TULSA PUBLIC SCHOOLS

HS Science

(Physical Science/Biology/Chemistry)

Distance Learning Activities

Dear families,

These learning packets are filled with grade level activities to keep students engaged in learning at home. We are following the learning routines with language of instruction that students would be engaged in within the classroom setting. We have an amazing diverse language community with over 65 different languages represented across our students and families.

If you need assistance in understanding the learning activities or instructions, we recommend using these phone and computer apps listed below.

Google Translate

- Free language translation app for Android and iPhone
- Supports text translations in 103 languages and speech translation (or conversation translations) in 32 languages
- Capable of doing camera translation in 38 languages and photo/image translations in 50 languages
- Performs translations across apps

Microsoft Translator

- Free language translation app for iPhone and Android
- Supports text translations in 64 languages and speech translation in 21 languages
- Supports camera and image translation
- Allows translation sharing between apps

3027 SOUTH NEW HAVEN AVENUE | TULSA, OKLAHOMA 74114
918.746.6800 | www.tulsaschools.org

Queridas familias:

Estos paquetes de aprendizaje tienen actividades a nivel de grado para mantener a los estudiantes comprometidos con la educación en casa. Estamos siguiendo las rutinas de aprendizaje con las palabras que se utilizan en el salón de clases. Tenemos una increíble y diversa comunidad de idiomas con más de 65 idiomas diferentes representados en nuestros estudiantes y familias.

Si necesita ayuda para entender las actividades o instrucciones de aprendizaje, le recomendamos que utilice estas aplicaciones de teléfono y computadora que se enlistan a continuación:

Google Translate

- Aplicación de traducción de idiomas para Android y iPhone (gratis)
- Traducciones de texto en 103 idiomas y traducción de voz (o traducciones de conversación) en 32 idiomas
- Traducción a través de cámara en 38 idiomas y traducciones de fotos / imágenes en 50 idiomas
- Realiza traducciones entre aplicaciones

Microsoft Translator

- Aplicación de traducción para iPhone y Android (gratis)
- Traducciones de texto en 64 idiomas y traducción de voz en 21 idiomas
- Traducción a través de la cámara y traducción de imágenes
- Permite compartir la traducción entre aplicaciones

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Physical Science Module 1: Energy Conversion

Distance Learning for April 13- April 29

Name:____________________ Period:_____________ Teacher:__________________

Instructions for Parents and Students: Students should spend about 30 minutes per day learning material in this packet, reviewing material, working on projects, and explaining content to others at home to make sure students meet their learning objectives.

If you have questions: email your teacher or email Dr. Jennifer Miller (milleje3@tulsaschools.org) for help. You may also call your teacher or 918.925.1118 if you need help and do not have internet access.

Goal: Given constraints, construct a machine that will convert one form of energy to another.

Big Question: How can energy be transferred to do work and complete a task?

Standard:

HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Learning Outcomes:

At the end of this module you should be able to:

- ❏ Explain that at the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
- ❏ Understand that energy cannot be destroyed, it can be converted to less useful forms — for example, to thermal energy in the surrounding environment
- ❏ Explain how changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
- ❏ Understand that modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.
- ❏ Design a device that converts one form of energy into another form of energy given constraints
- ❏ Demonstrate an understanding of Energy Conversion in regards to energy transfer and loss using your own experimental data and discussion of design plans and revisions.

WEEK 1: April 13-17

WHAT IS ENERGY?

Energy is a word which tends to be used a lot in everyday life. Though it is often used quite loosely, it does have a very specific physical meaning.

Energy is a measurement of the ability of something to do work. It is not a material substance. Energy can be stored and measured in many forms. Energy is measured in units called Joules (J). There are a lot of different kinds of energy in the universe, and that energy can do different things. Energy helps you walk across the street, throw a ball into the air, vacuum your house, watch television and ride the bus to school. Some of the above are possible because we have figured out how to convert energy from one form into another and use it to do our work.

