PROPERTY OF:

EARTH SCIENCE – UNIT 1 – CHAPTER 1 NOTES

THE NATURE OF SCIENCE

1.1 Sciences

Science = "having knowledge"
Technology = "the use of scientific discoveries for practical purposes"
Major sciences = Earth science, biology, chemistry, physics
All the major sciences are inter-related

1.1 The Four Branches of Earth Science

Geology = the study of Earth, its matter, and the processes that form and change Earth
    EX: volcanoes, earthquakes, maps, fossils, landforms, rocks, minerals, Earth's history
Meteorology = the study of weather and the forces and processes that cause it
    EX: storm patterns, climates, atmosphere, weather
Astronomy = the study of objects in space, including stars, planets, and comets
    EX: stars, planets, comets, moon phases, seasons
Oceanography = the study of Earth's oceans
    EX: ocean water, currents, tides, waves

1.1 The Scientific Method

scientific method = a series of problem-solving procedures used by scientists

1. Determine the problem. (What do you want to find out?)
2. Gather information. (Research background knowledge about your problem.)
3. Make a hypothesis. (Write down an educated prediction to the problem.)
4. Test your hypothesis. (Perform an experiment. Follow a procedure to see if your hypothesis is correct.)
5. Analyze the results. (Present data using tables, charts, graphs, etc. Interpret the data by trying to find out what the data means)
6. Draw conclusions. (Explain the results of the experiment. State whether or not your hypothesis was correct.)

Variable = a changeable factor in an experiment
    An experiment can only test 1 variable at a time. (NO EXCEPTIONS!)
Constants = all the parts of the experiment that stay the same among the different groups
Control Group = a standard for comparison in an experiment
    This is the part of the experiment that does not change
Experimental Group = the part of the experiment that is changed by the variable
Theory = an explanation backed by results obtained from repeated tests or experiments
Scientific Law = a rule of nature that describes the behavior of something.
    Can be observed, but not proven!

PROPERTY OF:

1.1 Problem-Solving Strategies
trial-and-error
identify a problem
eliminate possibilities
make predictions
organize information (tables, charts, etc...)
recognize patterns
make a model
use a drawing
use critical thinking skills
analyze a situation
evaluate all possibilities
determine what information is important
share ideas with others

1.2 Limits of Science
ethics
bias
being objective

1.2 Measurements
Length = the distance between two points (meter … ruler)
Mass = the amount of matter in an object (gram … balance)
Weight = a measure of the gravitational force on an object (Newton … balance)
Area = the amount of surface included within a set of boundaries (meters squared … ruler)
Volume = the amount of space an object occupies (liter … graduated cylinder or beaker)
Density = the amount of matter that occupies a particular space (grams per milliliter … balance and graduated cylinder or beaker)
Temperature = a measure of how hot or cold something is (a measure of how quickly the molecules are moving around) (degrees … thermometer)

1.2 SI Prefixes
K – H – D – B – D – C – M
King – Henry- Died – Before – Drinking – Chocolate - Milk
Kilo – Hecto – Deca – Base – Deci – Centi – Milli

1.2 The Four Safety Rules in Earth Science
Read the directions.
Follow the directions.
Ask the teacher for help.
ALWAYS USE COMMON SENSE!

PROPERTY OF:

EARTH SCIENCE – UNIT 1 – CHAPTERS 18 & 19 NOTES

OCEAN MOTION & OCEANOGRAPHY

18.1 Origin of Oceans
- 4000 MYA: Volcanic activity released a lot of water vapor.
  The water vapor accumulated in the atmosphere & condensed into storm clouds.
  When it rained, the water filled basins (low areas on Earth).
- REMEMBER: The Earth didn't always look the same as it looks now!
- 70% of the Earth is covered with water.

18.1 Ocean Salinity
- Salinity = the amount of solids (EX: salts) dissolved in seawater
- 4 most common ions in the ocean:
  - chloride (55%)
  - sodium (31%)
  - sulfate (8%)
  - magnesium (4%)
- Salts are released from volcanic activity.
- Why is the ocean salty?

18.2 Surface Currents
SEE MAP ON PAGE 518
- Surface Current = movement of the upper portion of the ocean water, powered by wind
  This produces horizontal movement of the water – not vertical movement!
  PROOF: floating message bottles
- Surface currents are deflected (bounce off) by continents.
- Most west-coast currents are cold.
- Most east-coast currents are warm.

18.2 Upwelling
- Upwelling = the rising of cold water from deep in the ocean to the surface
- only occurs near a coastline
- caused by surface winds
- brings nutrient-rich waters from deep in the ocean up to the surface
- 2 effects of upwellings:
  1. brings cooler weather to these coastal areas (because the water is cold)
  2. brings a lot of fish to these coastal areas (because the water has so many nutrients)

PROPERTY OF:

18.2 Density Currents

- Cold water is more dense than warm water.
- Also, high salinity water (salty water) is more dense than low salinity water (fresh water)
- Density Current = when more dense ocean water sinks under less dense ocean water.

- EX: Mediterranean Sea
  - Water is warmed and rises.
  - Some water evaporates, leaving salt behind.
  - The water sinks because it now has a high salt content.
  - The water flows into the Atlantic Ocean.

  DRAW CYCLE DIAGRAM OF THE MEDITERRANEAN DENSITY CURRENT

- EX: Antarctica
  - Water is warmed and rises.
  - Water forms ice, but the ice doesn't contain any of the salt.
  - The water sinks because the water that didn't freeze now has a high salt content.
  - The water flows into the Atlantic and Pacific Oceans.

  DRAW CYCLE DIAGRAM OF THE ANTARCTIC DENSITY CURRENT

18.3 Waves

- Wave = a rhythmic movement that carries energy through matter or space
  EX: ocean wave, earthquake waves (P, S, surface), electromagnetic waves (sunlight)
- Crest = the top of the wave
- Trough = the bottom of the wave
- Wave Height = the distance from the crest to the trough
- Wave Length = the distance from one crest to the next crest

SHOW DIAGRAM OF A WAVE AND LABEL CREST, TROUGH, HEIGHT & LENGTH

- EX: Suppose you place a ball in the middle of the ocean. (This is different near the shore.)
  As waves pass, the ball will move vertically (up and down).
  It will NOT move horizontally (forward or backward, left or right).
  Only the energy moves through the water – not the water particles themselves!

18.3 Waves Near the Shore

- Near the shore, waves changes shape because they start to drag against the bottom of the ocean.
- The wavelength gets shorter and shorter as it reaches the shore.
- The top of the wave moves faster than the bottom of the wave.
- The top of the wave is not slowed down as much by the ocean floor.
- The top of the wave outruns the bottom of the wave. This is when the wave "breaks".
- Breaker = an ocean wave that collapses and tumbles forward as it reaches the shore because the top is moving faster than the bottom

PROPERTY OF:

18.3 Tides

- the periodic rise and fall of the surface level of the oceans
- caused by a giant wave formed by the gravitational attraction between the sun, moon, and Earth
- one tidal cycle takes 12 hours and 25 minutes
- two tidal cycles take 24 hours and 50 minutes (just slightly longer than 1 day)
- tidal range = the difference in ocean level between low tide and high tide
- As the Earth rotates, the side closest to the moon gets a high tide.
- The opposite side also gets a high tide.
- The two sides in between those sides get a low tide.
- Spring Tide = the sun, moon, and Earth align (makes higher high tides + lower low tides)
- Neap Tide = the sun, moon, and Earth are at a right angle (lower high tides + higher low tides)

SHOW DIAGRAM OF EARTH + MOON → HIGH AND LOW TIDES
SHOW DIAGRAM OF EARTH, SUN, AND MOON → SPRING AND NEAP TIDES

19.1 Ocean Features

- Continental Shelf =
  the gradually sloping end of a continent that extends out under the ocean
- Continental Slope =
  the ground that extends from the edge of the continental shelf and dips steeply down to the ocean floor
- Abyssal Plain =
  the flat seafloor in the deep ocean
- Mid-Ocean Ridge =
  the place where new ocean floor forms
  resembles an underwater mountain chain
  formed when tension forces create a divergent plate boundary in the middle of the ocean
  EX: Mid-Atlantic Ridge
- Trench =
  a long, narrow depression (deep part) in the ocean floor
  located where the thinner ocean plate slides under a thicker continental plate
  occurs at an ocean-continent convergent plate boundary
  EX: Peru-Chile Trench off the western coast of South America
  The Nazca Plate (oceanic) slides into/under the South American Plate (continental)

PROPERTY OF:

EARTH SCIENCE – UNIT 1 – CHAPTER 2 NOTES

MATTER

2.1 Levels of Organization

3. MOLECULE = a chemical made of 2 or more atoms
   (water = H_2O, carbon dioxide = CO_2)
2. ATOM = the smallest unit made of only one element
   (hydrogen, carbon, helium, nitrogen)
1. SUBATOMIC PARTICLE = particles found inside an atom
   (protons, neutrons, electrons)

2.1 Subatomic Particles

1. PROTON
   Location: found in the "nucleus" of an atom
   Function: # of protons determines the type of atom
   Charge: positive
2. NEUTRON
   Location: found in the "nucleus" of an atom
   Function: helps to stabilize the protons
   Charge: neutral
3. ELECTRON
   Location: spin around in "orbitals" that surround the nucleus
   Function: used to form ionic bonds and covalent bonds
   Charge: negative

2.1 The Periodic Table

1. Proper notation of elements: first letter capitalized, second letter lowercase
   EX: N = nitrogen
   I = iodine
   Ni = nickel
   NI = nitrogen iodine
2. 4 most common elements in biology: carbon, hydrogen, oxygen, nitrogen
3. atomic number = the number of protons, neutrons, and electrons in an atom (usually)
4. inert gases = He, Ne, Ar, Kr, Xe, Rn = elements that do not react with others because their outer orbitals are already filled with electrons (non-reactive!)
5. metals = located to the left of the staircase, have positive charges
6. non-metals = located to the right of the staircase, have negative charges

2.2 Three Rules for Orbital Diagrams

1. Write the number of protons and neutrons in the middle.
2. Draw the first 2 electrons in the 1st orbital.
3. Draw up to 8 electrons in each additional orbital.

Provide examples of orbital diagrams in class (Li, C, S, Mg).

PROPERTY OF:

2.2 Types of Chemical Bonds

1. IONIC BOND
   a bond that forms when one atom gives an electron to another atom
   in order to make both outer orbitals filled
   also called a "give and take" bond
   ion = an atom that has gained or lost electrons
   +1 ion = an ion that has lost one electron
   +2 ion = an ion that has lost 2 electrons
   +3 ion = an ion that has lost 3 electrons
   -1 ion = an ion that has gained 1 electron
   -2 ion = an ion that has gained 2 electrons
   -3 ion = an ion that has gained 3 electrons

Provide examples of ion orbital diagrams in class (Na^+, Cl^-).
Provide examples of ionic bond formation in class (BeO, LiCl).

2. COVALENT BOND
   a bond that forms when atoms must share electrons
   so that their outer orbitals are completely filled
   also called a "sharing" bond

Provide examples of covalent bond formation in class (N_2, H_2O, O_2).

