also, in preparation for science at the high school level, you will learn study strategies for approaching science tests. The unit culminates in a writing task in which you will synthesize what you have learned about processes that change the Earth's surface in order to make a prediction about what the surface of the Earth will look like in 1 million years. You will support your prediction with evidence from the texts and activities used throughout the unit.

Purposes of the Academic Notebook

The Academic Notebook has three roles in this course. First, the notebook provides you with a starter kit of tools aimed to prepare you for high school science courses. These tools will assist you in learning and comprehending the information from the scientific text, animations, and lectures you receive in the class.

A second role of the notebook is to provide you with a personal space to record your work. The Academic Notebook is where you will take your notes for the class on any materials you are covering. For example, if you are reading an article in class, take notes in this notebook. If you are doing a lab, make your observations and notes here. Likewise, if you are listening to a lecture, take notes here. Use the tools in the resource portion of the notebook to assist you in organizing your notes.

The third and final role of the notebook is that of an assessment tool. Your instructor may periodically collect the notebooks and review your work to ensure that you are remaining on task and to assist you with any material that is causing you difficulty. Your instructor may also assign tasks to be completed in the notebook, such as in-class writing assignments. At the end of this six-week module, your instructor will review the contents of this notebook as part of your overall grade. Thus, it is important that you work seriously as this notebook becomes the record of your activity in this course.

Helpful Hints for Science Literacy Success

About Scientists: How do scientists think?

As you will spend much of your time in class learning this on your own, it is best to be brief. In short, scientists learn by careful observation of the world around them to discover general principles. They do this through careful experimentation that results in data. Scientists use this data to draw conclusions. You likely have heard of the scientific method. Scientists use this method as a structured way to investigate the questions they have. An important use of the scientific method is to be able to replicate previous work. Scientists strive to organize, analyze, and explain things clearly. Scientists believe that science is an attempt to build understandings of the world and that science findings are tentative and subject to revision based on new understandings.

About Scientists: What do scientists ask?

Scientists ask lots of questions about nature and the world around them. These are questions that you will hopefully come to ask upon completing this coursework, and the tools in the Resource Materials section of the Academic Notebook are intended to aid you in asking these questions.

Scientists are systematic when they ask questions. Scientific inquiry helps scientists answer questions through investigation. They begin with observations. They may start with big, broad questions: “Why? What’s going on? How is this explained?” They then may break a larger question into smaller parts to examine. They examine work that has already been done. They use the scientific method to hypothesize, test, analyze, and draw conclusions. This inquiry is often, cyclical with experience and observation leading to new hypotheses.

Lesson 1
Gateway Activity

In this lesson, you will . . .

1. Develop scientific practices of observation, inference, and questioning.
2. Observe reconstructed maps of the Earth over time to make inferences regarding ways in which the Earth has changed over time.
3. Use observation and inference about the changing Earth to develop questions about the processes that cause such changes.
4. Categorize questions into research topics that you need to investigate throughout the unit.
5. Review the unit as a whole, as well as the culminating project, and discuss the implications for learning science in this course and beyond.
6. Students understand the components of the culminating project.

Activity

1 Animal Tracks: Observations and Inferences

Record your observations about each segment of the image:

1.

2.

3.

Reflect:

Why is it important to distinguish between observations and inferences? Why is it particularly important in science to distinguish between the two?

Activity

2 Earth Throughout History

As you view the images of Earth throughout history, make notes using the following graphic organizer.

Observations	Inferences	Questions

Activity

3 Unit Essential Question: What will the Earth look like in 1 million years?

Unit Inquiry Questions:

Unit Culminating Task: Prediction Essay

After researching informational texts on factors that change the earth's surface, create a model of what the earth will look like in 1 million years, and write an essay in which you argue the validity of your model. Support your discussion with evidence from the texts.

Write your initial reaction to the prompt below. Complete the graphic organizer below to record your initial thoughts. Ask yourself, “What is the prompt asking me to do?”“What do I need to know to be successful on this assignment?” “Where will I find evidence to support my prediction?”

What is the prompt asking me to do?	What do I need to know to be successful on this assignment?	Where will I find evidence to support my prediction?

Examining the Scoring Rubric

Write the criterion from the scoring rubric that your group has been assigned.

What does a score of "3" mean in your own words? Write your answer below and share.

Final version of what a score of "3" means:

Now that you have been introduced to the unit as a whole and the culminating writing task, you will use this graphic organizer to reflect on your learning at the end of each lesson and consider how what you learned may help you in making a prediction for the future.

Lesson	What processes have shaped the Earth's surface in the past?	How might these processes impact what the Earth may look like in 1 million years?
2		
3		
4		

Lesson	What processes have shaped the Earth's surface in the past?	How might these processes impact what the Earth may look like in 1 million years?
5		
6		
8		

Activity

4 Disciplinary Literacy in Science:

Some of the disciplinary ways science is written and represented can make it a challenge. So before we start this unit, let's talk about two common science writing practices to look for in science text: *Long noun phrases* and *multiple representations*.

Long noun phrases:

Example: Glass crack growth rate is associated with applied stress magnitude.

- Find the noun in this example sentence.

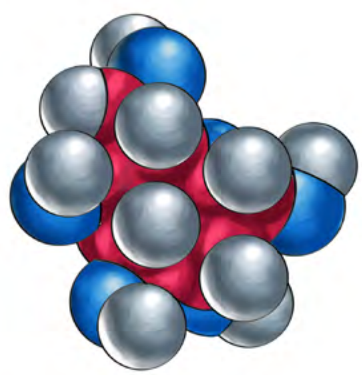
Science is filled with these noun phrases that help with the precision of ideas that are very important to scientists. Some other examples are:

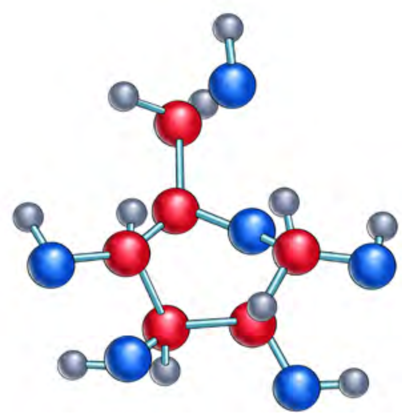
- gene replacement therapy
- primate genome sequences
- the polymerase chain reaction laboratory technique

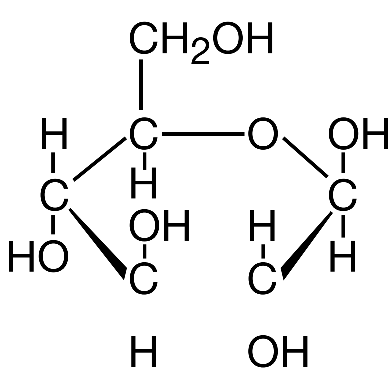
Being able to identify entire concepts by using a noun phrase is an essential skill for reading science and a skill we will continue to work on.

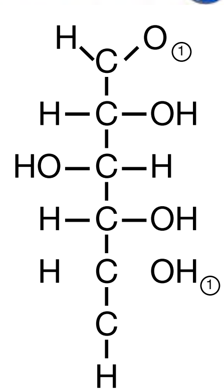
Multiple Representations:

What do these images have in common?









There is no one "right" way to represent molecules — which type a scientist uses depends on what he or she is trying to portray. However, you need to be able to see that they are all representing the same thing. You also need to be able to transform the information into other forms (for example, you should be able to view the molecule and write out the chemical structure).

In this unit we will learn several ways to transform science information from visual to text and back again.

How Scientists Think: Fostering Creativity In Problem Solving

Sep. 22, 2009 — Profound discoveries and insights on the frontiers of science do not burst out of thin air but often arise from incremental processes of weaving together analogies, images, and simulations in a constrained fashion. In cutting-edge science, problems are often ill-defined and experimental data are limited.

To develop an understanding of the system under investigation, scientists build real-world models and make predictions with them. The models are tentative at first, but over time they are revised and refined, and can lead the community to novel problem solutions. Models, thus, play a big role in the creative thinking processes of scientists.

Dr. Nancy J. Nersessian has studied the cognitive processes that underlie scientific creativity by observing scientists at work in their laboratories. She says, "Solving problems at the frontiers of science involves complex cognitive processes. In reasoning with models, part of the process occurs in the mind and part in the real-world manipulation of the model. The problem is not solved by the scientist alone, but by the scientist — model combination. This is a highly creative cognitive process." Her research is published in an upcoming issue of *Topics in Cognitive Science*.

Her study of the working methods of scientists helps in understanding how class and instructional laboratory settings can be improved to foster creativity, and how new teaching methods can be developed based on this understanding. These methods will allow science students to master model-based reasoning approaches to problem solving and open the field to many more who do not think of themselves as traditional "scientists."

http://www.sciencedaily.com/releases/2009/09/ 090921162150.htm

Lesson 2
Making Sense of Science Terminology

In this lesson, you will . . .

1. Learn how to approach discipline-specific vocabulary.
2. Use the discipline-specific vocabulary to explain a science diagram.

Activity

1 Understanding Science Vocabulary

Science terms originate from Greek and Latin languages. Scientists used word parts from those languages to create the terms we use today. By knowing the meaning of those word parts, you can determine the meaning of science vocabulary you come across in science textbooks or articles. In our first lesson, we are going to be learning about the layers of the Earth. This falls under the science Geology. Using your Roots, Prefixes, and Suffixes handout, find the meanings of geo- and –logy. Geo means Earth and logy means study of, so Geology means the study of Earth. When breaking apart your vocabulary terms, remember that words can consist of three parts – prefix, root, and suffix. The root is the main part of a word. Prefixes, such as un- and dis-, can be added to the beginning of a root word. Suffixes like -ing and -less can be added to the end of the root word.

SCIENTIFIC ROOT WORDS, PREFIXES AND SUFFIXES

http://www.succeedinscience.com/apbio/assignments/generalinfo/rootwords.pdf

a- an- ab-; -able	not; without; lacking; deficient away from; out from capable of	cente- centi- centr-	pierce; hundredth; center	-err- erythro- -escent	wander; go astray red; becoming
ac-	to; toward	cephal-	head	eso-	inward; within; inner
-aceous	of or pertaining to	cerat-	horn	eu-	well; good; true; normal
acou- acous -	hear	cerebr-	brain	eury-	widen
ad-	to; toward	cervic-	neck	ex-	out of; away from
aden-	gland	chel-	claw	extra-	beyond; outside
adip-	fat	chem-	dealing with chemicals	-fer-	bear; carry; produce
aero-	air	chir-	hand	ferro-	iron
agri-	field; soil	chlor-	green	fibr-	fiber; thread
-al	having the character of	chondr-	cartilage	-fid; fiss-	split; divided into
alb-	white	chrom-; -chrome	color	-flect -flex	bend
alg-; -algia	pain	chron-	time	flor-	flower
alto-	high	-chym-	juice	flu- fluct-; flux	flow
ambi-	both	-cid- -cis -	cut; kill; fall	foli-	leaf
ameb-	change; alternation	circa- circum-	around; about	fract-	break
amni-	fetal membrane	cirru-	hairlike curls	-gam-	marriage
amphi- am-pho-	both	co-	with; together	gastr-	stomach
amyl-	starch	cocc-	seed; berry	geo-	land; earth
ana-	up; back; again	coel-	hollow	-gen -gine	producer; former
andro-	man; masculine	coll-	glue	-gene-	origin; birth
anemo-	wind	coni-	cone	-gest-	carry; produce; bear
ang-	choke; feel pain	contra-	against	-glen-	eyeball
angi-	blood vessel; duct	corp-	body	-glob-	ball; round
ante-	before; ahead of time	cort- cortic-	outer layer	gloss-	tongue
anter-	front	cosmo-	world; order; form	gluc- glyc-	sweet; sugar
antho-	flower	cotyl-	cup	glut-	buttock
anti-	against; opposite	counter-	against	gnath-	jaw
anthropo-	man; human	crani-	skull	-gon	angle; corner
-ap- -aph-	touch	cresc- cret-	begin to grow	-grad-	step
apo- ap-	away from	crypt-	hidden; covered	-gram; graph	record; writing
aqu-	water	-cul-; -cule	small; diminutive	grav-	heavy
archaeo-	primitive; ancient	cumul-	heaped	-gross-	thick
-ary -arium	place for something	cuti-	skin	gymno-	naked; bare
arteri-	artery	cyan-	blue	gyn-	female
arthr-	joint; articulation	-cycle; cycl-	ring; circle	gyr-	ring; circle; spiral
-ase	forms names of enzymes	-cyst-	sac; pouch; bladder	-hal-; -hale	breathe; breath
aster- astr-	star	cyt-; -cyte	cell; hollow container	halo-	salt
-ate	verb form - the act of...	dactyl-	finger	hapl-	simple
ather-	fatty deposit	de-	away from; down	hecto-	hundred
-ation	noun form - the act of...	deca-	ten	-helminth-	worm
atmo-	vapor	deci-	tenth	hem-	blood
audi-	hear	deliquesc-	become fluid	hemi-	half
aur-	ear	demi-	half	hepar- hepat-	liver
auto-	self	dendr-	tree	herb-	grass; plants
bacter- bactr-	bacterium; stick; club	dent-	tooth	hetero-	different; other
barb-	beard	derm-	skin	hex-	six
baro-	weight	di- dipl- (Latin)	two; double	hibern-	winter
bath-	depth; height	di- dia- (Greek)	through; across; apart	hidr-	sweat
bene-	well; good	dia- (Latin)	day	hipp-	horse
bi- (Latin)	two; twic e	digit-	finger; toe	hist-	tissue
bi- bio- (Greek)	life; living	din-	terrible	holo-	entire; whole
-blast-	sprout; germ; bud	dis-	apart; out	homo- (Latin)	man; human

brachi-	arm	dorm-	sleep	homo- (Greek)	same; alike
brachy-	short	dors-	back	hort-	garden
brady-	slow	du- duo-	two	hydr-	water
branchi-	fin	-duct	lead	hygr-	moist; wet
brev-	short	dynam-	power	hyper-	above; beyond; over
bronch-	windpipe	dys-	bad; abnormal; difficult	hyph-	weaving; web
cac-	bad	ec-	out of; away from	hypno-	sleep
calor-	heat	echin-	spiny; prickly	hypo-	below; under; less
capill-	hair	eco-	house	hyster-	womb; uterus
capit-	head	ecto-	outside of	-iac	person afflicted with disease
carcin-	cancer	-elle	small	-iasis	disease; abnormal condition
cardi-	heart	-emia	blood	-ic	(adjective former)
carn-	meat; flesh	en- endo-; ent-	in; into; within	ichthy-	fish
carp-	fruit	-en	made of	ign-	fire
carpal-	wrist	encephal-	brain	in- il- im- ir-	not
cata-	breakdown; downward	enter-	intestine; gut	in- il- im- ir-	to; toward; into
caud-	tail	entom-	insects	in-	very; thoroughly
-cell-	chamber; small room	-eous	nature of; like	-ine	of or pertaining to
cen-; -cene	now; recent	epi-	upon; above; over	infra-	below; beneath
inter- intra-	between within; inside	-oma; omni-	abnormal condition; tumor; all	sacchar- sapr-	sugar rotten
-ism	a state or condition	onc-	mass; tumor	sarc-	flesh
iso-	equal; same	oo-	egg	saur-	lizard
-ist	person who deals with...	opthalm-	eye	schis- schiz-	split; divide
-itis	inflammation; disease	opt-	eye	sci-	know
-ium	refers to a part of the body	orb-	circle; round; ring	scler-	hard
-kary-	cell nucleus	-orium -ory	place for something	-scop-	look; device for seeing
kel-	tumor; swelling	ornith-	bird	-scribe -script	write
kerat-	horn	orth-	straight; correct; right	semi-	half; partly
kilo-	thousand	oscu-	mouth	sept-	partition; seven
kine-	move	-osis	abnormal condition	-septic	infection; putrefaction
lachry-	tear	oste-	bone	sess-	sit
lact-	milk	oto-	ear	sex-	six
lat-	side	-ous	full of	-sis	condition; state
leio-	smooth	ov-	egg	sol-	sun
-less	without	oxy-	sharp; acid; oxygen	solv-	loosen; free
leuc- leuk-	white; bright; light	pachy-	thick	som- somat-	body
lign-	wood	paleo-	old; ancient	somn-	sleep
lin-	line	palm-	broad; flat	son-	sound
lingu-	tongue	pan-	all	spec- spic-	look at
lip-	fat	par- para-	beside; near; equal	-sperm-	seed
lith-; -lite	stone; petrifying	path-; -pathy	disease; suffering	-spher-	ball; round
loc-	place	-ped-	foot	spir-; -spire	breathe
-log-	word; speech	-ped-	child	-spor-	seed
-logist	one who studies...	pent-	five	stat-; -stasis	standing; placed; staying
-logy	study of...	per-	through	stell-	stars
lumin-	light	peri-	around	sten-	narrow
-lys- -lyt-; -lyst	decompose; split; dissolve	permea-	pass; go	stern-	chest; breast