Types of Energy

There are many forms of energy, but they can be categorized into 2 types:

POTENTIAL ENERGY and KINETIC ENERGY

Potential Energy is the energy of position, or stored energy. It has 4 forms:

1. Chemical energy – the energy stored in the bonds between atoms that holds molecules together
2. Nuclear energy – the energy stored in the nucleus of the atom that holds the nucleus together
3. Gravitational energy (the potential energy part of mechanical energy) – the energy an object has because of its position or height
4. Elastic energy – or stored mechanical energy, is energy stored in an object by the application of force

Kinetic Energy is the energy of particles in motion. It has 5 forms:

1. Mechanical energy – or motion, is the movement of objects or substances from one place to another
2. Electrical energy – the energy from flow of electric charge (electricity)
3. Thermal energy – or heat energy
4. Radiant energy – or light energy, or electromagnetic energy
5. Sound energy – the movement of energy through substances to produce a sound

Check for Understanding:

1. What is energy?

2. Define the 2 main types of energy.

3. Gravitational energy is the potential energy part of Mechanical Energy. Read the definitions for each of these. How are they connected to each other? Write down one example where you can think of an object showing gravitational and mechanical energy.

4. Create a diagram or flowchart organizing the forms of energy into the two main types

of energy.

5. Pick any 2 forms of energy that are kinetic and any 2 forms of energy that are potential. Give one example for each of the forms you chose.

Let's Examine:

Gary Clark Jr. is playing an electric guitar in a concert. He plucks the strings of the guitar with skill, and the sounds of the music thrill the crowd. The bright stage lights in the otherwise dark concert hall add to the excitement, although they make it hot on stage. This scene represents energy in several different forms. Do you know what they are?

Comparing Forms of Energy

Energy, or the ability to do work, can exist in many different forms. The photo in Figure above represents six of the eight different forms of energy that are described in this lesson. The guitarist gets the energy he needs to perform from chemical energy in food. He uses mechanical energy to pluck the strings of the guitar. The stage lights use electrical energy and give off both light energy and thermal energy, commonly called heat. The guitar also uses electrical energy, and it produces sound energy when the guitarist plucks the strings.

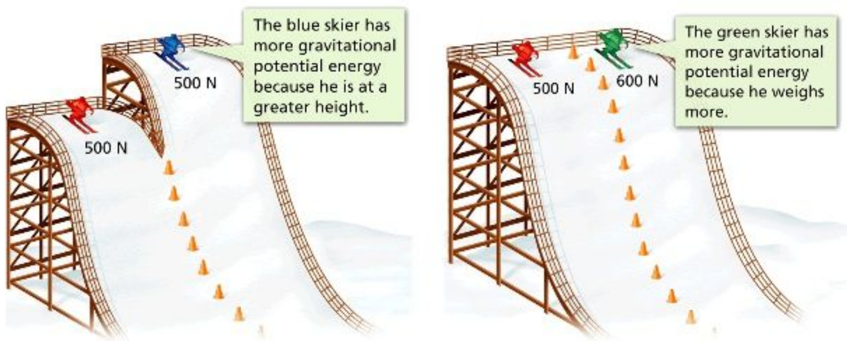
Mechanical Energy

Mechanical energy is the energy of an object that is moving or has the potential to move. It is the sum of an object's kinetic and potential energy. In Figure below, the basketball has mechanical energy because it is moving. The arrow in the same figure has elastic energy that will turn into mechanical energy because it has the potential to move due to the elasticity of the bow.

Energy associated with the movement and potential movement of objects is called mechanical energy.