2.2 Properties

1. Chemical Property = characteristics of an element or compound that determine how it will react with other elements or compounds
   (EX: effect of acid, effect of air, effect of water)
2. Physical Property = characteristics of an element or compound that do NOT determine how it will react with other elements or compounds
   (EX: density, color, mass, boiling point)

2.2 Combinations

1. Mixture = a combination of different substances in which each of the components keeps its own physical and chemical properties
   EX: Heterogenous Mixture = each component CAN be separated (EX: salad)
   EX: Homogenous Mixture = each component CAN NOT be separated (EX: cake batter)
2. Solution = a type of mixture in which one substance is dissolved in another
3. Compound = a combination of different elements in which the physical and chemical properties are different than the properties of the original elements (also called a molecule.

2.3 States of Matter

1. SOLID
2. LIQUID
3. GAS
4. PLASMA

PROPERTY OF:

Density, Rates, and Gradients

DENSITY:
the amount of matter that occupies a particular amount of space

matter → MASS → grams
space → VOLUME → ml or cm^3

density = mass ÷ volume

units: g/ml or g/cm^3

RATE:
a change in a value over a particular period of time

$$\text{rate} = \frac{\text{change in value}}{\text{change in time}}$$

units: value/time

EX: A baby grows from 7 pounds to 21 pounds in 7 months. What is the rate of growth?

change in value = 21 – 7 = 14 pounds
change in time = 7 months

rate = 14 ÷ 7
rate = 2 pounds/month

GRADIENT:
a change in a value over a particular distance

$$\text{gradient} = \frac{\text{change in value}}{\text{change in distance}}$$

units: value/distance

EX: In the front of a classroom, there are 5 grams of tar fumes. In the back of the classroom, there are 2 grams of tar fumes. The classroom is 30 feet long. What is the gradient?

change in value = 5 – 2 = 3 grams of tar
change in distance = 30 feet

gradient = 3 ÷ 30
gradient = 0.1 grams/foot

PROPERTY OF:

EARTH SCIENCE – UNIT 2 – CHAPTER 3 NOTES

MINERALS

****MINERALS ARE NOT THE SAME AS ROCKS!****

3.1 Minerals

Mineral = a naturally occurring, inorganic solid with a definite structure and composition

* naturally occurring = cannot be man-made
* inorganic = not alive; cannot be made by animals or plants (EX: shell, bone, fossil)
* solid = cannot be a liquid or gas; have a specific size and shape that doesn't change
* definite structure = the atoms are arranged in a specific pattern or order
* composition = each mineral has a very specific chemical formula

3.1 Crystals

Crystal = a solid in which the atoms are arranged in repeating patterns

* Square on both ends = cubic or tetragonal
    * all 6 sides are equal = cubic
    * the sides are not as long as the ends = tetragonal
* Rectangle on both ends = orthorhombic
* Hexagon on both ends = hexagonal
* sides are slanted = monoclinic or triclinic

3.1 How Minerals Form

1. Minerals form when magma (melted rock material) cools.
   As it cools, molecules lose energy, slow down, move close together, and form repeating patterns.
   The type of compounds in the magma determine the type of minerals that form.
   Cools quickly → small crystal size
   Cools slowly → large crystal size
2. Crystals form when a solution of minerals slowly evaporates.
   As the water evaporates, the minerals are left behind and form crystals.
   This works best when the solution is "super-saturated".

3.1 Most Common Elements on Earth

1. Oxygen
2. Silicon
3. Aluminum
4. Iron
5. Calcium
6. Sodium
7. Potassium
8. Magnesium

DRAW ORBITAL DIAGRAM FOR SILICON

PROPERTY OF:

3.1 Most Common Mineral Groups on Earth

NOTE: Minerals contain other elements than just the ones in parentheses.

1. Silicates (oxygen and silicon) – MOST COMMON!
2. Carbonates (carbon and oxygen)
3. Oxides (oxygen)
4. sulfides (sulfur)
5. sulfates (sulfur and oxygen)
6. hydroxide (oxygen and hydrogen)
7. phosphates (phosphorus and oxygen)
8. native elements (made of just 1 element)

HINT: The suffix "-ate" means that the mineral contains oxygen!

3.2 Physical Properties of Minerals

1. Color = a good starting point for mineral identification
   not usually a helpful property
2. Hardness = a measure of how easily the mineral can be scratched
   Mohs Hardness Scale – page 69
3. Luster = how light is reflected from the surface of a mineral
   EX: metallic, nonmetallic (dull, pearly, silky, vitreous/glassy, Earthy, waxy, etc.)
4. Streak Test = the color of a mineral's powder when it is rubbed across an unglazed porcelain tile
5. Break Pattern = whether a mineral breaks unevenly or along even planes
   EX: cleavage = breaks along smooth, flat, even surfaces (atoms have strong bonds)
   EX: fracture = breaks along rough, jagged, uneven surfaces (atoms have weak bonds)
6. Crystal System = the basic shape of the crystals found in a mineral
   EX: cubic, tetragonal, orthorhombic, hexagonal, monoclinic, triclinic
7. Density = how much matter (mass) is found in a specific amount of space (volume)
   EX: high density (feels heavy), low density (feels light)

3.2 Chemical Properties of Minerals

1. Magnetism = the ability of a mineral to act like a magnet (EX: Magnetite)
2. Acid Test = the ability of a mineral to fizz when acid is placed on it (EX: Calcite)

3.2 Optical Properties of Minerals

1. Opaque = cannot see through the mineral at all
   EX: when looking through a mineral, you cannot see any images
2. Double Refraction = when light passes through the mineral, it bends in 2 directions
   EX: when looking through a mineral, you see a double image
3. Fiber Optic = when light passes through the mineral, it bends in such a way that it speeds up
   EX: when looking through a mineral, an image looks closer
4. Translucent = when light passes through the mineral, but is scattered
   EX: you can see through the mineral, but image is not clear
5. Transparent = when light passes through the mineral, producing a clear image
   EX: you can see through the mineral, and the image is very clear
6. Prism = when light passes through the mineral, light splits into all colors of the spectrum
   EX: when you hold the mineral in front of a bright light, you see a rainbow of colors

PROPERTY OF:

3.3 Uses of Minerals

1. Gem = a mineral that is considered valuable because it is rare and beautiful
   - usually contains traces of certain minerals
   - usually is polished
   - usually is cut into a particular shape
2. Ore = a mineral that is considered valuable because it can be mined for a profit
   - can be refined or processed into a useful product
   - is worth more as a final product than as a raw material

3.3 Uses of Titanium

SILENT READING: MAKE A LIST OF PROS AND CONS

3.X Phosphates – Help or Hazard?

SILENT READING: MAKE A LIST OF PROS AND CONS

PROPERTY OF:

EARTH SCIENCE – UNIT 2 – CHAPTER 4 NOTES

ROCKS

4.1 Three Types of Rocks

Igneous Rock = a rock formed from the cooling and hardening of molten rock from a volcano or from deep inside the Earth (most abundant type of rock)

Sedimentary Rock = a rock formed when fragments of rocks, minerals, and/or organic matter are compacted or cemented together

Metamorphic Rock = a rock formed when an igneous, sedimentary, or other metamorphic rock is changed by heat and pressure

4.1 The Rock Cycle

SHOW DIAGRAM OF THE ROCK CYCLE

5 TYPES OF ROCKS (CLOCKWISE)

1. Igneous Rock
2. Sediments
3. Sedimentary Rock
4. Metamorphic Rock
5. Magma

5 WAYS ROCKS ARE AFFECTED

1. weathering and erosion (W+E)
2. compaction and cementation (C+C)
3. heat and pressure (H+P)
4. melting (M)
5. cooling (C)

4.2 Igneous Rocks

Igneous Rock = a rock formed from the cooling and hardening of molten rock from a volcano or from deep inside the Earth (most abundant type of rock)

1st way of classifying:

- intrusive = cooled below the Earth's surface; cools slowly; large mineral grains
- extrusive = cooled on or above the Earth's surface; cools quickly; small mineral grains

2nd way of classifying:

- basaltic = dense, heavy, dark-colored, usually contain iron and magnesium
- granitic = less dense, light, light-colored, usually contain silicon and oxygen
- andesitic = in between basaltic and granitic

4.3 Metamorphic Rocks

Metamorphic Rock = a rock formed when an igneous, sedimentary, or other metamorphic rock is changed by heat and pressure

Heat and pressure causes mineral grains to melt and become flattened

SHOW PICTURE OF PARTICLES BEING FLATTENED BY HEAT AND PRESSURE

Main way of classifying:

- foliated = when mineral grains flatten and line up in parallel bands
- non-foliated = when mineral grains flatten and rearrange, but do not form parallel bands

PROPERTY OF:

4.4 Sedimentary Rocks

Sedimentary Rock = a rock formed when fragments of rocks, minerals, and/or organic matter are compacted or cemented together

Sediment = loose materials, such as rock fragments, mineral grains, or plant/animal remains, moved by wind, water, ice, or gravity

Sediments are made by…

- weathering = breaking of rock into smaller pieces
- erosion = the movement of weathered material by wind, water, ice, or gravity

1st way of classifying:

- compaction = layers of small sediments become compressed by the weight of the layers above them (small grain size; produces a banding pattern)
- cementation = large sediments are glued together by mineral deposits in between the sediments (large grain size; usually no banding pattern)
- evaporation = formed when solutions (liquids) evaporate, leaving behind mineral deposits (usually contains calcite or halite)

2nd way of classifying:

- clastic or detrital = broken down fragments of other rocks
  EX: conglomerate (rounded pieces), breccia (sharp angles)
- chemical = formed when a solution evaporates
  EX: limestone (calcite), rock salt (halite)
- organic = formed from the remains of dead plants and animals
  EX: chalk (finely crushed shells), coal

PROPERTY OF:

EARTH SCIENCE – UNIT 3 – CHAPTER 6 NOTES

VIEWS OF EARTH

6.1 Landforms

1. Coastal Plains = large, flat, broad areas along the ocean's shore
   also called lowlands (low elevation, near sea level)
   EX: Atlantic Coastal Plain = formed from a buildup of ocean sediments on the ocean floor; became visible when the sea level dropped
   EX: Gulf Coastal Plain = formed from a building of sediments caused by erosion and deposition from the Mississippi River; became visible when the sea level dropped
2. Interior Plains = a large, flat, broad region of the US from the Rocky Mountains to the Appalachian Mountains
   also called high plains (high elevation, above sea level)
   EX: Great Plains = formed from the erosion and deposition of sediments from streams over millions of years
3. Plateaus = flat, raised areas of land that rise steeply from nearby land
   EX: Colorado Plateau = the land was uplifted by Earth's forces, and cut into by the Colorado River, located west of the Rocky Mountains, forming the GRAND CANYON
4. Mountains = a landform that rises high above the surrounding land
   EX: folded mountains = forms when the Earth's crust is squeezed inward from the sides
   EX: upwarped mountains = forms when the crust is pushed up by Earth's forces
   EX: fault-block mountains = forms when one of the Earth's plates moves past another plate at a fault (crack in the Earth's surface)
   EX: volcanic mountains = forms when a volcano erupts, depositing new layers of sediments in the shape of a cone

6.2 Viewpoints

1. latitude = horizontal lines; shows distance NORTH or SOUTH
2. equator = line of latitude at zero degrees north/south
3. longitude = vertical lines; shows distance EAST or WEST
4. prime meridian = line of longitude at zero degrees east/west
5. time zones = lines of longitude every 15 degrees; earlier in the west; later in the east
   EX: NYC is 2:00 pm → California is 11:00 am

DISCUSS JET LAG ON A TRIP FROM NEW JERSEY TO HAWAII

6. international date line

	L	R	
WEST	Mon	Sun	EAST
	Tues	Mon	
	Wed	Tues	
	Thurs	Wed	
	Fri	Thurs	
	Sat	Fri	
	Sun	Sat	

PROPERTY OF:

6.3 Types of Maps

DISCUSS MERCATOR PROJECTION, CONIC MAP, AND ROBINSON MAP
STUDENTS GENERATE A LIST OF PROS AND CONS FOR EACH TYPE OF MAP

6.3 Topographic Maps

1. topographic map = map that shows the elevation of Earth's surface
2. contour line = a line on a topographic map that connects points of equal elevation
3. contour interval = the difference in elevation between 2 contour lines
   EX: contour interval is small → the land is very steep
   EX: contour interval is large → the land is gently sloping
4. map scale = relationship between the distance on the map and the distance on Earth's surface ("real life")
   EX: If 1 inch = 10 miles, then 2.5 inches = 25 miles

6.3 Rules for Topographic Maps:

1. Contour lines can never cross.
2. Water always flows downhill.
3. Hachure lines always indicate depressions.
4. Use the map scale to calculate distances.

