SEE WHAT EARTH SCIENCE IS ALL ABOUT™

4-6

ASTRONOMY:

* **Review K-3 concepts with students, especially daily counterclockwise rotation of the earth.** [lesson]

  Demonstrate the Foucault pendulum (model)

  globe washer string

Moon facts

1. In mass, 81 moons = 1 earth.

   Because of a combination of its reduced mass and the diameter of the moon (2160 miles compared to earth's diameter of 7,900 miles) the gravity on the moon is only 1/6th that of the earth's gravity. Therefore, you would weigh only 1/6th as much on the moon. Muscles, however, remain as strong so you could jump higher, throw objects further, lift huge boulders, etc. Things will fall to the surface of the moon, only slower.

2. There is no atmosphere (not enough gravity to hold gas molecules to moon surface).

   Sky is always black (you can see sun and stars at the same time).
   There is no wind or weather.
   There are extreme temperatures: sunny side +100° C (212 °F)
   dark side -150° C (-240° F)

3. There is no magnetic field.

4. The distance from earth is approximately 250,000 miles (400,000 km).

* **What equipment would still work on the moon?** [lesson]

  Would a match burn? (no)
  electric motor work? (yes)
  helium balloon float? (no)
  gasoline engine work? (no)
  magnetic compass work? (no)

> Note: The moon also turns on its axis once every 28 days. As it circles the earth it also turns, always keeping the same "face" pointed toward earth. Daytime on the moon is 14 earth days long (followed by a 14-earth-day night).

Motion of the moon, phases

Model: styrofoam ball (1/2 dark, 1/2 light) (moon)
globe with paper "people" (earth)
light source (sun)

* **Which way does the moon orbit the earth, clockwise or counterclockwise?** [observational activity]

1. Makes one revolution in 28 days (360° in 28 days = approximately 12° in one day).
2. Use a model, **assume** moon is going counterclockwise. Will moon appear to rise earlier or later each day? **Assume** it is moving clockwise -- what will happen?
3. Make actual observations and see if the moon rises earlier or later each day.
4. Conclude that the moon must be moving counterclockwise.

* **Phases of the moon:** [lesson]

Waxing: New (back side lit up)
Crescent
1st quarter (half lit) -- rises at noon, sets at midnight
Gibbous ("hunched")
Full -- rises at sunset, sets at sunrise

Waning: Gibbous
Last (or 3rd) quarter -- rises at midnight, sets at noon
Crescent
New

Eclipses

* **What causes eclipses:** [observational activity]

Perigee (pear) -- closest in orbit
Apogee (apple) -- furthest away in orbit

1. Solar eclipse (use model):

   New moon between sun and earth -- "spot" projected onto earth. As earth turns, "spot" zooms across earth (700 to 1000 mph).

2. Lunar eclipse (use model):

   Full moon drops into shadow cast by earth. Projection of earth's shadow on moon demonstrates that the earth is round. You can see layer of earth's atmosphere (reddish edge).

* **There are 4 - 7 eclipses each year (minimum - 2 solar and 2 lunar):** [lesson]

Sky calendars tell when and where they will occur.
Never look directly at sun (i.e., solar eclipse - refer to Solar Projection activity under "Stars and Constellations").

Planets

* **Name the nine planets in order:** [lesson]

Memory aid: Mary Valentine Eats Moldy Jelly (Mercury, Venus, Earth, Mars, Jupiter)
S U N (Saturn, Uranus, Neptune)
Pluto

* **How long is a year?** [lesson]

1 year on Earth = 365 Earth days

1 year on Mercury = 88 Earth days

1 year on Venus = 225 Earth days

1 year on Mars = 700 Earth days

1 year on Jupiter = 12 Earth years

1 year on Pluto = 250 Earth years (this means that our Earth orbits the sun 250 times for each orbit of Pluto).

Conclusion: Planets closest to the sun orbit in the least time, planets furthest away take the most time.

"Where would a hypothetical planet be located that had a 500 Earth day year?"

* **Observe Venus as the morning star or the evening star.** [observational activity]

Use a sky calendar to locate this very bright object.

Use model to demonstrate why it is always near the sun (visible just before sunrise or just after sunset).

globe (earth)   light source (sun)   tennis ball (Venus)

* **Observe other planets:** [observational activity]

Use sky calendar to locate Mercury, Mars, Jupiter and Saturn (you can see Jupiter's moons with binoculars).

Comets

* **Comet information:** [lesson]

The word "comet" means "long hair" in Latin.

Comets have solid nuclei made up of frozen gases, ice, rocks and fine dust.

The diameter is usually 1 to 30 miles (1 to 50 km.)

