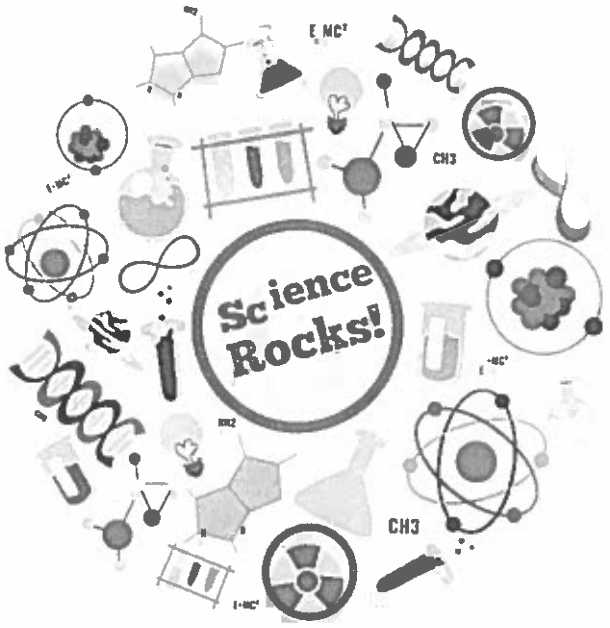
Lathrop Intermediate

8th grade Science

2nd Semester



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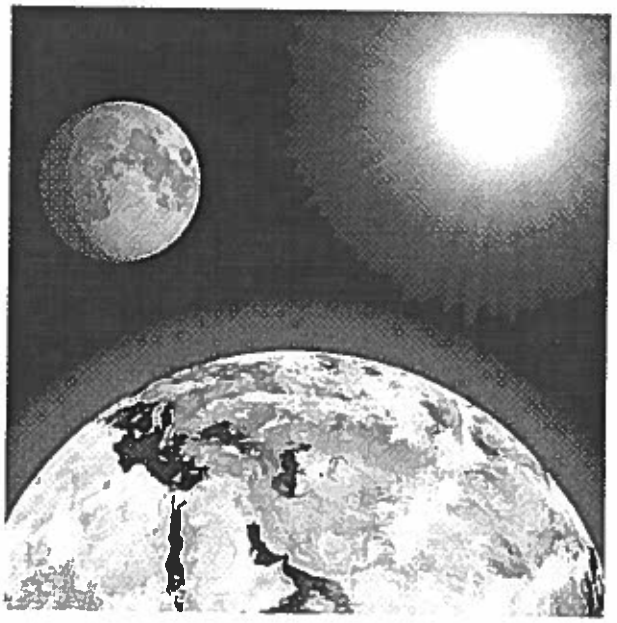
Period: _____

Lathrop Intermediate

8th grade Science
Space and Gravity Unit



8.2.0 - Ball on a String (Print 2 copies and place in plastic sleeves)

Student-Led INVESTIGATIONS Task Card

Focus Question: *How does a ball stay in motion spinning around on a string?*

Task: Develop an annotated model using technical writing tools to show what happens when variables are changed in an investigation.

Time: 10-minutes

Materials (per group):	**Safety:**
• Balls of various sizes • Strings of various lengths • tape	• Attach the strings securely to the orbiting ball • When spinning, give the spinner plenty of room • DO NOT spin the ball too fast, the point is not to make the ball fly off the string

Task Steps:

1. Decide what variable (size of ball and length of string) for each trial and set up a data table in your notebook.

Trials / Setup variables	Labeled Diagram of Ball Spinning	Observations of orbit motion or lack of motion
1. _____		
2. _____		
3. _____		

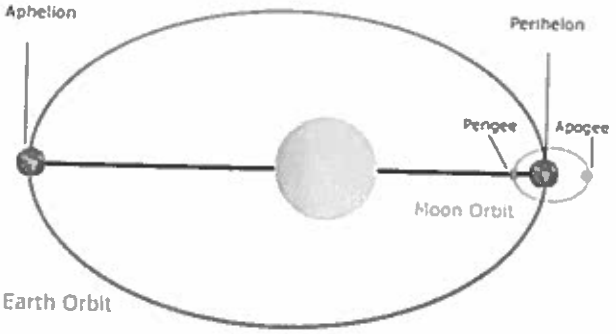
2. Choose a size of ball, length of string and speed of spin
3. Spin the ball and record observations of its motion. Try spinning the ball slowly and quickly
4. If time permits, add another trial/variable.
5. Return objects to their bins.

Evaluation Criteria:

- Data Table includes at least 3 trials/variable changes
- Model is annotated with technical writing tools for each trial/variable change
- Observational data is recorded for each trial/variable change

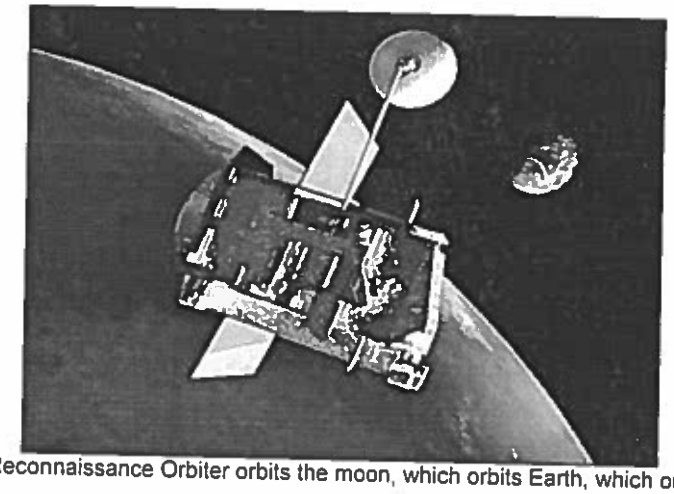
What Is an Orbit?

The International Space Station orbits Earth once every 90 minutes.



The point at which a planet is closest to the sun is called perihelion. The farthest point is called aphelion.

Credits: NOAA



The Lunar Reconnaissance Orbiter orbits the moon, which orbits Earth, which orbits the sun.

This article is part of the NASA Knows! (Grades 5-8) series.

An orbit is a regular, repeating path that one object in space takes around another one. An object in an orbit is called a satellite. A satellite can be natural, like Earth or the moon. Many planets have moons that orbit them. A satellite can also be man-made, like the International Space Station.

Planets, comets, asteroids and other objects in the solar system orbit the sun. Most of the objects orbiting the sun move along or close to an imaginary flat surface. This imaginary surface is called the ecliptic plane.

What Shape Is an Orbit?

Orbits come in different shapes. All orbits are elliptical, which means they are an **ellipse**, similar to an oval. For the planets, the orbits are almost circular. The orbits of comets have a different shape. They are highly eccentric or "squashed." They look more like thin ellipses than circles.

Satellites that orbit Earth, including the moon, do not always stay the same distance from Earth. Sometimes they are closer, and at other times they are farther away. The closest point a satellite comes to Earth is called its perigee. The farthest point is the apogee. For planets, the point in their orbit closest to the sun is perihelion. The farthest point is called aphelion. Earth reaches its aphelion during summer in the Northern Hemisphere. The time it takes a satellite to make one full orbit is called its period. For example, Earth has an orbital period of one year. The inclination is the angle the **orbital plane** makes when compared with Earth's equator.

How Do Objects Stay in Orbit?

An object in motion will stay in motion unless something pushes or pulls on it. This statement is called Newton's first law of motion. Without gravity, an Earth-orbiting satellite would go off into space along a straight line. With gravity, it is pulled back toward Earth. A constant tug-of-war takes place between the satellite's tendency to move in a straight line, or momentum, and the tug of gravity pulling the satellite back.

An object's **momentum** and the force of gravity have to be balanced for an orbit to happen. If the forward momentum of one object is too great, it will speed past and not enter into orbit. If momentum is too small, the object will be pulled down and crash. When these forces are balanced, the object is always falling toward the planet, but because it's moving sideways fast enough, it never hits the planet. Orbital velocity is the speed needed to stay in orbit. At an altitude of 150 miles (242 kilometers) above Earth, orbital velocity is about 17,000 miles per hour. Satellites that have higher orbits have slower orbital velocities.

Where Do Satellites Orbit Earth?

The International Space Station is in low Earth orbit, or LEO. LEO is the first 100 to 200 miles (161 to 322 km) of space. LEO is the easiest orbit to get to and stay in. One complete orbit in LEO takes about 90 minutes.

Satellites that stay above a location on Earth are in geosynchronous Earth orbit, or GEO. These satellites orbit about 23,000 miles (37,015 km) above the equator and complete one revolution around Earth precisely every 24 hours. Satellites headed for GEO first go to an elliptical orbit with an

apogee about 37,015 km. Firing the rocket engines at apogee then makes the orbit round. Geosynchronous orbits are also called geostationary.

Any satellite with an orbital path going over or near the poles maintains a polar orbit. Polar orbits are usually low Earth orbits. Eventually, Earth's entire surface passes under a satellite in polar orbit. When a satellite orbits Earth, the path it takes makes an angle with the equator. This angle is called the inclination. A satellite that orbits **parallel** to the equator has a zero-degree orbital inclination. A satellite in a polar orbit has a 90-degree inclination.

Words to Know

ellipse: A flattened circle or oval.

orbital plane: An imaginary, gigantic flat plate containing an Earth satellite's orbit. The orbital plane passes through the center of Earth.

momentum: The mass of an object multiplied by its velocity.

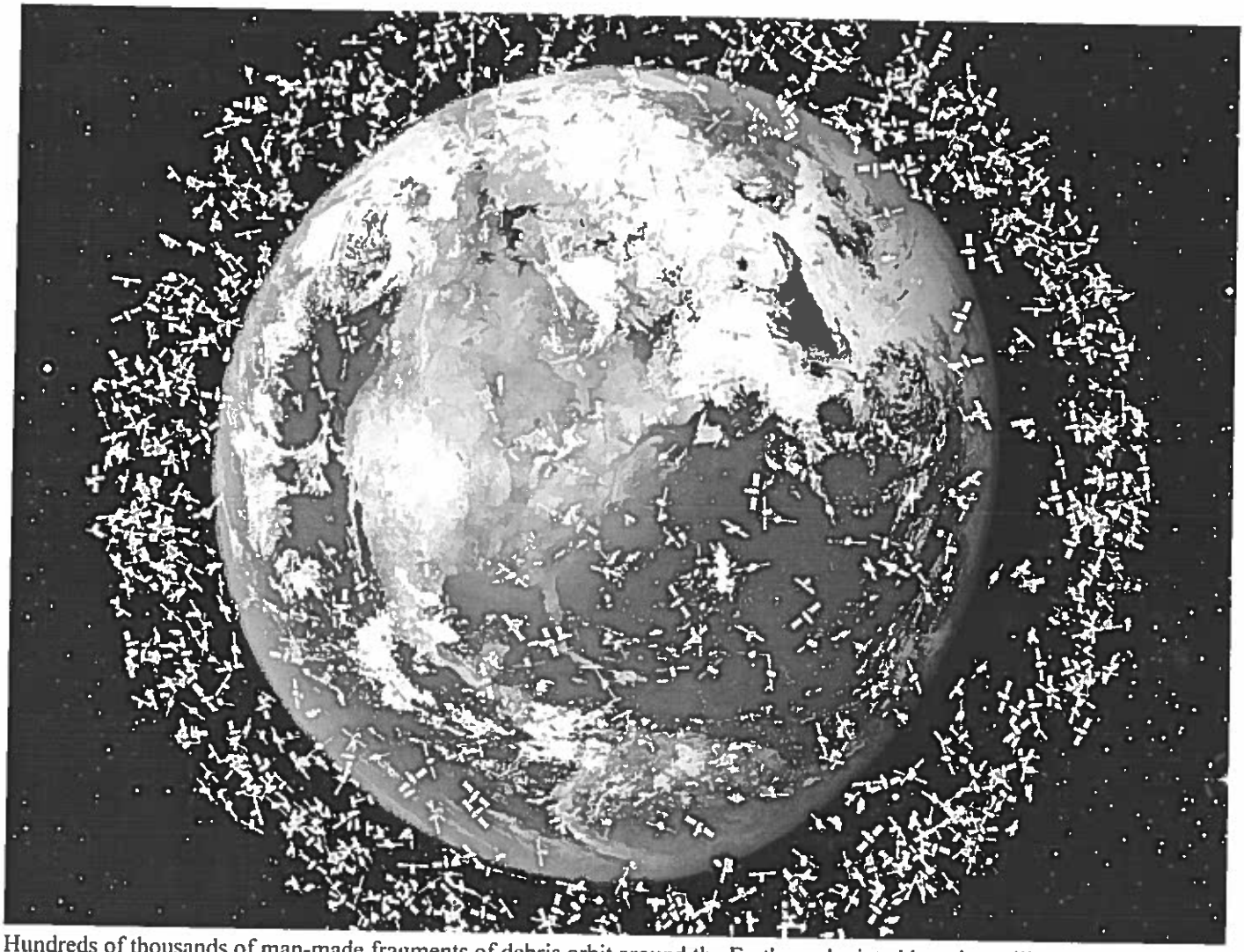
parallel: Extending in the same direction, everywhere equidistant, and not meeting.

Smithsonian.com

SmartNews Keeping you current

A Forgotten Piece of Space Junk is Headed for Earth

The object could be a lost piece of a rocket dating back to the Apollo missions



Hundreds of thousands of man-made fragments of debris orbit around the Earth, as depicted here in an illustration of the cosmic mess. (Science Photo Library/Corbis)

By Danny Lewis
smithsonian.com
October 28, 2015

In just a few weeks, a forgotten piece of space junk will re-enter the Earth's atmosphere above the Indian Ocean. Astronomers initially detected the object two years ago, but they're still unsure what it actually is.

After more than 60 years of flinging rockets, space stations and satellites into orbit, the sky has gotten pretty crowded. While Earth's orbit isn't quite as cluttered as in the future envisioned in "WALL-E," there is still plenty of debris left over from old satellites and space launches littering the sky.

Known as 'space junk,' this debris is often found in low orbit around Earth and is tracked by several space agencies, including the European Space Agency, NASA and the U.S. military.

What's curious about this new piece of space junk is how recently it was discovered and how odd its orbit is. According to the ESA, the mysterious object, called WT1190F, was first detected in 2013 by scientists at the Catalina Sky Survey, a project that scans the sky for near-Earth objects like asteroids and comets.

Unlike most space junk, WT1190F has an elliptical orbit that takes it deep into space. At its furthest point from Earth, the object is about twice as far as the distance between the Earth and the Moon, Traci Watson writes for *Nature News*.

Judging by its trajectory, scientists believe that it is just a few meters wide, not very dense and could be hollow. This data suggests that the space junk could be a part of an old rocket, panels from a past moon mission, or some other "lost piece of space history that's come back to haunt us," Harvard astrophysicist Jonathan McDowell tells Watson.

The object will re-enter the Earth's atmosphere above the Indian Ocean on November 13th. But there's no need to worry: WT1190F is tiny, cosmically speaking.

While most of it will probably burn up as it re-enters the atmosphere near the Sri Lankan coast, astronomers are excited for the rare chance to watch how WT1190F acts as it rockets through the sky.

Most funding and attention goes towards tracking space debris in low-Earth orbit, as it can interfere with communications satellites. Much less is known about objects in far-flung orbits like WT1190F, which is why it went for so long without being detected. Now that the object is on its way here, astronomers will get to test out a new set of tracking systems designed to detect and analyze debris with erratic orbits like this one, Alissa Walker reports for *Gizmodo*.

In the meantime, get ready for some spectacular shots of WT1190F plummeting back to Earth. While it may not be on track to cause any damage, the piece of junk should burn brightly enough to be visible during the day.

About Danny Lewis

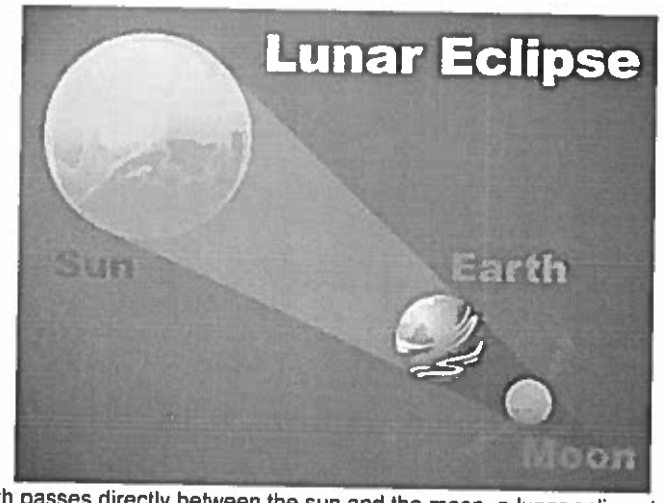
Danny Lewis is a multimedia journalist working in print, radio, and illustration. He focuses on stories with a health/science bent and has reported some of his favorite pieces from the prow of a canoe. Danny is based in Brooklyn, NY.

Earth-Sun-Moon Models

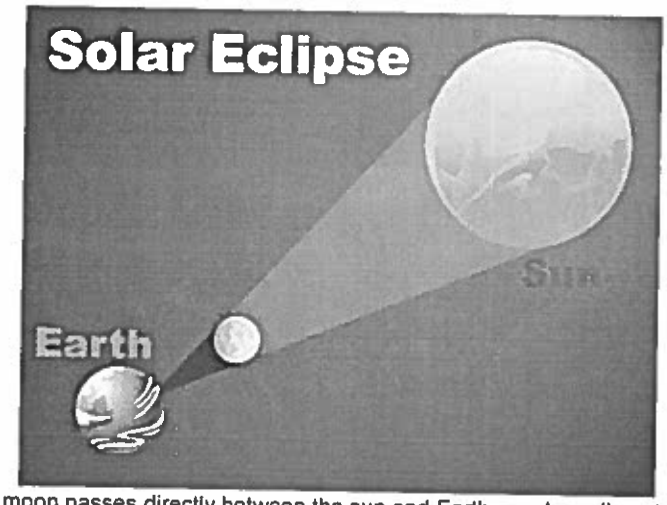
In the boxes below, please draw the positions of the earth, sun and moon at each of the stages listed. Be sure to add words and other illustrations to help explain the natural phenomena.

Full Moon	New Moon
Solar Eclipse	Lunar Eclipse
Summer (Northern Hemisphere)	Winter (Northern Hemisphere)

What Is an Eclipse?



When Earth passes directly between the sun and the moon, a lunar eclipse takes place.
Credits: NASA



When the moon passes directly between the sun and Earth, a solar eclipse takes place.
Credits: NASA

This article is part of the NASA Knows! (Grades K-4) series.

An eclipse (ee-CLIPS) takes place when a planet or moon passes between another planet, moon or the sun. There are two kinds of eclipses. One is an eclipse of the moon. The other is an eclipse of the sun.

What Is a Lunar Eclipse?

The moon orbits, or goes around, Earth. Earth orbits, or goes around, the sun. Once in a while, Earth lines up directly between the sun and the moon. When this happens, Earth blocks the light from the sun to the moon. Earth's shadow then falls on the moon. This is an eclipse of the moon. It is called a lunar eclipse.

During a lunar eclipse, we can see Earth's shadow on the moon. When Earth completely blocks the sunlight, the moon looks red or orange. A lunar eclipse can last for a few hours. At least two lunar eclipses happen every year.

Did You Know? *It is believed that lunar eclipses taught people that Earth is round. A long time ago, people thought that Earth was flat. Then they saw Earth's shadow on the moon. They learned that Earth is round.*

What Is a Solar Eclipse?

Sometimes when the moon orbits Earth, it lines up directly between the sun and Earth. When this happens, the moon blocks the light of the sun. This causes an eclipse of the sun, or a solar eclipse. During a solar eclipse, the moon casts shadows onto Earth.

A solar eclipse happens during the daytime. The daylight grows dim. Sometimes the moon blocks almost all of the sunlight. Then the daytime can look as dark as night during a solar eclipse!

Solar eclipses happen once every 18 months. Solar eclipses only last for a few minutes.

Did You Know? *You should **NEVER** look directly at the sun --not even during an eclipse when the moon blocks the sunlight! A solar eclipse is exciting. But looking at the sun is **dangerous**. It can damage your eyes.*

Why Does NASA Study Eclipses?

NASA scientists want to learn more about the moon. They took the moon's temperature during a lunar eclipse. They wanted to see how fast the moon cooled when Earth's shadow was on it. This helped NASA learn what the moon might be made of. The moon is our nearest neighbor, yet there is still much to learn about it.

NASA can study the top layer of the sun during some solar eclipses. The moon blocks the brightest rays of sunlight. This makes it easier for scientists to see the top layer of the sun. Scientists use tools on Earth and tools in space to take pictures of the sun. Then they study what they see.

When Is the Next Eclipse?

On Monday, August 21, 2017, people in North America will be able to see a solar eclipse. Some people will see a total solar eclipse. The moon will completely cover the sun so that only the outer edge can be seen. Others will see the moon cover part of the sun.

REMEMBER: *You should **NEVER** look directly at the sun -- not even during an eclipse when the moon blocks the sunlight!*

Brandi Bernoskie/Institute for Global Environmental Strategies
Heather Deiss/NASA Educational Technology Services

Last Updated: Aug. 4, 2017
Editor: Flint Wild

Our Moon's Phases and Eclipses

Our planet's satellite, which we call the Moon, is the easiest astronomical object to observe. The only "scientific instrument" you need is a pair of eyes. The Moon is the only thing in the sky (other than the Sun) that doesn't look like a point of light or an indistinct fuzzy patch to the unaided eye. Even more interesting, the way the Moon looks to us continually changes. Keeping track of its appearance from night to night (or day to day) is a fascinating and easy way to get acquainted with the rhythms of change in the sky.

The Moon is small, only about a quarter the size of the Earth. Looking at its light and dark patches, many people are reminded of the face of a person or the shape of a rabbit. Early astronomers who studied the Moon with the first telescopes were convinced that the dark areas were vast oceans, and so they named them "mare," the Latin word for "sea." We now know there are no bodies of water on the Moon's surface; in fact, it's an airless world, not hospitable to any kind of life. The maria (the plural form of the word "mare") are really large, smooth plains formed out of solidified lava.

The lighter patches are rocky regions covered with craters — circular pits or basins blasted out by high-speed impacts from rocks of varying sizes (from objects the size of small cities down to boulders and pebbles). Most of the craters bear silent witness to a time, billions of years ago, when collisions between such debris and planets were much more common. The Earth, too, experienced a similar bombardment, but erosion by wind, water, and the movement of the Earth's crust has largely erased ancient craters from the Earth's surface. On the Moon there is no wind or rain to wash away the evidence, preserving the cosmic history of our "neighborhood" for humans to study.

Over the millennia, the Moon has become "locked" into a special kind of motion around the Earth. It rotates on its axis at the same pace as it revolves around the Earth. As a result, the Moon always keeps the same "face" pointed toward us throughout its orbit. This is why astronomers speak of the "nearside" (the side we see) and "farside" (the side we never see) of the Moon. Indeed, it wasn't until the 1960s, when we sent spaceships to fly around the Moon, that we got our first glimpse of the far side of the Moon.

We only see the Moon because sunlight reflects back to us from its surface; it has no light source of its own. (This is probably important to emphasize. Many students are quite surprised to learn that moonshine is just reflected sunshine.) During the course of a month, the Moon circles once around the Earth. Indeed, the word "month" comes from "Moon"; younger students really enjoy it if you give them permission to say "moonth" instead of "month" for a while.

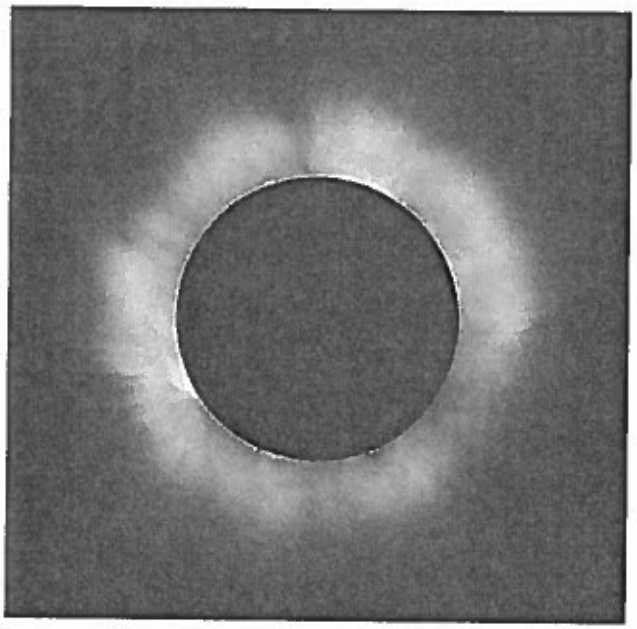
The half of the Moon facing the Sun is always lit; but the lit-up side does NOT always face the earth! As the moon circles the Earth, the fraction of its disk facing us that is lit by the Sun changes, altering how much of the lunar surface appears bright and how much is in darkness. The changes are known as phases, and repeat in a specific cycle each month. There are four primary phases: New Moon, First Quarter, Full Moon and Last Quarter. Each occurs about a week apart, with Last Quarter followed by another New Moon, which begins the cycle anew (it actually takes 29 and ½ days to go from one New Moon to the next). To understand the cycle of Moon phases, there really is no substitute to holding a small white ball in the light from a distant light-bulb and studying the changing shape of the illuminated part of the ball as you move it around you. The activities in this section demonstrate this quite well.

Several points about the Moon's phases should be emphasized. First, during the week it takes to move from one phase to another, the amount of the Moon's surface lit by the Sun changes gradually; it's not an abrupt change from one phase to the next (which is the impression some textbooks give). Second, despite what

some poets claim, the Moon is not limited to the night sky. Near both First and Last Quarter you can see the Moon during the daytime. (See the table below for more on when you can see the Moon.) Finally, it's worth repeating that the phases of the Moon depend only on the amount of reflected sunlight we see. The Earth's shadow plays no role in the Moon's phases.

But our shadow does darken the Moon during a special time — a lunar eclipse. Let's see why. The Earth circles the Sun once per year. The plane of the Earth's orbit is called the ecliptic. The Sun, the Earth and the Earth's shadow all fall within the plane of the ecliptic. However, the plane of the Moon's orbit is tilted a little bit (5°) from the plane of the ecliptic. When the Moon is on the side of the Earth away from the Sun (Full Moon), it passes very close to the Earth's shadow; so there is a chance of an eclipse every month. But because its orbit is tilted, the Moon usually passes just above or below the Earth's shadow. About once every six months the Moon can go right through the shadow of the Earth, creating a lunar eclipse.

Since the entire night side of the Earth faces the Moon when it is in its Full phase, everyone on the night side of the planet can see all or part of a lunar eclipse when it occurs. It takes the Moon a few hours to pass completely through the Earth's shadow. During that time, some parts of the Earth that were in nighttime when the eclipse started will rotate into daylight; people living there will miss the end of the eclipse. Similarly, parts of the Earth that were near sunset when the eclipse started will rotate into nighttime; for those people, the Moon will rise already in eclipse. Most of the Earth's night side, however, remains in darkness throughout the eclipse, enjoying the full spectacle.



Total Solar eclipse 1999 in France. *(Luc Viatour)*

Name: _____ Period: ____ Date: _____

8.4.2 Day 4 Student Task Card - Resource Sheet

A Change of Seasons…

Procedure 1: A DAY ON EARTH!

1. **For how much of the rotation is the push-pin in the light? The dark? What does one rotation represent?**

_____

_____

Procedure 2: Different Times of Year:

	For what fraction of the day is the dot in the light? More than half? Less than half? About half?	For what fraction of the day is the North Pole in the light?	How is the light from the sun striking the dot? Is it direct or at an angle? (sketch a picture)
March 21st			
December 21st			
September 21st			
June 21st			

<Adapted from Exploratorium: Modelling the seasons; http://www.exploratorium.edu/chaco/HTML/tg-seasons.pdf >

Name: _____ Period: ____ Date: _____

What special aspect of the sun's position or movement do we mark with the solstices and the equinoxes?

What would seasons on the earth be like if the axis weren't tilted?

How does your data from the model help to explain seasons?
What conclusions can you draw from looking at how long Oakland has sunlight? How does this affect our seasons?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

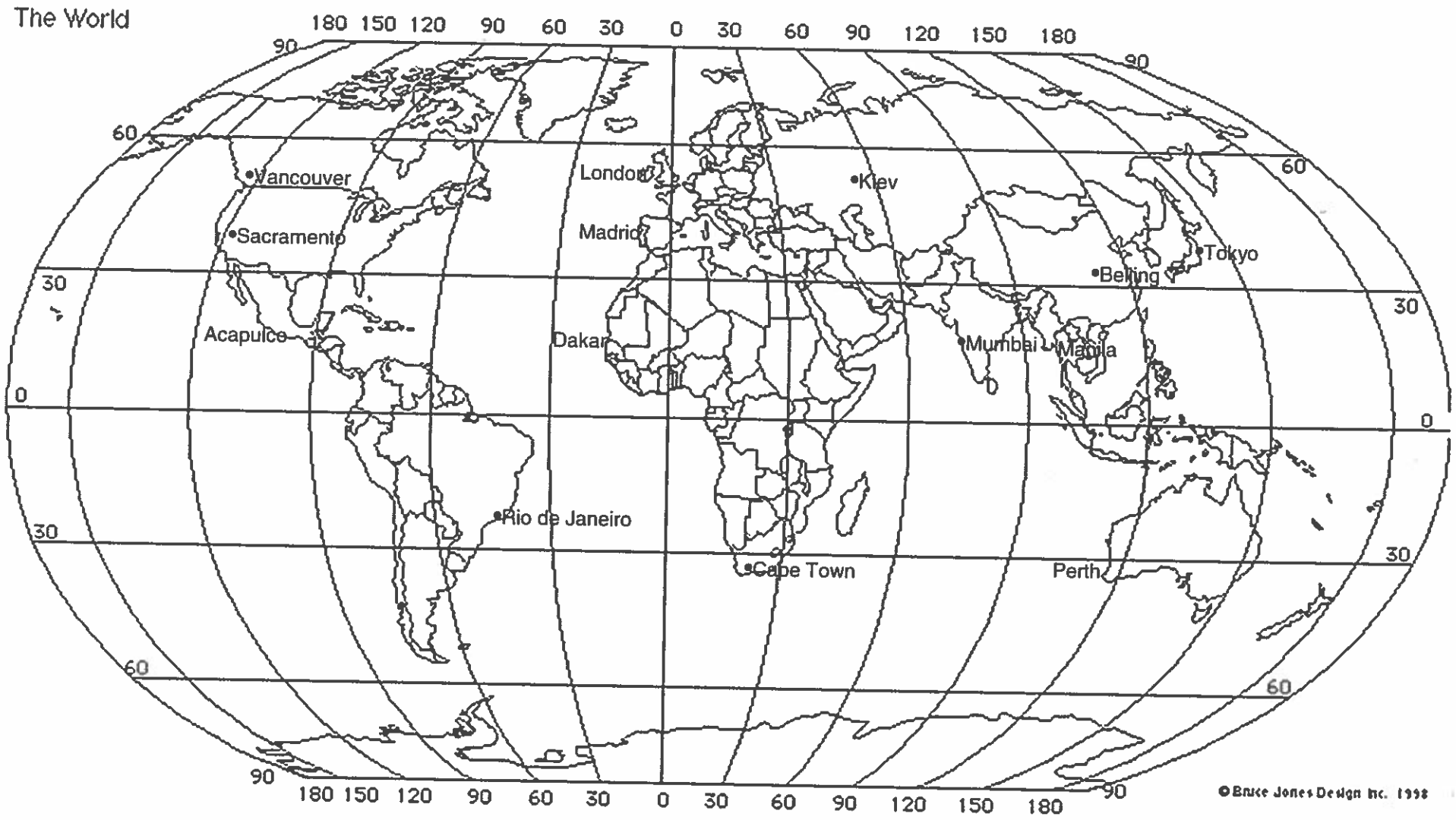
_____

<Adapted from Exploratorium: Modelling the seasons: http://www.exploratorium.edu/chaco/HTML/tg-seasons.pdf >

City	Jan (□)	July (□)
Acapulco	80	84
Beijing	25	81
Cape Town	73	60
Dakar	75	82
Kiev	28	65

City	Jan (□)	July (□)
London	40	66
Madrid	42	76
Manila	78	85
Mumbai	86	90
Perth	76	60

City	Jan (□)	July (□)
Rio de Janeiro	81	70
Sacramento	45	77
Tokyo	41	79
Vancouver	38	64



Do you notice anything about the temperatures of cities with the **same longitude**?

Do you notice anything about the temperatures of cities with the **same latitude**?

Is there anything interesting about the temperatures of cities **north** and **south** of the equator?

What causes the tides in the ocean?

By NASA and NOAA, adapted by Newsela staff on 02.09.17
Word Count **769**
Level **970L**

Flying gulls on Morro Strand State Beach, California, at low tide. Morro Rock is seen in the background. Photo taken January 21, 2012, by Mike Baird. Originally posted to Flickr, licensed under Creative Commons. MIDDLE: Graphic showing the moon's gravitational pull. BOTTOM: The tidal range.

High tides and low tides come and go, as the level of the sea goes up and down. This cycle of two high tides and two low tides happens most days on coastlines around the world.

Why Is That?

Tides are really all about gravity. When we're talking about the daily tides, it's the moon's gravity that's causing them.

As Earth rotates, the moon's gravity pulls on different parts of our planet. The moon is much smaller than Earth, so its gravity is much less than Earth's gravity. However, since the moon is so close to us, it has enough gravity to move things around. The moon's gravity even pulls on the land, but not enough for anyone to really tell.

When the moon's gravity pulls on the water in the oceans, however, someone's bound to notice. Water, being a liquid, has a much easier time moving around. It bulges toward the moon, and that bulge follows the moon as Earth turns beneath it.

That explains the first high tide each day, but what about the second high tide?

The ocean also bulges out on the side of Earth opposite the moon.

Wait, What?

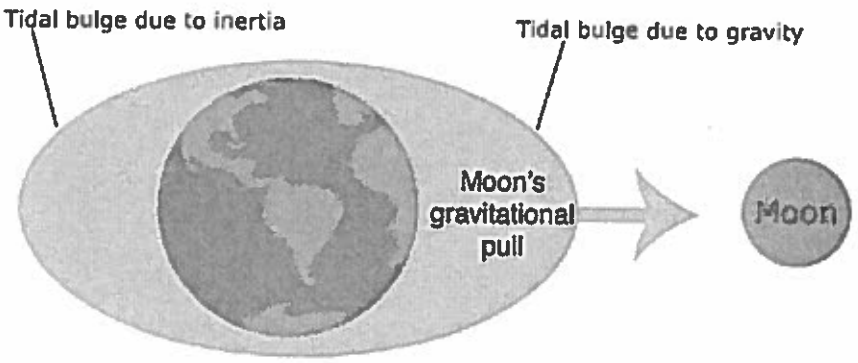
If the moon's gravity is pulling the oceans toward it, how can the ocean also bulge on the side of Earth away from the moon?

Gravity is the major force causing tides, but inertia is playing a part too. Inertia is a resistance against change in direction. It acts to balance out the force of gravity. Inertia causes moving objects to continue moving in a straight line. It wants to keep doing whatever it's doing, whether that's moving in a straight line or staying still, until another force acts on it.

While the water closest to the moon is getting pulled, the water farthest from the moon is staying right where it is. Both sides are experiencing gravity and inertia, but one always overpowers the other.

On the side by the moon, gravity wins. On the side away from the moon, inertia wins.

These two bulges explain why there are two high tides and two low tides each day.



Are Tides The Same Height Everywhere On The Planet?

The high and low tides are not the same height everywhere on the planet.

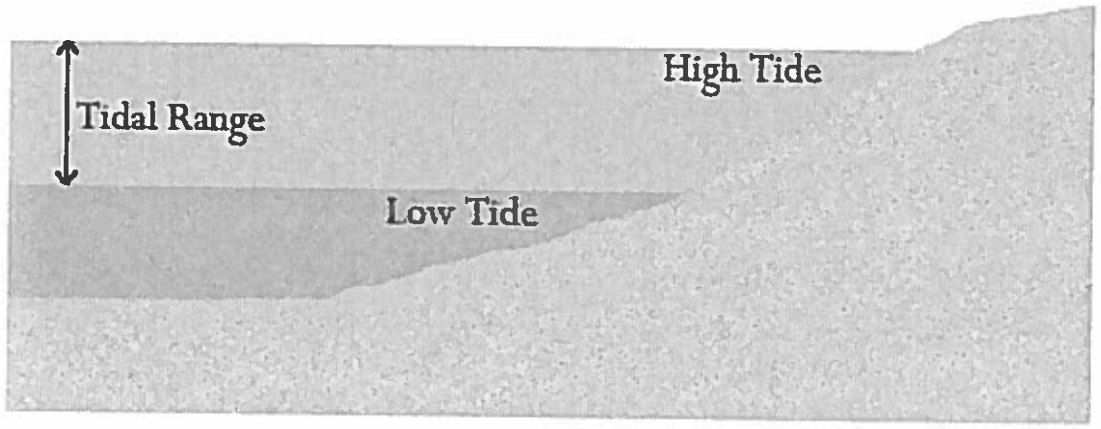
If Earth were perfectly round and completely covered in water, then high and low tides would be equally proportioned everywhere. But Earth is not a perfect sphere, and there are big continents getting in the way of water bulging in the direction of the moon. That's why in some places, the difference between high and low tide isn't very big. In other places, the difference is huge.

High And Low Tides

Tides begin in the oceans as waves. Then they move toward the coastlines, where they appear as the regular rise and fall of the sea surface. When the highest part of the wave, or its crest, reaches a particular location, high tide occurs. Low tide corresponds to the lowest part of the wave, or its trough.

Most coastal areas experience two high tides and two low tides every day. But, they are affected by the lunar day, not the solar day. Everyone knows the 24-hour solar day. This is the time it takes for the Earth to rotate about its axis so that the sun appears in the same position in the sky. A lunar day is the time it takes for the moon to make one complete orbit around the Earth and come back to the same position. This takes 24 hours and 50 minutes, slightly longer than a solar day.

The Earth rotates through two tidal "bulges" every lunar day. This means that every 24 hours and 50 minutes coastal areas experience two high tides and two low tides. High tides occur 12 hours and 25 minutes apart. It takes six hours and 12.5 minutes for the water at the shore to go from high to low, or from low to high.



Does Anything Else Affect Tides?

The sun has a part to play in tides as well. For instance, when the sun's gravitational pull lines up with the moon's gravitational pull, the tides are more extreme.

Wind and weather patterns also can affect tides. Strong offshore winds can move water away from coastlines, exaggerating low tides. Onshore winds can push water onto the shore, making low tides less visible.

High-pressure weather systems can push down sea levels, leading to sunny days with particularly low tides. Meanwhile, low-pressure systems, which lead to cloudy, rainy days, can cause tides that are much higher than predicted.

Lathrop Intermediate

8th grade Science
Force and Motion Unit

8.1.0 - Tablecloth Challenge (Print 2 copies and place in plastic sleeves)

Student-Led INVESTIGATIONS Task Card

Focus Question: *How can a tablecloth be pulled off a set table without breaking anything?*

Task: Develop an annotated model using technical writing tools to show what happens when variables are changed in an investigation.

Time: 10-minutes

Materials (per group):	**Safety:**
• Tablecloth • Flat table or desktop • Assortment of plastic tableware - forks, spoons, cups, plates • Variety of heavy fruits and vegetables	• Use the materials only as instructed. • Keep your work area clean and organized. • If observing, stand back from the table when tablecloth is being pulled.

Task Steps:

1. Decide what will be on your tablecloth for each trial and set up a data table in your notebook.

Trials / Variable	Labeled Diagram of Setup	Observations of items' motion or lack of motion
1. _____		
2. _____		
3. _____		

2. Set the table with the plates, food, etc. according to your team's decision.
3. Pull the tablecloth and record what happens.
4. If time permits, add another trial/variable.
5. Clean up your area.

Evaluation Criteria:

- Data Table includes at least 3 trials/variable changes
- Model is annotated with technical writing tools for each trial/variable change
- Observational data is recorded for each trial/variable change

Newton's Laws Exposition

Newton's Three Laws

1) An object in motion will stay in motion unless acted upon by another force; an object at rest will stay at rest unless acted upon by another force (Law of inertia).
2) The greater the force the greater the acceleration (F=ma).
3) For every action there is an equal and opposite reaction.

Station #1 – Coin Activity

Equipment	Directions
Cup Index card Coin	1) Place an index card on top of an empty cup 2) Place a coin on the card 3) Flick the card with your finger 4) Continue until the coin drops into the cup

Observations

Questions

1) Which of Newton's Laws are demonstrated by this station?

2) Why does the coin fall into the cup?

3) How you modify this station so the coin travels with the index card?

Station #3 – Greek Waiter Tray – PERFORM OUTSIDE

Equipment	Directions
Cup – filled with water Greek Waiter's Tray	1) Place a cup of water (half full) onto the platform. 2) Gently swing the platform back and forth, gradually increasing speed. 3) Continue to swing the platform until you have achieved a complete loop without spilling the water.