macr-	large	phag-	eat	stom-; -stome	mouth
malac-	soft	pheno-	show	strat-	layer
malle-	hammer	-phil-	loving; fond of	stereo-	solid; 3-dimensional
mamm-	breast	phon-; -phone	sound	strict-	drawn tight
marg-	border; edge	-phore; pher-	bear; carry	styl-	pillar
mast-	breast	photo-	light	sub-	under; below
med-	middle	phren-	mind; diaphragm	super-; sur-	over; above; on top
meg-	million; great	phyc-	seaweed; algae	sym-; syn-	together
mela- melan-	black; dark	phyl-	related group	tachy-	quick; swift
-mer	part	-phyll	leaf	tarso-	ankle
mes-	middle; half; intermediate	physi-	nature; natural qualities	tax-	arrange; put in order
met- meta-	between; along; after	phyt-; -phyte	plant	tele-	far off; distant
-meter -metry	measurement	pino-	drink	telo-	end
micro-	small; millionth	pinni-	feather	terr-	earth; land
milli-	thousandth	plan-	roaming; wandering	tetr-	four
mis-	wrong; incorrect	plasm-; -plast-	form; formed into	thall-	young shoot
mito-	thread	platy-	flat	-the- -thes-	put
mole-	mass	pleur-	lung; rib; side	-thel-	cover a surface
mono-	one; single	pneumo-	lungs; air	-therm-	heat
mort-	death	-pod	foot	-tom-	cut; slice
-mot-	move	poly-	many; several	toxico-	poison
morph-	shape; form	por-	opening	top-	place
multi-	many	port-	carry	trache-	windpipe
mut-	change	post-	after; behind	trans-	across
my-	muscle	pom-	fruit	tri-	three
myc-	fungus	pre-	before; ahead of time	trich-	hair
mycel-	threadlike	prim-	first	-trop-	turn; change
myria-	many	pro-	forward; favoring; before	-troph-	nourishment; one who feeds
moll-	soft	proto-	first; primary	turb-	whirl
nas-	nose	pseudo-	false; deceptive	-ul-; -ule	diminutive; small
necr-	corpse; dead	psych-	mind	ultra-	beyond
nemat-	thread	pter-	having wings or fins	uni-	one
neo-	new; recent	pulmo-	lung	ur-	urine
nephro-	kidney	puls-	drive; push	-ura	tail
-ner-	moist; liquid	pyr-	heat; fire	vas-	vessel
neur-	nerve	quadr-	four	vect-	carry
noct- nox-	night	quin-	five	ven- vent-	come
-node	knot	radi-	ray	ventr-	belly; underside
-nom- -nomy	ordered knowledge; law	re-	again; back	-verge	turn; slant
non-	not	rect-	right; correct	vig-	strong
not-	back	ren-	kidney	vit- viv-	life
nuc-	center	ret-	net; made like a net	volv-	roll; wander
ob-	against	rhag-; -rrhage	burst forth	-vor-	devour; eat
ocul-	eye	rhe-; -rrhea	flow	xanth-	yellow
oct-	eight	rhin-	nose	xero-	dry
odont-	tooth	rhiz-	root	xyl-	wood
-oid	form; appearance	rhodo-	rose	zo-; -zoa	animal
olf-	smell	roto-	wheel	zyg-	joined together
oligo-	few; little	rubr-	red	zym-	yeast

Not only will you be using word parts to help you learn your vocabulary terms, you will also create pictures to help you visualize the terms. Creating a picture will help reinforce the meaning of your science terms. You will use the template for each bolded term you encounter in your handouts. Notice that you will give the meaning of word parts and the definition of the term, using a dictionary. You will draw a picture and create a sentence for each term. You will complete the top part of the template before reading the articles and complete the bottom part of the template after reading the articles. The template is shown below, but you will be receiving handouts of the template to complete your work.

Making of Word Parts	Definition
Picture	**Sentence**

Text References:

HOW MANY LICKS DOES IT TAKE TO GET TO THE CENTER?

http://utahscience.oremjr.alpine.k12.ut.us/sciber00/7th/earth/sciber/erlayers.htm

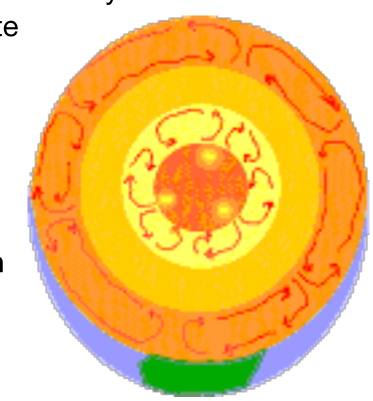
Have you ever wondered how many licks it takes to get to the core of a giant jaw breaker? 1, 2, 3… slurp. The earth is in some ways like a giant jaw breaker. It is composed of several layers: the crust, the mantel, and the core.

CRUST

What comes to mind when you think of the word crust? Perhaps it is the time old saying,” Eat your crust!” The earth's crust is a little different then the crust on a piece of bread. It is not soft and chewy, but it hard and composed of different minerals. The thin, outermost layer of the earth is called the crust. It makes up only one percent of the earth's mass. The continental crust is thicker than the oceanic crust. It can range from 25 km thick at the edges to 70 km thick near the center. The oceanic crust on the other hand is only about 7 km thick and considerably more dense. The crust and the uppermost part of the mantle make up the ***lithosphere***, a solid region that is broken into plates. It is about 65 to 100 km thick.

MANTLE

The mantle is the layer below the crust. It makes up almost two thirds of the earth's mass and is about 2900 km thick. The mantel is divided into two regions, the upper and lower sections. Directly below the upper section is the ***asthenosphere***. Heat and pressure cause a small amount of melting to occur in the asthenosphere. While still solid, the asthenosphere is able to flow. The ability of a solid to flow is called ***plasticity***. See "What's the matter?" for an activity to demonstrate plasticity. Since the asthenosphere is more liquid than the rest of the mantle, the broken lithosphere plates are able to "float" on it.



When the material in the asthenosphere is heated, it becomes less dense and rises. While the cooler material is more dense tends to sink. Circulating currents carry the warmer material up and the cooler material down. These circular currents in the asthenosphere are called **convection currents**. The circulating convection currents cause the plates to move.

CORE

Below the mantle is the core, the center of the earth. It makes up nearly one third the mass of the earth. The core is also divided into two regions, the inner core and the outer core. From seismic or earthquake waves, scientists believe the outer core is a liquid and the inner core is a solid. The outer core is made of iron and is very dense. Scientists hypothesize that the circulation of the outer core causes the magnetic field around the earth. It is believed to be circulating in the counter-clockwise direction giving us the north pole in its present location. It switches about every million years. A record of this "switching" is recorded in the rocks both on land and in the ocean crust. See "Go west young man! But which way is north?" The inner core is made of solid iron and nickel. Many scientists believe it is kept in the solid state because of the extreme pressure from the other layers.

Earth's Atmosphere: Composition, Climate & Weather
by Tim Sharp, Reference Editor | September 19, 2012 06:52pm ET

Earth is the only planet in the solar system with an atmosphere that can sustain life. The blanket of gases not only contains the air that we breathe but also protects us from the blasts of heat and radiation emanating from the sun. It warms the planet by day and cools it at night.

Earth's atmosphere is about 300 miles (480 kilometers) thick, but most of it is within 10 miles (16 km) the surface. Air pressure decreases with altitude. At sea level, air pressure is about 14.7 pounds per square inch (1 kilogram per square centimeter). At 10,000 feet (3 km), the air pressure is 10 pounds per square inch (0.7 kg per square cm). There is also less oxygen to breathe.

Composition of air

The gases in Earth's atmosphere include:

- Nitrogen – 78 percent
- Oxygen – 21 percent
- Argon – 0.93 percent
- Carbon dioxide – 0.038 percent

Water vapor and other gases exist in small amounts as well.

Atmosphere layers

Earth's atmosphere is divided into five main layers, the exosphere, the thermosphere, the mesosphere, the stratosphere and the troposphere. The atmosphere thins out in each higher layer until the gases dissipate in space. There is no distinct boundary between the atmosphere and space, but an imaginary line about 68 miles (110 kilometers) from the surface, called the Karman line, is usually where scientists say atmosphere meets outer space.

The ***troposphere*** is the layer closest to Earth's surface. It is 4 to 12 miles (7 to 20 km) thick and contains half of Earth's atmosphere. Air is warmer near the ground and gets colder higher up. Nearly all of the water vapor and dust in the atmosphere are in this layer and that is why clouds are found here.

The ***stratosphere*** is the second layer. It starts above the troposphere and ends about 31 miles (50 km) above ground. Ozone is abundant here and it heats the atmosphere while also absorbing harmful radiation from the sun. The air here is very dry, and it is about a thousand times thinner here than it is at sea level. Because of that, this is where jet aircraft and weather balloons fly.

The ***mesosphere*** starts at 31 miles (50 km) and extends to 53 miles (85 km) high. The top of the mesosphere, called the mesopause, is the coldest part of Earth's atmosphere with temperatures averaging about minus 130 degrees F (minus 90 C). This layer is hard to study. Jets and balloons don't go high enough, and satellites and space shuttles orbit too high. Scientists do know that meteors burn up in this layer.

The ***thermosphere*** extends from about 56 miles (90 km) to between 310 and 620 miles (500 and 1,000 km). Temperatures can get up to 2,700 degrees F (1,500 C) at this altitude. The thermosphere is considered part of Earth's atmosphere, but air density is so low that most of this layer is what is normally thought of as outer space. In fact, this is where the space shuttles flew and where the International Space Station orbits Earth. This is also the layer where the auroras occur. Charged particles from space collide with atoms and molecules in the thermosphere, exciting them into higher states of energy. The atoms shed this excess energy by emitting photons of light, which we see as the colorful Aurora Borealis and Aurora Australis.

The ***exosphere***, the highest layer, is extremely thin and is where the atmosphere merges into outer space. It is composed of very widely dispersed particles of hydrogen and helium.

Climate and weather

Earth is able to support a wide variety of living beings because of its diverse regional climates, which range from extreme cold at the poles to tropical heat at the Equator. Regional climate is often described as the average weather in a place over more than 30 years. A region's climate is often described, for example, as sunny, windy, dry, or humid. These can also describe the weather in a certain place, but while the weather can change in just a few hours, climate changes over a longer span of time.

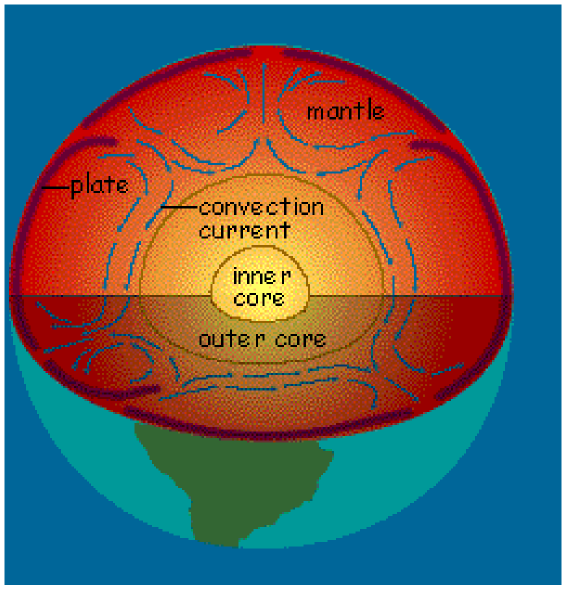
Earth's global climate is an average of regional climates. The global climate has cooled and warmed throughout history. Today, we are seeing unusually rapid warming. The scientific consensus is that greenhouse gases, which are increasing because of human activities, are trapping heat in the atmosphere.

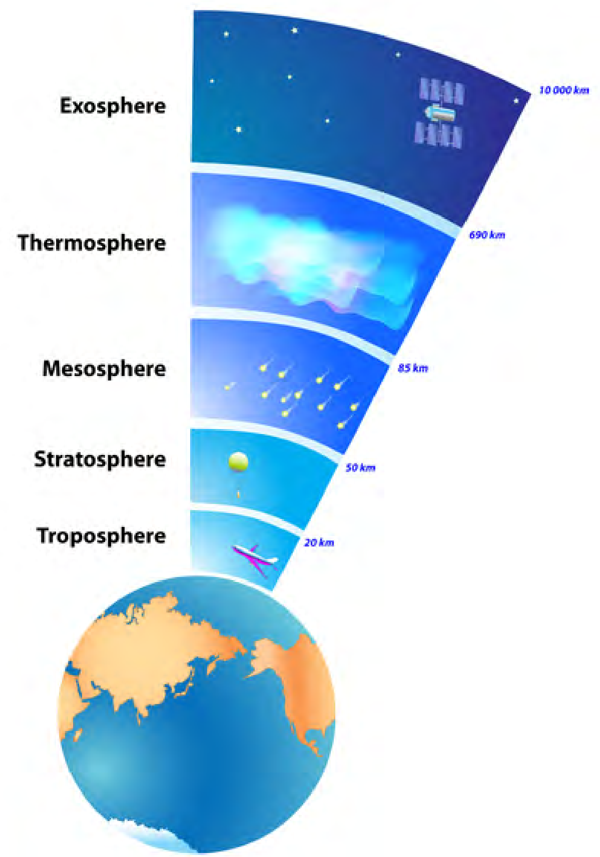
— Tim Sharp, Reference Editor

Activity

2 Interpreting Diagrams

Directions: Use the understanding you gained from the text and vocabulary exercise in Activity 1. In four to five sentences describe what each diagram is showing. In your description, use at least three of your vocabulary terms.




Exosphere
Thermosphere
Mesosphere
Stratosphere
Troposphere
10 000 km
690 km
85 km
50 km
20 km

Lesson 3
Developing Explanations

In this lesson, you will . . .

1. Identify evidence and synthesize information to create a model.
2. Use evidence to justify decisions in making a model.
3. Identify evidence and synthesize information from multiple sources including both models and text.
4. Use evidence to justify an explanation.

Activity

1 Plate Tectonics Puzzle

Use this space to glue your Plate Tectonics puzzle answer.

Activity

2 Close Reading and Annotation

Reading Science Text

(Adapted from Nist-Olejnik & Holschuh, 2013)

In science textbooks you will find many new terms and definitions. Often, the terms introduced in early chapters will be used later in the text to define other terms. So you need to be sure you understand the new terms as they appear to avoid trouble understanding future reading. Science textbooks also discuss proven principles and theories in terms of their relationship to each other. Therefore, it is important to be aware of and understand how the theories connect and how they explain the science concepts you are learning.

Concepts in science textbooks are usually presented sequentially, which means the concepts build on each other. Your best plan is to test yourself as you read to make sure you fully understand each concept. It is also helpful to create reading goals to monitor what you are learning. This means that rather than focusing on getting through a chapter, focus on learning concepts every time you read. Adopt a scientific approach and ask yourself questions such as:

- What data support this concept or theory?
- What other theories is this concept related to?
- How does this phenomenon work? What is the scientific process involved?
- Why does this phenomenon occur?
- What does it show us?

It is also important to pay attention to the diagrams in each chapter. They are there to help you picture the science process so that you can see what is happening. Understanding diagrams is crucial to doing well in most science courses.

Gearing Up for Reading

To gear up for reading, start by reading the chapter title and thinking about what you already know about that concept. Focus on primary and secondary headings to understand how the chapter is organized and how the ideas are related together. If your text has an outline of topics at the beginning of each chapter, use it to help you think about the key points. If not, skim through the chapter for key terms and think about how they are related to the appropriate heading or subheading. Pay special attention to diagrams and figures, and think about how they relate to the overall focus of the chapter. Finally, read the chapter objectives and guiding questions if your textbook has these features.

What and How to Annotate During Reading

Because of the large amount of new terminology involved in learning science, it is important for you to read your science textbooks before class. In this way, you will be familiar with the terms and concepts discussed in the text and you will be able to build your understanding of the concepts as you listen in class. It is also a good idea to connect the concepts discussed in class with the concepts described in your text by comparing your lecture notes to your text annotations each time you read. This will help you follow the flow of the concepts and will help you understand how the ideas are connected.

When you annotate your science text, you need to match your annotations to the course expectations. For example, if you are expected to think at higher levels, be sure your annotations include more than just the bold-faced terms. If you are expected to be able to explain science processes, be sure your annotations help you learn to do just that.

In general, it is a good idea to limit the amount of material you annotate. Annotate big concepts and save the details for your rehearsal strategies. A big mistake that students make when annotating science is that they tend annotate too much. It is also essential to focus on putting the ideas into your own words. This will help you monitor your understanding of what you have read and will keep you from copying exactly from the text. In addition, look for experiments and results or conclusions drawn from scientific theories, and seek to make connections between the experiments and the concepts they generate.

