



**Southern Africa**

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SCIENCE

Grade 7

NELSPRUIT, MPUMALANGA

JULY 11 - 15, 2016

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# Nelspruit Workshops

## Grade 7: Matter and Materials

1. Professional Development Topic: Promoting Wonder, Observation, and Communication in Science
  - a. Teacher Reference #1 -- Encouraging Discourse in Science (*Booklet Reading #1*)
  - b. "I Wonder Why" Demonstration: Straws as droppers.
    - i. What does chemistry tell you is happening?
    - ii. What will your students say is happening?
    - iii. Evidence for: Solid? Liquid? Gas? What are the differences?
  - c. Additional ideas/resources
    - i. Large flask/water bottle, transparency, water.
    - ii. Apple Observation activity (.docx file)
2. Teaching Topic: PARTICLES OF MATTER
  - a. Focus: What is the Particle Kinetic Theory?
    - Matter is made of particles
    - Particles of matter are always moving
    - particles of matter attract each other
  - b. Lesson Plan: an application of ACS #1.1 (.pdf and other files)  
<http://www.middleschoolchemistry.com/lessonplans/chapter1/lesson1>
    - i. Engage activity: Straws as Droppers Demonstration/Activity (above...)
    - ii. Explore: "Water Droplets and Particles" (*Booklet Activity #1*)
    - iii. Explain: Drawing pictures of "attracting" particles as a PKT model
  - c. Additional ideas/resources:
    - i. Water/oil/nail polish remover dropped onto pennies
    - ii. PhET simulation – States of Matter Basics (.jar file)  
<http://phet.colorado.edu/en/simulation/states-of-matter-basics>
3. Teaching Topic: LIQUIDS
  - a. Focus: How do particles in a liquid behave? (Creating a model)
    - Particles in a liquid are always moving
    - In a liquid, particles move past each other, changing locations within the sample
    - Heat makes them move faster
  - b. Lesson Plan: an application of ACS #1.2 (.pdf and other files)  
<http://www.middleschoolchemistry.com/lessonplans/chapter1/lesson2>
    - i. Engage demonstration: Food Coloring in Water Demonstration
    - ii. Explore: Food coloring in hot and cold water activity; Creating a droplet of liquid using students as a model for liquid particles.
    - iii. Explain: Explaining to a neighbor verbally – active communicating skills
  - c. Additional ideas/resources:
    - i. Warm syrup/cold syrup on pennies
    - ii. PhET simulation – States of Matter Basics (.jar file)  
<http://phet.colorado.edu/en/simulation/states-of-matter-basics>
4. Teaching Topic: SOLIDS
  - a. Focus: How do particles in a solid behave? (Creating a model)
    - Particles not moving fast enough to escape the attractions of their direct neighbors
    - In a solid, particles vibrate around a fixed location.
    - Fixed locations create ordered patterns of particles
  - b. Lesson Plan: an application of ACS #1.4 (.pdf and other files)  
<http://www.middleschoolchemistry.com/lessonplans/chapter1/lesson4>
    - i. Engage demonstration: Show some crystalline solids (rock candy?)
    - ii. Explore: Painting with copper sulfate or Epsom salts crystals (*Booklet Activity #2*); Creating a crystal of solid using students as a model for solid particles.
    - iii. Explain: Explaining to a neighbor verbally – active listening skills

- c. Additional ideas/resources:
  - i. Growing crystals on black paper (.docx file)
  - ii. PhET simulation – States of Matter Basics (.jar file)  
<http://phet.colorado.edu/en/simulation/states-of-matter-basics>

5. Teaching Topic: GASES

- a. Focus: How do particles in a gas behave? (Creating a model )
  - Particles in a gas move in straight lines until they collide with a container or with another particle
  - Speed is great enough that attractions between particles cannot constrain their motion – completely free to move in any direction.
  - Collisions with the sides of the container presses outward on the container
  - More particles or faster particles creates more pressure outward on the container
- b. Lesson Plan: ACS #1.5 (.pdf and other files)  
<http://www.middleschoolchemistry.com/lessonplans/chapter1/lesson5>
  - i. Engage demonstration: Weighing a large balloon before and after inflating
  - ii. Explore: Gases Hot and Cold activity (**Booklet Activity #3**); Creating a sample of gas using students as a model for gas particles
  - iii. Explain: Writing an explanation of why the soap bubble rose and fell... using a given list of vocabulary words to include
- c. Additional ideas/resources:
  - i. Tiny marshmallows in a syringe
  - ii. PhET simulation – Gas Properties (.jar file)  
<http://phet.colorado.edu/en/simulation/gas-properties>

6. Teaching Topic: THE PERIODIC TABLE

- a. Focus: What information is available on the periodic table?
  - The atoms in the periodic table are arranged to show characteristics and relationships between atoms and groups of atoms.
  - The atomic number = # of protons in its nucleus, = # of electrons surrounding nucleus.
  - Different atoms of the same element can have a different number of neutrons.
  - Atoms of the same element with different numbers of neutrons are called “isotopes”.
  - The atomic mass is the average mass of the different isotopes of the element.
- b. Lesson Plans: ACS #4.2 (.pdf and other files)  
Periodic Table Game cards. <http://www.middleschoolchemistry.com/lessonplans/chapter4/lesson2>
- c. Additional Ideas/Resources  
Periodic Table Game #2: Including energy levels  
<http://www.middleschoolchemistry.com/lessonplans/chapter4/lesson3>

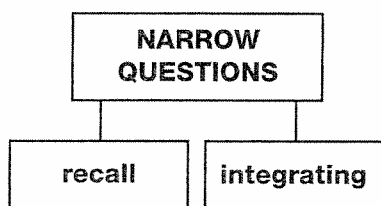
## ENCOURAGING DISCOURSE

Discourse is an important component of science learning. Students need to describe their observations and reasoning and to interpret how other students are thinking. Good questions posed by the teacher can enhance this discourse by contributing to the development of concepts and vocabulary and by helping students connect ideas among the sciences. Thoughtfully presented questions promote thinking and draw students into sharing observations, communicating ideas, and uncovering relationships.

Questions fall into two general categories. **Narrow questions** call for specific answers. They focus student thinking on specific knowledge. **Broad questions** invite individual thought. They diverge from a central idea, encouraging unique and creative thinking. Both kinds of questions have application in FOSS.

**Narrow Questions.** There are two kinds of narrow questions, recall and integrating. Discussions often start with **recall** questions that ask students to remember terminology and procedures.

As the discussion continues, more complex **integrating** questions encourage students to put pieces of information together to generate ideas with which they have had no direct experience. These questions have “right” answers, but there may be more than one way to express an answer.

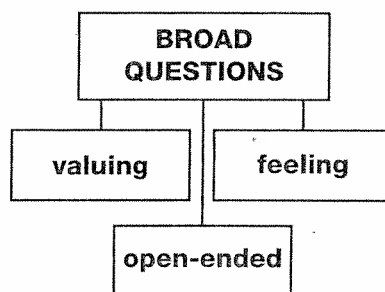


**Broad Questions.** Broad questions do not require specific answers that everyone agrees upon. Three kinds of broad questions invite students to share their personal ideas, feelings, and values about the subject matter under investigation. These questions have no right answers, so all student responses should be accepted, and many students should be invited to contribute to the discussion.

**Open-ended** questions encourage creative, speculative thinking.

**Valuing** questions allow students to reflect on the subject, based on their own value structure.

**Feeling** questions invite students to share their personal feelings about aspects of the topics being investigated.



Research shows that it is important to wait several seconds before calling on a student to respond to a question. Waiting improves the quality of student responses and increases the number of students who try to respond to the question.



## Activity #1: Water Droplets and the Particle Kinetic Theory

Adapted from: <http://www.middleschoolchemistry.com/lessonplans/chapter1/lesson1>

In this activity the students investigate the characteristics of water and begin to create a molecular-level model that explains why water acts as it does.

- Water in a small cup
- Index cards covered with wax paper
- Popsicle sticks

### METHOD

- ☐ Place a drop of water, the size of a small coin, on the wax paper.
- ☐ Gently tilt the wax paper in different directions so that the drop moves
- ☐ Use a stick to slowly move your drop around the wax paper.
- ☐ Use your stick to separate your drop into two drops.
- ☐ Use the stick to bring the drops close to each other, and then move them together so they just touch.

### OBSERVATION/DISCUSSION QUESTIONS:

1. When you were pulling the drop around, did it seem to hold together or come apart easily?
2. When you tried to split the drop, did the drop separate easily?
3. Was it easy or difficult to make the drops come together?
4. Imagine a drop of water hanging from your finger. How is this similar to the water staying together on the wax paper?
5. What is it about water molecules that helps explain why the water drops were difficult to split apart but easy to join together?

### DEMONSTRATION:

In a large clear container filled with water, squirt food coloring and let the solution sit.

- What does this tell you about water molecules?

### CREATE A MODEL:

Take out a clean piece of paper. Using circles to represent molecules and lines to represent motion, draw a model of water on the molecular level. Use the entire paper. Be sure to show that the water molecules are randomly arranged, close together, moving.

TAKING IT FURTHER: If possible, show a slow-motion video of a water balloon being popped.

[http://www.youtube.com/watch?v=TdMIsCF\\_7p0](http://www.youtube.com/watch?v=TdMIsCF_7p0)

- Why do you think the water keeps its shape the moment the balloon is popped?

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## Activity #2: Creating Crystals

In this activity students will create copper sulfate crystals from a concentrated solution, with help from the sun or other heat source

- White or black construction paper,
- Paint brush or straw
- Very warm water
- Scissors and Aluminum foil (optional)
- Copper sulfate or Epsom salts

### METHOD

- ☐ In a small cup, add 1 large spoonful of either copper sulfate or Epsom salts to a small amount of very warm water. Stir to dissolve. Continue to add solid until it will not all dissolve and some of the solid remains sitting in the bottom of the cup.
- ☐ Using the paint brush or using the straw as a eye-dropper, "paint" a picture on the paper. If using Epsom salts, use the black paper, if using copper sulfate, use the white paper.
- ☐ Hold the paper close to a heat source (in front of a hair drier? on a radiator?) or place in the sun.

### OBSERVATION/DISCUSSION QUESTIONS

1. Look closely at the crystals and observe their shape. What does this tell you about the arrangement of particles in a solid crystal?
2. How is the arrangement of particles in a solid different from in a liquid?
3. What happens, at a molecular level, when ice melts? When water freezes?

### Create a Model:

Take out a clean piece of paper. Using circles to represent molecules and lines to represent motion, draw a model of copper sulfate (or Epsom salt) particles on the molecular level. Use the entire paper. Be sure to show that the particles are arranged in an orderly fashion and close together.

- Do you think the particles are moving at all?

TAKING IT FURTHER: If possible, show a time-lapse video of a water crystals (snowflakes) forming.

<http://petapixel.com/2014/02/23/mesmerizing-time-lapse-captures-formation-snowflake/>

- Why do you think the crystals grow outward from a central point?
- Why do you think there are always six "points" to these water crystals?

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## **Activity #3: Gases Hot and Cold**

Adapted from: <http://www.middleschoolchemistry.com/lessonplans/chapter1/lesson5>

In this investigation you will observe how heating and cooling affects a gas.

- Two clear plastic cups
- A small water bottle
- Detergent solution in a small cup
- Hot water
- Cold water

### METHOD

- ❑ Pour hot water into one of the cups until it is about  $\frac{1}{2}$  full.
- ❑ Pour cold water into the other cup until it is  $\frac{1}{2}$  full.
- ❑ Turn the water bottle over and dip the opening into the soap solution to get a soap film at the rim.
- ❑ While holding the bottle, slowly push the bottom of the bottle down into the hot water.
- ❑ While there is still a bubble on the bottle, slowly push the bottom of the bottle into the cold water.

NOTE: If the bubble has popped, make another by dipping into the soap solution and pushing down into the hot water again. Then proceed.

- Write down your observations

### OBSERVATION/DISCUSSION QUESTIONS:

*Before answering, there are two important facts to consider. The first is that, when gases warm up, their molecules move faster. The other is that the air on the outside of the soap film is also made up of gas molecules. Keeping these facts in mind, consider the following:*

1. What caused the bubble to form when you placed the bottle into hot water?
2. What caused the bubble to "implode" when you placed the bottle in the cold water?

### CREATE A MODEL:

Take out a clean piece of paper. Using circles to represent molecules and lines to represent motion, draw a model of air on the molecular level. Use the entire paper. Be sure to show that the particles are randomly arranged and very far apart.

- Do you think the particles attract each other at all?

TAKING IT FURTHER: If possible, show a video of liquid nitrogen (at  $-196^{\circ}\text{C}$ ) being poured out on a table.

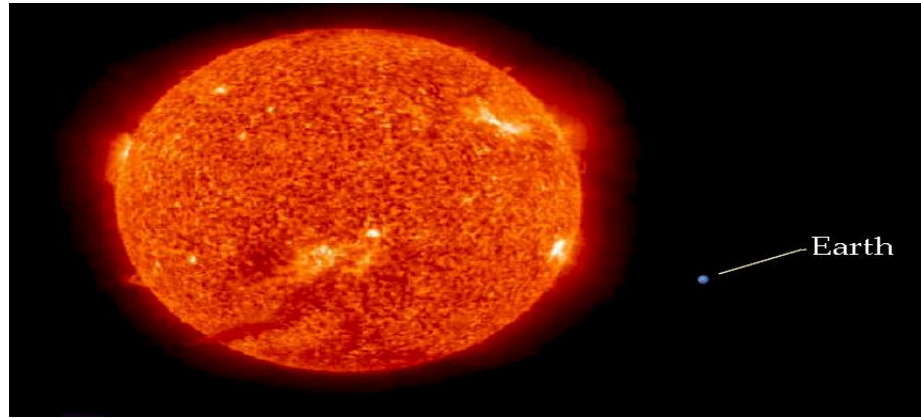
<http://www.youtube.com/watch?v=gvuOhpsl9yQ>

- Why does the liquid nitrogen disappear?
- Why does the gaseous nitrogen take up so much more space than the liquid nitrogen?
- Would you want to put your hand in liquid nitrogen?

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Periodic Table of the Elements																																
1 H Hydrogen 1.008	2 IIA 2A												5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180														
3 Li Lithium 6.941	4 Be Beryllium 9.012													13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948													
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948															
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 84.798															
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294															
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018															
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown															

Lanthanide Series	57 <b>La</b> Lanthanum 138.905	58 <b>Ce</b> Cerium 140.116	59 <b>Pr</b> Praseodymium 140.908	60 <b>Nd</b> Neodymium 144.243	61 <b>Pm</b> Promethium 144.913	62 <b>Sm</b> Samarium 150.36	63 <b>Eu</b> Europium 151.964	64 <b>Gd</b> Gadolinium 157.25	65 <b>Tb</b> Terbium 158.925	66 <b>Dy</b> Dysprosium 162.500	67 <b>Ho</b> Holmium 164.930	68 <b>Er</b> Erbium 167.259	69 <b>Tm</b> Thulium 168.934	70 <b>Yb</b> Ytterbium 173.055	71 <b>Lu</b> Lutetium 174.967
	89 <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.048	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [254]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]

# THE SUN'S RELATIONSHIP TO EARTH



The sun is a medium-sized star, one of billions in the Universe. Other stars often orbit each other, but the sun stands alone at the center of our solar system. It is just right in terms of size and mass to support life on earth and planetary motion. Although it sends out powerful solar flares, the sun is tame compared to other stars its size. The sun is essentially spherical with a diameter of roughly 865,000 miles. If you were to take the earth's diameter and multiply it by 100 that would be the Sun's diameter. Around *one million* planets the size of the earth can fit into the sun. The Sun is incredibly dense and its weight possibly bends space-time like Einstein predicted – its gravity will literally bend the light of other stars and causes planetary motion.

## **EXPERIMENT #1: The “Bent Space and Time” Theory of Gravity**

*Understanding Einstein's Theory of Gravity/Planetary Orbit*

### Supplies:

- ◆ A soft seat cushion from a couch or chair
- ◆ A bowling ball (A heavy rock will work as well.)
- ◆ A marble

**Introduction:** Einstein's General Theory of Relativity concludes that the gravitational “force” is not really a force but a result of the fact that mass bends space and time. This experiment will help illustrate such a strange concept.