Observation

Questions

1) Which of Newton's Laws is demonstrated at this station?

2) Why is the cup of water able to remain on the platform?

3) What would happen to the cup of water if you decreased the rate of spin?

Station #4 – Penny on a Coat Hanger

Equipment	Directions
Bent coat hanger penny	1) Place the coat hanger on the tip of your finger. 2) Carefully balance the penny on the tip of the hook. 3) Spin the coat hanger on the tip of your finger.

Observation

Questions

1) Which of Newton's Laws is demonstrated at this station?

2) Why is the penny able to remain on the tip of the hook?

3) What would happen to the penny if you increased the rate of spin?

Station #5 – Ping Pong Ball Activity

Equipment

Golf ball
Ping-Pong ball
Wooden ruler

Directions

Constant Force	**Constant Acceleration**
1) Place a ping-pong ball in front of the wooden ruler. 2) Carefully bend the ruler back and release it. 3) Record your observations 4) Place a golf ball in front of the wooden ruler. 5) Carefully bend the ruler back and release it. Be sure to bend the ruler back to the same spot (force needs to be constant). 6) Record your observations.	1) Place a ping-pong ball in front of the wooden ruler. 2) Carefully bend the ruler back and release it. 3) Record your observations 4) Place a golf ball in front of the wooden ruler. 5) Carefully bend the ruler back and release it. Be sure to bend the ruler back to achieve the same acceleration as the ping-pong ball (acceleration needs to be constant). 6) Record your observations.

Observations (constant force)

Ping-pong ball	
Golf ball	

Observations (constant acceleration)

Ping-pong ball	
Golf ball	

Questions

1) Which of Newton's Laws does this station demonstrate?

2) When the ruler was bent to the same spot (constant force) which ball accelerated faster? WHY?

3) When the ruler was bent to achieve similar acceleration (constant acceleration) which ball went faster? WHY? (TRICK QUESTION – BEWARE)

4) Explain the relationship between mass and acceleration.

5) How does Newton's Third Law apply to this experiment?

6) Which ball has more inertia? Explain.

Station #6 – Balloon Racers

Equipment	Directions
clips Small Paper clips Tape Balloons (2)	1) Inflate two balloons of unequal size (one small and one large) 2) Tape each balloon to the straws 3) Release at the same time 4) Record your observations 4) Inflate two balloons of equal size (same size) 5) Tape 5 large paper clips to one balloon 6) Tape one small paper clip to the other balloon 7) Release at the same time 8) Record your observations

Observations

Balloon race – different sizes	Balloon race – same size (different paper clips)

Questions

1) Which of Newton's Laws is demonstrated at this station?

2) When you raced the two balloons of the size and one had a penny, which one was faster? Why?

3) When you raced the two balloons without the penny and one was larger than the other, which one was faster? Why?

Station #7 – Paper Clip Racers

Equipment	Directions
Paper clips String	1) Tie a paper clip to each end of a long string. 2) Hook two more paper clips to one end. 3) Place the single paper clip end in the center of the table. 4) Hang the three paper clip end off the side if the table. 5) Release the paper clips and record your observations. 6) Add one more paper clip to the hanging end, repeat the experiment, and record your observations. 7) Place as many paper clips of your choosing on one end, repeat the experiment, and record your observations.

Observations

Three paper clips hanging	
Four paper clips hanging	
_____ paper clips hanging	

NOTE: By adding additional paper clips you have increased FORCE.

Questions

1) Which of Newton's Laws is demonstrated by this station?

2) What happened each time that you let go of the single paper clip? Explain.

3) Explain the relationship between the number of hanging paper clips and the motion of the single paper clip on the table (force vs. acceleration).

4) How does Newton's First Law apply to this experiment?

Station #8 – Skateboard Activity

Equipment	Directions
Skateboard Helmet Medicine Ball	1) Choose one person with skateboard experience. 2) Put on the helmet, knee pads, elbow pads, and wrist guards. 3) Sit on the skateboard holding the medicine ball. 4) All members stand around to catch any falls 5) Throw the medicine ball forward.

Observation

Questions

1) Which of Newton's Laws is demonstrated by this station?

2) What would happen to the skateboard and rider if the medicine ball is thrown forward with greater force?

3) Why did the skateboard and rider move in the opposite direction of the throw?

STATION #9 – Newton's Cradle

Rules	Directions
1) No items may be placed between the metal balls 2) No force may be added to the falling metal balls.	1) Pull one metal ball up and release it. Record your observation 2) Pull two metal balls up and release it. Record your observation. 3) Pull three metal balls up and release it. Record your observations.

Action	Observation
One metal ball released	
Two metal balls released	
Three metal balls released.	

Questions

1) Which of Newton's Law is demonstrated by this station?

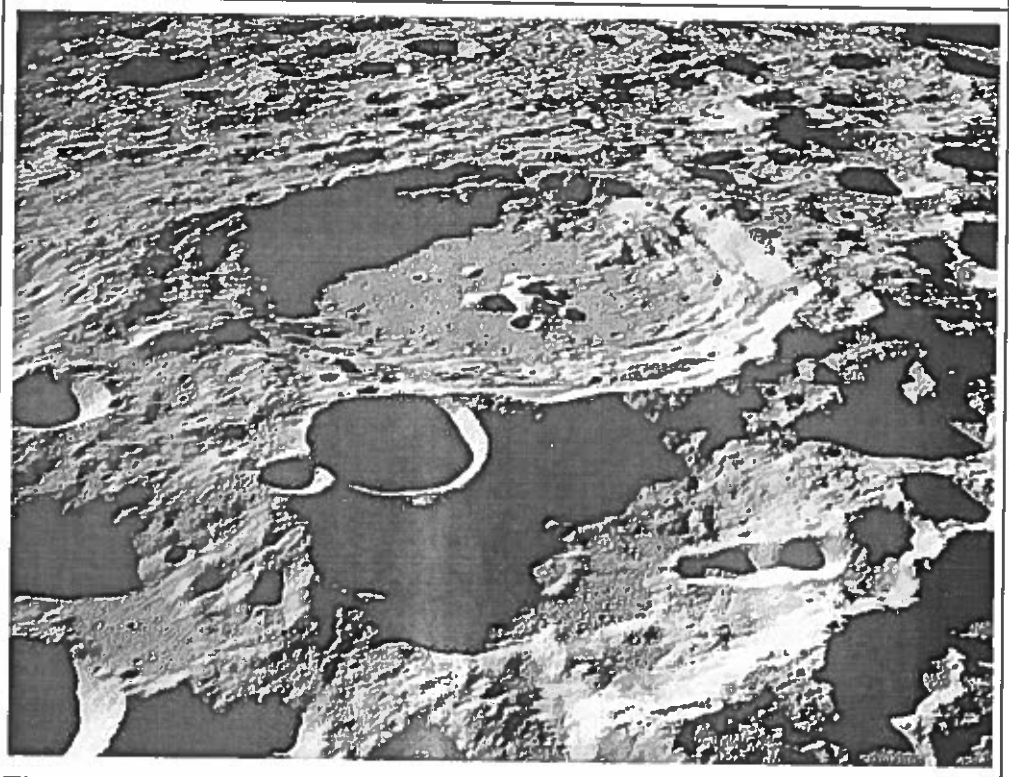
2) What factors cause the metal balls to cease moving?

3) Why is the metal ball on the opposite end able to move?

Name _____ Period _____ Date _____

8.1.2 Resource Sheet- Reading: **Craters**

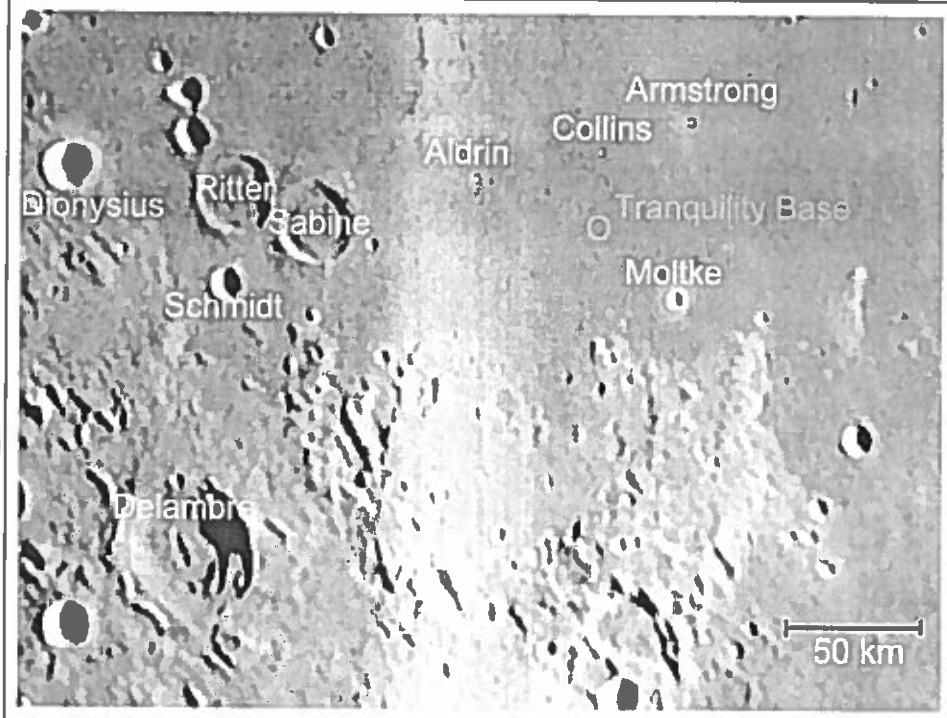
Focus Question: *What are craters and how are they formed?*

Talking to the Text: **Circle vocabulary words and unknown words, underline evidence that answers the focus question, Annotate pictures and titles**	**Annotations: Write Connections, Questions, Graphic Notes and/or Summarize**
1) What is a crater? A crater is a bowl-shaped depression, or hollowed-out area, produced by the impact of a meteorite, volcanic activity, or an explosion. Craters are produced by the collision of a meteorite with the Earth (or another planet or moon) are called impact craters. The high-speed impact of a large meteorite compresses, or forces downward, a wide area of rock. The pressure pulverizes the rock. Almost immediately after the strike, however, the pulverized rock rebounds. Enormous amounts of shattered material jet upward, while a wide, circular crater forms where the rock once lay. Most of the material falls around the rim of the newly formed crater.	**2) What is a crater?** A crater is an impact site.
 **The surface of the moon is thought to have been formed by the Earth's surface.**	

Name _____ Period _____ Date _____

What do we know about lunar craters?

The Earth's moon has many craters. Most were formed when meteors, bodies of solid matter from space, slammed into the lunar surface millions of years ago. Because the moon has almost no atmosphere, there is hardly any wind,erosion, or weathering. Craters and debris, called ejecta, from millions of years ago are still crystal-clear on the moon's surface. Many of these craters are landmarks. Craters on the moon are named after everyone from American astronaut Buzz Aldrin to ancient Greek philosopher Zeno.



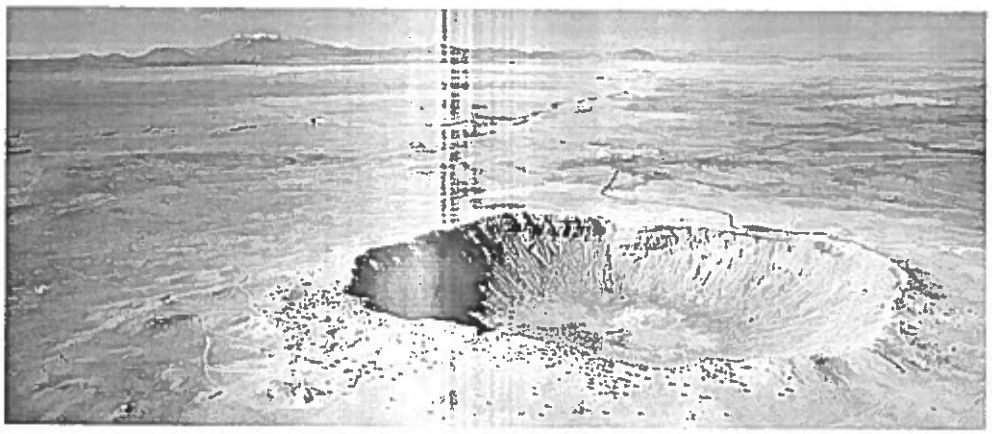
Surface of the Moon

What do we know about craters on Earth?

Many impact craters are found on the Earth's surface, although they can be harder to detect. The forces of wind,rivers, and precipitation can scrape away evidence of a crater. Vegetation can also grow over the area.

One of the best-known craters on Earth is Meteor Crater, near Winslow, Arizona. The crater was created instantly when a 50-meter (164-foot), 150,000-ton meteorite slammed into the desert about 50,000 years ago. Meteor Crater is 1.2 kilometers (0.75 miles) in diameter and 175 meters (575 feet) deep.

Name _____ Period _____ Date _____

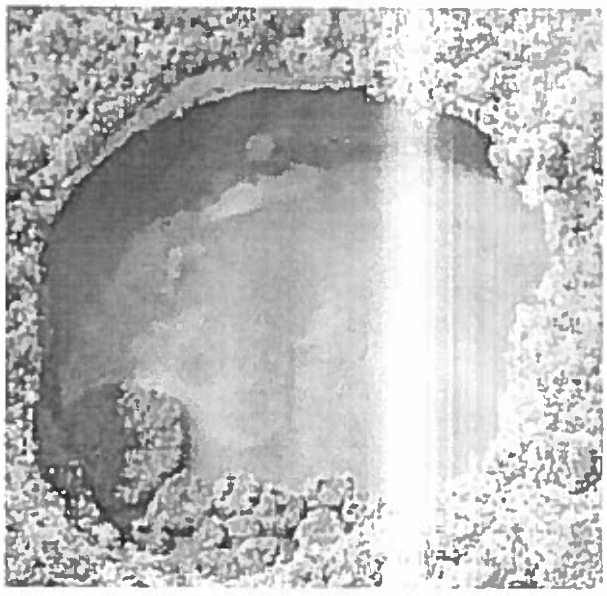


Meteor Crater in Winslow, Arizona

How have craters impacted planets?

The Chicxulub Crater, on Mexico's Yucatan Peninsula, was most likely created by a comet or asteroid that hit Earth about 65 million years ago. The crater is 180 kilometers (112 miles) wide and 900 meters (3,000 feet) deep. The object that created the Chicxulub Crater was probably about 10 kilometers (6 miles) wide.

The impact was so powerful the crater is called the Chicxulub Extinction Event Crater. Scientists say half the species on Earth—including the dinosaurs—went extinct as a result of the impact. The event was more than a billion times more explosive than all the atomic bombs ever detonated on Earth.



The Chicxulub Extinction Event Crater

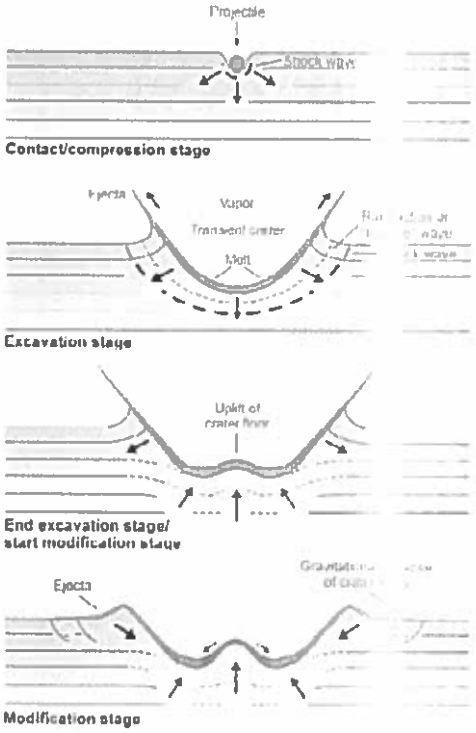
Name _____ Period _____ Date _____

What Forces interact to form craters?

No matter at what angle it makes contact, the enormous amount of kinetic energy the projectile carries immediately transfers to the target rock it hits, triggering powerful shock waves. Although craters look like imprints of a giant fist smashing the ground inward, impact shock waves have the opposite effect, which planetary scientists divide into three phases.

The compression stage of crater formation involves that initial exchange of energy between the projectile and the impact area. During the excavation phase, the massive shock wave causes the projectile to simultaneously melt and vaporize, spewing plumes of searing hot rock vapor miles high into the atmosphere. The force can catapult chunks of molten and solid rock hundreds of miles from the impact site — this material is known as ejecta flow.

And so far, the crater formation process has only lasted a few seconds. During the final modification phase, the remainder of ejecta partially refills and rings the crater site, and debris forms a rich mineral composite called breccia. Larger, more forceful impact events will form complex craters in which the rock at the center of the crater rebounds from the downward pressure of the shock wave and uplifts into a mound-like formation.

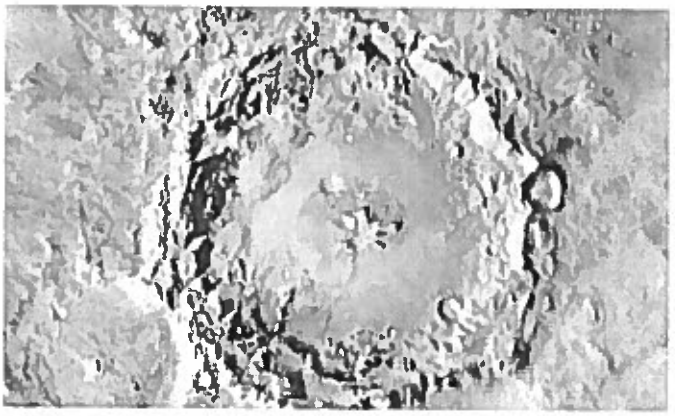


Question for Chunk #1	Question for Chunk #2
Evidence: Evidence: Evidence:	Evidence: Evidence: Evidence:
Question for Chunk #3	**Question for Chunk #4**
Evidence: Evidence: Evidence:	Evidence: Evidence: Evidence:

8.1.3 Task - How much does energy change? (Print 2 copies and place in plastic sleeves)

Guiding Question: ***How does the mass and velocity of a moving object affect its kinetic energy?***

Background Information:



Storyline: As a NASA engineer, you are designing transport vehicles to be used in future interplanetary missions. The transport vehicle will be traveling very fast when it hits the surface of the planet. As we design our vehicle, we must consider:

- *How much energy will be transferred to the vehicle at impact?*
- *How does it change with the size and speed of the lander?*
- *Which is the more IMPORTANT factor.*
- *Should we focus on making our vehicle LIGHTER or worrying about its VELOCITY?*

In physics, **KINETIC ENERGY** is the energy an object has BECAUSE of its motion. Kinetic energy is also a measure of how much change an object can cause.

- a *larger* moving object will do more damage (cause more change) than a *smaller* moving object.
- a *faster* moving object will do more damage (cause more change) than a *slower* moving object.

Task 1: Graphing Data

You will receive some experimental data that our NASA research scientists determined for the KINETIC ENERGY (measured in kilojoules (kJ) = 1000 Joules) of the impact of our lander.

1) Determine if you and your partner are graphing MASS vs KINETIC ENERGY or VELOCITY vs KINETIC ENERGY
2) Draw and label the axes for your data on the given graph paper
3) Label your axes with a proper SCALE so that your data will FILL the graph
4) Plot the points on your own paper
5) Connect the dots to see the relationship
6) When you are finished, compare your data with a team that recorded the OTHER set of data and answer the "data match" and analysis questions

8.1.3 Task - How much does energy change? (Print 2 copies and place in plastic sleeves)

MASS (kg) experimental lander velocity = 50 m/s (about 100 mph)	Energy (kJ)
200 kg	250 kJ
400 kg	500 kJ
600 kg	750 kJ
800 kg	1,000 kJ
1000 kg	1,250 kJ
1200 kg	1,500 kJ
1400 kg	1,750 kJ
1600 kg	2,000 kJ

VELOCITY (m/s) experimental lander mass = 1000 kg (about 2200 lbs)	Energy (kJ)
10 m/s	50 kJ
20 m/s	200 kJ
30 m/s	450 kJ
40 m/s	800 kJ
50 m/s	1,250 kJ
60 m/s	1,800 kJ
70 m/s	2,450 kJ
80 kg	3,200 kJ

Nam _____ Period: ____ Date: _____

8.1.3- Kinetic Energy Data Analysis - Output Sheet

Focus Question: Are the relationships between kinetic energy linear or nonlinear?

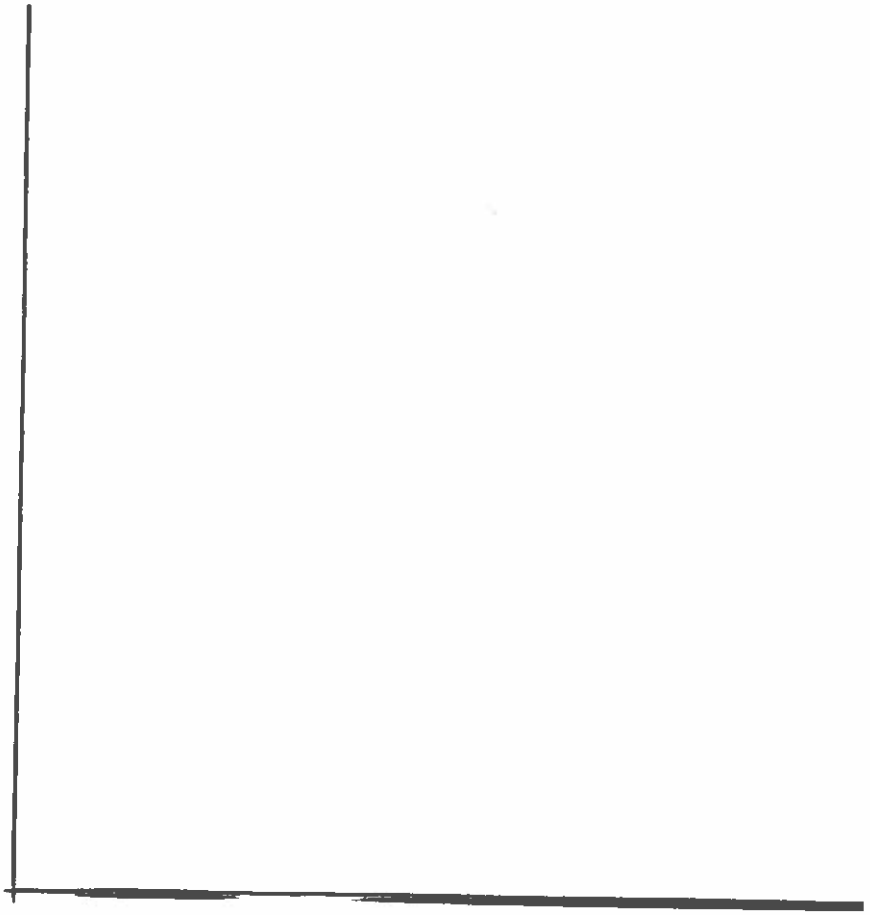
Graphs of Kinetic Energy

Instructions: On the graphs below, use the data from the Task Card to graph the KINETIC ENERGY of the lander-vehicle based on 1) INCREASING MASS OR 2) INCREASING VELOCITY.

You will need to...

a) name each axis (choose which are the INDEPENDENT and DEPENDANT variables)
b) set a scale for each axis (choose the minimum and maximum values for the axis)
c) plot the data points for each graph
d) connect the points to determine the *linear or nonlinear* relationships

MASS vs KINETIC ENERGY



Nam _____ Period: ____ Date: _____

8.1.3 y Data Analysis - Output Sheet

Focus: the relationship between kinetic energy linear or nonlinear?

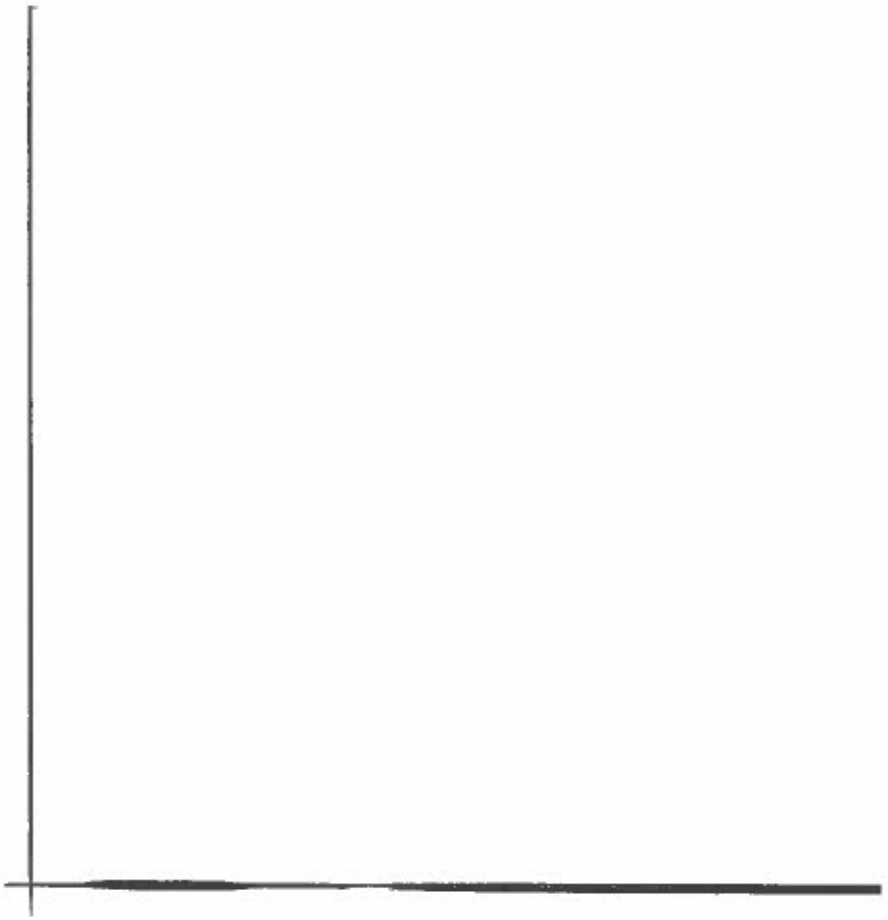
Graphs of Kinetic Energy

Instructions: On the graphs below, use the data from the Task Card to graph the KINETIC ENERGY of the larger vehicle based on 1) INCREASING MASS OR 2) INCREASING VELOCITY

You will need to...

a) name each axis (choose which are the INDEPENDENT and DEPENDANT variables)
b) set a scale for each axis (choose the minimum and maximum values for the axis)
c) plot the data points for each graph
d) connect the points to determine the *linear or nonlinear* relationships

VELOCITY vs KINETIC ENERGY



8.1.3 Task - How much does energy change? (Print 2 copies and place in plastic sleeves)

Task 2: Data Analysis

DATA MATCH: CIRCLE the statements (more than one) that agree with the graphs you made on your *output sheet.*

1) Kinetic energy increases when mass increases.
2) Kinetic energy decreases when speed increases.
3) A small object (small mass) can have the same kinetic energy as a large object (large mass) IF its velocity is large enough
4) The shape of the MASS vs ENERGY graph has a *NON-LINEAR RELATIONSHIP.*
5) The VELOCITY vs ENERGY graph shows a *NON-LINEAR RELATIONSHIP.*
6) An increase in velocity of 100 m/s leads to a LARGER increase in kinetic energy than an increase of 100 kg

QUESTIONS: Answer in complete sentences

1) What happens to the kinetic energy when you increase the mass?

_____

2) What happens to the kinetic energy when you increase the speed?

_____

3) How can a small object (small mass) have the same energy as a large object (large mass)?

_____

4) a) What is the shape of the MASS vs ENERGY graph? Is it a *LINEAR RELATIONSHIP?*
b) What happens when you DOUBLE the mass?

_____

5) a) What is the shape of the VELOCITY vs ENERGY graph? Is it a *LINEAR RELATIONSHIP?* b) What happens when you DOUBLE the velocity?

_____

6) Which makes a bigger difference: a 100 kg increase in the mass or a 100 meter/sec rise in velocity?

_____

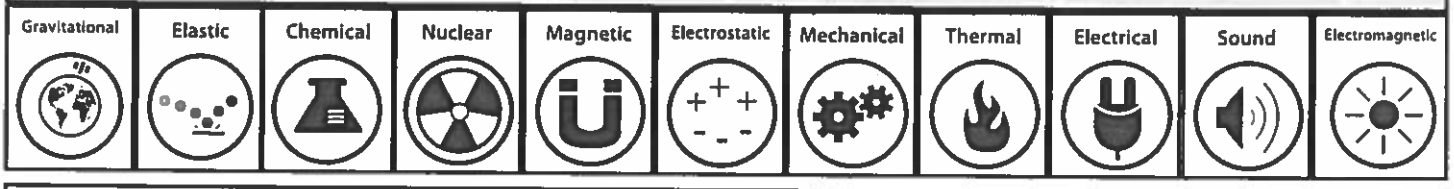
DESIGN DISCUSSION

7) What's more important for your EGG DROP lander design the MASS of your lander or its IMPACT VELOCITY?_____

OPERATION: INFINITE POTENTIAL — ***Coaster Creator: Pre-lab***

Name:	Period:

Forms of Energy : Highlight all of the energy forms you observe throughout this lab.



1. Look at the equation for potential energy below:

$$PE = \underset{\text{Mass}}{\square} \times g \times \underset{\text{Height}}{\square}$$

A. As the mass increases, would you expect the potential energy (PE) to increase or decrease? Explain your answer.

B. As the height increases, would you expect the potential energy to increase or decrease? Explain your answer.

C. Look at the three equations below. Notice that the mass and gravity stay the same in each equation, and the only difference is the height.

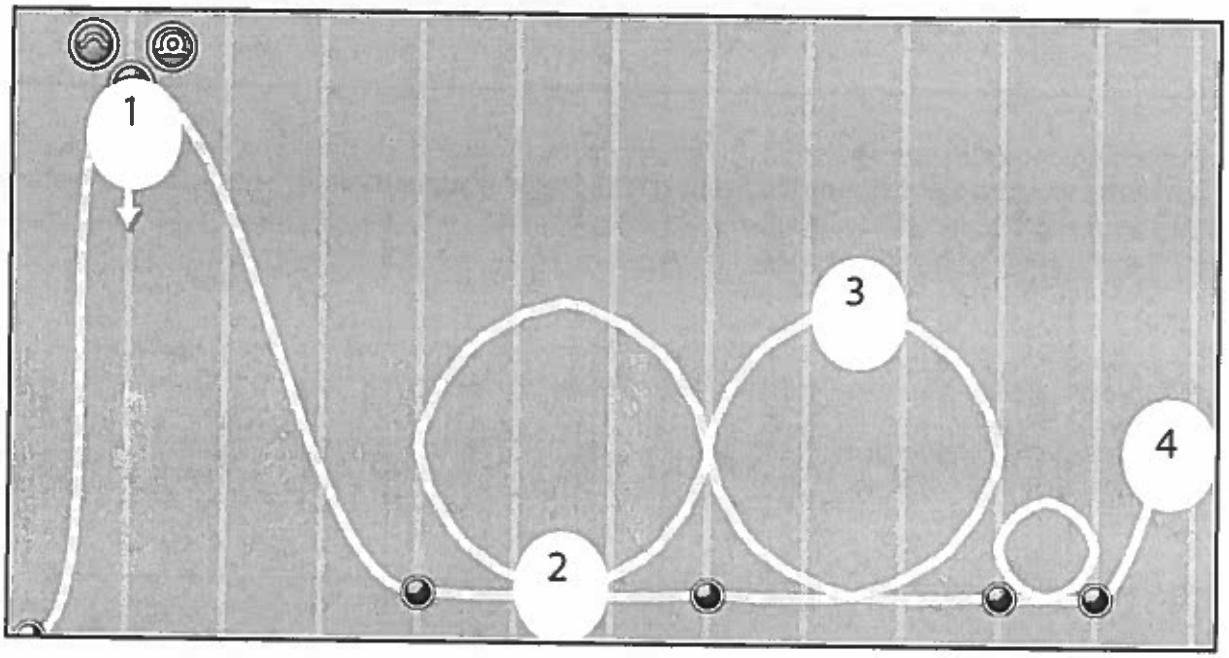
Circle the equation that will have the greatest potential energy. Use the space below to explain why you made your selection.

$$PE = \underset{\text{Mass}}{300Kg} \times g \times \underset{\text{Height}}{62.0m}$$

$$PE = \underset{\text{Mass}}{300Kg} \times g \times \underset{\text{Height}}{16.6m}$$

$$PE = \underset{\text{Mass}}{300Kg} \times g \times \underset{\text{Height}}{34.2m}$$

D. Look at the roller coaster track below. At which point (1, 2,3, or 4) do you think *potential energy* would be the greatest? (*Hint:* Think about how height affects potential energy.) Explain your answer.



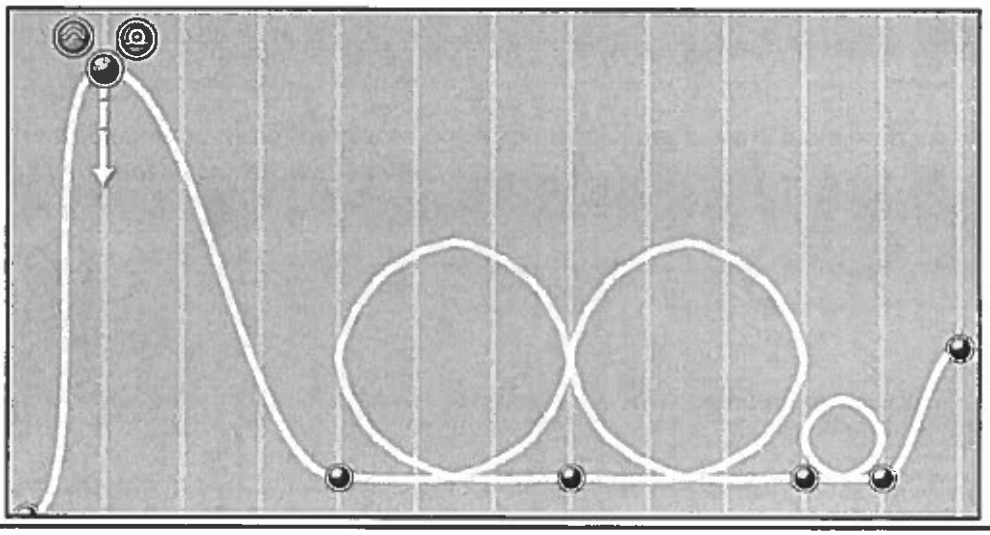
2. Use the space below to define: Friction

3. Use the space below to define: Thermal Energy (see page 9 in your book)

4. Use the space below to define: Conservation of Energy (see page 9 in your *Operation: Infinite Potential* book)

5. Sometimes when people are cold they rub their hands together to create friction. Keeping this is mind, briefly explain the relationship between *friction* and *thermal energy*.

A. Using the track below, circle the place where you think your car will have built up the most friction. Explain why you chose your answer:



OPERATION: INFINITE POTENTIAL — ***Coaster Creator: Lab***

Name:	Period:

Forms of Energy : Highlight all of the energy forms you observe throughout this lab.

Gravitational	Elastic	Chemical	Nuclear	Magnetic	Electrostatic	Mechanical	Thermal	Electrical	Sound	Electromagnetic
										

Materials:

For this activity, you will need:

- One regular pencil
- Access and log in to: www.jason.org (Go to Operation: Infinite Potential>>Digital Labs>>Coaster Creator)
- Three colored pencils, markers, or crayons:
  - Red
  - Green
  - Orange

Getting started: Once you have chosen "Build Coaster Now!" in Coaster Creator, you will be asked to design your roller coaster car and add cars:

1. Write the name of your roller coaster here:

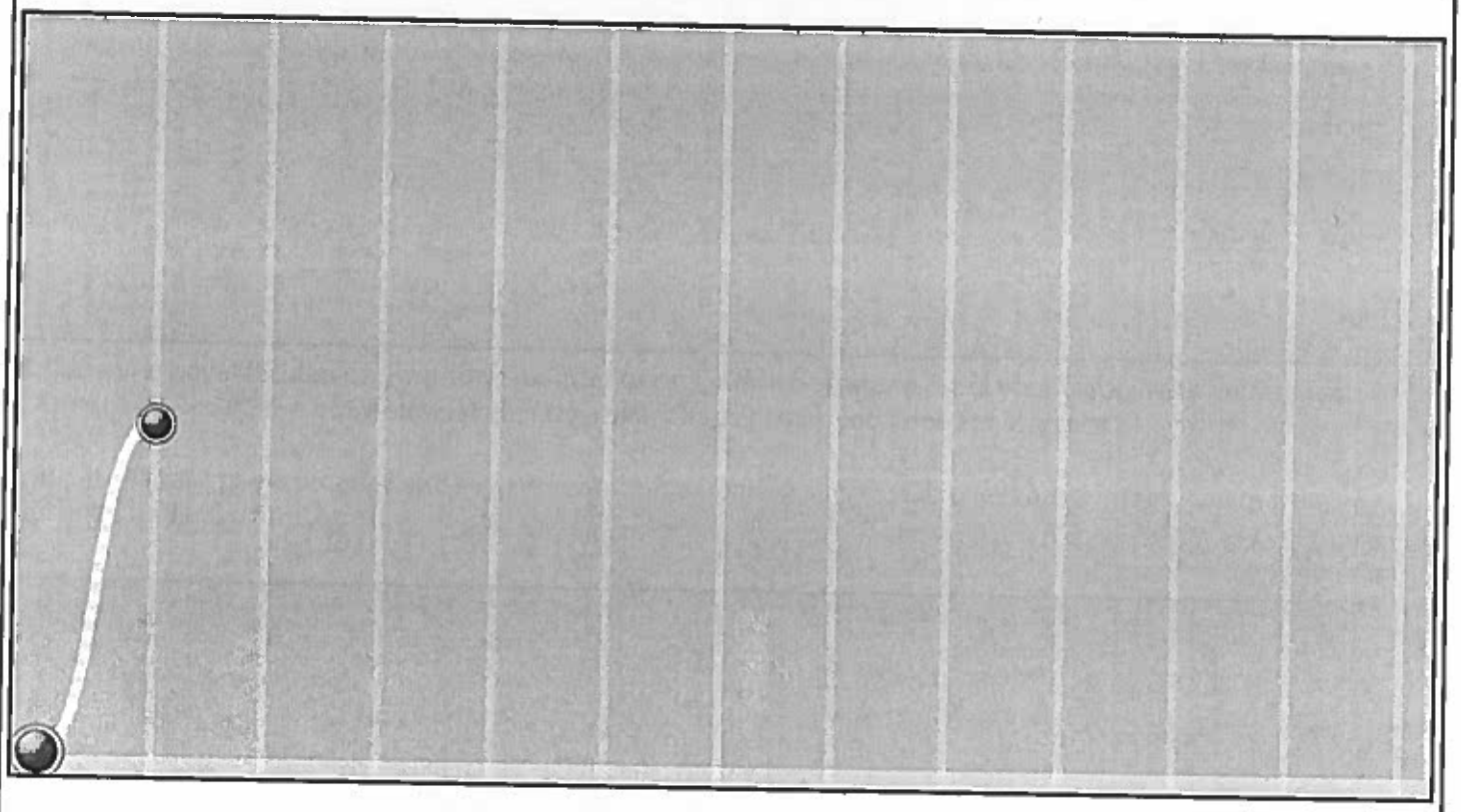
2. How many carts do you have?

3. What is the total mass of your carts? Fill in the appropriate squares below:

$$PE = \square_{\text{Mass}} \times g \times \square_{\text{Height}} \qquad KE = \tfrac{1}{2} \square_{\text{Mass}} \times \square_{\text{Velocity}}^{2}$$

4. Once you have decided on your total number of cars, it will be time to build your track. With your regular pencil and using the box below, sketch the roller coaster track you have constructed.

Hint: It will take some practice and experimentation to make a successful roller coaster track. Learn from your mistakes and have fun!

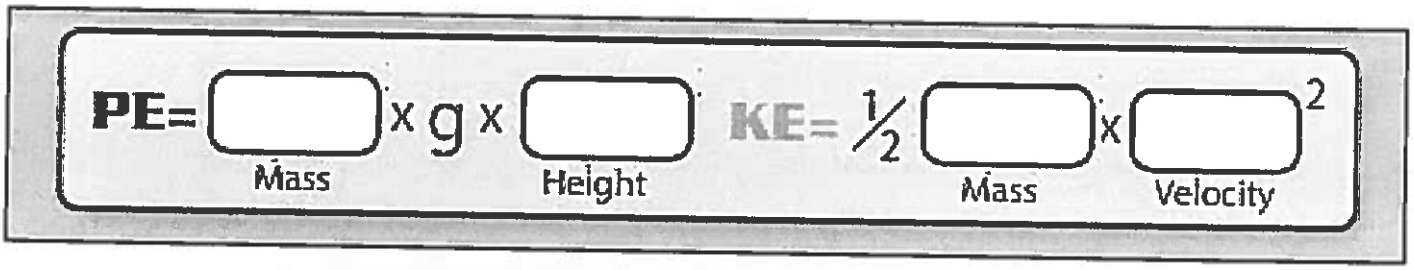


A) Using the red colored pencil, circle the part of the track where you expect to find the *maximum potential energy*

B) Using the green colored pencil, circle the part of the track where you would expect to find the *maximum kinetic energy*

C) Using the orange colored pencil, circle the part of the track where you would expect to find the maximum thermal energy

5. Before you run your roller coaster, click on the very first node (these are the black dots) in your roller coaster. Look at the equation at the top of your screen, and fill in the numbers you see there:



6. Run your roller coaster. Keep an eye on the bar that will start to fill up at the top and answer the following questions: (*Hint:* You can rerun your coaster as many times as you like. When your coaster has finished running, select the "Back" button to go back to the track building screen. If you don't make any changes, clicking on "Next" will let you rerun the same track.)