Science texts often contain diagrams or charts to explain concepts. Because science exams usually contain questions about the concepts described in diagrams or charts, you must be able to read and understand each one. As you read your text, annotate the diagrams and take the time to reflect on what they are depicting. A good self-testing strategy to make sure you fully understand the concept is to cover up the words in the diagram and try to talk through the information. If you can explain how the concept works, you've shown that you understand it. If you find that you cannot explain it, reread your annotations or the diagram text to be sure you understand the key points.

In the annotation example, notice how the annotations focus on explaining the concepts rather than just memorizing the terms.

What is Annotation?

- Writing brief summaries in the textbook's margin.
- Enumerating multiple ideas (i.e., causes, effects, reasons characteristics).
- Sketching pictures or charts to explain difficult processes/concepts.
- Writing possible test questions.
- Noting puzzling or confusing ideas that need clarification.
- Underlining key ideas.

Why Should I Annotate?

- It will improve your concentration so you will not become distracted and have to reread.
- It can provide an immediate self-check for your understanding of the textbook's key ideas.
- It will help you remember more.
- It can assist you in test preparation.
- It will negate the need of time spent in rereading the chapters.
- It will help you state ideas in your words.

What Should I Annotate?

- Definitions
- Lists, features, causes, effects, reasons, characteristics
- Diagrams and Processes
- Examples of good ideas

Example of Annotations in a Science Textbook

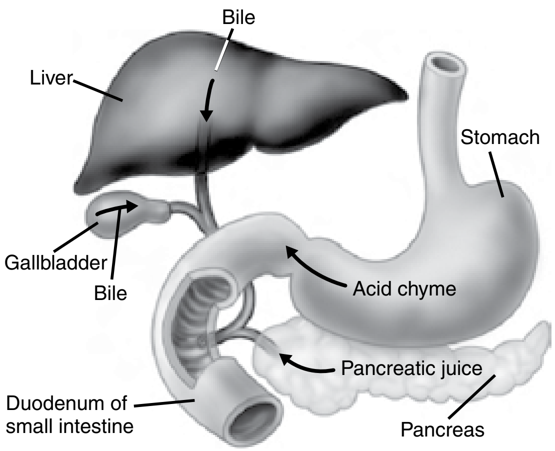


Figure 22.12
The duodenum. Acid chyme squirted from the stomach into the duodenum (the beginning of the small intestine) is mixed with pancreatic juice, bile from the liver and gallbladder, and intestinal juice produced by the duodenal lining itself. As peristalis propels the mix along the small intestine, hydrolases break food molecules down to their monomers.

The duodenum receives digestive juices from the pancreas, liver, and gallbladder (**Figure 22.12**). The **pancreas** is a large gland that secretes pancreatic juice into the duodenum via a duct. Pancreatic juice neutralizes the stomach acids that enter the duodenum and contains hydrolases that participate in the chemical digestion of carbohydrates, fats, proteins, and nucleic acids.

Bile is a juice produced by the **liver**, stored in the **gallbladder**, and secreted through a duct into the duodenum. Bile contains no digestive enzymes but does have substances called bile salts that make fats more accessible to lipase. Fats, including those from the cheese of the pizza we're following, are a special problem for the digestive system because they do not dissolve in water. The fats in chyme start out as relatively large globules. Only those molecules on the surface of the globules are in contact with the lipase dissolved in the surrounding solution. Agitation from the rhythmic contraction of muscles in the intestinal wall breaks the fat globules into small droplets, but without the help of bile salts, those droplets would quickly fuse again into larger globules that would be difficult to digest. Through a process called emulsification, bile salts essentially coat the tiny fat droplets and prevent them from fusing. Similarly, emulsification by a chemical additive helps keep oil permanently mixed with vinegar in some commercial salad dressings.

The intestinal lining itself also aids in enzymatic digestion by producing a variety of hydrolases. The cumulative activities of all these hydrolytic enzymes break the different classes of food molecules completely down into monomers, which are now ready for absorption into the body.

Absorption of Nutrients Wait a minute! The previous sentence said that nutrients "are now ready for absorption by the body." Aren't these nutrients already in the body? Not really. The alimentary canal is a tunnel running through the body, and its cavity is continuous with the great outdoors. The doughnut analogy in **Figure 22.13** should convince you that this is so. Until nutrients actually cross the tissue lining of the alimentary canal to enter the bloodstream, they are still outside the body. If it were not for nutrient absorption, we could eat and digest huge meals but still starve to death, in a sense.

Most digestion is complete by the time our pizza meal reaches the end of the duodenum. The next several meters of small intestine (called the jejunum and the ileum) are specialized for nutrient absorption. The structure of the intestinal lining, or epithelium, fits this function (**Figure 22.14**). The surface area of this epithelium is huge—roughly 300m^2, equal to the floor space of a one bedroom apartment. The intestinal lining not only has large folds, like the stomach, but also fingerlike outgrowths called villi, which makes the epithelium something like the absorptive surface of a fluffy bath towel. Each cell of the epithelium adds even more surface by having microscopic projections called microvilli. Across this expansive surface of intestinal epithelium, nutrients are transported into the network of small blood vessels and lymphatic vessels in the core of each villus.

<u>Digestion Sm Intestine</u>
- when food reaches sm int. it has been thru mech. and chem. digestion
- hydrolisis is initiated

<u>Duodendum</u>
1st ft. of sm int.
- where food is broken into monomers
- gets digest. juice from pancreas (pancreatic juice via duct—neutralizes stomach acid & contains hydrolases for chem digest), liver (bile), gallbladder (where bile is stored and via duct)
- Bile salts—make fats accessible to lipase thru emulsification—bile salts coat fat droplets to keep them separated (like oil and water in dressing) Int. lining produces hydrolases to get food ready for absorption

<u>Absorption</u>
Nutrients don't really 'enter' body until entering bloodstream. Nut abs occurs in jejunum and ileum (next parts of sm int.) Epithelium—int. lining (huge—300m^2, folded, and has villi). Very abosorptive. Each cell has microvilli—all help transport nutrients

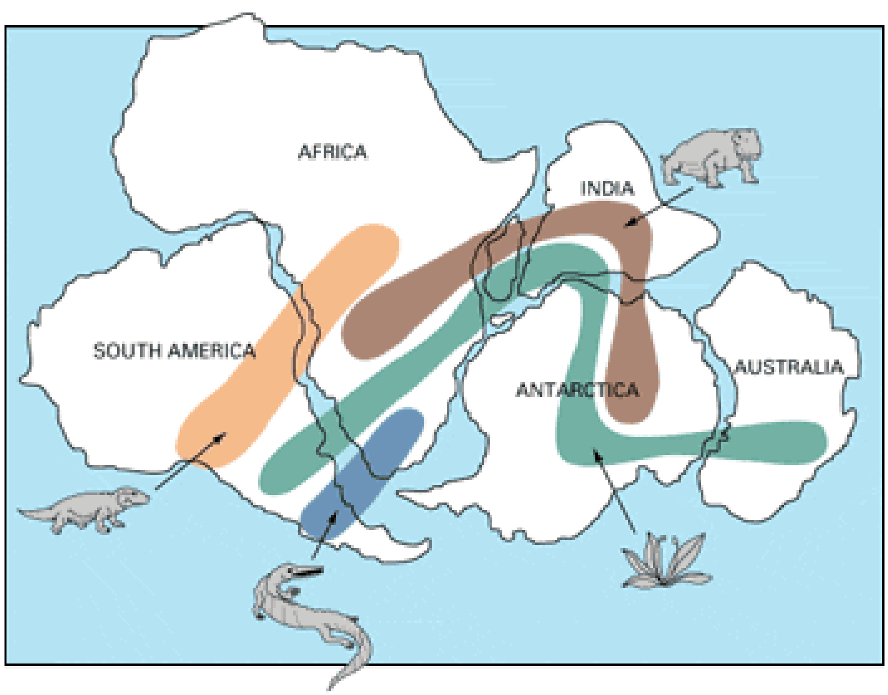
Alfred Wegener article: http://earthobservatory.nasa.gov/Features/Wegener/wegener_4.php

Alfred Wegener (1880-1930)

Wegener began by demolishing the theory that large land bridges had once connected the continents and had since sunk into the sea as part of a general cooling and contraction of the Earth. He pointed out that the continents are made of a different, less dense rock (granite) than the volcanic basalt that makes up the deep-sea floor in which Wegener proposed that the continents floated somewhat like icebergs in water. Wegener also noted that the continents move up and down to maintain equilibrium in a process called isostasy. As an example he cited the sinking of Northern Hemisphere lands under the weight of continental ice sheets in the last ice age, and their rise since the ice melted some 10,000 years ago.

"Wegener also noted that the continents move up and down to maintain equilibrium in a process called isostasy."

Given the difference in density between continents and sea floor, plus the process of isostasy, Wegener reasoned that if continent-size land bridges had existed and somehow been forced to the ocean bottom, they would have "bobbed-up" again when the force was released. Therefore, since fossil and geological evidence clearly showed the continents were once connected, the only logical alternative was that the continents themselves had been joined and had since drifted apart.



Certain fossils appear in continuous bands across continents that are now separated by thousands of miles of ocean. Wegener believed this fact was one of the strongest pieces of evidence for his theory. In the above map, orange indicates the fossil remains of *Cynognathus*, a Triassic land reptile. Dark blue indicates fossil remains of the freshwater reptile *Mesosaurus*. Green indicates fossils of the fern *Glossopteris*, found in all of the southern continents. Brown indicates fossil evidence of the Triassic land reptile *Lystrosaurus*. (Map courtesy This Dynamic Earth, United States Geological Survey)

Wegener also offered a more plausible explanation for mountain ranges. According to the cooling, contracting-Earth theory, they formed on the Earth's crust as wrinkles form on the skin of a drying apple. If this were so, however, they should be spread evenly over the Earth; instead mountain ranges occur in narrow bands, usually at the edge of a continent. Wegener said they formed when the edge of a drifting continent crumpled and folded — as when India hit Asia and formed the Himalayas.

He also noted that when you fit Africa and South America together, mountain ranges (and coal deposits) run uninterrupted across both continents, writing:

It is just as if we were to refit the torn pieces of a newspaper by matching their edges and then check whether the lines of print ran smoothly across. If they do, there is nothing left but to conclude that the pieces were in fact joined in this way.

By his third edition (1922), Wegener was citing geological evidence that some 300 million years ago all the continents had been joined in a supercontinent stretching from pole to pole. He called it Pangaea (all lands), and said it began to break up about 200 million years ago, when the continents started moving to their current positions.

Perhaps the best summary of Wegener's revolutionary theory was provided by countryman Hans Cloos: "It placed an easily comprehensible, tremendously exciting structure of ideas upon a solid foundation. It released the continents from the Earth's core and transformed them into icebergs of gneiss [granite] on a sea of basalt. It let them float and drift, break apart and converge. Where they broke away, cracks, rifts, trenches remain; where they collided, ranges of folded mountains appear."

Claim *What made Wegener think the continents were once joined?*	**Evidence** *What data/evidence supports these ideas?*

Summary

Explain Wegener's theory and evidence in your own words. Compare this to the evidence you used in Activity 1: A Plate Tectonics Puzzle.

Activity

3 Gathering Information

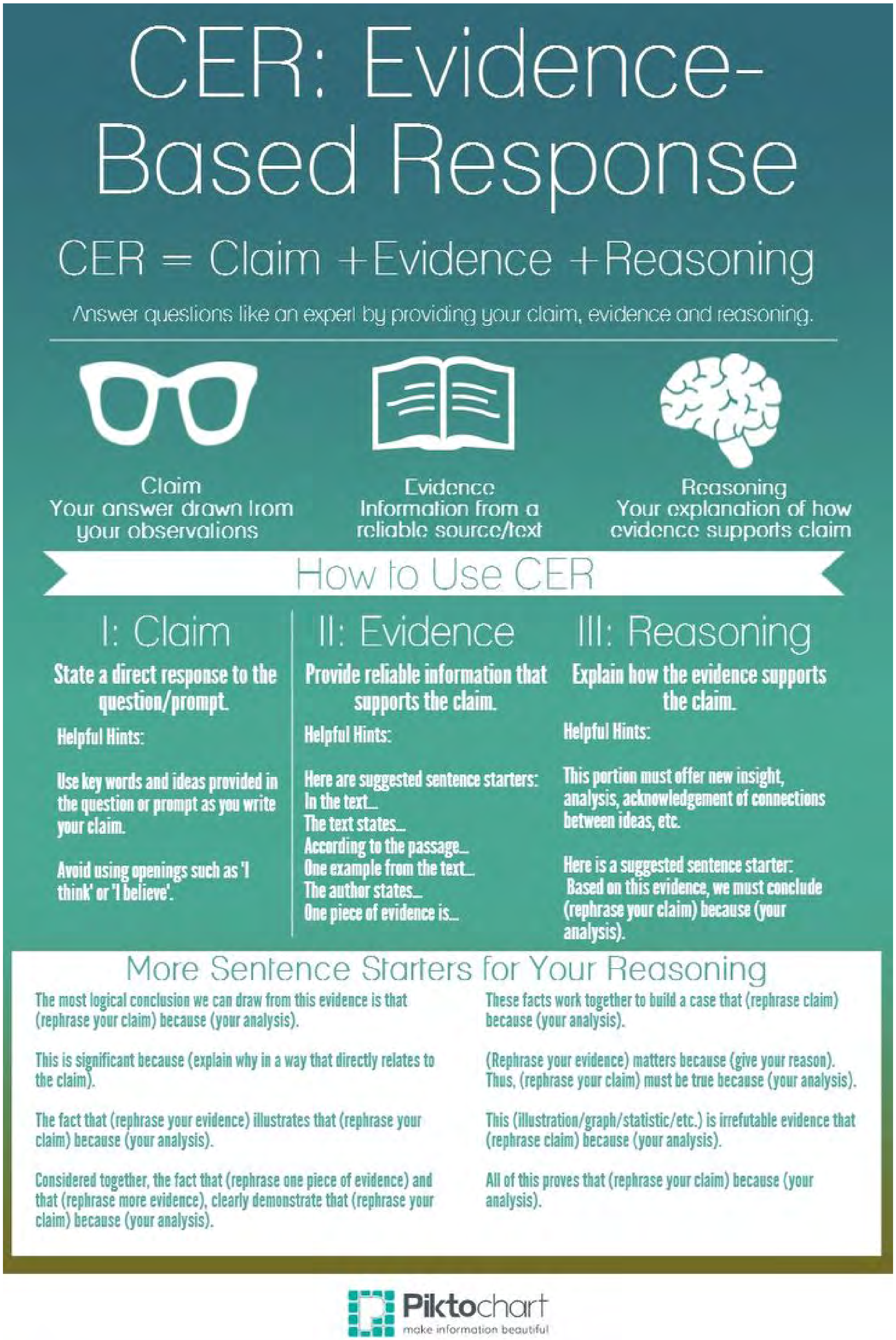
How do plates move?

Factor	Source	Description	How does this help explain how plates move?
Density of Basalt and Granite			
Sea Floor Spreading			
Convection Currents			
Ridge-Push			
Slab-Pull			

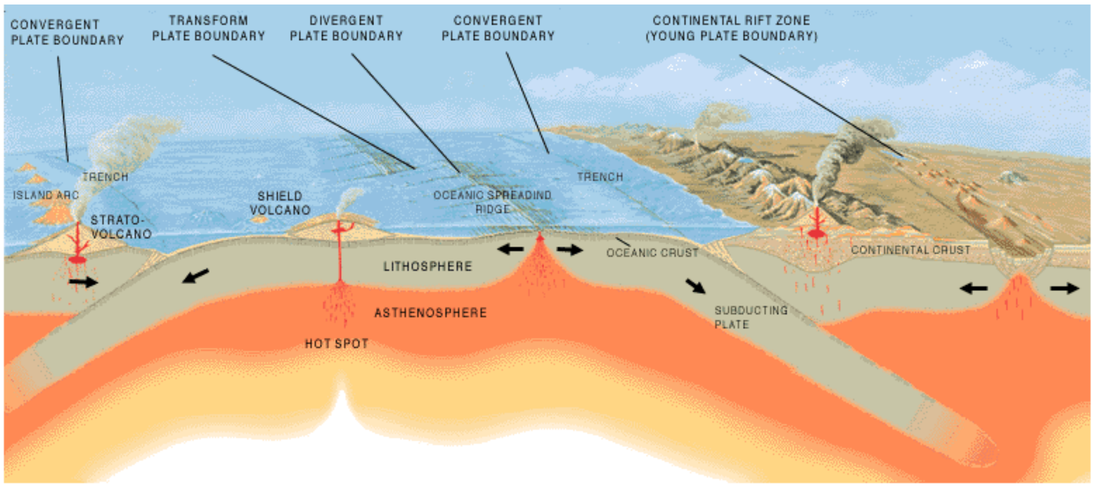
Activity

4 Using Evidence to Justify an Explanation

Analyze the infographic below about scientific explanations, using the claim-evidence-reasoning strategy. How might this provide a clear and thorough scientific explanation?