Surface of a comet gets hot and vaporizes as it approaches the sun. Gas and dust particles break loose and form around the nucleus (this is called the "coma"). The coma eventually spreads out to a diameter of up to 100,000 miles (larger than Jupiter). Because of radiation and outrushing of gases from the sun, some material from the coma forms the "tail" and points away from the sun (as far as 100 million miles into space.

Comets are only visible when close to the sun (light is reflected sunlight and excited gas molecules — like a neon light).

Comet path is either closed (eliptical) or open (hyperbola or parabola).

* **Halley's comet:** [lesson]

Has eccentric, eliptical orbit ("eccentric" means that the perigee distance is very small compared to the apogee distance).

Orbits the sun every 76 years, has been seen 28 times since 240 B.C. Was at perigee in 1986 and returns again in 2062.

Time - Earth's revolution

* **Difference between rotation and revolution:** [lesson]

1. Earth rotates on axis once a day.

   Continental U.S. rotation speed is approximately 700 mph (1100 kph)
   At equator speed is approximately 1000 mph (1600 kph)

   Use a record to demonstrate relative speeds.

2. Earth revolves around the sun (365-day journey).

   Speed = 20 miles per second (72,000 mph or 116,000 kpm).

Seasons

* **What causes the seasons?** [observational activity]

globe of earth | light source (sun) | flashlight

Earth is tilted at $23\frac{1}{2}°$.

Light is more direct in southern hemisphere during January and February.
Light is more direct in northern hemisphere during July and August.
Because of the earth's tilt, the duration of a day is longer in the summer.

Stars and constellations

* **Winter constellations and summer constellations:** [observational activity]

globe with paper "people" (earth)
umbrella with paper "stars" (space)
light source (sun)

Using model, show that the position of the earth, with respect to the sun, enables us to see different star groups throughout the year.

Only circumpolar stars (those above the poles) are visible all year.
The North Pole, Polaris, lies on the extension of the earth's axis.
Note: Emphasize that real stars are **not** star-shaped!

* **Solar projection:** [observational activities]

clay
clothespin
tiny mirror
tape

1. Project the sun onto a wall in the classroom -- observe projection during a solar eclipse.

2. Project sun onto butcher paper. Outline the shape at regular intervals. Measure the distance it appears to move per time interval. (Note: If different groups will be comparing values, the distance from the mirror to the butcher paper must be the same for each group).

Measuring degrees

* **How many degrees per hour does the earth turn?** [lesson]

1. Earth rotates 360° in 24 hours:

$$\frac{360°}{24 \text{ hrs}} = 15° \text{ in one hour}$$

Therefore: 15° equals 1 hour of movement in the sky (i.e., sun, moon and stars appear to move 15° [of arc] each hour).

2. Measure time with your fists.

Two fists (outstretched arms) = 15° = 1 hour

* **Making a quadrant:** [activity]

cardboard/posterboard semicircle
soda straw
string
protractor
brad
nut
tape

Using a protractor, mark degrees on cardboard with 0° at bottom and 90° at each end (in 5° to 10° increments).

Hang nut on string from center of circle. Tape straw along top edge.

* **Using the quadrant:** [observational experiments]

1. Sighting Polaris:

   Locate star through the straw.
   Pinch string. Read off angle and record (should equal your latitude).
   Compare values in class.

2. Measuring the sun's angle:

   a. DO NOT LOOK AT SUN THROUGH STRAW, use the palm of the hand.
      Record angle and time.
      Compare all data on blackboard - discuss error, high/low values, average, etc.

   b. Try at same time during the year (winter = low angle, summer = high angle)

   c. Measure the sun's angle every five minutes from 11:45 to 12:15.
      Determine the time when the angle was the greatest (actual time of "noon". Note: This varies depending on your location within your time zone. It may actually happen before 11:45 or after 12:15).

   d. Find other applications for the quandrant:

      Refer to 4-6 Earth Science, "Hot Air Balloon".
      Measure height of a flagpole or building.