A) What is the dominant color of your bar when you are at the top of the first hill?

B) What type of energy does this represent?

C) What is your car doing when the bar is primarily green?

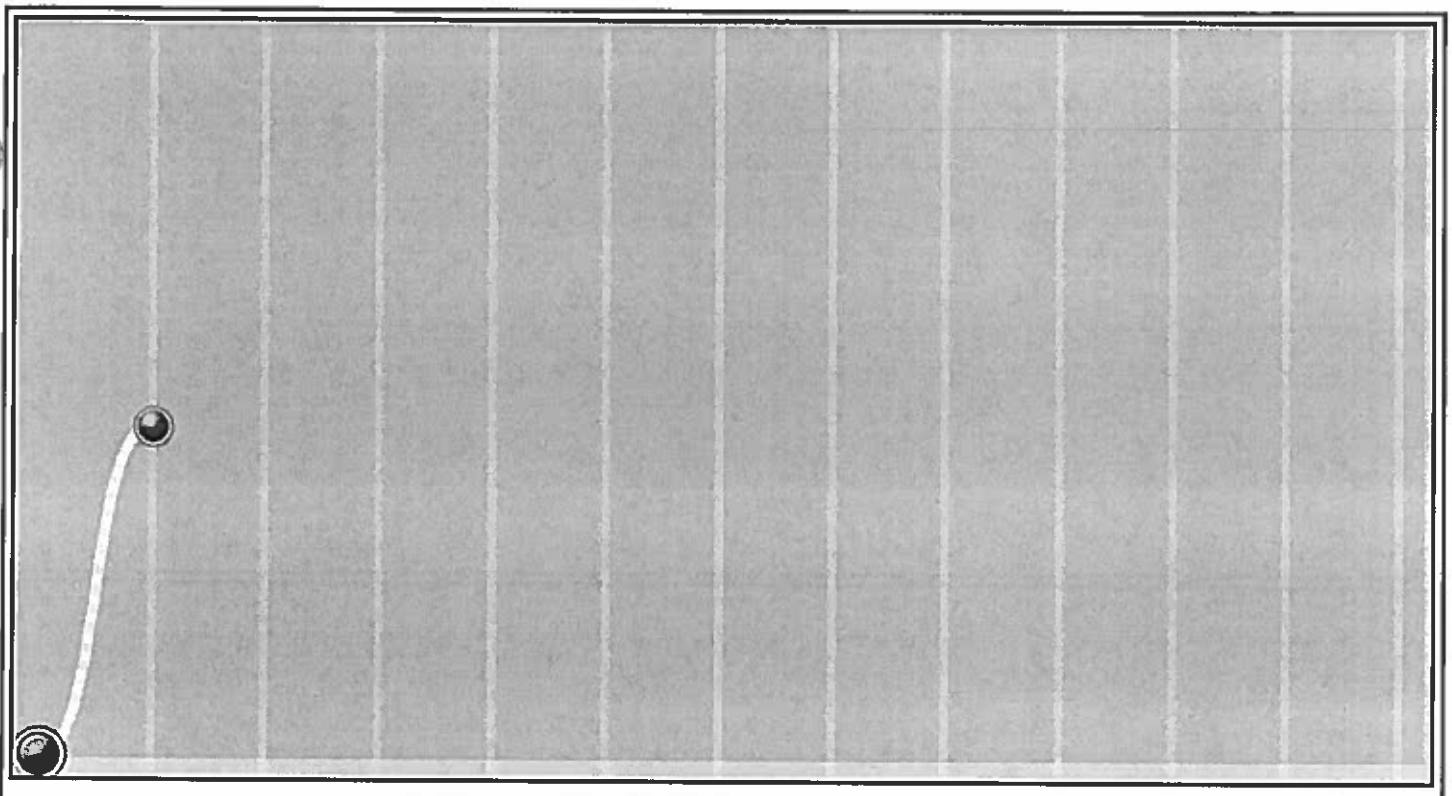
D) At what point during this ride is it most desirable to see a lot of orange? What does the orange bar represent?

7. When your coaster reaches the end of its run, circle the ends state of your coaster:

crash success stuck

If your coaster was *successful*, <u>do not close your game</u>. Keep the game open. Get the post-lab from your teacher in order to proceed.

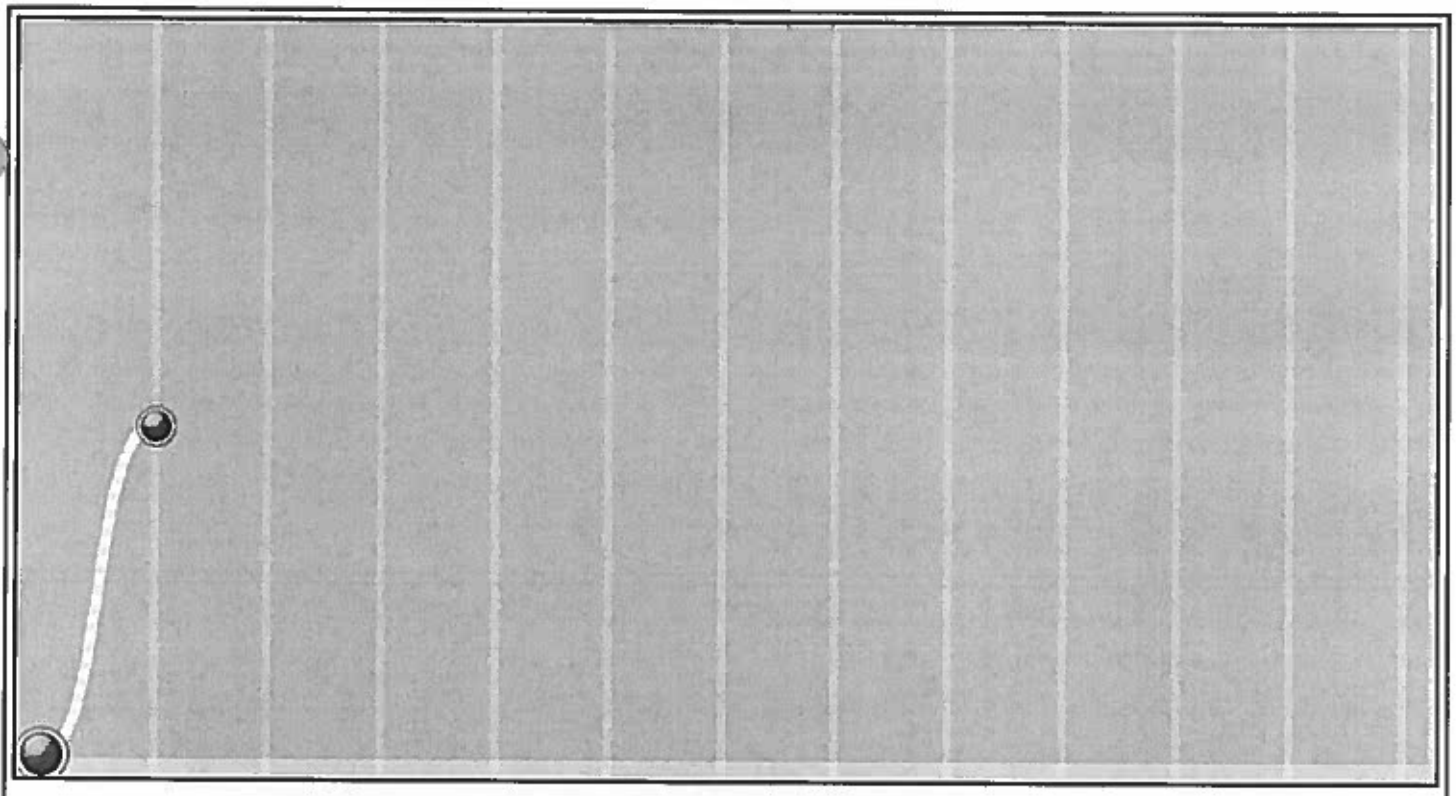
If your coaster got *stuck* or *crashed*, go back to the track builder and modify your coaster. Record your modifications on the following page.



Explain why you made the changes you did (how do you think this will increase your opportunity for success?)

Circle the end state of this track. If the track is successful, proceed to the post lab. Otherwise try again. Record your modifications

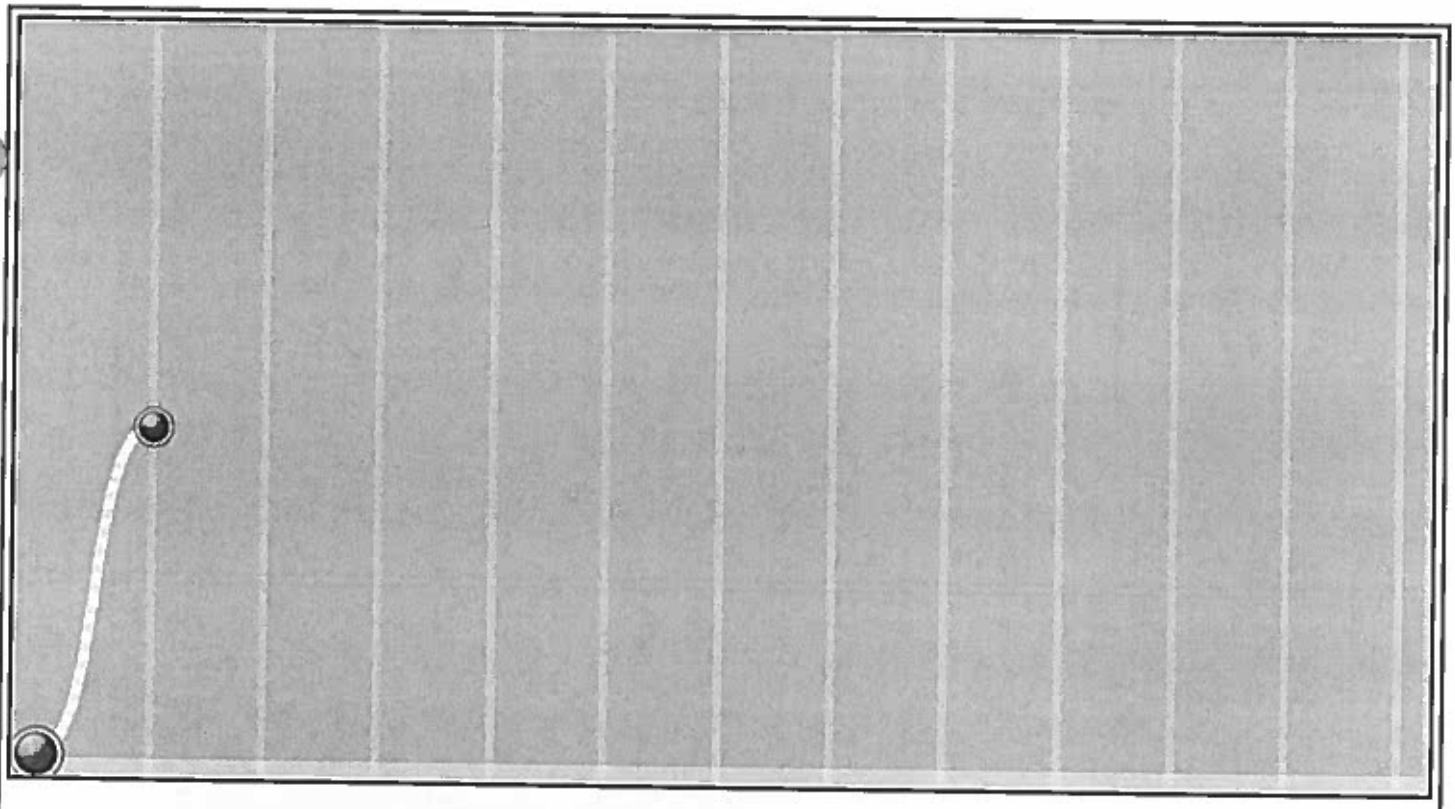
crash success stuck



Explain why you made the changes you did (how do you think this will increase your opportunity for success?)

Circle the end state of this track. If the track is successful, proceed to the post lab. Otherwise try again. Record your modifications

crash success stuck



Explain why you made the changes you did (how do you think this will increase your opportunity for success?)

Circle the end state of this track. If the track is successful, proceed to the post lab. Otherwise try again. Record your modifications

crash success stuck

OPERATION: INFINITE POTENTIAL

Coaster Creator: Postlab

Name:	Period:

Forms of Energy : Highlight all of the energy forms you observe throughout this lab.

Gravitational	Elastic	Chemical	Nuclear	Magnetic	Electrostatic	Mechanical	Thermal	Electrical	Sound	Electromagnetic
										

Materials:

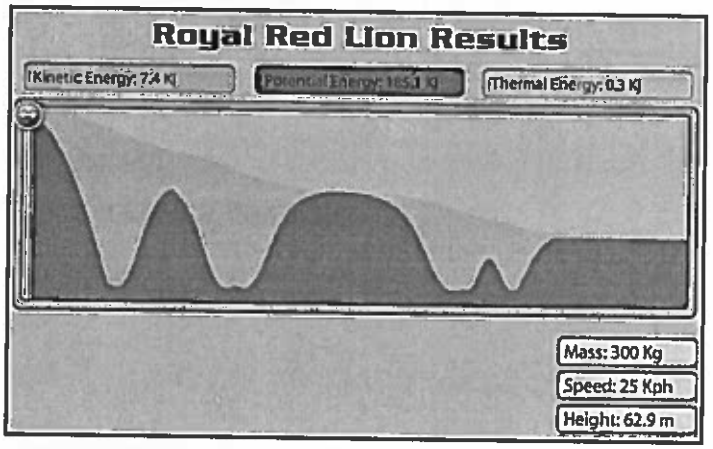
For this activity, you will need:

- One regular pencil
- Completed copy of your Coaster Creator-Prelab
- Access and log in to: www.jason.org (Go to Operation: Infinite Potential>>Digital Labs>>Coaster Creator)
- Three colored pencils, markers, or crayons:
- Red
- Green
- Orange

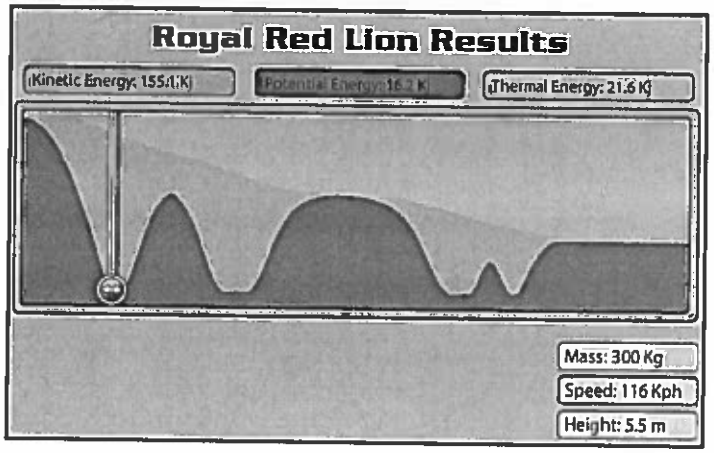
Before answering questions about your own successful roller coaster, respond to the following questions:

1. Compare two different points on the same "Results" graph:

First Point



Second Point



A. Write down the correct numbers for the corresponding values of the *First Point*. Don't forget to label your units.

PE

Height

KE

Speed

B. Write down the correct numbers for the corresponding values of the *Second Point*. Don't forget to label your units.

PE

Height

KE

Speed

C. What do you notice about the relationship between *potential energy* and *height*? As height increases, explain what happens to *potential energy*.

D. What do you notice about the relationship between *kinetic energy* and *height*? As *height* increases, explain what happens to *kinetic energy*.

E. What do you notice about the relationship between *kinetic energy* and *speed*? As *speed* increases, explain what happens to *kinetic energy*.

F. What do you notice about the relationship between potential energy and speed? As *speed* increases, explain what happens to *potential energy*.

2. Once you have built a successful track, go to your results page and recreate the graph found there in the box below using:

Red to represent *Potential Energy*
Green to represent *Kinetic Energy*
Orange to represent *Thermal Energy*

A. Explain what your roller coaster is doing at the point where there is no longer any green. How would this graph be different if your roller coaster *crashed*?

B. Circle the place on the roller coaster you think this represents where your carts were traveling their fastest and write the word "maximum speed" in the circle. Explain how you knew this is where your carts were traveling their fastest.

3. Use the arrow slider on your own "Results" page to help you answer the following questions.

A. Find the area where your *potential energy* was the greatest. Using your regular pencil, circle that area in the results graph you created in question #2 and label "PE" inside that circle along with what your total potential energy is in Joules.

B. Was your *potential energy* greatest at the beginning, towards the middle, or towards the end of your roller coaster?

C. Look at where you expected to see the *greatest potential energy* in question #1D of your prelab. Did you predict that potential energy would reach its maximum at the start, towards the middle, or towards the end of the ride? Now that you have the results in front of you, was your prediction correct?

D. Find the area where your *kinetic energy* was greatest. Using your regular pencil, circle that area in the graph you created in question #2 and label "KE" inside that circle along with what your total potential energy is in Joules.

E. Was your *kinetic energy* greatest at the beginning, towards the middle, or towards the end of your roller coaster?

F. Find where your thermal energy was greatest. Using your regular pencil, circle that area in the graph you created in question #2 and label "TE" inside that circle along with what your total potential energy is in Joules.

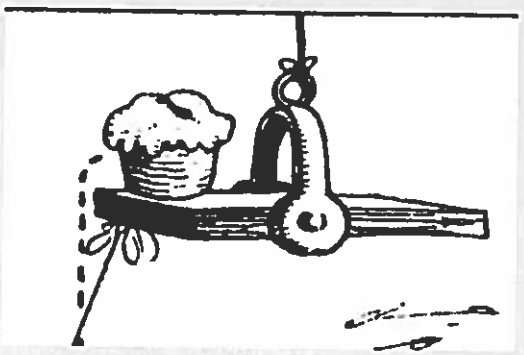
G. Was your *thermal energy* greatest at the beginning, towards the middle, or towards the end of your roller coaster?

4. If a much younger student wanted to know the "secret" behind making a successful roller coaster right away, what would you tell that student? Using simple language, write down a brief explanation for how to design a successful roller coaster track. Make sure you use the words, "*height*, *speed*, *friction*, and *energy conversion*" in your explanation.

Lever

lev·er, 'levər,'lēvər/, *noun*
1. a rigid bar resting on a pivot, used to help move a heavy or firmly fixed load with one end when pressure is applied to the other.
Synonyms: Crowbar.

Make a lever out of the given materials and explore the relationship of the fulcrum to the load. Discover that it is easier to move an object when the fulcrum is closer to the load.
Materials: Wooden ruler, Object to lift, Tape, Can or toilet paper roll.



Does the lever make it easier to lift the load?

Move the fulcrum closer to and away from the load. Which is easier to lift?

Draw an example of a lever in action.

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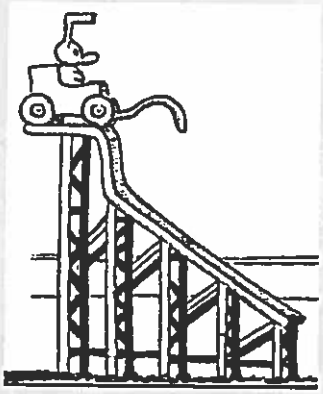
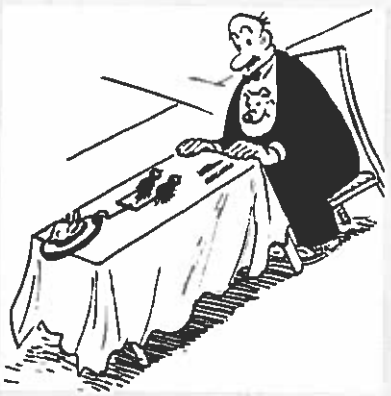
Inclined Plane

in·clined plane, *noun*
1. a plane inclined at an angle to the horizontal. 2. a sloping ramp up which heavy loads can be raised by ropes or chains.
Synonyms: Ramp, slant, gradient.

Make inclined planes with boards varying the slope of the board. Try leaning the board against objects of different heights. Tie rubber bands around the book. Tie the string to the rubber bands and pull the books up the different inclined planes. Also pull the books straight up without using the inclined planes.
Materials: 2 Boards varying in lengths, String, Rubber bands, Ruler, Heavy Book.





Is it easier to pull the book straight up in the air, or up the inclined plane? Why?

Look at the stretch of the rubber bands during the straight up pull compared to different inclined planes. During which is the rubber band longer?

What is an example of an inclined plane in your every-day life?

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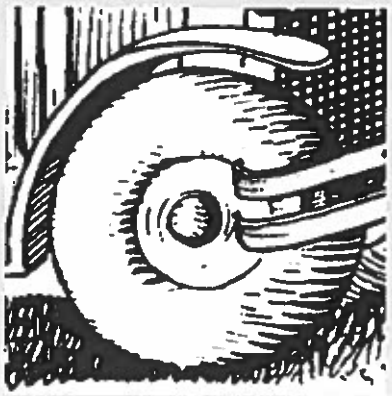
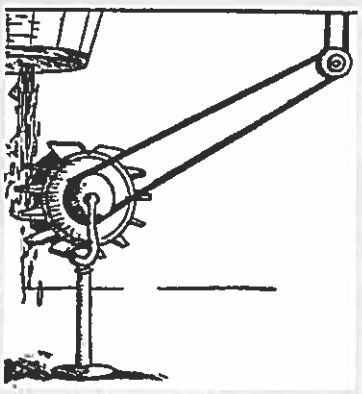
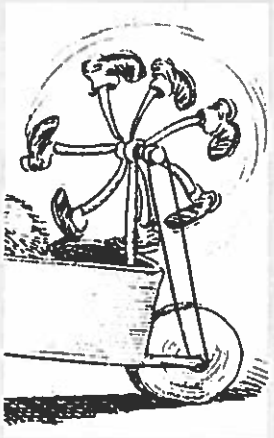
Wheel and Axle

wheel and ax·el, *noun*
1. a simple lifting machine consisting of a rope that unwinds from a wheel onto a cylindrical drum or shaft joined to the wheel to provide mechanical advantage.
Synonyms: Axis, shaft.

Push one car on its side and the other on its wheels. Note the difference in distance traveled.
Materials: 2 matchbox cars, Rulers.







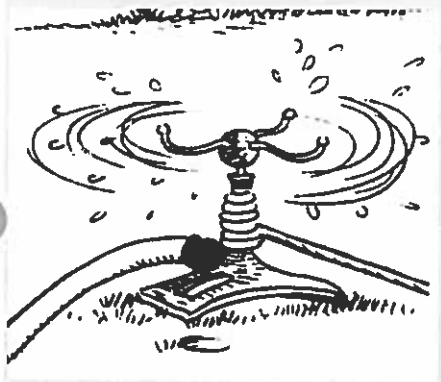
Which car moved easier, the one on its' wheels or the one on its' side?

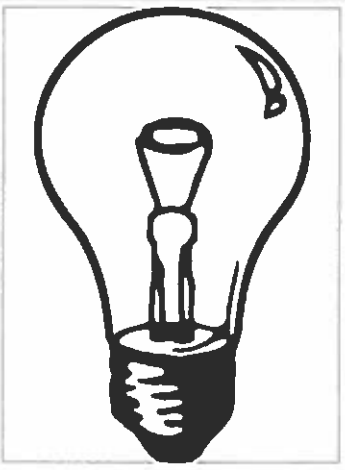
If cars did not have wheels, how might they move? Would it be harder this way?

Screw

skro͞o/, *noun*
1. a short, slender, sharp-pointed metal pin with a raised helical thread running around it and a slotted head, used to join things together by being rotated so that it pierces wood or other material and is held tightly in place.
Synonyms: Bolt, fastener.

Make a screw out of an inclined plane. Cut the paper square diagonally to make an inclined plane. Tape one of the short edges of the triangle to a pencil. Wrap the triangle around the pencil. An inclined plane is part of a screw.
Materials: 9 inch Paper Square, Tape, Pencil, Scissors.





What is a screw typically made out of?

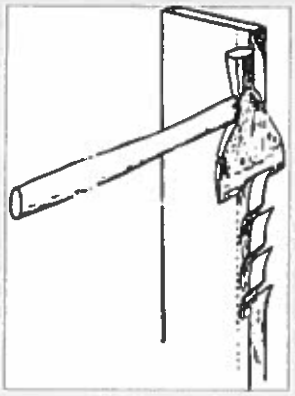
What do we use screws for in every-day life?

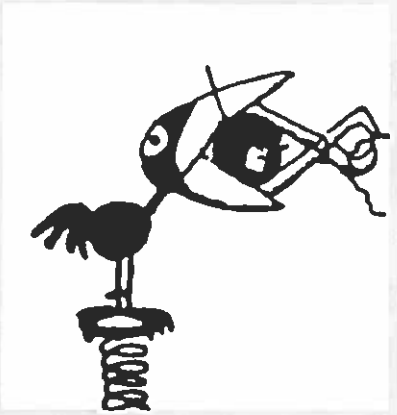
What tool do we use to get a screw into a piece of wood? Why?

Wedge

wej/, *noun*
1. a piece of wood, metal, or some other material having one thick end and tapering to a thin edge, that is driven between two objects or parts of an object to secure or separate them.
Synonyms: Doorstop, chock.

Scissors are made up of two wedges (the blades) and fixed at an axis point. Cut paper with both sharp scissor and dull scissors. Observe that the sharp scissors cut better than the dull scissors as the wedge's point narrower and therefore slices more easily.
Materials: Paper, Dull Scissors, Sharp Scissors.





Which scissor is easier to cut with, the sharp or the dull? Why?

How are the cuts different?

Is a scissor a simple machine or a compound of two simple machines?

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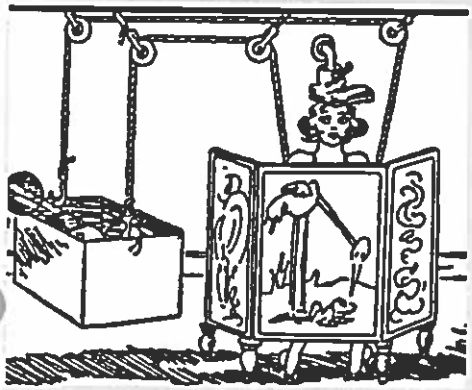
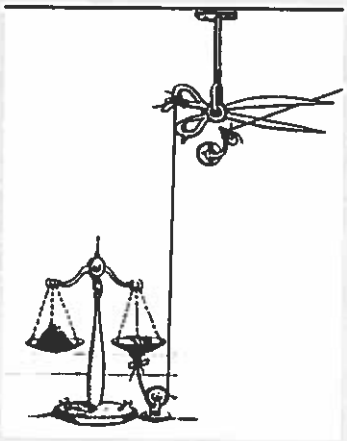
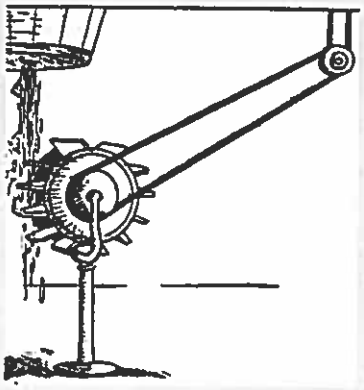
Pulleys

pul·ley, ˈpo͝olē/, *noun*
1. a wheel with a grooved rim around which a cord passes. It acts to change the direction of a force applied to the cord and is chiefly used (typically in combination) to raise heavy weights.
Synonyms: Sheave, drum.

Make a pulley with a sewing spool, string, and a pencil. Use this pulley to lift an object. Compare lifting the object with the pulley and without the pulley.
Materials: Sewing spool, String, Pencil, Object to lift.







Compare using the pulley and not using the pulley. Which is easier to lift the load?

Where do we use pulleys in our every-day life?

Draw an example of a pulley system using more than one pulley.

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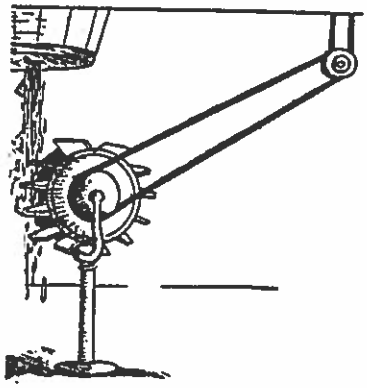
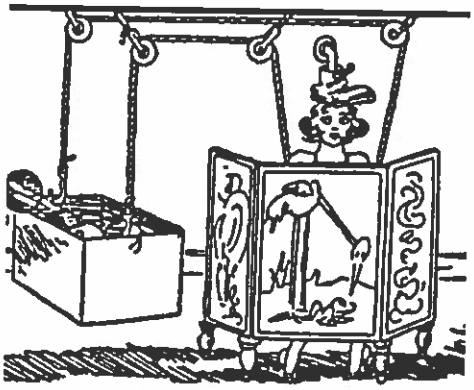
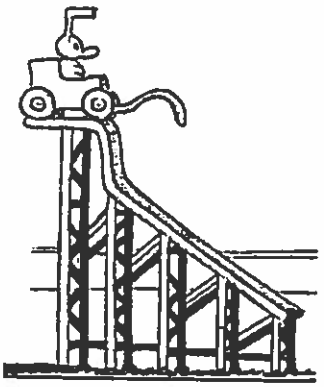
RUBE GOLDBERG MACHINES

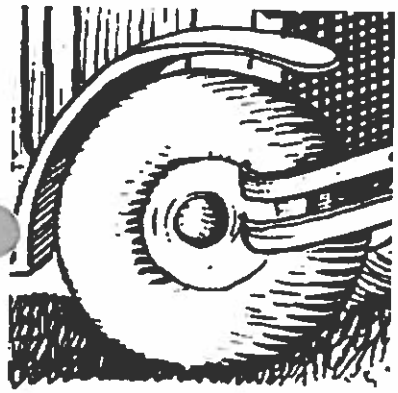
Name:_____ Date:_____

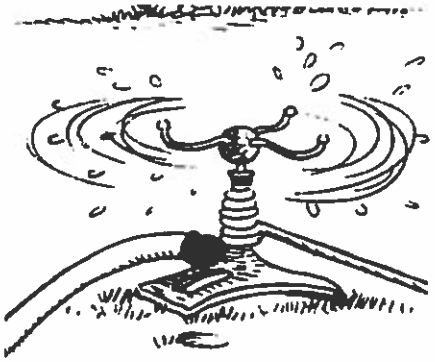
Label the 6 Simple Machines in Rube's Cartoons

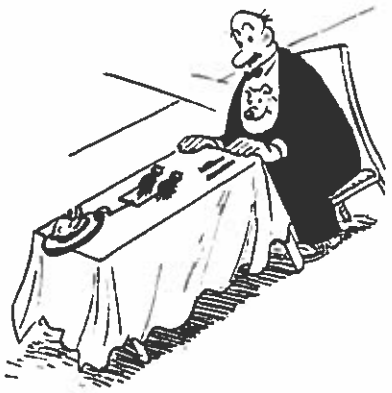


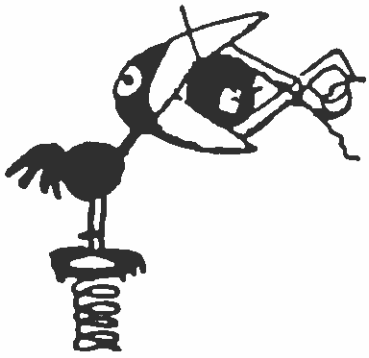


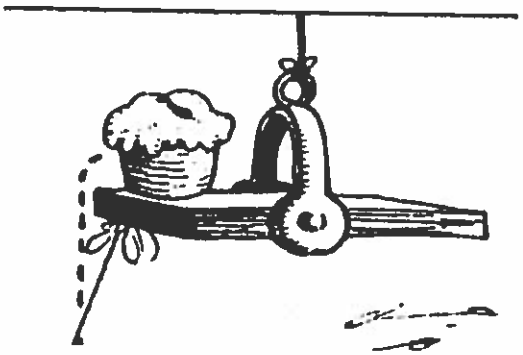


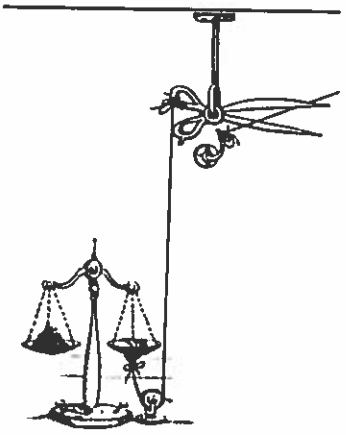












Key words: Pulley, Lever, Inclined Plane, Screw, Wedge, Wheel and Axel

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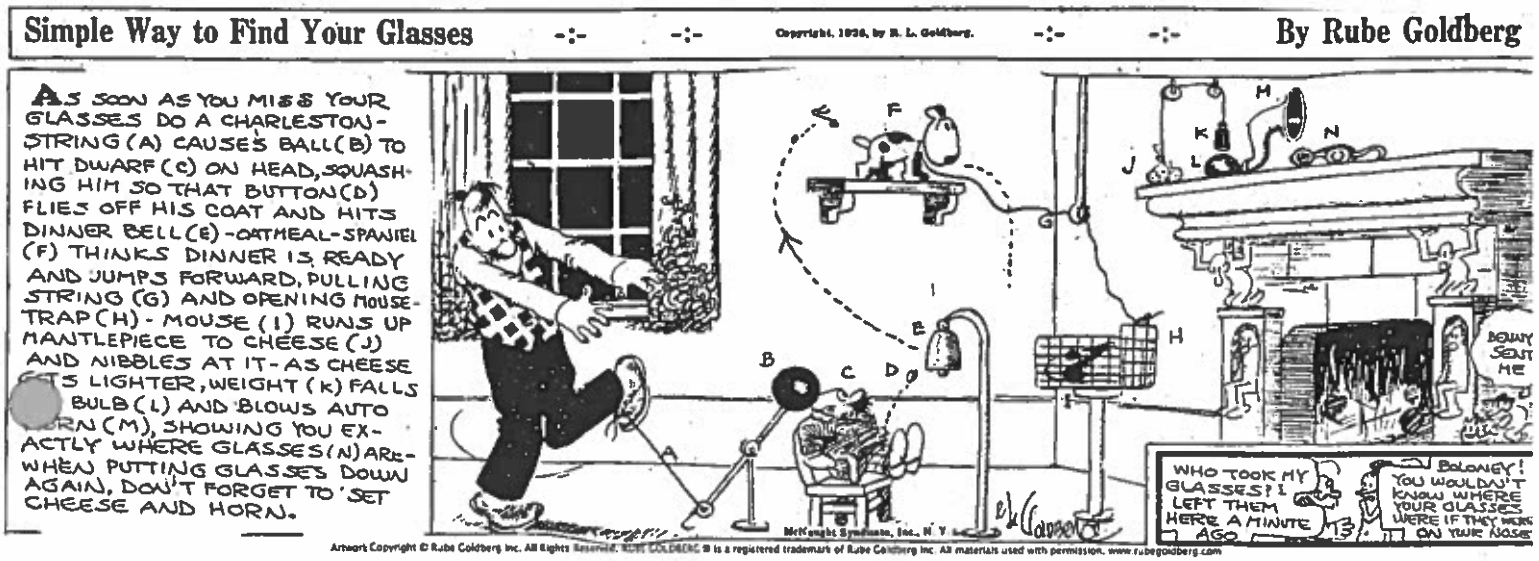
Name:_____ Date:_____

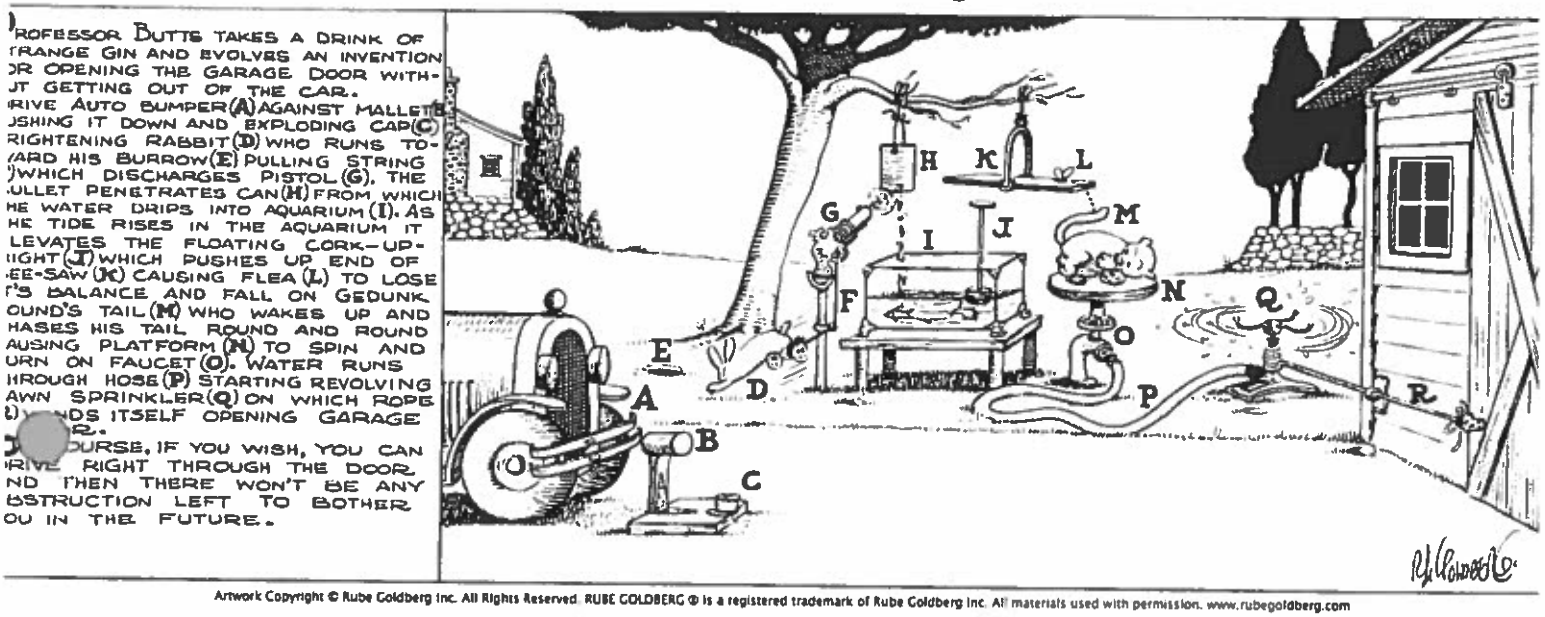
Circle and Label the Simple Machines in Rube Goldberg's Cartoons



Name:_____ Date:_____

Circle and Label the Simple Machines in Rube Goldberg's Cartoons

Opening the Garage Door by Rube Goldberg



RUBE GOLDBERG MACHINES

Name:_____ Date:_____

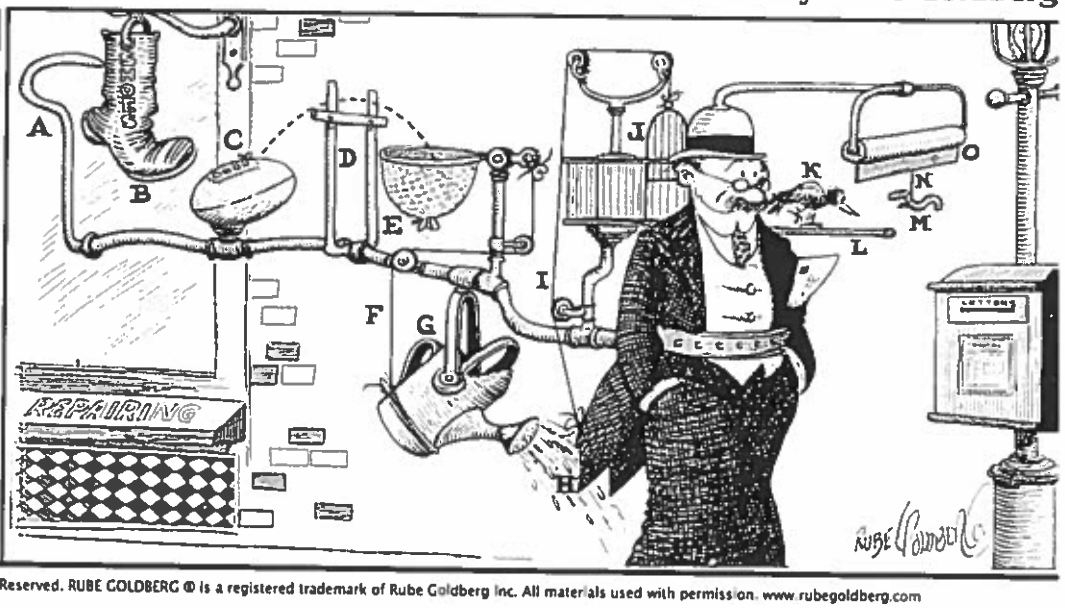
Circle and Label the Simple Machines in Rube Goldberg's Cartoons

Simple Idea to Keep You From Forgetting To Mail Your Wife's Letter

By Rube Goldberg

PROFESSOR BUTTS GETS CAUGHT IN A REVOLVING DOOR AND BECOMES DIZZY ENOUGH TO DOPE OUT AN IDEA TO KEEP YOU FROM FORGETTING TO MAIL YOUR WIFE'S LETTER.