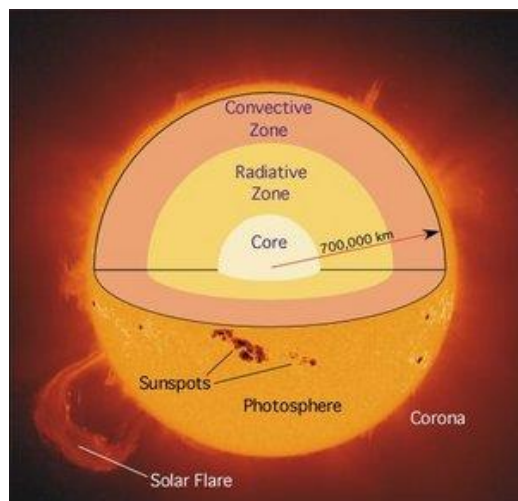
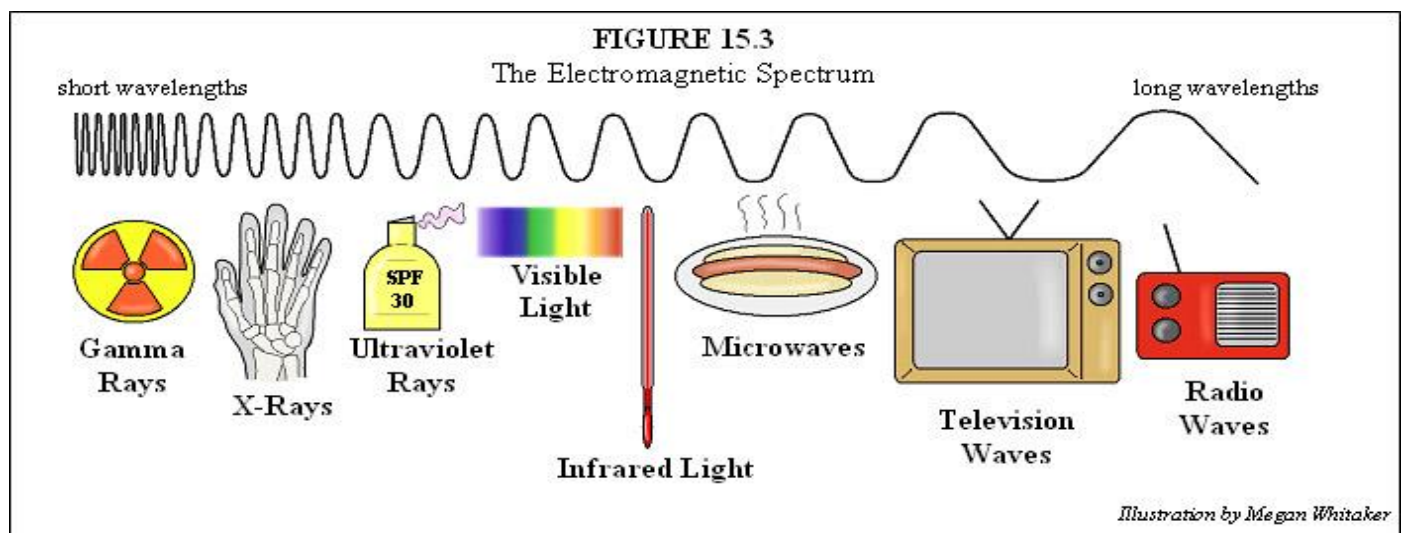
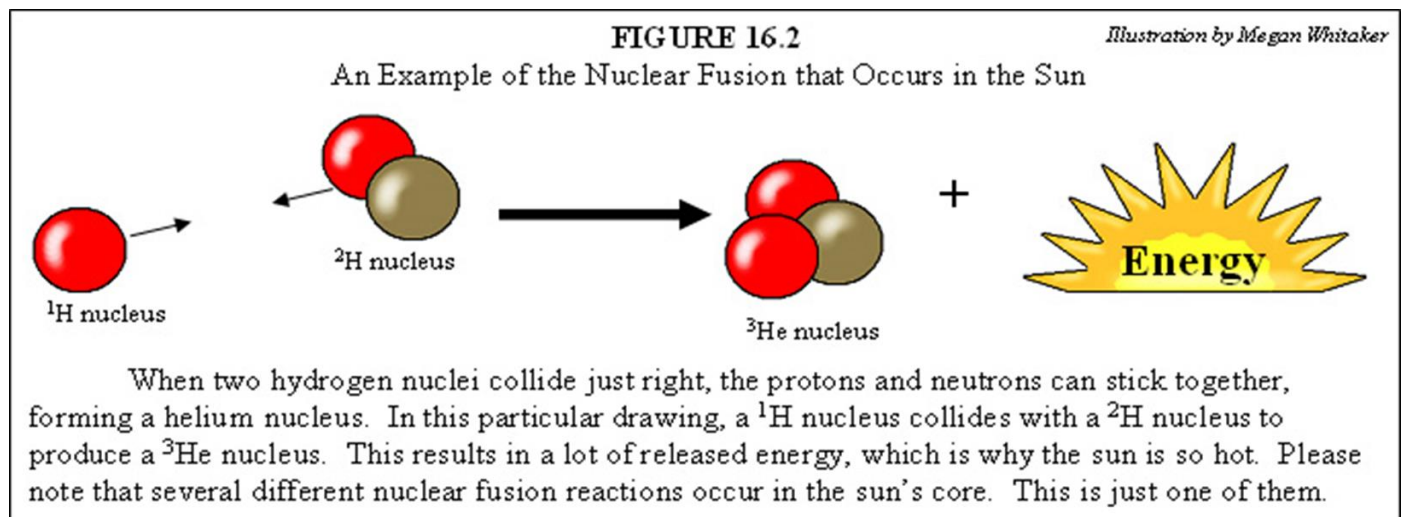
### Procedure:

1. Lay the seat cushion on the floor. Find a spot on the cushion that is away from the center and relatively flat. Lay the marble on that point so that it stays there without rolling.
2. Lay the bowling ball on the very center of the cushion. Note what happens to the marble.
3. Take the bowling ball off the cushion and smooth it out so that it is reasonably flat again.
4. Roll the marble (slowly) straight across the cushion, but not near the center – roll straight
5. Put the bowling ball back in the center of the cushion and roll the marble along the same path that you rolled it before, with the same slow speed. Note the path that the marble takes.



# Solar Energy

Nuclear Fusion powers the sun and provides the energy we need to support life on earth. Much like air bubbles rising through a pot of boiling water, these hot gases rise through the sun's convection zone until they reach the surface, which we call the **photosphere**. From there the energy is released in the form of electromagnetic waves of light. This light is known as incoming solar radiation, or **insolation**.



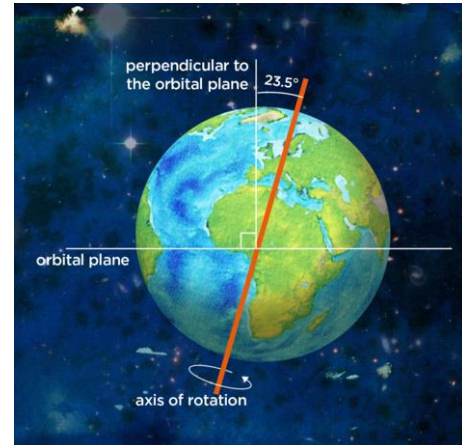
# THE EARTH'S ROTATION & TILT

The Earth revolves around the Sun in an almost perfect circle, completing one **revolution (orbit)** around the Sun per year (or 365  $\frac{1}{4}$  days to be precise). As the Earth revolves around the Sun it also rotates (spins) on its axis at the same time. Having two words both beginning with "r" relating to movement can be confusing! Let's check now that you know what they mean before we continue.

In your own words explain what is meant by the Earth's **rotation**.

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In your own words explain what is meant by the Earth **revolving**.

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## DIRECT & INDIRECT LIGHT

Let's see now what effect this tilt has on the Earth.

### MATERIALS:

- A4 sized or larger piece of black card, one per pair
- torch, one per pair
- bin bags to darken the room if necessary
- pencil or pen, one per pair

### INSTRUCTIONS:

1. You will need to work in a pair for this activity.
2. Place the card flat on a desktop or table.
3. Darken the room using curtains or bin bags.
4. One person should hold the torch about 25 cm above the card pointing straight down. Shine the light onto the card.
5. Look at the beam shining on the black card and note its size. The person in the pair not holding the torch should draw around the edge of the beam with a pen or pencil.
6. Swap places and point the torch towards the card at an angle of 45°, keeping it at the same distance from the card as before. Shine the light onto the card.
7. Look at the beam shining on to the card, draw around the edge of the beam with a pen or pencil.

### QUESTIONS:

In which case is the light more concentrated? (direct or indirect)

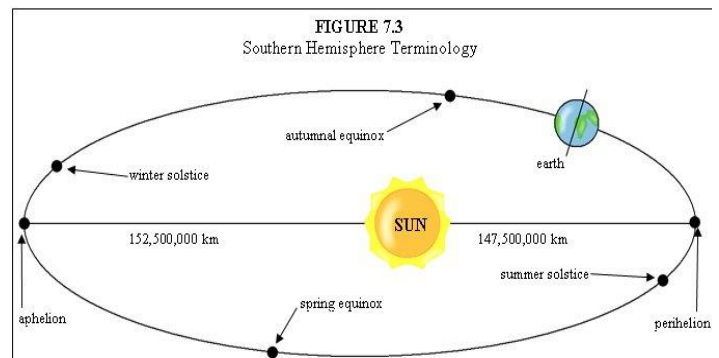
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In which case is the light more spread out? (direct or indirect)

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If the light is more concentrated, does this mean that the energy from the torch is more concentrated or spread out?

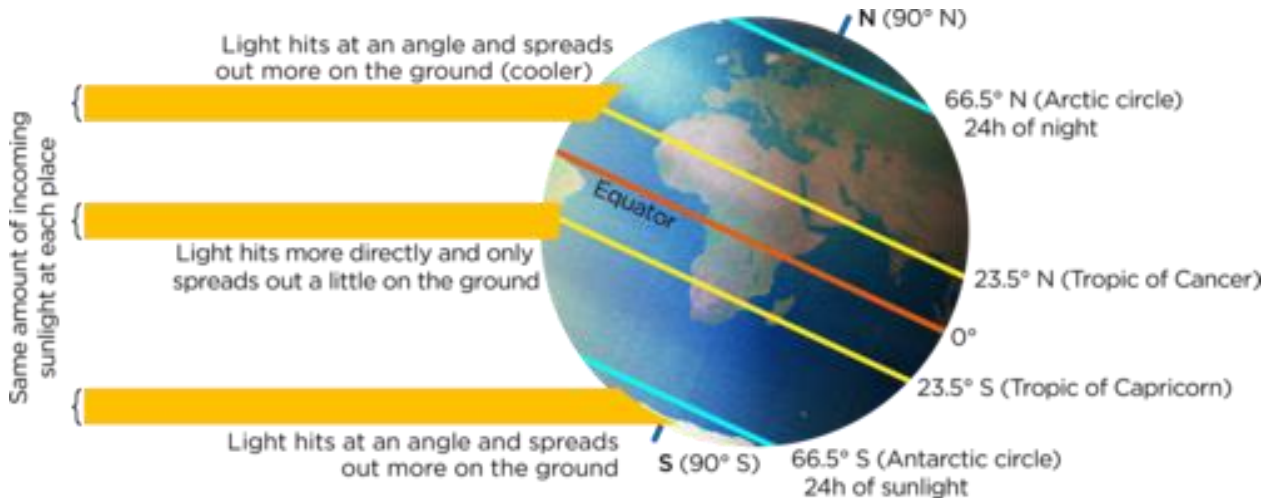
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# INSOLATION & SEASONS

## INSTRUCTIONS:

1. Look at the example picture below. It shows sunlight hitting the Earth.
2. Look at the Sun's rays and see how the angle at which they hit the Earth's surface changes at different points along the surface of the Earth because of its curved shape.



## QUESTIONS:

Does the equator receive more or less direct light than the poles?

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Which hemisphere receives more direct light in the picture? Why is this?

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Which hemisphere in this diagram receives more indirect light? Why is this?

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Why do you think it is warmer at the equator than at the poles?

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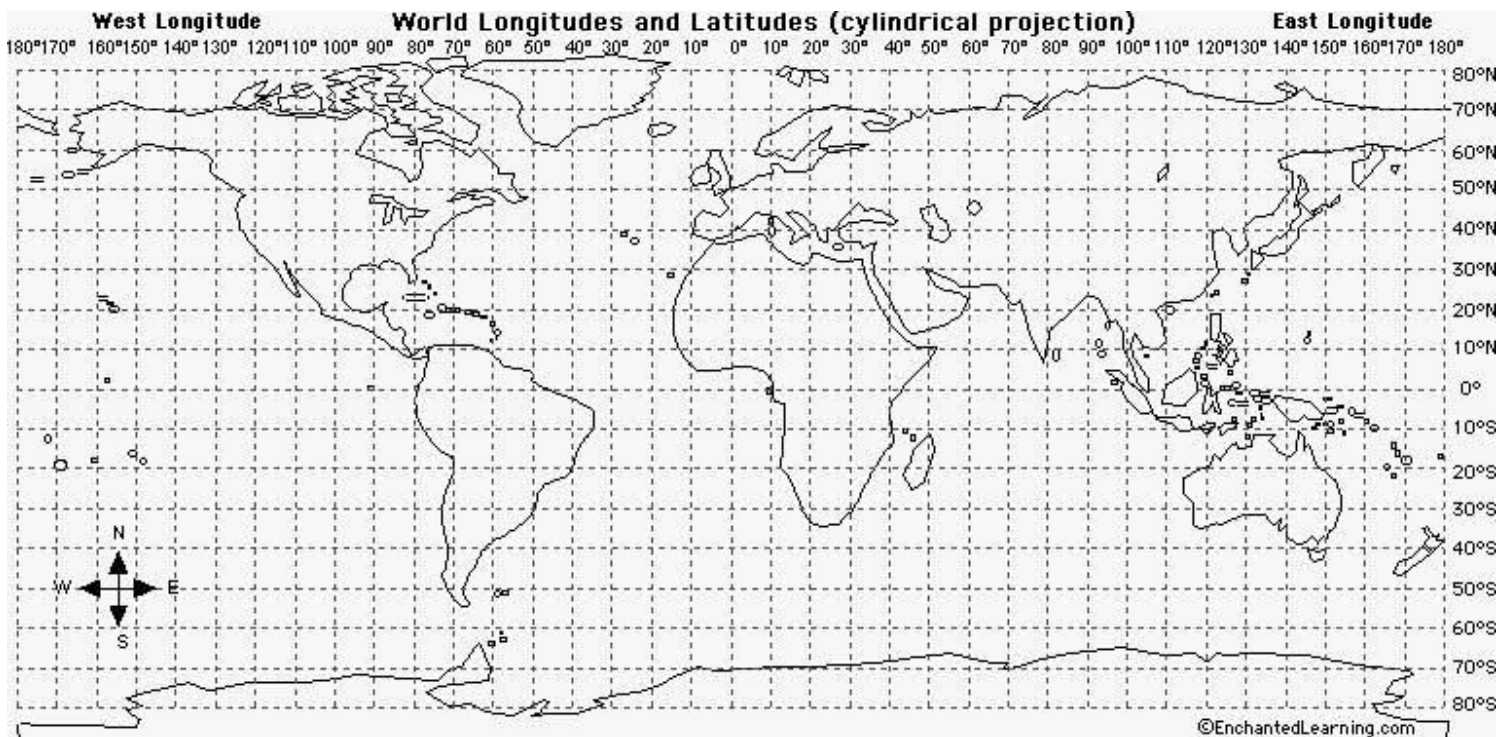
Is it summer or winter in the Southern Hemisphere in this example? What season is it in the Northern Hemisphere?

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What would happen to the seasons if the Earth was tilted in the opposite direction, with the Northern Hemisphere tilted towards the Sun instead?



## LATITUDE & LONGITUDE & THE COORDINATE SYSTEM BEHIND IT



Place these countries on the map in the right latitude and longitude.

• Barcelona, Spain	41 N, 2 E	Rio de Janeiro	22 S, 43 W
• Edinburgh, Scotland	55 N, 3 W	Melbourne, Australia	37 S, 144 E
• Lima, Peru	12 S, 77 W	Los Angeles, CA	34 N, 118 W
• Mecca, Saudi Arabia	21 N, 39 E	Cape Town, South Africa	35 S, 18 E
• Moscow, Russia	55 N, 33 E	Oklahoma City, OK	35 N, 97 W

### EXPERIMENT #2: Understanding the Power of Pressure

This experiment will demonstrate how intense pressure can be and how the atmosphere actually exerts pressure on everything it touches. In order to capture the Sun's solar energy and preserve it in fossil fuels lots of pressure over long amounts of time is required.

#### Supplies:

- ◆ Frying pan
- ◆ Two bowls
- ◆ Ice cubes



- ◆ Heat Source
- ◆ Two empty, 12-ounce aluminum cans
- ◆ Water
- ◆ Tongs

#### Procedure:

1. Put a small amount of water in each aluminum can. Only use enough to cover the bottom of the can with a small amount of water. The more water you use, the less dramatic the effect.
2. Place the two aluminum cans in the frying pan so that they stand up.
3. Put the frying pan on the stove and turn the heat up to "high." This will heat up the water in the cans.
4. While you are waiting for the water in the cans to heat up, fill each bowl half full of water.
5. Place a few ice cubes in each bowl so that the water becomes ice cold.
6. Wait for steam to start rising out the opening of each can. The water inside should boil vigorously.
7. Once a steady stream of steam is coming out of each can, use the tongs to grab one can and place it upright in one of the bowls of water.
8. Use the tongs to grab the other can and place it *upside down* in the bowl of water.

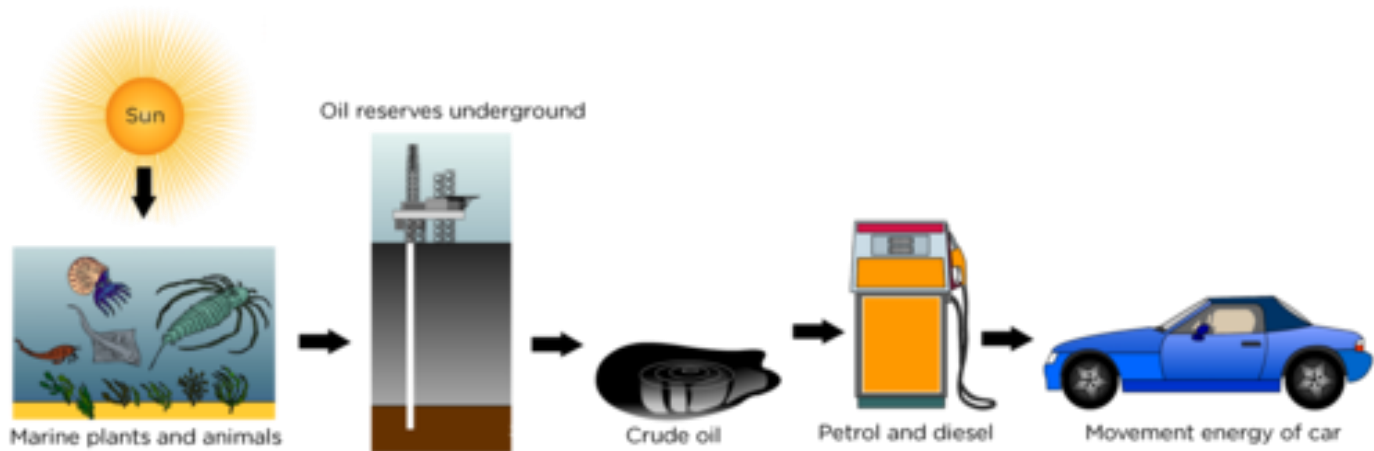


## Fossil Fuels Store and Transfer Solar Energy

Oil, also known as crude oil, and natural gas were formed millions of years ago by processes similar to those leading to the formation of coal. Sea animals and plants died in the oceans and were deposited on the ocean floor. Over millions of years, layer upon layer of marine deposits formed and were covered by sand/silt. Through the actions of temperature and pressure, the deposits were changed into crude oil and natural gas. Today, oil and gas are trapped under layers of rocks and sediment and have to be drilled and pumped out of the Earth. What type of energy is stored in fossil fuels?