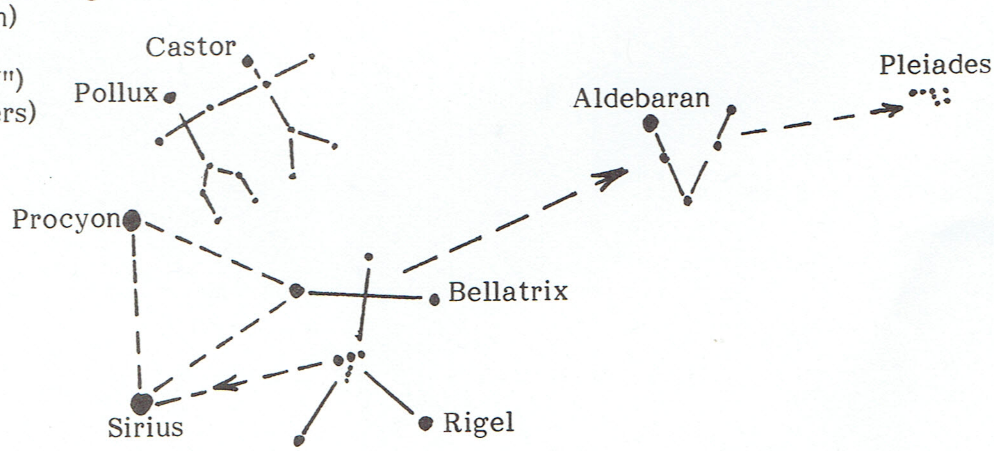
* **Constellation viewer:** [observational activity]

paper towel tube
rubber band
aluminum foil
straight pin

Pick a constellation, punch holes in foil to illustrate it. Write on tube (1) which end is up, (2) name of constellation, and (3) time of year to view it.

* **Finding constellations:** [observational activity]

Orion (The Hunter) - January through April
Canis Major (Sirius, the brightest star)
Canis Minor (Procyon)
Gemini (The Twins)
Taurus (The Bull - "V")
Pleiades (Seven Sisters)



* **- Develop process skills by involving students as much as possible in these activities.**

GEOLOGY/OCEANOGRAPHY:

Chemistry of rocks and minerals

* **Chemistry:** [lesson]

There are 92 elements found in nature, 88 in the earth itself.
Iron is most abundant by weight (core of the earth).

Eight elements make up 99% of earth's crustal material:

1.	Oxygen	O_2*	48%	5.	Calcium	Ca	3%
2.	Silicon	Si	30%	6.	Sodium	Na	2%
3.	Aluminum	Al	8%	7.	Potassium	K	2%
4.	Iron	Fe	5%	8.	Magnesium	Mg	2%

* - Oxygen is found in compound form, not as a free gas.
Most crustal materials will be combinations (compounds) of these eight elements.

Common minerals are made from these eight elements. For example:

Quartz (sand) SiO_2 Feldspar $KAlSi_3O_8$

Minerals: five requirements -

1. Inorganic.
2. Solid (water is not a mineral, but ice is!)
3. Formed by nature (pearls or coral are not minerals)
4. Crystalline shape.
5. Uniform chemical composition.

Rock: one or more minerals (therefore, mineral is a rock but a rock is usually not a mineral).

Growing crystals

* **How minerals form:** [observational activities]

1. "Grow" salt crystals (refer to K-3 Geology).
2. "Grow" alum crystals (grow quickly, make 4-sided double pyramid [orthorhombic]).

   3 oz. (7 T.) alum 1 c. very hot water string with small weight

   Explain about spaces between water -- as it cools, alum must go somewhere.

Cooling rate vs. crystal size

* **Does a crystal grow larger when cooled slowly or rapidly?** [observational experiment]

sand
hot water
3-4 small paper cups to fit loosely inside
ice
magnifiers
3-4 large cups (can be styrofoam)

Cool sample "A" rapidly in ice water, sample "B" slowly in sand, and sample "C" more slowly in hot water. Sample "D" can be left at room temperature.

After hot water reaches room temperature, pour liquid off, retrieve crystals and observe their size with a magnifier. Compare sizes (this explains how we get different size minerals).

Identifying minerals

* **Rock-forming minerals:** [lesson/observational activities]

Most common: silicates (made with silicon and oxygen).

Granite: Quartz - most common SiO_2, has a high luster
Feldspar - milky white, flesh pink or pale gray
Hornblend - dark, long, narrow, "prismatic" crystals
Mica - brilliant jet-black flakes

Physical properties:

1. Luster: metallic (glistens) or nonmetallic (dull, transparent)
2. Hardness: 1-10 rating (1 being soft and 10 hard)

   Talc is "1" (can be scratched with a fingernail)
   Quartz (glass) is "7"
   Corundum is "9" (will scratch glass)
3. Streak: color formed on porcelain square
4. Density: amount of compactness (see 4-6 Physical Science, "Matter")

Activities:
1. Students observe a sample of granite and identify all minerals.
2. With mineral sample kit (from science supply house), students characterize samples by recording hardness (scratch test), luster, streak and density (Note: To find density, you'll need overflow cans and balances).