AS YOU WALK PAST COBBLER SHOP, HOOK(A) STRIKES SUSPENDED BOOT(B) CAUSING IT TO KICK FOOTBALL(C) THROUGH GOAL POSTS(D). FOOTBALL DROPS INTO BASKET(E) AND STRING (F) TILTS SPRINKLING CAN(G) CAUSING WATER TO SOAK COAT TAILS(H). AS COAT SHRINKS CORD(I) OPENS DOOR(J) OF CAGE ALLOWING BIRD(K) TO WALK OUT ON PERCH(L) AND GRAB WORM(M) WHICH IS ATTACHED TO STRING(N). THIS PULLS DOWN WINDOW SHADE(O) ON WHICH IS WRITTEN, "**YOU SAP, MAIL THAT LETTER.**" A SIMPLE WAY TO AVOID ALL THIS TROUBLE IS TO MARRY A WIFE WHO CAN'T WRITE.



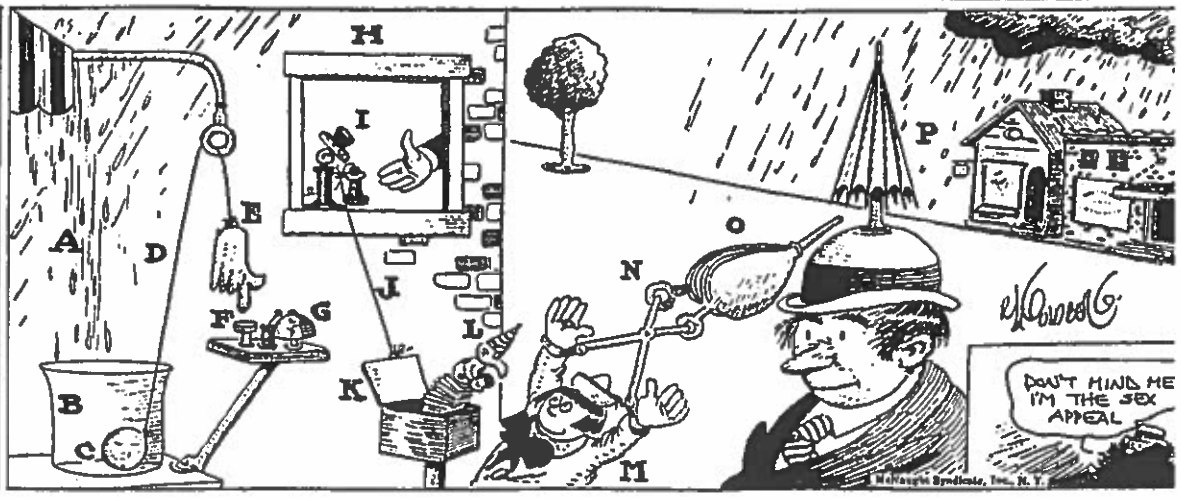
RUBE GOLDBERG MACHINES

Name:_____ Date:_____

Draw a Rube Goldberg Machine

Get One of Our Handy Self-Opening Umbrellas -:- -:- -:- -:- ***By Rube Goldberg***

RAINDROPS (A) FILL TUMBLER (B), CAUSING BALL (C) TO RISE - STRING (D) MOVES WITH BALL AND IRON HAND (E) PRESSES BUTTON (F), RINGING ELECTRIC BELL (G) - MAN IN NEARBY BUILDING (H) THINKS HIS PHONE IS RINGING AND PICKS UP RECEIVER (I), CAUSING STRING (J) TO OPEN BOX (K) - JACK-IN-THE BOX (L) JUMPS OUT AND LITTLE BOY (M) IS SO HAPPY HE CLAPS HANDS, CAUSING ARRANGEMENT (N) TO BLOW BELLOWS (O) AND OPEN UMBRELLA (P)!



The Secret of the Machines

BY RUDYARD KIPLING

(MODERN MACHINERY)

We were taken from the ore-bed and the mine,
We were melted in the furnace and the pit—
We were cast and wrought and hammered to design,
We were cut and filed and tooled and gauged to fit.
Some water, coal, and oil is all we ask,
And a thousandth of an inch to give us play:
And now, if you will set us to our task,
We will serve you four and twenty hours a day!

We can pull and haul and push and lift and drive,
We can print and plough and weave and heat and light,
We can run and race and swim and fly and dive,
We can see and hear and count and read and write!

Would you call a friend from half across the world?
If you'll let us have his name and town and state,
You shall see and hear your crackling question hurled
Across the arch of heaven while you wait.
As he answered? Does he need you at his side?
You can start this very evening if you choose,
And take the Western Ocean in the stride
Of seventy thousand horses and some screws!

The boat-express is waiting your command!
You will find the *Mauretania* at the quay,
Till her captain turns the lever 'neath his hand,
And the monstrous nine-decked city goes to sea.

Do you wish to make the mountains bare their head
And lay their new-cut forests at your feet?
Do you want to turn a river in its bed,
Or plant a barren wilderness with wheat?
Shall we pipe aloft and bring you water down
From the never-failing cisterns of the snows,
To work the mills and tramways in your town,
And irrigate your orchards as it flows?

It is easy! Give us dynamite and drills!
Watch the iron-shouldered rocks lie down and quake
As the thirsty desert-level floods and fills,
And the valley we have dammed becomes a lake.

But remember, please, the Law by which we live,
We are not built to comprehend a lie,
We can neither love nor pity nor forgive.
If you make a slip in handling us you die!
We are greater than the Peoples or the Kings—
Be humble, as you crawl beneath our rods!-
Our touch can alter all created things,
We are everything on earth—except The Gods!

Though our smoke may hide the Heavens from your eyes,
It will vanish and the stars will shine again,
Because, for all our power and weight and size,
We are nothing more than children of your brain!

RUBE GOLDBERG MACHINES

What is always present but never visible? ENERGY! <u>Label Potential and Kinetic Energy Below:</u>

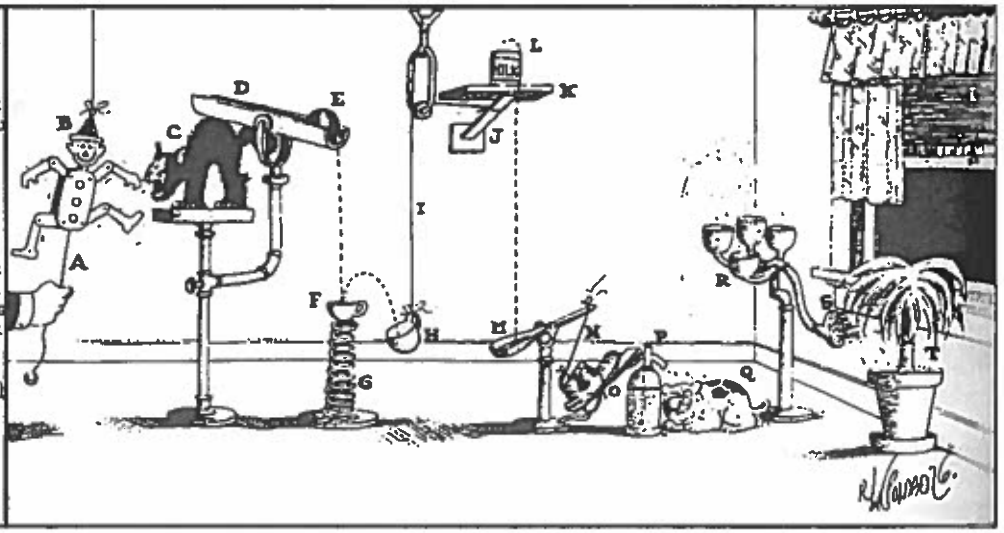
Energy is the ability to do work or cause change. Much like mass or volume, energy is a property of an object. Movement, sound, heat, and light provide evidence that energy is present and being used.

Potential energy (PE) appears in many different forms, and is defined as the energy in matter due to its position or the arrangement of its parts. The various forms of potential energy include gravitational potential energy, elastic potential energy, chemical potential energy, and electrical potential energy.

Kinetic energy (KE) is the energy of motion. Potential energy is converted into kinetic energy as soon as the object begins to move. A thrown football, a speeding automobile, a waterfall, or a rock falling from a cliff are examples of objects that have kinetic energy.

Self-Watering Palm Tree

PROFESSOR BUTT'S BRAIN TAKES A NOSEDIVE AND OUT COMES HIS SELF-WATERING PALM TREE.
STRING (A) WORKS JUMPING JACK (B), FRIGHTENING CAT (C) WHICH RAISES BACK AND LIFTS TROUGH (D) CAUSING BALL (E) TO FALL INTO TEACUP (F). SPRING (G) MAKES BALL REBOUND INTO CUP (H) PULLING ON STRING (I) WHICH RELEASES STICK (J), CAUSING SHELF (K) TO COLLAPSE. MILK CAN (L) DROPS ON LADLE (M) AND TENSION ON STRING (N) TILTS SHOE (O) AGAINST JIGGER ON SELTZER BOTTLE (P), SQUIRTING SELTZER ON ASH-CAN SPANIEL WHO HASN'T HAD A BATH IN FOUR YEARS. SURPRISE CAUSES HIM TO TURN THREE SOMERSAULTS OVER APPARATUS (R) AND WATER SPLASHES NATURALLY INTO BOWLS, RUNNING THROUGH SPRAY (S) WATERING PALM (T), AND SAVING YOURSELF A TRIP TO HAVANA FOR TROPICAL ATMOSPHERE.



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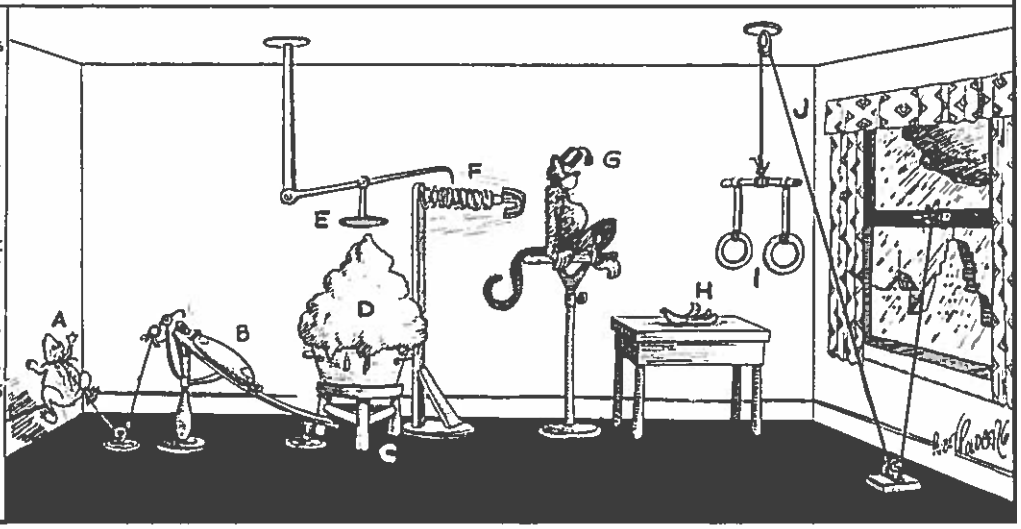
Closing the Windows While You Are Away

THE PROFESSOR TAKES A PILL AND DOPES OUT A DEVICE FOR CLOSING THE WINDOW IF IT STARTS TO RAIN WHILE YOU'RE AWAY.
PET BULL FROG (A) HOMESICK FOR WATER, HEARS RAIN STORM AND JUMPS FOR JOY, PULLING STRING (B) WHICH OPENS CATCH (C) AND RELEASES HOT WATER BAG (D) ALLOWING IT TO SLIDE UNDER CHAIR (E). HEAT RAISES YEAST (F) LIFTING DISK (G) WHICH CAUSES HOOK (H) TO RELEASE SPRING (I). TOY AUTOMOBILE-BUMPER (J) SOCKS MONKEY (K) IN THE NECK PUTTING HIM DOWN FOR THE COUNT ON TABLE (L). HE STAGGERS TO HIS FEET AND SLIPS ON BANANA PEEL (M). HE INSTINCTIVELY REACHES FOR FLYING RINGS (N) TO AVOID FURTHER DISASTER AND HIS WEIGHT PULLS ROPE (O) CLOSING WINDOW (P), STOPPING THE RAIN FROM LEAKING THROUGH ON THE FAMILY DOWNSTAIRS AND THINNING THEIR SOUP.



3-step Rube Goldberg Machine

Task:

Description

7-step Rube Goldberg Machine

Task:

Description

15-step Rube Goldberg Machine

Task:

Description

Summative Task Report – Rube Goldberg Machine
Present arguments using evidence

Now that you have designed, experimented, studied, tested, revised, constructed and analyzed your Rube Goldberg machine, it is time to share your experience in writing.

Write a six paragraph report explaining how you fulfilled the requirements of this project. Think of yourself as a scientist sharing your findings. Explain so someone from another school could understand what you have done, how you did it, and what it all meant.

- Your report must be typed.
- Your report must be in Times New Roman or Arial font.
- Your report must be in 12 point font.
- Your report may be submitted electronically or printed.

- Your report must be structured like this:
  - I. Introduction
    - a. The purpose of this project is to gain a greater understanding of physics concepts by using them to construct a machine.
    - b. This report will describe the design process.
    - c. This report will also describe how physics concepts are demonstrated in the machine.
  - II. Process
    - a. Planning and conducting investigation.
    - b. Analyzing data and design
    - c. Modeling and design
    - d. Construction and testing
    - e. Include at least one drawing or picture
  - III. Simple machines
    - a. What simple machine(s) did you use, and how did they help the device?
  - IV. Physics concept choices
    - a. Which two physics concepts did you choose to demonstrate in your machine?
      - i. Wave (sound or mechanical)
      - ii. Collision
      - iii. Chemical reaction
      - iv. Temperature change
      - v. Magnetism
      - vi. Electricity
      - vii. Change of motion (acceleration)
      - viii. Light
    - b. Define the concept, and use evidence to describe how it was used in your machine.
  - V. Physics basics
    - a. Define the concept, and use evidence to describe how it was used in your machine.
      - i. Potential Energy
      - ii. Kinetic Energy
      - iii. Inertia
      - iv. Momentum
      - v. Speed
  - VI. Conclusion and reflection
    - a. How did your machine help you understand the way physics works?
    - b. What would you change or do differently if you were asked to build another machine?

Rube Goldberg Report Rough Draft

Write down some words and phrases of ideas of what to write for each part of your report.

I. Introduction

a. _____

b. _____

c. _____

II. Process

a. _____

_____

b. _____

_____

c. _____

_____

d. _____

_____

e. _____

III. Simple machines

a. _____

_____

_____

_____

IV. Physics concept choices

a. Which two physics concepts did you choose to demonstrate in your machine?

i. _____

_____

ii. _____

_____

b. Define the concept, and use evidence to describe how it was used in your machine.

i. _____

_____

_____

_____

ii. _____

_____

_____

_____

V. Physics basics

a. Define the concept, and use evidence to describe how it was used in your machine.

i. Potential Energy

1. _____

ii. Kinetic Energy

1. _____

iii. Inertia

1. _____

iv. Momentum

1. _____

v. Speed

1. _____

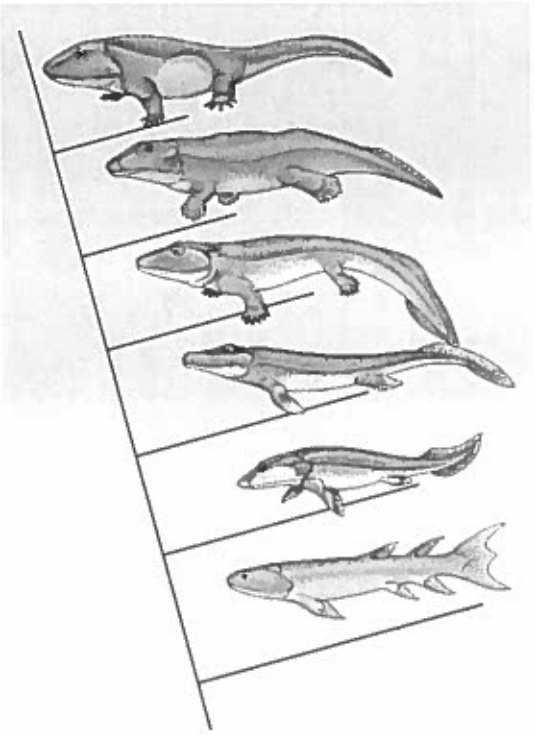
VI. Conclusion and reflection

a. _____

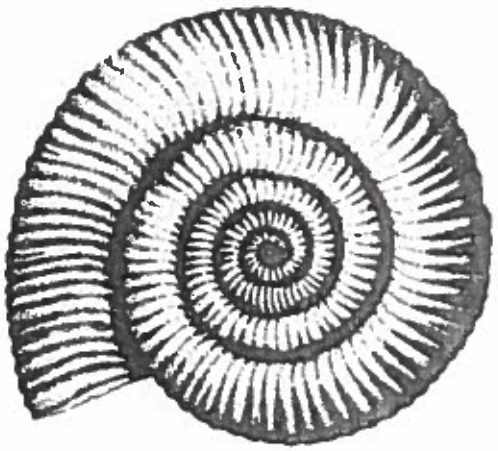
b. _____

Lathrop Intermediate

8th grade Science
Evolution Unit



8.4.1 Geologic Time Scale: PART A (Print 2 copies and place in plastic sleeves)



Focus Question: How do people use the fossil record to reconstruct and date events in Earth's planetary history?

Introduction/Framing:
Sort activity cards with overlapping sets in order to understand relative dating.
Show how fossils can be used to give relative dates to rock layers.

Objectives: Determine the correct sequence of the 8 cards by comparing letters that are common to individual cards (that overlap).

Time: 20-min

Group Roles: Facilitator Reporter/Recorder Materials Manager Time Keeper	Materials: Sort A Cards

Task Steps:

1. Spread the cards from Sort A out on the table, face up so that you can see all of the cards.

2. Locate the first card in the sequence, it has "Card 1, Set A" in the lower left-hand corner. This is the bottom of the sequence. If the letters "T" and "C" represent fossils, these are the oldest fossils, or the first fossils formed in the past for this sequence of rock layers.

3. Decide who on the team will go first. Their job is to look for a card that has either a "T" or a "C" written on in. The card with a common letter must go on top of the TC card. The fossils represented by the letters on this card are younger than the "T" or "C" fossils.

4. Take turns sequencing the remaining cards by using the same process. When you finish, you should have a vertical stack of cards with the top card representing the youngest fossils of this rock sequence and the "TC" card at the bottom of the stack representing the oldest fossils.

5. Once you have completed the sorting activity, answer the questions on the back of this page in your Science Notebook.

8.4.1 Geologic Time Scale: PART A (Print 2 copies and place in plastic sleeves)

Analysis and Conclusions:

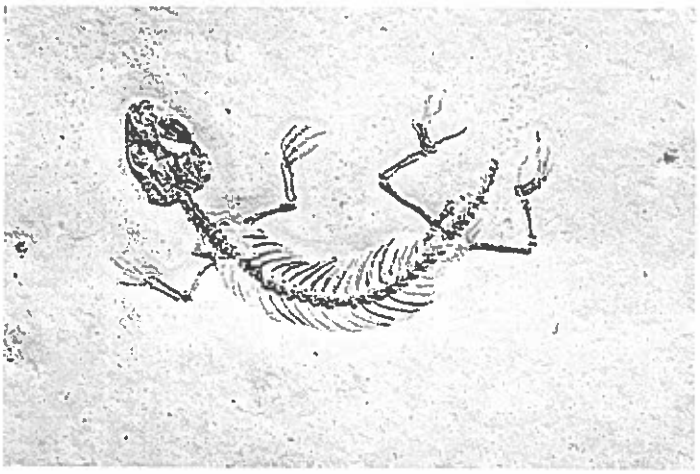
1) Write your sequence of letters (using each letter only once) on a separate piece of paper. Starting with the top card, the letters should be in order from youngest to oldest. Label the oldest and youngest letters using technical writing tools.

2) How do you know that "X" is older than "M"?

3) Explain why "D" in the rock layer represented by DM is the same age as "M."

4) Explain why "D" in the rock layer represented by OXD is older than "D" in the rock layer represented by DM.

8.4.1 Geologic Time Scale - PART B (Print 2 copies and place in plastic sleeves)



Focus Question: How do people use the fossil record to reconstruct and date events in Earth's planetary history?

Introduction/Framing:
Sort activity cards with overlapping sets in order to understand relative dating.
Show how fossils can be used to give relative dates to rock layers.

Objectives: Use this information to sequence the cards in a vertical stack of fossils in rock strata. Arrange them from oldest to youngest with the oldest layer on the bottom and the youngest on top.

Vocabulary: **Index Fossil**: a fossil used to identify or define a geologic period.
Time: 20-min

Group Roles:	Materials:
Facilitator Reporter/Recorder Materials Manager Time Keeper	Sort B Cards Student Resource Card

Task Steps:

1) Look at the second set of cards with sketches of fossils on them. Each card represents a particular layer of rock with a collection of fossils that are found in that layer.

All of these fossils would be found in sedimentary rocks of marine origin.
The Student Resource Card contains information about each fossil.

2) Locate the oldest rock layer, marked with the letter "M" in the lower left-hand corner. Ignore the other letters for now.

3) Take turns finding a rock layer that has at least one of the fossils you found in the oldest rock layer. This rock layer would be younger as indicated by the appearance of new fossils in the rock stratum.

Tips:
Keep in mind that extinction is forever. Once an organism disappears from the sequence it cannot reappear later.

8.4.1 Geologic Time Scale - PART B (Print 2 copies and place in plastic sleeves)

Once you have completed the sorting activity, answer the questions on the back of this page in your Science Notebook.

Interpretation Questions:

1) Using the letters printed in the lower left-hand corner of each card, write the sequence of letters from the youngest layer to the oldest layer (i.e., from the top of the vertical stack to the bottom). This will enable your teacher to quickly check whether you have the correct sequence.

2) Which fossil organisms could possibly be used as **index fossils**?

3) Name three organisms that probably could not be used as **index fossils** and explain why.

4) How does extinction of species affect the geologic time scale?

5) This collection of fossils is from a marine environment. Explain what kinds of geologic events may affect the fossil record in the ocean.

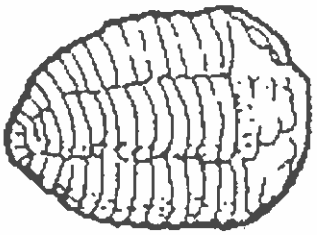
Name: _____ Period: ____ Date: _____

8.5.1 - Resource Sheet

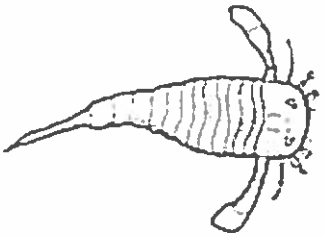
Fossil Information Card

Figure 2-A. Sketches of Marine Fossil Organisms (Not to Scale)

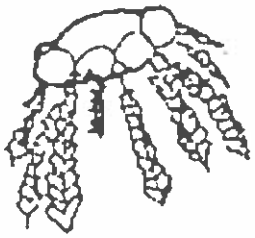
NAME: Brachiopod
PHYLUM: Brachiopoda
DESCRIPTION: "Lampshells"; exclusively marine organisms with soft bodies and bivalve shells; many living species



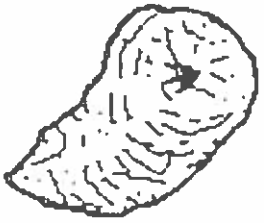
NAME: Trilobite
PHYLUM: Arthropoda
DESCRIPTION: Three-lobed body; burrowing, crawling, and swimming forms; extinct



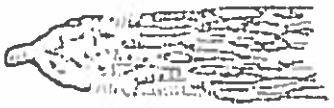
NAME: Eurypterid
PHYLUM: Arthropoda
DESCRIPTION: Many were large (a few rare species were 5 feet in length); crawling and swimming forms; extinct



NAME: Graptolite
PHYLUM: Chordata
DESCRIPTION: Primitive form of chordate; floating form with branched stalks; extinct



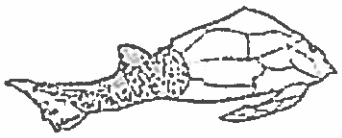
NAME: Horn coral
PHYLUM: Coelenterata (Cnidaria)
DESCRIPTION: Jellyfish relative with stony (Cnidaria) (calcareous) exoskeleton found in reef environments; extinct



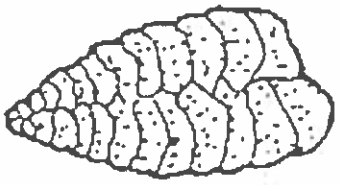
NAME: Crinoid
PHYLUM: Echinodermata
DESCRIPTION: Multibranched relative of starfish; lives attached to the ocean bottom; some living species ("sea lilies")

<Adapted from http://www.ucmp.berkeley.edu/fosrec/BarBar.html#SETA >

Name: _____ Period: ____ Date: _____

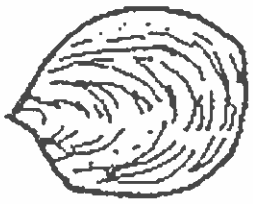


NAME: Placoderm
PHYLUM: Vertebrata
DESCRIPTION: Primitive armored fish; extinct

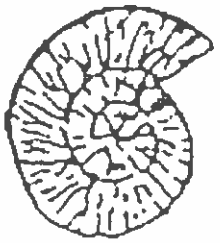


NAME: Foraminifera (microscopic type)
PHYLUM: Protozoa (Sarcodina)
DESCRIPTION: Shelled, amoeba-like organism

NAME: Gastropod
PHYLUM: Mollusca
DESCRIPTION: Snails and relatives; many living species



NAME: Pelecypod
PHYLUM: Mollusca
DESCRIPTION: Clams and oysters; many living species



NAME: Ammonite
PHYLUM: Mollusca
DESCRIPTION: Squid-like animal with coiled, chambered shell; related to modern-day Nautilus

NAME: Icthyosaur
PHYLUM: Vertebrata
DESCRIPTION: Carnivore; air-breathing aquatic animal; extinct

---

NAME: Shark's tooth
PHYLUM: Vertebrata
DESCRIPTION: Cartilage fish; many living species

CONCEPT 1 Relative Ages of Rocks

Lesson Objectives

- Explain how stratigraphy can be used to determine the relative ages of rocks.
- State how unconformities occur.
- Identify ways to match rock layers in different areas.
- Describe how Earth's history can be represented by the geologic time scale.

Vocabulary

- geologic time scale
- key bed
- law of superposition
- relative age
- stratigraphy
- unconformity

Introduction

The way things happen now is the same way things happened in the past. Earth processes have not changed over time. Mountains grow and mountains slowly wear away, just as they did billions of years ago. As the environment changes, living creatures adapt. They change over time. Some organisms may not be able to adapt. They become **extinct**, meaning that they die out completely.

Historical geologists study the Earth's past. They use clues from rocks and fossils to figure out the order of events. They think about how long it took for those events to happen.

Laws of Stratigraphy

The study of rock strata is called **stratigraphy**. The laws of stratigraphy can help scientists understand Earth's past. The laws of stratigraphy are usually credited to a geologist from Denmark named Nicolas Steno. He lived in the 1600s. The laws are illustrated in **Figure** 1.1. Refer to the figure as you read about the laws below.

Law of Superposition

Superposition refers to the position of rock layers and their relative ages. **Relative age** means age in comparison with other rocks, either younger or older. The relative ages of rocks are important for understanding Earth's history. New rock layers are always deposited on top of existing rock layers. Therefore, deeper layers must be older than

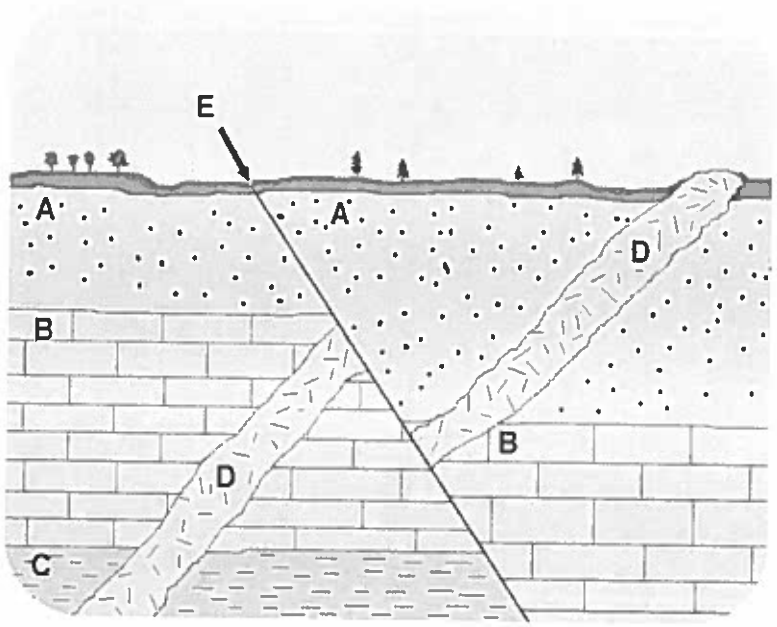


FIGURE 1.1

Laws of Stratigraphy. This diagram illustrates the laws of stratigraphy. A = Law of Superposition, B = Law of Lateral Continuity, C = Law of Original Horizontality, D = Law of Cross-Cutting

layers closer to the surface. This is the **law of superposition**. You can see an example in **Figure** 1.2 and at the link below.

[Link about law of superposition here.]

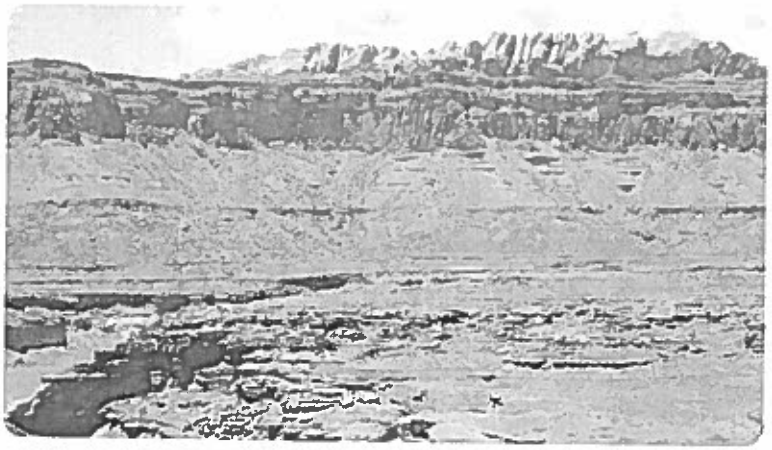


FIGURE 1.2

Superposition. The rock layers at the bottom of this cliff are much older than those at the top. What force eroded the rocks and exposed the layers?

Law of Lateral Continuity

Rock layers extend laterally, or out to the sides. They may cover very broad areas, especially if they formed at the bottom of ancient seas. Erosion may have worn away some of the rock, but layers on either side of eroded areas will still "match up."

Look at the Grand Canyon in **Figure** 1.3. It's a good example of lateral continuity. You can clearly see the same rock layers on opposite sides of the canyon. The matching rock layers were deposited at the same time, so they are the same age.

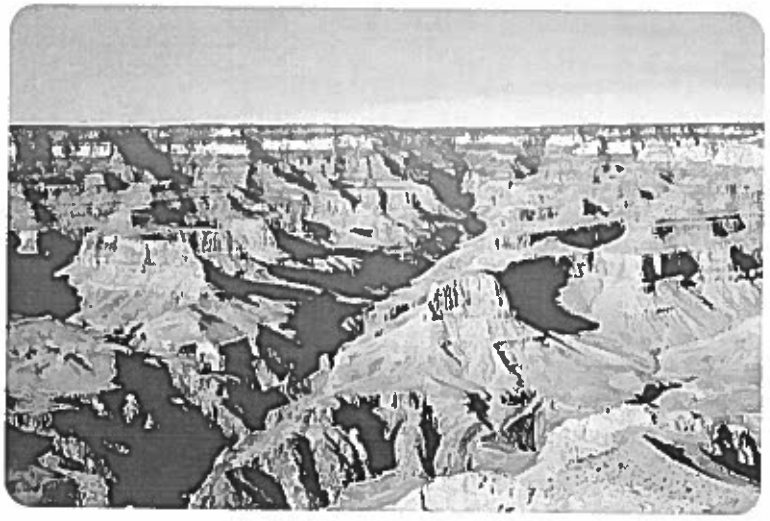


FIGURE 1.3

Lateral Continuity. Layers of the same rock type are found across canyons at the Grand Canyon.

Law of Original Horizontality

Sediments were deposited in ancient seas in horizontal, or flat, layers. If sedimentary rock layers are tilted, they must have moved after they were deposited.

Law of Cross-Cutting Relationships

Rock layers may have another rock cutting across them, like the igneous rock in **Figure** 1.4. Which rock is older? To determine this, we use the law of cross-cutting relationships. The cut rock layers are older than the rock that cuts across them.

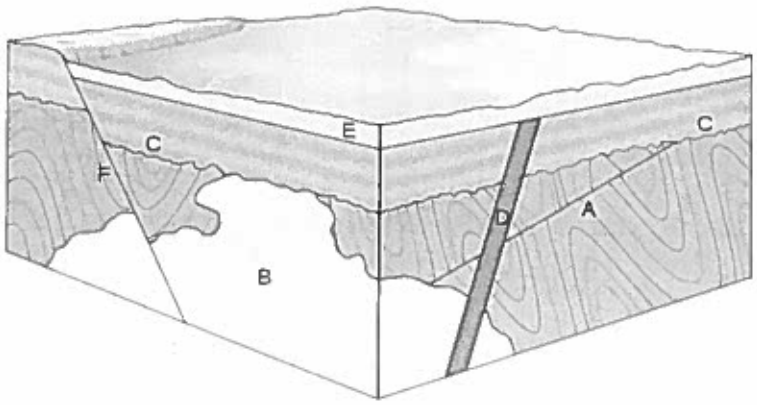


FIGURE 1.4

Cross-cutting relationships in rock layers. Rock D is a dike that cuts across all the other rocks. Is it older or younger than the other rocks?

Unconformities

Geologists can learn a lot about Earth's history by studying sedimentary rock layers. But in some places, there's a gap in time when no rock layers are present. A gap in the sequence of rock layers is called an **unconformity**.

Look at the rock layers in **Figure** 1.5. They show a feature called Hutton's unconformity. The unconformity was discovered by James Hutton in the 1700s. Hutton saw that the lower rock layers are very old. The upper layers are much younger. There are no layers in between the ancient and recent layers. Hutton thought that the intermediate rock layers eroded away before the more recent rock layers were deposited.

Hutton's discovery was a very important event in geology! Hutton determined that the rocks were deposited over time. Some were eroded away. Hutton knew that deposition and erosion are very slow. He realized that for both to occur would take an extremely long time. This made him realize that Earth must be much older than people thought. This was a really big discovery! It meant there was enough time for life to evolve gradually.

You can learn more about it at the link below. [Insert a link to a video or animation about Hutton's unconformity.]

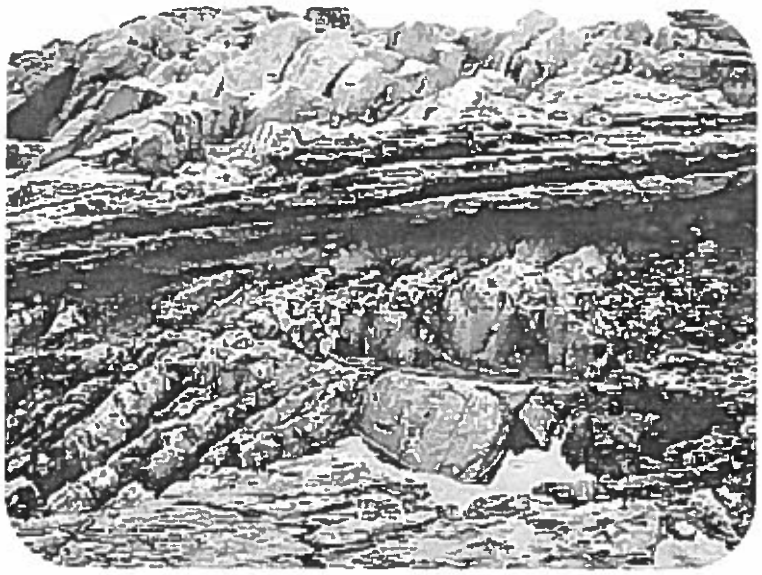


FIGURE 1.5

Hutton's unconformity, in Scotland.

Matching Rock Layers

When rock layers are in the same place, it's easy to give them relative ages. But what if rock layers are far apart? What if they are on different continents? What evidence is used to match rock layers in different places?

Widespread Rock Layers

Some rock layers extend over a very wide area. They may be found on more than one continent or in more than one country. For example, the famous White Cliffs of Dover are on the coast of southeastern England. These distinctive rocks are matched by similar white cliffs in France, Belgium, Holland, Germany, and Denmark (see **Figure** 1.6). It is important that this chalk layer goes across the English Channel. The rock is so soft that the Channel Tunnel connecting England and France was carved into it!

Key Beds

Like index fossils, key beds are used to match rock layers. A **key bed** is a thin layer of rock. The rock must be unique and widespread. For example, a key bed from around the time that the dinosaurs went extinct is very important. A

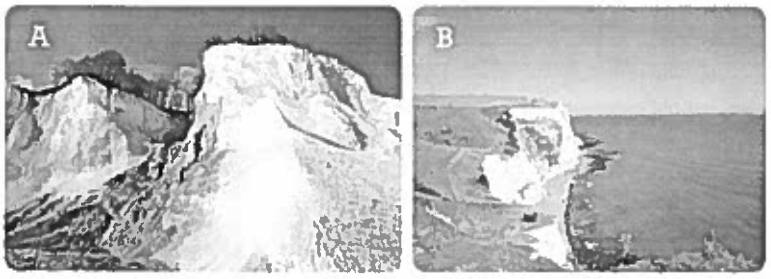


FIGURE 1.6

Chalk Cliffs. (A) Matching chalk cliffs in Denmark and (B) in Dover, U.K.

thin layer of clay was deposited over much of Earth's surface. The clay has large amount of the element iridium. Iridium is rare on Earth but common in asteroids. This unusual clay layer has been used to match rock up layers all over the world. It also led to the hypothesis that a giant asteroid struck Earth and caused the dinosaurs to go extinct.

Using Index Fossils

Index fossils are commonly used to match rock layers in different places. You can see how this works in **Figure 1.7**. If two rock layers have the same index fossils, then they're probably about the same age. You can watch a video about index fossils and how they are used at his link:

[Insert a link to a video about using index fossils to match rock layers in different places.]

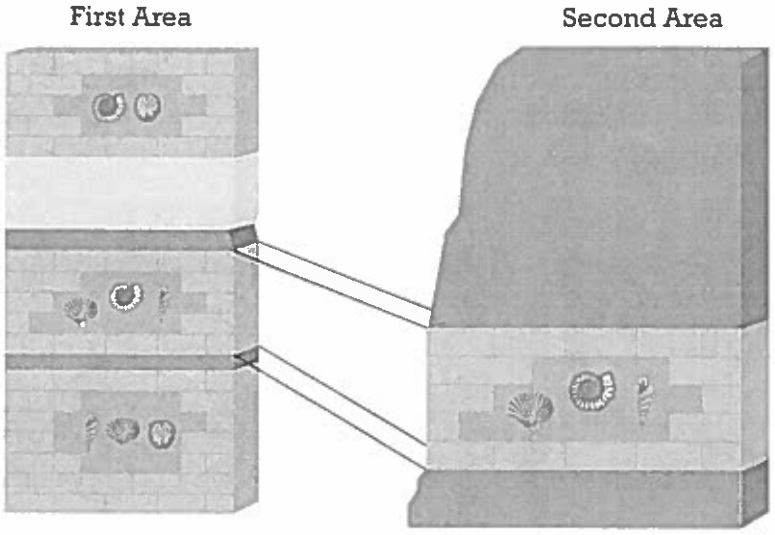


FIGURE 1.7

Using Index Fossils to Match Rock Layers. Rock layers with the same index fossils must have formed at about the same time. The presence of more than one type of index fossil provides stronger evidence that rock layers are the same age.