### INSTRUCTIONS:

Petrol is made from crude oil, a fossil fuel. Use the diagram below to answer the questions about how the Sun's energy is captured in petrol and how this helps life on Earth.



### QUESTIONS:

Using the diagram, explain how the Sun's energy is captured in petrol and used in cars.

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What transfer of energy takes place within the system?

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Why is petrol important in our lives?

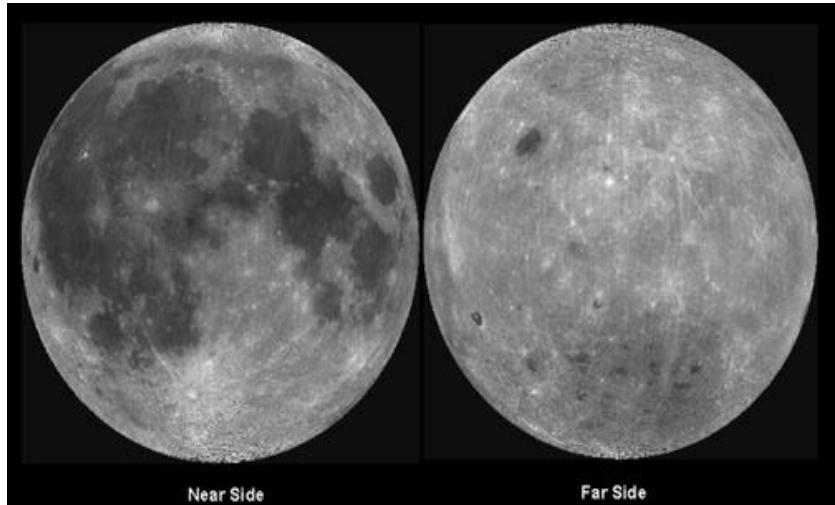
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Draw a labelled flow diagram to show the transfer of energy from the Sun to a fire made from burning anthracite, a type of coal.

## THE MOON IN RELATIONSHIP TO EARTH



Images of the near side and far side of the Moon taken with NASA's Clementine spacecraft. Look at the difference between the two images, what do you notice?

### INSTRUCTIONS:

1. Study the images of the Moon.
2. After studying the images of the moon, begin to drop the balls in front of you in the flour.
3. Answer the questions based on your observations below.

### QUESTIONS:

Does the Moon's surface have any oceans or lakes? Craters?

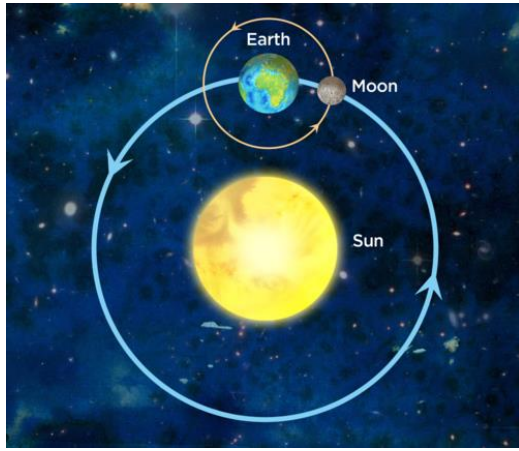
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Based upon your observations of the various impacts of the balls, what kind of meteors have affected the moon?

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The Moon orbits around the Earth completing one revolution every 27.3 days. Our Moon rotates on its own axis and experiences daytime and dark nighttime just like the Earth does. However, the Moon spins much more slowly than the Earth does and completes one rotation on its axis once every 27.3 days. Did you notice that the Moon takes the same amount of time to spin on its axis as it does to orbit completely around Earth? This means that from the Earth, we always see the same side of the Moon ('nearside'). The side we do not see from Earth, is called the 'farside',

Characteristic	Sun	Earth	Moon
Relative position	Is at the centre of our solar system	Orbits the Sun once every 365.25 days	Orbits the Earth once every 27.3 days
Rotation	Spins on its own axis roughly once every 28 days	Spins on its own axis once every 24 hours	Spins on its own axis once every 27.3 days
Distance from orbited body	-	23 481 Earth radii from the Sun	60 Earth radii from Earth
Size	Diameter is roughly 100 times the Earth's diameter	-	Diameter is roughly $\frac{1}{3}$ times the Earth's diameter



## Newton's Universal Law of Gravitation

1. All objects with mass are attracted to one another by the gravitational force.
2. The gravitational force between two masses is directly proportional to the mass of each object.
3. The gravitational force between two masses is inversely proportional to the square of the distance between those two objects.

The word **gravity** is used to describe the **gravitational pull (force)** an object experiences on or near the surface of a planet or moon. The gravitational force is a force that attracts objects with mass towards each other. *Any object with mass exerts a gravitational force on any other object with mass.* The gravitational force between two objects decreases as the objects move further apart. If you double the distance between two objects the gravitational force between them decreases by a factor of four (triple the distance = decrease by factor of 9). This explains why we are stuck to the Earth rather than the Sun. Since the Sun is 333 000 times more massive than the Earth and its gravity is much stronger but we are so far away the gravitational force the Sun exerts on us, is much smaller. The Moon is held in orbit around the Earth by the gravitational force between the Earth and the Moon.

### MATERIALS

- rope
- ball (tennis balls are ideal)

### INSTRUCTIONS

1. Tie a ball to the end of a piece of rope. You may have to wrap the rope around the ball a few times.
2. Hold the rope up high above your head and swing the rope around in a horizontal circle.
3. Let go of the rope and observe what happens.

### QUESTIONS:

How can you describe the movement of the ball as you swing it around?

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What force holds the Moon in orbit around the Earth?

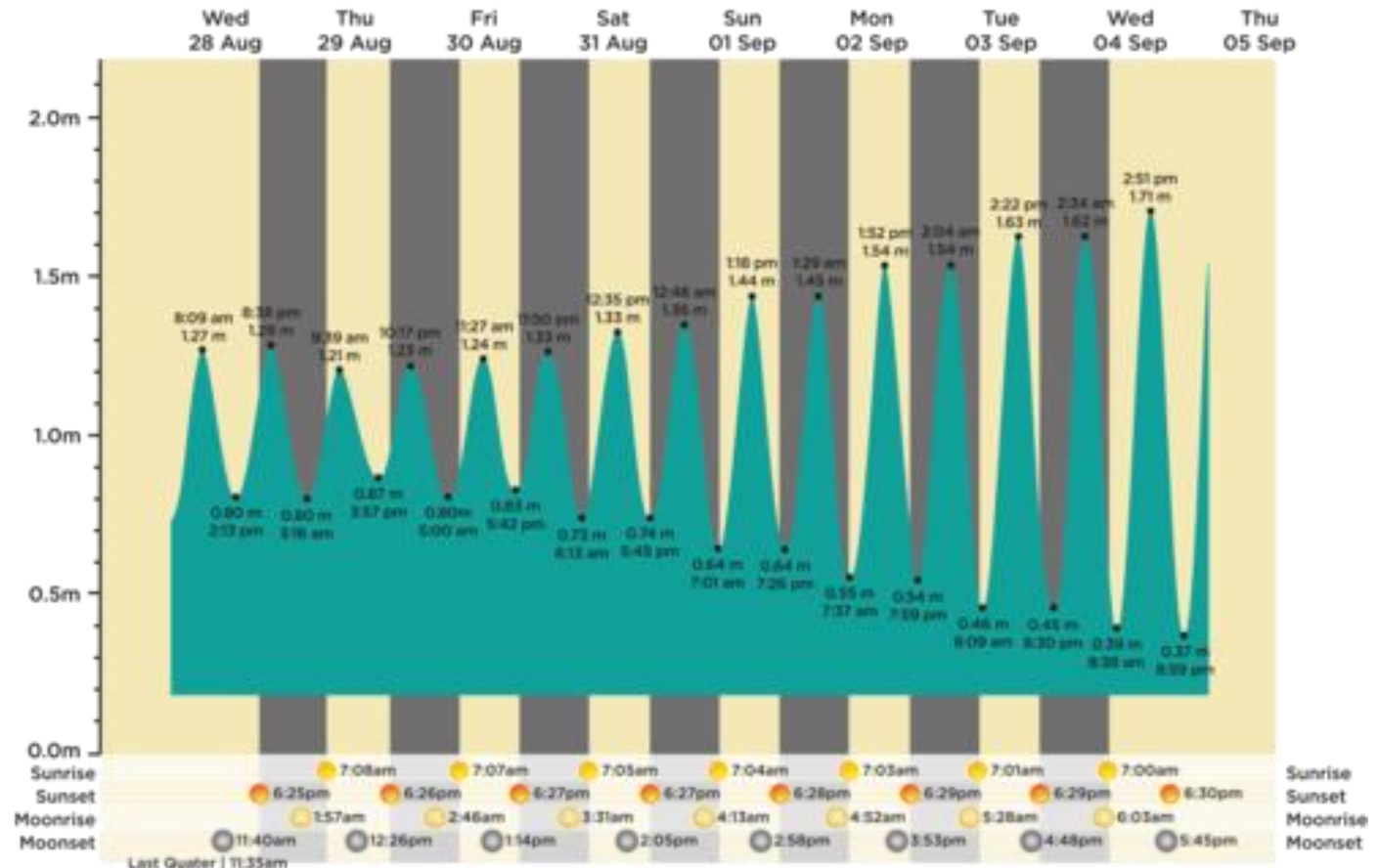
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What happens to the ball when you let the rope go? What does this represent in terms of the Earth and the Moon?

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# Tides

Tides are the predictable, repeated rise and fall of sea levels on Earth. In general there are two low and two high tides per day on the sea, which can be observed on the beaches or even in estuaries. The times of high and low tides are not exactly the same every day, they occur roughly one hour later each day.



This graph shows the predicted tides for a period of one week in Cape Town. Although the graph only includes data for one week, the actual pattern of high and low tides repeats every day throughout the year.

## INSTRUCTIONS:

1. Look at the chart above, it shows the predicted times of low and high tide for one week in Cape Town.
2. The peaks represent times of high tide and the heights are listed in metres along with the time of high tide. The troughs represent the times of low tide.

## QUESTIONS:

How many peaks appear per day in the chart? What do these correspond to? High or low tide?

How many troughs appear per day in the chart? What do these correspond to? High or low tide?

What is the height in metres of the highest low tide during the week?

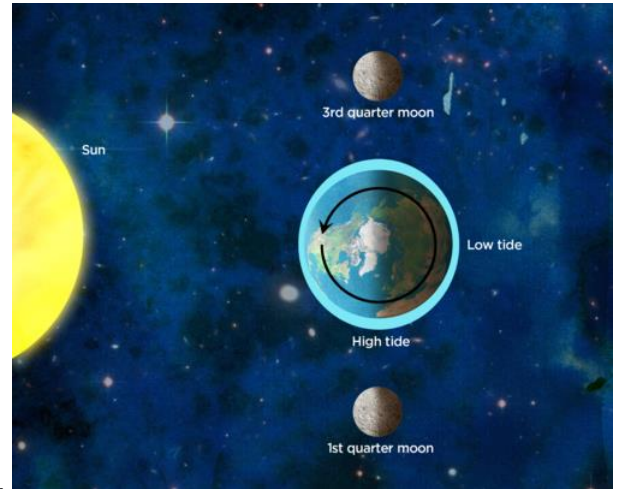
When does the lowest high tide occur? (date and time)

# TIDES & PHASES OF THE MOON

Look carefully at the following diagrams, it shows the size of the tides at Full and New Moon and at the first and third quarter phase. Answer the following questions



Spring tide = size of the tides at New/Full moon.



Neap tide = size of the tides at first/third quarter

## QUESTIONS


During what phases of the Moon do the Moon's and Sun's gravitational pulls partly cancel each other out?


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
During what Moon phases would you expect the highest high tides and the lowest low tides?


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
Name each phase on the line provided and shade in the accompanying "moon" to show how the phase appears from Earth


 A: \_\_\_\_\_

 B: \_\_\_\_\_


 C: \_\_\_\_\_

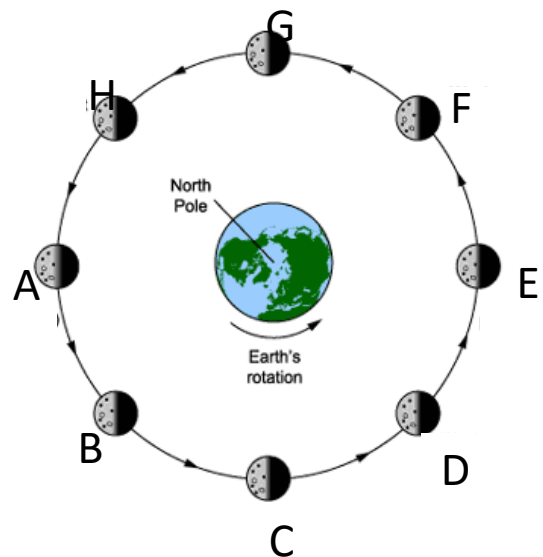
 D: \_\_\_\_\_

 E: \_\_\_\_\_

 F: \_\_\_\_\_

 G: \_\_\_\_\_

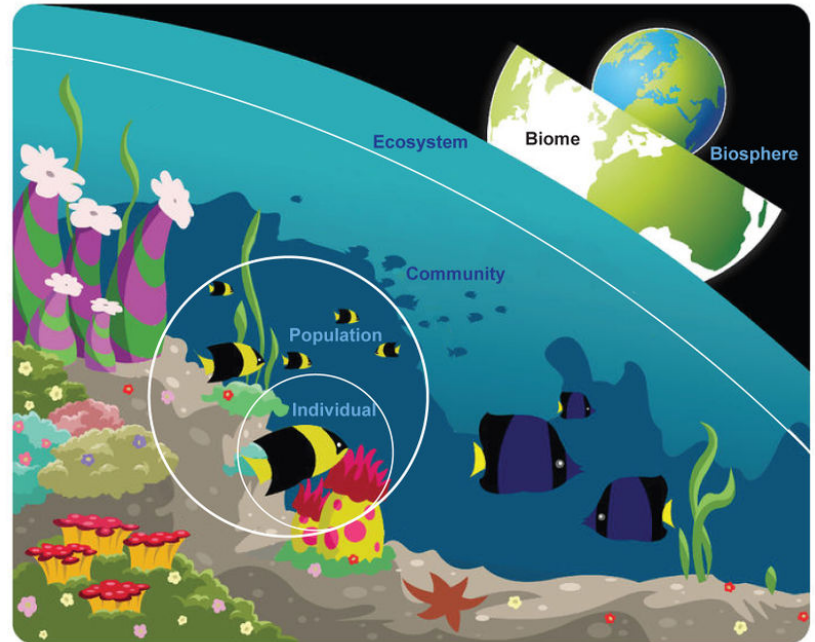
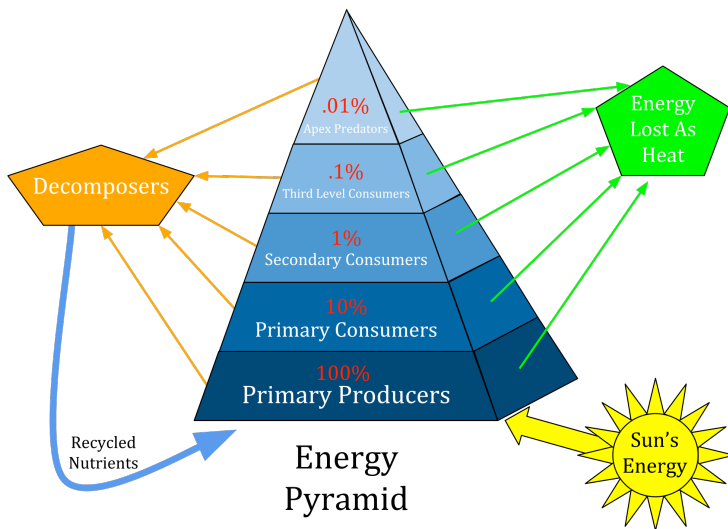
 H: \_\_\_\_\_





# Ecology and Biodiversity

## Energy Flow



## **Activity: Food Web Interactive**

Estimated time: 10 minutes (can last as long as you want depending on how much you develop the activity).

Materials: yarn, index cards, hole puncher, marker.

Objective: Students will understand the interrelatedness of food webs and see how populations affect other populations.

### Content:

1. Write the names of various plants and animals (a variety of types) on index cards. You can use the list below, construct your own, or have participants select their own organism. Be sure to include the sun, plants, plant eaters, and flesh eaters in the array.

sun, grasshopper, robin, grass, berry brush, hawk, quail, dandelion, mouse, worm, rabbit, cow, flea, meadowlark, owl, wheat, tick, fox, weeds, coyote, mushrooms, microscopic bacteria

2. Punch holes in each card and give each participant a card and a piece of string to hang the card around his/her neck.
3. Have individuals identify energy (or food) sources. As each one is identified, pass a ball of yarn between the two people. For example: One student is a cow, and one is the grass. The cow will take the ball of yarn, hold onto one end of the string and pass the rest of the ball to the grass. The grass will hold onto the yarn and pass the rest of the ball to "what it eats," in this case, the sun. Be sure that the sun is connected to all the plants. Once the string gets to the sun, cut it off, and start again in another place.
4. Continue building the web, making the relationships as complex as time and numbers of participants allow. Define terms such as herbivore, carnivore, insectivore, decomposer, etc and include them in your web.