Rock types

* **Three types of rocks:** [lesson/observational activities]

1. Igneous: (fire -- ignition, ignite)
   a. Can cool quickly in air or water (extrusive) and form small crystals, or can cool slowly (if stays just under the crust), and produce large crystals (intrusive).
   b. Characteristics: large or small crystals, not in any particular order. Usually multicolored, has irregular, rough edges.
   c. Examples: granite, obsidian (cools very rapidly, no crystals), rhyolite, basalt, scoria and pumice (floats).
2. Sedimentary:
   a. Made of compacted sediments, may contain fossils.
   b. Two categories:
      (1) Clastic -- material settles out slowly, layered.
      Examples: shale (compressed mud)
      kaolin (light weight, slow settling in calm water)
      sandstone (soft rock, layers of sand cemented together)
      conglomerate (a cementation of rounded fragments the size of pebbles, cobbles or boulders)
      (2) Non-clastic -- water evaporates away, leaving rock behind (evaporites)
      Examples: tufa, halite (salt), gypsum, travertine, calcite and flint.

3. Metamorphic: (means "to change")

   a. The oldest rocks — were once igneous or sedimentary. Rocks are changed when put under extreme heat and pressure. NOTE: There is a more popular theory for this heat in the earth: This interior heat is caused by radioactivity and not overlying pressure of material.

   b. Two types:

      (1) Foliated -- have visible bands of minerals, are very hard.
      Examples: slate (from shale)
      schist (from a variety of rocks)
      gneiss ["nice"] (from granite), very common, has bands.

      (2) Nonfoliated -- single mineral rock (no bands)
      Examples: marble (from limestone, a sedimentary rock)
      quartzite (from sandstone)
      serpentine (from basalt, an igneous rock)

Activities:

1. Demonstrate how sedimentary rocks form:
   tall glass container with water and different size particles (silt, sand, small rocks)
   Shake mixture together. After it settles, note layers of materials.

2. Settling rates of different materials [experiment]
   Set up 5 to 10 stations, each with: jars of water (all jars must be same height)
   a black card or piece of construction paper
   different size particles (as above)

   Students drop materials into water and record time to hit bottom, then move on to next station. List results. Formulate conclusions.

3. Metamorphic rock model #1:

   crayon pieces
   paper "collar"
   hot water
   wax paper
   coffee can

   Hot water in coffee can melts crayons into a "metamorphic rock" (art activity)

4. Metamorphic rock model #2:

   clay
   wax paper
   washers
   book

   Sandwich clay between wax paper, compress with book. Washers will line up in layers.

Weathering of rocks

* **Physical weathering:** [observational activity]

Using a model, demonstrate weathering. Show rounded (seashore) rocks.

When granite weathers, the quartz, which is very hard ("7" hardness rating), washes down river to beach as sand.

Feldspar is softer, becomes clay (tinier particles), carries further into ocean.
Note: Deep sea floor is mostly clay, not sand!

* **Factors that affect erosion rate:** [lesson]

1. Type of rock (hardness).
2. Amount of area exposed to weather.
3. Climate of area.

* **Water expands when it freezes, can crack rocks:** [observational activity]

iron pipe with 2 cap ends | water | cornstarch (optional)

Fill pipe with water, tightly cap each end and freeze.

Safety note: Do this overnight. After frozen, pack in bag of ice when you transport.

* **Rock tumbler:** [observational activity]

Demonstrate physical weathering with a rock tumbler (takes about 3 weeks).

* **Biological weathering:** [observational activity]

2 small milk cartons | lima beans
tape | water

Fill both cartons with seeds. One carton is control (no water). The other carton (water added) expands and splits within 1-3 days.

* **Action of chemicals (i.e., acids) on rocks (pennies):** [observational activity]

3 tarnished pennies | 3 small containers
vinegar | salt

Sample #1: salt only

Sample #2: vinegar only

Sample #3: both vinegar and salt

Observe each penny. Salt and vinegar, when combined, make a new chemical that reacts with the penny (chemical change).

Note: Sample #3 shiny penny will later turn green. This is caused by another chemical change (oxygen combining with copper).

* **Action of water on steel wool:** [observational activity]

Sample #1: in air

Sample #2: in moist sand

Sample #3: in water

Observe each sample and note signs of a chemical change (color change).

* **Observe soil samples for signs of weathered rocks:** [observational activity]

magnifiers | soil samples

Note organic and inorganic items in samples.

Earthquakes, faults

* **Three types of faults:** [lesson/observational activity]

two blocks of wood cut diagonally and painted

1. Normal -- vertical, one block moves up, other moves down.
2. Thrust -- diagonal cut block moves up and over a first block.
3. Strike-slip -- lateral movement (sideways), San Andreas fault (California).

* **Earthquakes:** [lesson/observational activity]

When friction holds blocks together, energy can build up (like in a coiled spring). When it releases there is an earthquake. Magnitude differs depending on amount of energy released.