6.3 Technology

1. SONAR (Sea Beam Technology) = a sound wave is sent down to the ocean floor; the depth of the ocean floor is determined based on how long the sound wave takes to return (trenches take more time, mid-ocean ridges take less time)
2. GPS = global positioning system = a set of 24 satellites that send/receive signals to determine a person's location; used for driving, map-making, and animal-tracking.

PROPERTY OF:

EARTH SCIENCE – UNIT 3 – CHAPTER 7 & 8 NOTES

WEATHERING & EROSIONAL FORCES

7.1 Weathering

- Weathering = a process that breaks down rocks into smaller and smaller fragments
  EX: potholes, statues breaking down, gravestone writing getting blurred, etc.

DRAW DIAGRAM OF A ROCK WEATHERING INTO SMALLER PIECES
DRAW DIAGRAM OF ICE WEDGING IN A ROCK
DRAW DIAGRAM OF PLANT ROOTS ON A SIDEWALK
DRAW BEFORE & AFTER DIAGRAMS OF WEATHERING ON A GRAVESTONE

- Mechanical weathering = when rocks break apart without changing their chemical composition (physical change)
  EX: plant roots growing (as the roots grow, they break rocks into smaller pieces)
  EX: ice wedging (water fills in the cracks in rocks, then freezes, expands, and breaks the rock)
- Chemical weathering = when rocks break apart by changing their chemical composition; occurs when air, water, acids, or other substances react with the minerals in the rocks (chemical change)
  EX: carbonic acid dissolves away limestone (calcite) → produces caves
  EX: oxygen coming in contact with iron → rust

SHOW DEMONSTRATION FROM ACTIVITY 6-1: WEATHERING CHALK
SHOW THE EFFECT OF SURFACE AREA ON CHALK USING AN ACID
DRAW DIAGRAMS OF CHEMICAL AND MECHINCAL WEATHERING OF CHALK

- Effect of Surface Area = when a rock is already broken into small pieces (by mechanical weathering), chemical reactions can take place more easily (by chemical weathering)

- WEATHERING OF A LARGE ROCK IS THE FIRST STEP IN CREATING SOIL!

6.1 Effect of climate

- Cool areas: Mechanical weathering is more common (more chances for ice wedging to occur)
- Warm, wet areas: Chemical weathering is more common (more chances for chemical reactions to occur)

PROPERTY OF:

8.1 Vocab

- Weathering = a process that breaks down rocks into smaller and smaller fragments
- Erosion = the movement of weathered material from one place to another
  EX: gravity, glaciers, wind, and water (rivers)
- Deposition = the dropping of sediments as a result of weathering and erosion

8.1 Mass Movements

- Mass Movement = erosion caused by gravitational forces
  - EX 1: Slump = when loose materials or rocks slip down a slope
    Underlying material is weakened and can't support the rock and sediment above.
    Produces a curved scar at the bottom.
  - EX 2: Creep = when sediments slowly inch their way downhill
    Causes trees and utility poles to lean downhill
  - EX 3: Rockslide = when large blocks of rock break loose from a steep slope and start tumbling. Common on mountains or cliffs.
    Usually caused by heavy rains, earthquakes, or ice fractures.
    Produces a "domino effect" – when one piece falls, the rest of them do too…
  - EX 4: Mudflow = thick mixture of sediments and water flowing down a slope
    Occurs in relatively dry areas after a heavy rain.
    Produces a cone-shaped deposit of sediments at the bottom.

8.1 Building on Steep Slopes is Dangerous

1. Building houses makes a slope even steeper.
2. Building houses removes vegetation (plants) from the land.
3. Building houses on steep slopes makes the land prone to slumps.
4. You can slow down erosion, but you can never eliminate it!

8.1 Steep Slopes Can Be Made Safe

1. Grow plants or trees to reduce erosion.
   2 ways that plants reduce erosion:
   - Plants hold the soil in place.
   - Plants absorb water
2. Build terraces (broad step-like cuts in the side of a slope)
   Terraces reduce erosion by making it harder for sediments to move.
3. Build retaining walls
   A retaining wall is a wall of stones or rocks built onto a slope.
   Retaining walls reduce erosion by preventing sediments from sliding downhill.

PROPERTY OF:

8.2 Glaciers
- Glacier = a moving mass of ice and snow
- Continental Glacier = a thick glacier covering a vast area; found near the poles
- Valley Glacier = glaciers found high on mountains where the temperature is lower

8.2 Glacial Erosion
- Glacial Erosion = the movement of loose or ice-fractured solid materials by glaciers
- Plucking = when boulders, gravel, and sand are added to the bottom and sides of a glacier
- Plucked materials erode other material more easily than glaciers alone
- Glaciers create U-shaped valleys (because plucking erodes the sides of the valley)
- Streams create V-shaped valleys (no plucking; erosion only occurs on the bottom of the valley)

8.2 Glacial Deposition
- Till = a mixture of different sized sediments that is deposited when the glacier stops moving
  till is deposited in front of the glacier (not in back!)
- Outwash = materials that are deposited from the melting of glaciers

8.3 Wind Erosion
- wind erosion = the movement of sediments by wind
  - EX 1: Deflation =
    when wind blows loose sediments, removing small particles and leaving behind more coarse particles
  - EX 2: Abrasion =
    when wind-blown sediments strike rock, creating a "sandblasting" effect
  - EX 3: Sand Storm =
    wind erosion over short distances (deserts, beaches, and dry riverbeds)
    EX: winds blowing sand at the beach
  - EX 4: Dust Storm =
    wind erosion over long distances (Dust Bowl: Kansas → New England)

8.3 Wind Deposition
- Sand Dune = the buildup of wind-blown sediments in front of a rock
- Dune Migration = the movement of sand dunes caused by further wind erosion
** SHOW DIAGRAM OF THE FORMATION OF A SAND DUNE **

8.3 Reducing Wind Erosion
1. Tree Belts (a physical block to wind)
2. Plant Vegetation (keeps the soil sediments in place)

PROPERTY OF:

EARTH SCIENCE – UNIT 4 – CHAPTER 11 NOTES

EARTHQUAKES

11.1 Earthquakes

Elastic limit = limit to the amount the Earth's crust can bend, stretch, or compress.
causes breaks, called faults, leads to earthquakes.

3 types of faults: normal fault, reverse fault, and strike-slip fault
SHOW DIAGRAMS OF EACH TYPE OF FAULT

Normal Fault	Reverse Fault	Strike-Slip Fault
caused by tension force	caused by compression force	caused by shearing force
vertical plate movement	vertical plate movement	horizontal plate movement
divergent plate boundary	convergent plate boundary	transform-fault boundary
plates move apart	plates move closer together	plates slip past each other

11.2 Earthquake Information

1. Seismic waves = energy generated by an earthquake

SHOW DIAGRAM OF A WAVE AND LABEL WAVELENGTH AND AMPLITUDE

- high frequency = shorter wavelengths (*SHOW DIAGRAM*)
- low frequency = longer wavelengths (*SHOW DIAGRAM*)
- high frequency = more energy! (EX: x-rays and ultraviolet rays)
- low frequency = less energy! (EX: radio waves)

2. Focus = point in the Earth's interior where the energy is released
P and S waves are produced and travel outward.

3. Epicenter = point on the Earth's surface that is directly above the focus
Surface waves are produced at the epicenter.

11.2 Seismic Waves

1. Primary (P) waves = waves of energy that travel through the Earth by causing particles to compress and stretch apart in the direction of the wave

2. Secondary (S) waves = waves of energy that travel through the Earth causing particles to move at right angles to the wave.

3. Surface waves = Waves of energy that radiate from the epicenter and travel along the surface of the Earth in a rippling motion. Causes a lot of damage by forcing parts of buildings up and other parts down.

PROPERTY OF:

11.2 Speed of Waves
P wave – fastest – arrives first
S wave – medium – arrives second
surface wave – slowest – arrives last
DRAW SEISMOGRAPH RESULTS & LABEL P / S / SURFACE WAVES

11.2 How to Find the Epicenter Location
1. Convert time of arrival into distance.
2. Draw a circle around each station on a map (using the distance as the radius of the circle).
3. Repeat for a minimum of 3 stations.
4. The point of intersection is the epicenter. (*SHOW DIAGRAM OF 3 CIRCLES*)

11.2 Detecting Earthquakes
Seismograph = An instrument used to measure the magnitude of an earthquake. A pen (attached to a pendulum) traces a record of Earth's vibrations onto a sheet of paper. It records all 3 types of waves.

DRAW & LABEL A DIAGRAM OF A SEISMOGRAPH

* if S + P waves are close together → EQ is nearby
* if S + P waves are far apart → EQ is far away

DRAW SEISMOGRAPH RESULTS & LABEL AS "NEAR" OR "FAR"

11.3 Measuring Earthquake Magnitude
Richter Scale = a measure of the energy released by an earthquake (from 1 to 10) every difference of 1 unit = 10 times stronger

EX: A magnitude 5 EQ is ____ times stronger than a magnitude 4. (Answer: 10)
EX: A magnitude 5 EQ is ____ times stronger than a magnitude 3. (Answer: 100)
EX: A magnitude 8 EQ is ____ times stronger than a magnitude 4. (Answer: 10,000)
* Always multiply!

11.3 Tsunamis
Tsunami = an ocean wave that begins over an earthquake's focus can reach over 30 meters high, forming a towering crest as the wave breaks on shore

PROPERTY OF:

EARTH SCIENCE – UNIT 4 – CHAPTER 12 NOTES

VOLCANOES

12.1 Volcanoes
- volcano = an opening in Earth's surface that forms a mountain when layers of lava and ash erupt and build up
- vent = the opening at the surface of a volcano

12.1 Three Locations
1. Divergent Plate Boundary = plates moving away from each other (DPB)
   EX: Mid-Atlantic Ridge

DRAW DIAGRAM OF OCEANIC PLATE & CONTINENTAL PLATE SEPARATING

2. Convergent Plate Boundary = plates moving toward each other (CPB)
   EX: Pacific Ring of Fire (forms a trench or subduction)

DRAW DIAGRAM OF OCEANIC PLATE & CONTINENTAL PLATE COLLIDING

3. Hot Spots = areas in Earth's mantle (underground) that are hotter than usual, forming melted rock (magma) that rises towards the crust
   EX: Hawaiian islands (chains of islands forms as the plate moves over the hot spot.
   NOTE: THE HOT SPOT NEVER MOVES – THE PLATES MOVE!