The Geologic Time Scale

Earth formed 4.5 billion years ago. Geologists divide this time span into smaller periods. Many of the divisions mark major events in life history.

Dividing Geologic Time

Divisions in Earth history are recorded on the **geologic time scale**. For example, the Cretaceous ended when the dinosaurs went extinct. European geologists were the first to put together the geologic time scale. So, many of the names of the time periods are from places in Europe. The Jurassic period is named for the Jura Mountains in France and Switzerland, for example.

Putting Events in Order

To create the geologic time scale, geologists correlated rock layers. Steno's laws were used to determine the relative ages of rocks. Older rocks are at the bottom and younger rocks are at the top. The early geologic time scale could only show the order of events. The discovery of radioactivity in the late 1800s changed that. Scientists could determine the exact age of some rocks in years. They assigned dates to the time scale divisions. For example, the Jurassic began about 200 million years ago. It lasted for about 55 million years.

Divisions of the Geologic Time Scale

The largest blocks of time on the geologic time scale are called "eons." Eons are split into "eras." Each era is divided into "periods." Periods may be further divided into "epochs." Geologists may just use "early" or "late." An example is "late Jurassic," or "early Cretaceous." **Figure** 1.8 shows you what the geologic time scale looks like.

EON	ERA	PERIOD	MILLIONS OF YEARS AGO
Phanerozoic	Cenozoic	Quaternary	1.6
		Tertiary	66
	Mesozoic	Cretaceous	138
		Jurassic	205
		Triassic	240
	Paleozoic	Permian	290
		Pennsylvanian	330
		Mississippian	360
		Devonian	410
		Silurian	435
		Ordovician	500
		Cambrian	570
Proterozoic	Late Proterozoic Middle Proterozoic Early Proterozoic		2500
Archean	Late Archean Middle Archean Early Archean		3800?
Pre-Archean			

FIGURE 1.8
The Geologic Time Scale

Life and the Geologic Time Scale

The geologic time scale may include illustrations of how life on Earth has changed. Major events on Earth may also be shown. These include the formation of the major mountains or the extinction of the dinosaurs. **Figure** 1.9is a different kind of the geologic time scale. It shows how Earth's environment and life forms have changed.

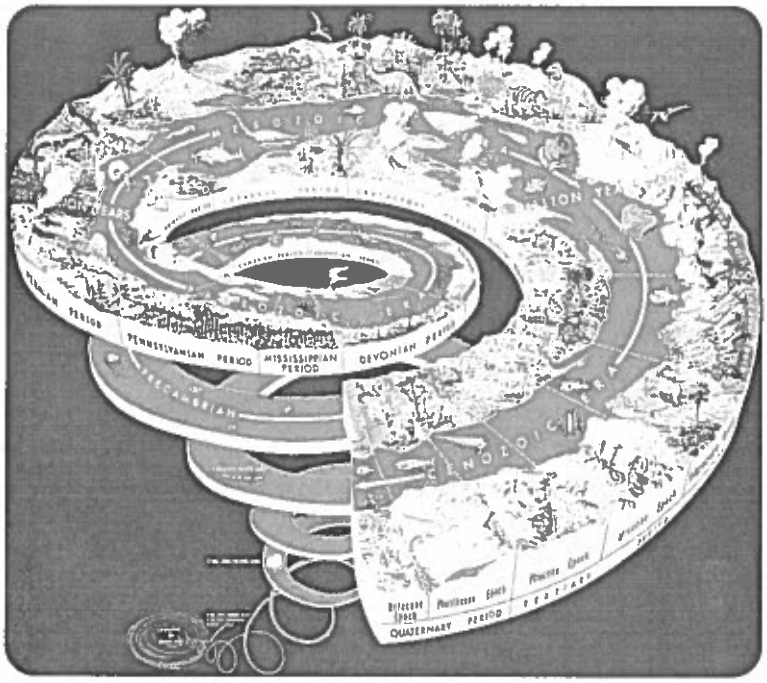


FIGURE 1.9
The evolution of life is shown on this spiral.

Your Place in Geologic Time

We now live in the Phanerozoic eon, the Cenozoic era, the Quarternary period and the Holocene epoch. "Phanerozoic" means visible life. During this eon, rocks contain visible fossils. Before the Phanerozoic, life was microscopic. The Cenozoic era means new life. It encompasses the most recent forms of life on Earth. The Cenozoic is sometimes called the Age of Mammals. Before the Cenozoic came the Mesozoic and Paleozoic. The Mesozoic means middle life. This is the age of reptiles, when dinosaurs ruled the planet. The Paleozoic is old life. Organisms like invertebrates and fish were the most common lifeforms.

Lesson Summary

- The study of rock layers is called stratigraphy. Laws of stratigraphy help scientists determine the relative ages of rocks. The main law is the law of superposition. This law states that deeper rock layers are older than layers closer to the surface.
- An unconformity is a gap in rock layers. They occur where older rock layers eroded away completely before new rock layers were deposited.
- Other clues help determine the relative ages of rocks in different places. They include key beds and index fossils.
- Scientists use the geologic time scale to illustrate the order in which events on Earth have happened.

Name: _____ Period: ____ Date: _____

8.5.1 Geologic Time Scale - Output Sheet

Relative Ages of Rocks

Focus Question: How do rocks tell us the relative age of the Earth?

Directions: Answer the following questions. Be sure to include quotes from the article that support your thinking:

1. What is the law of superposition? How does it help us to organize rock strata by age?

2. How does the law of cross-cutting relationships work? Use the model in Figure 1.4 to explain your reasoning.

3. What features make a layer of rock a good key bed?

4. What are index fossils? How is this similar to a key bed?

5. What are unconformities caused by?

6. How does extinction affect geology?

Name: _____ Period: ____ Date: _____

7. How is geological time split up into units?

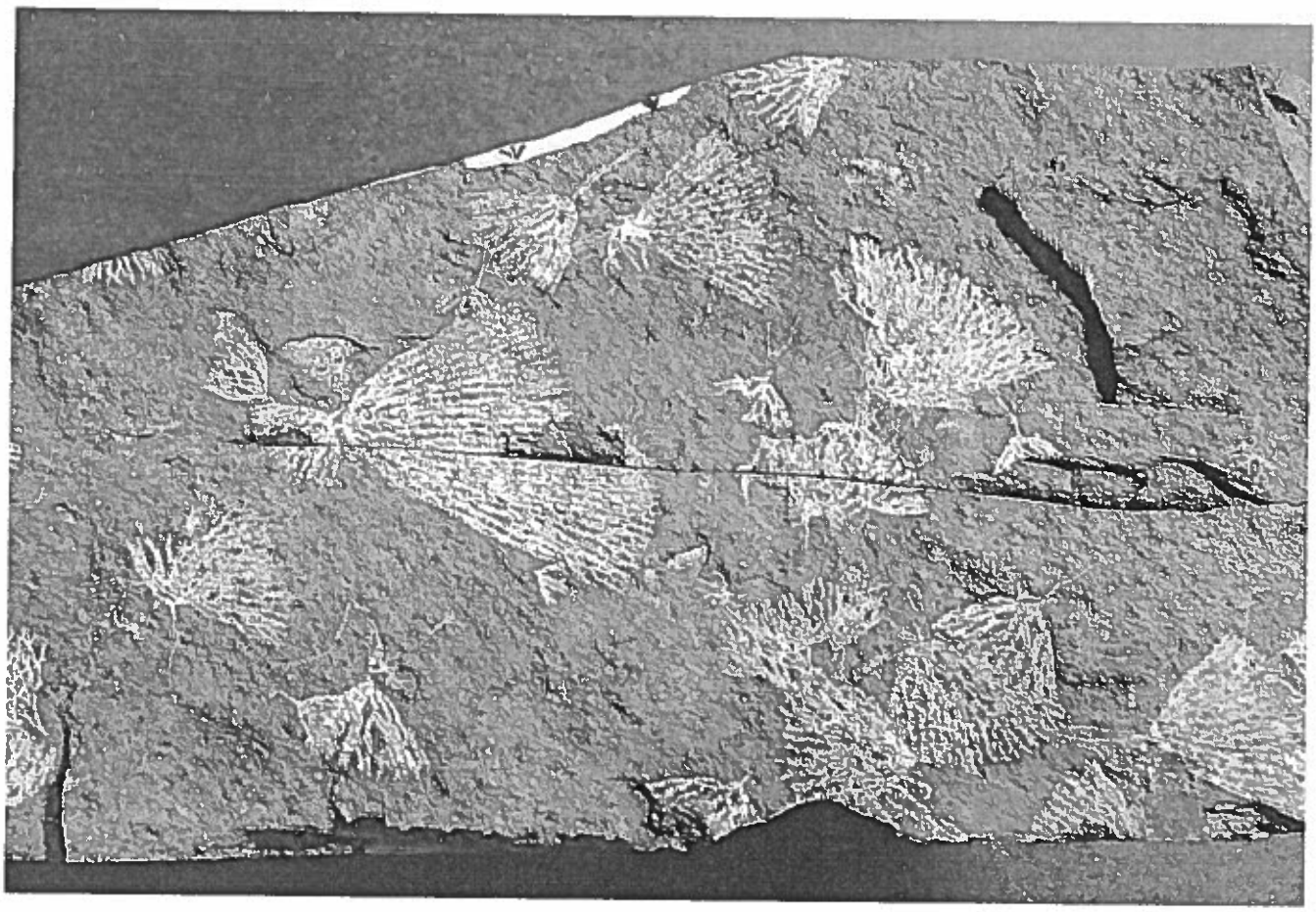
8. What is the difference between a relative time scale and a calendar?

9. How did the discovery of radioactivity change the geologic time scale?

10. Why did early geologic time scales not include the years ago that events happened?

Reading A

The big five mass extinctions



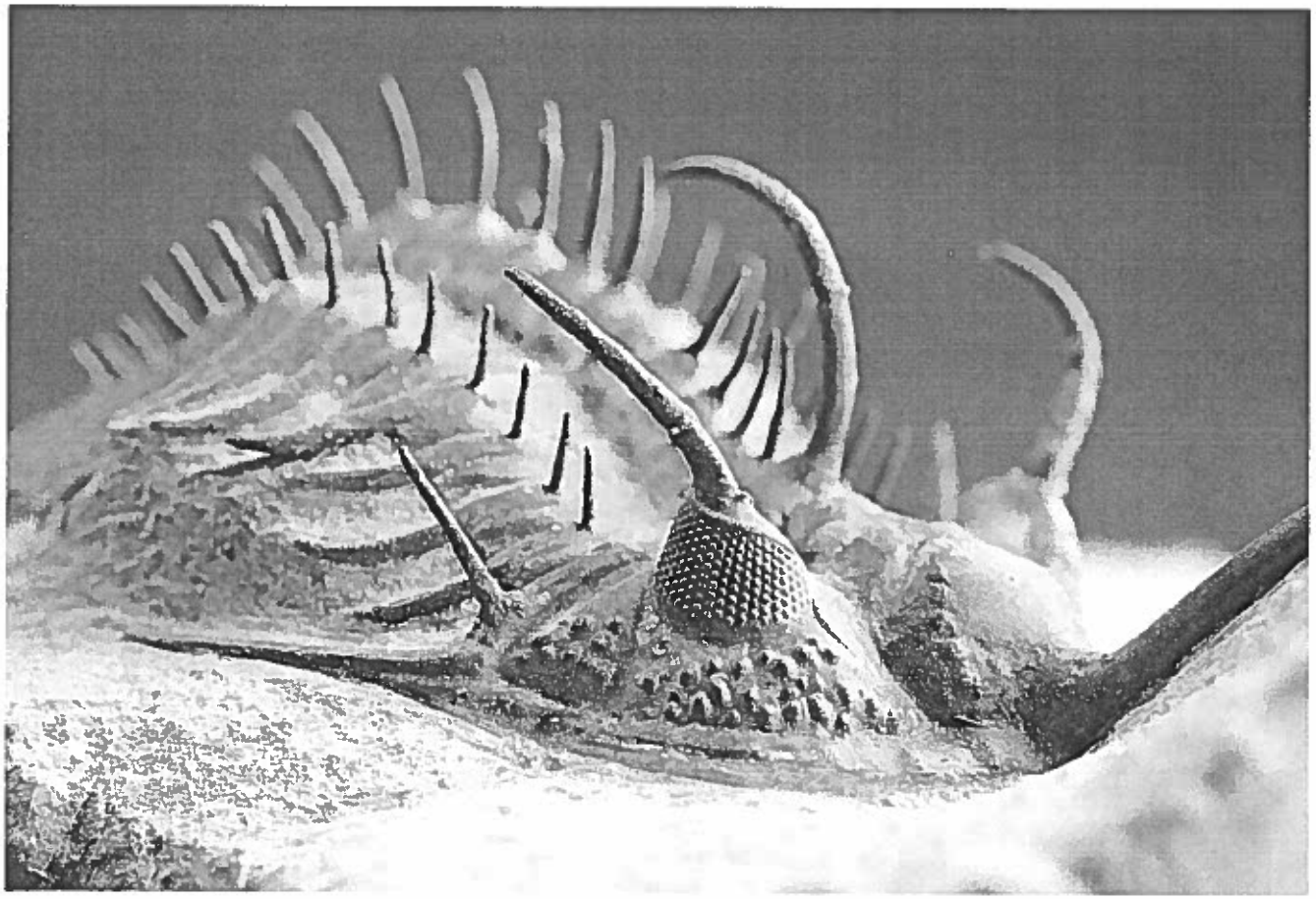
Biologists suspect we're living through the sixth major mass extinction. Earth has witnessed five, when more than 75% of species disappeared. Palaeontologists spot them when species go missing from the global fossil record, including the iconic specimens shown here. "We don't always know what caused them but most had something to do with rapid climate change", says Melbourne Museum palaeontologist Rolf Schmidt.

End Ordovician, 444 million years ago, 86% of species lost
— Graptolite 2-3 cm length

Reading A

Graptolites, like most Ordovician life, were sea creatures. They were filter-feeding animals and colony builders. Their demise over about a million years was probably caused by a short, severe ice age that lowered sea levels, possibly triggered by the uplift of the Appalachians. The newly exposed silicate rock sucked CO_2 out of the atmosphere, chilling the planet.

CREDIT: CREDIT: JAIME MURCIA / MUSEUM VICTORIA

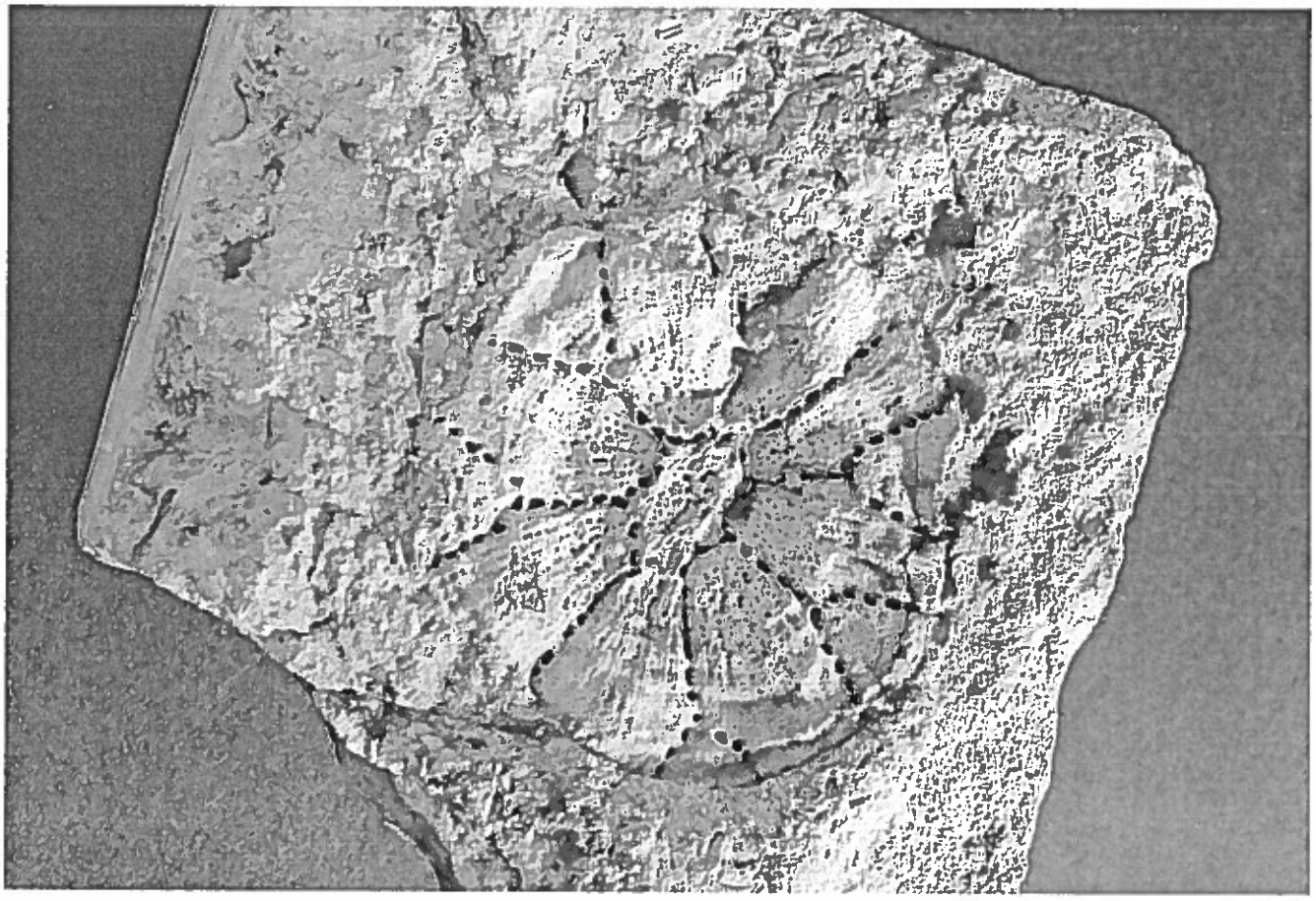


Late Devonian, 375 million years ago, 75% of species lost — Trilobite, 5 cm length

Trilobites were the most diverse and abundant of the animals that appeared in the Cambrian explosion 550 million years ago. Their great success was helped by their spiky armour and multifaceted eyes. They survived the first great extinction but were nearly wiped out in the second. The likely culprit was the newly evolved land plants that emerged, covering the planet during the Devonian period. Their deep roots stirred up the earth, releasing nutrients into the ocean. This might have triggered algal blooms which sucked oxygen out of the water, suffocating bottom dwellers like the trilobites.

CREDIT: CREDIT: CHIP CLARK / SMITHSONIAN INSTITUTION

Reading A



End Permian, 251 million years ago, 96% of species lost — Tabulate coral, 5 CM

Known as "the great dying", this was by far the worst extinction event ever seen; it nearly ended life on Earth. The tabulate corals were lost in this period – today's corals are an entirely different group. What caused it? A perfect storm of natural catastrophes. A cataclysmic eruption near Siberia blasted CO_2 into the atmosphere. Methanogenic bacteria responded by belching out methane, a potent greenhouse gas. Global temperatures surged while oceans acidified and stagnated, belching poisonous hydrogen sulfide. "It set life back 300 million years," says Schmidt. Rocks after this period record no coral reefs or coal deposits.

CREDIT: CREDIT: JAIME MURCIA / MELBOURNE MUSEUM

Reading A

End Triassic, 200 million years ago, 80% of species lost
— Conodont teeth 1 mm

Palaeontologists were baffled about the origin of these toothy fragments, mistaking them for bits of clams or sponges. But the discovery of an intact fossil in Scotland in the 1980s finally revealed their owner – a jawless eel-like vertebrate named the conodont which boasted this remarkable set of teeth lining its mouth and throat. They were one of the first structures built from hydroxyapatite, a calcium-rich mineral that remains a key component of our own bones and teeth today. Of all the great extinctions, the one that ended the Triassic is the most enigmatic. No clear cause has been found.

CREDIT: CREDIT: PAUL TAYLOR / NATURAL HISTORY MUSEUM

End Cretaceous, 66 million years ago, 76% of all species lost — Ammonite 15 cm length

The delicate leafy sutures decorating this shell represent some advanced engineering, providing the fortification the squid-like ammonite required to withstand the pressure of deep dives in pursuit of its prey. Dinosaurs may have ruled the land during the Cretaceous period but the oceans belonged to the ammonites. But volcanic activity and climate change already placed the ammonites under stress. The asteroid impact that ended the dinosaurs' reign provided the final blow. Only a few dwindling species of ammonites survived. Today, the ammonites' oldest surviving relative is the nautilus. Will it survive the sixth great extinction?

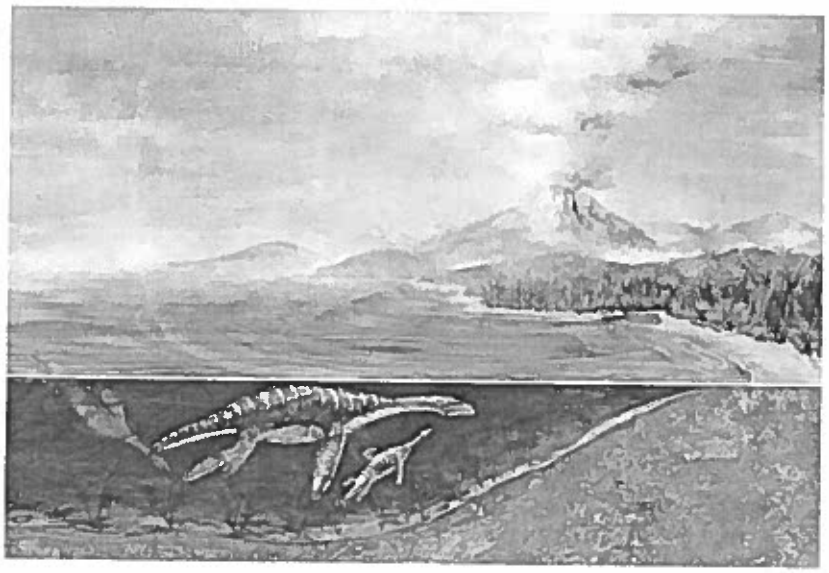
CREDIT: CREDIT: JAIME MURCIA / MUSEUM VICTORIA

Viviane Richter is a freelance science writer based in Melbourne.

Reading B

Greatest Mysteries: What Causes Mass Extinctions?

By Charles Q. Choi, Live Science Contributor | August 8, 2007 05:28am ET



Temperatures in Antarctica were much warmer 70 million years ago.

Credit: Nicolle Rager, National Science Foundation

Editor's Note: *We asked several scientists from various fields what they thought were the greatest mysteries today, and then we added a few that were on our minds, too. This article is one of 15 in LiveScience's "Greatest Mysteries" series running each weekday.*

They are known ominously as the Big Five—the five greatest mass extinctions over the past 500 million years, each of which is thought to have annihilated anywhere from 50 to 95 percent of all species on the planet.

Many unsolved mysteries remain regarding these disasters, perhaps the greatest of which is what caused each of them. But research is uncovering how these extinction events dictated the fate of life on this planet—for instance, determining which animals first crawled onto land and which ruled the oceans.

•

The main suspects behind these catastrophes seem to come either from above, in the form of deadly asteroids or comets, or from below, in the form of extraordinarily massive volcanism. Occasionally, however, unexpected culprits arise—for instance, otherwise innocuous forests.

The K-T extinction

The most recent of the Big Five is the most familiar one—the cataclysm that ended the Age of Dinosaurs. The end-Cretaceous or Cretaceous-Tertiary extinction event, otherwise known as K-T, killed off all dinosaurs save birds roughly 65 million years ago, as well as roughly half of all species on the planet, including pterosaurs.

Not only did mammals sweep across the planet after K-T, but sharks expanded across the seas, explained American Museum of Natural History vertebrate paleontologist Jack Conrad.

"Throughout the Age of Dinosaurs, you always had these large reptile carnivores dominating the water, such as ichthyosaurs, mosasaurs and plesiosaurs," Conrad explained. "Only after they die do you see big sharks becoming really prevalent. You probably wouldn't have seen orcas or blue whales either had reptile dominance of the seas not gone by the wayside."

Reading E

Although research suggests the planet was on the verge of environmental upheaval before the K-T extinction event, the straw that broke the dinosaur's back is widely thought to have been an impact with an asteroid or comet. Still, a number of researchers contend evidence commonly linked with such an impact, such as the metal iridium, which is rare on the Earth's crust, could also be caused by the massive volcanic eruptions at the Deccan Flats in India, another popular contender for the dinosaur-killing catastrophe.

The Triassic-Jurassic extinction

The end-Triassic, or Triassic-Jurassic extinction event about 200 million years ago is thought by many to possibly have set dinosaurs on the path to their 135-million-year domination of much of life on Earth. It also ended life for roughly half of all species.

Until this disaster, mammal-like creatures known as therapsids were actually more numerous than the ancestors of the dinosaurs, known as archosaurs.

"The dinosaurs definitely survived better than the early proto-mammals did, and the extinction event might have entirely tipped it in their favor," said Rutgers University paleobiologist George McGhee.

Of the Big Five, the Triassic-Jurassic extinction has the fewest number of scientists currently researching it, "although that's changing right now," said Columbia University paleoecologist Paul Olsen. Its cause remains under great debate, with the best contender so far being the massive volcanic eruptions at the "Central Atlantic magmatic province," a region that encompassed a staggering 4.2 million square miles (11 million square kilometers), an area larger than Canada. Another main possibility could be an astronomical impact, Olsen said, although as with the K-T event, the evidence for both types of catastrophe can get maddeningly blurry.

The Permian-Triassic extinction

The largest of the Big Five was the end-Permian or Permian-Triassic extinction event roughly 250 million years ago, which eliminated as much as 95 percent of the planet's species.

Before this extinction, marine animals were mostly filter feeders stuck in place on the seafloor, such as crinoids or "sea lilies." Afterward, the seas became far more complex with mobile creatures such as snails, urchins and crabs.

The most likely final trigger for the end-Permian was again massive volcanism, this time at the Siberian Traps, which spewed as much as 2.7 million square miles (7 million square kilometers) of lava out, an area nearly as large as Australia.

Recent evidence suggests, however, that the end-Permian may have been long in the making.

The late Devonian extinctions

The late Devonian extinction events were actually two sharp pulses of death about 360 million years ago, each just 100,000 to 300,000 years apart.

Each pulse was accompanied by a massive drop in temperature, with the steaming seas of the Devonian—surface temperatures of which were about 93 degrees F (34 degrees C)—dropping to about 78 degrees F (26 degrees C), "and marine organisms would not have liked that at all," McGhee said. As to what caused these cold snaps, the ever-popular suspects are ash and dust kicked up by either astronomical impacts or massive volcanism.

At that time, plants had made it onto land, as had spiders, scorpions and similar creatures. Right before the extinction events, the first proto-amphibians made it onto shore. However, the invasion of the so-called elpistostegalians—distant relatives of the coelacanth—"got wiped out by these extinction events," McGhee explained. "It wasn't until at least another 10 million years later that we got footprints from vertebrates on land

Reading B

again, this time from the ichthyostegalians, the proto-amphibians we're all descended from. Who knows how the world might have been different."

The Ordovician-Silurian extinctions

The earliest of the Big Five, the end-Ordovician or Ordovician-Silurian extinction events some 444 million years ago, are reckoned by many to be the second largest.

These also consisted of a pair of die-offs, apparently involving massive glaciation and a resulting fall in sea levels. The cause of this glaciation remains a mystery, but one idea was that land plants actually caused it, pulling so much carbon dioxide out of the atmosphere that global coolingresulted, McGhee explained.

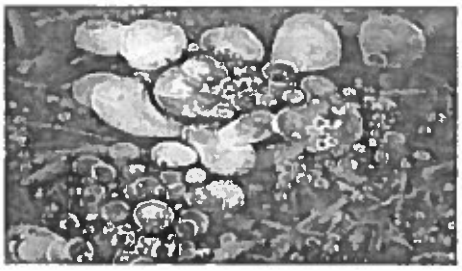
Curiously, even though the end-Ordovician led to a huge loss of life, in a way it actually had very little impact on the persistence of lineages. Although the four other Big Five extinction events led to huge changes in which animals rose to prominence, the same animals that dominated before the end-Ordovician dominated afterward.

Otherwise, "one neat thing about mass extinction events is that they're often reset buttons, where you change what dominates the globe," Conrad said. "You open the door to things like us to live."

BBC NATURE Prehistoric life

Mass extinction theories

Asteroid impacts, climate change, volcanoes - there have been many theories about the causes of mass extinctions. In some cases, such as the Cretaceous mass extinction event, more than one such factor was involved in the global catastrophe.



Catastrophic methane release

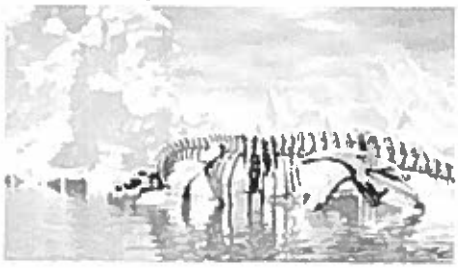
Catastrophic methane release has been suggested as a possible cause of mass extinction. Methane clathrate is an ice-like substance formed from water and methane in the sea bed, arctic lakes and permafrost.

Flood basalt eruptions

Flood basalt eruptions are a type of large-scale volcanic activity, both in terms of extent and duration, that can

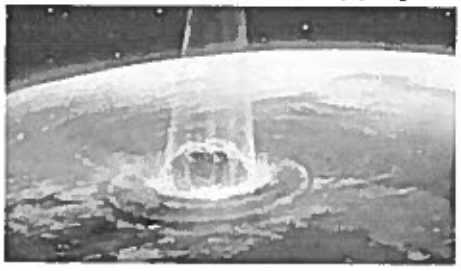
Reading C

occur on land or on the ocean floor. A flood basalt may continue to erupt for tens of thousands - possibly millions - of years and the lava can cover hundreds of thousands of kilometres.



Climate change

Earth's climate is not constant. Over geological time, the Earth's dominant climate has gone from ice age to tropical heat and from steamy jungles to searing deserts.



Impact events

Impact events, proposed as causes of mass extinction, are when the planet is struck by a comet or meteor large enough to create a huge shockwave felt around the globe. Widespread dust and debris rain down, disrupting the climate and causing extinction on a global, rather than local, scale.

Big Five extinction events

1. Ordovician-Silurian mass extinction
2. Late Devonian mass extinction
3. Permian mass extinction
4. Triassic-Jurassic mass extinction
5. Cretaceous-Tertiary mass extinction

Reading D

Mass Extinctions

More than 90 percent of all organisms that have ever lived on Earth are extinct. Learn what may cause animal die-offs.

ARTWORK BY PETER ARNOLD, INC., ALAMY

More than 90 percent of all organisms that have ever lived on Earth are extinct. As new species evolve to fit ever changing ecological niches, older species fade away. But the rate of extinction is far from constant. At least a handful of times in the last 500 million years, 50 to more than 90 percent of all species on Earth have disappeared in a geological blink of the eye.

Though these mass extinctions are deadly events, they open up the planet for new life-forms to emerge. Dinosaurs appeared after one of the biggest mass extinction events on Earth, the Permian-Triassic extinction about 250 million years ago. The most studied mass extinction, between the Cretaceous and Paleogene periods about 65 million years ago, killed off the dinosaurs and made room for mammals to rapidly diversify and evolve.

Scientists have narrowed down several of the most likely causes of mass extinction. Flood basalt events (volcano eruptions), asteroid collisions, and sea level falls are the most likely causes of mass extinctions, though several other known events may also contribute. These include global warming, global cooling, methane eruptions and anoxic events–when the earth's oceans lose their oxygen.

Both volcano eruptions and asteroid collisions would eject tons of debris into the atmosphere, darkening the skies for at least months on end. Starved of sunlight, plants and plant-eating creatures would quickly die. Space rocks and volcanoes could also unleash toxic and heat-trapping gases that—once the dust settled—enable runaway global warming.

LARGEST FIVE DIE-OFFS

Reading D

An extraterrestrial impact is most closely linked to the Cretaceous-Paleogene extinction event, one of the five largest in the history of the world, and the most recent. A huge crater off Mexico's Yucatán Peninsula is dated to about 65 million years ago, coinciding with the extinction. Global warming fueled by volcanic eruptions at the Deccan Flats in India may also have aggravated the event. Dinosaurs, as well as about half of all species on the planet, went extinct.

Massive floods of lava erupting from the central Atlantic magmatic province about 200 million years ago may explain the Triassic-Jurassic extinction. About 20 percent of all marine families went extinct, as well as most mammal-like creatures, many large amphibians, and all non-dinosaur archosaurs. An asteroid impact is another possible cause of the extinction, though a telltale crater has yet to be found.

The Permian-Triassic extinction event was the deadliest: More than 90 percent of all species perished. Many scientists believe an asteroid or comet triggered the massive die-off, but, again, no crater has been found. Another strong contender is flood volcanism from the Siberian Traps, a large igneous province in Russia. Impact-triggered volcanism is yet another possibility.

Starting about 360 million years ago, a drawn-out event eliminated about 70 percent of all marine species from Earth over a span of perhaps 20 million years. Pulses, each lasting 100,000 to 300,000 years, are noted within the larger late Devonian extinction. Insects, plants, and the first proto-amphibians were on land by then, though the extinctions dealt landlubbers a severe setback.

DINOSAURS 101 They ruled the Earth for more than 160 million years, but much about how dinosaurs lived and died remains a mystery. See what we know and don't know about the age of dinos.

Reading D

The Ordovician-Silurian extinction, about 440 million years ago, involved massive glaciations that locked up much of the world's water as ice and caused sea levels to drop precipitously. The event took its hardest toll on marine organisms such as shelled brachiopods, eel-like conodonts, and the trilobites.

EXTINCTION TODAY

Today, many scientists think the evidence indicates a sixth mass extinction is under way. The blame for this one, perhaps the fastest in Earth's history, falls firmly on the shoulders of humans. By the year 2100, human activities such as pollution, land clearing, and overfishing may drive more than half of the world's marine and land species to extinction.

Extinction Name and details	Causes (from video)	Causes (from articles)
Ordovician		
Late Devonian		
End Permian		
End Triassic		
End Cretaceous		

Name _____ Period _____

Jigsaw Matrix – Mass Extinction Events

	Ordovician	Late Devonian	End Permian	End Triassic	Cretaceous (KT)
When did this extinction take place?					
What % of life was lost?					
What kinds of organisms lived before the extinction?					
What do scientists believe caused the extinction event?					
What types of plants and/or animals evolved after the extinction event.					

Name: Period:

Anchor Text

ARTICLE	QUESTION, CONNECTION, SUMMARY
Human Actions and the Sixth Mass Extinction (Causes)	
 (Figure 1)	
This is one of the most powerful birds in the world. Could it go extinct? The Philippine Eagle (Figure 1), also known as the Monkey-eating Eagle, is among the rarest, largest, and most powerful birds in the world. It is critically endangered, mainly due to massive loss of habitat due to deforestation in most of its range. Killing a Philippine Eagle is punishable under Philippine law by twelve years in jail and heavy fines.	
Human Actions and the Sixth Mass Extinction Over 99 percent of all **species** that ever lived on Earth have gone extinct. Five mass extinctions are recorded in the **fossil record.** They were caused by major geologic and climatic events. Evidence shows that a sixth **mass extinction** is occurring now. Unlike previous mass extinctions, the sixth extinction is due to human actions.	
Some scientists consider the sixth extinction to have begun with early hominids during the Pleistocene. They are blamed for over-killing big mammals such as mammoths. Since then, human actions have had an ever greater impact on other species. The present rate of extinction is between 100 and 100,000 species per year. In 100 years, we could lose more than half of Earth's remaining species	

Causes of Extinction

The single biggest cause of extinction today is **habitat loss**. Agriculture, forestry, mining, and urbanization have disturbed or destroyed more than half of Earth's land area. In the U.S., for example, more than 99 percent of tallgrass prairies have been lost. Other causes of extinction today include:

Exotic species introduced by humans into new habitats. They may carry disease, prey on native species, and disrupt food webs. Often, they can out-compete native species because they lack local predators. An example is described in **Figure 2**

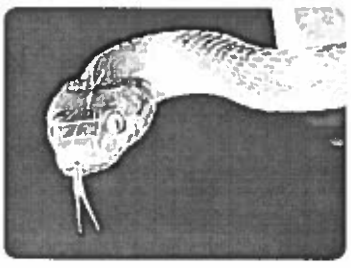
Over-harvesting of fish, trees, and other organisms. This threatens their survival and the survival of species that depend on them.

Global climate change, largely due to the burning of fossil fuels. This is raising Earth's air and ocean temperatures. It is also rising sea levels. These changes threaten many species.

Pollution, which adds chemicals, heat, and noise to the environment beyond its capacity to absorb them. This causes widespread harm to organisms.

Human overpopulation, which is crowding out other species. It also makes all the other causes of extinction worse.

Brown Tree Snake



Brown tree snakes "hitch-hiked" from their native Australia on ships and planes to Pacific Islands such as Guam. Lacking local island predators, the snakes multiplied quickly. They have already caused the extinction of many birds and mammals they preyed upon in their new island ecosystems.

Figure 2

The brown tree snake is an exotic species that has caused many extinctions on Pacific islands such as Guam.

Effects of Extinction The results of a study released in the summer of 2011 have shown that the decline in the numbers of large predators like sharks, lions and wolves is disrupting Earth's ecosystem in all kinds of unusual ways. The study, conducted by scientists from 22 different institutions in six countries, confirmed the sixth mass extinction.	
The study states that this mass extinction differs from previous ones because it is entirely driven by human activity through changes in land use, climate, pollution, hunting, fishing and poaching. The effects of the loss of these large predators can be seen in the oceans and on land.	
Fewer cougars in the western US state of Utah led to an explosion of the deer population. The deer ate more vegetation, which altered the path of local streams and lowered overall biodiversity. In Africa, where lions and leopards are being lost to poachers, there is a surge in the number of olive baboons, who are transferring intestinal parasites to humans living nearby. In the oceans, industrial whaling led a change in the diets of killer whales, who eat more sea lions, seals, and otters and have dramatically lowered the population counts of those species	
The study concludes that the loss of big predators has likely driven many of the pandemics, population collapses and ecosystem shifts the Earth has seen in recent centuries.	
Disappearing Frogs Around the world, frogs are declining at an alarming rate due to threats like pollution, disease, and climate change. Frogs bridge the gap between water and land habitats, making them the first indicators of ecosystem changes.	

Nonnative Species Scoop a handful of critters out of the San Francisco Bay and you'll find many organisms from far away shores. Invasive kinds of mussels, fish, and more are choking out native species, challenging experts around the state to change the human behavior that brings them here.	
How You Can Help Protect Biodiversity There are many steps you can take to help protect **biodiversity**. For example: Consume wisely. Reduce your consumption wherever possible. Re-use or recycle rather than throw out and buy new. When you do buy new, choose products that are energy efficient and durable. Avoid plastics. Plastics are made from petroleum and produce toxic waste. Go organic. Organically grown food is better for your health. It also protects the environment from pesticides and excessive nutrients in fertilizers. Save energy. Unplug electronic equipment and turn off lights when not in use. Take mass transit instead of driving.	

Summary

- Evidence shows that a sixth mass extinction is occurring. The single biggest cause is habitat loss caused by human actions.
- There are many steps you can take to help protect biodiversity. For example, you can use less energy.

Vocabulary

Term	Definition
exotic species	Species that is introduced (usually by human actions) into a new habitat where it may lack local predators and out-compete native species.
habitat loss	Destruction or disruption of Earth's natural habitats; most often due to human actions such as agriculture, forestry, mining, and urbanization.
sixth mass extinction	Current mass extinction; caused primarily by habitat loss due to human actions.

CHAPTER 1

Human Actions and the Sixth Mass Extinction

- Describe the sixth mass extinction.
- Relate human actions to the sixth mass extinction.
- Define habitat loss and exotic species.
- Give examples of the effects of extinction.
- Describe how biodiversity can be protected.

This is one of the most powerful birds in the world. Could it go extinct?

The Philippine Eagle, also known as the Monkey-eating Eagle, is among the rarest, largest, and most powerful birds in the world. It is critically endangered, mainly due to massive loss of habitat due to deforestation in most of its range. Killing a Philippine Eagle is punishable under Philippine law by twelve years in jail and heavy fines.

Human Actions and the Sixth Mass Extinction

Over 99 percent of all species that ever lived on Earth have gone extinct. Five mass extinctions are recorded in the fossil record. They were caused by major geologic and climatic events. Evidence shows that a **sixth mass extinction** is occurring now. Unlike previous mass extinctions, the sixth extinction is due to human actions.