Slinky model (three types of waves):

1. "P" wave -- "push" or compression wave moves in line with spring. Note speed of wave.
2. "S" wave -- "shake" wave, like an ocean wave. Slower than "P" wave.

   Note: "P" (primary) waves and "S" (secondary) waves are called "body waves" as they travel through the inner earth. The "P" wave travels at about twice the velocity of the "S" wave.
3. "L" wave -- "long" wave, travels along the crust. This is the wave that causes the most damage, is slower and diminishes rapidly with distance.

* **Volcanos:** -- Don't forget volcanos in your earth science unit!

Ocean floor, features

* **Indirect measuring activities:** [observational activities]

1. Obsertainer kit (This is an exceptional activity for higher-level process skills, i.e., inferring, predicting)

   Determine the shape of the barriers.
2. 3-D ocean floor box

shoe box	flour	ruler
wood sticks (skewers)	salt	nail
block of wood	water	

   a. Students work in teams to make a model sea floor with ingredients above. Flour mixture can be hardened quicker in low-temperature oven. Number each box.

   b. Punch holes in lid (grid pattern). Best way is to drive a nail through a block of wood making a handle for the nail. Place lid over something soft (cardboard box or ground), punch out all grid marks. Tape lid onto box.

   c. Measure depth with wood skewer and ruler (use cm). Record all depths -- do row "A" first (Note: More measurements make better approximations).

   d. Graph each row, connect the "dots", cut out each row of the "ocean floor" and glue to the "3-D" board.

Observe finished approximations, open box and compare to original.

Sonar

* **How can we measure the depth of the ocean?** [lesson/math]

SOund Navigation And Ranging

Speed of sound in water: 4,800 feet/second (1,500 meters/sec) is four times faster than in air .

Math problem:

Time = 1 second, speed = 4,800 fps, then

the distance to bottom and back = $4{,}800 \frac{\text{ft.}}{\text{sec.}}$ X 1 sec. = 4,800 ft.

one-way distance = $\frac{1}{2}$ (4,800) = 2,400 ft.

Features, plate tectonics

* **Explain location and characteristics of these features:** [lesson]

1. Abyssal plains (average depth -- 4 km. or $2\frac{1}{2}$ miles).
2. Trenches (deepest points - 10 km.). Sea floor being driven under, into earth.
3. Volcanic islands, seamounts, guyots (flat topped, under the surface).
4. Mid-ocean ridge and rift (where new sea floor originates).
5. Continental shelf and slope (extensions of continent).

* **How much of the earth is water?** [observational activity]

globe of earth
green and blue 1" (3 cm) paper squares
tape

Lightly tape squares on globe (green for land, blue for water). Count total number of all squares and blue squares. Note: Check surface of globe for durability first.

$\frac{\text{\# of blue}}{\text{Total}}$ = 75% (amount of water)

Discuss causes of error if result is not 75%.

* **How much salt is in sea water?** [observational experiment]

coffee pot
balance
sea water (or use 1 liter water + 35 grams salt mixed in advance)

1. Weigh empty coffee pot.
2. Pour in sea water, place on hot plate (don't leave unattended).
3. After all water has evaporated (approx. 10 hours), weigh again. Calculate difference (should equal 35 grams). Discuss results -- why was it more or less than 35 grams?

*** - Develop process skills by involving students as much as possible in these activities.**

METEOROLOGY:

Review

* **Density of gases:** (from K-3 Earth Science, "Meteorology")

   1. Air particles are further apart at higher altitudes (less air above, pushing down).

   2. Warm air is less dense (particles are further apart) than cold air (hot air rises).

* **Seasons:** (from 4-6 Earth Science, "Astronomy")

   Show flashlight demonstration, if necessary.

Heating of earth and water

* **How does time in sunlight affect temperature?** [observational activity]

   2 bowls of dry soil
   2 thermometers

   Place bowl #1 in sun for 15 minutes, bowl #2 in sun for 30 minutes.

   Conclude that number of hours of sunlight effects temperature of earth (and water). Soil is holding heat.

* **Which heats up (cools down) faster, soil or water?** [observational activity]

   2 bowls
   2 thermometers
   dry soil
   water

   Conclusion: soil (land) heats up and cools down faster than water (bodies of water).

* **Why the wind blows:** [lesson]

   Daytime: Air near soil (land) heats up first and rises. Air over water (still cool) rushes in to fill the empty space (over land).

   Evening: Land cools off first. Air over water is now warmer and you get the reverse effect (wind blows the other way).

Cause of winds - earth's features

   pan of water
   hot plate with sturdy pan of soil
   large rock
   convection spiral

* **Demonstrate, with spiral, that hot air rises:** [observational activity]

   Creates low pressure area over land and causes wind to blow from high to low.