Gravitational Energy

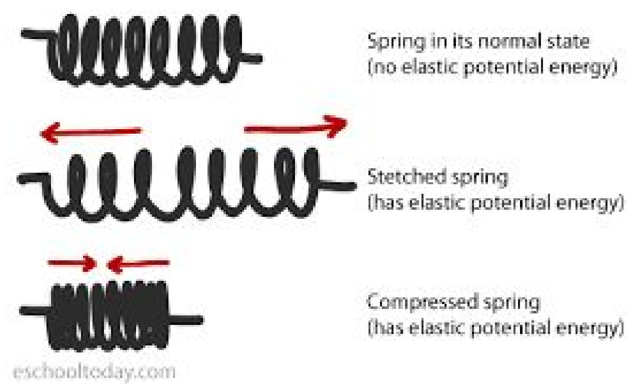
Gravitational potential energy is the energy stored in an object as the result of its vertical position or height. The energy is stored as the result of the gravitational attraction of the Earth for the object.



GPE = Mass x Gravity ($9.8 m/s^2$) x Height (mgh)

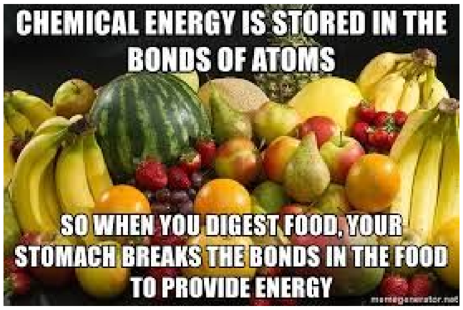
Elastic Energy

Elastic potential energy is the energy stored in elastic materials as the result of their stretching or compressing. Elastic potential energy can be stored in rubber bands, bungee cords, trampolines, springs, an arrow drawn on a bow string, etc. The amount of elastic potential energy stored in such a device is related to the amount of stretch of the device - the more stretch, the more stored energy. Springs are a special instance of a device that can store elastic potential energy due to either compression or stretching. A force is required to compress a spring; the more compression there is, the more force that is required to compress it further.



Chemical Energy

Energy is stored in the bonds between atoms that make up compounds. This energy is called chemical energy, and it is a form of potential energy. If the bonds between atoms are broken, the energy is released and can do work. The wood in the fireplace in Figure below has chemical energy. The energy is released as thermal energy when the wood burns.



People and many other living things meet their energy needs with chemical energy stored in food. When food molecules are broken down, the energy is released and may be used to do work.

Electrical Energy

Electrons are negatively charged particles in atoms. Moving electrons have a form of kinetic energy called electrical energy. If you've ever experienced an electric outage, then you know how hard it is to get by without electrical energy. Most of the electrical energy we use is produced by power plants and arrives in our homes through wires. Two other sources of electrical energy are pictured below.

An average lightning bolt has about 500 million joules of electrical energy!

Over its lifetime, an AA battery may provide about 9000 joules of electrical energy.

Nuclear Energy

The nuclei of atoms are held together by powerful forces. This gives them a tremendous amount of stored energy, called nuclear energy. The energy can be released and used to do work. This happens in nuclear power plants when nuclei fission, or split apart. It also happens in the sun and other stars when nuclei fuse, or join together. Some of the sun's energy travels to Earth, where it warms the planet and provides the energy for photosynthesis.

In the sun, hydrogen nuclei fuse to form helium nuclei. This releases a huge amount of energy, some of which reaches Earth.

Thermal Energy

The atoms that make up matter are in constant motion, so they have kinetic energy. All that motion gives matter thermal energy. Thermal energy is defined as the total kinetic energy of all the atoms that make up an object. It depends on how fast the atoms are moving and how many atoms the object has. Therefore, when an object with more mass it has greater thermal energy than the object with less mass, even if their individual atoms are moving at the same speed. You can see an example of this in Figure below.

Atoms are moving at the same speed in the soup on the spoon as they are in the soup in the pot. However, there are more atoms of soup in the pot, so it has more thermal energy.

Electromagnetic Energy (Light)

Energy that the sun and other stars release into space is called electromagnetic energy. This form of energy travels through space as electrical and magnetic waves. Electromagnetic energy is commonly called light. It includes visible light, as well as radio waves, microwaves, and X rays (Figure below).