DEMONSTRATE HOT SPOTS USING A SHEET OF PAPER AND A COMPASS

12.2 Eruptions
- Eruptions depend on 3 factors

1. trapped gases
   - low pressure = quiet eruption
   - high pressure = explosive eruption
2. magma composition
   - basaltic = less silica, more fluid, quiet eruption
     lava runs down the side of the volcano
     gases are easily released
     usually occur at hot spots
   - granitic = more silica, less fluid, explosive/violent eruption
     more thick – causes pressure of gases to build up
     gases expand rapidly during explosion → violent explosion
     usually occur in subduction zones (convergent plate boundaries)
   - andesitic = in-between basaltic and granitic
3. magma water content
   - high water content = granitic, violent eruptions
     occurs at subduction zones (water from the oceanic plates)
     water vapor is trapped in the thick magma
   - low water content = basaltic, quiet eruptions
     occurs at hot spots

PROPERTY OF:

12.2 Three Forms of Volcanoes

1. Shield Volcano =
   - broad volcano with gently sloping side
   - quiet eruptions
   - basaltic magma
   - slowly flows out – cools to form layers of lava
   - found mainly at hot spots
2. Cinder-Cone Volcano =
   - steep-sided volcano
   - violent eruptions
   - granitic magma
   - produces ash, cinders, and large rocks
   - cools to form layers of tephra
   - found mainly at CPB and DPB
3. Composite Volcano =
   - steep-sided volcano
   - alternating quiet and violent eruptions
   - alternating layers of lava and tephra
   - found mainly at CPB and DPB

12.3 Top of a Volcano

- vent = the opening at the surface of a volcano
- crater = a steep-walled depression surrounding the vent
- caldera = very large opening that is caused by the top of a volcano collapsing after an eruption
  EX: Crater Lake in Oregon

SHOW DIAGRAMS OF VENT, CRATER, AND CALDERA

5.2 Geothermal Energy

- Refer to pages 132-133 for a description and diagram of geothermal energy.

PROPERTY OF:

EARTH SCIENCE – UNIT 4 – CHAPTER 10 NOTES

PLATE TECTONICS

10.1 Continental Drift
- theory that the continentals have moved along Earth's surface over time
- proposed by Alfred Wegener in 1912
- his theory was rejected (not believed) until after his death
- he couldn't explain HOW, WHEN, or WHY the continents moved
- his theory was based on the shapes of the continents
- the continents fit together like puzzle pieces
- his theory needed more evidence from fossils, climate, and rocks to be accepted by others

10.1 Evidence For Continental Drift
1. PANGAEA
   - a large landmass that began to break apart 200 million years ago
2. FOSSIL CLUES
   - similar fossils were found on inter-locking continents
   EX. 1: Mesosaurus was found in South America and in Africa. It never could have crossed the Atlantic Ocean, so it must have been able to walk between the two continents. Therefore, they must have been connected.
   EX. 2: Glossopteris (fossil fern) was found in Africa, Australia, India, South America, and Antarctica. Why did this fern grow in so many places?
3. CLIMATE CLUES
   - many continents used to have very different climates
   EX. 1: There is evidence of glaciers in South America, Africa, India, and Australia. Perhaps these continents were all connected and found near the south pole.
   EX. 2: There is fossil evidence of warm-weather plants found on islands in the Arctic Ocean, which is by the north pole. Perhaps these islands used to be near the equator.
4. ROCK CLUES
   - similar rock structures are found on inter-locking continents
   EX. 1: The Appalachian Mountains in the eastern USA are geologically similar to mountains found in Greenland and in western Europe.
   EX. 2: The mountains in eastern South America and geologically similar to mountains in western Africa.

10.2 Seafloor Spreading
- Seafloor spreading means that the Atlantic Ocean is getting bigger (spreading apart).
- Over time, North America and Europe/Africa will be farther apart.
- This happens VERY SLOWLY over the course of MILLIONS of years!
- When the oceanic crust "bumps into" continental crust, subduction zones (trenches) are formed.
- The thinner (less dense) oceanic crust goes underneath the thicker (more dense) continental crust.

SHOW DIAGRAM OF SEAFLOOR SPREADING

PROPERTY OF:

10.2 Evidence For Seafloor Spreading

1. The youngest rocks in the Atlantic Ocean are found at the Mid-Atlantic Ridge.
2. Rocks become older and older as you move away from the Mid-Atlantic Ridge in BOTH directions.

THIS PROVES THAT NEW OCEAN MATERIAL IS PRODUCED AT THE MID-ATLANTIC RIDGE. OLDER MATERIALS ARE THEN PUSHED OUTWARD.

3. The oldest ocean crust is 200 million years old.
4. The oldest continental crust is 4 billion (4000 million) years old.

THIS PROVES THAT OCEANIC CRUST IS CONTINUOUSLY REGENERATED. WHEN THE OCEANIC CRUST SPREADS OUT AND REACHES THE CONTINENTAL CRUST, IT FORMS A "SUBDUCTION ZONE" OR TRENCH. THIS MEANS THAT THE OCEANIC CRUST GOES UNDERNEATH THE OLDER, THICKER CONTINENTAL CRUST.

5. Earth's magnetic field has reversed itself many times in Earth's long history.
6. There are alternating bands of normal and reversed magnetic alignment in the oceanic crust.

THIS (AGAIN) PROVES THAT, THROUGHOUT EARTH'S HISTORY, THE OCEANIC CRUST IS CONTINUOUSLY REGENERATED AND SLOWLY SPREADS OUT FROM THE MID-ATLANTIC RIDGE.

10.3 Theory of Plate Tectonics

- Earth's crust and upper mantle are broken into sections.
- The upper mantle consists of 2 parts: the lithosphere and the asthenosphere.
- Lithosphere = the top part of the upper mantle (less dense part of the mantle)
- Asthensosphere = the lower part of the upper mantle (more dense part of the mantle)
- The crust (also known as PLATES) float around on top of the mantle.

SHOW DIAGRAM OF CRUST, LITHOSPHERE, AND ASTHENOSPHERE

10.3 Three Types of Boundaries

1. DIVERGENT PLATE BOUNDARY (DPB)
   - 2 plates moving away from each other
   EX. 1: North American plate moving away from the Eurasian and African plates
   → Mid-Atlantic Ridge (oceanic example)
   EX. 2: African plate is starting to separated in northern Africa
   → Great Rift Valley (continental example)
2. CONVERGENT PLATE BOUNDARY (CPB)
   - 2 plates moving toward each other
   EX. 1: Nazca plate moving toward the South American plate
   → Andes Mountains and the Peru-Chile Trench
   EX. 2: Philippine plate moving toward the Eurasian plate
   → island arc of Japan and a trench
   EX. 3: Indo-Australian plate is moving toward the Eurasian plate
   → Himalaya Mountains (separating India and Asia)
3. TRANSFORM FAULT BOUNDARY
   - 2 plates sliding past each other
   EX: Pacific plate is sliding past the North American plate
   → San Andreas Fault in California

PROPERTY OF:

10.3 Convection Currents

- based on the idea that cool air sinks and warm air rises
- in the Earth's mantle, cool magma sinks and warm magma rises
- Cool air/magma is MORE DENSE than warm air/magma. Therefore, it sinks.
- Warm air/magna is LESS DENSE than cool air/magma. Therefore, it rises.
- Convection currents in the upper mantle are the cause for plate tectonics.
- Basic steps for a convection current:
    1. Warm (less dense) magma rises to the surface.
    2. When the magma reaches the surface, it moves the plate horizontally.
    3. As it moves the plate, the magma cools down.
    4. The cool (more dense) magma sinks back down into the mantle.
    5. When the magma becomes warm again, this cycle will repeat.

SHOW DIAGRAM OF A CONVECTION CURRENT AT A DPB
SHOW DIAGRAM OF A CONVECTION CURRENT AT A CPB

PROPERTY OF:

EARTH SCIENCE – UNIT 5 – CHAPTER 13 NOTES

CLUES TO EARTH'S PAST

13.1 Fossils

- Fossil = evidence of once-living organisms preserved in rock
- 3 categories of fossils: remains, imprints, or traces
- fossilization usually needs these 3 requirements to happen:
    - a quick "burial" (being covered by sediments to prevent decomposition)
    - no decomposition (if it is broken down by decomposers, there will be nothing left!)
    - the organism contains hard parts (bones, teeth, shells)

13.1 Six Types of Fossils

1. Petrified Remains =
   plant or animal remains that have been turned into rock
   occurs when hard minerals in the groundwater replace softer tissues
   EX: petrified wood often contains quartz
   (Petrified Remains can also be referred to as Permineralized Remains)
2. Carbonaceous Film =
   a fossil imprint in a rock that shows an outline of the original specimen
   formed when heat and pressure (during burial) create an outline from the carbon atoms in the organism
   (Carbonaceous Films can also be referred to as Carbon Films)
3. Mold =
   an empty cavity in a rock that has the shape of a fossil that used to be there
   occurs when the fossil is buried under sediments and is weathered away by water, air, acids, etc.
4. Cast =
   a type of fossil in which a mold is filled with hardened minerals or sediments
   occurs when sediments or hard minerals from the groundwater fill in a mold
5. Original Remains =
   fully preserved organisms or parts of organisms
   occurs when the organism cannot decay because decomposers were not able to live there
   EX: grasshopper preserved in sticky resin
   EX: woolly mammoths preserved in frozen tundra
   EX: cave-man preserved in a glacier
6. Trace Fossils =
   traces of animal activities preserved in rock
   EX: footprints, worm holes, burrows

13.1 Index Fossils

- fossils that scientists use to determine the relative age of a rock sample
- index fossils must meet 3 criteria:
    1. species could only exist for a short period of time
    2. species were abundant (there were a lot of them)
    3. species can be found throughout the world
- NOTE: Index fossils are NOT a 7th type of fossil! They can be any one of the 6 categories!