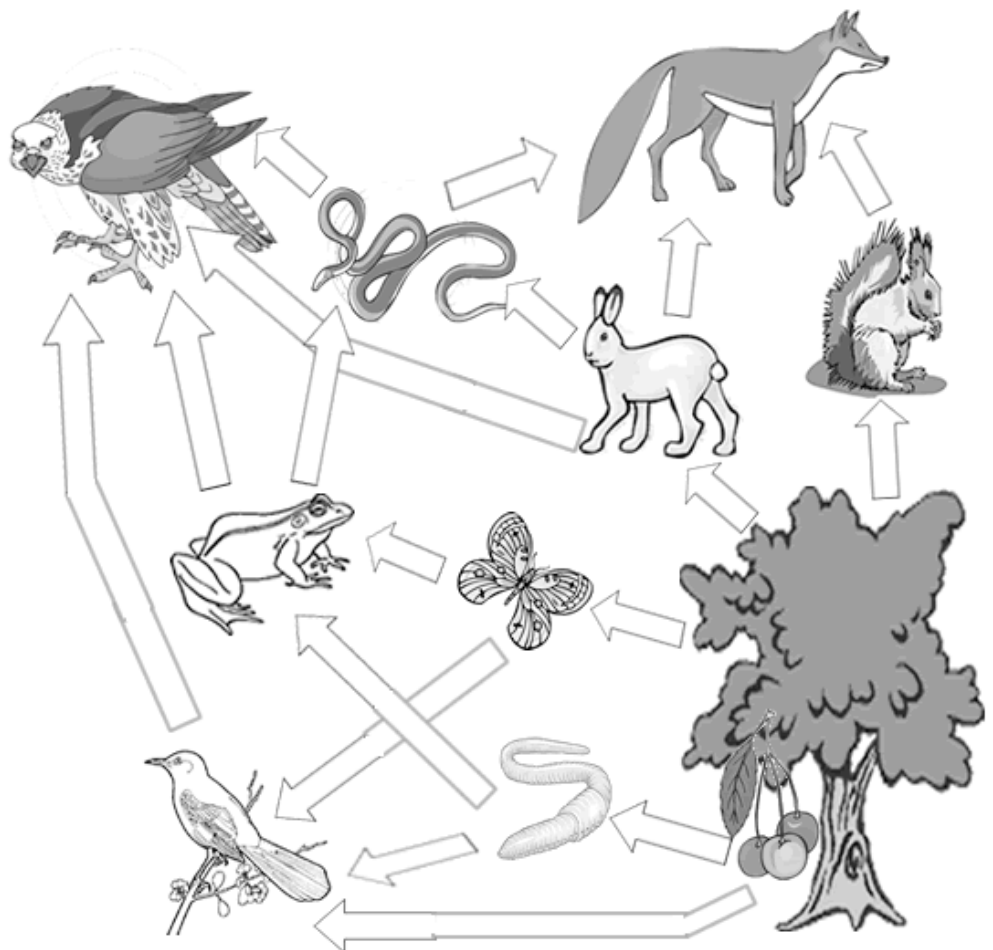
[Note that insectivores are specialized carnivores.] Students can be in as many chains as you have time for; they do not have to be in all of the chains.

5. Discuss the nature and complexity of the food web that is formed. Note that it is not as complete or complex as most natural food webs, but that it illustrates how living things are dependent upon one another. Biologists feel that more complex food webs are more stable than simple ones.
6. After discussing the food web, the leader could ask what would happen if a species were removed from the web. Have a student pull on the strings they hold; anyone who feels a tug is directly affected by that organism. Those “organisms” affected directly could then pull on their strings and more organisms are affected. Have different students pull on their strings. When the “sun” pulls on its string, everyone should be affected. Have some organisms drop their string (become extinct) and see who is affected. Have students tell you if certain populations will grow or decline. The teacher can represent nature and cause any type of problem to occur; for example, a wildfire could occur, but some birds were able to fly away and some types of trees reseed well after a fire. The teacher defines what happens and who is affected; the students then reveal what would happen. New species could also move into the area at any time disrupting the web.
7. Discuss what would happen if all of the predators were removed. Some species might exhaust their food supply and starve, but others will continue to reproduce only until the food supply becomes limiting or their interactions limit population size.
8. If desired, discuss the simplified food webs that produce most foods used by people. Remind the participants that such food webs are inherently unstable and require large amounts of management (raising/slaughtering cows, chickens, etc) to avoid problems.

Closure: Review everything with students telling them that this is the way a food web works. They can throw away their yarn pieces.

Assessment: The activity could be assessed by participation, or students could complete a worksheet to demonstrate their mastery of the concepts, as seen below:

For the food web, label each organism (some may have more than 1 label): producer, primary consumer, secondary consumer, tertiary consumer, quaternary consumer. Then, label each organisms as either a herbivore, carnivore, or omnivore.



## African Grassland Food Web Activity

*In this African Grassland Food Web activity, students will be asked to connect all the individual food chains that make up this food web. Once complete, students will be asked to label which trophic level each organism belongs.*

Directions: The following organisms are part of an African Grasslands food web. Using these notes, construct a food web of this ecosystem in the box by drawing arrows between the organisms, making sure to use different colors to represent each food chain in the food web. After, label what trophic level each organism belongs to: producer, primary consumer, secondary consumer, tertiary consumer, etc.

If this were to be a complete food chain/food web, what is one thing missing? Explain why it is important to include that missing part of the food chain/food web?

Organisms (photos):



Dung Beetles



Zebra



Vulture



Baboon



Termites



Fungi (including mushrooms)



Acacia



Grasses



Giraffe



Lion



Hyena



Hunting Dog



Impala



Wildebeest



Cheetah



Leopard



Organisms (dietary habits):

- Baboon: eats grasses and other producers
- Vulture: scavenger that will feed on the remains of any dead animal
- Grasses: producer
- Acacia: producer
- Hunting Dog: eats zebra, impala, wildebeest, baboon, and hyena
- Hyena: eats impala and zebra
- Leopard: eats cheetah, impala, baboon, and hyena
- Cheetah: eats impala and zebra
- Zebra: eats grasses
- Dung Beetles: decomposers that feed on the solid waste of other animals
- Fungi (including mushrooms): decomposers of dead plants and animals
- Termites: feed on wood from the Acacia tree and will feed on grasses also
- Lion: will hunt and feed on cheetah, leopard, giraffe, impala, baboon, zebra, wildebeest, and hyena
- Giraffe: eats the leaves and new shoots of the Acacia
- Wildebeest: eats grasses
- Impala: eats grasses and the leaves of the Acacia

Food Web

## **The Fox and the Rabbit game**

Jackie Sibenaller

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Based on an original activity from "Biology: A Community Context" predator-prey simulation.

### **Summary**

This simulation illustrates how predator-prey interactions affect population sizes and how competitive interactions affect population sizes. The student simulates the interactions between a predator population of fox and a prey population of rabbits in a meadow. After collecting the data, the student graphs the data and then analyzes the graph to predict the populations for several more generations. Students can also examine the co-evolutionary interaction between predator and prey (how predators react to selective pressure by increasing their efficiency and how prey becomes more skillful at evading their predators).

### **Learning Goals**

One goal of this activity is to have students understand how predator-prey interactions affect population size. Students will also analyze data to predict future population sizes. A third goal is for students to explore the major factors that influence the predator-prey relationship.

Key concepts the student should acquire from this activity include how carrying capacity of the environment for the prey population defines the maximum number of prey individuals that can be maintained. They should also see how the reproductive rates of both predator and prey play a crucial role in both population sizes. A third concept students should identify is that behavioral responses of the predators to changes in prey density (migration or change in prey) will affect the pressure on prey.

Before playing this game students should be able to define a food chain, population, immigration, carrying capacity, predator and prey.

### **Context for Use**

I use this activity with a special education inclusion class in 10th grade biology. It can be used in the regular biology classroom, but I would increase the rigor of the game by adding additional predators and other biological factors that can affect populations. This activity is used during a study of populations and ecosystems. The game takes approximately 30 minutes to play. So with an introduction to the game and a closure after the game, I usually allow 45 minutes.

### **Materials:**

- 50 10x10 cm tagboard squares of one color (representing the fox)
- 200 5x5 cm construction paper squares of another color (representing the rabbits)
- 1 50x50 cm square section of table top (the meadow)
- Masking tape (to mark off the meadow)
- Data table
- Graph paper

### **Rules of the game:**

You will start the first round with 3 rabbits and 1 fox. The surviving rabbits each produce one offspring for the start of the next round. The fox will survive if it captures (lands on) at least one rabbit, but will only reproduce if it lands on three or more rabbits during one drop in one round. If the fox does not land on any rabbits during a round, it dies, and a new fox will immigrate into the meadow so you will always have at least one fox to start each round. If all the rabbits are captured during a round, three new rabbits will immigrate into the meadow to start the next round. Each round represents one year or a generation.

### **Procedure:**

Use masking tape to outline a 50x50 cm square on a flat surface to simulate a meadow in an ecosystem.

Randomly distribute 3 rabbit cards in the meadow.

Take the fox square and drop it from a height of 10 to 15 cm above the rabbits in an effort to catch a rabbit. (At this point in the activity there is no way that the fox can catch the 3 rabbits that it needs to survive and reproduce. The fox is not allowed to skid and the rabbits should be distributed throughout the field.)

Complete the data table for generation #1. The fox will starve if it did not land on a rabbit and there will be no surviving fox or new baby fox.

At the beginning of generation #2, double the rabbits left at the end of generation #1. A new fox immigrates into the meadow. Be sure to disperse the rabbits in the meadow.

Eventually the rabbit population increases to a level that allows the fox to catch 3 rabbits in a single toss. If the fox catches 3 rabbits it not only survives but it reproduces too! It has one baby fox for each 3 rabbits that it catches. Therefore, if it catches 6 rabbits it will have 2 babies. Fox are not allowed to cheat, but they should try to be efficient. Stupid foxes result in an overabundance of rabbits.

As the number of fox increases, throw the tagboard square once for each fox. Record the number of rabbits caught by each fox. The simulation is more realistic if the number of new baby fox is based on each foxes' catch rather than merely the total number of rabbits caught in a generation.

There are always at least 3 rabbits at the beginning of a generation. If and when the entire rabbit population is wiped out, then three new rabbits immigrate into the meadow.

Remember that the number of rabbits in the meadow needs to be correct at all times. Remove the rabbits caught and add new ones as indicated by your data table.

Model about sixteen generations and predict nine more or up to a total of 25 generations. Base the prediction on the pattern observed during the first sixteen generations.

### **Analysis:**

Graph the data for 25 generations. Place both the rabbit and the fox data (the first two columns of the data table) on the same graph so that the interrelationship can be easily observed. Label the vertical axis "Number of Animals" and the horizontal axis "Generations." Use one color of line for rabbits and another color of line for fox.

### **Resources:**

There are many versions of this simulation in use. Other versions include owl and mice, etc. If your students are unable to run the simulation at their own workstations then it may be played on an overhead projector. You may wish to introduce disturbances in the cycle such as killing off the fox or starving the rabbits. This activity serves as a good introduction to computer models.

### **Teaching Notes and Tips**

Students play the game in groups of three to four.

You could introduce a new predator, such as a wolf, that would require more rabbits for survival, (by using a different color card) to the game as students are playing or after they are finished to see how this new "invader" can affect the population sizes of the existing predator and prey populations.

### **Assessment**

Students will develop a graph from their data. They will need to analyze their graph to identify limiting factors and carrying capacity of the populations. Also, the graphs will be presented, group by group, to the entire class.

Generation	Rabbits	Fox	Rabbits Caught	Fox Starved	Fox Surviving	New Baby Fox	Rabbits Left
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
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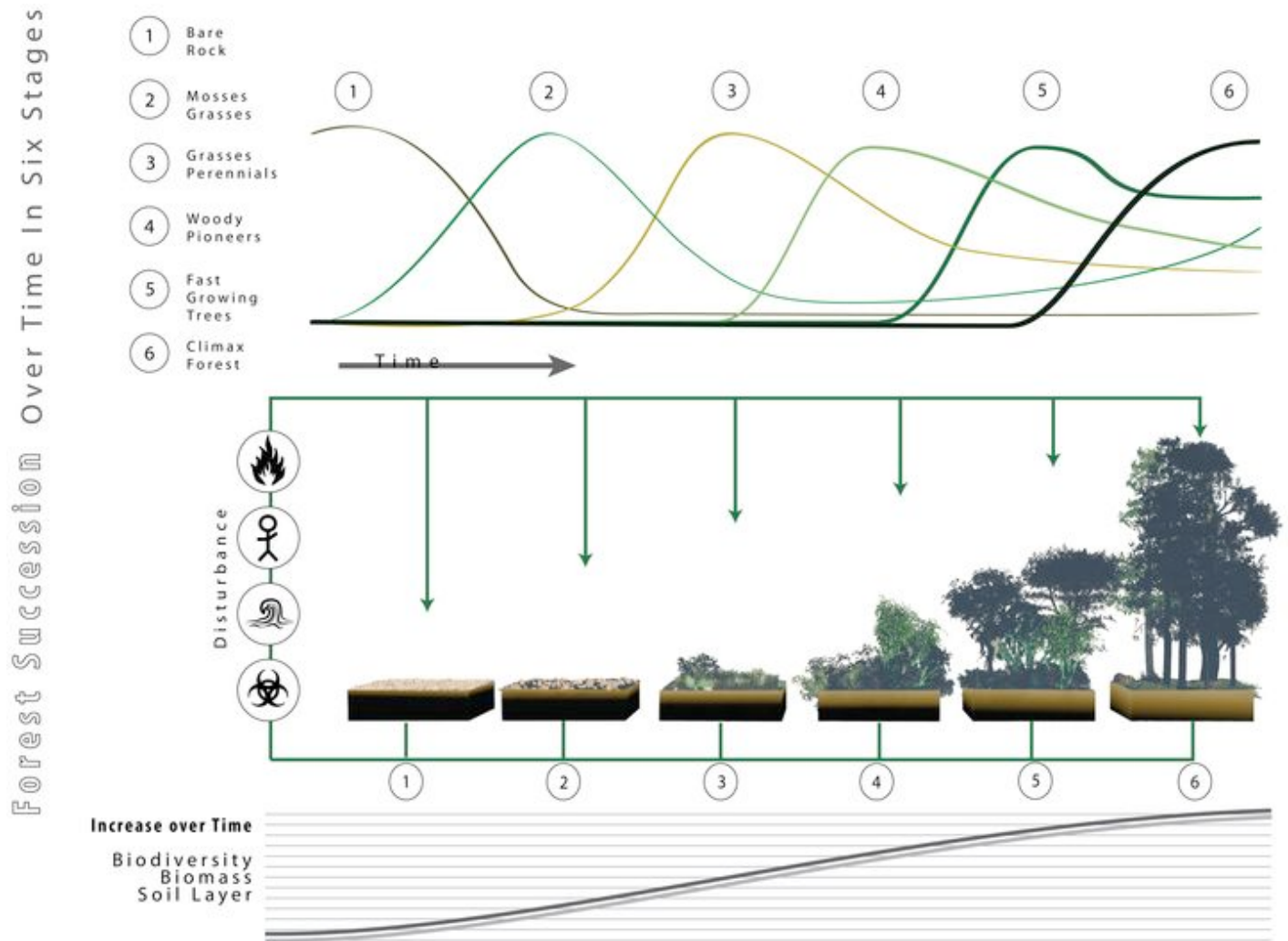
## Symbiotic Relationships

Students will be given several examples of symbiotic relationships and will need to decide if the relationship is an example of parasitism, mutualism or commensalism. Students will put each example in Pocket Foldable. Have students write the definition of each symbiotic relationship on the front of foldable.

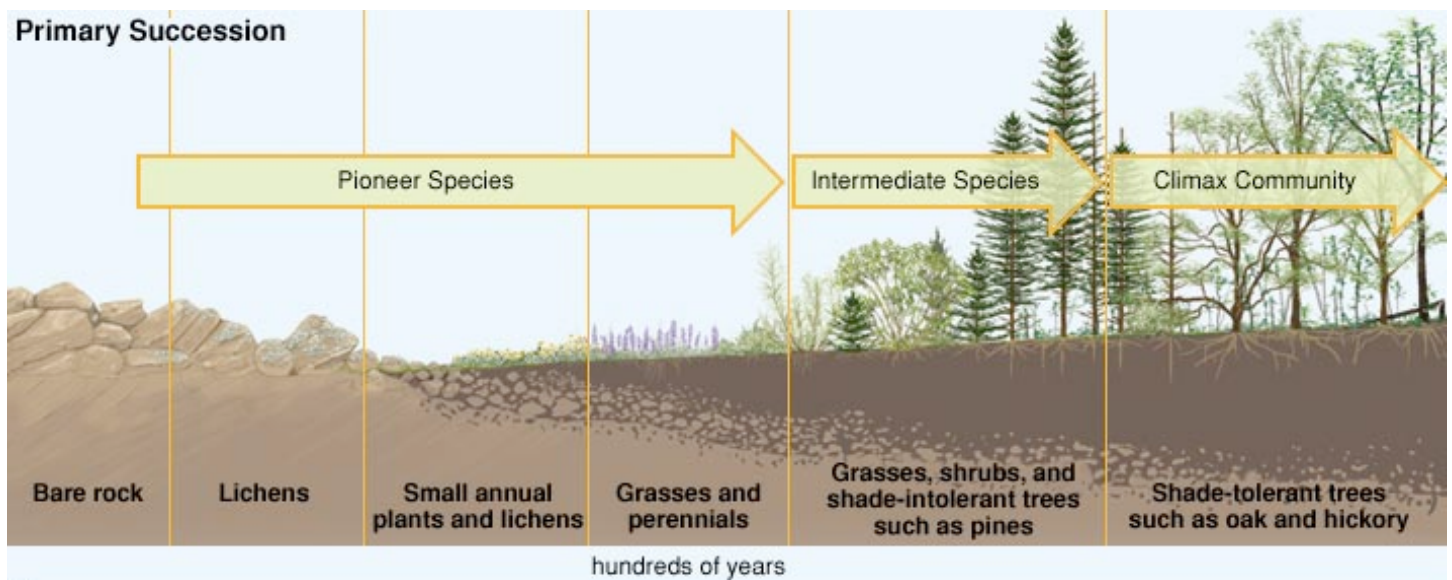
Directions: Read the following descriptions of symbiotic relationships and decide which example of symbiosis it belongs. Cut out the description and place in the corresponding pockets of the symbiosis pocket foldable: Mutualism, Commensalism or Parasitism. Pick three of the examples and either draw illustrations on your page or find pictures to paste in your notebook.