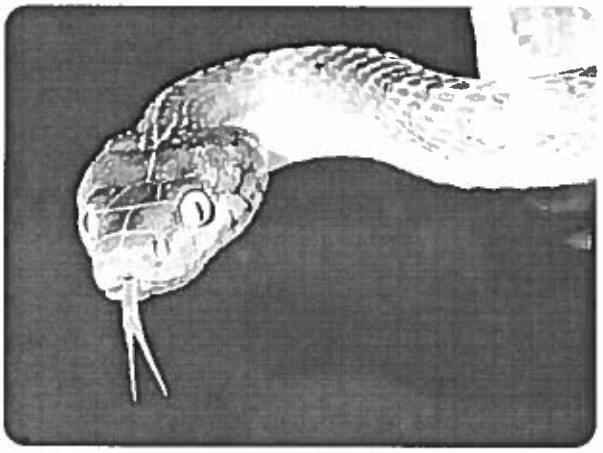
Some scientists consider the sixth extinction to have begun with early hominids during the Pleistocene. They are blamed for over-killing big mammals such as mammoths. Since then, human actions have had an ever greater impact on other species. The present rate of extinction is between 100 and 100,000 species per year. In 100 years, we could lose more than half of Earth's remaining species.

Causes of Extinction

The single biggest cause of extinction today is **habitat loss**. Agriculture, forestry, mining, and urbanization have disturbed or destroyed more than half of Earth's land area. In the U.S., for example, more than 99 percent of tall-grass prairies have been lost. Other causes of extinction today include:

- **Exotic species** introduced by humans into new habitats. They may carry disease, prey on native species, and disrupt food webs. Often, they can out-compete native species because they lack local predators. An example is described in **Figure** 1.1.
- Over-harvesting of fish, trees, and other organisms. This threatens their survival and the survival of species that depend on them.
- Global climate change, largely due to the burning of fossil fuels. This is raising Earth's air and ocean temperatures. It is also raising sea levels. These changes threaten many species.
- Pollution, which adds chemicals, heat, and noise to the environment beyond its capacity to absorb them. This causes widespread harm to organisms.
- Human overpopulation, which is crowding out other species. It also makes all the other causes of extinction worse.

Brown Tree Snake



Brown tree snakes "hitch-hiked" from their native Australia on ships and planes to Pacific Islands such as Guam. Lacking local island predators, the snakes multiplied quickly. They have already caused the extinction of many birds and mammals they preyed upon in their new island ecosystems.

FIGURE 1.1

The brown tree snake is an exotic species that has caused many extinctions on Pacific islands such as Guam.

Effects of Extinction

The results of a study released in the summer of 2011 have shown that the decline in the numbers of large predators like sharks, lions and wolves is disrupting Earth's ecosystem in all kinds of unusual ways. The study, conducted by scientists from 22 different institutions in six countries, confirmed the sixth mass extinction. The study states that this mass extinction differs from previous ones because it is entirely driven by human activity through changes in

land use, climate, pollution, hunting, fishing and poaching. The effects of the loss of these large predators can be seen in the oceans and on land.

- Fewer cougars in the western US state of Utah led to an explosion of the deer population. The deer ate more vegetation, which altered the path of local streams and lowered overall biodiversity.
- In Africa, where lions and leopards are being lost to poachers, there is a surge in the number of olive baboons, who are transferring intestinal parasites to humans living nearby.
- In the oceans, industrial whaling led a change in the diets of killer whales, who eat more sea lions, seals, and otters and have dramatically lowered the population counts of those species.

The study concludes that the loss of big predators has likely driven many of the pandemics, population collapses and ecosystem shifts the Earth has seen in recent centuries.

Disappearing Frogs

Around the world, frogs are declining at an alarming rate due to threats like pollution, disease, and climate change. Frogs bridge the gap between water and land habitats, making them the first indicators of ecosystem changes.

MEDIA

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Nonnative Species

Scoop a handful of critters out of the San Francisco Bay and you'll find many organisms from far away shores. Invasive kinds of mussels, fish, and more are choking out native species, challenging experts around the state to change the human behavior that brings them here.

MEDIA

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URL: https://www.ck12.org/flx/render/embeddedobject/444

How You Can Help Protect Biodiversity

There are many steps you can take to help protect biodiversity. For example:

- Consume wisely. Reduce your consumption wherever possible. Re-use or recycle rather than throw out and buy new. When you do buy new, choose products that are energy efficient and durable.
- Avoid plastics. Plastics are made from petroleum and produce toxic waste.
- Go organic. Organically grown food is better for your health. It also protects the environment from pesticides and excessive nutrients in fertilizers.
- Save energy. Unplug electronic equipment and turn off lights when not in use. Take mass transit instead of driving.

Lost Salmon

Why is the salmon population of Northern California so important? Salmon do not only provide food for humans, but also supply necessary nutrients for their ecosystems. Because of a sharp decline in their numbers, in part due to human interference, the entire salmon fishing season off California and Oregon was canceled in both 2008 and 2009. The species in the most danger of extinction is the California coho salmon.

MEDIA

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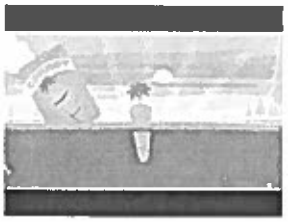
Summary

- Evidence shows that a sixth mass extinction is occurring. The single biggest cause is habitat loss caused by human actions.
- There are many steps you can take to help protect biodiversity. For example, you can use less energy.

Review

1. How is human overpopulation related to the sixth mass extinction?
2. Why might the brown tree snake or the Philippine Eagle serve as "poster species" for causes of the sixth mass extinction?
3. Describe a hypothetical example showing how rising sea levels due to global warming might cause extinction.
4. Create a poster that conveys simple tips for protecting biodiversity.

Resources



MEDIA

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Name
Period
Date

Topic: Mass Extinction
Essential Question: What conclusions can be drawn based on the evidence presented in The Day the Mesozoic Died about the extinction of the dinosaurs?

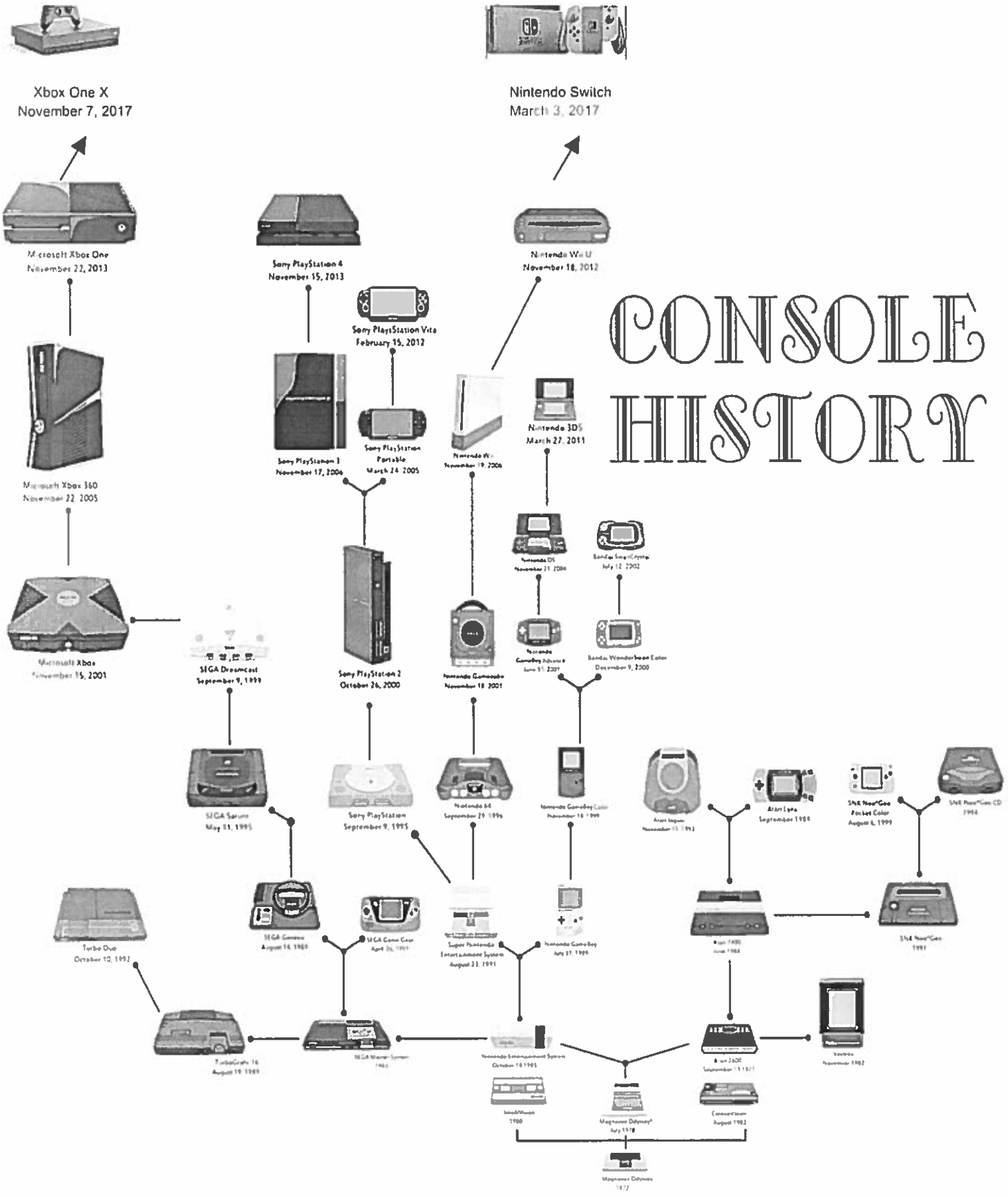
Questions and Key Points	Class Notes
	0:00 <u>Act 1: An Earth Shattering Hypothesis</u> 1. 00:20 What kind of animal species are the dinosaurs? 2. 05:00 What is the Cretaceous-Tertiary or "K-T" boundary? 3. 07:00 During what era of geologic time did the dinosaurs live? (Paleozoic, Mesozoic, Cenozoic) 4. 12:00 What is a possible source of high levels of iridium in sediments? 5. 14:00 true or false: "The entire scientific community accepted the asteroid hypothesis after Dr. Alvarez published his paper showing high iridium levels at the K-T boundary." 15:30 <u>Act 2: An Earth Shattering Hypothesis</u> 6. 15:30 Why was the scientific community was slow to accept the asteroid impact hypothesis of Dr. Louis Alvarez? 23:00 <u>Act 3: An Earth Shattering Hypothesis</u> 28:30 How could an asteroid impact kill off so many different species?

	8. 30:00 Why do we define the K-T event as a mass extinction event? **9. 32:00 What did Dr. Carroll mean at the end of the film when he said...** **"It's not always the survival of the fittest; sometimes it's the survival of the luckiest?"**

Summary

Use your questions and key points to create a summary of learning. It should be at least **10 sentences** long.

CONSOLE HISTORY



Name _____ Date_____

Period _____

Fossil Record Experience

Background:

Fossils are traces of organisms that lived in the past. When fossils are found, they are carefully excavated and then analyzed. Most fossils form by one of three methods. Sometimes the hard structures such as bones, teeth or shells create an imprint in rocks. Another way fossils are formed is by the replacement of structures in the organism with minerals in a process known as petrification. The third procedure resulting in the creation of a fossil is simply when the body part is preserved when sediment covers it. Analysis of fossils includes dating and careful observations of **morphology,** or the changes in physical characteristics, so that relations to other fossils or existing organisms can be determined.

Goal:

In this lab you will be working with the a fictitious organism of the genus "Adventurian", You will categorize "Adventurian" fossils by similarities in **morphology** and age in an attempt to give specific evidence that organisms of the genus "Adventurian" evolved. Hint: Look for patterns.

Hypothesis: Do you think it is possible to tell if an organism has evolved from examining its fossil record? Explain your thinking.

_____

_____

_____

_____

_____

_____

Directions:

1. Gather one piece of chart paper (27" x 30") per team. Cut it in half vertically. Tape both pieces together to create a long piece of paper.

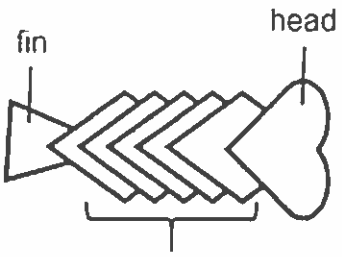
2. Copy the FOSSIL ORGANISM TABLE found on PG 5 of these instructions to your chart paper. Each row should measure around 2" in height. Notice that the "organism" column takes up more than half the page. Calculate the duration (in millions of years) for each era/epoch, and fill it your answers is the correct column.

3. The group of "fossils" you will work with are fictitious (not real) animals. Each fossil on your sheet is marked with a time period. Cut out each fossil making sure you include the **time period** marked below it. Arrange the fossils by age. On your chart, place each fossil in the period from which the fossil came from.

Adapted from https://betterlesson.com/lesson/638053/fossil-record-experience 12/8/17

4. There is one fossil marked "mystery fossil." Place this fossil aside. You will be using it later on in the activity.

5. While keeping the fossils in the proper age order, arrange them by **morphology** (appearance). To help you understand the **morphology** of the specimen, view the diagram to the right.



6. Arrange the fossils using the following steps.
   a. Center the oldest fossil at the bottom of the fossil column (the oldest layer).

   b. Through the chart, those fossils that appear to be the same (or close to the same) as the fossils preceding them should be placed in a vertical line on top of the oldest fossil. (So you follow The Law of Superposition)

   c. During a certain period, the fossils will split into two branches. In other words, one fossil from that period will show one type of change, and another fossil will show a different change. When this happens, place the fossils side by side in the appropriate time period. From this point on you will have two **lineages** (a group that can demonstrate their common descent).

7. Once all the fossils have been placed correctly according to time and **morphology,** tape or glue the fossils in place.

Fossil Lab Analysis Questions

1. **Directly on your chart**, describe the evolutionary changes you see. This means, add a description of the change from one organism to the next. For example:

Barbs appear under the face  Silurian	443 MYA	26 MY
 Cambrian	545 MYA	50 MY

2. During which time period did the fossils differentiate (break) into two branches.

   _____

3. After the branching, what kind of environment do you think the "gray heads" lived in? Explain why you think so providing evidence from your observations and your own knowledge of animals.

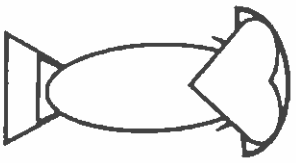
_____
_____
_____
_____
_____
_____

4. After the branching, what kind of environment do you think the "white heads" lived in? Explain why you think so,providing evidence from your observations and your own knowledge of animals.

_____
_____
_____
_____
_____
_____

5. EUREKA! You have found another fossil!

Compare its morphology to the fossils you have on your chart. In what time period do you think this fossil belongs? Tape your Mystery Fossil on your chart where you think it belongs. Explain why you decided to place the mystery fossil here on the chart.



Mystery fossil

6. Of the two major species that arose from the parent species, which was more successful? How do you know?

7. Go back to your hypothesis found on PG 1, use evidence from your fossil chart to prove/disprove that the genus Adventurian has evolved.

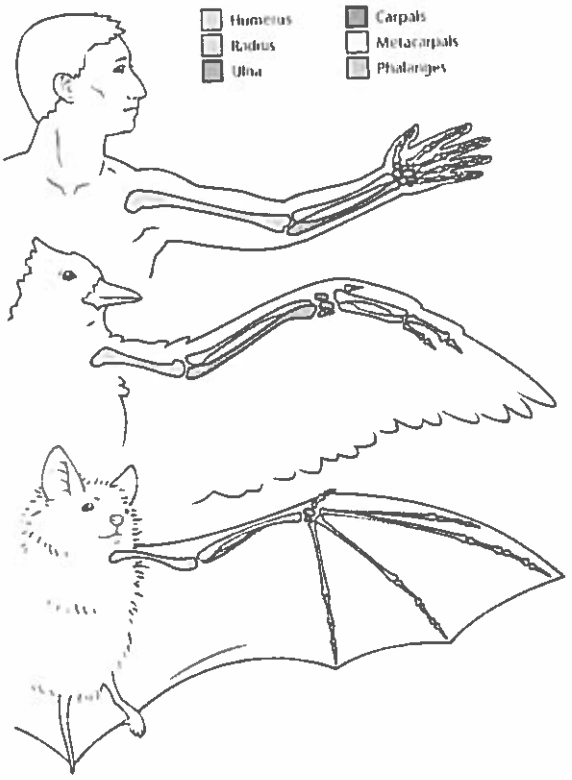
FOSSIL ORGANISM CHART

Organism	Eras/Epochs	Began (millions of years ago)	Duration (in million years)
	Tertiary/Miocene	21 mya	18.5 my
	Tertiary/Californian	23.8 mya	
	Tertiary/ Oligocene	33.7 mya	
	Tertiary/ Eocene	54.8 mya	
	Tertiary/ Paleocene	65 mya	
	Cretaceous	142 mya	
	Jurassic	205.7 mya	
	Triassic	248.2 mya	
	Permian	290 mya	
	Pennsylvanian	323 mya	
	Mississippian	354 mya	
	Devonian	417 mya	
	Silurian	443 mya	
	Ordovician	495 mya	52 my
	Cambrian	545 mya	50 my

NAME _____ Date_____

Period _____

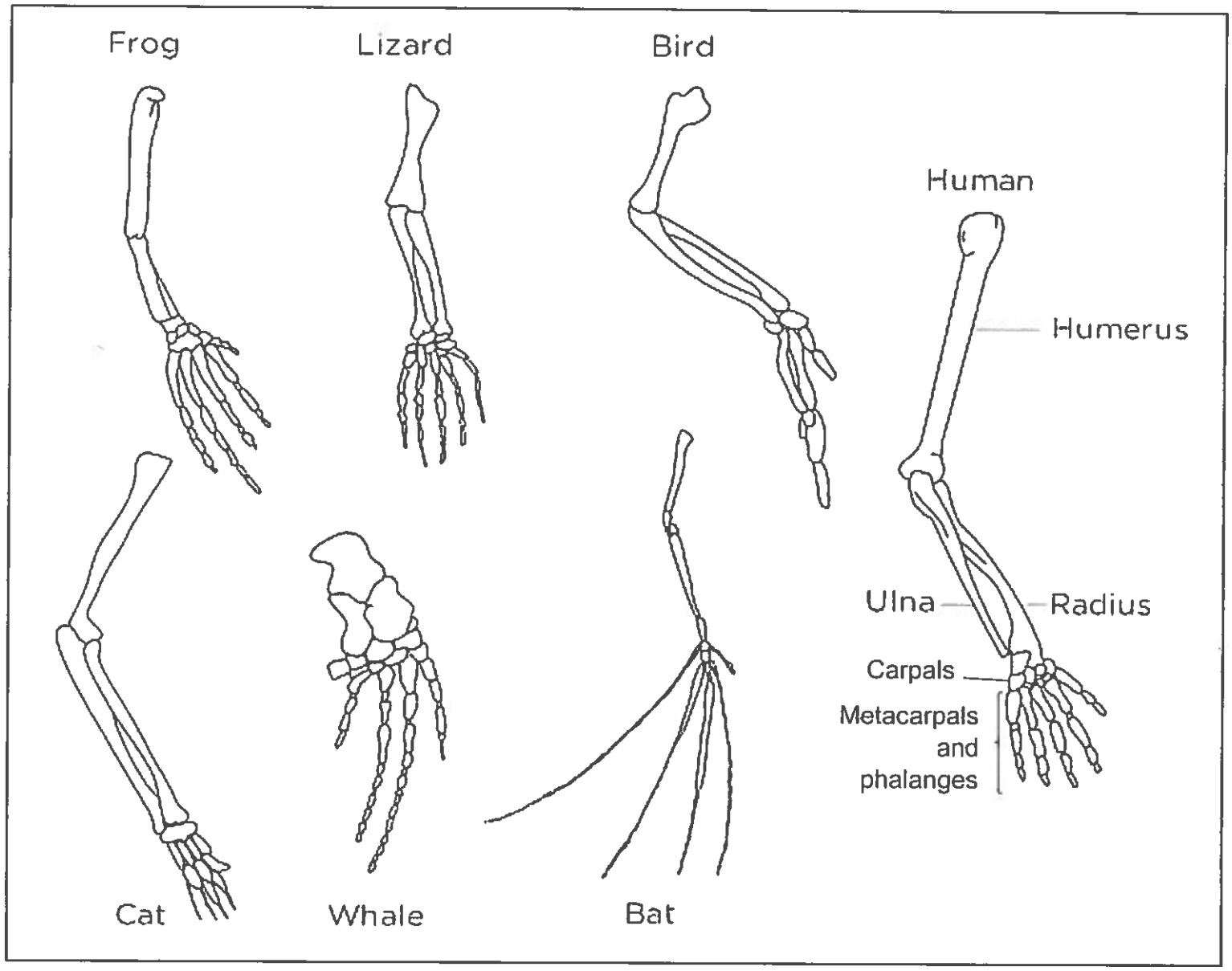
Homologous Structures



Directions: "Based on what we have discussed, and the evidence you see here, who do you think we (humans) are more closely related to, bats or chickens?" Use the TEPAC strategy to support your answer.

Name: _____

Identify the homologous structures in these bones. Use five different colors.



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Whale of a Tale Activity

Whales, dolphins, and porpoises are mammals that live in the sea. Like all mammals, they are warm-blooded animals that give birth to live young and need air to breathe. DNA evidence shows that whales are closely related to hoofed land mammals such as hippopotamuses, pigs, cows, and sheep. All of these mammals are thought to have descended from a single species that lived millions of years ago and is now extinct. Besides DNA evidence, what other evidence suggests that these animals are related?

How are modern and fossil skeletons used to investigate evolution?

Getting Started:

1. Whales are aquatic mammals. How do you think whales evolved: Do you think that some mammals moved from land to sea or that a type of fish evolved to have mammalian (mammal) traits?

_____

_____

_____

2. What type of evidence could help answer this question?

_____

_____

_____

The Fossil Exhibit

You've just been hired as the assistant curator of the fossil collection of a museum. On your first day, you discover that the skeletons in the exhibit on the evolution of whales have all been moved to a new room and need to be arranged. Unfortunately, you are not a whale expert and the skeletons are not clearly labeled.

A local middle school has scheduled a field trip to the museum. It is very important that you arrange the skeletons properly before the students arrive. You decide to examine them to see if you can figure out how they should be arranged.

Procedure:

1. **Compare** the "Skeleton Cards". Based on similarities you observe, group the skeletons into two sets, each containing two or three cards. The set of skeletons containing Skeleton A should be called "Group 1." The other set of skeletons will be "Group 2."
2. In the first column of the table below, **record** which skeletons you put in each group.
3. **Compare** the skeletons *within* each group. In the table, **describe and record** as many similarities and differences as you can.
4. **Compare** Group 1 skeletons with those of Group 2. In your table, **describe and record** as many similarities and differences as you can.

Comparing Skeletons

	Similarities	**Differences**
Group 1 skeletons: (List the letters in this group)		
Group 2 skeletons: (List the letters in this group)		
Group 1 skeletons compared with Group 2 skeletons		

Order of Skeletons for Exhibit:

It's time to figure out how to arrange the exhibit! Use similarities and differences in the skeletons to arrange the cards in order. (While all five skeletons can be in a single line, they don't have to be.) **Record** the order in which you have arranged the skeletons in the space provided below. Hint: Place the two least similar skeletons on either side of your desk. Then arrange the other three skeletons between them.

You're in luck! You discover a chart with information about the relative ages of the five skeletons. See Student Sheet 99.1, "Whale Fossil Chart."

Compare the age data from Student Sheet 99.1 with the order in which you placed the skeletons above.

If necessary, rearrange your Skeleton Cards. **Record** your final reconstruction of the museum exhibit in the space provided below.

Final Reconstruction:

Follow-Up:

Use the Whale Evolution Chart to answer the following questions.

1. How are whales and cows related?

2. Is there a **pattern** in this evolutionary tree toward evolving to live in water?

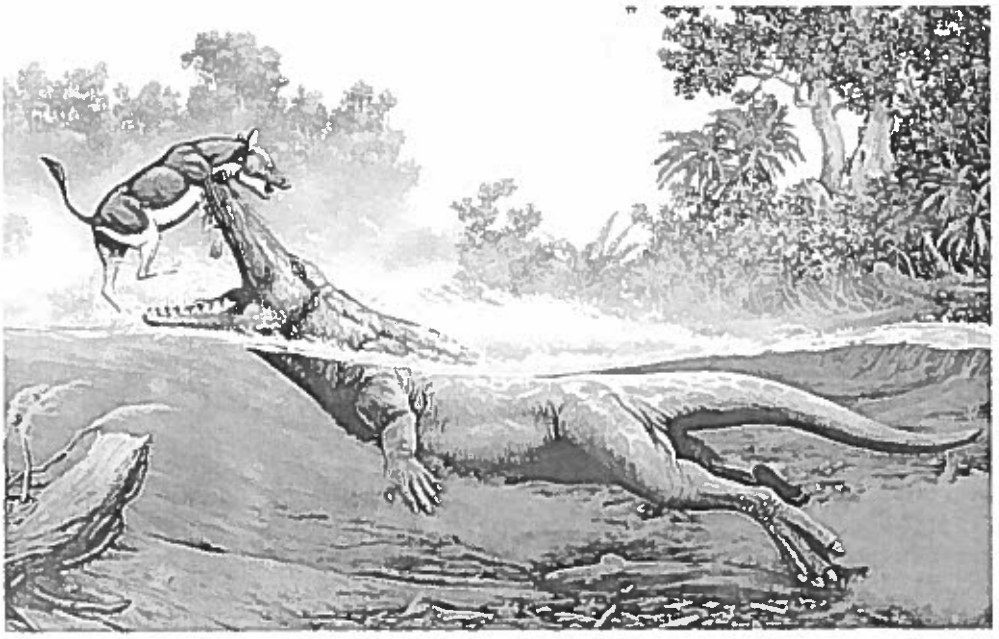


Figure 1 - Scientific Illustration of an Ambulocedtid

3. Look at Figure 1 on the previous page. Do you think the ambulocetid is a reptile? Explain your thinking.

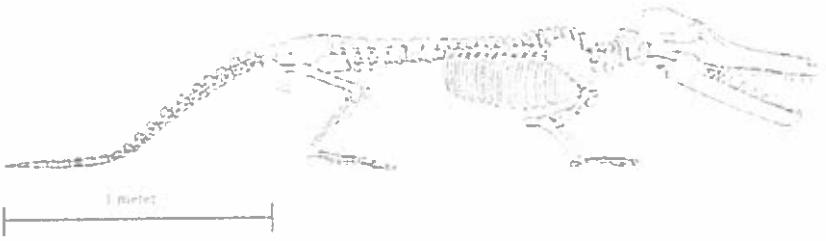
4.. **Compare** the amubulocetid to the modern whale? What are their similarities?

5.. Look again at Skeleton A. This is known as an ambulocetid (am-byoo-low-SEE-tid). The word *ambulocetid* means "walking whale." Where do you think the ambulocetids lived? Describe how you think they lived?

6. In this activity, you examined extinct and modern whale skeletons. How does the study of these skeletons provide evidence about how species are related?

Skeleton Cards

A



LAB-aIDS Issues Life Science

B

LAB-aIDS Issues Life Science

D

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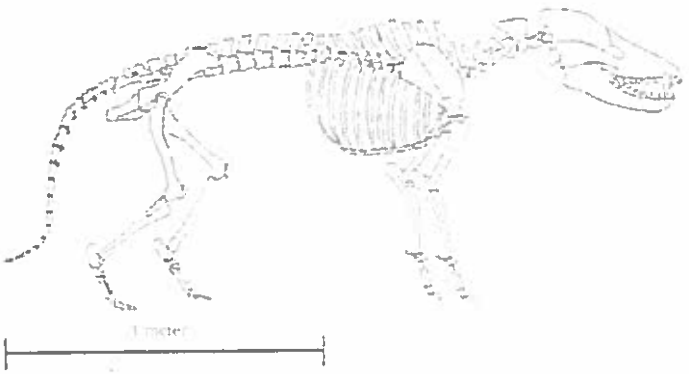
Skeleton Cards

M



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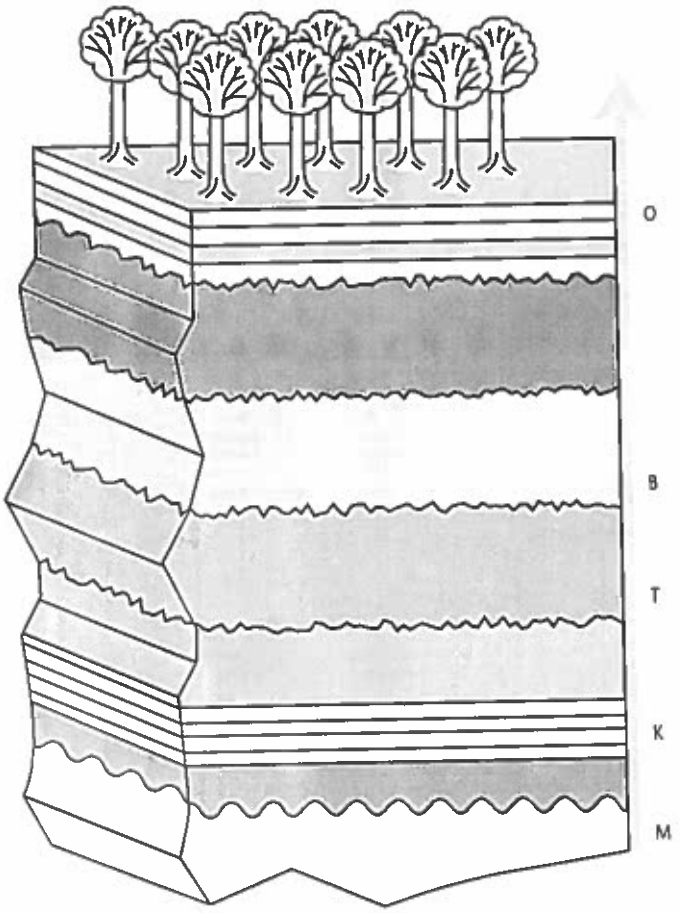
NAME _____ DATE _____

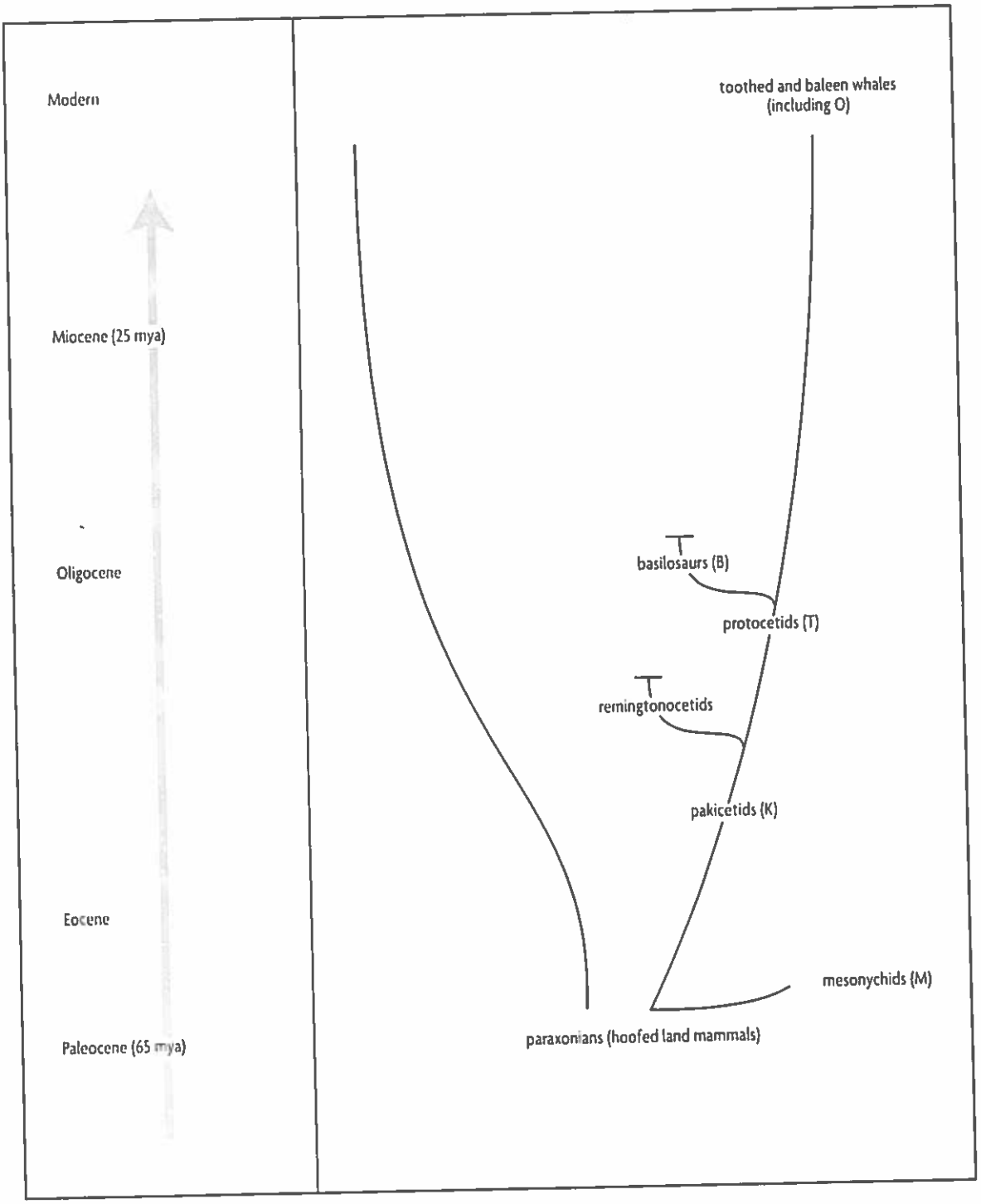
Whale Fossil Chart

The layers of rock shown are called strata. Deeper strata are older, while upper strata are more recent.



NAME _____ DATE _____

Whale Evolutionary Tree



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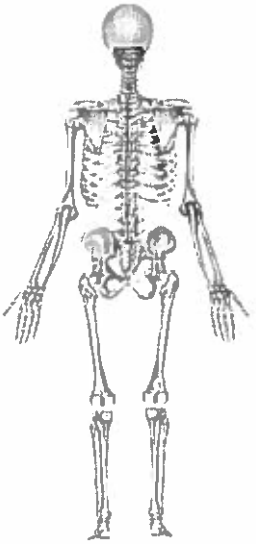
4.5: Structural Evidence for Evolution

Difficulty Level: **At Grade** Created by: CK-12

Author's Claim: _____

_____

Directions: Highlight evidence that either supports or disproves the author's claim. In the boxes annotate your highlights making either: a question, connection, or summary of the information you chose to highlight. Lastly, STAR any crosscutting concepts that you see in the article. In the box write how this cross cutting concept helps you "think like a scientist."

Why do you have a tail bone? If you look closely at a skeleton, you might notice a triangular bone at the end of the spinal column. This is your tailbone. Why would you have a tailbone when you don't have a tail? You have a tailbone because your ancient ancestors *did* have a tail. These sorts of "left-over" structures support the **theory of evolution.**	
Structural Evidence Even though two different species may not look similar, they may have similar internal structures that suggest they have a **common ancestor**. That means both evolved from the same ancestor organism a long time ago. Common ancestry can also be determined by looking at the structure of the organism as it first develops.	

Vestigial Structures Some of the most interesting kinds of evidence for evolution are body parts that have lost their use through evolution (**Figure** below). For example, most birds need their wings to fly. But the wings of an ostrich have lost their original use. Structures that have lost their use through evolution are called **vestigial structures**. They provide evidence for evolution because they suggest that an organism changed from using the structure to not using the structure, or using it for a different purpose. Penguins do not use their wings, known as flippers, to fly in the air. However, they do use them to move in the water. The theory of evolution suggests that penguins evolved to use their wings for a different purpose. A whale's pelvic bones, which were once attached to legs, are also vestigial structures. Whales are descended from land-dwelling ancestors that had legs.	
Homologous structures are structures that have a common function and suggest common ancestry. For example, homologous structures include the limbs of mammals, such as bats, lions, whales, and humans, which all have a common ancestor. Different mammals may use their limbs for walking, running, swimming or flying. The method the mammal uses to move is considered a common function.	

Moles live underground where they do not need eyes to find their way around. This mole's eyes are covered by skin. Body parts that do not serve their original function are vestigial structures.

Similar Embryos

Some of the oldest evidence of evolution comes from **embryology**, the study of how organisms develop. An embryo is an animal or plant in its earliest stages of development. This means looking at a plant or animal before it is born or hatched. Centuries ago, people recognized that the embryos of many different species have similar appearances. The embryos of some species are even difficult to tell apart. Many of these animals do not differ much in appearance until they develop further.

Some unexpected traits can appear in animal embryos. For example, human embryos have gill slits just like fish! In fish they develop into gills, but in humans they disappear before birth. The presence of the gill slits suggests that a long time ago humans and fish shared a common ancestor.

The similarities between embryos suggests that these animals are related and have common ancestors. For example, humans did not evolve from chimpanzees. But the similarities between the embryos of both species suggest that we have an ancestor in common with chimpanzees. As our common ancestor evolved, humans and chimpanzees went down different evolutionary paths and developed different traits.	

Summary

- Vestigial structures, or structures that have lost their use through evolution, are important evidence of evolution.
- Studying the embryos of organisms also provides evidence that two very different animals could have descended from a common ancestor.

Vocabulary:

Evolution - change over time

Common ancestor - the most recent ancestor from which two different species evolved

Vestigial structures- structures that have lost their use through evolution

Homologous structures - structures that have a common function and suggest common ancestry.

Embryology- the study of how organisms develop

Name _____ Date _____

Anticipation Guide: Origins of Species

Before starting the activity, mark whether you agree (+) or disagree (–) with each statement below. After completing the activity, mark whether you agree (+) or disagree (–) with each statement below. Under each statement, explain how the activity gave evidence to support or change your ideas.

Before	After	
____	____	1. There is no variation within a species, only between species.
____	____	2. All genetic variation is due to mutations.
____	____	3. Harmful mutations often get passed on to the next generation.
____	____	4. A mutation can never be helpful to a species.
____	____	5. Natural selection means the organism that is best adapted to its environment is more likely to survive.
____	____	6. Two organisms are considered to be different species if they cannot successfully reproduce with each other.
____	____	7. Darwin observed beagles to develop his theory of evolution.

94 A Meeting of Minds

ROLE PLAY

Plenty of fossil evidence shows that most of the species that have lived in the past are no longer alive today. It also seems that most of the species on Earth today were not always here. In other words, different species of organisms have lived at different times in Earth's history. New species have descended from earlier species, but have changed over long periods of time. These changes through time are called **evolution.**

But how does evolution happen? Two major theories were proposed during the 19th century. The first was disproved and abandoned, while the second has helped evolution become a central idea in modern biology. What would it sound like if the original experts met and discussed the problem?

CHALLENGE **How does evolution happen?**

MATERIALS

For each student

1 **Student Sheet 94.1, "Intra-act: A Meeting of Minds"**

PROCEDURE

1. Assign a role for each person in your group. Assuming there are four people in your group, each of you will read one role.

Roles

Charles Darwin, 19th century scientist

Isabel Matos, science reporter for Station W-EVO

Jean-Baptiste Lamarck, 19th century scientist

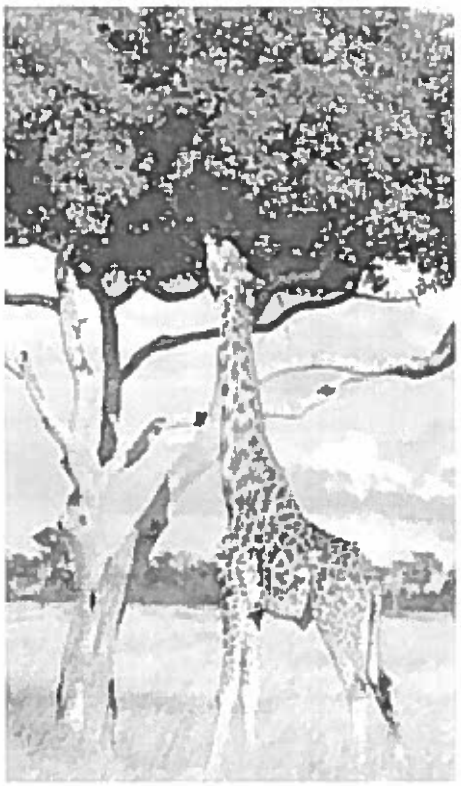
Wendy Chin, middle school student

2. Read the role play on the next pages aloud. As you read, think about what each character is saying.
3. Mark whether you think scientists today would agree or disagree with the statements on Student Sheet 94.1, "Intra-act: A Meeting of Minds."
4. Discuss the statements with your group.

HOW DO SPECIES EVOLVE?

Isabel Matos: In today's episode of "Time Travel News," we have brought together two of the first scientists to publish ideas on how evolution occurs. Visiting us from the 19th century are Jean-Baptiste Lamarck and Charles Darwin. Monsieur Lamarck, let's start with you.

Jean-Baptiste Lamarck: I was one of the first to recognize that species evolve. In 1809, I proposed the first theory of how evolution occurs. Allow me to explain my theory. Let's begin by talking about giraffes. Wendy, why do you think giraffes have such long necks?