A radio tower (left) sends radio waves through the air. Radios in the area can pick up the energy and convert it to sound.

A microwave oven (above right) sends microwaves through food, causing it to cook quickly.

An X- ray machine sends out X rays that pass through soft tissues such as skin but not through hard tissues such as teeth. The X rays create an image on film (bottom right).

Radio waves, microwaves, and X rays are examples of electromagnetic energy.

Sound Energy

The drummer, Meg White, is hitting the drum heads with drumsticks. This causes the drumheads to vibrate. The vibrations pass to surrounding air particles and then from one air particle to another in a wave of energy called sound energy. We hear sound when the sound waves reach our ears. Sound energy can travel through air, water, and other substances, but not through empty space. That’s because the energy needs particles of matter to pass it on.

Meg White from The White Stripes. Vibrating objects such as drumheads produce sound energy.

Check for Understanding:

6. Fill in the table for each form of energy:

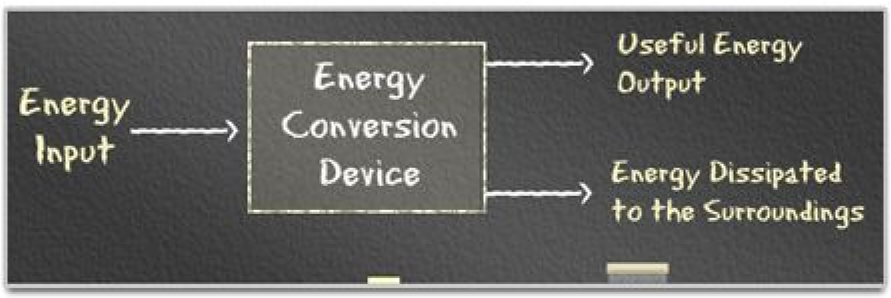
Energy Form	Potential or Kinetic	Example
Example: Thermal Energy	Kinetic	A hot cup of coffee

THE LAW OF CONSERVATION OF ENERGY

Although we often hear people talking about energy consumption, energy is never really destroyed. It is just transferred from one form to another, doing work in the process. Some forms of energy are less useful to us than others.

In physics, the term conservation refers to something which doesn't change. This means that the variable in an equation which represents a conserved quantity is constant over time. It has the same value both before and after an event. Let's explore an example:

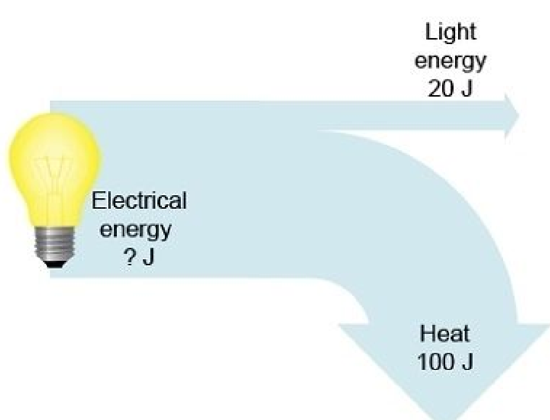
Figure 2



In this example, electrical energy is the energy input into the lightbulb. The lightbulb acts as an energy conversion device to produce light energy and heat energy. The light is the useful energy since we use it to illuminate our homes, but heat is the wasted energy dissipated to the surroundings. We want the light, but not the heat so the light is useful energy and the heat is dissipated energy.

Remember that the law of conservation of energy states that energy can not be created or destroyed, but only transferred.

Figure 3



In the lightbulb, we see that 20 Joules of energy is light energy at 100 Joules of energy is given off as heat energy. What is the total amount of electrical energy that was put into the light bulb?