A barracuda takes a head up posture near a coral to let the cleaner fish, living in the coral, know that it's safe for them to come out and clean its gills.	The cuckoo bird lays its eggs in a warblers nest. When the baby cuckoo hatches, it pushes the warbler's eggs out of the nest and the warbler feeds and raises the cuckoo's young.	Whales are seen having barnacles attached to them, creating a home site for the barnacle.	Orchids grow inside bromeliad plants, which don't harm the bromeliad, but allows the orchid to obtain water and nutrients.
The tree sloth has algae growing in its fur. The alga camouflages the sloth in the tree to hide it from predators.	Heartworms develop inside a dog's heart, living off the blood and causing severe health problems, and sometimes death.	Remoras attach themselves to a shark's body, feeding on scraps leftover from the shark's meal. The remoras neither hurt nor harm the shark.	In the rainforest, the acacia tree provides nectar and shelter for acacia ants and in return the ants kill herbaceous insects and any nearby plant competing for the space.
Honey guide birds alert and direct badgers towards bee hives. The badger exposes the hive to eat the honey, then the honey birds take a turn to eat the honey.	A spruce tree starts to die when mistletoe seeds grow into the spruces' roots, extracting water and nutrients from it.	The cattle egret follows herds of cattle eating the insects stirred up by the cattle.	The oxpecker rides on the back of rhinos eating off the ticks and alerting the rhinos to predators.
A wasp will lay its eggs on the back of a caterpillar called the catalpa worm. When the larvae hatch, they will feed on the caterpillar and kill it.	A solitary golden jackal will follow a tiger at a safe distance alerting the tiger to a kill, then eating the leftovers when the tiger is done.	The Egyptian plover lands inside a Nile crocodile's mouth, getting a good meal, and cleaning the crocodile's teeth at the same time.	Hermit crabs live in shells made by snails who have since abandoned them.

## Ecological Succession: Primary and Secondary



### Primary Succession



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## Ecological Succession Flip Book

Students will create an Ecological Succession Flipbook to show examples of primary and secondary succession.

### Directions:

1. Make a flip book foldable according to your teacher's instructions.
2. Label the foldable according to the following diagram and cut the top three tabs up the middle (see the dotted lines).

Primary Succession - After Volcano	Secondary Succession - After Wildfire
After 3-5 Years	After 3-5 Years
After 15-30 Years	After 15-30 Years
After 100 Years	After 100 Years

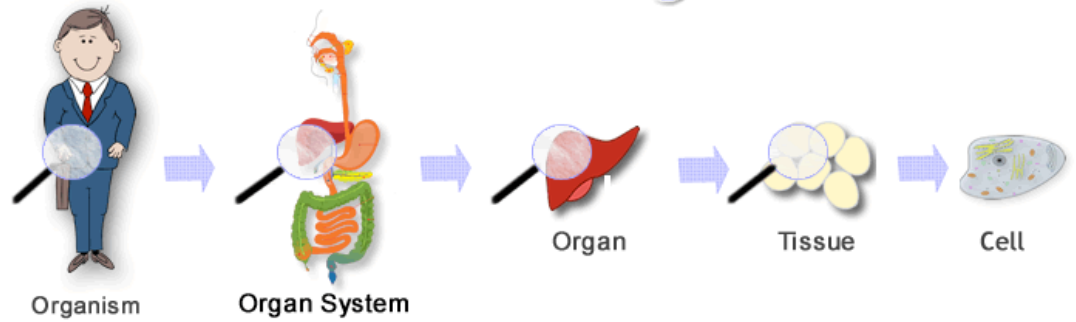
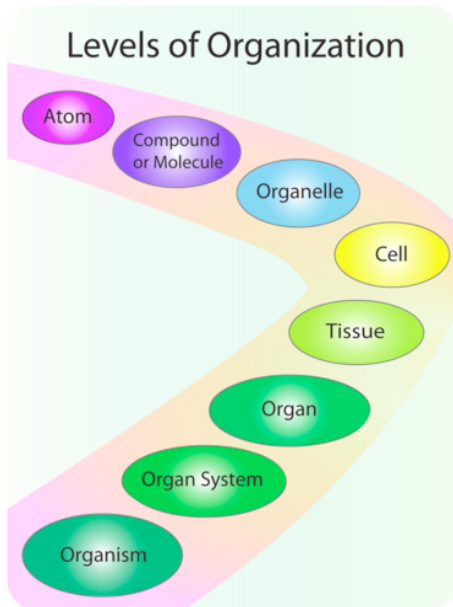
3. On the front tab, for each side, draw an illustration of how the area would look after the disaster.
4. Read the following descriptions of each type of succession, Using what you know about succession, write a description about what is happening for each time frame, then add plant and animal species to each tab that correlates with the number of years after each disaster.

<p style="text-align: center;"><b>Primary Succession</b></p> <p>After a volcanic eruption, the land is mostly bare for three to five years until lichens, moss and small pioneer species of plants begin to grow in cracks of rocks. Eventually these pioneer plants die and begin to form soil. About 20 years later a soil layer has formed able to support herbs, grasses and small berry bushes and shrubs. Insects live in grassy areas eating herbs, while mice live in burrows eating berries and insects. After 100 years the soil is able to support larger shrubs, berry bushes and small trees where some birds can build their nests, rabbits can hide and foxes can live in burrows, coming out to hunt birds, mice, rabbits and insects.</p>
<p style="text-align: center;"><b>Secondary Succession</b></p> <p>The wildfire that burned the forest has released many of the nutrients in stumps and branches, as well as opened up some seeds that need heat to start reproducing. In three to five years grasses, weeds and small plants have taken over. Saplings are starting to spring up, along with large berry bushes, such as blackberry. Small animals that eat insects and berries have taken resident in the larger bushes and ground covering. A noticeable change occurs about 20 years later when the area begins to start looking like a forest, with pines and cedars growing. Acorns and other nuts are being produces allowing squirrels to inhabit the trees, along with a variety of birds, including owls who feed on mice below. 100 years later, the forest has pines and oaks that are 70-100 feet tall, that tower over the smaller trees and berry bushes. The mature forest allows covering for many animals, including deer and bears. Birds are singing in trees and small rodents are rustling along the ground collecting food and making shelters.</p>

# Human Body and Healthy Living

## Levels of Organization

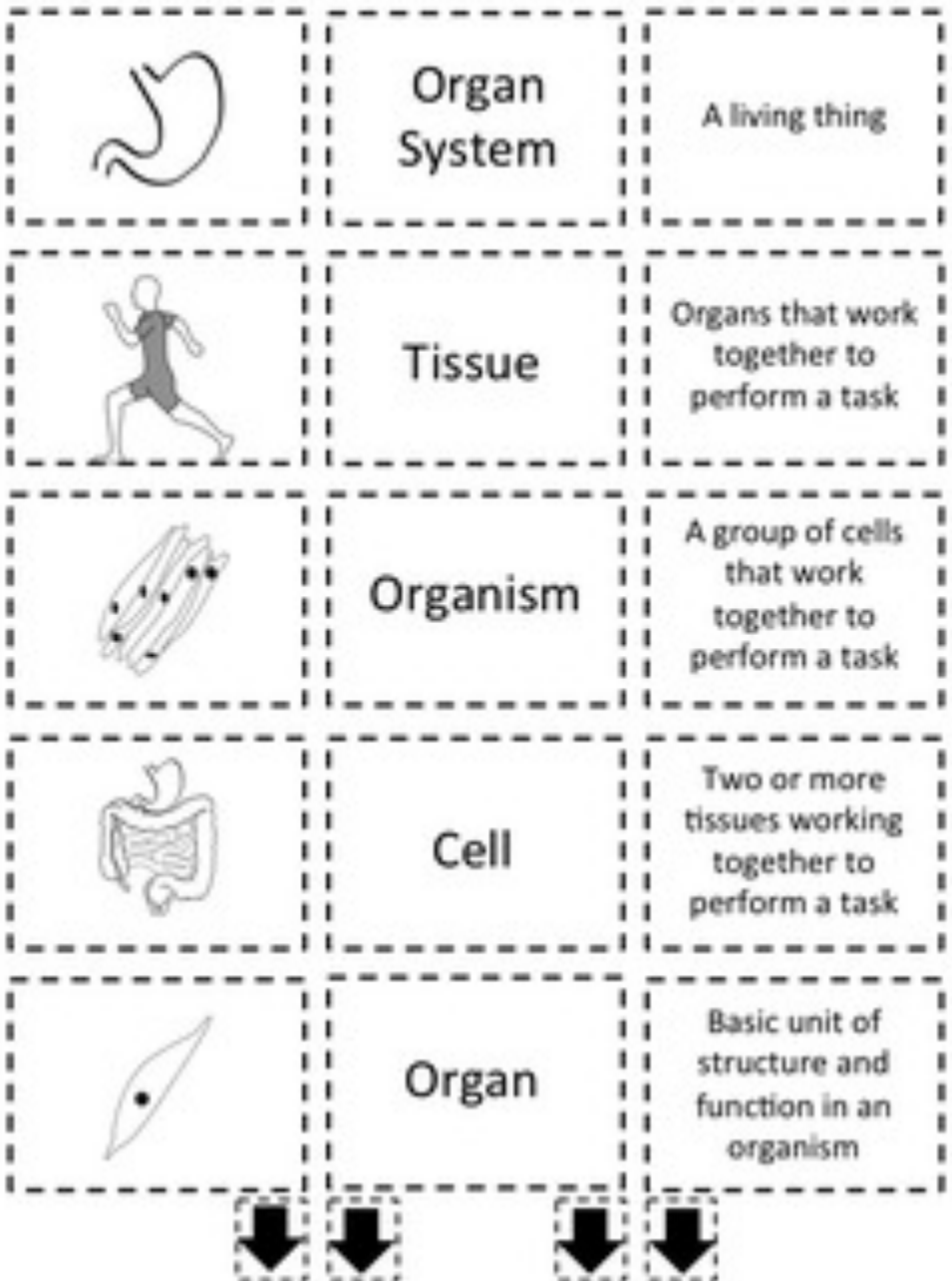
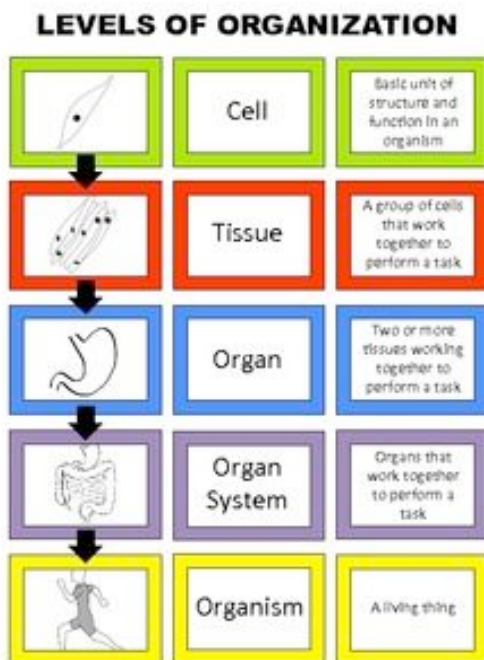
## Levels of Cellular Organization



### Task:

Using three columns (picture, term, and definition), cut out and arrange the 15 boxes into the levels of organization in order from the cell to the organism. Additionally, give an example at each level.

### Answer Key:





These drawings show how WE are made of CELLS.

**Directions:**

1. Match the correct word from the **WORD LIST** below to the drawings 1-5.
2. Color each drawing the CORRECT color noted under the word.
3. Use your colored drawings and the same words to fill in the blanks for questions 1-10.

**Word List:**  
color to use

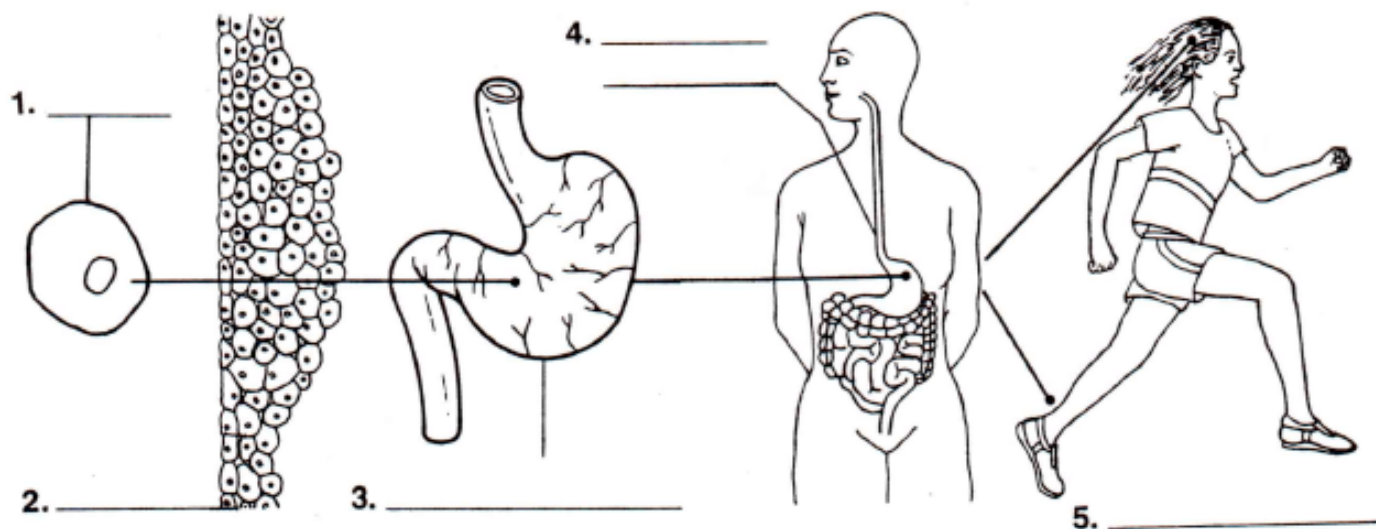
**organism**  
(purple)

**organ system**  
(blue)

**organ**  
(green)

**tissue**  
(yellow)

**cell**  
(red)



1. A \_\_\_\_\_ is the smallest unit of structure and function of a living thing.
2. An example of a **cell** is a \_\_\_\_\_ cell.
3. A **tissue** is made of a group of similar \_\_\_\_\_ working together.
4. An example of a **tissue** is \_\_\_\_\_ tissue.
5. An **organ** is made of different \_\_\_\_\_ working together to do a special job.
6. An example of an **organ** is the \_\_\_\_\_.
7. An **organ system** is made of many \_\_\_\_\_ working together to do a special job.
8. An example of an **organ system** is the \_\_\_\_\_ system.
9. An \_\_\_\_\_ is a living thing that carries out its own life activities.
10. An example of an **organism** is \_\_\_\_\_.

## Digestive System

### **What Happens When You Eat?**

*Objectives: These activities will show students what organs aid in digestion and how digestion occurs in the human body.*

#### Activity #1: How Long is the Digestive System?

- yarn

Have students cut a piece of yarn according to the following measurements. Allow students to use different color yarn to represent different organs. After the yarn has been cut tie the pieces together.

Esophagus: 25 cm, Stomach: 20 cm, Small Intestine: 700 cm, Large Intestine: 150 cm; TOTAL: 895 cm

#### Activity #2: Digestion

- sugar cubes                      - granulated sugar                      - 2 clear cups filled with water

Place a sugar cube in a cup of water. Place about a spoonful of granulated sugar in the other cup of water. Observe what happens.

#### Activity #3: Carbohydrate Digestion

- unsalted soda crackers (2 per student)

Have the students chew two unsalted soda crackers for two minutes without swallowing.

#### Activity #4: How do Villi aid the Small Intestine in Absorption?

- paper towels (10 per group)                      - 4 cups of an equal amount of water                      - graduated cylinder

Compare how 1, 2, 3, and 4 folded paper towels absorb. Dip each paper towel into a cup of water (use the same amount of water in each cup). Record the volume of water left in the cup (using a graduated cylinder).

#### Activity #5: A Digestive System Simulation

- large thin plastic bag	- newspaper	- markers & paper	- sponges
- paper sacks (2 sizes)	- Zip-lock bags	- candy	- masking tape
- trash can	- labeled spray bottles of water		

#### **Procedure:**

1. FOOD TUBE: Lay out two parallel lines of tape on the floor, 3' apart and long enough for half the class to stand shoulder to shoulder on one side of the parallel lines.
2. FOOD PARTICLE: The food particle consists of M&M's placed in small zip-lock bags. These are placed in wadded newspapers in small paper sacks. Place the small sacks in larger sacks with added newspaper. Place all sacks and add newspaper until the large plastic bag is full. This bag is then taped or tied closed to complete the food particle.

#### **Action:**

1. Peristaltic Movement: Put the food particle to be eaten at one end of the food tube and a large trash can at the other. Have students line up on both sides, facing each other, squeeze the food particle the length of the food tube.

2. Digestion: Label and/or instruct the players. As the food comes to a student they should narrate what they are doing and why.

Teeth - tear food apart (break plastic bag)

Saliva - use spray bottles to moisten food particle

Stomach - tear small bags apart

Pancreatic juices - spray food

Small Intestine - absorbs food, find bags of candy and pass to blood (teacher plays role of the blood)

Large Intestine - reabsorbs water, sponge up water on the floor

Rectum/Anus - puts the waste papers in the trash can

Performance Assessment: At the completion of this simulation, answer the following questions:

1. What system in your body is the same length as the completed piece of yarn? What is its length (in centimeters, in feet)?
  