PROPERTY OF:

13.2 Determining the Age of Rocks

1. The Principle of Superposition = in an undisturbed layer of rocks, the oldest are at the bottom and the youngest are at the top
2. Relative Dating = determining the order of events and the relative age of rocks ("older" or "younger") by examining the positions of rocks in layers
   THIS DOES NOT TELL YOU THE EXACT AGE!!!
3. Absolute Dating = a method of determining the exact age of rocks
   EX: carbon dating
4. Rock Correlations = comparing 2 rock samples based upon their rock layers to see if there are any similarities
5. Unconformities = gaps in the rock layers due to erosions (in other words, part of a layer was eroded, so it becomes more difficult to do relative dating)
   - 2 types of unconformities: angular unconformity and disconformity
   EX. 1: Angular Unconformity
      (1) horizontal layers of rock are tilted and uplifted
      (2) the tops of the tilted layers are eroded
      (3) younger sediments are deposited on top
   EX. 2: Disconformity
      (1) horizontal layers of rock are eroded
      (2) younger sediments are deposited on top, which buries the eroded surface

13.2 Diagrams

1. Original Sequence (Principal of Superposition)
2. Disconformity – Part 1 (Erosion)
3. Disconformity – Part 2 (New Layers)
4. Fault – Before
5. Fault – After
6. Fault, then Erosion
7. Erosion, then Fault
8. Uplifting or Folding – Before
9. Uplifting or Folding – After
10. Angular Unconformity
11. Igneous Intrusion or Igneous Dike

PROPERTY OF:

EARTH SCIENCE – UNIT 5 – CHAPTER 14 NOTES

GEOLOGIC TIME

14.1 Geologic Time Scale
- the division of Earth's history into smaller units of time
- made up of eras, periods, and (sometimes) epochs

1. - Pre-Cambrian Time: 4600 MYA – 544 MYA (not divided into any periods)

2. - Paleozoic Era: 544 MYA – 248 MYA (7 periods in the Paleozoic Era)

3. - Mesozoic Era: 248 MYA – 66 MYA (3 periods in the Mesozoic Era)
   → Triassic Period
   → Jurassic Period
   → Cretaceous Period

4. - Cenozoic Era: 66 MYA – present day (2 periods in the Cenozoic Era)
   → Tertiary Period
   - 5 epochs
   → Quaternary Period
   - 2 epochs

PLACE THESE EVENTS IN THE CORRECT ORDER FROM 1 (FIRST) TO 13 (LAST).
ALSO INDICATE THE ERAS IN WHICH THEY TOOK PLACE.
REFER TO PAGE 393 IN THE TEXTBOOK.

a. first trilobites evolved _____ _____
b. the Jurassic Period began _____ _____
c. early bacteria (first life) are present _____ _____
d. the Himalaya Mountains formed _____ _____
e. first birds appeared _____ _____
f. first amphibians evolved _____ _____
g. first reptiles evolved _____ _____
h. first fish evolved _____ _____
i. first land plants evolved _____ _____
j. the 1st mass extinction took place _____ _____
k. the 2nd mass extinction took place (dinos) _____ _____
l. Pangaea broke up _____ _____
m. present day _____ _____

PROPERTY OF:

14.2 EARLY EARTH HISTORY: PRE-CAMBRIAN TIME & THE PALEOZOIC ERA

14.2 Pre-Cambrian Time

- 4600 MYA – 544 MYA
- very limited fossil record for 3 reasons:
    1. rocks are deeply buried in the Earth (principal of superposition)
    2. rocks and fossils are highly affected by heat and pressure
    3. rocks are highly eroded
- early life:
    1. Cyanobacteria (one of the first organisms) first appeared 3500 MYA.
    2. Invertebrate animals (without a backbone) appeared late in Pre-Cambrian Time.
    3. PROOF: fossil imprints of jellyfish and marine worms
    4. BUT… ONE PROBLEM: these were soft-bodied organisms (no hard parts) so very few fossils actually formed
- early atmosphere:
    1. There was no oxygen!!!!
    2. Oxygen didn't appear until plants evolved and started doing photosynthesis.
    3. There was virtually no ozone layer for UV protection (ozone is made of oxygen)

14.2 Paleozoic Era

- "ERA OF ANCIENT LIFE"
- 544 MYA – 248 MYA
- transition from the Pre-Cambrian Time to the Paleozoic Era:
    1. The Paleozoic Era began with the evolution of organisms with hard body parts.
    2. There are lots of fossils from organisms that lived in the Paleozoic Era.
    3. Most life forms were marine because most of the Earth was covered with water.
- geologic events:
    1. The Appalachian Mountains formed. The Eurasian and African plates both collided with the North American plate.
    2. During the Paleozoic Era, the shallow seas that completely covered North America began to dry up.
- ancient life:
    1. Plants evolved from marine plants into land plants.
    2. Fish were a dominant form of life in the early Paleozoic Era.
    3. As the shallow seas dried up, the fish evolved into amphibians and reptiles.
    4. Amphibians evolved. Amphibians can live on land and breathe air, but must return to the water in order to lay their eggs.
    5. Amphibians were a dominant form of life in the middle Paleozoic Era.
    6. Reptiles evolved. Reptiles can live and reproduce on land. They produce an *amniotic egg*, which they lay on land, not in the water.
    7. Reptiles were a dominant form of life in the late Paleozoic Era (Mesozoic).
- end of the Paleozoic Era:
    1. The continents collided to form Pangaea.
    2. There were many mass extinctions (a time when a lot of plants and animals died). There were 4 main causes of the mass extinctions:
        - the shallow seas were drying up
        - deserts were forming
        - mountains were built
        - climate was changing

PROPERTY OF:

14.3 MIDDLE AND RECENT EARTH HISTORY: THE MESOZOIC & CENOZOIC ERAS

14.3 The Mesozoic Era

- "ERA OF MIDDLE LIFE"
- "AGE OF REPTILES"
- 248 MYA – 66 MYA
- 3 periods of the Mesozoic Era: Triassic Period, Jurassic Period, Cretaceous Period
    1. Triassic: breakup of Pangaea, small dinosaurs, first mammals
    2. Jurassic: breakup of Pangaea continues, larger dinosaurs, first birds
    3. Cretaceous: breakup of Pangaea continues, larger dinosaurs, first angiosperms
- breakup of Pangaea:
    1. Pangaea formed at the end of the Paleozoic Era.
    2. Pangaea began to break up at the beginning of the Mesozoic Era.
    3. As continents moved into different areas, the environment changed.
    4. The environments had different climates and less water.
- reptiles:
    1. Reptiles have hard scales to prevent them from drying out in the drier climates.
    2. Reptiles lay an amniotic egg, which does not have to be placed in the water.
- dinosaurs:
    1. Dinosaurs were reptiles that came in a variety of sizes.
    2. Dinosaurs had a range of diets. Some were carnivores (meat-eaters) and some were herbivores (plant-eaters).
- birds
    1. Dinosaurs (reptiles) evolved into birds.
    2. Birds have wings and feathers, which they use to fly.
    3. *Archaeopteryx* was the link between dinosaurs and birds.
        - It had teeth and claws, which are dinosaur traits.
        - It had wings and feathers, which are bird traits.
- mammals
    1. Mammals evolved throughout the Mesozoic Era, but did not become dominant until the Cenozoic Era.
    2. Mammals are vertebrates (have a backbone) with 4 main traits:
        - They can regulate their own body temperature (warm-blooded).
        - They have body hair.
        - The females produce milk and nurse their young.
        - The females have a live birth (babies do not hatch from eggs).
- gymnosperms
    1. Gymnosperms are called *naked seed plants*.
    2. Gymnosperms are plants that do not produce fruit or flowers.
    3. They are the simpler form of plants.
- angiosperms
    1. Angiosperms are called *flowering plants*.
    2. Angiosperms are plants that produce fruit and/or flowers.
    3. They are the more complex form plants.
- end of the Mesozoic Era
    1. Meteorite Hypothesis?
    2. Alternate Hypothesis?

PROPERTY OF:

14.3 The Extinction of Dinosaurs

1. Meteorite Hypothesis:
   - Meteor collided with Earth.
   - Dust and debris were then released into the atmosphere.
   - The sun was blocked out.
   - Plants died from a lack of photosynthesis.
   - Plant-eating dinosaurs had no food and died.
   - Meat-eating dinosaurs had no food and died.

   PROOF:
   - evidence of an impact from 65 million years ago
   - the crater contains a lot of iridium (often found in meteors)
   - data from rocks indicate a temperature drop at this time

2. Alternate Hypothesis:
   - Dinosaurs went extinct through environmental changes.
   - This is an example of natural selection (Charles Darwin's theory)
   - Dinosaurs could not survive the colder temperatures.

   PROOF:
   - iridium-rich sediments could have come from volcanic activity
   - volcanic activity could have put dust and debris in the air

14.3 The Cenozoic Era

- "ERA OF RECENT LIFE"
- "AGE OF MAMMALS"
- 66 MYA – present day
- 2 periods of the Cenozoic Era: Tertiary Period, Quaternary Period
- geologic events:
  1. The Alps Mountains formed when the African and Eurasian plates collided. (TERTIARY)
  2. The Himalaya Mountains formed when the Indian and Eurasian plates collided. (TERTIARY)
  3. The Grand Canyon formed as the Colorado River cut through the Colorado Plateau. (QUATERNARY)
  4. There was a major ice age in North America. (QUATERNARY)
- biological events:
  1. Mammals continued to evolve and become dominant. Some mammals, like whales and dolphins, even moved back into the water. (TERTIARY)
  2. Some mammals, like kangaroos, became isolated on certain continents due to the breakup of Pangaea. (TERTIARY)
  2. Angiosperms (the flowering plants) continued to evolve and become dominant. (TERTIARY)
  3. Early human-like ancestors (cave-men) evolved about 5 MYA (QUATERNARY)
  4. Humans (*Homo sapiens*) evolved about 0.5 MYA (500,000 years ago) (QUATERNARY)
  5. Humans became dominant about 0.01 MYA (10,000 years ago) (QUATERNARY)

PROPERTY OF:

EARTH SCIENCE – UNIT 6 – CHAPTER 23 NOTES

THE SUN-EARTH-MOON SYSTEM

23.1 Roundness Ratio

- sphere = a round, 3-D object whose surface at all points is the same as the distance from the center
- The Earth is NOT a perfect sphere.
- roundness ratio = a way to compare the equatorial circumference with the polar circumference
- polar circumference = the distance around the Earth along the prime meridian (north-south)
- equatorial circumference = the distance around the Earth along the equator (east-west)
- The equatorial circumference is slightly greater than the polar circumference.
- Therefore, the roundness ratio of Earth is slightly greater than 1.

$$\text{ROUNDNESS RATIO} = \frac{\text{equatorial circumference}}{\text{polar circumference}}$$

23.1 Planet Earth

- axis = an imaginary line around which the Earth spins
- Earth spins on its axis at a 23.5° angle.

SHOW DIAGRAM OF EARTH SPINNING ON ITS AXIS AT A 23.5° ANGLE

- 1 complete rotation on its axis takes 23 hours and 56 minutes (or about a day)
- In one year, the Earth completes 365.25 rotations → 1 leap year every 4th year
- The rotation of the Earth on its axis causes DAY and NIGHT!
- The Earth revolves around the sun.
- ellipse = the shape of the Earth's orbit as it moves around the sun (like an oval)
- LITTLE KNOWN FACT #1: The Earth is closest to the sun in January, but it's winter.
- LITTLE KNOWN FACT #2: The Earth is farthest from the sun in July, but it's summer.
- Seasons are caused by the TILT of the Earth on its axis – not the distance from the sun!