* **Explain why (on West Coast) there are deserts on east side of mountains:** [observational activity]

   Model shows ocean, a mountain range and the desert.

   1. Air over ocean is holding lots of water
   2. Air gets colder as it rises up face of mountain.
   3. Water gets "squeezed" out -- rain on west side of mountain.
   4. Dry air absorbs moisture on east side and makes deserts.

* **Why is climate so different on East Coast compared to West Coast?** [observational activity]

1. Wind tends to blow from west to east (this is caused by the counterclockwise rotation of the earth).

2. Air hitting East Coast has been traveling over 3,000 miles of soil (not water). Land has greater temperature variations than water. West Coast climate is influenced by winds that have traveled over the water (moderate climate).

<u>Temperature/pressure relationship</u>

bicycle pump aerosol hair spray

* **Gases cool when they expand:** [observational activity]

Spray compressed gas (hair spray). Notice spray tip, it will be cold.

* **Gases heat up when they are compressed:** [observational activity]

Pump a bicycle pump. Feel end of nozzel, it will be hot.

<u>Water cycle</u>

Lesson:

Use model to explain that water evaporates, condenses, rains, travels to ocean and evaporates again. Think of the water you're drinking. How many times has it run down a mountain (or worse yet, been in a sewer)!

<u>Hot air balloon</u>

* **Make and fly a hot air balloon:** [activity]

See handout for construction, etc.

* **Use quadrant to measure vertical height:** [observational activity/math]

1. Measure 100 feet (30 meters) in two or more directions from launch site.

2. Launch balloon (in still air). Each student measures maximum angle using their quadrant (if balloon goes straight up, all measurements should be roughly equal).

3. Average this number (optional). If wind is blowing, observer downwind will get a higher angle than one upwind. This brings up a good class discussion question.

4. Scale down on paper in classroom 1" = 10 ft. (or 1 cm. = 1 meter). Draw a horizontal line 10 inches long representing 100 feet. Inscribe angle measured with a protractor. Measure vertical distance up and convert back to feet (or meters).

* **The speared balloon:** [observational activity]

What to do with a "leftover" balloon (and knitting needle). Try it, but be bold when inserting needle!

HOT AIR BALLOON

Start a balloon craze in your school! Give awards for the most colorful, highest or furthest flying balloons.

When charged from a camping stove, this five-foot balloon should rise from 50 to 100 meters high.

To make and fly one, you'll need:

- a dozen sheets of tissue paper (20" X 30")
- some large paper clips
- a glue stick
- some fine wire (i.e. telephone wire)
- newspaper
- one large juice can (both ends cut out)
- gloves
- a hair dryer
- a camp stove or charcoal barbeque

Making Your Balloon

1. Begin by making a pattern with newspaper. Tape or glue two sheets together to form one large sheet (approximately 55" long). Fold it in half lengthwise.

2. Start at the top "fold" of the newspaper and mark the top point. Measure down 5" along the fold and then 3" away from the fold and place a second mark. Continue measuring down 5" and then in from the fold as shown in Figure 1 until you have plotted all eleven points.

   Connect the dots to make a smooth curve. Cut through both layers of newspaper and your pattern is complete. To make additional patterns for your class, simply trace or cut around your pattern on additional pieces of folded newspaper.

3. To make the balloon panels, begin by gluing two 20" X 30" tissue sheets together to make one long 20" X 60" sheet (the seam should be approximately 3/4" wide). Make six of these. Fold each lengthwise and stack them with the folded edges together.

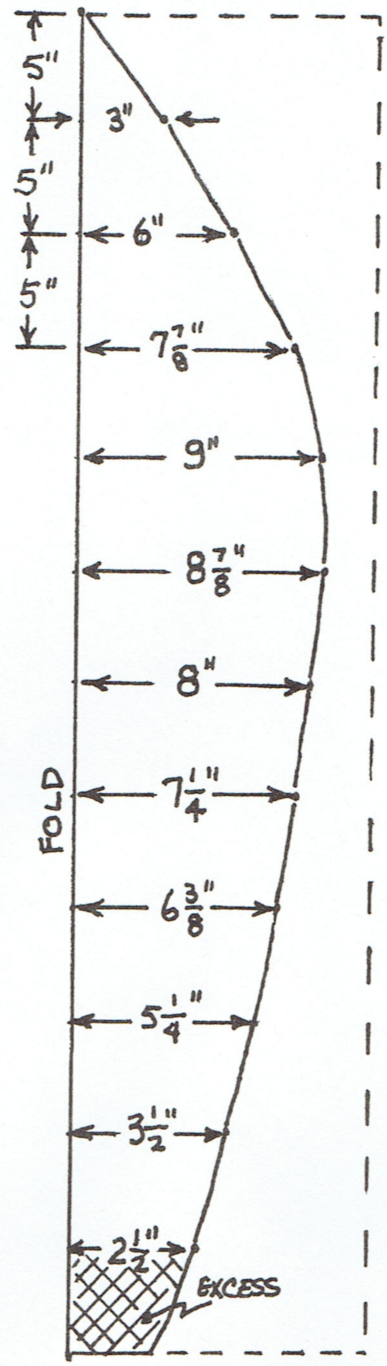


Figure 1

4. Place the pattern on top of the stack and use five or six paperclips along the folded edges to secure the stack. Trace around the pattern and cut through all 12 layers at once. Do not cut off excess tissue at the bottom (mouth of balloon).