2. From your observations in Activity #2, what can you conclude must be done to food before digestion begins?
  
3. What physical and chemical changes occurred to the soda cracker?
  
4. What caused the physical and chemical changes to the soda cracker?
  
5. Did you notice a taste change in the soda cracker?
  
6. How was mechanical or chemical digestion simulated in Activity #4.
  
7. Which paper towel had the largest surface area?
  
8. Which cup had the highest volume of water left?
  
9. How do the villi (of the small intestine) aid in absorption?
  
10. Follow the path of a food particle through the digestive system; include the organs and their functions.

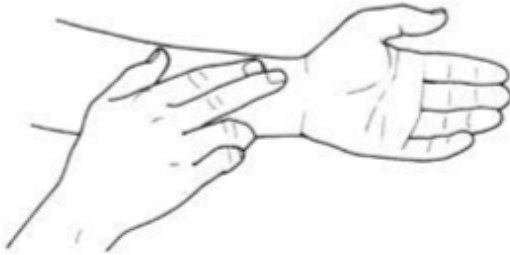
## Cardiovascular/Circulatory System

*Note: For children ages 6-15, the normal resting heart rate is 70-100 beats per minute. Resting heart rates for children and adolescents are typically faster than adults' because they have smaller bodies.*

### The Heart: What a Muscle!

Directions: Part 1: Find your pulse and use it to calculate your heart rate. Next, you will complete a list of physical activities then count and record your heart rate after each activity. Use your data to create a bar graph (or use the grid below) and compare with others in your group. Part 2: Label and color the heart diagram.

#### Measuring Heart Rate



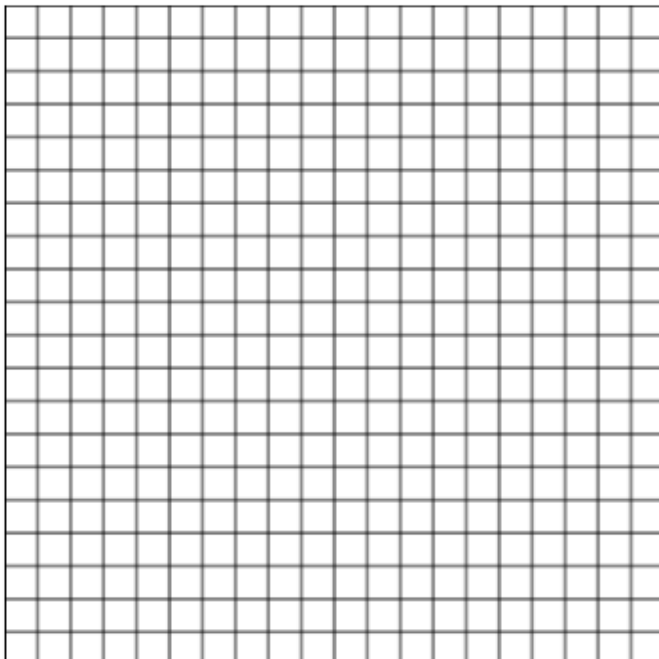
To measure your heart rate you will need to use your pulse. To find your pulse, gently place your index and middle finger on the artery shown in the diagram. Do not use your thumb because it has its own pulse they you may feel.

Count the pulses for 20 seconds, then multiply by 3 to get the number of heart beats per minute.

#### Data Table and Graph

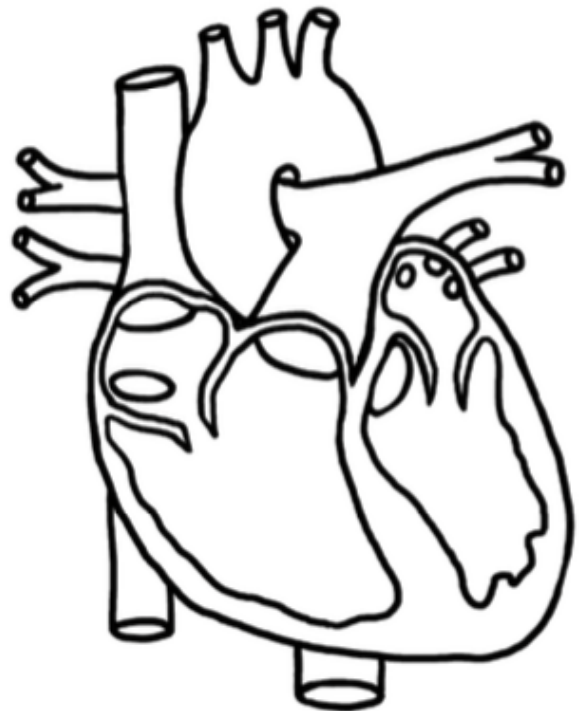
After each activity rest for at least two minutes in order to let your heart rate recover.

Physical Activity	Heart Rate
Sitting in a chair	
Standing	
Walk a leisurely pace for 2 minutes	
Speed walk for 2 minutes	
Jog in place for 2 minutes	
Do 30 jumping jacks	
Run fast in place for 1 minute	



#### Heart Diagram

Color and label the heart diagram below.



#### Discussion

In your notebook, give a description of what you observed between your physical activities and your heart rate. Why do you think this occurred?

## Respiratory System

*The Respiratory Flap Book is a great way for students to see how the parts of respiratory system work together. They will be able to see the individual structures and will need to identify each in order to write the function of each.*

### **Respiratory System Flap Book**

Directions: Cut out Diagrams A, C and D along the solid lines. Cut out Diagram B around the shape. Paste each diagram by stacking in order A - D. (Note that Diagram B will actually be glued to the top of the trachea.) For Diagram C and D, fold along the dotted lines to make tabs for gluing., then cut up the center to make "flaps". On the back of each diagram "door" write the function or importance of each part of the respiratory system. Finally, draw in the alveoli and explain their function.

Diagram A: The trachea and the bronchi



Diagram B: The pharynx



Diagram C: The lungs

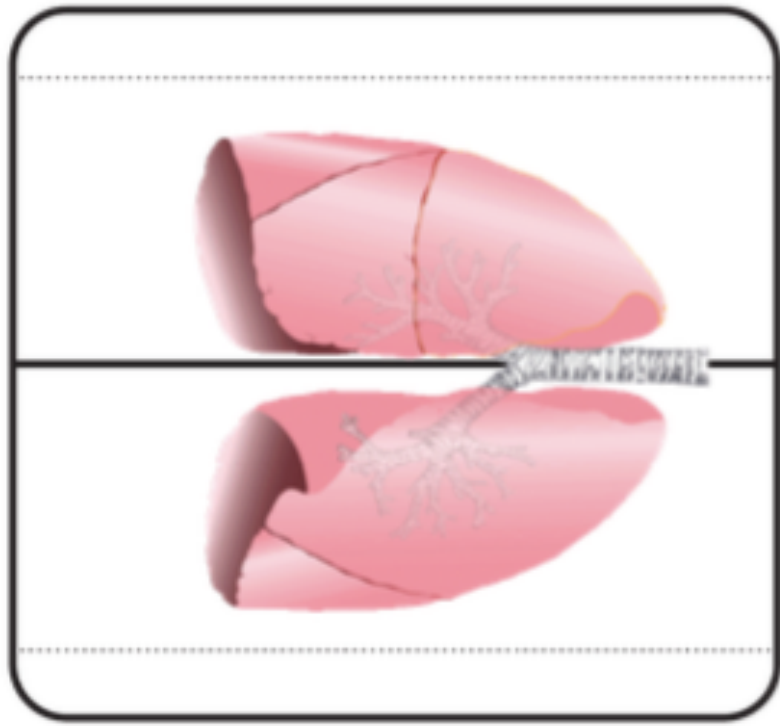
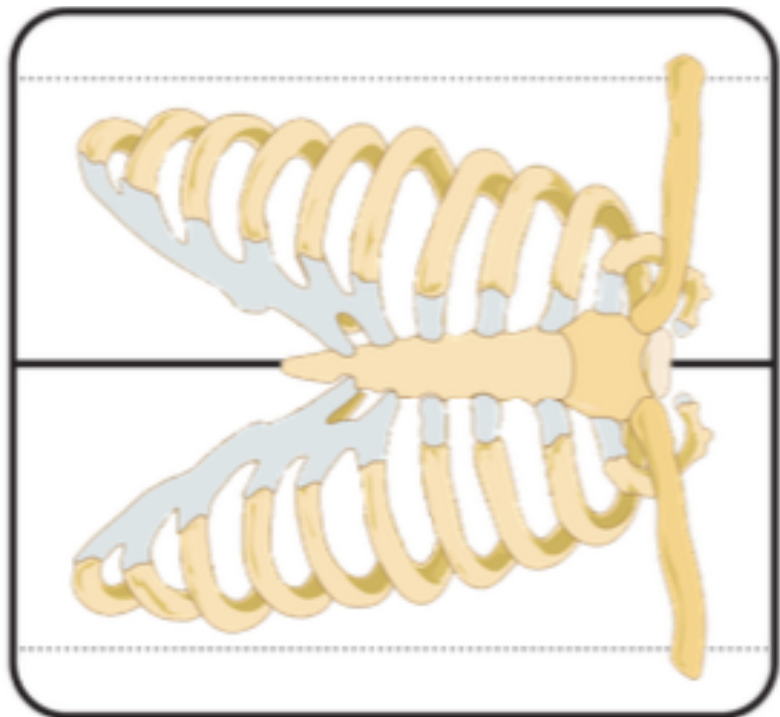


Diagram D: The ribcage

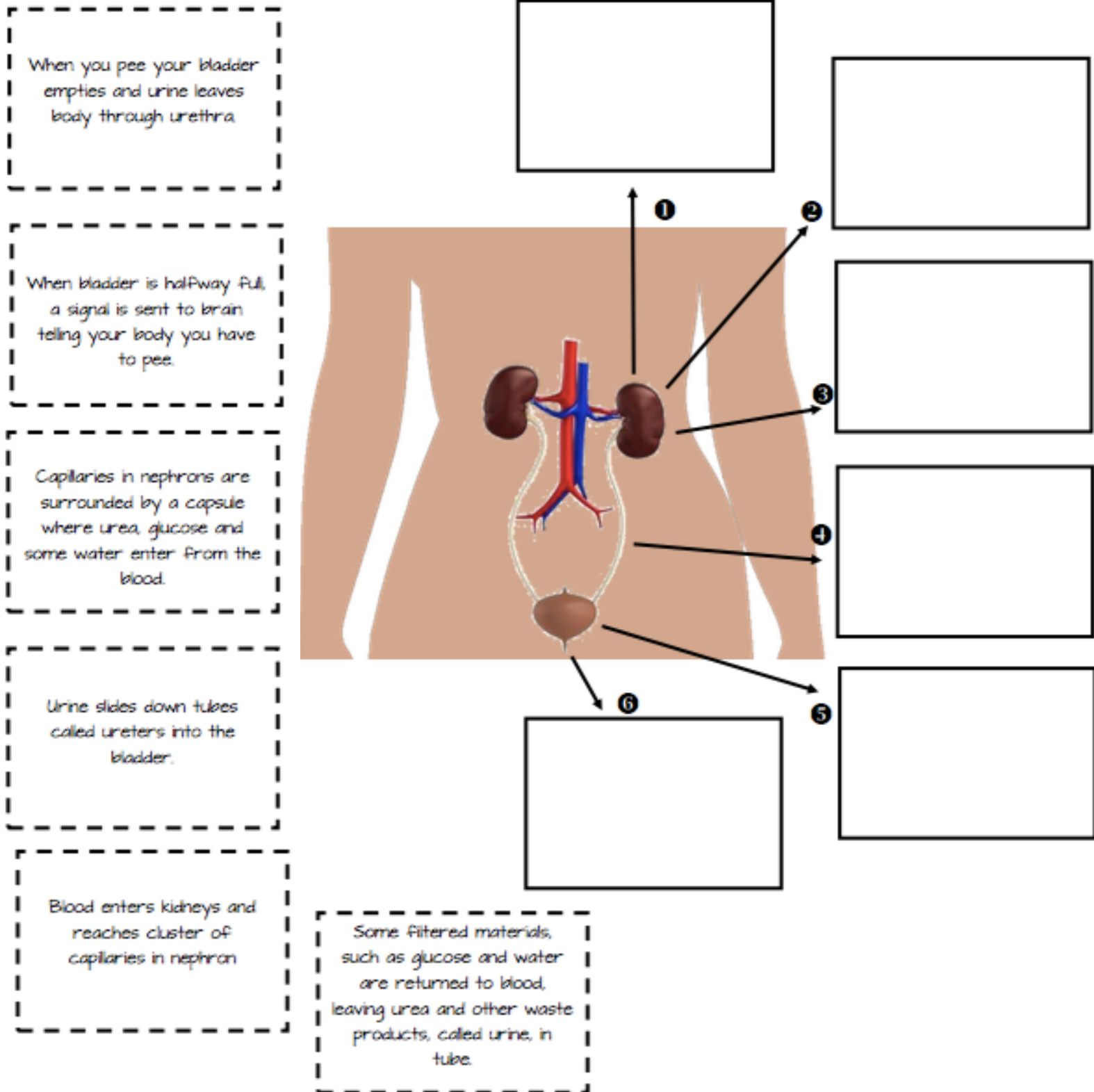


## Excretory System

Students learn and understand how the excretory system removes waste from your body by sorting the stages for When You Gotta "Go"! The stages start with blood entering the kidneys and finish with the body going pee.

### When You Gotta Go!

Directions: Cut out and unscramble the stages that describe how your body produces urine. Paste in proper order on the diagram.





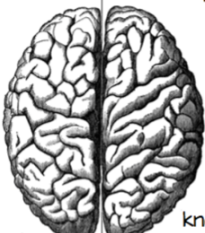
## The Nervous System: Central Nervous System and Peripheral Nervous System

*This is a great activity to get students thinking about the nervous system and their brain. They will love determining which side of their brain is more dominant which will lead to discussions among group members about other possible personality traits or actions that may be controlled by the right and left brain.*

### **Right or Left Brain Dominant?**

Introduction: Human brains are like a complex computer system that is composed of two hemispheres. Each hemisphere controls different skills or ways of thinking. The right hemisphere of the brain is referred to as the analog brain. It controls three-dimensional sense, creativity and artistic senses; processing information from the “big picture” first then looking at the details. The left brain is sometimes referred to as the digital brain since it controls logical thinking, reading and writing and processes information in an analytical and sequential way.

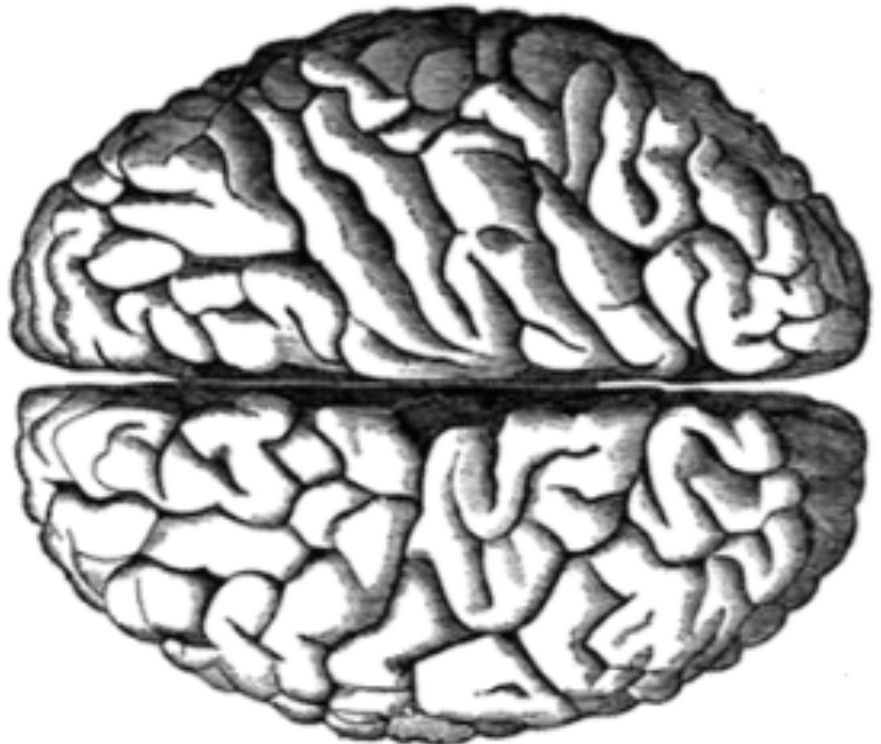
The funny thing about our brain, however, is that our right and left hemispheres control the opposite side of our bodies. For instance, the right hemisphere controls our left side movements and what our left eye sees, whereas our right hemisphere controls the right side of our body and processes what our right eye sees.

LEFT BRAIN FUNCTIONS		RIGHT BRAIN FUNCTIONS
uses logic		uses feeling
detail oriented		"big picture" oriented
facts rule		imagination rules
words and language		symbols and images
present and past		present and future
math and science		philosophy
knowing		believes
acknowledges		appreciates
pattern perception		spatial perception
knows object name		knows object function
reality based		fantasy based
forms strategies		presents possibilities
safe		risk taking

Even though humans tend to have a more dominant side, both sides of the brain are used and thought processes shift between the two sides since they have overlapping skills and different ways of thinking. So, next time you're working with your partner on a project, try to be aware that he or she may be using a different brain hemisphere and that they may process information differently. It's also important to be self-aware of your most successful way of learning and understanding.

Directions: Identify which of your brain hemispheres may be more dominant by completing each task in the data table. Mark whether the task was right or left side dominant, or mark both if the task could be done easily with both your left and right sides. When you are finished with the tasks, cut out the table and fold it shutter style with opening in center. Paste brain diagram on the front of shutter foldable, cut up the center, and then color the hemisphere that was your dominant side.