23.1 Seasons

Summer Solstice	Fall Equinox	Winter Solstice	Vernal Equinox
June 21/22	September 22/23	December 21/22	March 20/21
N = summer	N = fall	N = winter	N = spring
S = winter	S= spring	S = summer	S = fall
sunlight hits Earth	sunlight hits Earth	sunlight hits Earth	sunlight hits Earth
at 23.5°N latitude	at 0°N or 0°S latitude	at 23.5°S latitude	at 0°N or 0°S latitude
(Tropic of Cancer)	(Equator)	(Tropic of Capricorn)	(Equator)

SHOW SUN-EARTH DIAGRAMS FOR EACH OF THE FOUR SEASONS

PROPERTY OF:

23.2 Earth's Moon (Luna)
- The moon rotates (spins) on its axis once every 27.3 days.
- The moon revolves around (moves around) the Earth every 27.3 days.
- Therefore, the same side of the moon is always facing the Earth.
- Lunar calendars are based on (approximately) a 4 week cycle (EX: Jewish calendar)
- The moon does not create its own light, like the sun.
- moon light = sunlight that is reflected off the surface of the moon

23.2 Phases of the Moon

- new moon
- waxing crescent
- first quarter
- waxing gibbous
- full moon
- waning gibbous
- third quarter
- waning crescent

SHOW SUNLIGHT-EARTH-MOON DIAGRAMS FOR EACH OF THE EIGHT PHASES

23.2 Solar Eclipse
- occurs when the moon's shadow blocks out part of the Earth
- only a small portion of the Earth is affected at a time
- line up in this order: SUN MOON EARTH
- can only occur during a new moon (when the moon is between the sun and the Earth)
- umbra = darkest portion of the moon's shadow (this part of Earth receives a total eclipse)
- penumbra = lighter part of the moon's shadow (this part of Earth receives a partial eclipse)

SHOW DIAGRAM OF A SOLAR ECLIPSE

23.2 Lunar Eclipse
- occurs when the Earth's shadow blocks out the moon
- affects the entire night-time side of the Earth
- line up in this order: SUN EARTH MOOON
- can only occur during a full moon (when the moon is behind the sun and Earth)
- umbra = darkest portion of Earth's shadow (this part of the moon receives a total eclipse)
- penumbra = lighter part of Earth's shadow (this part of the moon receives a partial eclipse)

SHOW DIAGRAM OF A LUNAR ECLIPSE

PROPERTY OF:

23.2 Origin of the Moon

1. Capture Theory =
   The moon was captured by Earth's gravity.
   It formed somewhere else in the solar system and migrated toward the Earth.
   It was brought into Earth's gravitational field, and began to revolve around the Earth.
2. Impact Theory =
   About 4600 MYA (when the Earth was formed), a large object collided with Earth.
   This sent a lot of gas and debris into the air and into space.
   The gas and debris condensed into a solid object, forming the moon.
   (This is the most accepted theory.)

22.1 Light Pollution

- Light pollution is the glow in the night sky caused by urban, suburban, and rural lights.
- Light can't travel very easily through clouds and smog.
- The glare from lights can cause faint areas to appear completely dark (shadowy effect).
- PRO-LIGHTS: Lights are used for crime prevention.
  Lights are used for security lighting.
- ANTI-LIGHTS: Light pollution makes it difficult or impossible to view stars, meteors, etc.
  Light pollution makes it difficult or impossible to view the "natural" sky.

PROPERTY OF:

EARTH SCIENCE – UNIT 6 – CHAPTER 24 NOTES

THE SOLAR SYSTEM

24.1 Sun-Centered Model
- first supported by Copernicus and Galileo (in the 1500's)
- 9 planets orbit the sun (although in 2006, scientists removed Pluto* from the list)
- sun = central object in the solar system, contains 98% of the mass of the entire solar system
- solar system is divided into 2 parts: inner planets and outer planets
- inner planets = Mercury, Venus, Earth, Mars
- outer planets = Jupiter, Saturn, Uranus, Neptune, Pluto*

24.1 Formation of the Solar System
1. A large cloud of gas, ice, and dust once occupied our place in space.
2. Gravity pulled matter inward, causing the cloud to begin to spin.
3. The dense center grew to be very hot.
4. Gas and dust particles in the outer rim began to clump together.
5. The clumps grew into larger objects.
6. The clumps became the 9* planets, and the core grew denser and hotter.
7. Nuclear fusion began in the core, creating a star (the sun).
8. The smaller objects became the moons and their rings.

24.1 Terms Used to Identify Planets
1. type of planet (inner planet or outer planet, large or small, rocky or gaseous)
2. size (based on diameter and mass)
3. density (whether the planet is "heavy" or "light")
4. distance to the sun (based on average distance and period/time of revolution)
5. eccentricity (high eccentricity = elliptical, low eccentricity = circular)
6. orbital speed (how fast the planet spins on its axis)
7. satellites (moons) or rings
8. atmosphere (how thick or thin the atmosphere is affects the temperature of the planet)

Table 1 Planetary Data

Planet	Average Distance from Sun AU	Average Distance from Sun Millions of km	Period of Revolution	Orbital Velocity km/s	Period of Rotation	Diameter (km)	Relative Mass (Earth = 1)	Average Density (g/cm^3)	Number of Known Satellites*
Mercury	0.39	58	88^d	47.5	59^d	4878	0.06	5.4	0
Venus	0.72	108	225^d	35.0	244^d	12,104	0.82	5.2	0
Earth	1.00	150	365.25^d	29.8	$23^h\ 56^m\ 04^s$	12,756	1.00	5.5	1
Mars	1.52	228	687^d	24.1	$24^h\ 37^m\ 23^s$	6794	0.11	3.9	2
Jupiter	5.20	778	12^{yr}	13.1	$9^h\ 50^m$	143,884	317.87	1.3	63
Saturn	9.54	1427	29.5^{yr}	9.6	$10^h\ 14^m$	120,536	95.14	0.7	31
Uranus	19.18	2870	84^{yr}	6.8	$17^h\ 14^m$	51,118	14.56	1.2	25
Neptune	30.06	4497	165^{yr}	5.3	$16^h\ 03^m$	50,530	17.21	1.7	13
Pluto	39.44	5900	248^{yr}	4.7	6.4^d	approx. 2300	0.002	1.8	1

*Includes all satellites discovered as of March 2004.

NOTES: "Period of Revolution" = how long one year is on a planet
"Period of Rotation" = how long a combined day and night is on a planet

PROPERTY OF:

24.2 Planet # 1 – Mercury

1. small, rocky, inner planet
2. 2nd smallest planet based on diameter and mass
3. 2nd most dense planet
4. closest planet to the sun based on average distance and period (time) of revolution
5. 2nd highest eccentricity of orbit (highly elliptical orbital path around the sun)
6. highest orbital speed (spins very quickly on its axis)
7. no satellites (moons), no rings
8. very thin atmosphere – low gravitational pull allows gases to escape into the atmosphere, causes temperature extremes between day (450°C) and night (-170°C)

24.2 Planet # 2 – Venus

1. large, rocky, inner planet
2. 4th smallest planet based on diameter and mass (just slightly smaller than Earth)
3. 3rd most dense planet
4. 2nd closest planet to the sun based on average distance and period (time) of revolution
5. very low eccentricity of orbit (orbital path around the sun is nearly a perfect circle)
6. 2nd highest orbital speed (spins very quickly on its axis)
7. no satellites (moons), no rings
8. very dense atmosphere – lots of carbon dioxide, traps heat (like an extreme type of greenhouse effect), extremely high temperatures (470°C) that are fairly constant between day and night

24.2 Planet # 3 – Earth

1. large, rocky, inner planet
2. middle-sized planet based on diameter and mass (4 are larger and 4 are smaller)
3. most dense planet
4. 3rd closest planet to the sun based on average distance and period (time) of revolution
5. very low eccentricity of orbit (orbital path around the sun is nearly a perfect circle)
6. 3rd highest orbital speed (spins very quickly on its axis – every 23 hours, 56 minutes)
7. 1 satellite (the moon), no rings
8. atmosphere – allows light to pass through, while reflecting most ultraviolet (UV) rays, also prevents temperature extremes, which allows living things to be able to survive

24.2 Planet # 4 – Mars

1. small, rocky, inner planet
2. 3rd smallest planet based on diameter and mass
3. 4th most dense planet
4. 4th closest planet to the sun based on average distance and period (time) of revolution
5. medium eccentricity of orbit (orbital path around the sun is somewhat elliptical)
6. 4th highest orbital speed (spins on its axis at a medium speed)
7. 2 satellites (2 very small moons), no rings
8. very thin atmosphere – somewhat large temperature fluctuations between day (35°C) and night (-170°C), similar to Mercury in that way (but a little less extreme)

PROPERTY OF:

24.3 Planet # 5 – Jupiter

1. large, gaseous, outer planet (gas giant)
2. largest planet based on diameter and mass
3. 3rd least dense planet
4. 5th (middle) planet from the sun based on average distance and period (time) of revolution
5. medium eccentricity of orbit (orbital path around the sun is somewhat elliptical)
6. middle orbital speed (4 planets spin faster on its axis, 4 planets spin slower on its axis)
7. 16 satellites (moons), 1 ring of dust
   4 moons are listed below:
   a. Io = most volcanically active object in the solar system; red color (lots of sulfur)
   b. Europa = has rocky interior, has a crust of ice, has many visible cracks
   c. Ganymede = the largest satellite (moon) in the solar system
   d. Callisto = has a rocky interior, has a crust of ice, has many visible craters
8. atmosphere – mostly contains hydrogen and helium gases
   - planet has a solid, rocky core and a large outer area of liquid hydrogen and helium
   - Great Red Spot = a large storm in Jupiter's atmosphere

24.3 Planet # 6 – Saturn

1. large, gaseous, outer planet (gas giant)
2. 2nd largest planet based on diameter and mass
3. least dense planet
4. 6th planet from the sun based on average distance and period (time) of revolution
5. medium eccentricity of orbit (orbital path around the sun is somewhat elliptical)
6. 4th lowest orbital speed (spins on its axis at a medium speed)
7. 18 satellites (moons), 1000's of rings of ice, rocks, and dust
   1 moon is listed below:
   a. Titan = largest moon of Saturn (larger than Mercury), has thick clouds of smog
8. atmosphere – mostly contains hydrogen and helium gases
   - planet has a solid, rocky core and a large outer area of liquid hydrogen and helium

24.3 Planet # 7 – Uranus

1. large, gaseous, outer planet (gas giant)
2. 3rd largest planet based on diameter and mass
3. 2nd least dense planet
4. 7th planet from the sun based on average distance and period (time) of revolution
5. medium eccentricity of orbit (orbital path around the sun is somewhat elliptical)
6. 3rd lowest orbital speed (spins on its axis at a slow speed)
   - the axis of rotation is tilted on its side
   - Uranus rotates perpendicular to the plane of its orbit
7. 15 satellites (moons), 11 rings that are thin and dark
8. atmosphere – mostly contains hydrogen, helium, and methane gases
   - the methane gas in the atmosphere gives Uranus a blue-green color
   - planet has a solid, rocky core and a large outer area of liquid H_2O, methane, & ammonia

24.3 Planet # 8 – Neptune

1. large, gaseous, outer planet (gas giant)
2. 4th largest planet based on diameter and mass
3. 4th least dense planet
4. 8th planet from the sun based on average distance and period (time) of revolution
   - Sometimes Neptune is the 9th planet from the sun. It occasionally crosses Pluto's path.