Since energy is conserved, the energy put into the system MUST be EQUAL to the energy released. 20J (light) +100J (heat) = **120 J into**

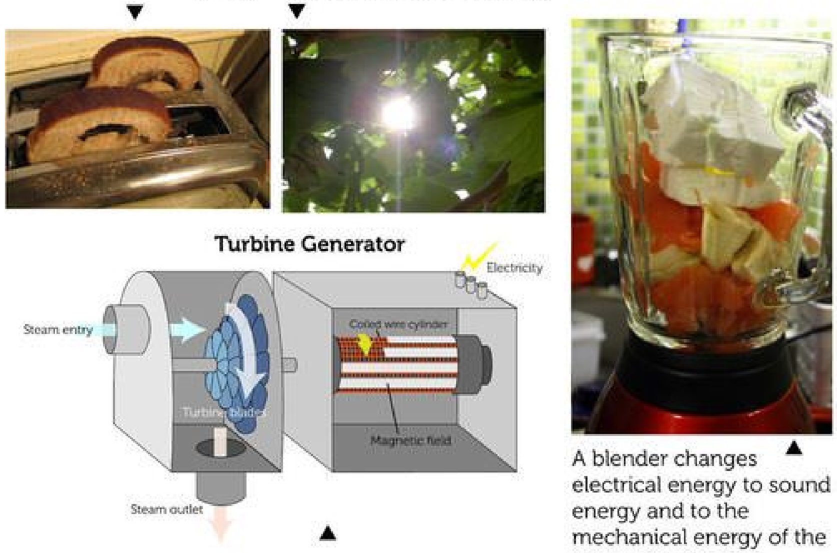
How Energy Changes Form

Energy often changes from one form to another. For example, the mechanical energy of a moving drumstick changes to sound energy when it strikes the drumhead and causes it to vibrate.

Any form of energy can change into any other form. Frequently, one form of energy changes into two or more different forms. For example, when wood burns, the wood's chemical energy changes to both thermal energy and light energy. Other examples of energy conversions are described in Figure below.

A toaster changes electrical energy to thermal energy, which toasts the bread.

During photosynthesis, plants change light energy from the sun to chemical energy stored in food. Organisms that eat plants change the chemical energy in food to other forms of energy, such as thermal energy and kinetic energy.



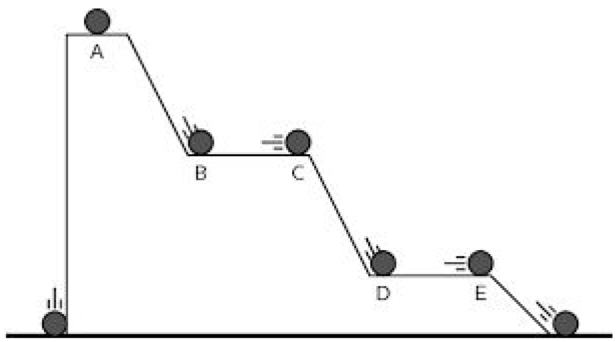
In a steam turbine, thermal energy heats water to create steam. The steam turns the turbine blades, giving them mechanical energy. The turning blades cause a coil of wire to rotate around a magnet. This generates electrical energy.

A blender changes electrical energy to sound energy and to the mechanical energy of the turning blades. The rapidly turning blades blend the food.

Energy is conserved in energy conversions. No energy is lost when energy changes form, although some may be released as thermal energy due to friction. For example, not all of the energy put into a steam turbine in Figure above changes to electrical energy. Some changes to thermal energy because of friction of the turning blades and other moving parts. The more efficient a device is, the greater the percentage of usable energy it produces. Appliances with an "Energy Star" label like the one in Figure below use energy more efficiently and thereby reduce energy use.

Check for Understanding:

7. In your own words, what does the Law of Conservation of Energy mean?

8. 

   a. At which letter does the ball have the LEAST gravitational potential energy?___
   b. At which letter does the ball have NO kinetic energy? ____
   c. This system has 50J of energy total. How much gravitational potential energy does it have a point A?_____
   d. At point E, the ball has 5 J of potential energy. How many Joules of kinetic energy will it have?________

9. Give an example of each of the energy conversions listed in the table below. You may NOT use the same examples given previously.