Write a thorough explanation to a peer in this class, in which you use evidence to explain how the plates move. Use your graphic organizer to help you in composing a thorough explanation of plate tectonics. You may use the USGS cross-section diagram of plates and plate motion, (below), to remind you of the different processes that occur as the plates move.



http://pubs.usgs.gov/gip/dynamic/Vigil.html

	Claim *A statement or conclusion that answers the original question/problem*	**Evidence** *Scientific data that supports the claim. The data needs to be appropriate and sufficient to support the claim.*	**Reasoning** *A justification that connects the evidence to the claim. It shows why the data counts as evidence by using appropriate and sufficient scientific solutions.*
0	Does not make a claim, or makes an inaccurate claim like, "Levers do not affect work."	Does not provide evidence, or only provides evidence like, "The data shows me it is true" or "It would be a lot harder to move a piano without a lever."	Does not provide reasoning, or only provides inappropriate reasoning like, "Levers are used in lots of ways in our lives."
1	Makes an accurate but vague or incomplete claim like, "Levers make work easier" or "Levers do not make work easier." (It can actually depend.)	Makes a general statement about how in the investigations levers sometimes make the work easier and sometimes did not make the work easier. Does not include specific data.	Repeats evidence and links it to the claim, but does not include scientific principles.
2	Makes an accurate and complete claim like, "Levers sometimes make work easier."	Provides 1 of the following 2 pieces of evidence: • Specific data (e.g., numbers) from the investigation when the lever made the work easier. • Specific data (e.g., numbers) from the investigation when the lever made the work harder.	Provides 1 of the following 2 pieces of evidence: • A lever can make work feel easier depending on the load, the effort applied, and the position of the fulcrum. • Doing work is the ability to move an object. If it takes less force, the work feels easier.
3		Provides 2 of the following 2 pieces of evidence: • Specific data (e.g., numbers) from the investigation when the lever made the work easier. • Specific data (e.g., numbers) from the investigation when the lever made the work harder.	Provides 2 of the following 2 pieces of evidence: • A lever can make work feel easier depending on the load, the effort applied, and the position of the fulcrum. • Doing work is the ability to move an object. If it takes less force, the work feels easier.

Lesson 4
Transforming Information

In this lesson, you will . . .

1. Approach discipline-specific vocabulary.
2. Transform information from an animation into text and from a text into an animation.
3. Use previously learning note-taking strategies during a lecture on the rock cycle.

Vocabulary Study:

You will complete the vocabulary templates for the key terms that you will be exploring throughout this lesson.

Activity

1 Transforming Information

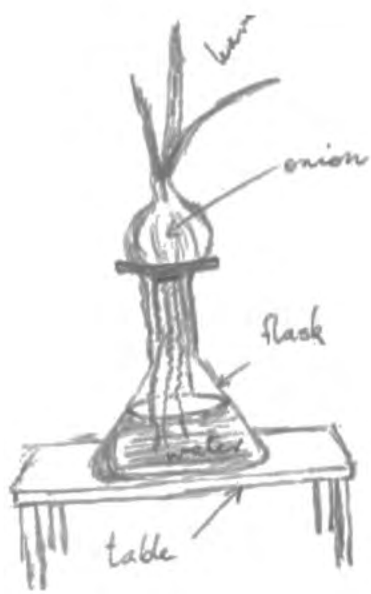
Scientific Diagrams

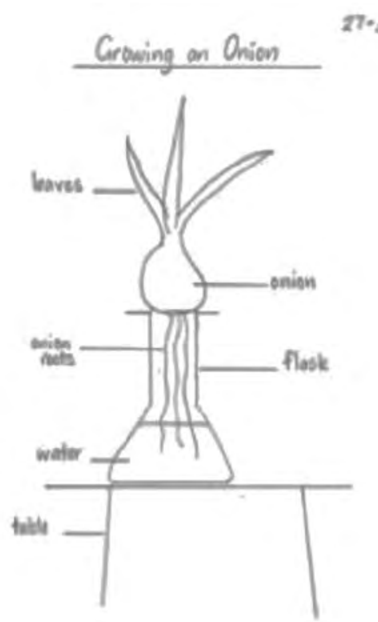
http://nswagtc.org.au/blogs/science-guru/1078-scientific-diagrams.html

Science is very much about precision and facts — and the rules about diagrams reflect this. Correct diagrams show exactly what is needed: no more, no less. They are clear, accurate line drawings with as few lines as possible.

How to draw a correct scientific diagram:

1. Use a very sharp lead pencil, preferably 2B.
2. Print a heading at the top of the page. Underline it.
3. Draw a simple, side-on view of the experiment/animal/plant (the focus of your diagram). Include only the essential details (e.g., if drawing a beaker, just draw sides and base).
4. Print (no running writing) all labels. Write them horizontally to the diagram and close to the relevant feature. Arrange them neatly around the drawing. Rule a straight line (no arrowheads) between the label and the feature. Labels should include purpose of feature (e.g., pouch: where immature young develop).
5. Rule all straight lines, including underlining headings and titles. Do not underline labels!





The diagram above left has many flaws:

- unnecessary shading makes the image unclear
- unnecessary detail is shown — e.g., three-dimensional drawing of table and flask
- label lines have arrowheads
- labels are arranged all over the diagram and are too far away from the relevant label line and they're not all horizontal!
- it has no title or date

How Is Rock Continually Recycled in the Rock Cycle?

by Kevin Lee, Demand Media

Like a giant recycling machine, Earth constantly creates rocks, breaks them down and converts them into new types of rock. This rock cycle occurs because of the way weather and other natural forces react with minerals above and below the Earth's surface. The cycle never stops and it ensures that the planet never runs out of rocks.

Rocks Begin in the Molten Stage

Magma and lava mark the beginning of the rock cycle. Magma is molten rock that exists below the surface. Most of it forms in the Earth's crust. Lava is magma that makes its way to the surface through volcanic activity or some other natural process. When molten rock cools, it hardens and becomes igneous rock. Basalt and granite are the two main types of igneous rock.

Breaking Things Apart

After igneous rock forms, erosion and weather conditions eventually cause it to break down into smaller pieces called sediments. Wind, rivers, glaciers and other natural forces can carry this sediment to distant locations, where it hardens and forms sedimentary rock. Sedimentary rock contains pieces of other rocks. Geologists call these pieces clasts, from the Greek meaning "broken piece." Common examples of sedimentary rock include limestone, gravel, sandstone and chert.

Metamorphosis Brings About Change

Metamorphic rock forms when other types of rock experience extreme stress, pressure and high heat for a long time. Sedimentary, igneous and other metamorphic rock can become metamorphic rock. These do not melt to form metamorphic rock. Instead, the molecules are rearranged by environmental stress. Metamorphic rocks become more metamorphosed the longer they experience metamorphic stresses.

Back into the Molten State

As time passes, metamorphic rock subjected to stress may heat to the point where it turns into magma below the surface. This magma then begins the cycle again by creating igneous rock. Events in the cycle can happen in more than one order. For instance, an igneous rock buried deep beneath the surface may bypass the sedimentary rock phase and change into a metamorphic rock. Rocks can also remain in the same state for long periods.

Rock Cycle Diagram

Before drawing your diagram below, refer to the rubric below.

Rock Cycle Diagram Rubric				
Category	**Multiplier**	**3**	**2**	**1**
Creation	X 2	The student correctly creates the rock cycle diagram to include the three different stages.	The student creates the rock cycle diagram with one error in the drawing of the different stages of the rock cycle.	The student creates the rock cycle diagram with more than one error in the drawing of the different stages of the rock cycle.
Labeling	X 1	The student labels all stages of the rock cycle correctly.	The student labels some stages of the rock cycle correctly.	The student labels none of the stages of the rock cycle correctly.
Descriptions	X 3	The student's written description of the rock cycle includes all three stages and they are correctly described.	The student's written description of the rock cycle includes at least two stages and/or they are correctly described.	The student's written description of the rock cycle does not include any of the three stages and does not describe the stages.

Animation Description

Before describing your animation below, refer to the rubric below.

Animation Description				
Category	**Multiplier**	**3**	**2**	**1**
Animation Sequences	X 2	The student correctly identifies all ten sequences in the animation.	The student identifies at least five of the sequences in the animation.	The student identifies fewer than five of the sequences in the animation.
Descriptions	X 3	The student's written description of the rock cycle animation includes all ten sequences and they are correctly described.	The student's written description of the rock cycle animation includes at least five sequences and/or they are correctly described.	The student's written description of the rock cycle animation includes fewer than five sequences.

Activity

2 Taking Notes from a Lecture

Claim	Evidence

Note-Taking Checklist

1. Did I use the same template from Lesson 3?	☐ Yes	☐ No
2. Are my notes neat and organized?	☐ Yes	☐ No
3. Do I have five key ideas?	☐ Yes	☐ No
4. Have I included supporting information for the key ideas?	☐ Yes	☐ No

Lesson 5
Inquiry in Weathering and Erosion

In this lesson, you will . . .

1. Conduct an inquiry investigation in which you explore the effects of weathering and erosion, drawing conclusions that will support your understanding of these processes.
2. Use close reading and annotation to help you deepen your understanding of weathering and erosion.
3. Design your own investigation to model a novel weathering or erosion process that was not included in the class stations.
4. Write a formal lab report in which you communicate your model design, observations, and analysis of the validity of the model created.

Activity

1 What is weathering and erosion, and how do these processes shape the surface of the Earth?

WEATHERING AND EROSION

Lab Stations

Purpose: To investigate the processes of weathering and erosion.

Background Information: Weathering involves two processes that often work together to decompose rocks. Both processes occur in place. No movement is involved in weathering. Chemical weathering involves a chemical change in some of the minerals in a rock. Mechanical weathering involves physically breaking rocks into fragments without changing the chemical make-up of the minerals within them. As soon as a rock particle (loosened by one of the two weathering processes) moves, we call it erosion or mass wasting. Mass wasting is simply movement down slope due to gravity. Rock falls, slumps, and debris flows are all examples of mass wasting. We call it erosion if the rock particle is moved by some flowing agent such as air, water or ice.

Materials:

8 Stations – materials and task cards at each station

Procedures:

1. There are eight stations in the classroom. Each station is numbered. Each station has all of the materials you will need to investigate one aspect of weathering and erosion. Each station also has a TASK CARD with instructions for completing the investigation.
2. Rotate through each station one at a time. You may go to the stations in any order.
3. Read the TASK CARD at each station. Read it again. Make sure you understand the instructions.
4. Follow the procedure on the task card. Record your observations and data on this station in your Academic Notebook

NO MORE THAN 3 people at a time at any station.

Because of the difficulty in setting up separate stations and keeping them set up for the duration of the activity, your teacher may decide to conduct the inquiry activity as a whole group lesson. Follow the instructions of your teacher to complete your assignments.

Station Notes

Station #1 – Wind Erosion

Observations	
Wind	
Sandpaper on rocks	

What would a very strong wind do to the sand?

What would happen if the sand hit clay?

What would happen if the sand hit rock?

How is rubbing sandpaper across a rock like windblown sand hitting a rock?

Station #2 – Splash Erosion

As water falls, it is a source of potential energy. The greater the height from which the water falls, the greater the potential energy. Falling raindrops strike the earth at about 20 mph. The effect of one drop is little, but many, drops can tear apart the surface of the soil.

Describe what happened to the surface of the sand.

What do you think will happen to the surfaces of mountains that have large amounts of rainfall?

How do you think the material that makes up different types of rock will affect how easily each type is worn away?

What difference did the height of the water make?

Station #3 – Weathering and Erosion

Observations:

Describe what you think has happened to the water that collects in the bottom of the tray.

Describe what has happened to the surface of the "rock."

What do you think happens to rock that has been dissolved?

Station #4 – Mechanical Weathering

Observations:

List one natural situation that is similar to the process used in this investigation.

Station #5 – Wave Action

Observations:

Beach Sketch BEFORE Waves

Height in cm:

Beach Sketch AFTER Waves

Height in cm:

Station #6 – Soil Erosion

Observations:

Which particles moved first? Second? Last?

How does the size of the particles affect the rate of erosion?

Would the amount of water affect the rate of erosion? Explain your answer.

Would the hardness of the rain affect the rate of erosion? Explain your answer.

If you wanted to control erosion on a hill, what type of particles would be best? Explain.

Station #7 – More Soil Erosion

Observations:

Do the bottle caps affect the rate of erosion? Explain your answer.

How could you prevent erosion on a dirt hill?

Station #8 – Chemical Weathering

Observations:

How are the bags the same? How are they different?

What caused the changes in the wet steel wool?

Explain how this kind of weathering could happen to a rock.

Activity 2

NATIONAL GEOGRAPHIC

For the complete encyclopedic entry with media resources, visit: http://education.nationalgeographic.org/encyclopedia/erosion/

Erosion

Erosion is the act in which earth is worn away, often by water, wind, or ice. A similar process, weathering, breaks down or dissolves rock, weakening it or turning it into tiny fragments. No rock is hard enough to resist the forces of weathering and erosion. Together, they shaped the sharp peaks of the Himalaya Mountains in Asia and sculpted the spectacular forest of rock towers of Bryce Canyon, in the U.S. state of Utah.

The process of erosion moves bits of rock or soil from one place to another. Most erosion is performed by water, wind, or ice (usually in the form of a glacier). These forces carry the rocks and soil from the places where they were weathered. If water is muddy, it is a sign that erosion is taking place. The brown color indicates that bits of rock and soil are suspended in the water and being transported from one place to another. This transported material is called sediment.

When wind or water slows down, or ice melts, sediment is deposited in a new location. As the sediment builds up, it creates fertile land. River deltas are made almost entirely of sediment. Delta sediment is eroded from the banks and bed of the river.

Erosion by Water

Moving water is the major agent of erosion. Rain carries away bits of soil and slowly washes away rock fragments. Rushing streams and rivers wear away their banks, creating larger and larger valleys. In a span of about 5 million years, the Colorado River cut deeper and deeper into the land in what is now the U.S. state of Arizona. It eventually formed the Grand Canyon, which is more than 1,600 meters (1 mile) deep and as much as 29 kilometers (18 miles) wide in some places.

Erosion by water changes the shape of coastlines. Waves constantly crash against shores. They pound rocks into pebbles and reduce pebbles to sand. Water sometimes takes sand away from beaches. This moves the coastline farther inland.

The Cape Hatteras Lighthouse was built in 1870, on the Outer Banks, a series of islands off the coast of the U.S. state of North Carolina. At the time, the lighthouse was nearly 1,000 meters (3,300 feet) from the ocean. Over time, however, the ocean eroded most of the beach near the lighthouse. By 1999, the surf endangered the structure. Many people thought it would collapse during a strong storm. The lighthouse was moved 880 meters (2,900 feet) inland.

The battering of ocean waves also erodes seaside cliffs. It sometimes bores holes that form caves. When water breaks through the back of the cave, it creates an arch. The continual pounding of the waves can cause the top of the arch to fall, leaving nothing but rock columns. These are called sea stacks. All of these features make rocky beaches beautiful, but also dangerous.

Erosion by Wind

Wind is also an agent of erosion. It carries dust, sand, and volcanic ash from one place to another. Wind can sometimes blow sand into towering dunes. Some sand dunes in the Badain Jaran area of the Gobi Desert in China reach more than 400 meters (1,300 feet) high.

In dry areas, windblown sand blasts against rock with tremendous force, slowly wearing away the soft rock. It also polishes rocks and cliffs until they are smooth.

Wind is responsible for the dramatic arches that give Arches National Park, in the U.S. state of Utah, its name. Wind can also erode material until nothing remains at all. Over millions of years, wind and water eroded an entire mountain range in central Australia. Uluru, also known as Ayers Rock, is the only remnant of those mountains.

Erosion by Ice

Ice can erode the land. In frigid areas and on some mountaintops, glaciers move slowly downhill and across the land. As they move, they pick up everything in their path, from tiny grains of sand to huge boulders.

The rocks carried by a glacier rub against the ground below, eroding both the ground and the rocks. Glaciers grind up rocks and scrape away the soil. Moving glaciers gouge out basins and form steep-sided mountain valleys.

Several times in Earth's history, vast glaciers covered parts of the Northern Hemisphere. These glacial periods are known as ice ages. Glaciers carved much of the northern North American and European landscape. They scoured the ground to form the bottom of what are now the Finger Lakes in the U.S. state of New York. They also carved fjords, deep inlets along the coast of Scandinavia.