PROPERTY OF:

24.3 Planet # 8 – Neptune (continued)

5. very low eccentricity of orbit (orbital path around the sun is nearly a perfect circle)
6. 2nd lowest orbital speed (spins on its axis at a slow speed)
7. 8 satellites (moons), 4 rings of various thicknesses
   1 moon is listed below:
   a. Triton = largest moon of Neptune, has an atmosphere of nitrogen and methane
8. atmosphere – mostly contains hydrogen, helium, and methane gases
   - the methane gas in the atmosphere gives Neptune a blue-green color
   - planet has a solid, rocky core and a large outer area of liquid H_2O, methane, & ammonia

24.3 Planet # 9 – Pluto*

1. small, rocky, outer planet* (NOT CONSIDERED A PLANET ANYMORE)
2. smallest planet* based on diameter and mass
3. 5th most dense planet* (middle planet* based on density)
4. 9th planet* from the sun based on average distance and period (time) of revolution
   - Sometimes Pluto* is the 8th planet* from the sun. It occasionally crosses Neptune's path.
5. high eccentricity of orbit (highly elliptical orbital path around the sun)
6. lowest orbital speed (spins on its axis at a very slow speed)
7. 1 significant satellite (moon), no rings
   Pluto's largest moon is listed below:
   a. Charon = moon that is half the diameter of Pluto, called a "double planet*"
8. very thin atmosphere
   - planet* has a solid, icy-rock surface
   - scientists are not sure how Pluto and Charon originated –
     possibly from the Kuiper belt of comets or as moons that escaped from other planets

24.4 Other Objects in the Solar System

1. Comets
   - Comets are composed of dust, rocks, ice, and gases.
   - Comets develop a bright tail as they pass by the sun.
   - Solar winds push away small particles from the nucleus of the comet, forming a tail.
   - After a comet has orbited the sun many times, only a few solid particles are left.
   - The remaining small pieces of rock are called meteoroids.

SHOW DIAGRAM OF A COMET & LABEL THE NUCLEUS, COMA, AND TAIL

2. Meteoroids
   - Meteoroids are small pieces of rock that move through space.
   - Meteoroids formed when the solar wind reduced a comet to a few small rocks
     (what was originally in its nucleus)
3. Meteors
   - Meteors are simply meteoroids that have burned up in Earth's atmosphere.
   - They burn up because they fall onto Earth at such a fast speed.
   - Meteors do NOT hit the ground if they complete burn up.
4. Meteorites
   - Meteorites are meteors that didn't complete burn up in Earth's atmosphere.
   - Meteorites hit the ground, leaving a crater.
5. Asteroids
   - Asteroids are pieces of rock that orbit the sun.
   - Asteroids are similar in structure to the rocky planets, but are smaller.
   - Asteroids can be large rocks or small rocks.
   - Most asteroids are found in the "Asteroid Belt" between Mars and Jupiter.
   - The "Asteroid Belt" could have been a planet that never quite formed.

PROPERTY OF:

EARTH SCIENCE – UNIT 6 – CHAPTER 25 NOTES

STARS AND GALAXIES

25.1 Stars and Constellations

- constellation = a grouping of stars that resemble a particular shape
- Some stars can be seen year-round, while others can only be seen during certain seasons.
- EX: Orion can only be seen in the winter. (It faces the Earth during the daytime, not at night.)
- circumpolar constellation = constellation that is visible throughout the entire year.
- Polaris = the "North Star" – located almost directly above the north pole
- Circumpolar constellations appear to move around Polaris.

25.1 Energy, Temperature, and Distance to Stars

- absolute magnitude = a measure of the actual amount of light a star gives off
- apparent magnitude = a measure of the amount of the light that is received on Earth
- EX: A star that is close to Earth will be very bright.
  A star that is very far away from Earth will be dull.
- Parallax = the apparent shift in position of an object (star) when viewed from different places
- Parallax can help determine the distance from the Earth to the star.
- EX: A star that is close to Earth will "move" a lot in the sky throughout the year.
  A star that is very far away will stay in the same part of the sky throughout the year.
- The color of a star is an indication of its temperature.
- The sun, which is yellow, is an average star that is slightly on the cooler side.

25.1 The Speed of Light

- Light travels at the speed of 300,000,000 meters every single second (over 670 million mph!)
- Light travels from the sun to the Earth in 499 seconds (8 minutes, 19 seconds).
- Therefore, the distance from the sun to the Earth is "499 light seconds".
- Astronomical distances are measured in light years.
- 1 light year is the distance that light travels in one year.
- 1 light year = 5.9 trillion miles (the distance that light can travel in one year)
- A "light year" is a unit of DISTANCE, not TIME!!!
- Looking into space is really like looking back in time:
  EX: If you look at a planet that is 1000 light years away, you are really seeing what happened 1000 years ago!

25.2 The Sun

- The sun makes up 99% of the matter in our solar system.
- The sun is an average-sized, average-temperature, middle-aged star.
- The sun is basically a large ball of gas.
- corona = the outer part of the sun's atmosphere, where the temperature can reach 2,000,000 °C.
- sunspots = dark spots on the sun's surface that are a little bit cooler than the rest of the sun
- Sunspots can be seen in cycles.
- Sunspots near the sun's equator rotate every 27 days.
- Sunspots near the sun's poles rotate every 31 days.
- A complete sunspot cycle takes 11 years (when maximum # of sunspots that are visible).
- Solar flares and solar prominences are bright spots in the sun's atmosphere.
- The sun is the only star in our solar system.
- In other systems, stars exist in pairs (called a binary system) or in clusters.

PROPERTY OF:

25.3 The Hertzsprung-Russell Diagram

SHOW PICTURE OF THE H-R DIAGRAM ON PAGE 734

- Most stars fit into the "main sequence" of the H-R Diagram.
- main sequence stars = Stars that are brighter are hotter. Stars that are dimmer are cooler.
- Blue stars are the largest and the hottest. Red stars are the smallest and the coolest.
- Fusion reactions take place inside of all stars.
- fusion = a reaction between hydrogen and helium atoms that produce a lot of energy

25.3 The Evolution of Stars

1. Nebula =
   A large cloud of dust and gas spins around and contracts (gets smaller).
   When it has fully collapsed, the star forms in the middle and begins to do fusion.
2. Main Sequence Stars =
   The star does fusion reactions, using hydrogen and helium atoms to produce energy.
   As the hydrogen and helium are used up, the star gets smaller, dimmer, and cooler.
3. Red Giant =
   When the hydrogen is all used up, the star contracts again, causing it to get hotter.
   The outer layers of the star expand to become very large and very cool.
4. White Dwarf =
   When the core of the red giant runs out of helium, it contracts even more.
   The outer layers of the sun (it's atmosphere) escape into space.
   The star's core is all that remains.

25.3 Other Types of Stars

1. Supergiant =
   In extremely large stars, the stages of evolution occur more quickly and more violently.
   The star gets much larger because the temperatures are so much higher in the core.
2. Supernova =
   When the supergiant collapses, the force causes the outer part of the star to explode.
3. Black Hole =
   When the supergiant collapses, the core may become so dense that nothing can escape its gravitational field – not even light!

25.4 Galaxies

- galaxy = a large group of stars, gas, and dust held together by gravity
- EX: The Milky Way galaxy contains 200 billion stars, including the sun.
  It is 100,000 light years across. It is considered a spiral galaxy.
- There are 3 types of galaxies: elliptical, spiral, and irregular
- EX: 1. elliptical galaxies = oval-shaped galaxies; may look like spheres, eggs, or footballs
  2. spiral galaxies = galaxies with a bright center and long, curved arm-like spirals
  3. irregular galaxies = galaxies with no particular shape or pattern
- Doppler Shift = stars appear to have a slightly different color depending on how they are moving
- EX: When galaxies move away from Earth, they appear a little bit more red.
  When galaxies move toward Earth, they appear a little bit more blue.
- Big Bang Theory = theory of how the universe began about 15 billion years ago (15,000 MYA)
  (see page 744)
- NOTE: The Big Bang did **NOT** occur 4,600 MYA! That's when the Earth formed.

PROPERTY OF:

EARTH SCIENCE – UNIT 7 – CHAPTER 15 NOTES

ATMOSPHERE

15.1 Earth's Atmosphere
- 2 major gases: oxygen (21%) and nitrogen (78%)
- 3 trace gases: argon, carbon dioxide, and water vapor
- 7 super-trace gases: neon, helium, methane, xenon, krypton, hydrogen, and ozone
- The 3 trace gases and the 7 super-trace gases add up to 1% of the atmosphere.

SHOW PIE CHART DIAGRAM OF ATMOSPHERIC GASES

15.1 Layers of the Atmosphere

5. EXOSPHERE =
   - upper-most layer of the atmosphere
   - borders "outer space"
   - There is no clear boundary between the top of the exosphere and the beginning of space.
   - There are very few molecules in the exosphere.
4. THERMOSPHERE =
   - contains a layer of electrically charged particles (also called the ionosphere)
   - In the daytime, these particles interfere with radio transmission.
   - At night, these particles do not interfere with radio transmission.
   - Therefore, radio signals are "stronger" and go farther at night.
3. MESOSPHERE =
   - the middle layer of the atmosphere
2. STRATOSPHERE =
   - contains the ozone layer (which protects us from the sun's ultraviolet radiation)
   - contains the jet streams
1. TROPOSPHERE =
   - the lowest layer of the atmosphere
   - contains 75% of all atmospheric gases
   - contains weather, clouds, smog, dust, ice (snow), liquid water (rain)

15.1 Pressure and Temperature
- HOT AIR: molecules are able to spread apart
  low density
  low air pressure
  hot air always rises!

SHOW DIAGRAM OF PARTICLES THAT ARE FOUND IN HOT AIR

- COLD AIR: molecules are packed tightly together
  high density
  high air pressure
  cold air always sinks!

SHOW DIAGRAM OF PARTICLES THAT ARE FOUND IN COLD AIR

PROPERTY OF:

15.1 Pressure, Temperature, and the Atmosphere
- Air pressure is highest in the troposphere, and becomes less and less as you move up in the air.
- The exosphere has the lowest air pressure because it contains so few gas particles.
- As you move up in the troposphere, the temperature decreases until you reach the stratosphere.
- As you move up in the stratosphere, the temperature increases until you reach the mesosphere.
    - The stratosphere contains ozone, which absorbs sunlight, making it get hotter.
- As you move up in the mesosphere, the temperature decreases until you reach the thermosphere.
- As you move up in the thermosphere and exosphere, the temperature increases.
    - The thermosphere contains electrically-charged particles, making it get hotter.
- Therefore, the divisions of the atmosphere into its 5 layers are primarily based on temperature variations.

15.1 The Ozone Layer: CFC's and The Ozone Hole
- SILENT READING
1. What is the cause of CFC's? (Where do they come from?)
2. What is the effect of CFC's? (How do they impact the atmosphere?)

15.2 Energy From the Sun
- reflection = when the light bounces off of an object (in this case, the Earth)
- absorption = when the light does not bounce off of an object and is taken into it
- thin atmosphere: most of the sun's energy is reflected back into space (bounces off Earth)
    EX: Mercury or Mars (weather is warm/hot in the daytime and freezing cold at night)
- thick atmosphere: most of the sun's energy is absorbed or trapped
    EX: Venus (weather is very hot in the daytime and very hot at night)
- medium atmosphere: some of the energy is reflected and some is absorbed/trapped
    EX: Earth (moderate temperatures during the daytime and at night)

SHOW DIAGRAMS OF THIN, THICK, AND MEDIUM ATMOSPHERES

15.2 Radiation
- the transfer of energy through electromagnetic waves
- does NOT require direct contact with the heat source (you don't touch it)
- EX: tanning on a beach
- EX: sitting in front of a fireplace or campfire
- Energy is ALWAYS transferred from the warmer object to the cooler object!
- It is NEVER transferred from the cooler object to the warmer object.
- Some radiation is reflected back into space and some is absorbed.