Brain Diagram





Left Side <input checked="" type="checkbox"/>	Task	Right Side <input checked="" type="checkbox"/>
	Write your name - which hand did you use?	
	Give someone a "high five" - which hand did you use?	
	Fold hands - which thumb is on top	
	Throw a paper ball in wastebasket with both right and left hand - which was easier?	
	Start to run - which foot did you start with?	
	Kick a ball - which foot did you use?	
	Stand on one foot - which side has better balance?	
	Look through a "telescope" made with your two hands. -which eye did you use to look through it?	
	Draw a horse (side view) - mark which direction the horse is facing.	
	Draw a circle with right hand then with left hand. If both circles were drawn clockwise mark right, counterclockwise mark left, if one in each direction mark both.	
	◀ TOTALS ▶	
Which body side seems to be your dominant side? _____ Which is your dominant brain side? _____		

## Potential Energy → Kinetic Energy

### Rubber Band Energy

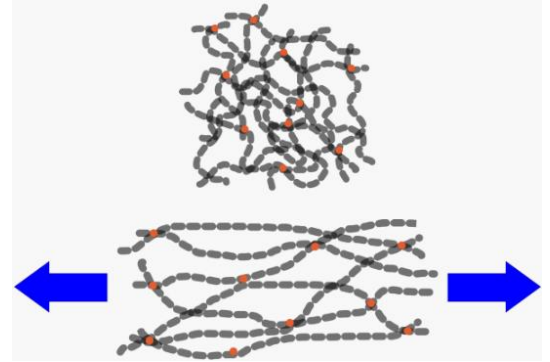
#### What to do:

1. Place your thumbs through a thick rubber band, one on each end. Without stretching the band, hold it to your forehead and note the temperature - does the band feel cool or warm or about the same as your skin? Repeat the test several times until you are sure of the result.
2. Move the rubber band slightly away from your face, so it is not touching your skin. Quickly stretch the band about as far as you can and, holding it in the stretched position, touch it again to your forehead. Does it feel warmer or cooler or about the same as it did when it was relaxed?
3. Move the stretched rubber band away from your face. Quickly let it relax to its original size and again hold it to your skin. Does it feel warm or cool?
4. Repeat the stretching and testing, and relaxing and testing several times until you are sure of the results.

#### Why does it happen?

An object feels cool or cold to you when heat flows from your skin to the object. Conversely, an object feels warm or hot when heat flows from the object into your skin. If the stretched rubber band feels cool, then it absorbs heat from your skin. If it feels warm, then it gives off heat to your skin. If the band feels neither warm nor cool, then there is no detectable heat flow.

Rubber contains millions of randomly coiled long molecules called polymers, which are each made of shorter molecules known as monomers. When you stretch a piece of rubber the coiled molecules are pulled straight; when you let go again they move around at random through thermal vibrations, which restore them to their more compact coiled configuration.



So why does an elastic band become hotter when you stretch it and colder when it shrinks?

When you stretch the rubber band you are adding energy to the rubber, which causes it to vibrate more strongly and this makes it hotter. Then, when you let go, the rubber molecules must do work to pull the polymer chains back into their compact configuration; since this process uses energy, the elastic band must have less energy after it has shrunk and therefore it becomes colder.

### Potential to Kinetic Energy Transfer

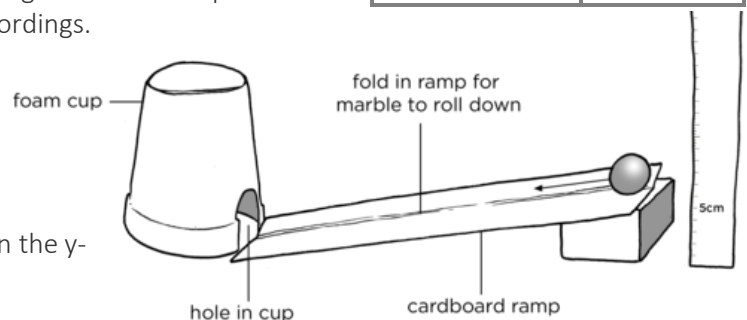
How can you give a marble more potential energy so that it can transfer more kinetic energy to the cup?

1. Build the setup. Set up the ramp so that the top of the ramp is at a height of 5 cm. Roll the marble from a height of 5 cm & then measure how far the styrofoam cup moves.
2. Adjust the height of the ramp by increasing by 5 cm each time. Each time place the marble at the top of the ramp and roll it down, measuring how far the cup moves.
3. Repeat the measurements until you have at least 6 recordings.
4. Graph: marble height vs. the distance the cup moved.

Height of marble up the ramp (cm)	Distance cup moves (cm)

independent variable = the value you changed in the investigation & is written on the x-axis (horizontal axis).

dependent variable = variable you measured & is written on the y-axis (vertical axis).



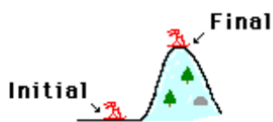
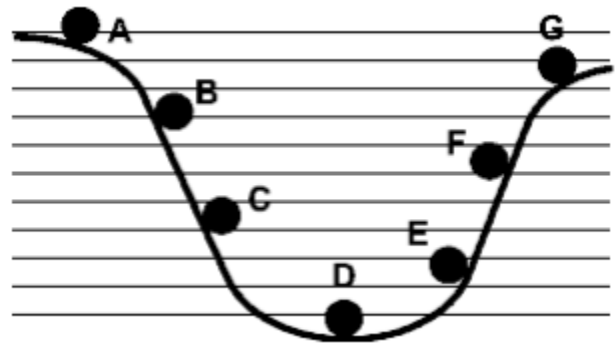
## Energy Transfers

1. Making toast in a toaster changes \_\_\_\_\_ to \_\_\_\_\_.
2. Watching television changes \_\_\_\_\_ to \_\_\_\_\_ and \_\_\_\_\_.
3. Using an iron to press clothes changes \_\_\_\_\_ to \_\_\_\_\_.
4. Turning on a lamp changes \_\_\_\_\_ to \_\_\_\_\_ and \_\_\_\_\_.
5. Driving a car changes \_\_\_\_\_ to \_\_\_\_\_ and \_\_\_\_\_.
6. Using a cell phone changes \_\_\_\_\_ to \_\_\_\_\_ and \_\_\_\_\_.
7. Playing a drum changes \_\_\_\_\_ to \_\_\_\_\_.
8. A growing plant changes \_\_\_\_\_ to \_\_\_\_\_.
9. Applying the brakes on your bicycle changes \_\_\_\_\_ to \_\_\_\_\_.
10. A marble falling off a table changes \_\_\_\_\_ to \_\_\_\_\_ and \_\_\_\_\_.
11. The 2 factors that determine the amount of kinetic energy in an object are \_\_\_\_\_ and \_\_\_\_\_.
12. Kinetic energy is measured in units of \_\_\_\_\_.
13. The 3 factors that determine the amount of potential energy in an object are \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.
14. Potential energy is measured in units of \_\_\_\_\_.

## Potential vs. Kinetic Energy

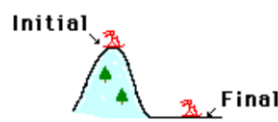
This graph shows a ball rolling from A to G:

- a. Which letter shows the ball when it has maximum kinetic energy? \_\_\_\_\_
- b. Which letter shows the ball when it has maximum potential energy? \_\_\_\_\_
- c. Which letter shows the ball when it has minimum kinetic energy? \_\_\_\_\_
- d. Which letter shows the ball when it has minimum potential energy? \_\_\_\_\_
- e. Explain what is true of the ball's total energy at every point along the graph.



As the skier skis up a hill  
kinetic energy is lost and  
potential energy is gained.

$$KE_i + PE_i = KE_f + PE_f$$



As the skier skis down a hill  
potential energy is lost and  
kinetic energy is gained.

$$KE_i + PE_i = KE_f + PE_f$$

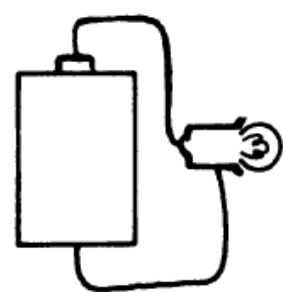
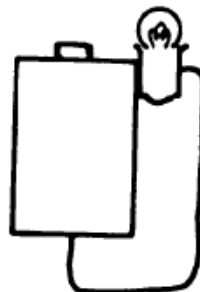
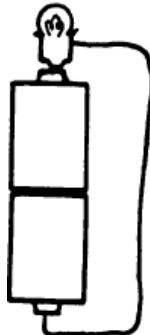
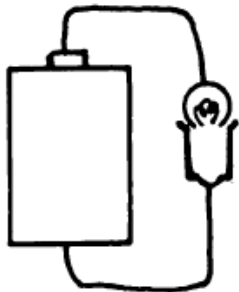
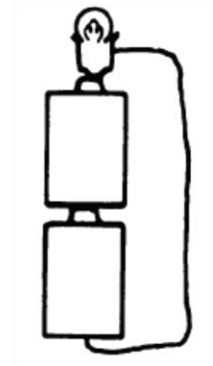
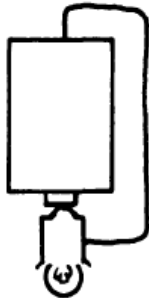
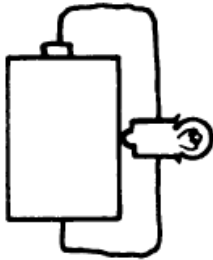
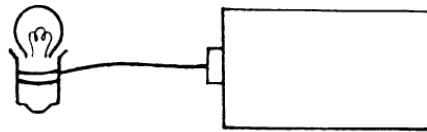
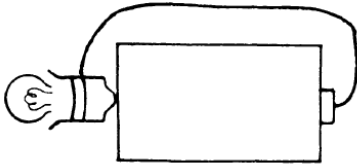
## Electricity Misconceptions

Learners' INCORRECT understandings of electricity include these non-scientific ideas:

1. The electricity companies supply electrons for your household current.
2. We pay electricity companies for power.
3. 'Static' and 'current' electricity are two types of electrical energy.
4. 'Electricity' is used up in electric circuits.
5. Charge is used up in electric circuits.
6. Energy is used up in electric circuits.
7. More devices in a series circuit mean more current because devices 'draw' current.
8. Electrical power is the same as electrical energy.
9. Electricity means the same thing as current, or voltage, or energy.
10. Batteries store, and supply, electrons or 'electricity' to the electric circuit.
11. A wire from a battery to a bulb is all that is needed for the bulb to light up.
12. The electrical energy in a circuit flows in a circle.
13. Electric current is a flow of energy.
14. The stuff that flows through wires is called 'electric current'.
15. Electrons travel at, or near, the speed of light in the wires of an electric circuit.
16. Voltage flows through a circuit.
17. Voltage is energy.
18. High voltage by itself is dangerous.
19. Electrons move by themselves.
20. Current is the same as voltage.
21. A conductor has no resistance.
22. The bigger the battery, the more voltage.
23. Batteries create energy out of nothing.
24. Alternating current (AC) charges move all the way around a circuit and all the way back.

### Which Circuit Works?

Which bulbs are correctly connected to the battery and will be able to light up?



**1** Make some wire from aluminum foil and tape. To do this . . .

30 cm  
IS A LITTLE LONGER  
THAN THIS PAGE.

30 cm

. . . stick a piece of tape about 30 cm long to the *dull* side of a strip of aluminum foil.

**2** Cut around the edge of the tape to make a foil ribbon.

CUT ALL AROUND

**3** Fold the ribbon along its length, so the shiny side stays out and the tape is folded inside.

SHINY SIDE OF FOIL

TAPE

**4** Crease the fold along the edge of your table.

**5**

TOPS WIRE FACTORY

REMEMBER HOW YOU MADE THIS RIBBON. YOU'LL NEED MORE LATER.

**6** Use this foil ribbon to light a bulb with a dry cell.

2. Using one bulb, your wire, and one battery, find four different ways to make the bulb light up. Sketch all four successful attempts and 2 unsuccessful attempts. Show in detail where the bulb and wire are touching the battery. Use these shapes to represent the components:



Success!☺	Success!☺	Unsuccess☹
Success!☺	Success!☺	Unsuccess☹

3. Use two foil wires. The bulb may NOT touch the battery. Draw it:

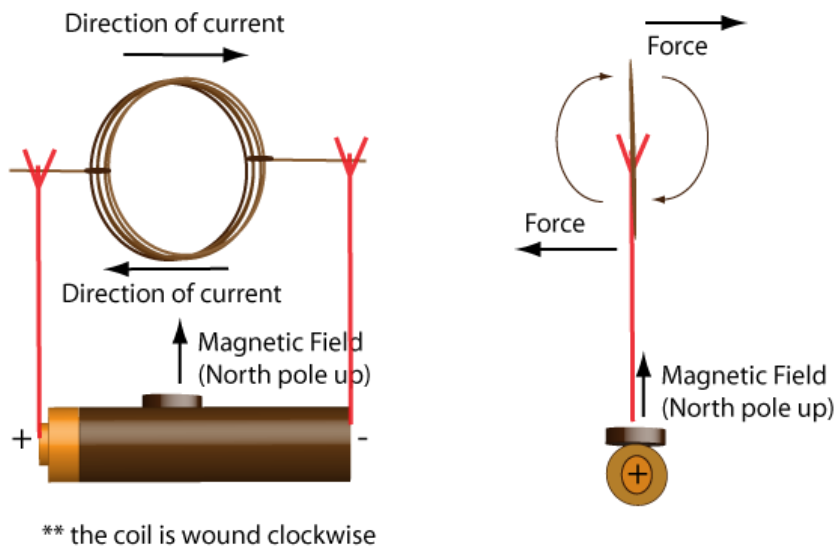
4. To light a bulb, \_\_\_\_\_ places on the battery must connect to \_\_\_\_\_ places on the bulb.



## Electromagnetic Induction

### Simple Motor:

1. Starting in the center of the wire, wrap the wire tightly & neatly around the battery several times.
2. Slide the coil you made off the battery.
3. Wrap each loose end of the wire around the coil a few times to hold it together, then point the wires away from the loop. Use sandpaper to remove the top-half of the wire insulation on each free end of the coil. The exposed wire should be facing the same direction on both sides.
4. Thread each loose end of the wire coil through a bent open paper clip. Try to keep the coil as straight as possible without bending the wire ends.
5. Lay the battery sideways on a flat surface.
6. Tape the battery down so it does not roll away.
7. Place the paper clips upright next to the terminals of each battery so that the side of each needle touches one terminal of the battery & tape them in place.
8. Tape the small magnet to the side of the battery so that it is centered underneath the coil.
9. Give your coil a spin. *What happens? What happens when you spin the coil in the other direction? What would happen with a bigger magnet? A bigger battery? Thicker wire?*



How does it work? The metal, paper clips, & wire create a closed loop circuit that carries current. Current flows from the negative battery terminal, through the circuit, and to the positive battery terminal. Current also induces a magnetic field in the coil, which helps explain why the coil spins. Magnets have two poles, north and south. North-south interactions attract, and north-north and south-south interactions repel. The magnetic field created by the current in the wire is not perpendicular to the magnet taped to the battery, so at least some part of the wire's magnetic field will repel and cause the coil to continue to spin.

## Heat Transfer

### Use:

- \* a medium sized container for cold water
- \* a small container for warm water (a small metal can)
- \* 2 thermometers
- \* 1 cup of cold water (ice water, if possible)
- \* 1/2 cup of warm water (heat with electric kettle, if possible)

### Start:

- put the warm water container into the cold water container
- Every minute, measure & record BOTH temperatures.
- Continue for 15 minutes.
- Graph the temperatures (2 lines on one graph)



## Electrical Conductors & Insulators

### Objective:

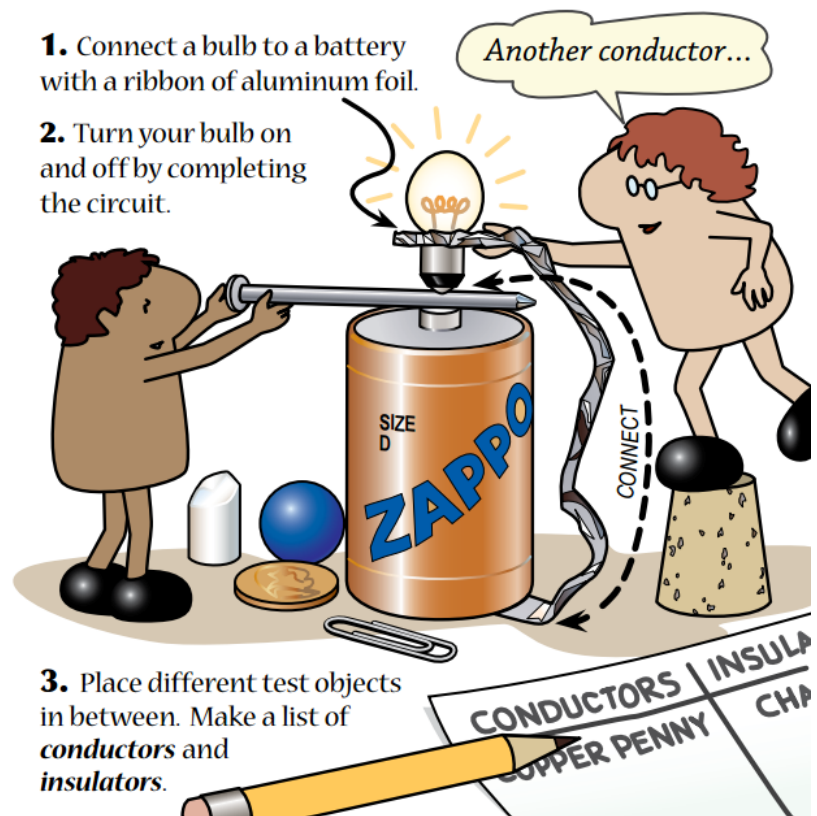
Use a bulb and battery to find materials that conduct or resist electric current.

### Materials:

Battery and bulb

Aluminum foil strip, 8" long, folded for strength.