Today, in places such as Greenland and Antarctica, glaciers continue to erode the earth. These ice sheets, sometimes more than a mile thick, carry rocks and other debris downhill toward the sea. Eroded sediment is often visible on and around glaciers. This material is called moraine.

Erosion and People

Erosion is a natural process, but human activity can make it happen more quickly. Trees and plants hold soil in place. When people cut down forests or plow up grasses for agriculture or development, the soil washes away or blows away more easily. Landslides become more common. Water also rushes over exposed soil rather than soaking into it, causing flooding.

Erosion control is the process of reducing erosion by wind and water. Farmers and engineers must regularly practice erosion control. Sometimes, engineers simply install structures to physically prevent soil from being transported. Gabions are huge wire frames that hold boulders in place, for instance. Gabions are often placed near cliffs. These cliffs, often near the coast, have homes, businesses, and highways near them. When erosion by water or wind threatens to tumble the boulders toward buildings and cars, gabions protect landowners and drivers by holding the rocks in place.

Erosion control can also be done by physically changing the landscape. Living shorelines, for example, are a form of erosion control for wetland areas. Living shorelines are constructed by placing native plants, stone, sand, and even living organisms such as oysters along wetland coasts. These plants help anchor the soil to the area, preventing erosion. By securing the land, living shorelines establish a natural habitat. They protect coastlines from powerful storm surges as well as erosion.

Global warming, the latest increase in temperature around the world, is speeding erosion. The change in climate has been linked to more frequent and more severe storms. Storm surges following hurricanes and typhoons threaten to erode miles of coastline and coastal habitat. These coastal areas have homes, businesses, and economically important industries, such as fisheries.

The rise in temperature is also quickly melting glaciers. This is causing the sea level to rise faster than organisms can adapt to it. The rising sea erodes beaches more quickly. In the Chesapeake Bay area in the eastern United States, it is estimated that a rise in sea level of 8 to 10 centimeters (3 to 4 inches) will cause enough erosion to threaten buildings, sewer systems, roads, and tunnels.

NATIONAL GEOGRAPHIC

For the complete encyclopedic entry with media resources, visit:
http://education.nationalgeographic.org/encyclopedia/weathering/

Weathering

Weathering is the breaking down or dissolving of rocks and minerals on Earths surface. Water, ice, acids, salt, plants, animals, and changes in temperature are all agents of weathering.

Once the rock has been broken down, a process called erosion transports the bits of rock and minerals away. No rock on Earths surface is hard enough to resist weathering. Together, the processes of weathering and erosion carved the Grand Canyon, in the U.S. state of Arizona. This massive canyon is 446 kilometers (277 miles) long, as much as 29 kilometers (18 miles) wide, and 1.6 kilometers (1 mile) deep.

Weathering and erosion constantly change the Earth. Weathering wears away exposed surfaces over time. It smooths sharp, rough areas on rocks. Weathering also helps create soil as tiny bits of weathered rock mix with plant and animal remains.

Weathering can be a mechanical or a chemical process. Often, these two types of weathering work together.

Mechanical Weathering

Mechanical weathering, also called physical weathering, causes rocks to crumble. Water seeps into cracks and crevices in rock. If the temperature drops low enough, the water will freeze. When water freezes, it expands. The ice then works as a wedge. It slowly widens the cracks and splits the rock. When ice melts, water performs the act of erosion by carrying away the tiny rock fragments lost in the split.

Mechanical weathering also occurs as the rock heats up and cools down. The changes in temperature cause the rock to expand and contract. As this happens over and over again, the rock weakens. Over time, it crumbles.

Another type of mechanical weathering occurs when clay or other materials near hard rock absorb water. The clay swells with the water, breaking apart the surrounding rock.

Salt also works to weather rock. Saltwater sometimes gets into the cracks and pores of rock. If the saltwater evaporates, salt crystals are left behind. As the crystals grow, they put pressure on the rock, slowly breaking it apart.

Plants and animals are agents of mechanical weathering. The seed of a tree may sprout in soil that has collected in a cracked rock. As the roots grow, they widen the cracks, eventually breaking the rock into pieces. Over time, trees can break apart even large rocks. Even small plants, such as mosses, can enlarge tiny cracks as they grow.

Animals that tunnel underground, such as moles and prairie dogs, also work to break apart rock and soil. Other animals dig and trample rock aboveground, causing rock to slowly crumble.

Chemical Weathering

Chemical weathering changes the materials that make up rocks and soil. Sometimes, carbon dioxide from the air or soil combines with water. This produces a weak acid, called carbonic acid, that can dissolve rock.

Carbonic acid is especially effective at dissolving limestone. When the carbonic acid seeps through limestone underground, it can open up huge cracks or hollow out vast networks of caves. Carlsbad Caverns National Park, in the U.S. state of New Mexico, includes more than 110 limestone caves. The largest is called the Big Room. At about 1,200 meters (4,000 feet) long and 190 meters (625 feet) wide, it is the size of six football fields.

Sometimes, chemical weathering dissolves large regions of limestone or other rock on the surface of the Earth to form a landscape called karst. In these dramatic areas, the surface rock is pockmarked with holes, sinkholes, and caves. One of the worlds most spectacular examples of karst is Shilin, or the Stone Forest, near Kunming, China. Hundreds of slender, sharp towers of limestone rise from the landscape.

Another type of chemical weathering works on rocks that contain iron. These rocks rust in a process called oxidation. As the rust expands, it weakens the rock and helps break it apart.

Weathering and People

Weathering is a natural process, but human activities can speed it up. For example, certain kinds of air pollution increase the rate of weathering. Burning coal, natural gas, and oil releases chemicals such as nitrogen oxide and sulfur dioxide into the atmosphere. When these chemicals combine with sunlight and moisture, they change into acids. They then fall back to Earth as acid rain.

Acid rain rapidly weathers limestone, marble, and other kinds of stone. The effects of acid rain can be seen on gravestones. Names and other inscriptions can be impossible to read.

Acid rain has also damaged many historic buildings and monuments. At 71 meters (233 feet) tall, the Leshan Giant Buddha at Mount Emei in China is the worlds largest statue of the Buddha. It was carved 1,300 years ago and sat unharmed for centuries. But in recent years, acid rain has turned its nose black and made some of its hair crumble and fall.

Annotation Checklist

- ☐ Your annotations are perfect! Keep up the good work.
- ☐ You have missed many key ideas. Go back and annotate them.
- ☐ You need to put your annotations in your own words — do not copy from the book!
- ☐ Be briefer in your annotations. You do not need to write in full sentences.
- ☐ You have ignored the graphic aids. Annotate them.
- ☐ You need to note the specific examples — they could reappear on the exam.
- ☐ You need to enumerate the specific facts, characteristics, causes, events, etc., in the margin or in the text. Get the details, too!
- ☐ Your annotations need to focus on the key ideas more, and less on details.
- ☐ You are underlining too much — work more on writing your summaries in the margin.
- ☐ You are annotating too much! It will take you forever to do a chapter.
- ☐ You are annotating too little! You do not have enough information annotated to use as a study aid.
- ☐ You need to develop some symbols of your own and use them.
- ☐ You need to develop a method for organizing your annotations.
- ☐ Please annotate these sections or pages again.

p. p. p. p.

Activity 3

Weathering and Erosion at Work: Modeling the Construction of Landforms

Introduction:

You have learned about how weathering and erosion shaped the surface of the Earth. You have completed several short lab investigations of various ways that weathering and erosion can act, and have seen several images of how these processes have shaped the Earth. Your task is to investigate a particular example of how weathering or erosion has shaped the Earth, and then create a lab investigation to model this process at work.

You will begin with an image of a particular land form that has been shaped through weathering and erosion. You must research the process, and then create a working model that will demonstrate that process at work. You will create a detailed procedure for creating your model for other scientists. Scientists should be able to use your model to investigate the process in the lab setting, and even collect data to help them make predictions about the conditions and time necessary to create that particular landform.

Examples of Landforms:
(retrieved from: http://examples.yourdictionary.com/examples-of-landforms.html)

Landforms are natural physical features of the Earth's surface. As an element of topography, a landform is defined by its shape, location, and how it was formed.

Aeolian Landforms

Aeolian landforms are formed by either the erosive or the constructive action of the wind. As the wind erodes the land it has the effect of sandblasting the surface, leaving rock surfaces such as those found in the desert.

Examples are:

- Barchan – A convex-shaped sand dune with a gentle slope up the side of the wind direction and a 30–35 degree slip face that faces away from the wind.
- Blowout – A small hollow.
- Desert pavement – A sheet-like surface of rock.
- Desert varnish – A dark stain on the surfaces of desert rocks.
- Dune – A hill or mountain of sand.
- Dreikanter – A three-faced weathered rock.
- Erg – A sand covered desert.
- Loess – An accumulation of sediment or silt that is joined together by calcium carbonate.
- Dry lake – A waterless lakebed, typically covered in fine-grained rocks that contain salt.
- Sandhill – A sandy or low-vegetation hill area that receives minimal rainfall and has trouble retaining the water.
- Ventifact – Rocks that have been cut and polished by the wind.
- Yardang – Very large or very long, streamlined, sculpted forms caused by wind erosion.

Landforms Produced by Erosion and Weathering

- Badlands – A dry terrain with steep slopes and little or no vegetation.
- Butte – An isolated hill that typically has a flat top and steep sides.
- Canyon – A deep ravine between two cliffs or encasements, like the Grand Canyon.
- Cave – An underground space created by the weathering of rocks that is enclosed and large enough to enter.
- Cliff – An area with a steep drop-off, usually formed by erosion and near rock exposures.
- Cuesta – A hill or a ridge with a gentle slope.
- Gulch – A deep valley that has generally been formed by land erosion.
- Gully – A ditch or valley created by erosion.
- Hogback – A narrow ridge of hills with steep slopes and a narrow crest. The slopes are usually close to equal on both sides.
- Hoodoo – A tall thin rock formation protruding from the bottom of a badland.
- Lavaka – A hole in the side of a hill caused by erosion.
- Mesa – A tableland, or an elevated area with a flat top and steep cliff-like sides.
- Mountain pass – A path through a mountain range over a low point in a ridge.
- Plain – A large area that is flat or gently rolling, usually low in elevation.
- Plateau – An area that is high in elevation and basically flat.
- Ravine – Formed by running water, a ravine is smaller than a canyon and is steep and deep.
- Ridge – A chain of hills or mountains.
- Rock shelter – An cave-like opening at the base of a cliff.
- Scree – A collection of broken rocks at the base of a mountain.
- Strath – A wide shallow river valley.
- Summit – The highest point on a hill or mountain.
- Valley – A low area between hills or mountains.

Creating the Model:

After choosing the landform you would like to research, you will need to research the specific processes of weathering and erosion that creates your landform. You will apply your understanding of those processes to create a model, using everyday materials, that can simulate how your landform was created. The model should effectively simulate the process by which this landform is created, using the materials provided. You must make observations about your model and revise it as needed so that it simulates the process as effectively as possible.

Materials Available to Create Your Model:

- Potting soil
- Sand
- Rocks
- Gravel
- Clay
- Chalk
- Water
- Vinegar (a weak acid)
- Straws
- Paper cups
- Dish pans
- Freezer
- Hotplate
- Hammer
- Chisel

Chosen Landform to Research

Notes from Research:

How are weathering and erosion responsible for creating this landform?

Model Design:

Questions to guide your design process:

What materials would be best to demonstrate the processes of weathering and erosion at work in this particular example?

How will this model illustrate how this landform is created?

What observations will I be able to make from this model?

Will it clearly simulate the process by which this landform is made?

After constructing the model, what did I observe?

Aew there any changes or revisions that need to be done before it is ready to share?

Activity
4

Modeling Weathering and Erosion: Lab Report

Task:

Write a formal lab report to communicate your findings from your weathering and erosion investigation. You will communicate the purpose of the investigation and any pertinent background information, as well as explain the model you created to simulate the Earth process you researched. You must include a procedure to create the model and analyze how well your model simulated the specific example of weathering or erosion that you researched. Finally, you must draw conclusions regarding the efficacy of your model and its usefulness in simulating this particular Earth process. Consider revisions to the model and possible next steps to refine your model. Use the following Lab Report Format to guide your writing.

Lab Report Format

Include the following sections in your report. Label all sections!

Introduction:

In this section state the purpose of the investigation. Explain any background information that you researched that is important in understanding this particular example of weathering or erosion.

Model Rationale:

Clearly explain your reasoning for developing your particular model/ simulation of your researched example of weathering or erosion.

Materials/Procedure:

Give a detailed description of your model. Include step-by-step (numbered) instructions on how you built the model. Include the types of measurements and observations you made in creating your model.

Analysis:

Include a written description of the efficacy of your model/simulation. Include both qualitative and quantitative observations as applicable. Determine if the model you created is an accurate representation of the process of weathering/erosion that you researched. Explain how your observations support or reject that claim. Infer about WHY you think the results turned out the way they did.

Conclusion:

Summarize your inquiry investigation. Was the model you created an accurate simulation of the process? Discuss any sources of error and revisions you would make to your model. What would you do differently next time? Or what would your next steps be? What are any future implications of your findings?

Science Writing Do's and Don'ts:

Do

- Follow the format exactly.
- Label all sections.
- Write formally (not like a letter to a friend).
- Use full sentences (no fragments or run-ons).
- Be detailed BUT concise.
- Make sure to support your "claims" with DATA collected.
- Proof read your lab report.

Don't

- Deviate from the format.
- Use pronouns in the writing – I, we, you.
- Discuss other groups findings – only about your experiment.
- Be "fluffy" in the writing, just stick to the point.
- Don't assume the reader was there for the lab — be detailed!

Lab Report Peer-Assessment

Introduction

1. Is there a *purpose* statement for why the inquiry is being performed? ☐ Yes ☐ No
2. Does the report include the experimental question being investigated? ☐ Yes ☐ No
3. Does it have multiple pieces of *background information* that help you to understand the process that will be modeled? ☐ Yes ☐ No

Model Rationale

1. Is there reasoning that explains the connection between the erosion/weathering process and the model that can simulate that process? ☐ Yes ☐ No

Materials

1. Is there a list of the materials they will need? ☐ Yes ☐ No All there? ☐ Yes ☐ No
2. Are safety precautions listed if necessary? ☐ Yes ☐ No

Procedures

1. By reading their procedures, could you replicate the model exactly as they did it? ☐ Yes ☐ No
2. Are the procedures numbered, easy to follow, and neat? ☐ Yes ☐ No
3. Are measurements and observations to be made clearly identified? ☐ Yes ☐ No

Analysis

1. Are the observations used to support or reject the efficacy of the model? ☐ Yes ☐ No
2. Is there *reasoning/explanation* as to ***why*** the model worked the way that it did? ☐ Yes ☐ No

Conclusion

1. Is there a summary of what was done in the investigation and how the observations indicate the efficacy of the model created? ☐ Yes ☐ No
2. Is there a discussion about the validity of the model? Sources of error? ☐ Yes ☐ No
3. Is there a discussion of what should be done next in this investigation? How the model could be revised? ☐ Yes ☐ No

Scientific Writing Conventions

1. Is science vocabulary used? (Consider key terms important in understanding the Earth processes of weathering and erosion!) ☐ Yes ☐ No
2. Does the writing sound like a letter to a friend or a formal piece of analytical writing? ☐ Yes ☐ No
3. Is the report neat and easy to read? ☐ Yes ☐ No
4. Does it follow basic grammar rules? (Ex. capitals start a sentence, punctuation used, commas where needed) ☐ Yes ☐ No
5. Is it written in the 3rd person, with all personal pronouns removed (I, we, our)? ☐ Yes ☐ No
6. Are the lab report sections labeled? ☐ Yes ☐ No
7. Is it detailed, leaving no room for interpretation? ☐ Yes ☐ No
8. Is evidence used to support all claims? ☐ Yes ☐ No