SHOW DIAGRAM OF ABSORPTION AND REFLECTION
- 1. 15%: Energy is absorbed by the clouds and atmosphere.
- 2. 50%: Energy is absorbed by Earth's surface.
- 3. 5%: Energy is reflected off of Earth's surface.
- 4. 30%: Energy is reflected off of the clouds and atmosphere.

PROPERTY OF:

15.2 Conduction
- the transfer of energy when molecules bump into each other
- requires a direct contact with the heat sources (the 2 objects must touch each other)
- Energy is ALWAYS transferred from the warmer object to the cooler object!
- It is NEVER transferred from the cooler object to the warmer object.
- Warmer objects have fast-moving molecules (more energy).
- Cooler objects have slow moving molecules (less energy).
- EX: ice melting into a glass of soda (the soda is the warmer object)
- EX: walking barefoot on hot pavement (the pavement is the warmer object)
- EX: a baby touching a hot stove (the stove top is the warmer object)

15.2 Convection
- the transfer of energy when molecules by the flow of a heated material (liquid or gas)
- warm air: molecules spread out
  takes up more volume
  is less dense
  has a lower air pressure
- cold air: molecules are close together
  takes up less volume
  is more dense
  has a higher air pressure
- Hot air rises and cool air sinks due to DENSITY differences.
- Hot air is less dense, so it rises. Cool air is more dense, so it sinks.
- This produces a circular movement of air called a convection current.

DRAW DIAGRAM OF A CONVECTION CURRENT
- EX: The attic is the warmest part of a house. The basement is the coolest.
- EX: Convection currents in Earth's upper mantle cause divergent or convergent boundaries.

15.3 Movement of Air
- wind =
  - the movement of air from high pressure to low pressure
  - caused by the uneven heating of Earth's surface
  - uneven heating is caused by Earth's tilt of 23.5°
  - winds are named based on where they come FROM
  - EX: a westerly wind blows from west to east
  - EX: an easterly wind blows from east to west
- cold air =
  - originates at the poles
  - sinks because it has a high density and a high air pressure
- warm air =
  - originates at the equator
  - rises because it has a low density and a low air pressure
- Coriolis Effect =
  - the effect of Earth's rotation on air and water
  - northern hemisphere = clockwise movement of water and air
  - southern hemisphere = counter-clockwise movement of water and air

PROPERTY OF:

15.3 Surface Winds

- global wind patterns caused by the uneven heating of Earth's surface
- creates convection currents in Earth's atmosphere
    - Polar Easterlies: east → west 90°N (north pole) – 60°N
    - Prevailing Westerlies: west → east 60°N – 30°N
    - Trade Winds: east → west 30°N – equator
    - Doldrums: no movement equator
    - Trade Winds: east → west equator – 30°S
    - Prevailing Westerlies: west → east 30°S – 60° S
    - Polar Easterlies: east → west 60°S – 90°S (south pole)

SHOW DIAGRAM OF EARTH'S SURFACE WINDS

- jet streams =
    - narrow belts of strong winds in the stratosphere that blow primarily from west to east at the border between the different surface winds
    - located at 60°N, 30°N, 30°S, and 60°S
    - planes save fuel when flying east
    - planes try to avoid jet streams when flying west

15.3 Daily Winds

1. Sea Breeze =
    - In daytime, sunlight heats the land more than the water.
    - The air over the land is heated by conduction and rises.
    - Cool, more dense air over the water sinks and moves over the land.
    - This is called a sea breeze because the wind comes FROM the water TO the land.
    - EX: The wind blows from the ocean back onto the beach.
    - THE WIND BLOWS FROM THE WATER TO THE LAND (DAYTIME ONLY).
2. Land Breeze =
    - At night, the land cools more quickly than the water.
    - The air over the land becomes cooler than the air over the water.
    - The cooler, more dense air over the land sinks and moves over the water.
    - The warm air over the water rises and moves over the land.
    - This is called a land breeze because the wind comes FROM the land TO the water.
    - EX: The wind blows from the beach back into the ocean.
    - THE WIND BLOWS FROM THE LAND TO THE WATER (NIGHT-TIME ONLY).

SHOW DIAGRAMS OF A SEA BREEZE AND A LAND BREEZE

PROPERTY OF:

EARTH SCIENCE – UNIT 7 – CHAPTER 16 NOTES

WEATHER

16.1 Weather
- weather = the behavior of the atmosphere at a particular place and time
- includes wind, temperature, pressure, and precipitation
- based primarily on two components: water cycle and convection currents
- The water cycle controls the amount of moisture in the air.
- The convection currents (hot air rising and cold air sinking) determine the temperature.

16.1 Humidity
- humidity = the amount of water vapor that the air can hold
- Air holds water vapor like a sponge!
- EX: Air holds more water vapor when it is warmer.
  Air holds less water vapor when it is colder.
- cold air → more dense → less space for water → lower humidity
  This causes condensation! (clouds/rain)
- hot air → less dense → more space for water → higher humidity
  This prevents condensation! (no clouds/rain)
- Air is saturated when it contains as much water vapor as possible.
- After the air is saturated, extra water vapor will turn into a solid (snow) or liquid (rain).
- dew point = the temperature at which air is saturated and condensation takes place
- The dew point changes based on the humidity.
- EX: water on the outside of a glass, early morning dew

SHOW CIRCLE & DOT DIAGRAMS TO INDICATE WARM AND COLD AIR

16.1 Clouds
- Clouds form when condensation occurs around small nuclei in the atmosphere.
- EX: Nuclei in the atmosphere include dust, smog, salt, smoke, etc.
- Clouds form any time that warm, moist air rises or is pushed up.
- What causes clouds?
  Warm air can hold more water vapor than cold air.
  As it is pushed up, the air becomes colder.
  Cold air holds less water vapor.
  As a result, some of the water vapor turns into water (rain) or ice (snow).
- EX: On a hot day, a glass of iced tea forms beads of water on the outside of the glass.

PROPERTY OF:

16.1 Cloud Terminology
- Stratus = form layers or smooth, even sheets
- Cumulus = puffy, white clouds
- Cirrus = fibrous, curly, or wispy clouds
- Cirro- = high clouds
- Alto- = middle clouds
- strato- = low clouds
- Nimbus or Nimbo- = dark clouds that are usually associated with precipitation
  (There is so much water in them at sunlight cannot pass through.)

16.1 Precipitation
- Precipitation is produced after water vapor condenses into water in the air (clouds)
- EX: Rain =
  Rain falls when the air near the ground is warm (above the freezing point).
- EX: Snow =
  Snow falls when the air in the clouds is so cold that the water droplets turn into ice crystals.
  As the ice crystals freeze, they form snowflakes.
- EX: Sleet =
  Sleet begins as snow crystals.
  As the snow crystals fall, they pass through a region of warmer air.
  The crystals melt. Then they refreeze because the air near the ground is cold.
  As a result, sleet looks like little balls of ice.
- EX: Hail =
  Hail falls when the air in the clouds is so cold that it forms ice crystals.
  Convection currents in the atmosphere cause the ice crystals to go up and down in the air.
  As they move up and down, they get larger and larger.
  As a result, hail looks like large lumps of ice.

16.2 Air Masses
- a large body of air that has the same properties as the surface over which it formed
- Arctic air masses will be cold.
- Tropical air masses will be warm.
- Air masses that form over water will be moist.
- Air masses that form over land will be dry.
- EX: cool + moist
  warm + moist
  cold + dry
  hot + dry

SHOW MAP OF AIR MASSES ON PAGE 462

PROPERTY OF:

16.2 High Pressure Systems
- A high pressure system is caused by air that is descending (sinking) onto the Earth.
- caused by cold air sinking
- NOTE: This does NOT mean that the weather will be cold or will be getting colder!
- Since the cold air is sinking, the warm air is not able to rise.
- Since the warm air doesn't rise, condensation is not able to take place.
- Since there is no condensation taking place, there are no clouds.
- Since there are no clouds, there is no precipitation.
- Therefore, high pressure = good weather!
- The air moves in a clockwise movement around the center of the high pressure system.
- Air is pushed down and out as it sinks.

SHOW DIAGRAM OF AN "H" WITH CLOCKWISE ARROWS AROUND IT

16.2 Low Pressure System
- A low pressure system is caused by air that is ascending (rising) into the atmosphere.
- caused by warm air rising
- NOTE: This does NOT mean that the weather will be warm or will be getting warmer!
- Since the warm air is rising into the atmosphere, the air starts to cool down.
- Since the cooler air holds less water vapor than warmer air, condensation takes place.
- Since there is condensation taking place, clouds form in the sky.
- Since there are clouds, there is precipitation.
- Therefore, low pressure = bad weather!
- The air moves in a counter-clockwise movement around the center of the low pressure system.
- Air is pulled up and in as it rises.

SHOW DIAGRAM OF AN "L" WITH COUNTER-CLOCKWISE ARROWS AROUND IT

16.2 Fronts
- Front =
  A front is a boundary between 2 different air masses.
  Air ALWAYS moves from the high pressure system to the low pressure system!
  (There are never any exceptions to this.)
- Warm Front =
  A warm air mass moves over a departing cold air mass.
  The warm air mass gently/slowly moves up and over the cold air masses.
  This produces a lot of precipitation over a wide area for a long period of time.
- Cold Front =
  A cold air mass moves in and goes underneath the warm air mass.
  The warm air mass quickly rises up over a small area.
  This produces a narrow band (thin area) of violent storms for a short period of time.
- Occluded Front =
  Cold air masses move in from both sides and go underneath the warm air mass.
  The warm air mass is pushed up between the two cold air masses.
  This produces heavy rains, strong winds, and violent storms.
- Stationary Front =
  A cold air mass and a warm air mass move toward each other, but stop moving.
  The warm air mass rises up, but does not continue moving over the cold air mass.
  The produces light wind and precipitation for a few days.

PROPERTY OF:

16.2 Thunderstorms
- occur inside warm air masses and at fronts
- warm air rises rapidly to form cumulonimbus clouds
- strong winds formed when the rain creates drafts of moving air
- lightning forms due to positive and negative ions in clouds (water conducts electricity)
- thunder = sound waves produced by the rapid heating and cooling of the air due to lightning

16.2 Tornadoes
- a violent, whirling wind that moves in a narrow path over land
- usually moves from southwest to northeast
- form along a front during thunderstorms
- produced by winds moving in different directions and at different speeds
- winds are formed by differences in air pressure between the center of the tornado and the outside of the tornado
- forms a funnel cloud

16.2 Hurricanes
- a large, swirling low-pressure storm that forms over tropical oceans
- uses heat energy from the ocean to generate the winds
- warm, moist (humid) air rises and then cools and condenses
- this area of warm air rising is a low pressure system
- eye = the center of the hurricane where cool, dry air descends (sinks)
- There is no danger, precipitation, or bad weather in the eye of a hurricane.

16.3 Terms Used on Weather Maps and Weather Station Models
- isotherm = a line connecting points of equal temperatures
- isobar = a line connecting points of equal air pressures
- If isobars are close together, there will be a lot of wind. WHY?
- H = center of a high pressure system
- L = center of a low pressure system
- barometric pressure:
  + = air pressure is increasing (a high pressure system is approaching)
  — = air pressure is decreasing (a low pressure system is approaching)
- cold front, warm front, and stationary front symbols
- wind speed and direction
- temperature and dew point
- Winds are always defined based on where they ORIGINATE (come from)!
- All weather patterns move across the USA from west to east (prevailing westerlies).