Test objects: metal/rubber washer, button, glass, painted surfaces, string, leaf, copper, chalk, skin, candle, tin, eraser, aluminum, wood



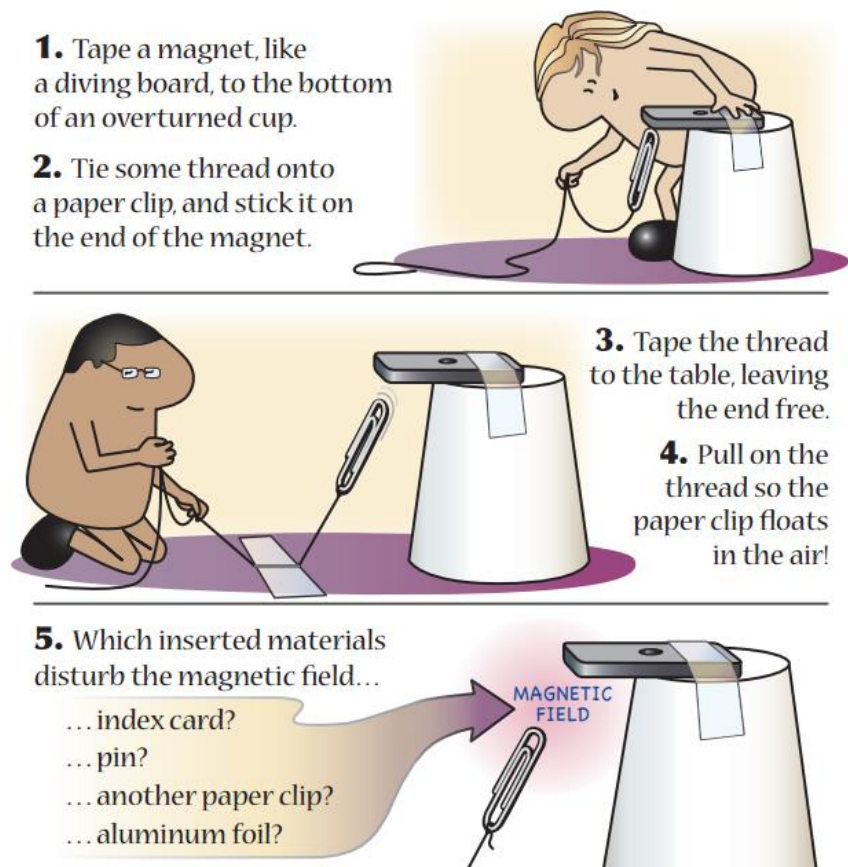
## Magnetic Force at a Distance

### Objective:

To observe that a magnetic field passes through solid objects if they are not magnetic.

### Magnetic Force acting at a Distance:

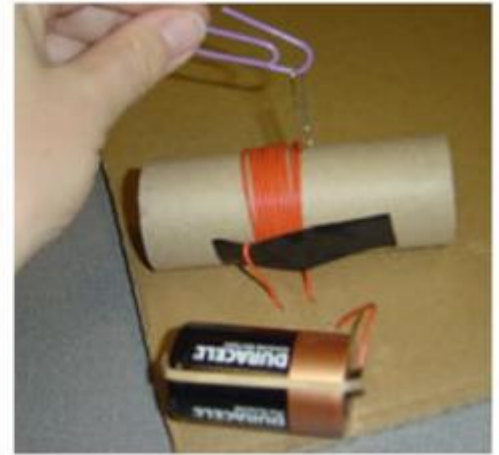
Magnetic lines of force pass undisturbed through nonmagnetic materials (paper, aluminum, plastic, glass), with no visible effect on the floating clip. The field is altered by magnetic materials like iron or steel. When passing through a magnetic field, steel pins and clips become temporary magnets and interact with the field, causing the floating clip to wobble or fall.



# Electromagnet

## Making an electromagnetic field:

1. Wrap insulated wire around a paper tube several times.
2. Leave two long tails of wire hanging from the coil.
3. Use tape or a rubber band to connect one end of the coil wire to any battery, leaving the other end of the wire not connected to the battery until you're ready to use it.



## Testing the electromagnetic field:

1. To locate the magnetic field of the electromagnet, move a compass in a circle around the electromagnet, paying attention to the direction that the compass points. Can you determine which end is North and which is South?
2. What happens if you dangle a paperclip from another paperclip near the coil?

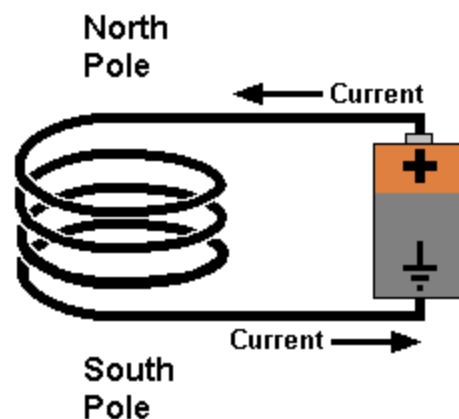
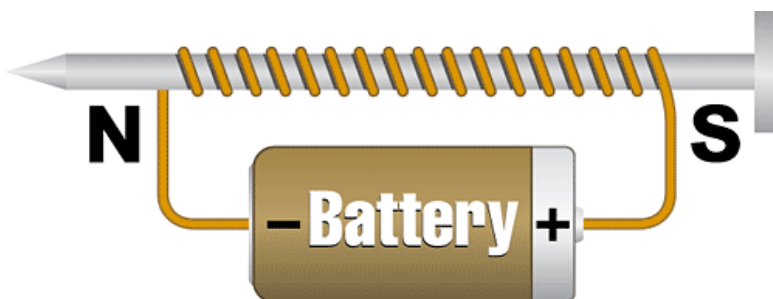
## The magnetic field of an electromagnet:

The magnetic field around an electromagnet is just the same as the one around a bar magnet. It can, however, be reversed by turning the battery around.

Unlike bar magnets, which are permanent magnets, the magnetism of electromagnets can be turned on and off just by closing or opening the switch.

## We can make an electromagnet stronger by doing these things:

- wrapping the coil around an iron core
- adding more turns to the coil
- increasing the current flowing through the coil.



## Energy Transfer to Surroundings

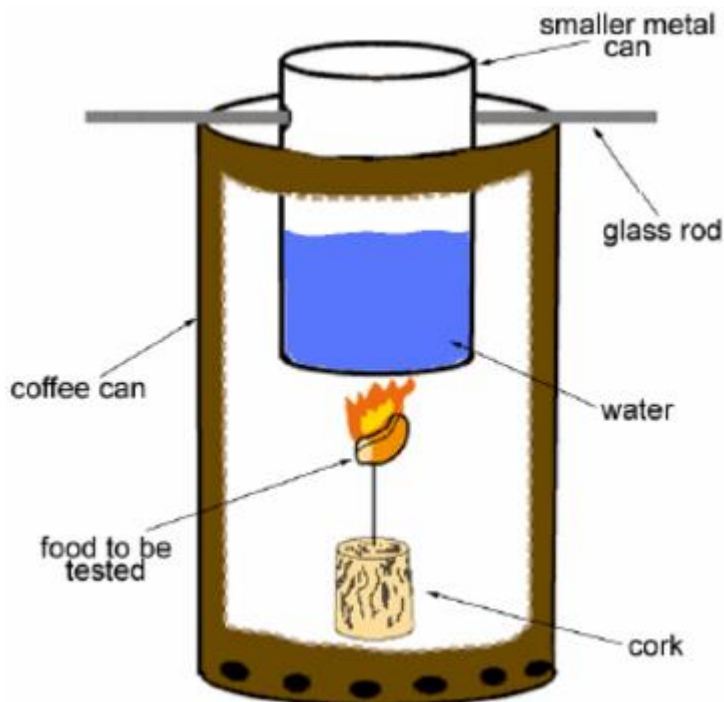
Objective: to measure the potential energy in foods.  
You must release the chemical energy stored in food so that your body has fuel. Here, you will release the chemical energy in food and use it to heat water.

### Conservation of energy:

Energy released by food = energy absorbed by water

#### Steps:

1. Make food holder using cork and pins.
2. Make burning station using cans and rod.
3. Measure and record the combined mass of the food holder and sample.
4. Measure & record the initial temperature of water.
5. Light the food sample and center it under the soda can. Allow the water to be heated until the food sample stops burning. Record the maximum (final) temperature of the water in the can.
6. Measure and record the final mass of the food holder and sample.



How much heat energy is gained by the water?

Use your data to determine the heat energy gained by the water (in Joules).

Use the equation:

$$Q_{\text{water}} = m_{\text{water}} * c(T_f - T_i)$$

$Q_{\text{water}}$  = heat absorbed (in J)

$T_f - T_i$  = change in temperature (in °C)

$m_{\text{water}}$  = mass of the water heated (in g)

$C$  = specific heat capacity (4.18 J/g°C for water).

	Sample 1	Sample 2	Sample 3
Type of food used			
Initial mass of food + holder			
Final mass of food + holder			
Food mass change			
Initial water temp			
Final water temp			
Water temp change			

#### Questions:

- How can you calculate the amount of energy released per gram of food?
- Which foods are the most energy-dense?
- How is this similar to what happens in your body? How is it different?
- What happened to some of the heat released by burning the food?
- Is this an open system or a closed system?

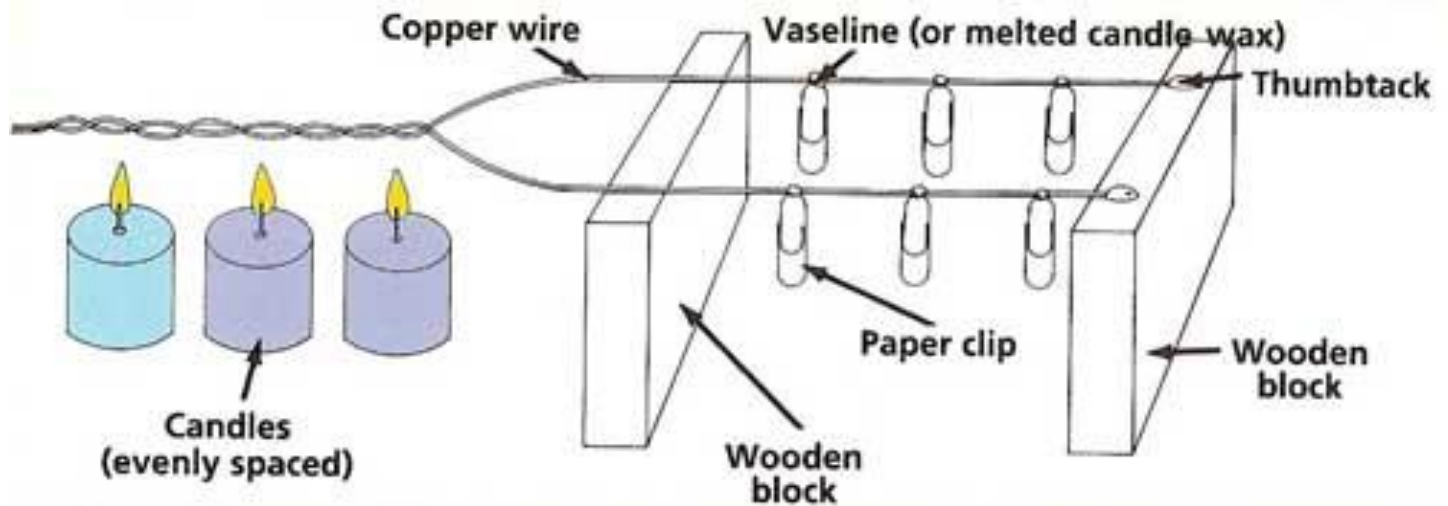




## Heat Transfer

### Objective:

Which material is a better conductor?



### Setup:

1. Twist the ends of two different wires together, making sure that the twisted part of each wire is the same length.
2. Support the wires between the two wooden blocks (or aluminum foil) and fasten their free ends to one of the blocks with thumbtacks.
3. Attach paper clips 3 cm apart along each wire, using Vaseline or drops of melted wax from a candle.
4. Space the three candles evenly under the middle of the twisted wires and light them.
5. Time how long it takes for each paper clip along each wire to fall off.
6. Plot a graph of time versus distance. From your results, decide which metal is the better conductor.

Taking it further: compare two wires of the same metal but of different thickness.

- Does heat travel faster along a thinner wire of copper than a thicker one?
- If so, how much faster?
- For instance, if one wire is half as thick as another, does heat travel twice as fast along it?

### Wood, Metal, Plastic:

Which spoon is the best conductor? Which is the best insulator? Use butter & hot water to find out!



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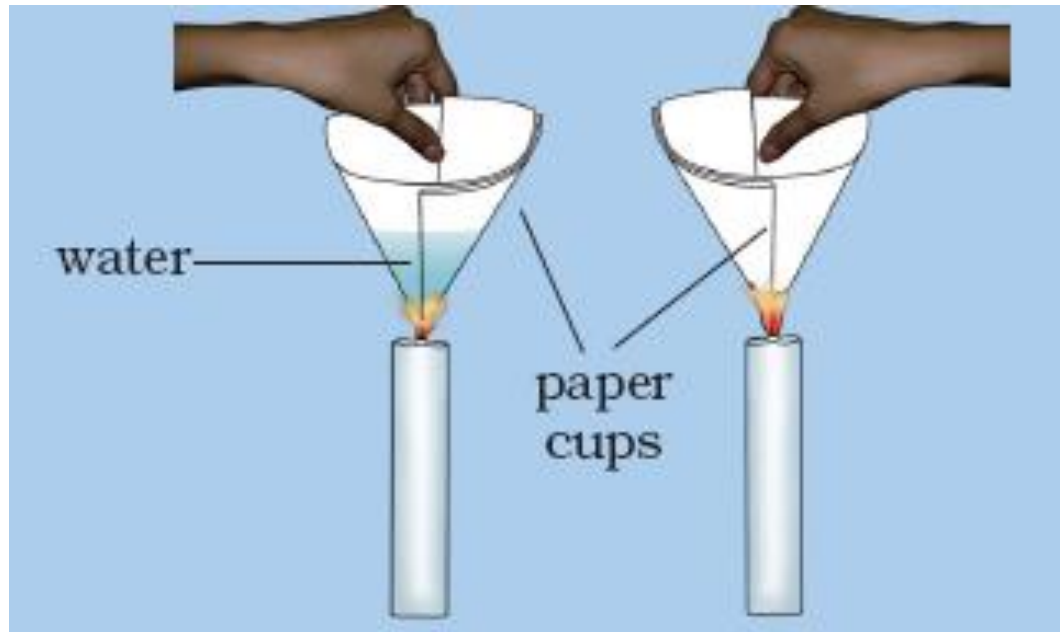


## Heat Transfer

### Heating water in a paper cup:

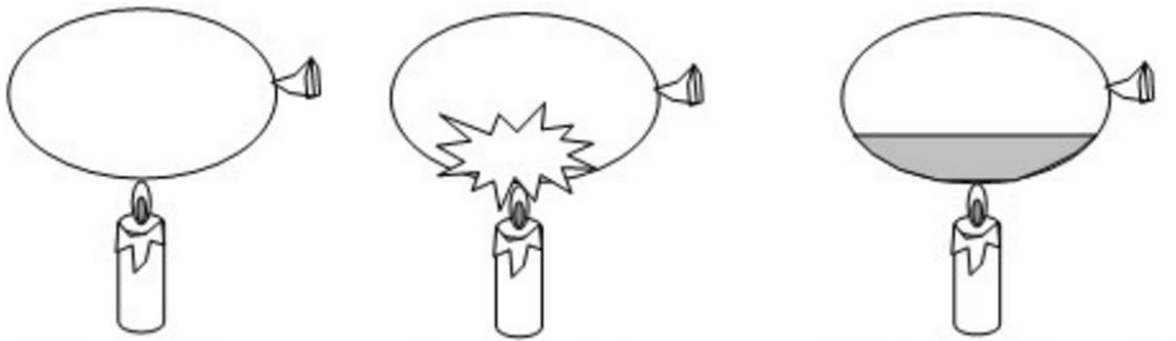
- Make two paper cups by folding a sheet of paper. Tape or staple it closed.
- Pour about 50 mL of water in one of the cups.
- Heat both the cups separately with a candle.
- What do you observe?  
What happens to the empty paper cup? What happens to the paper cup with water? Does water in this cup become hot? If we continue heating the cup, we can even boil water in the paper cup.

Can you think of an explanation for this phenomenon?



### Heating a balloon:

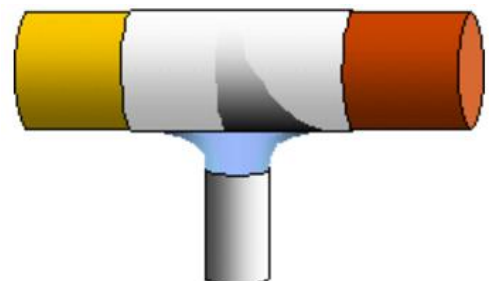
- What happens when you heat a balloon filled with air over a candle?
- What happens when you heat a balloon filled with water over a candle?
- How can you use what you know about energy transfer to explain your observations?



### Heating a paper wrapped around metal or wood:

- What happens when you wrap paper around a wooden stick and hold it in a candle flame?
- What happens when you wrap paper around a metal stick and hold it in a candle flame?

The heat supplied to the paper is transferred to stick by conduction. So, the metal conducts the heat energy away so, the ignition temperature of paper is not reached. Hence, it does not burn.



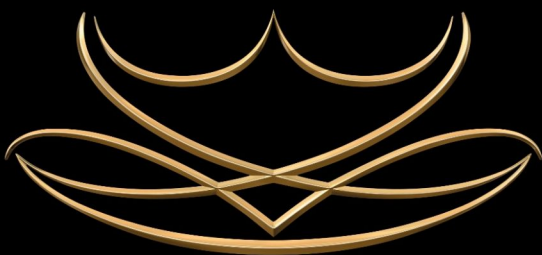
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