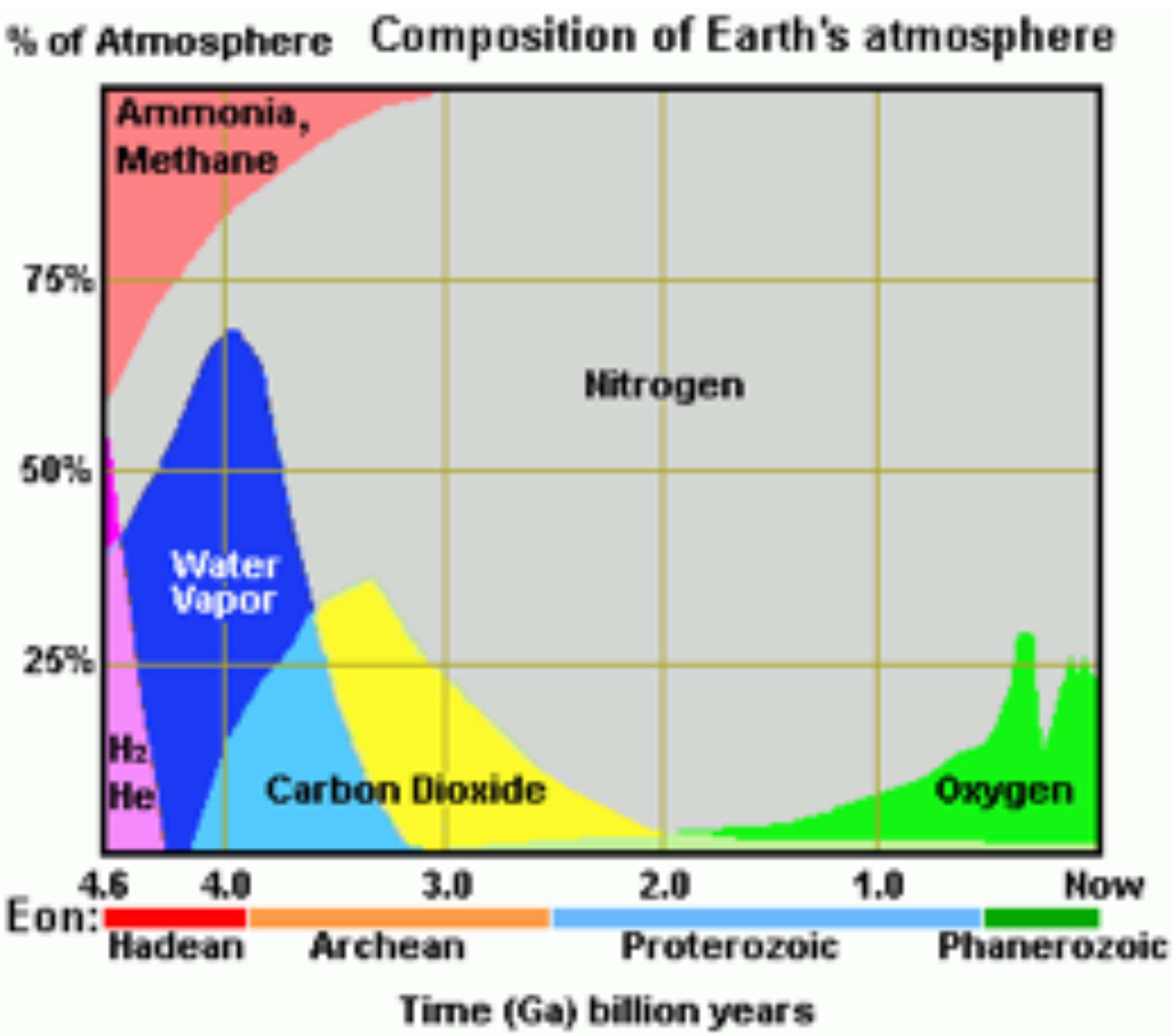
Lesson 6
Analyzing Data

In this lesson, you will . . .

1. Interpret graphs of atmospheric changes.
2. Use data to determine cause and effect.
3. Collect data over time to make predictions.

Activity

1 History of the Atmosphere



The Changing Atmosphere		
Use the graph to identify changes in the Earth's atmosphere over time. List changes in this column. Try to identify at least five changes.	**For each change, look in the texts below for evidence for what caused the change. Explain the cause of the change.**	**List which source you used for your evidence.**
Example: Hydrogen and helium decrease (almost disappear). These gases could have escaped.	These gases could have escaped Earth's gravity because they move so fast.	How did Earth's atmosphere form? http://scijinks.jpl.nasa.gov/atmosphere-formation/

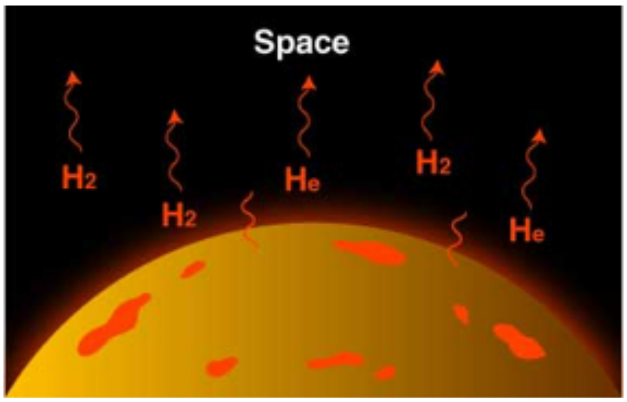
Breathe!

No one knows of any other planet where you can do this simple thing.

Other planets and moons in our solar system have atmospheres, but none of them could support life as we know it. They are either too dense (as on Venus) or not dense enough (as on Mars), and none of them have much oxygen, the precious gas that we Earth animals need every minute.

So how did our atmosphere get to be so special?

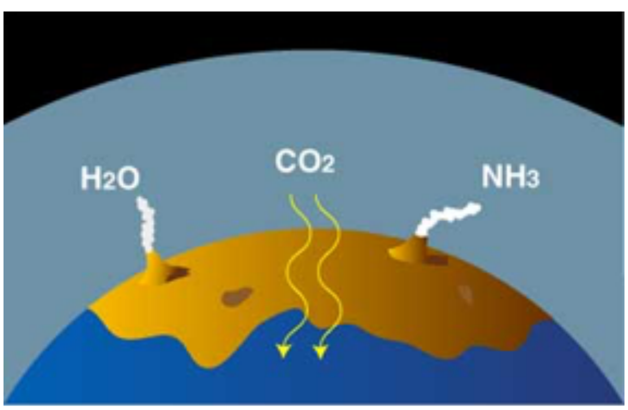
Some scientists describe three stages in the evolution of Earth's atmosphere as it is today.



Just formed Earth: Like Earth, the hydrogen (H2) and helium (He) were very warm. These molecules of gas moved so fast they escaped Earth's gravity and eventually all drifted off into space.

Atmosphere #1

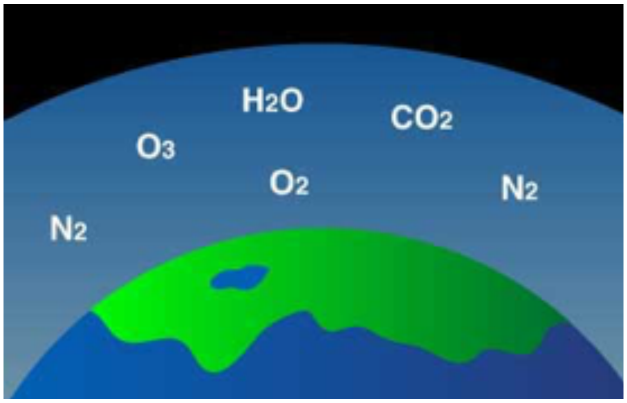
1. Earth's original atmosphere was probably just hydrogen and helium, because these were the main gases in the dusty, gassy disk around the Sun from which the planets formed. The Earth and its atmosphere were very hot. Molecules of hydrogen and helium move really fast, especially when warm. Actually, they moved so fast they eventually all escaped Earth's gravity and drifted off into space.



Young Earth: Volcanoes released gases H2O (water) as steam, carbon dioxide (CO2), and ammonia (NH3). Carbon dioxide dissolved in seawater. Simple bacteria thrived on sunlight and CO2. By-product is oxygen (O2).

Atmosphere #1

2. Earth's "second atmosphere" came from Earth itself. There were lots of volcanoes, many more than today, because Earth's crust was still forming. The volcanoes released
   a. steam (H2O, with two hydrogen atoms and one oxygen atom),
   b. carbon dioxide (CO2, with one carbon atoms and two oxygen atoms),
   c. Ammonia (NH3, with one nitrogen atom and three hydrogen atoms).



Current Earth: Plants and animals thrive in balance. Plants take in carbon dioxide (CO2) and give off oxygen (O2). Animals take in oxygen (O2) and give off CO2. Burning stuff also gives off CO2.

Atmosphere #3

3. Much of the CO2 dissolved into the oceans. Eventually, a simple form of bacteria developed that could live on energy from the Sun and carbon dioxide in the water, producing oxygen as a waste product. Thus, oxygen began to build up in the atmosphere, while the carbon dioxide levels continued to drop. Meanwhile, the ammonia molecules in the atmosphere were broken apart by sunlight, leaving nitrogen and hydrogen. The hydrogen, being the lightest element, rose to the top of the atmosphere and much of it eventually drifted off into space.

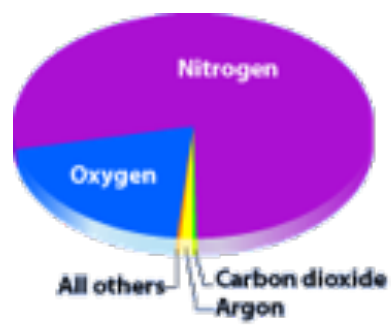
Now we have Earth's "third atmosphere," the one we all know and love — an atmosphere containing enough oxygen for animals, including ourselves, to evolve.

So plants and some bacteria use carbon dioxide and give off oxygen, and animals use oxygen and give off carbon-dioxide — how convenient! The atmosphere upon which life depends was created by life itself.

The atmosphere life depends on was created by life itself? Woah!

What's in Earth's atmosphere now?

Note that this pie does not account for any water in the air. As you can see, air is mostly nitrogen (78%), with oxygen a distant runner up (21%). Argon and some other gases make up another small amount (about 1%). And carbon dioxide is only a very tiny slice (.0385% or only about 385 parts per million parts of air). But these proportions were quite likely different in Earth's much younger days.



http://scijinks.jpl.nasa.gov/atmosphere-formation/

History of the Atmosphere

Earth is believed to have formed about 5 billion years ago. In the first 500 million years a dense atmosphere emerged from the vapor and gases that were expelled during degassing of the planet's interior. These gases may have consisted of hydrogen (H_2), water vapor, methane (CH_4), and carbon oxides. Prior to 3.5 billion years ago the atmosphere probably consisted of carbon dioxide (CO_2), carbon monoxide (CO), water (H_2O), nitrogen (N_2), and hydrogen.

The hydrosphere was formed 4 billion years ago from the condensation of water vapor, resulting in oceans of water in which sedimentation occurred.

The most important feature of the ancient environment was the absence of free oxygen. Evidence of such an anaerobic reducing atmosphere is hidden in early rock formations that contain many elements, such as iron and uranium, in their reduced states. Elements in this state are not found in the rocks of mid-Precambrian and younger ages, less than 3 billion years old.

One billion years ago, early aquatic organisms called blue-green algae began using energy from the Sun to split molecules of H_2O and CO_2 and recombine them into organic compounds and molecular oxygen (O_2). This solar energy conversion process is known as photosynthesis. Some of the photosynthetically created oxygen combined with organic carbon to recreate CO_2 molecules. The remaining oxygen accumulated in the atmosphere, touching off a massive ecological disaster with respect to early existing anaerobic organisms. As oxygen in the atmosphere increased, CO_2 decreased.

High in the atmosphere, some oxygen (O_2) molecules absorbed energy from the Sun's ultraviolet (UV) rays and split to form single oxygen atoms. These atoms combining with remaining oxygen (O_2) to form ozone (O_3) molecules, which are very effective at absorbing UV rays. The thin layer of ozone that surrounds Earth acts as a shield, protecting the planet from irradiation by UV light.

The amount of ozone required to shield Earth from biologically lethal UV radiation, wavelengths from 200 to 300 nanometers (nm), is believed to have been in existence 600 million years ago. At this time, the oxygen level was approximately 10% of its present atmospheric concentration. Prior to this period, life was restricted to the ocean. The presence of ozone enabled organisms to develop and live on the land. Ozone played a significant role in the evolution of life on Earth, and allows life as we presently know it to exist.

http://teachertech.rice.edu/Participants/louviere/history.html

Activity

2 Human Impact on the Atmosphere

How does the emission rate of CO_2 affect global temperature?

Record your data from the computer simulation in the table below.

CO_2 Emission Rate (gigatons/year)	Year	CO_2 Concentration in the Atmosphere (ppm)	Average Global Temperature (°C)

Activity

3 Organizing, Communicating and Analyzing Data

Your class will be discussing the questions below. Reflect on them by writing some brief notes during the discussion. This will help you to organize your thoughts for the writing assignment that follows.

Questions for discussion and reflection:

1. What trends or patterns do you see in the data?

2. Does the rate of CO emission affect these trends? If so, how?

3. Brainstorm sources of CO2.

4. How do humans impact the composition of the atmosphere?

5. What other global impact is caused by CO2 emission?

Use the data collected during the climate model simulation in Activity 2, your notes, and graphic organizers to create a concise report illustrating your findings. This should include a summary of trends indicated by the data and a brief analysis of this data and its implications. You should also draw conclusions about the impact of humans on Earth's atmosphere. Include a graphic representation of the data you collected, to illustrate and justify the conclusions drawn from the data.

Scoring Criteria
Report summarizes the data collected.
Report provides analysis of the data.
Report concludes with the impact on Earth's atmosphere.
Data is represented graphically.
Report is written in readable prose.

Lesson 7
Taking Tests in Science

In this lesson, you will . . .

1. Utilize strategies to generate your own test reviews.
2. Learn to organize concepts as a way to comprehend science processes.
3. Take a multiple-choice and short-answer test.
4. Evaluate your own test performance.

Activity

1 Generating a Concept Map

You will generate your own test review. Rather than using a teacher-generated review, you will work together to create a review that covers all of the material up to this point. You will learn a strategy to help you create the review: concept maps.

Concept maps help you organize the information learned. In the center of the map is the big concept or idea. Surrounding the big concept or idea are issues related to it. Off of each of the related issues is information to support those issues. A completed concept map can be used to prepare for exams.

(Adapted from Nist & Holschuh, 2012 College Success Strategies, 4th edition)

How Do You Use Maps to Study?

When you study your map, you can begin by rehearsing one concept at a time. Then cover up everything except the main concept, and begin to talk the information through. Say the related material and then check your accuracy. Focus on how the concepts are related to each other because that is the major strength of mapping.

Concept Mapping			
Criteria	Approaching Expectation **(1-4 marks)**	Meeting Expectation **(1-4 marks)**	Exceeding Expectation **(1-4 marks)**
Concepts (Knowledge)	• Number of insufficient concepts selected related to topic • Arrangement of concepts demonstrates little understanding of relationship between them • Relationships between concepts are weak	• Acceptable number of concepts selected, with some relationships to topic • Arrangement of concepts demonstrates some understanding of relationship between them • Relationships make some logical sense	• Most concepts and all significant concepts selected, and they clearly relate to the topic • Arrangement of concepts demonstrates complete and insightful understanding of relationship between them • Relationships make logical sense, with few errors
Hierarchical Structure (Communications)	• Only a few concepts connected in a hierarchical structure	• Some concepts connected in a hierarchical structure moving from major ideas to minor ideas	• Most or all concepts connected in a hierarchical structure moving from more complex to less complex, and on to specific concepts
Linkages (Thinking)	• A few relationships indicated by connecting lines • Only a few lines labeled with linking words • Many errors in the linking words	• Some relationships indicated by connecting lines • Some lines labeled with linking words • Some errors in the linking words	• Most or all relationships indicated by connecting lines • All lines labeled with linking words • Most or all linking words are accurate and varied
Cross Links (Application)	• No cross links used	• A few cross links are used to illustrate straight forward connections	• Cross links show complex relationships between two or more distinct segments of the concept map

Activity

2 Test Review

Use the concept map you created in Activity 1 to review, working outward from the main concept.

After reviewing on your own, you will work with a partner and talk through the map you created. Then your partner will talk through their map.

A "talk-through" is a method of preparing and reviewing for an exam that involves practicing and rehearsing aloud the key ideas of a text or science process. A talk-through is very similar to a lecture that you would give someone. In fact, when giving a talk-through, you should imagine being a teacher giving a lecture to students who know very little about the topic you are teaching. You will complete your talk-through the way you completed your map. Begin with the main concept, then the supporting concepts and the details of those supporting concepts. Your partner will have your map so they can tell if you have covered the information needed. Once you have completed this task, then you and your partner will swap roles.

Activity

4 Evaluating the Science Test

Test Evaluation

The purpose of this evaluation is to help you learn from your experience preparing for and taking the test. Think about how you felt about your level of preparation before the test, where you focused your effort, and how you felt taking the test.

1. Test Preparation Survey:

Were your study materials detailed?	☐ Yes	☐ No
Did you focus during the in-class study session?	☐ Yes	☐ No
Did you study outside of class?	☐ Yes	☐ No
When taking the test, did you feel confident?	☐ Yes	☐ No

2. What went right? Analyze the test to determine what areas you were successful in, and consider what helped your thinking about those concepts.