Energy transfer:	Example:
Example: Nuclear to Thermal	Energy released in an atomic bomb
Elastic to Mechanical	
Electromagnetic (Light) to Electrical	
Gravitational to Mechanical	
Electrical to Thermal	
Mechanical to Sound	

RUBE GOLDBERG MACHINES

A Rube Goldberg machine is a complex multistep machine used to complete a simple task. Let's look at a sample Rube Goldberg machine:

Check for understanding:

1. What is the task this machine is completing?

2. Find three examples where energy is transferred in the machine above. There are lots! You only need to describe 3. Explain what is occurring, how the energy is transferred and what types of energy are transferred.
 (example: block knocks over axe: the block hits the axe causing the gravitational energy in the axe to become mechanical energy as it falls over.)

PROJECT! PLAN DEVELOPMENT

Your objective is to design a device that converts one form of energy into another form of energy given constraints. Devices could include, but are not limited to: Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators.

Constraints: You can only use objects you already have in your house or things you can find for for free outside.

Explore what you have to work with and decide what you would like to build.

Write down your ideas and the materials you will use in the space below:

Keep going…

WEEK 2: April 20-24 and part of WEEK 3: April 27-29

PROJECT DESIGN, TRIAL, AND ANALYSIS
(Final project due Wednesday, April 29)

Steps:

1. Continue to develop a plan for your device. Draw a sketch or blueprint for your plan that you will work on over the next several days. In your sketch or plan you must include the following:
   a. Identify what scientific ideas provide the basis for the energy conversion design;
   b. Identify the forms of energy that will be converted from one form to another in the designed system;
   c. Identify losses of energy by the design system to the surrounding environment;
   d. Describe the scientific reasoning for choices of materials and structure you chose
   e. Describe how your device applies scientific knowledge and engineering design to increase benefits for modern civilization while decreasing costs and/or risk. (What will your machine do to benefit others?)

Biology Module 1: Ecosystem Dynamics

Distance Learning for April 13-24

Name: ________________ period:_________ teacher: ____________

Instructions for Parents and Students: Students should spend about 30 minutes per day learning material in this packet and additional time reviewing material, working on projects, and explaining content to others at home to make sure students meet their learning objectives.

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Goal: Analyze data to determine the effects of factors on carrying capacities of ecosystems.

Big Question: How do specific factors limit the carrying capacity of ecosystems?

Standards:

HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

- Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.

Learning Outcomes:

By the end of this module, you should be able to:

- ❏ Demonstrate understanding that ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support.
- ❏ Explain how these limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease.
- ❏ Determine that organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite.
- ❏ Explain how this fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.
- ❏ Identify and describe the components in the given mathematical and/or computational representations (e.g., trends, averages, histograms, graphs, spreadsheets) that are relevant to supporting given explanations of factors that affect carrying capacities of ecosystems at different scales.
- ❏ Analyze and use given mathematical and/or computational representations:
- ❏ To identify the interdependence of factors (both living and nonliving) and resulting effect on carrying capacity
- ❏ As evidence to support the explanation and identify the factors that have the largest effect on the carrying capacity of an ecosystem for a given population.
- ❏ Submit a presentation, speech, discussion, file, etc. demonstrating their understanding of mathematical and/or computational representations to identify the interdependence of factors (both living and nonliving) and resulting effect on carrying capacity
- ❏ As evidence to support the explanation and identify the factors that have the largest effect on the carrying capacity of an ecosystem for a given population.

Large portions of this packet are from the CK-12 Foundation.

Week 1: April 13-17 / Week 2: April 20-24

Examining Human Population

Introduction

Improvements in agriculture, sanitation, and medical care have enabled the human population to grow enormously in the last few hundred years. As the population grows, consumption, waste, and the overuse of resources also grows. People are beginning to discuss and carry out sustainable development that decreases the impact humans have on the planet.

Populations

Biotic (living) and abiotic (nonliving) factors determine the population size of a species in an ecosystem. Biotic factors include the amount of food that is available to that species and the number of organisms that also use that food source. Habitable space and climate are some abiotic factors that all help determine a species population.