Wendy Chin: To reach leaves at the tops of trees, I guess. They have to be able to get food.

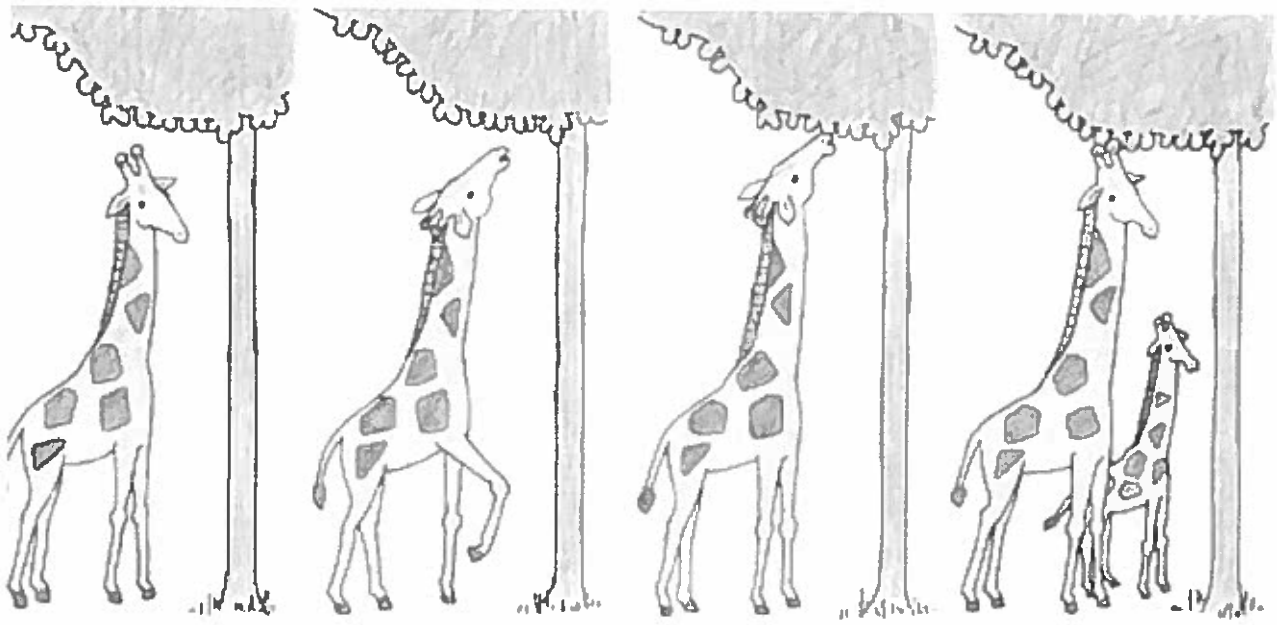
Lamarck: Quite right. I began to wonder how giraffes' necks became so long.

Wendy: I bet they evolved that way.

Lamarck: But how did this evolution occur? This is what I wanted to understand. My theory was that giraffes stretched their necks by reaching for leaves that were higher and higher on the trees. This made their necks longer.

Then, when they had babies, their babies had longer necks too. Look—this sketch helps explain my ideas.

LAMARCKIAN EVOLUTION



This is an adult giraffe.

The giraffe reaches for leaves slightly out of reach.

The use of the neck causes it to lengthen slightly.

The offspring of the giraffe also has a longer neck.

Wendy: Shouldn't a theory be based on evidence?

Matos: Mr. Lamarck, did you ever see an adult giraffe grow its neck longer?

Lamarck: Of course not. My idea was that the growth was very small, too small to measure in one generation.

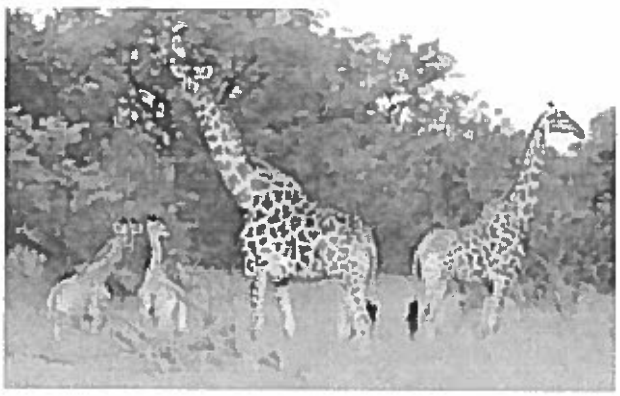
Charles Darwin: I'd like to explain another theory, called natural selection. Alfred Russel Wallace and I constructed this theory at about the same time. We also noticed that not all animals of the same type have the same features. Take horses, for instance.

Wendy: Oh, I know what you mean! There are horses of different sizes and colors, but they are all one species and can interbreed.

Darwin: Exactly—and the same is true of giraffes. Have you noticed that animals in the same species look different, or varied? This is important because, in the wild, some animals in each species usually die every year. Only animals that survive can give birth to offspring. Now, what feature of a giraffe might help it to survive and live to reproduce?

Lamarck: Its neck, of course! As I said before, it must stretch from being used so vigorously. Giraffes can then pass on the longer necks to their children.

What differences do you observe in these giraffes of the same species?



Matos: But Mr. Lamarck, modern scientists have found no evidence for your hypothesis that parents can pass *acquired* traits to their offspring. Consider professional wrestlers. They build muscles by lifting weights. But their babies are no stronger than other babies. If these babies want to have muscles like their parents, they have to pump a lot of iron too!

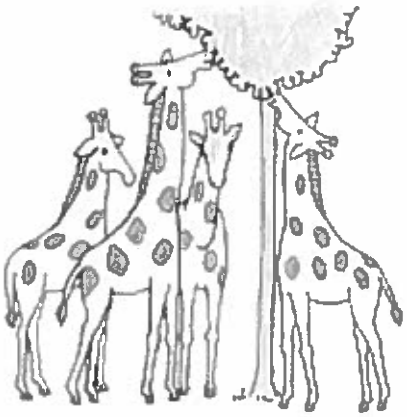
Darwin: But just like human babies, not all giraffes are the same. They have slight differences in all their characteristics, including neck length.

Lamarck: So you're saying any giraffe that happens to have a slightly longer neck can eat leaves that are higher in a tree than a shorter-necked giraffe can and therefore is more likely to survive.

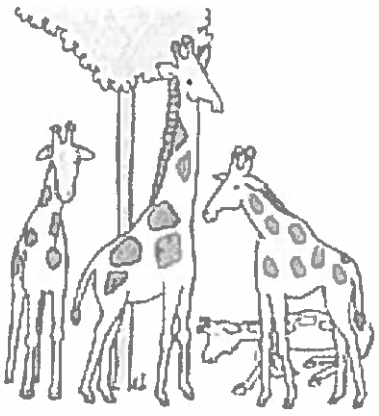
Wendy: So the longer-necked giraffes are more likely to live longer because they can reach more food. If more of these giraffes live longer, they can produce more offspring!

Darwin: That's right. Animals with certain features, such as giraffes with longer necks, are more likely to live to adulthood and have more babies. We call that process **natural selection**. Here's a sketch of how it works

DARWINIAN EVOLUTION (NATURAL SELECTION)



Giraffes with longer necks tend to reach leaves more easily.



Longer-necked giraffes are more likely to eat enough to survive . . .

. . . and reproduce. The offspring inherit their parent's longer necks.

Wendy: But why will the offspring of longer-necked giraffes have longer necks too?

Matos: Well, tall parents are more likely to have tall children, aren't they? The same is probably true of giraffes.

Darwin: According to my theory, each new generation of giraffes has, on the average, slightly longer necks than the generation before.

Lamarck: But not because they stretched their necks? Only because the longer-necked giraffes were more likely to survive and reproduce?

Wendy: I get it. Individual animals don't change, but over very long periods of time, the population of an entire species does.

Lamarck: But, Mr. Darwin, can your theory of natural selection explain why extinction occurs?

Darwin: I believe so. Consider the mammoth, which became extinct a few thousand years ago. Why didn't mammoths evolve and continue to survive?

Wendy: There are several theories about that. They became extinct during a time when the global climate was warmer than it had been before. The changing climate may have affected the mammoth's food supply, and human hunters may have contributed to the extinction.

Matos: So a species becomes extinct when it doesn't survive an environmental change. No individuals in the population have the traits necessary to survive.

Darwin: That's all it is. The **variation** in the population isn't enough to withstand environmental changes. In fact, sooner or later, most species become extinct.

Wendy: Let me get this straight. As time passes, species change, and we call this evolution. The way this occurs is by natural selection—some individuals in a population happen to be better suited to the environment and they're more likely to survive and reproduce.

Lamarck: As a result, the population as a whole over many generations comes to have an **adaptation**, such as a giraffe's longer neck.

Matos: Today, we know that we pass on characteristics like longer necks to our offspring through genes. Genes don't change because you exercise your neck.

Darwin: Tell us more about these genes.

Wendy: I learned about genes in school. Genes are things in our cells that we inherit from our parents. They cause us to have traits—the way we look and stuff.

Lamarck: Fascinating. I would like to learn more about this.

Darwin: Without this modern evidence, I hesitated to publish my theory for years, until Wallace sent me a brief paper containing the same ideas. Within a few years of our publications, scientists widely accepted the idea that species arise by descent with modification, or evolution.

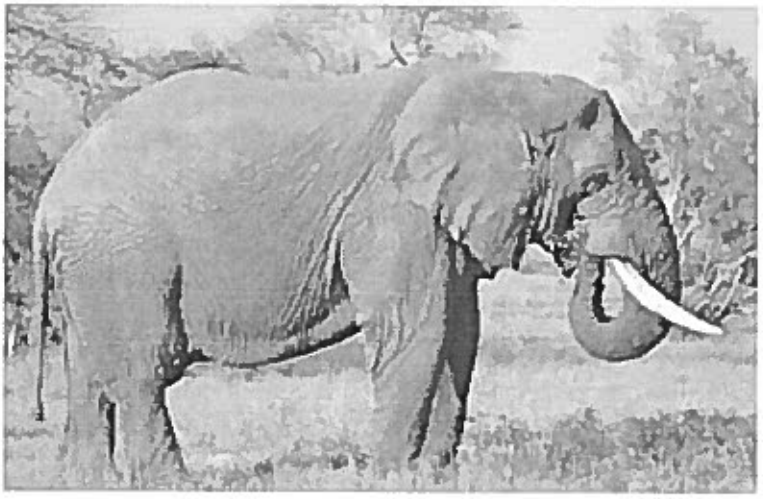
Matos: Thank you, Mr. Lamarck and Mr. Darwin. Viewers, I hope you've enjoyed meeting people from our past. Join us next week for a scintillating conversation with Marie Curie, the first woman scientist to receive a Nobel Prize.

ANALYSIS

1. a. Compare and contrast Lamarck's and Darwin's theories of evolution: What are the similarities? What are the differences?

   b. Why do scientists find Darwin's theory more convincing?

2. Ancestors of modern elephants had much shorter trunks than elephants do today. Use Lamarck's theory of evolution to explain how the trunks of elephants might get longer over many generations. Drawing a picture may help you to explain what you have learned.



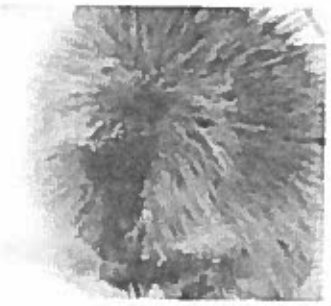
3. Use the Darwin/Wallace theory of natural selection to explain how the trunks of elephants might get longer over many generations. Drawing a picture may help you to explain what you have learned.

4. **Reflection:** When antibiotics were first used, antibiotic-resistant bacteria were rare. Today antibiotic resistance is becoming more and more common. How is the problem of antibiotic resistance in bacteria an example of natural selection?

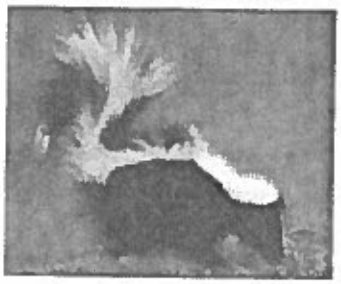
Name _____ Date _____
Period _____

Worm Natural Selection Lab

A SPECIES' INTERACTION WITH its environment can affect how likely members of the species are to survive and reproduce. Imagine a group of giraffes, all with slightly different neck lengths. Longer-necked giraffes would be better able to reach the uppermost leaves on tall trees. This might make them more likely to survive, reproduce, and pass their trait for a long neck on to their offspring. If this were to continue over many generations, longer necks would be called an adaptation to the tall-tree environment. An **adaptation** is a change in a trait that makes a species more likely to survive in its environment.



Adaptations that make a species more successful are not always traits that make the species stronger, bigger, or faster. For example, some adaptations decrease the chances that a species will be eaten by another species. Adaptations of this type include the skin colors of lizards, the spines of porcupines, and the scent glands of skunks.



CHALLENGE **How do factors such as the environment and the presence of predators affect the process of a species evolving?**

MATERIALS

- *For each group of four students*
  - 2 paper bags
  - 100 green toothpicks
  - 100 beige toothpicks
- *For each student*
  - 1 Student Sheet 60.1, "Worm Populations"
  - 1 clear plastic bag

Name _____ Date _____
Period _____

The Toothpick Worm Model

Imagine that you are a bird that eats small worms. In this activity, toothpicks of two different colors will represent the worms that you eat.

Procedures

Set up:

1. Each lanyard string represents a worm. Count 25 green "worms" and 25 white "worms" and place them into the paper bag labeled "worms". This will be your initial number of worms for each color.
2. Place the rest of the strings into the bag labeled "Reserved Toothpicks".
3. Shake the "Worm" bag to mix the worms.
4. As directed by your teacher, scatter the worms on top of a the "grass" (green construction paper) the worms are living on.

Lets Begin....

5. You are going to play the role of a bird that eats worms. Your group must "eat" (pick up) 40 worms, and so decide how many worms each member of your group will "eat".
6. Prepare to record your data
7. You must pick up the first worms that you see, regardless of the color, and place them in the clear plastic bag, which represents the bird's stomach.
8. Count the total number of green and beige worms eaten by your group. Record these totals in Row 2 of your data table. Be sure to stay in Generation 1 only.
9. Some worms are still alive. Subtract the number of worms that your group "ate" (row 2) from the initial population (row 1) and record the number of worms survived in row 3.
10. Each living worm is reproducing. Multiply the numbers of worms still alive by 4 and record your total in row 4.
11. Add one toothpick for each NEW green and beige worm into your paper bag labeled "Worms".
12. Calculate your final worm population by adding your total number of worms survived (row 3) and the total number of offspring (row 4) together. Record your FINAL worm population in row 5.
13. Repeat steps 3-12 for Generations 2 and 3.

Name _____ Date _____
Period _____

Table 1:	**Green** Worm Population			**White** Worm Population		
	Generation 1 (G1)	Generation 2 (G2)	Generation 3 (G3)	Generation 1 (G1)	Generation 2 (G2)	Generation 3 (G3)
1. Initial Worm Population	25	(G1 Row 5 #)	(G2 Row 5 #)	25	(G1 Row 5 #)	(G2 Row 5 #)
2. Number of Worms Eaten						
3. Number of Worms Survived (Row 1 - Row 2)						
4. Each living worm reproduces. Multiply (Row 3 x 4).	_____ x 4 = _____	_____ x 4 = _____	_____ x 4 = _____	_____ x 4 = _____	_____ x 4 = _____	_____ x 4 = _____
5. Final Worm Population in the Wild (Add Row 3 and Row 4)						

Lab Conclusion

1. In this activity, what effect did the environment (the color of the construction paper) have on the process of natural selection (who got eaten)?

_____
_____
_____
_____

2. In this activity, what role did the predator (bird) have in the process of natural selection (who got eaten)?

_____
_____
_____
_____

Name _____ Date _____
Period _____

3. Think about an alternative (different) scenario: Suppose a prolonged drought (very long period with little to no rain) resulted in the worm's habitat to change. The grass begins to dry and die, leaving only dead grass stalks. Would natural selection occur in one or both of the worms favor and why?

4. Based on the new scenario, how could you change the lab to test your prediction?

5. Next, think about what would happen if you repeated the lab blindfolded. How would your results be different?

6. What crosscutting concepts did you use in this lab to help you think like a scientist?

Reference Crosscutting Concepts

- Patterns.
- Cause and effect
- Scale, proportion, and quantity.
- Systems and system models.
- Energy and matter: Flows, cycles, and conservation.
- Structure and function.
- Stability and change.

Battling Beaks

During the history of Earth, species have both evolved and become extinct. Why do some species survive to reproduce while others do not?

EQ: What role does variation play in the process of natural selection?

The Forkbird Model

You will role-play a species called "forkbirds." They feed by spearing or scooping their food. During feeding time, each bird gathers "wild loops" and puts them in its "stomach" before gathering more food. Your goal is to gather enough food to survive and reproduce. This will allow you to pass your genes to the next generation. Sometimes a forkbird offspring will have a genetic mutation that makes it look different from its parent.

Materials

Plastic forks with 1, 2 and 4 tines
Plastic cups, number cube, tray, 1 cup of "wild loops"

Procedure

1. The initial forkbird population has beaks with only two tines. Each person in your group should begin the activity with a 2-tined fork. Record the initial population of each type of forkbird in the table.
2. Your teacher will tell you when feeding time begins, and then all of the forkbirds can feed.
3. When feeding time ends, count the number of wild loops eaten by each forkbird. Within your group, the two forkbirds that gathered the most food survive to reproduce. (If there is a tie for second place, then three forkbirds survive. The two forkbirds that tie should keep their forks and skip Step 4.)
4. The two surviving forkbirds should each toss the number cube. Use the table below to determine the type of beak of the offspring of each surviving forkbird. The group members whose forkbrids did not survive should now assume the roles of the offspring.

Number Cube Key

Your Toss	Forkbird Offspring
1	1-tined forkbird
2	2-tined forkbird
4	4-tined forkbird
3, 5, 6	Same as parent forkbird

5. Record the new population of each type of forkbird in your group in the next row of your table.
6. Return all the wild loops to the "forest floor" to simulate the growth of wild loops.
7. Repeat Steps 2-6 for nine more rounds to represent additional generations.
8. Share your data with the class. As a class, record the population of each type of forkbird over many generations. Be sure to copy the class data onto your data table.
9. Create a graph of the class totals of each type of forkbird over many generations. You can plot the data for all three types of forkbirds on a single graph. Be sure to title your graph, label the axes, and provide a key (SULTAN).

FORKBIRD POPULATIONS

Table 1. *Group* Forkbird Population Data

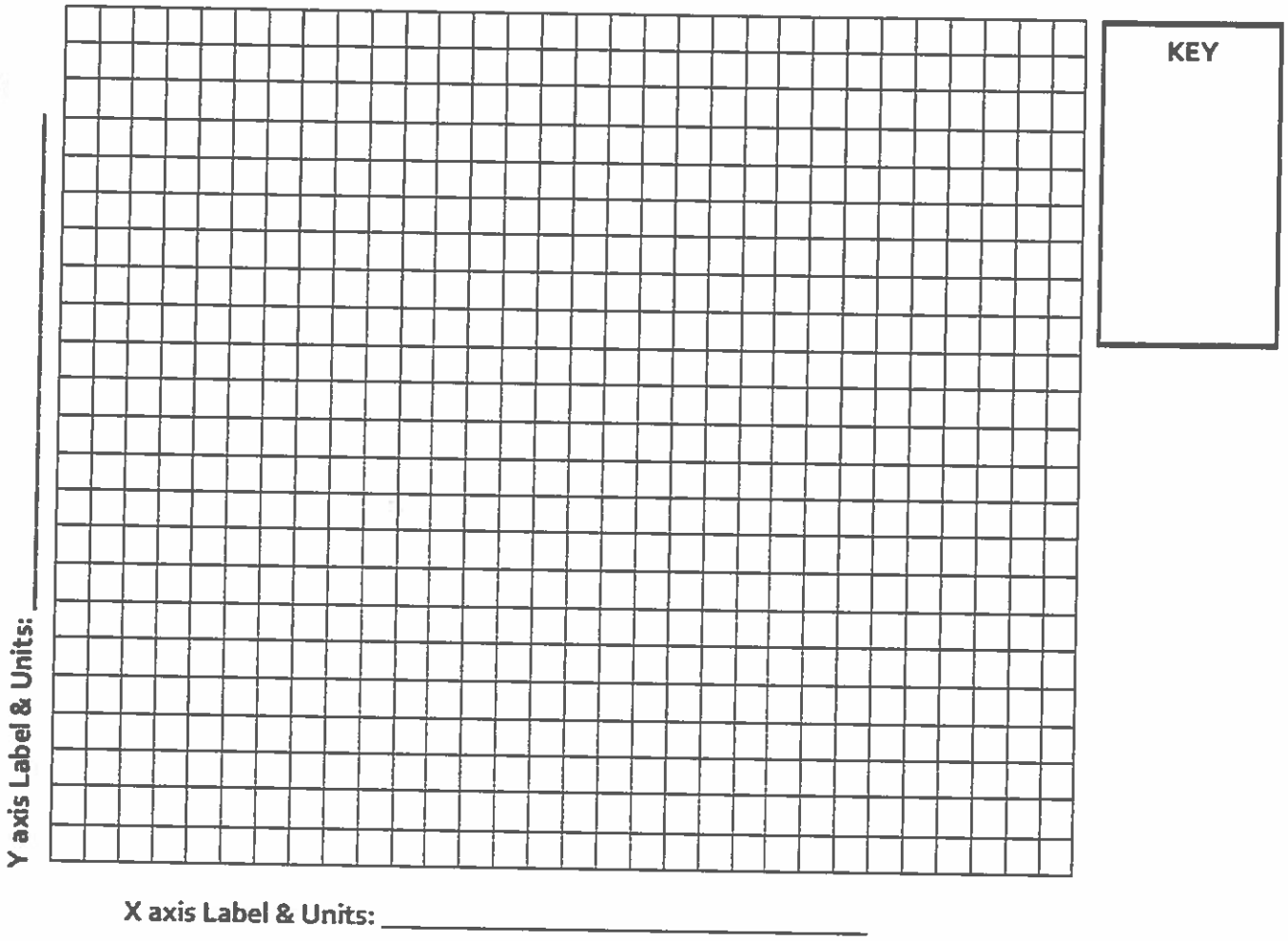
Generation	1-Tined Forkbirds	2-Tined Forkbirds	4-Tined Forkbirds
Initial			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Table 2. *Class* Forkbird Population Data

Generation	1-Tined Forkbirds	2-Tined Forkbirds	4-Tined Forkbirds
Initial			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

DATA ANALYSIS:

Title: _____

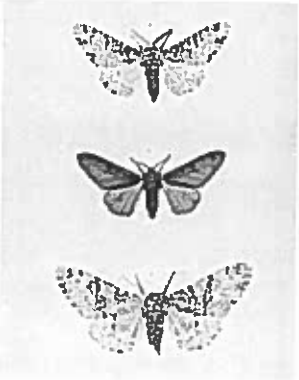


Conclusion

1. Which type of forkbird was the most successful? Explain how the class data support this conclusion.
2. a. Look at your graph of the class results. Describe what happened to the number of each type of forkbird over many generations.
   b. In the forkbird model, mutations at reproduction were much more common than they are in real life. Imagine that the number of mutations was lowered, so that the vast majority of offspring had beaks similar to those of their parents. Predict what you think would have happened to the numbers of each type of forkbird in future generations.
3. How did the forkbird activity simulate the process of natural selection? Explain.
4. The forkbirds that you studied are a single species. Although they look slightly different, they are part of a single, interbreeding population. Imagine that a change in food supply occurred.
   a. As a result of heavy rains, the major source of forkbird food is now soft berries, like blueberries. After many, many generations, how many types of forkbirds do you think will be in the population? Explain your reasoning.
   b. As a result of a drought, the major source of forkbird food is now sunflower seeds. After many, many generations, how many types of forkbirds do you think will be in the population? Explain your reasoning.
5. Did this activity model Darwin's or Lamarck's theory of evolution?
6. What are the strengths and weaknesses of this activity as a model for evolution?
7. Reflection: The cheetah, an extremely fast and efficient hunter, is an endangered species. The few cheetahs alive today show very little variation. How does this help to explain why cheetahs are on the verge of becoming extinct?

Naturally Selected to Survive

Michael Stahl



The earth has changed, over and over again, throughout the course of its history. Some of these changes have happened quickly. Others have occurred over long stretches of time. For example, the planet has experienced ice ages that took place over *thousands* of years. During those eras, huge sheets of ice covered much of the surface of the globe. Then for a few thousand years between the ice ages, the earth warmed up. Scientists believe that this cycle has actually occurred a few times, and it might be one of the many reasons behind the recent global warming we have experienced.

As the planet goes through this cycle, environments may go through changes. In order to survive in changing environments, species oftentimes must undergo a process of adaptation. Adaptation refers to a mutation or genetic change that enables an organism such as an animal or plant to survive in its environment. This trait is passed down from one generation to the next, becoming an inherited trait of the species. A species may have to adapt to warmer temperatures, increased precipitation, or even developing air pollution. If the organisms of a species cannot change along with the area in which they live, they risk dying out. Though an uncountable number of species that have roamed the earth have become extinct, the planet has seen many others adapt as well. These select organisms have been able to go on living in their environment.

A species adapts to a changing environment as organisms with favorable traits reproduce and survive. These favorable traits, which help the species survive, are passed down through different generations of the species. This process is called "natural selection." Recent history has given us an important example of how organisms are able to survive once their environments change.

Light gray peppered moths and dark-colored peppered moths lived in the countryside between the cities of Manchester and London in England. Many years before the 19th century, more of the light gray peppered moths had been able to survive in their environment mostly because of their color. Their thin layer of skin, as well as their large wings, was mostly gray with a little bit of black "peppered" all around. This color was advantageous because the light gray peppered moths were camouflaged when they stayed on gray-colored areas on the sides of trees in their habitat. Predators, which were mostly birds, could not see the light-colored moths on the trees because the color of the moths blended in with the color of the trees. Instead, the predators were able to see the dark-colored peppered moths more easily.

In the early 19th century, though, England began the first years of its Industrial Revolution. Many areas, especially in and between the cities of Manchester and London, became populated by a growing number of factories. This was because companies began to use a lot of new machinery that had been invented in the decades before. These machines made work a lot easier in many ways. The companies could build more products faster than ever before. However, many of these factories needed coal to provide energy for the machines. When coal burns, it gives off a lot of dark-colored smoke. Soot is a black substance that collects on a surface that comes into contact with smoke. Smoke's dark particles stick onto surfaces like paint. In the English countryside near industrialized areas, the trees began to blacken with soot because of all of the smoke in the air from the factories. This made the light gray peppered moths much more vulnerable. Predators could see them on the trees more clearly and easily hunt them down.

Sometime in the next hundred years, scientists began to notice a huge change in the moth population living in and between the cities of Manchester and London near where many of those factories had been constructed. Most of the peppered moths were the dark-colored kind! What caused this change was the fact that predators had eaten a lot of the light gray peppered moths because the moths were clearly visible on the black-colored trees. The dark-colored peppered moths in the area survived much more easily and mated with other dark-colored peppered moths until most of the population of peppered moths became dark-colored.

Many scientists feel that this example of evolution in a species supports Charles Darwin's theory of natural selection. An author named J.W. Tutt published a report about the moths a few years after Darwin's death, writing that the change in the peppered moth population seemed to support Darwin's ideas. Though Darwin was not alive to read the Tutt report, his teachings about nature live on.

Name: _____ Date: _____

1. According to the passage, what happens when organisms cannot adapt to changes in their environment?

A) They move to another environment.
B) They risk dying out.
C) Nothing happens.
D) They wait for the environment to change again.

2. What does the author mainly describe in the passage?

A) how natural selection changed the population of peppered moths
B) how the Industrial Revolution improved the lives of workers
C) how Charles Darwin devised his theory of natural selection
D) how humans influence organisms via artificial selection

3. Smoke given off by the factories threatened the survival of the light gray peppered moths. What evidence from the text best supports this conclusion?

A) Soot is a black substance that collects on a surface that comes into contact with smoke.
B) When coal burns, it gives off a lot of dark-colored smoke.
C) Predators could see the light gray peppered moths on the black trees covered by soot and easily hunt them down.
D) The trees began to blacken with soot because of all of the smoke in the air from the factories.

4. What conclusion can be drawn from the change in population of light gray peppered moths and dark-colored peppered moths?

A) The color change had nothing to do with the change in environment.
B) There were previously no dark-colored peppered moths.
C) The lighter peppered moths migrated to a new environment.
D) Darker coloring is currently better for the peppered moth's survival.

5. What is this passage mostly about?

A) Charles Darwin
B) The Industrial Revolution
C) natural selection
D) global warming

6. Read the following sentences: "In the English countryside near industrialized areas, the trees began to blacken with soot because of all of the smoke in the air from the factories. This made the light gray peppered moths much more **vulnerable**. Predators could see them on the trees more clearly and easily hunt them down."
What does "**vulnerable**" mean?

A) quick to change
B) open to attack
C) easily defended
D) in a strong position

7. Choose the answer that best completes the sentence below.
_____ of the smoke given off by coal burned in the factories, the nearby trees became blackened with soot.

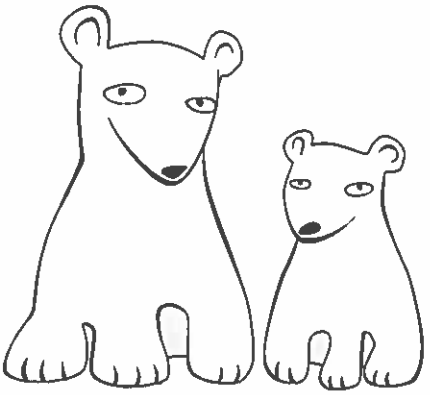
A) On the other hand
B) Primarily
C) As an illustration
D) As a result

8. What is natural selection?

9. How did the peppered moth's environment change, and what caused this change?

10. How did the peppered moth population become mostly dark-colored?

Is It "Fitter"?



Natural selection is sometimes described as "survival of the fittest." Four friends were arguing about what the phrase "survival of the fittest" means. This is what they said:

Dora: "I think 'fit' means bigger and stronger."

Lance: "I think 'fit' means more apt to reproduce."

Felix: "I think 'fit' means able to run faster."

Hap: "I think 'fit' means more intelligent."

Which person do you most agree with? Explain what you think "survival of the fittest" means.

Name
Date
Period

Artificial vs. Natural Selection

Activity 1:
Directions: Please answer the following questions in complete sentences.

What are the benefits to artificial selection?

The benefits of artificial selection are

Can you identify any potential negative impacts?

Some potential negative impacts of artificial selection are

Activity 2:
Your task is to use the next 25 minutes to create a list of organisms whose genetics have been influenced using selective breeding. I encourage you to be secretive and creative as you put your list together because this is a challenge and the winning team will win a prize.

The rules:
1. All items on your list must be living organisms that are capable of reproduction
2. You must cite your sources for each item on your list so we can look it up if needed (just copy and paste the url to your document)
3. All subgroups of a larger group will only count as 1 item (huskies and poodles are both dogs so they would only count as 1 item)
4. Be creative, you will only get points for items that are on your list but NOT on anyone else's list.

Place your list below:

Activity 3

Do you respond differently to these organisms knowing that they have been created by humans using artificial means? Explain your thinking using a TEPAC

Comparing Natural Selection and Artificial Selection

Name:_____ Period:_____ Date:_____

1. **Natural** Selection and **Artificial** Selection are *SIMILAR* because they both...

_____

_____

_____

_____

2. **Natural Selection** and **Artificial Selection** are *DIFFERENT* because...

Natural Selection _____, but Artificial Selection _____.

Natural Selection _____, but Artificial Selection _____.

Natural Selection _____, but Artificial Selection _____.

Natural Selection _____, but Artificial Selection _____.

Natural Selection _____, but Artificial Selection _____.

3. Summary: Use the information collected; create a paragraph comparing **Natural** Selection and **Artificial** Selection.

_____

_____

_____

_____

_____

Name _____ Block _____ Date _____

Evolution Handout Day 18

Artificially Selecting Dogs

OVERVIEW

1. You will learn how artificial selection can be used to develop new dog breeds with characteristics that make the dog capable of performing a desirable task.
2. You will begin by examining canine features and their functions.
3. Then, you will be given a scenario that describes the type of task you need a new breed of dog to perform.
4. Next, you will select two existing breeds you feel will most likely produce a successful new breed and determine the resulting offspring's characteristics.

Materials

- ☑ "Dog Packet" - includes: Dog Breeds handout, Ownership Card, Puppy Traits - generations 1 & 2.
- ☑ Blank Paper for drawing.
- ☑ 1 penny

Procedure

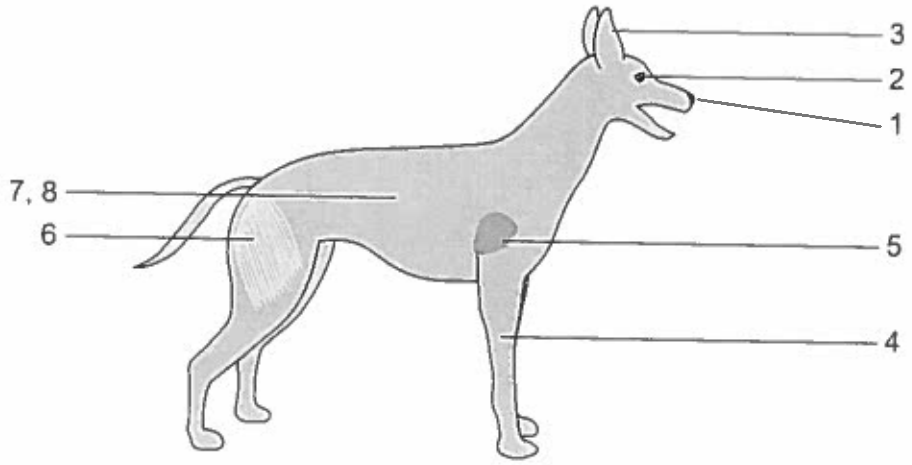
1. You will be trying to artificially select a new dog with certain traits by crossing two existing breeds. Take out your "Ownership Card", put you and your partner's name on the card and follow the directions given in Part I.
2. Next, take out your "Dog Breeds" handout and review the descriptions given for each breed. Discuss this information with your partner and select two dogs that have the features most likely to produce a breed with the features you need. In Part II write in the breed names and reasons for your selections.
3. Now, choose which dog will be the mother and which will be the father. Your breeding pair will produce 3 puppies and each puppy will have a chance of inheriting traits from either the mother or father.
4. You will use a penny to determine which trait is inherited by your puppy. Keep track using the "Puppy Traits – Generation 1" worksheet provided.
   a. Heads = females (mother's) trait is inherited
   b. Tails = males (father's) trait is inherited
5. Repeat step 4 again for the second puppy and again for the third puppy.
6. Now, pick the puppy you feel would get you closest to your goal. Identify this puppy below.

   Puppy #: _____

7. After making your puppy selection, visit with a neighboring group, collect "trait" information for a puppy from that group you feel would most likely get you closer to your goal. Record these on the "Puppy Traits – Generation 2" handout.
8. Next, repeat steps 3, 4, and 5, except now use Puppy Traits – Generation 2 to record your data.
9. Pick the puppy from this second generation which you feel will provide a dog that can perform the assigned task. **Draw** this puppy on your blank sheet of paper and label the significant features of this animal.

Dog Traits

Physical traits	Function/significance
1) Smell	Above average olfactory receptors =
2) Sight	Above average number of rods =
3) Hearing	Long pointed ears =
4) Speed	Long legs =
5) Endurance	Large heart =
6) Strength	Large muscles =
7) Coat color	
8) Hair length	long hair = short hair =



Behavioral traits	Function/significance
Trainability:	High trainability = low trainability =
Disposition:	Vicious = Compatible =
Bark:	Loud bark = Quiet bark =

Dog Breeding Example

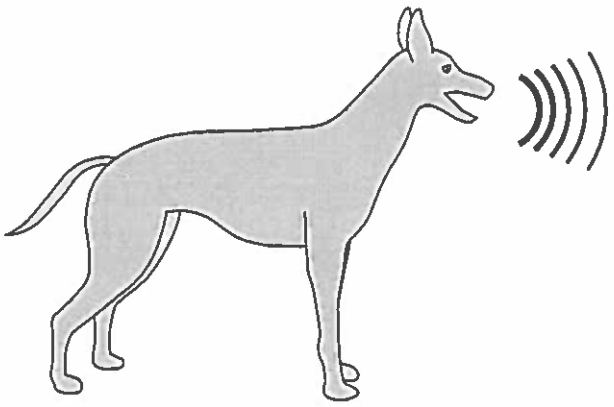
You want a dog that can hear a polar bear approaching and alarm the bear so that it will turn back.

Which of the following dogs would you selectively breed to produce offspring that would be most effective in scaring away a polar bear?

Existing breeds

Traits

Breed 1:



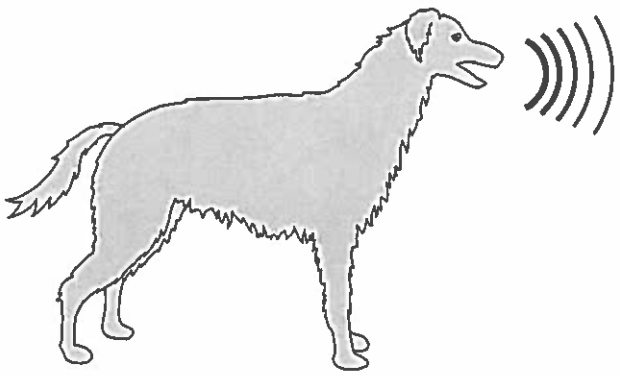
pointed ears

green eyes

short coat

medium bark

Breed 2:



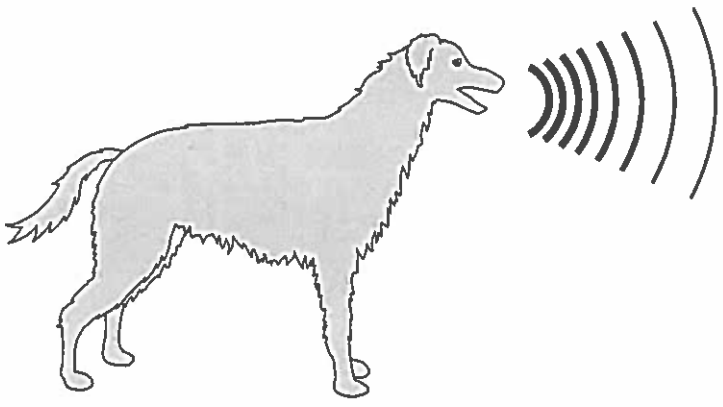
floppy ears

blue eyes

long coat

medium bark

Breed 3:



floppy ears

blue eyes

long coat

loud bark

Ownership Card

Breeders' names: _____

Date: _____

Assignment: "You are a dog breeder. You have been contacted by a scientist who wants dogs that could be used to see and retrieve waterfowl (ducks and geese) from lakes in the area so the birds can be tagged and re-released. The birds are very skittish (scare easily) and must be retrieved unharmed and with a minimum amount of stress."

Part I: Desired features of the new breed
For each feature below, circle the desired form you ideally want your dogs to have. For features that you do not think will affect your breed's ability to perform the given task, circle "any."