3. What went wrong? Analyze the test to discuss areas you might want to work on. In this analysis:

   Think about the errors you made and diagnose the nature of your difficulties as they relate to the concepts learned, problem solving expected, or your beliefs about science and/or science learning. Note: Don't just describe a difficulty; you need to analyze your thinking. (Example: A poor diagnosis would be, "I was confused" or "I picked the wrong answer.") A good diagnosis would provide a reason for the errors: "I thought that the Earth's crust and lithosphere were the same."

4. What will I do differently next time? Conduct an overall assessment of your performance. This is where you will look for patterns to your errors and think about particular aspects of the test that may have been difficult for you — types of questions you missed, general concepts that were difficult, etc. In your assessment, write about how understanding these issues will impact your science test taking in the future.

Lesson 8
Analyzing Cause and Effect

In this lesson, you will . . .

1. Model the analysis strategies in a sample case study to determine the root cause and human impact.
2. Apply that same level of analysis to investigate other cases of environmental change.
3. Use the case study analysis to write a cause-and-effect essay in which you argue the impact of humans on environmental changes.

Activity

1 Human Impact Analysis Chart

Environmental Change	Possible Causes	Root Cause	Human Impact

Activity 2

Acid Rain Case Study: http://www.nps.gov/nama/blogs/Acid-Rains-Slow-Dissolve.htm

Acid Rain's Slow Dissolve

May 22, 2012 Posted by: Megan Nortrup, Science Communicator, National Capital Region

Remember acid rain? Ever wondered if it's still around? Acid rain has not gone away, but it has gotten somewhat better.

Acid rain is a threat to both natural areas and to our national monuments and memorials. Many monuments are made from limestone, marble, and bronze-materials that can be altered or slowly dissolved by acid precipitation. "Slowly" is the key word of course. No one expects the Washington Monument to melt into a toothpick, but acid rain damage may slowly add up for our beloved icons.

What Exactly is Acid Rain?

Acid rain is rain that contains nitrogen and sulfur oxides washed out of the air. When these oxides mix with water, they create weak acids that lower the pH of rainwater (and snow, fog, or dew too). Liquids with a pH less than 7 are acidic, and those with a pH greater than 7 are alkaline (or basic). "Clean" or unpolluted rain has a slightly acidic pH of 5.6, while acid rain can have a pH as lrfdcow as 4.

Washington, D.C.'s Rain is Better, But Still Has a Ways to Go

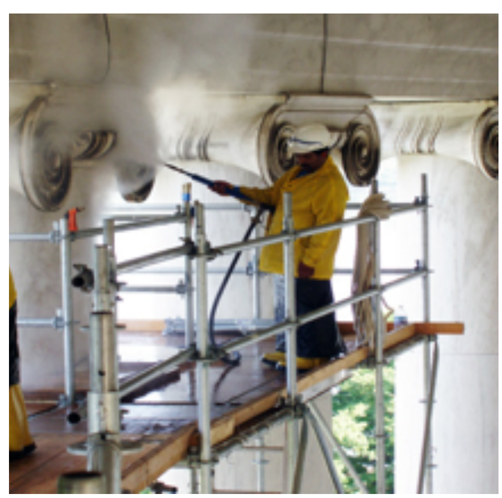
In 1997, the average rain pH around Washington, D.C. was between 4.2 and 4.4.

Now, thanks in part to federal regulations that limit the amount of nitrogen and sulfur oxides that industries produce, the pH of rain in Washington, D.C. has improved. In 2010, the average pH of rain around Washington, D.C. was 4.8 to 4.9. You can see evidence of acid rain's effects in several spots on the National Mall.

The Evidence

When acids in polluted air react with calcite, a calcium-containing mineral in marble and limestone, the calcite dissolves. In exposed areas of buildings and statues, acid rain effects show up as roughened surfaces instead of smooth ones, as pits and pocks where material was removed, and as a loss of carved details. Stone surface material may be lost all over or only in spots that are more reactive.

Sheltered areas on limestone and marble buildings and monuments that rain does not directly touch are at risk too. Sulfur dioxide gas in the air still reacts with calcite in stone, creating black crusts that sometimes peel off, revealing crumbling stone beneath. The black crust is primarily made of the mineral gypsum, which is normally washed away from exposed surfaces by rain. Gypsum is white, but the crystals trap particles of dirt and pollutants as they form, so the crust looks black.


Cleaning the Jefferson Memorial's volutes

Cleaning the Jefferson Memorial's volutes

One of the striking effects acid precipitation is having on the marble in the Thomas Jefferson Memorial is the loss of silicate mineral inclusions in the marble columns as the calcite matrix holding them together is dissolved. Close examination of the grooves on the columns shows glittery flakes of mica and sometimes grains of pyrite. Loss of material has resulted in a weakening of the stone. In order to prevent stone from falling, ties were placed around the volutes, the scrolls atop the columns, to support them. Before restoration work in 2004, black crusts were visible on the column capitals (tops) that are sheltered from rain and from regular washing of the monument. Black crusts can be removed by intermittent water misting, which softens the crust allowing it to be carefully removed.

The Ulysses S. Grant Memorial

The Ulysses S. Grant Memorial, across the street from the Capitol Building, shows the effects that acid rain has on bronze, a metal alloy consisting of copper and a small amount of tin. The green stains on the statue's marble pedestal come from dissolved and oxidized copper as it runs down from the statue to the ground. The statues show typical deterioration of bronzes in an urban outdoor environment. Similar to stone, areas that do not receive a regular wash from rain trap particles of dirt and pollutants resulting in disfiguring streaks. The NPS's specially trained statue preservation crew periodically washes the bronze statues of the National Mall and Memorial Parks with a conservation detergent and applies a microcrystalline wax to a surface heated with torches. The wax protects the metal for one to two years, depending on exposure, and is easily renewed. (In 2011, the Ulysses S. Grant Memorial was transferred to the care of the Architect of the Capitol.)

Green streaks are evidence of acid rain's effect on the Ulysses S. Grant Memorial

Beyond the National Mall

Acid rain affects natural areas too, especially lakes, streams, and watersheds. It changes water chemistry in ways that can affect algae, fish, aquatic plants, frogs, salamanders, and other aquatic creatures. For example, acidic pH levels in lake and stream waters cause naturally-occurring aluminum compounds to become more toxic to fish and amphibians. Trees and other plants can exhibit visible death of plant tissue, break down of the waxy covering on leaves, faster leaching of leaf nutrients, and conifers (like pines) can show reduced seed sprouting and seedling growth. Some lichens are also especially sensitive to acid rain.

What You Can Do to Help

It is important to do your part and help limit the creation of the chemicals that cause acid rain. Nitrogen oxides ("nox") and sulfur oxides ("sox") are produced in small amounts naturally but in large amounts by power plants and industries. Nox is also produced by vehicle exhaust, oil and gas production, fertilized crops, livestock production, and municipal and residential activities. To reduce your impact, you can cut down on activities that produce these chemicals.

Thanks for joining us in caring for these special monuments and memorials that make our National Mall great.

Global Warming Case Study: http://www.actionbioscience.org/environment/chanton.html

Global Warming & Rising Oceans

Humans rely heavily on fossil fuels in this industrial age.

Carbon dioxide output has accelerated with the increased use of fossil fuels.

The deep ocean seafloor is often a cold, dark place, barren of life. But from time to time a large bounty such as a whale carcass will drift down from the surface. Then sea life explodes: all manner of worms and other invertebrates arrive in larval form to colonize the dead organic matter and population increases dramatically — for a short time. Inevitably the resource dwindles and the population collapses.

In a similar fashion, humans now live upon the resource of dead organic matter. We've found our dead whale below ground, in the form of oil, gas and coal — the fossil remains of plants that lived long ago.

Fossil energy has fueled the advent and development of the industrial age and allowed human population to explode. The product of our industrial respiration, carbon dioxide (CO2), has increased in the atmosphere and now threatens to spoil our nest. The atmosphere does more than provide us with oxygen to breathe, it controls the heat balance of the world. The trouble is, compared to the ocean, the atmosphere is relatively small in mass, so human-induced changes can affect it dramatically.

Our atmosphere is small in mass, so changes to it are serious.

The greenhouse effect

- Prior to the advent of the industrial age, the concentration of CO2 in the atmosphere was about 280 ppm (parts per million).
- Today it's over 360 ppm. That's an increase of about 30% in less than 300 years.

There is now more CO2 in our atmosphere than ever before in human history.

For the earth, this is an unprecedented rate of change, about 10,000 years' worth of change compressed into 100 years. And there is more CO2 in our air now than at any time since humans evolved, more than anytime over the last million years! The earth is used to slow changes, not fast ones. Slow changes allow the biosphere and earth's species time to adjust. Quick change may cause biological chaos and disrupt agricultural production. Carbon dioxide is critical to controlling the earth's heat balance because it absorbs infrared radiation (IR), basically heat.

- Coming to earth from the sun, visible radiation passes through the clear atmosphere and hits the earth.
- A portion of it is absorbed and re-radiated back to space as IR.
- CO2 traps this IR and reflects it back to the earth's surface, causing further warming.

The greenhouse effect — the warming of our atmosphere — relies on CO2.

This is called the greenhouse effect. Without it, water would freeze on earth. With too much greenhouse effect, water would boil off, leaving the surface of earth a desert. This may have been what happened on earth's neighbor, Venus. There is a delicate balance between sunlight, CO2 concentration, and heat that we must be careful not to disrupt.

To illustrate the greenhouse effect, consider a car with the windows rolled up:

The heat on Earth would be unbearable with too much greenhouse effect.

- The sun's rays pass through the car's windows (visible light), and hit the car's seats.

- There the visible light is absorbed, and re-radiated to the interior of the car as IR.
- But the car's glass windows, while transparent to visible light, are opaque to IR, so the heat is trapped within the car, and the car's interior temperature becomes unbearable.

So that's why many scientists think that increasing the amount of CO2 in the air may well cause the earth to get warmer.

Rising oceans

Glaciers are already melting on 5 continents.

Global sea level rise is caused by two factors. One is the delivery of water to the ocean as land ice melts, such as mountain glaciers and polar icecaps. Current evidence of global warming includes the widespread retreat of glaciers on 5 continents. For example:

- The ice cap on Mount Kilimanjaro may be gone in 20 years. About 1/3 of Kilimanjaro's ice field has disappeared in the last 12 years and 82% of it has vanished since it was first mapped in 1912.
- Sea ice in the Arctic Ocean is thinning.
- Massive Antarctic ice sheets have collapsed into the sea with alarming rapidity.

Some animals depend on sea ice for survival, like this mother and pup ribbon seal (Histriophoca fasciata). Sea ice is thinning at an alarming rate. Photo: Dave Withrow, 2007 Bering Sea Ice Expedition, NOAA.

As water temperatures rise, oceans spread, the 20th century has seen a dramatic rise in sea levels.

The second factor is the thermal expansion of water within the oceans. As the temperature of the waters in the oceans rises and the seas become less dense, they will spread, occupying more surface area on the planet. Increased temperature will accelerate the rate of sea level rise.

Since the end of the last ice age, 18,000 years ago, sea level has risen by over 120 meters.

- Geological data suggests that global average sea level may have risen at an average rate of 0.1 to 0.2 mm/yr over the last 3000 years.
- However, tide gauge data indicate that the global rate of sea level rise during the 20th century was 1 to 2 mm/yr.

Along relatively flat coastlines, such as those of the Atlantic, or coastlines bordering fertile, highly populated river deltas, a 1 mm rise in sea level causes a shoreline retreat of about 1.5 meters. We are already seeing evidence of shoreline retreat in the U.S.:

Coastal U.S. has seen beach erosion and dying coastal plants.

- Along the marshy Gulf Coast of Florida, the effects of sea level rise can be observed in the number of dead cabbage palms at the seaward edge of the salt marsh.
- Along the Atlantic Coast of the USA, erosion is narrowing beaches and washing out vacation houses. As sea level rises and coastal communities continue to grow and pump water from aquifers, salt water intrusion into groundwater will become a greater problem.

Low-lying Pacific island nations will be inundated or the rising sea level will invade their drinking water aquifers.

Land of some island nations is being submerged under water.

- Tuvalu comprises nine coral atolls between Australia and Hawaii. Their highest point is 5 meters (15 feet) above sea level. As sea level has risen, Tuvalu has experienced lowland flooding. Saltwater intrusion is adversely affecting drinking water and food production. Tuvalu's leaders predict that the nation will be submerged in 50 years. In March 2002, the country's prime minister appealed to Australia and New Zealand to provide homes for his people if his country is washed away, but the plight of this nation is being ignored.
- Other threatened island nations include the Cook Islands and the Marshall Islands. During the last decade, the island of Majuro (Marshall Islands) has lost up to 20 per cent of its beachfront.

The near future could see millions of "climate refugees."

In addition to island nations, low-lying coastal countries are threatened by rising sea level. A 1 meter rise in sea level would inundate half of Bangladesh's rice land. Bangladeshis would be forced to migrate by the millions. Other rice growing lowlands which would be flooded include those of Viet Nam, China, India and Thailand. Millions of climate refugees could be created by sea level rise in the Philippines, Indonesia and Egypt.

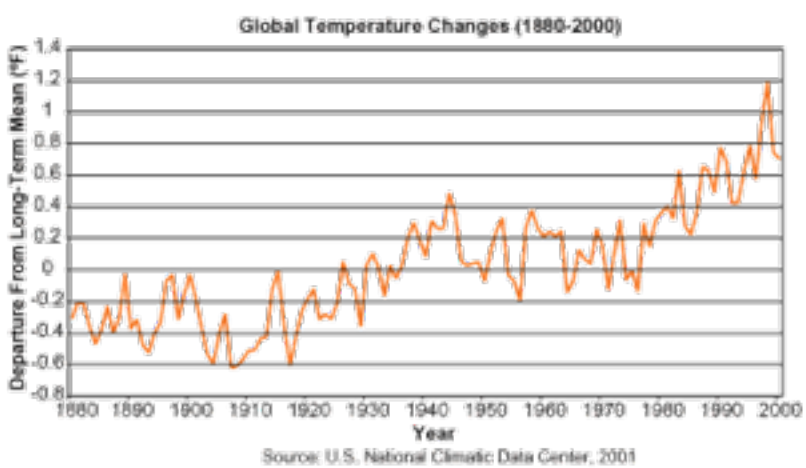
Earth has been experiencing the 10 warmest years on record.

Current rate of fossil fuel consumption indicates that the carbon dioxide content of the air will double by 2100.

Changing climate

The 10 warmest years on record have been since 1983 and the 7 warmest years on record have been since 1990. If business continues as usual, our current rate of fossil fuel consumption indicates that the carbon dioxide content of the air will double by 2100.

- This doubling will enhance the greenhouse effect and result in a 1 to 5 degree Centigrade increase in global temperature.
- Land areas will warm more rapidly than the global average as the temperature of oceanic areas will be moderated by the heat capacity of water.
- Warming will also be greatest at higher latitudes, for in the past, climate change has affected the earth's polar regions to the greatest extent.
- Humidity effects, included in the heat index, will exacerbate warming effects.



Warming trends will affect plant distributions and animal habitats.

Increased rain variability — wetter conditions: more insect pests; drier conditions: more wildfires

Climate extremes kill plants and animals.

In addition to rising oceans, warmer temperatures will likely affect:

Ecosystems

Warming trends will change the distribution of trees and other native plants, altering animal habitat. Models predict the northward retreat of temperate tree species and the northward advancement of tropical and subtropical species. But individual species will respond differently to climate change. Communities of species will not simply march back and forth, chasing the ice caps. Normal associations of plants and animals may be disrupted. Human barriers such as motorway corridors may present significant obstacles for migrating native species to jump, allowing the spread and dominance of weedy and exotic plants.

Rainfall patterns

Changing climate will change rainfall patterns. Drier conditions lead to increased wildfires while wetter conditions can result in more insect pests like mosquitoes and pine beetles. Increased CO2 in the atmosphere can stimulate plant growth, but there is evidence that plants growing under elevated carbon dioxide contain less nitrogen in their foliage, thus making them less nutritious to grazers.

Climate variability

Elevated CO2 may also affect climatic variability. Extremes kill plants and wildlife. For example, consider a period of time where variability increases but the long-term average is constant. Plants may be killed if the temperature falls below freezing for even a few hours. Likewise birds and insects may die if temperatures get too warm. Increasing variability is a big event, without even considering long-term change.

How can we stop global warming?

Conclusion: Making energy-efficient choices and developing alternative energy sources will alleviate global warming.

There is no immediate fix to the problem other than to curtail our use of fossil energy. As individuals we can help in the short term:

- We need to drive smaller vehicles and heat and cool our buildings more moderately.
- Carbon dioxide emissions can be reduced if consumers purchase more energy-efficient appliances, such as new refrigerators.
- Compact fluorescent light bulbs save tremendous amounts of fuel.