   Place one **folded** sheet of tissue on a large sheet of newspaper. Using the glue stick, apply a continuous line of glue around the top curved side (make the seam approximately 1/2" wide). Place another folded sheet on top of the first one and press the curved edges together. Apply glue to the top of the second one and glue the third sheet to it. Continue until all six sheets are glued together accordion-style. Insert newspaper between the layers to keep the tissue paper from gluing itself to the panel underneath it. Allow the glue to set. Finally, apply glue to the top curved edge and carefully bring the bottom sheet out from under the stack and around to seal it to the top sheet to complete the "envelope."

   Check the top seal where all the points come together. If it is loose, glue a circular tissue patch onto it for reinforcement.

   Make a 1" cuff at the mouth of the balloon. Put a loop of wire into the cuff and seal it with glue. Test the balloon with the hair dryer. Check for holes and weak seams. Patch them with glue and tissue paper.

Launching Your Balloon

1. Balloons should be launched outside only. Ideally, you want a day with cool air, clear skies and no wind. Choose a launch site away from obstructions and upwind from an open landing area. Have teachers, parents or students assist as recovery teams.

2. Use the juice can as a chimney and place it on a camping stove or barbeque. Have 2 or 3 students help hold the balloon while you direct the hot air into the mouth of the balloon. Don't let the balloon touch the chimney. **IF THE BALLOON CATCHES ON FIRE, LET GO OF IT AND LET IT BURN OUT.** When the balloon is filled with hot air and the tissue paper is warm to the touch, **IT'S TIME!** Count to three and have everyone let go at once.

Theory

The balloon rises because the density of the envelope and hot air (combined) is less than the density of the surrounding air. As wood will float to the top of a tank of water, your balloon will continue to rise as long as it is "lighter than air" or, put scientifically, "less dense than air."

The amount of lift is dependent on the difference between the outside air temperature and the temperature of the air inside the balloon. It is also dependent on the **amount** of hot air in the balloon (i.e. size of balloon) and the weight of the balloon. Once these variables are understood, students can experiment with their own designs and shapes.

This activity has obvious value in understanding concepts in science...properties of air, density and meteorology. Using mathematics, students can use a quadrant and a simple graphic solution to determine the altitude the balloon reaches (refer to **SEE WHAT EARTH SCIENCE IS ALL ABOUT**™ 4-6 Meteorology). The history of ballooning is another very fascinating topic, especially the early experiments in France by the Montgolfier brothers.

Air pressure - effects

* **Demonstrate that air exerts pressure:** [observational activity]

glass of water
piece of cloth or playing card
cola can
fish tank full of water

1. Invert glass of water covered by piece of cloth. It doesn't fall off. Note "bow" in cloth.

2. Try the same thing with the cola can and glass of water.

3. Use a plastic cup with a (secret) hole bored in the side. Cover the hole with your finger when you hold it upside down in the tank of water. Water stays in the glass because of air pressure. Invite students to try this, too. Since they don't know about the hole, the water runs out. Conclusion: Air must be getting into the cup.

4. Crush the can:

   a. Fill can with enough water to cover bottom, bring to boil.

   b. Remove from heat, cap tightly. When it cools, it crushes.

   c. Explanation: Steam in can condenses to liquid (may make 10 drops). Now very little air is in the space above water. Air tries to get in, crushes the can.

Temperature/humidity

* **Demonstrate why water evaporates:** [observational activity]

2 balls of one color (H_2)
1 ball of another color (O)
1 rag (dust)

1. Make a model of a water molecule (H_2O). Discuss relative speed of molecules, like billiard balls on a table. If particle goes fast enough, it evaporates.

2. When you measure the temperature of a liquid, you are measuring the average motion of the particles. Individual particles are evaporating all the time (regardless of the "average" temperature).

3 Air pressure (pushing down on water) is also important in "holding them in", retarding the evaporation rate.

   a. Would water boil easier (at a lower temperature) on a mountain top (less air pressure)? Solicit responses. (Answer: Yes, there is less air pressure).

   b. A pressure cooker demonstrates the reverse effect. Food cooks in less time (greater pressure makes water boil at higher temperature).