Physical features	**Desired form**			
Smell:	above average	average	below average	any
Sight:	above average	average	below average	any
Hearing:	above average	average	below average	any
Speed:	above average	average	below average	any
Endurance:	above average	average	below average	any
Strength:	above average	average	below average	any
Coat color:	very dark	average	very light	any
Hair length:	long	average	short	any
Behavioral features				
Trainability:	high	average	low	any
Disposition:	vicious	compatible	meek	any
Bark:	very loud	average	very quiet	any

Part II: Dog breeds chosen to mate: _____ X _____ (Generation 1)

Reason:

Part III: Dog breeds chosen to mate: _____ X Neighbor's Puppy (Generation 2)

Reason:

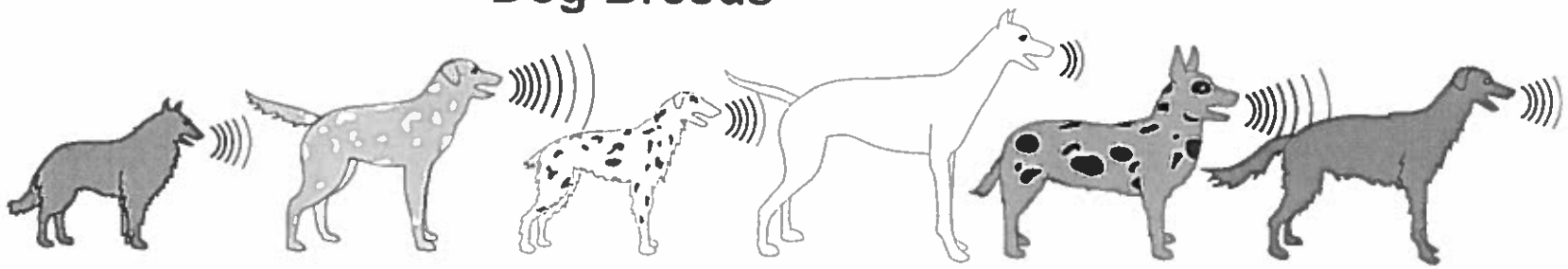
Puppy Traits - Generation #1

Physical features	Puppy #1	Puppy #2	Puppy #3
Smell:			
Sight:			
Hearing:			
Speed:			
Endurance:			
Strength:			
Coat color:			
Hair length:			
Behavioral features			
Trainability:			
Disposition:			
Bark:			

Puppy Traits - Generation #2

Physical features	Neighbor Puppy Traits	Puppy #1	Puppy #2	Puppy #3
Smell:				
Sight:				
Hearing:				
Speed:				
Endurance:				
Strength:				
Coat color:				
Hair length:				
Behavioral features				
Trainability:				
Disposition:				
Bark:				

Dog Breeds



	Breed A **Tally Collie**	Breed B **Floxich**	Breed C **Gootagan**	Breed D **Spalling**	Breed E **Cruxtic**	Breed F **Horvisianer**
Physical features						
Smell:	above average	average	above average	below average	average	above average
Sight:	average	average	average	above average	average	above average
Hearing:	above average	average	average	above average	above average	average
Speed:	average	above average	above average	above average	below average	average
Endurance:	below average	average	above average	average	above average	below average
Strength:	above average	above average	average	below average	average	below average
Coat color:	black	brown	white	white	brown	black
Hair length:	long	medium	long	short	medium	long
Behavioral features						
Trainability:	average	average	high	high	low	high
Disposition:	meek	meek	vicious	meek	compatible	vicious
Bark:	average	very loud	average	very quiet	very loud	average

Name:_____ Date:_____

Planet Earth II: Cities

1. What is the new habitat that has formed on our planet?

2. Why are the monkey's living in the city?

3. What do the Falcons prey on?

4. What animal does the Leopard prey on?

5. Is the Leopard coming into the city a learned behavior or an inherited trait?

6. What type of interaction is shown between the bird and the items that it is collecting? (living to living or living to non-living)

7. Name one adaptation that helps the raccoons get the food that they need in the backyard.

8. Name 2 structures and functions that help the Macaque Monkey move and navigate through the city.

9. Are the Macaque Monkeys stealing food an instinct, learned behavior, or inherited trait?

10. What kind of consumers are the Hyenas? (omnivore, herbivore, carnivore)

11. What animal is a predator of the Pigeons?

12. The Whales Catfish has taken over the area that they live in and have made it impossible for other fish to survive. They also have no predators. What is it called when a species has no natural predators and they take over an area?

13. Are the Hawksbill Turtles moving back towards the sea an instinctive behavior or a learned behavior?

14. What type of consumer is the crab? (omnivore, carnivore, herbivore)

15. What form of energy is causing the Hawksbill Turtles to become confused on where to go? (MELTS)

16. What are some things we could do to help animals coexist with us? What would you do to help animals and people coexist? List at least 3 ways that we could work on making our cities more animal friendly.

NAME _____ Period _____

Urban Evolution

Do you believe that wild animals, such as jaguars or hyenas, should live in city environments? Why or why not?

_____

_____

_____

_____

_____

_____

_____

"Cities are beneficial habitats to animal adaptations and evolution".
I agree / disagree with this statement because:

Reason 1:	Reason 2:	Reason 3

NAME _____ Period _____

Evidence from video to support or refute this reason.	Evidence from video to support or refute this reason.	Evidence from video to support or refute this reason.

Underline the TOP three pieces of evidence from the video that support your claim.

Star the TOP three pieces of evidence from the video that counter your claim.

NAME _____ Period _____

EXIT TICKET:

Which side of the argument are you on now and why?

Name _____ Date_____

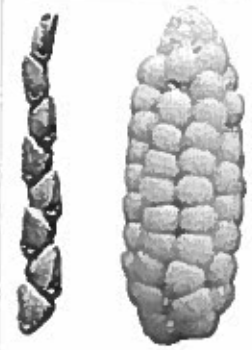
Period _____

Directions: In these boxes highlight information that supports or refutes the author's claim.	Directions: In these boxes annotate your highlights with a question, connection, or summary.
Artificial Selection at Work	**Prior Knowledge: What do you already know about Artificial Selection?**
What is artificial selection? Artificial selection is the intentional reproduction of individuals in a population that have desirable traits. In organisms that reproduce sexually, two adults that possess a desired trait — such as two parent plants that are tall — are bred together. In this example, the mechanisms of heredity dictate that the next generation will consist of more tall plants than previous generations.	
If artificial selection is continued, all of the population will ultimately be tall. Also called selective breeding, artificial selection is perhaps best understood as a contrast to natural selection, where the random forces of nature determine which individuals survive and reproduce. In both cases, the outcome is the same: a population changes over time, so that certain traits become more common.	
What are some examples of artificial selection? Artificial selection has generated untold diversity in both plants and animals. In agriculture, superior strains of corn, wheat, and soybeans have resulted from careful breeding. The *Brassicas* are great examples of artificial selection. Cabbage, broccoli, cauliflower, Brussels sprouts, collards, and kale are all members of the same species, *Brassica oleracea*. Gardeners have cultivated flowers such as roses and orchids, carefully manipulating heredity to produce the "perfect" hybrid.	

Taken from: http://www.learner.org/courses/essential/life/session5/closer1.htm

Some consider domesticated animals to be the ultimate products of artificial selection. Thoroughbred racehorses are one example of artificial selection of animals. The meats we eat are the result of the careful selective breeding of cows, pigs, sheep, and chickens. Our pets are a far cry from their "wild" ancestors. Cats and dogs, which were originally domesticated for pest control, hunting, or shepherding, eventually were bred to become companion animals. A glance at a group of dogs — all of the species *Canis familiaris* — reveals an astounding diversity of body type, size, and coloration.	
There can be a downside to artificial selection. Because this process essentially removes variation in a population, selectively bred organisms can be especially susceptible to diseases or changes in the environment that would not be a problem for a natural population. Inbreeding — the mating of closely related individuals — is also a problem. In dogs, this has resulted in breeds that have health issues ranging from decreased life span to hip dysplasia.	

A variety of vegetables of the *Brassica oleracea* species



Teosinte (left) and its modern descendent, corn, a product of artificial selection

Taken from: http://www.learner.org/courses/essential/life/session5/closer1.htm

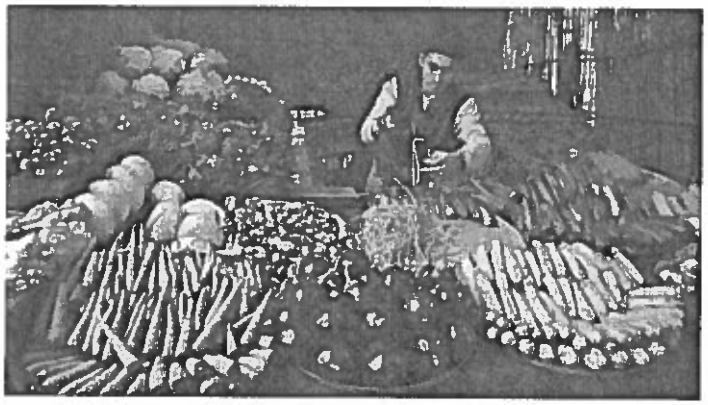
Name _____ Date_____

Period _____

From farm to lab to table, a tale of tomatoes and a top banana

By Washington Post, adapted by Newsela staff
05/24/2016

Directions: In the margin space, annotate the article with definitions, questions, comments, and connections



A teenage boy sells vegetables at a market in Peshawar, Pakistan, April 21, 2009.

When we're kids, we learn that carrots are orange, bananas are yellow, and eggplants are big and purple. Fruits and vegetables did not always look the same, though. If you went back in time, even a few hundred years, you might not even recognize some of them.

Humans have been changing the shape and color of fruits and vegetables since farming began about 12,000 years ago. For ages, farmers have been collecting seeds from the best fruits and vegetables for the next planting. They would replant the seeds of the plums or the carrots that had the best taste and the most pleasing feel.

Only The Best Genes Survive

Carefully choosing the seeds of only the best fruits and vegetables to replant changed the plants' genetics. Over time, the more colorful and tasty genes were passed on, and the bitter genes gradually disappeared. This is called selective breeding. Anyone who has tried a wild plum can

tell you that wild fruits are often more sour and have thick, bitter skins.

The fruits and vegetables in grocery stores have been selectively bred over generations. Compared with their wild ancestors, they are huge, sweet and easy to eat.

Each plant has its own story. The eggplant, for example, got its English name because the original plant looked like a small white egg. Selective breeding turned it into a large fleshy purple vegetable. The shape and color changed as people chose to replant the larger eggplants with less bitter taste.

The carrot was also transformed by farmers. Wild carrots grow in a variety of colors from yellow to purple to white. Dutch folklore says that the orange carrot was selectively bred in the Netherlands during the 1600s to honor William of Orange. He led the cause for Dutch independence.

From Mendel To GMOs

In the mid-1860s, Gregor Mendel experimented with breeding pea plants. He showed how genetic traits like color, size and taste in the pea plants were passed on through selective breeding. Those experiments paved the way for the modern understanding of genetics.

Today, a new kind of selective breeding has become controversial. In 1994, the first genetically modified tomato, called the "Flavr Savr," hit grocery stores. Scientists at Calgene, Inc. in Davis, California, had inserted a gene in the Flavr Savr that stopped the tomatoes from ripening too quickly. It was a scientific success, but many people did not want to buy the new tomato. The public viewed genetic engineering as suspicious, even though humans have been changing plants for thousands of years.

Genetically modified foods (GMOs) have become more common since the 1990s. Today, corn is the most widely grown crop in the United States. About 90 percent of corn grown is genetically modified.

Respected scientific bodies such as the American Medical Association have found no scientific reason to not eat GMOs. However, a 2015 survey found that more than half of consumers who were polled (57 percent) consider GMOs potentially dangerous.

Bananas Face Big Trouble

Part of this fear has to do with the fact that it can be risky to rely on a single variety of a crop. The practice of growing one and only one kind of crop with the same genes is called monoculture. Crops grown in this way have trouble fighting off disease.

The banana is an example. The yellow Cavendish banana sold in grocery stores was named after the Englishman William Cavendish. He was the sixth duke of Devonshire. The duke's gardeners were the first to grow the Cavendish banana in greenhouses at Chatsworth House in Derbyshire, England, in the 1830s. The banana was then shipped to Samoa and the Canary Islands and farmed on a large scale soon after.

Although fruits, including wild bananas, have seeds, the Cavendish banana lacks them. These bananas are clones. Each banana plant is genetically the same because it is cut from the roots of a single mother plant and then replanted. This results in the exact same fruit produced generation after generation.

Unfortunately, this also means that each generation is the same, so the plant can't adapt to protect itself from diseases and pests.

The Cavendish banana became popular in the 1950s because it was resistant to Panama Disease. The Panama Disease was a fungus that destroyed the previous popular variety, which was named Gros Michel (or "Big Mike"). The Cavendish did not become the most popular banana variety because of its taste, which is apparently plain compared with the Gros Michel.

With its thicker skin, the Cavendish was easier to ship because it didn't bruise as much as other varieties. Today, the Cavendish variety represents 99 percent of bananas, but its reign as king banana may come to an end. Years of monoculture have made the Cavendish banana unable to fight a new strain of Panama Disease. Once the Panama Disease fungus reaches crops in Latin America, the Cavendish banana could disappear in a hundred years.

Artificial Selection Research Project

Directions: Create a presentation of your choice (poster, Google Slides, video, picture book..etc) that answers the following questions about an organism that has been selectively bred by humans.

1) What is the name of the organism that has been selectively breed? (5 pts)

2) Please provide a picture of the organism that yours originally came from and a picture of the organism in its modified state. (example: Before: picture of a wolf After: Picture of a chihuahua) (5pts)

3) Please explain why there is a need to artificially change this organism. (Why did humans do this?) (10 pts)

4) What traits or genes were desired for this organism? (10 pts)

5) Are there any disadvantages or problems with the organism now that it has been genetically modified? (5pts)

6) How does this organism benefit human society or the environment? Why or why not? (5pts)

7) Please cite (copy and paste) the websites that you used for this project. (5 pts)

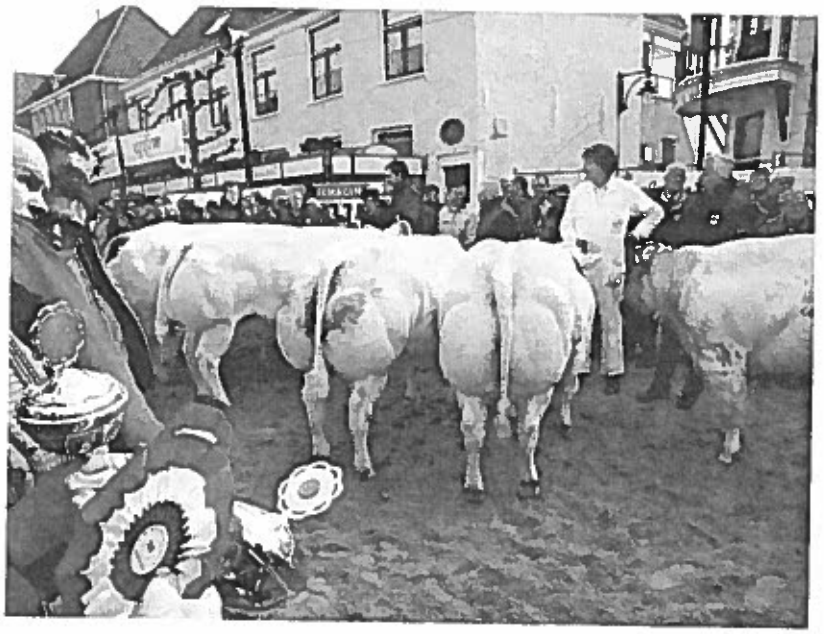
8) Presentation must be neat and show your best work. (10 pts)

9) Presentation must be free of grammatical and spelling errors (5pts)

TOTAL _____/60pts

Name _____ Date_____

GENETICALLY MODIFIED ANIMALS WILL BE ON YOUR PLATE IN NO TIME



A woman in traditional dutch clothing waits to hand out prizes to owners of cows of the Belgian Blue White race during a cattle show in Schagen, northwestern Netherlands, Wednesday March 16, 2005. The festival, more than 100 years old, is a chance for cattle farmers to show off their prize cows and is a major pick up scene for rural youth. (AP Photo/Peter Dejong)

NO ONE EATS genetically modified animals. That is to say, human beings have modified almost every domesticated foodstuff, plant, and animal through traditional breeding techniques. But start using genetic engineering technology, moving genes around or inserting one from one living thing into another, and people freak right the hell out. That's what happened two weeks ago—France went into a panic because a lamb that was the offspring of a sheep modified to express a green fluorescent protein made it to market. In Europe, genetically modified organisms are outright banned; in the US, lots of staple crops like corn have plenty of modified genes. But animals? That's a line supermarkets haven't crossed.

They could, though. The fact is, biologists have been tinkering with animal genomes for a couple decades, working on increasing muscle mass (that's meat, after all), speeding up growth rates, and otherwise overclocking the kind of traits that the food business values. Now, no genetically engineered animals are approved for human consumption. The Food and Drug Administration regulates them as animal drugs—that is, medicine for animals, rather than food. So they have to go through a testing process so rigorous that it's too expensive for them to be viable commercially. But they exist. And they're actually...kind of cool.

Super Muscular Pigs

In an article published in Nature last Tuesday, Jin-Soo Kim, a molecular biologist at Seoul National University, showed off pictures of hogs with extraordinarily large backsides. (That's a part that pork-

eaters particularly value, just in case you don't dig on swine.) Kim's team, from Korea and China, looked at a mutation in a super-jacked variety of cattle called the Belgian Blue; a gene that ordinarily inhibits muscle growth gets switched off. Using a gene-editing technique called TALEN, the researchers induced a similar mutation in their pigs. Result: porkier Porky.

Breeders probably could have arrived at the same result—hey, it worked for Belgian Blues. But the genetic modification saved what might have been years of work. Whether it'll sell is another matter. Kim and his team want to sell edited pig sperm in China, which is investing heavily in gene editing and historically hasn't been strict on regulation. Also, because the genetic modification involves a knocking out a single gene rather than transplanting one from a completely different animal, the scientists are hoping that their modified sperm will get approved more quickly. But bigger pigs isn't always better—the sows can have challenges birthing baby piglets because their extra muscle makes them so bulky.
Chance of you eating one in the next five years: High

Growth-spurty Salmon

Canadian scientists first developed fast-growing salmon in 1989, and the breed developed by Massachusetts-based company AquaBounty has been stuck in the FDA's regulatory approval process since 1995. These Atlantic salmon have genes from a Chinook salmon and an ocean pout—a type of eel—that make more than the usual dose of growth hormone, so they reach market size in 16 to 18 months instead of the salmon-standard three years.
Commercializing this fish has been slow-going: The FDA actually declared AquaBounty salmon safe to eat in 2010, and the company promised to breed only sterile female fish—that way if any of them jumped into the wild they wouldn't be able to spread their mutant genes. That didn't hold any water with Trader Joe's or Whole Foods, which declared that they wouldn't sell the fish. By 2012, AquaBounty was reportedly running out of money and in the hands of an investor from Georgia (the country, not the state).

Chance of you eating one in the next five years: Medium

AKIO KON/BLOOMBERG VIA GETTY IMAGES

Hornless Cattle

Ranchers typically de-horn cattle when they're calves to make them less likely to injure other animals or the people who handle them. It's a painful, traumatic process. Scientists had bred hornless beef cattle without horns, but the same approach in dairy cows seemed to reduce milk production. In 2013, Minnesota-based Recombinetics used TALEN to insert a gene from a hornless Angus into Holsteins, a classic dairy breed. Recombinetics got the horns to go away, but the cows still can't produce milk.1

Chance of you drinking milk from one in the next five years: Low

Hypoallergenic Cows

Something like two or three percent of all human infants are allergic to milk, and at least some of them trace that allergy to one specific protein. In 2012, a New Zealand government-owned science company, AgResearch, engineered a cow named Daisy to produce milk without that protein. Using a technique called RNA interference, they knocked out the gene that makes the protein without altering milk production. It's a cool example of how we can alter nutritional content of food through gene editing, although Daisy was just a proof of concept, and the milk is still a long way from market, undergoing the long testing process and the scrutiny of protective parents. No word from AgResearch on how testing is going.

Chance of you drinking milk from one in the next five years: Low

UPDATE 09:00 ET 07/15/15: This story was updated to correct the milk-making status of Recombinetics' cows.

Name _____ **Date**_____

Author's Claim: _____

_____

Directions: In these boxes highlight information that supports or refutes the author's claim.	**Directions:** In these boxes annotate your highlights with a question, connection, or summary.
GMO Pros and Cons **Written by Treacy Colbert** **Medically Reviewed by Debra Sullivan, PhD, MSN, CNE, COI on October 5, 2016**	
What are GMOs? If you've eaten anything today, chances are you've snacked on **GMOs**. GMO stands for genetically modified organism. Genetically modified (GM) foods are made from soy, corn, or other crops grown from seeds with **genetically engineered** DNA.	
According to the U.S. Department of Agriculture (USDA), GM seeds are used to plant more than 90 percent of corn, soybeans, and cotton grown in the United States. Unless you consciously avoid them, GM foods likely find their way into many of your snacks and meals. Some people believe GM foods are safe, healthy, and **sustainable**, while others claim the opposite. Read on to learn about the pros and cons — and what the research says.	
Pros of GM foods Scientists genetically engineer seeds for many reasons. For example, they sometimes make changes designed to increase a plant's: • resistance to insects • tolerance to herbicides • tolerance for heat, cold, or drought • crop yield	
They also engineer seeds to give GM foods stronger colors, increase their shelf life, or eliminate seeds. That's why we can buy seedless watermelons and	

grapes. Some GM foods also have been engineered to have higher levels of specific nutrients, such as protein, calcium, or folate.	
Proponents of GM food contend that genetic engineering can help us find sustainable ways to feed people. Specifically, in countries that lack access to nutrient-rich foods. The heartiness of some GM crops makes it so they can grow in marginal environments. The longer shelf life of some GM foods allows them to be shipped to remote areas.	
Potential Cons of GM Foods On the other hand, some people wonder if GM foods are safe and healthy to eat. Genetic engineering is a relatively new development. As a result, research on the long-term health effects of GM foods is limited.	
GM foods have to meet the same safety requirements as foods grown from non-GM seeds. But critics suggest there's more to be concerned about. Some people worry that GM foods may be linked to allergies, **antibiotic resistance,** or cancer. Others suggest these concerns are unfounded. Here's what the research says.	
Allergies Food allergies are a growing problem in the United States. According to the Centers for Disease Control and Prevention (CDC), food allergies in children under 18 years of age have increased; from 3.4 percent between 1997 and 1999 to 5.1 percent between 2009 and 2011. Some people believe that spike is linked to GM foods. But there's no evidence that GM foods in general are more likely to trigger allergic reactions than non-GM foods, according to a study from Harvard University.	
Others raise concerns about the transfer of specific proteins from one plant to another in genetic engineering. Proteins found in a relatively small number of foods cause most allergic reactions. Tree nuts are one of the most common triggers.	

In the mid-1990s, researchers examined a strain of GM soybean that was engineered to contain protein from Brazil nuts. According to their report in the New England Journal of Medicine, the soybeans triggered allergic reactions in people with Brazil nut allergy. Those soybeans never entered the market and aren't sold to consumers.	
The Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO) have since established protocols for GM foods. They require GM foods to be tested for their ability to cause allergic reactions. According to the Mayo Clinic, none of the GM foods that are currently on the market have been found to have allergenic effects.	
Antibiotic resistance Antibiotic-resistant bacteria can resist antibiotics, making them hard to kill. According to the CDC, antibiotic-resistant germs infect two million people each year. Those infections kill at least 23,000 people per year. Scientists often modify seeds using antibiotic-resistant genes in the genetic engineering process. Some people wonder if there's a link between these GM foods and rising rates of antibiotic resistant bacteria. No studies have confirmed this claim, but more research is needed.	
Cancer In 2013, the journal Food and Chemical Toxicology retracted a paper that linked the herbicide Roundup and Roundup-tolerant GM corn to cancer and premature death in rats. Due to concerns about the paper, the journal's editor reviewed the researchers' raw data and the peer-review process. They found the researchers had used too few rats, the specific strain	

of rats was prone to cancer, and the results were inconclusive. Since then, the paper has been republished in another journal, Environmental Sciences Europe. The controversy surrounding the study's findings has continued. According to the American Cancer Society, more research is needed to assess the potential long-term health effects of GM foods.	
How can you tell if you're buying GM food? The European Commission requires GM food products in Europe to be labeled as such. But in the United States, no federal mandate exists for labeling GM foods. As a result, it can be hard to know if you're buying and eating GM foods. If you decide to avoid GM foods, look for products that are USDA certified organic. **Certified organic** foods are grown and handled without the use of GMOs.	

VOCABULARY:

GMO

Sustainable

genetically engineered

antibiotic resistance

Certified organic

Name _____ Date_____

Webquest: Harvest of Fear

Go to this web address: bit.ly/CropLab

Click on: Engineer a Crop

1. Name four gene altered food products humans consume.
   a. _____
   b. _____
   c. _____
   d. _____
2. How was the first corn on the cob produced?

3. Do organisms have to be similar in order to successfully insert genes into each other? Yes / No

4. What are the two methods of engineering a crop?
   a. _____
   b. _____

Click on: Selective Breeding

1. Why would farmers not eat their "best" corn?

2. Name 3 traits could a famer find most desirable?
   a. _____
   b. _____
   c. _____

Complete the selective breeding simulation choosing the largest ear of corn each time. When you reach generation number 5, use the arrow to scroll up and fill in the data table below.

	Small (thin) corn	Medium corn	Large corn
Generation 1			
Generation 2			
Generation 3			
Generation 4			
Generation 5			

Name _____ Date_____

Looking at your data from pg 1, explain what happened to the number of small and narrow corn by the 5th generation?

Click start over and this time selectively breed for the small and narrow corn. Is there a difference in this 5th generation then the one you recorded on the table above?

Food/Item	What's being done?	How does it help?
Fruit		
Flower		
Fries		
Corn		
Sushi		
Coffee		
Pizza		
Bananas		
Flies		

Click on: Transgenic Manipulation

1. How is a transgenic plant created?

2. Explain how you will be able to make a tomato plant more resistant to certain insects?

3. What is Bt short for and what does this gene do?

4. What is a vector?

Name _____ Date_____

5. Why was the vector placed into the Agrobacterium cell?

6. Explain what happens once tomato plant cells have been added to Agro bacteria?

7. How do you know when the plant cell has successfully been transformed with the insect resistant gene, Bt before testing it with insects?

Glow in the Dark Cats- bit.ly/GlowInTheDarkCats

Genetic Modification- bit.ly/GeneMod

Summary and Connections

Name _____ Period _____

In Pieces Webquest

DIrections:
Go to bit.ly/speciesinpieces

Click on 

There are 30 species on the website. Scroll though each of the species using the up and down arrows:

When you find a species you would like to learn more information about, click on

1. What is the name of the endangered species: _____
   a. Why is it endangered?
      _____
      _____
      _____
      _____
   b. What is an interesting thing you learned about this species from this interactive?_____
      _____
      _____
      _____

2. What is the name of the endangered species: _____
   a. Why is it endangered?
      _____
      _____
      _____
      _____
   b. What is an interesting thing you learned about this species from this interactive?_____
      _____
      _____

3. What is the name of the endangered species: _____

a. Why is it endangered?

_____
_____
_____
_____

b. What is an interesting thing you learned about this species from this interactive?_____
_____
_____
_____

4. What is the name of the endangered species: _____

a. Why is it endangered?

_____
_____
_____
_____

b. What is an interesting thing you learned about this species from this interactive?_____
_____
_____
_____

5. What is the name of the endangered species: _____

a. Why is it endangered?

_____
_____
_____
_____

b. What is an interesting thing you learned about this species from this interactive?_____
_____
_____
_____

Name _____ Date_____

Genetic modification proposed to save endangered species

Author's Claim:

_____

_____

_____

Highlight any information that supports or refutes the author's claim	**Annotate your highlights with questions, connections, and/or summary of importance. Write definitions to key vocabulary words or words you do not understand.**
Biologists suggest genes might be introduced even from other species to help survival in changing climatic conditions **Alok Jha** *Science correspondent* Thu 26 Sep 2013	
American chestnuts: genes inserted. Photograph: Allen Breed/AP 	
Genetic modification of animals so that they can deal with changing climate and habitats may be the only way to save some of the most endangered species from becoming extinct, according to biologists who want to start a debate on how to stem species loss.	
Biologist Michael Thomas said conservationists needed to debate what he and his colleagues called "facilitated adaptation", which involved rescuing populations or species by introducing gene variants that allow them to survive in changing temperatures or different ecological niches.	
"Even the most conservative estimates predict that 15–40% of living species will be effectively extinct by 2050 as a result	

of climate change, habitat loss and other consequences of human activities," wrote Thomas, of Idaho State University in Pocatello, and his colleagues in a comment article for the journal Nature.	
This could happen in several ways. Animals from a threatened population could be hybridised with individuals from the same species that were better adapted to a new environment. Or, if scientists could identify the genes that made one population more suited to an environment than another, they could insert those genes directly into the less-suited populations or individuals.	
The most extreme (and most likely controversial) idea proposed by Thomas is to take genes from a well-adapted species and insert them into the genomes of endangered individuals from completely different species.	
Such transgenic organisms are already common in plants – genes from the cress plant Arabidopsis have been used to engineer tomato plants so that they can more easily tolerate low temperatures.	
"Today, 12% of arable land worldwide is planted with genetically modified (GM) crops; the GM seed market alone is valued at US$15 billion," Thomas wrote. "We believe that these combined factors mean that conservationists will almost certainly be tempted to apply genetic engineering to safeguard biodiversity.	
"Facilitated adaptation might be less logistically challenging than moving entire populations, and less fraught with ecological and socio-economic complications — relocation could introduce harmful invasive species, for example, or unleash outbreaks of disease."	
Scientists have already inserted genes from the Asian chestnut tree into its American cousin to make the latter less susceptible to disease, and their plan is to release the genetically-modified seeds across the US.	

Kate Jones, a professor of ecology and biodiversity at the Centre for Biodiversity and Environment Research at University College, London, said Thomas's ideas had merit, but conservationists needed to tread carefully in legal, ethical and practical terms.	
"[It is] important to think about priorities – which species would benefit from intervention the most?" She said the gene-manipulation techniques being developed by synthetic biologists should be studied more closely by conservation biologists anyway, to see where they might be useful.	
Thomas acknowledged there were many unknowns in the proposals that "could bring unintended and unmanageable consequences" and therefore argued that the ideas needed research from a mass collaboration of ecologists, climate scientists and molecular biologists, among others, to begin mapping out the possibilities.	
"Facilitated adaptation will also require a change in people's views about biodiversity conservation and its ethics, practices and impact on society," Thomas wrote. "For some species, [it] could turn out to be the only viable remedy."	

KEY VOCABULARY WORDS:

Biologist:

Hybrid:

Genetic modification:

Conservationist:

Adaptation:

Biodiversity:

After reading this article, do you feel we should use genetic modification to help our endangered species? Use the TEPAC model to write your response.

_____

_____

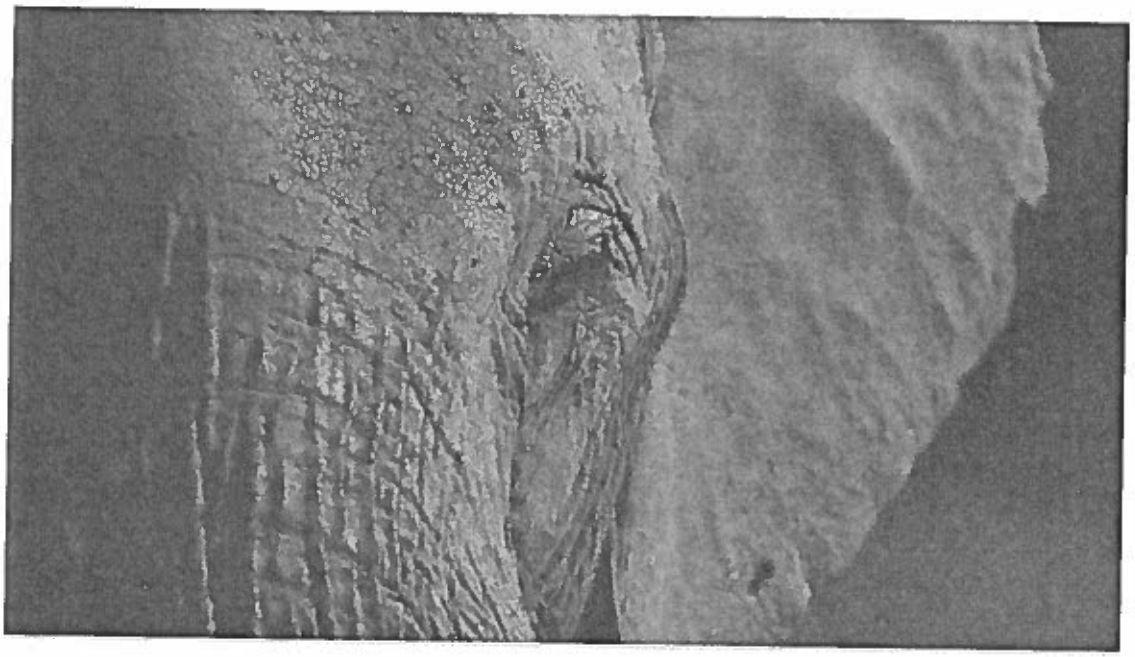
_____

_____

_____

More Elephants Are Being Born Tuskless Thanks to Poaching

May 25, 2017 *by* ROBBY BERMAN



(CAMERON SPENCER)

Natural selection as a means of evolution is generally thought of as a slow process, and it usually is. That is, unless there's some unnaturally strong influence at work. And that's exactly what's happening to African elephants. The unnatural influence is humans, or more specifically, poachers, and it's causing an increase in the births of tuskless elephants. Those who do have tusks are becoming less likely to reproduce since they're hunted down and killed for their ivory.

Not every elephant has tusks. In a population without significant poaching going on, from 2% to 6% of females are born without tusks. Males without them are less common because they're required weapons for earning procreation rights, and tuskless males don't generally get to reproduce.

In areas where there is poaching, however, the story's very different, and the quest for elephant ivory is changing the types of offspring now being produced. In Gorongosa National Park in Mozambique, half of the

older females have tusks. The situation has improved since poaching was brought under control there 20 years ago, but a third of the younger elephants are tuskless nonetheless, a meaningful increase over the historical norm.

In Zambia's South Luangwa National Park and the Lupande Game Management Area, tuskelessness increased from 10.5% in 1969 to 38.2% in 1989 The numbers have improved slightly since then there as well, but only due to more tusked females migrating from nearby areas.

There's been big money in China's black market for ivory, from a peak of $2,100 USD per kilogram in 2014 to $730 per kilogram in February of 2017. There are several factors in the reduction, most notably the easing of demand for luxury goods due to the country's economic slowdown, the government's efforts to shut down the ivory business, and changes in Chinese consumers' attitudes toward ivory and its cost to elephants.

But between 2007 and 2014, some 144,000 African elephants were killed, placing the species perilously close to extinction in some areas. Researchers warn that over time, African elephants may evolve into primarily tuskless creatures, as Asian elephant have.

And that, in itself, is a problem. For elephants, tusks perform a number of important functions. They're weapons for use against predators and other elephants, watering holes can be dug with them and bark can be stripped from trees, and they're useful for pushing away brush and other obstacles in their path. (Interestingly, elephants, when it comes to tusks, can be "lefties" or "righties" — there's evidence that they prefer one tusk over the other.)

So while an elephant without tusks may be safe from poaching, it's in a precarious position when it comes to survival, especially on its own, and being affiliated with a herd that has enough tusks to take care of the necessary tasks is the only real defense.

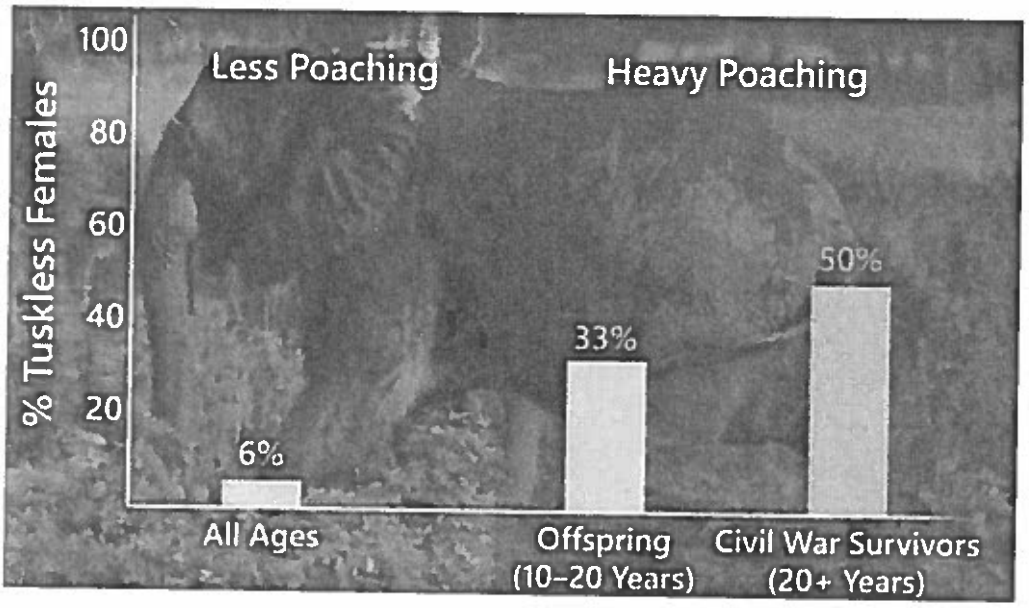
"Conservationists say an elephant without tusks is a crippled elephant," says the BBC.

Name: _____ Period: _____

Tusklessness: Problem or Solution?
Part II

Watch the video clip at http://www.hhmi.org/biointeractive/selection-tuskless-elephants

Use the following data and information from the video to answer the questions that follow.



1) You made a prediction in the last activity that asked about elephants younger than 20 years of age. With this new data above, explain whether your prediction came close and why.

_____

_____

2) Who is leading the elephant study in Gorongosa National Park in Mozambique, Africa? _____

3) What exactly is she studying? _____

4) How did the civil war affect elephant populations? _____

5) Dr. Poole noticed a high proportion of tuskless elephants after the war. But why did males still have their tusks?

_____

6) What was the selective pressure that increased the numbers of tuskless elephants? _____

7) Explain how this selective pressure shifted the population to be more tuskless. _____

_____

8) Why are there fewer tuskless elephants born after the war (ages 10-20 years old)? _____

_____

Continue to the next page.

9) Why do tuskless elephants have a selective advantage? _____

_____

10) Besides poaching, what other major factor is causing a decline in elephant populations? _____

Using the graphs below at the right, answer the following questions.

11) In what year(s) were the most tusked females present in this population? _____

12) Based on the answer to Q11, how many elephants were present in this population at this time? _____

13) In what year(s) were the most tuskless females present in this population? _____

14) Based on the answer to Q13, how many elephants were present in this population at this time? _____

15) Describe what the top graph illustrates.

_____

_____

_____

_____

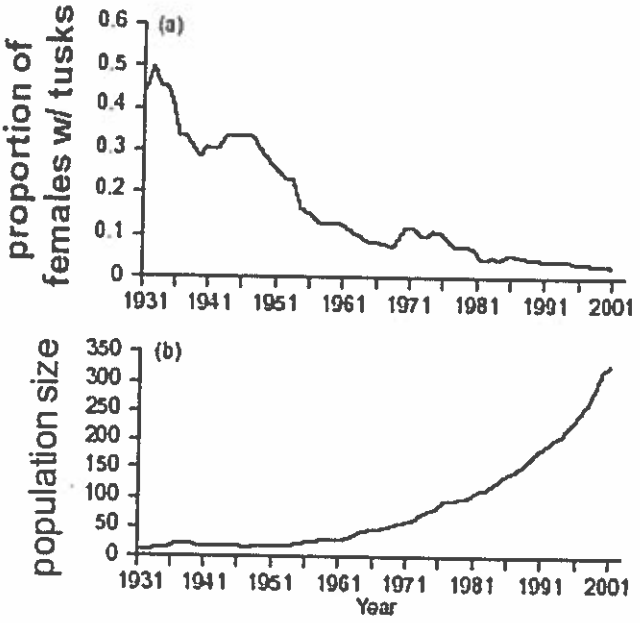
16) Describe what the bottom graph illustrates.

_____

_____

_____

_____



Complete the Claim-Evidence-Reasoning below. Cite evidence from any of the data you observed including the video.

Claim: There was an increase in tuskless elephants in areas with heavy poaching.

Evidence: _____

_____

_____

_____

Reasoning: _____

_____

_____

Summative Task: Saving a Species

Task: As one of the nation's leading genetics engineers you must prepare a written report for Congress stating why a certain endangered species should be saved. You must be prepared to present your report in front of a senate panel where you will either be granted or denied the monies for your proposal. Your report must include the following items. Final product must be typed and bound in a report cover.

- **MS-LS4-4.** Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environments.

- **MS-LS4-5.** Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms

Part One of Report:

1. Scientific Name of Species (5pts)
2. Common Name (5pts)
3. Conservation status (5pts)
4. Why the endangered species matters? Why are they important to save? (10 pts)
5. Human threats to the species? Why are they endangered? (10 pts)
6. What are the current efforts to help this endangered species? (5 pts)

Part Two of Report:

1. What traits/genes does the endangered species have that help them survive in their current environment? How has the species adapted to their current environment? (10pts)
2. What trait could humans artificially select or change to increase the species chances of survival? How could these traits/genes help them chances of survival? (10pts)
3. Could genetic modification help the species? If yes, how? If no, why? (10 pts)
4. Picture of the current species (5 pts)
5. Sketch/drawing of post selection species (5 pts)

Part Three of Report:

1. Create a timeline that shows how the species will be able to evolve? (label generations and changes to each. Note the original mutation.) (10pts)

Additional Parts of Report:

1. Report is neat and presented professionally (5pts)
2. Report is free of spelling and grammatical errors (5pts)

Total _____/100

Name _____ Period _____
Date_____

Endangered Species Research Project

Name of Endangered Species	
Physical Description of the endangered species	
World Location/Habitat/Ecosystem (description of where its lives and is found.)	
Diet/Prey/Predator (What does it eat? What does it hunt? Who hunts it?)	
Interesting Facts (Any information that explains more about their behavior)	
Why are they endangered? What is the statistical data on why they are endangered?	
What's being done? How are we intervening?	
Cite Resources - what websites, books, videos did you use	