But in the long term, we need to extract energy more efficiently from fossil fuels and to develop alternative energy sources that do not lead to the production of greenhouse gases. By doubling the concentration of atmospheric CO2, we are conducting a planetary wager — one we can't afford to lose.

Fertilizer Runoff Case Study: http://www.scientificamerican.com/article/fertilizer-runoff-overwhelms-streams/

Fertilizer Runoff Overwhelms Streams and Rivers — Creating Vast "Dead Zones

The nation's waterways are brimming with excess nitrogen from fertilizer — and plans to boost biofuel production threaten to aggravate an already serious situation

By David Biello | March 14, 2008

©LAURA JOHNSON

The water in brooks, streams and creeks from Michigan to Puerto Rico carries a heavy load of pollutants, particularly nitrates from fertilizers. These nitrogen and oxygen molecules that crops need to grow eventually make their way into rivers, lakes and oceans, fertilizing blooms of algae that deplete oxygen and leave vast "dead zones" in their wake. There, no fish or typical sea life can survive. And scientists warn that a federal mandate to produce more biofuel may make the situation even worse.

Researchers led by aquatic ecologist Patrick Mulholland of the Oak Ridge National Laboratory in Tennessee report in *Nature* that streams and other waterways are losing their ability to filter excess nitrates from fertilizers and sewage. They discovered this by releasing a concentrated nitrate solution carrying an unusual isotope of nitrogen into 72 different streams — ranging from heavily altered urban waterways to pristine rivulets — and then tracked the isotope to find out how much made it downstream. The amount at the end indicated each stream's ability to naturally remove the pollutant — a measure of its health.

"We found that they continue to take up nitrate, but they remove a smaller fraction of the overall nitrate as you overload them," Mulholland says. "This is probably the reason we're seeing hypoxia [low oxygen levels] and other problems in coastal waters."

Typically, bacteria remove excess fertilizer from water through a chemical process known as denitrification, which enables them to convert nitrate to nitrogen that is then released into the atmosphere as a gas. The team found, however, that bacteria in the streams they studied only eliminated an average of 16 percent of the nitrogen pollution; bacteria in the most undisturbed streams performed the best, removing as much as 43 percent.

"Denitrification is the only process that we know for sure removes nitrogen from water," Mulholland says. "The other 84 percent [of the pollution] was just taken up by algae, microbes and other organisms in the stream bottom. A portion of that is probably also denitrified, and it could be a large portion. But we don't know that fate of that material."

What is clear is that a significant portion of such fertilizer is still making its way through the soil and water to the sea. As a result, algae and other microorganisms take up the nitrogen, bloom and, after they die, suck the oxygen out of coastal waters. Such "dead zones" have appeared seasonally near most major river mouths, including those emptying into Maryland's Chesapeake Bay as well as the Gulf of Mexico, where lifeless waters now cover more than 7,700 square miles (20,000 square kilometers) during the summer months.

The bulk of this nitrate comes from fertilizer running off agricultural fields. Scientists warn that a boom in crops such as corn for biofuel will only make matters worse. Last year, U.S. farmers planted more than 90 million acres (35 million hectares) of corn for the first time since the 1940s as a result of growing demand for that crop for both fuel and food.

Based on this trend, geographer Simon Donner of the University of British Columbia and atmospheric scientist Christopher Kucharik of the University of Wisconsin–Madison predict that nitrogen pollution from the Mississippi River Basin — the nation's largest watershed — will increase as much as 34 percent by 2022 if corn kernels continue to be the source of a growing proportion of ethanol fuel that U.S. energy legislation mandates.

That would also make it almost impossible, they say, to reduce the New Jersey-sized dead zone at the Mississippi's outlet into the Gulf of Mexico to less than 2,000 square miles (5,000 square kilometers), as recommended by a 2001 U.S. Environmental Protection Agency task force.

In fact, the scientists wrote this week in Proceedings of the National Academy of Sciences, the only way to increase ethanol production from corn and reduce nitrogen runoff would be for Americans to stop eating meat, thereby freeing up corn used as livestock feed for other uses.

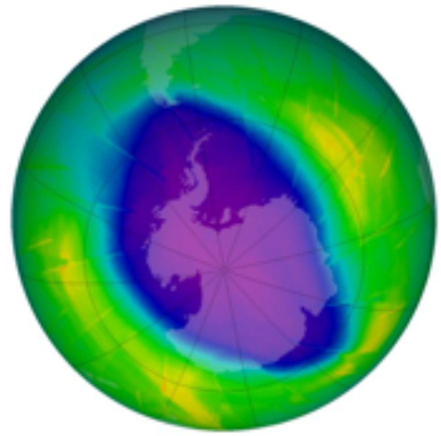
Potential solutions to overloaded streams seem equally difficult, such as restoring their natural flow or reducing the fertilizer and sewage draining into them. "We need to either maintain or, in many cases, restore the integrity of this stream network, including the smallest streams," Mulholland says. "That [also] means not utilizing all the land to grow crops."

He adds: "Certainly, the outlook is not great because there is a lot of pressure to go in the other direction."

Ozone Depletion Case Study: http://news.nationalgeographic.com/news/2010/05/100505-science-environment-ozone-hole-25-years/

Whatever Happened to the Ozone Hole?

By Brian Handwerk, for *National Geographic News*



Satellite data show the Antarctic ozone hole as it appeared last fall.

IMAGE COURTESY NASA

What would the 1980s have been without big hair and ice-cold wine coolers?

Luckily no one had to find out: Key substitutions in hairsprays and refrigerants allowed such products to exist without chlorofluorocarbons (CFCs), which were found to be ripping a huge "hole" in Earth's protective ozone layer.

Today the ozone hole, which was first spotted 25 years ago, appears headed for a happy ending, thanks to unprecedented international action.

Could a similar effort rein in climate change? And is the closing ozone hole actually making global warming worse?

Ozone at High Risk From CFCs

The ozone layer lies between about 9.3 and 18.6 miles (15 and 30 kilometers) above Earth's surface. This blanket of ozone, or O3, blocks most of the sun's high-frequency ultraviolet rays.

These UV rays can cause skin cancer and cataracts in humans, as well as reproductive problems in fish, crabs, frogs, and even in the single-celled phytoplankton at the bottom of the ocean food chain.

Ozone is created naturally when oxygen molecules (O2) high in the atmosphere get broken by sunlight into two free oxygen atoms. A free atom can then bond with an unbroken O2 molecule, and ozone is born.

Ozone is unstable, however, and it's easily broken up by trace elements.

Invented in the 1920s, CFCs proved to be an exceptional problem for ozone, because many of these synthetic chemicals can persist for decades, allowing them to make their way into the upper atmosphere. (Related: "Rocket Launches Damage Ozone Layer, Study Says.")

In that rarefied air, ultraviolet light breaks the molecular bonds in CFCs and free chlorine atoms get released. Chlorine then destroys ozone molecules by "stealing" their oxygen atoms.

Ozone Hole a Shocking Surprise

Scientists had theorized since the 1970s about the chemistry that could lead to ozone depletion. But in May 1985 scientists with the British Antarctic Survey shocked the world when they announced the discovery of a huge hole in the ozone layer over Antarctica.

Technically a substantial thinning of the ozone layer, the ozone "hole" has been opening every spring since the 1970s, the scientists reported.

Their data, collected at the Halley Research Station in Antarctica, suggested that CFCs were to blame. That's because atmospheric conditions during the cold, dark, Antarctic winters were building stockpiles of CFCs over the South Pole.

Returning spring sunshine would then spawn an abundance of free chlorine, depleting ozone levels above Antarctica by as much as 65 percent. (Related: "Laughing")

"One lesson is that the planet can change very rapidly in an unexpected way," said Jonathan Shanklin, one of the British scientists who made the ozone hole discovery and co-author of a paper on the ozone hole anniversary appearing in this week's issue of the journal Nature.

"Nobody was expecting to see anything like this in the Antarctic."

Fixing the Ozone Hole a Unanimous Decision

The disturbing discovery set the stage for an environmental triumph: the Montreal Protocol of 1987.

This pact to phase out the use of CFCs and restore the ozone layer was eventually signed by every country in the United Nations — the first UN treaty to achieve universal ratification.

The unparalleled cooperation has had a major impact.

"If we had just kept letting CFCs increase at a pretty nominal rate, characteristic of the 1970s, the decreased ozone levels of the hole would have eventually covered the entire planet," said atmospheric physicist Paul Newman of NASA's Goddard Space Flight Center.

"Global ozone dropped a little bit [after CFCs were banned], but the good news is that if we had done nothing, it would have gotten really, really bad."

Now a complete rebound seems imminent. Some scientists project that by 2080 global ozone will return to 1950s levels.

(Related: "Old Fridges, Cars Slow Ozone Hole Recovery, Scientists Say.")

Now How About Global Warming?

As climate scientists around the globe urge action to curb greenhouse gas emissions, might the ozone hole experience provide some useful parallels? Perhaps, experts say — but the situations do have some significant differences.

In the 1980s people were faced with the clear and present health dangers from ozone depletion, leading to widespread public support for CFC bans.

"There was a scary side of the ozone hole, linked to skin cancers and cataracts and so on, which immediately engaged the public," the British Antarctic Survey's Shanklin said. "The real impact of what a rapidly warming world could do is not so obviously intuitive."

Chemical manufacturers were also able to create substitutes for CFCs with little added costs, enabling governments to address the problem without great impacts on the economy or average lifestyle.

Global warming, on the other hand, has become a politically loaded and often divisive topic.

And many potential fixes to the problem — such as alternative energies and reduced consumption — could cause major disruptions to economic and geopolitical norms in a way that replacing CFCs simply did not, Shanklin said.

Ozone Recovery to Warm Antarctica?

Meanwhile, some scientists say the environmental triumph of a recovering ozone layer could have a troubling side effect: boosting global warming, at least in the Antarctic region.

Ozone itself is a greenhouse gas. A thinner ozone layer not only reduced heat trapped over the region, it helped stir circumpolar winds, which in turn created sea spray that formed reflective, cooling clouds.

"It's very difficult to quantify the impact on a global scale, but I think the evidence suggests filling the hole will have a regional effect on the Antarctic, possibly leading to more warming for the bulk of the Antarctic," Shanklin said. "That could drastically change predictions about global sea level change."

Ken Carslaw of the U.K.'s University of Leeds was a co-author on the study that suggested closing the ozone hole would lead to a bump in Antarctic warming. Still, he thinks that any warming mitigation produced by the ozone hole was merely a side effect and not a net gain.

"I wouldn't say that these discoveries [of possible warming] suggest the formation of the ozone hole was a good thing," he said.

NASA's Newman agreed: "The consequences of unabated CFC growth were disastrous for life," he said.

"So at some point you had to act, and fortunately they acted before it became a really severe problem. We never got to the level of an environmental catastrophe.

"It really is a testament to the good science that went into [understanding] the ozone hole and the nerve of the politicians to act on that science."

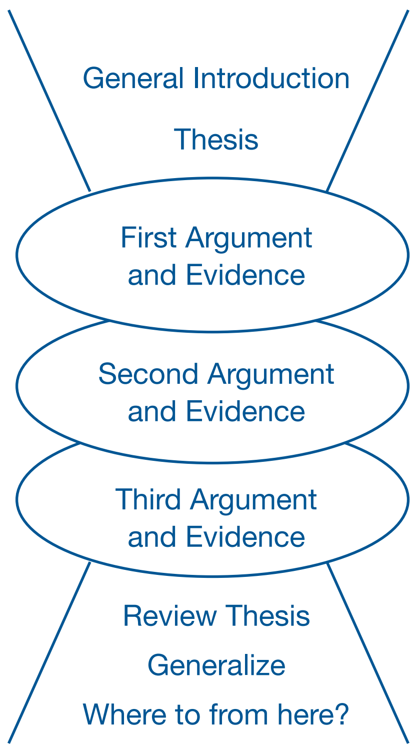
Activity

3 Argumentative Essay: Human Impact on the Environment

After researching case studies of environmental changes, write an essay that argues the causes of the environmental problems and explains the effects humans on the environment. What conclusions can you draw? Support your discussion with evidence from the texts.

Your essay should consist of five paragraphs and be no more than two pages in length and should follow a basic format:

1. Introduce the environmental changes that were examined in the case studies.
2. Lead to your thesis (argument) on the impact humans have on these environmental changes.
3. Support your thesis with three arguments or reasons, each with specific evidence from the text.
4. Draw a conclusion that refers back to your thesis and generalizes about the role of humans in changing the environment as a whole.
5. Based on your conclusions, what implications does this have for humans in making decisions regarding the environment?



Pre-Write Organizer

Introduction:

Thesis:

First Argument:

Evidence:

Second Argument:

Evidence:

Third Argument:

Evidence:

Summarize and Generalize

Implications for Human Decision-Making and the Environment:

Essay

Essay Scoring Rubric							
Scoring Elements	**Emerging**		**Approaches Expectations**		**Meets Expectations**		**Advanced**
	1	1.5	2	2.5	3	3.5	4
Controlling Idea	Attempts to address the prompt and make a claim, but it is unclear or unfocused.		Addresses the prompt appropriately and makes a claim, with an uneven focus.		Addresses all aspects of the prompt appropriately and establishes and maintains a clear claim.		Addresses all aspects of the prompt appropriately and establishes and maintains a clear, generally convincing claim.
Development/ Use of Sources	Refers to details from sources, with irrelevant, incomplete, or inaccurate elements.		Includes relevant details, examples, and/or quotations from sources to support and develop the argument, with minimal explanation or minor errors in explanation.		Accurately explains relevant details, examples, and/ or quotations from sources to support and develop the argument.		Thoroughly and accurately explains well-chosen and relevant details, examples, and/or quotations from sources to effectively support and develop the argument.
Organization	Lacks an evident structure. Makes unclear connections among claim, reasons, and evidence.		Uses a basic organizational structure to develop argument. Attempts to use transition words to connect ideas, with minor lapses in coherence or organization.		Uses an appropriate organizational structure to develop argument. Uses transitional phrases to clarify the relationships among claim(s), reasons, and evidence.		Maintains an appropriate, logical organizational structure to develop a cohesive argument. Uses varied syntax and transitional phrases that clarify the precise relationships among claim(s), reasons, and evidence.
Conventions	Lacks control of grammar, usage, and mechanics. Uses inappropriate language or tone. Rarely or never cites sources.		Demonstrates an uneven command of standard English conventions. Uses language and tone with some inaccurate, inappropriate, or uneven features. Inconsistently cites sources.		Demonstrates a command of standard English conventions, with few errors. Uses language and tone appropriate to the audience and purpose. Cites sources with minor formatting errors.		Demonstrates and maintains a well-developed command of standard English conventions, with few errors. Consistently uses language and tone appropriate to the audience and purpose. Cites sources using appropriate format.

Lesson 9

Synthesizing Information to Make Predictions

Unit Culminating Task: Prediction Essay

How does the Earth change and how do humans impact that change? After researching informational texts on factors that change the Earth's surface, create a model and write a prediction in which you argue what the Earth will look like in 1 million years. Support your discussion with evidence from the texts.

Activity 3

Prediction Planning Graphic Organizer

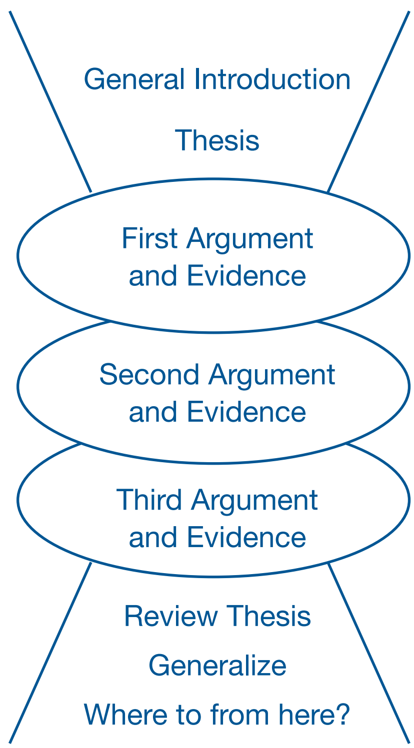
Process that Shapes the Earth's Surface	Predicted Impact in 1 Million Years (Include evidence/support.)
Composition of the Earth	
Plate Tectonics	

Process that Shapes the Earth's Surface	Predicted Impact in 1 Million Years (Include evidence/support.)
Rock Formation/Rock Cycle	
Weathering and Erosion	

Process that Shapes the Earth's Surface	Predicted Impact in 1 Million Years (Include evidence/support.)
Atmospheric Changes	
Human Impact on the Earth	

Pre-Write

Use the graphic below to help you organize your predication essay.



Rubric (Use the same rubric as for the previous essay.)

Essay