* **What causes clouds (and rain)?** [lesson]

1. Need a "nucleus" (i.e., dust particle).

2. Electrically charged dust attracts charged water molecules.

3. More particles come together to form a drop.

4. Tiny drops form clouds (these are made of liquid water so tiny that they hardly fall).

* **Measuring Rainfall** [observational activity]

Rain is a very important resource. With a simple rain gauge you can keep rainfall records. Inexpensive gauges (conical or wedge-shaped plastic) are available from science supply houses or you can make your own.

1 tall, thin cylindrical jar (3 oz. olive jar works well)
ruler
masking tape
waterproof marker
(optional) 1 tin can with top completed removed (NOTE: for Advanced Method, diameter of this can should be about twice the diameter of the jar. A 1 lb. vegetable or fruit can will work well).

1. Simple Method:

   a. Put a 5-inch strip (approximately 12 centimeters) of masking tape on a table. With the ruler, mark off each inch (or each centimeter) onto the masking tape. If possible, mark sub-divisions for each tenth of an inch (weather stations measure rain in inches and tenths!). Transfer the marked tape onto the outside of your "olive jar" with the zero mark lined up with the bottom of the jar.

   b. Place the empty jar outside in an open area. After a rainstorm, simply read and record the level of the water in the jar. Empty the jar before the next storm.

2. Advanced Method:

   a. Pour exactly one inch of water into the can (insert ruler into can to measure).

   b. Transfer this water into the jar. Since the jar is "thinner," the water level will be higher (i.e. up about $4\frac{1}{2}$ inches).

      Cut a piece of masking tape to this length (i.e. $4\frac{1}{2}$ inches). Denote that length as one inch of rain. Mark the halfway point (i.e. $2\frac{1}{4}$ inches) and denote it as 1/2 inch of rain. If possible, divide the total segment ($4\frac{1}{2}$ inches) into ten equal increments (1/10 inch each). When finished, place the tape on the bottle.

   c. Now, instead of using the bottle, this time put the dry can outside. After a rainfall, transfer the water to the jar and read the amount. This method will demonstrate how we can make more accurate measurements by "amplifying" the amount of water collected.

3. Thought questions:

   a. Why should you record the rainfall soon after the storm? (evaporation)

   b. What could make a difference between your measurements and those on TV (or those of other students)?

   c. Why should you use a cylindrical jar — what would happen if you used a ketsup bottle, for example?

<u>Relative humidity</u>

* **What is humidity?** [lesson]

1. Air can hold only so much water at a particular temperature.

   a. When it is holding all it can, we say the humidity is 100%.

2. Relative humidity is the amount of water in the air as compared to this maximum amount (which is temperature dependent, i.e. 80% relative humidity is air holding 80% of the maximum possible).

* **Measuring relative humidity** [observational activity]

  2 thermometers (one with a wet shoelace on the bulb)
  humidity table

1. Fan air across both thermometers. Wet bulb cools.
2. Record: (a) dry bulb temperature, and
   (b) difference between wet and dry bulbs.

Refer to humidity table to find the relative humidity.

Weather charts

* **Keep accurate weather information throughout the year.** [observational activity]

RELATIVE HUMIDITY TABLE

Dry-bulb Thermometer Readings (°C)	Difference between wet- and dry-bulb thermometer readings (°C)									
	1	2	3	4	5	6	7	8	9	10
10	88	77	66	55	44	34	24	15	6	
11	89	78	67	56	46	36	27	18	9	
12	89	78	68	58	48	39	29	21	12	
13	89	79	69	59	50	41	32	23	15	7
14	90	79	70	60	51	42	34	26	18	10
15	90	80	71	61	53	44	36	27	20	13
16	90	81	71	63	54	46	38	30	23	15
17	90	81	72	64	55	47	40	32	25	18
18	91	82	73	65	57	49	41	34	27	20
19	91	82	74	65	58	50	43	36	29	22
20	91	83	74	66	59	51	44	37	31	24
21	91	83	75	67	60	53	46	39	32	26
22	92	83	76	68	61	54	47	40	34	28
23	92	84	76	69	62	55	48	42	36	30
24	92	84	77	69	62	56	49	43	37	31
25	92	84	77	70	63	57	50	44	39	33
26	92	85	78	71	64	58	51	46	40	34
27	92	85	78	71	65	58	52	47	41	36
28	93	85	78	72	65	59	53	48	42	37
29	93	86	79	72	66	60	54	49	43	38
30	93	86	79	73	67	61	55	50	44	39

*** - Develop process skills by involving students as much as possible in these activities.**