When does a population grow? A population grows when the number of births is greater than the number of deaths. *When does a population shrink?* When deaths exceed births.
For a population to grow there must be ample resources and no major problems. A population can shrink either because of biotic or abiotic limits. An increase in predators, the emergence of a new disease, or the loss of habitat are just three possible problems that will decrease a population. A population may also shrink if it grows too large for the resources required to support it.

Check for Understanding:

1. What two factors regulate population size? Give examples of each that are NOT listed above.

2. The human population is growing at incredibly high rates. Why do you predict the human population is able to grow so quickly?

3. Can human growth continue at such a rate? Explain your answer.

4. Explain the effect of COVID-19 on the human population. What type of factor is COVID-19?

Carrying Capacity

When the number of births equals the number of deaths, the population is at its carrying capacity for that habitat. In a population at its carrying capacity, there are as many organisms of that species as the habitat can support. The carrying capacity depends on biotic and abiotic factors. If these factors improve, the carrying capacity increases. If the factors become less plentiful, the carrying capacity drops. If resources are being used faster than they are being replenished, then the species has exceeded its carrying capacity. If this occurs, the population will then decrease in size.

Limiting Factors

Every stable population has one or more factors that limit its growth. A limiting factor determines the carrying capacity for a species. A limiting factor can be any biotic or abiotic factor: nutrient, space, and water availability are examples (Figure below). The size of a population is tied to its limiting factor.

What happens if a limiting factor increases a lot? Is it still a limiting factor? If a limiting factor increases a lot, another factor will most likely become the new limiting factor.
This may be a bit confusing so let's look at an example of limiting factors.
Say you want to make as many chocolate chip cookies as you can with the ingredients you have on hand. It turns out that you have plenty of flour and other ingredients, but only two eggs. You can make only one batch of cookies, because eggs are the limiting factor. But then your neighbor comes over with a dozen eggs. Now you have enough eggs for seven batches of cookies, and enough other ingredients but only two pounds of butter. You can make four

batches of cookies, with butter as the limiting factor. If you get more butter, some other ingredient will be limiting.

Species ordinarily produce more offspring than their habitat can support (Figure below). If conditions improve, more young survive and the population grows. If conditions worsen, or if too many young are born, there is competition between individuals. As in any competition, there are some winners and some losers. Those individuals that survive to fill the available spots in the niche are those that are the most fit for their habitat.

A frog in frog spawn. An animal produces many more offspring than will survive.

Check for Understanding:

5. In your own words, define carrying capacity.

6. What causes the carrying capacity to decrease in an ecosystem?

7. In a desert such as this, what is the limiting factor on plant populations? What would make the population increase? What would make the population decrease?

8. In terms of carrying capacity and limiting factors, why might it be important that species produce more offspring than will survive?

9. What are three limiting factors that affect the carrying capacity of the Earth for humans? Explain your answers.

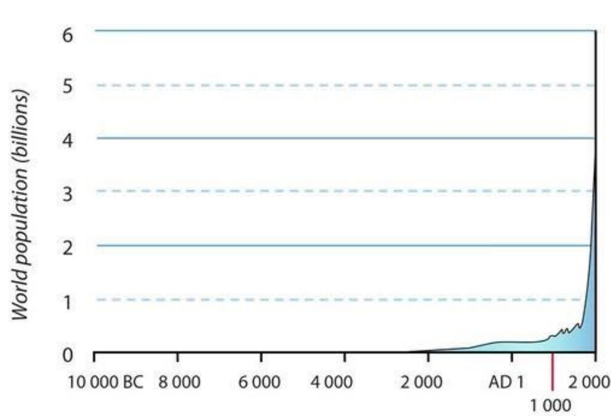
Human Population Growth

Human Population Numbers

Human population growth over the past 10,000 years has been tremendous. Human population from 10,000 BC through 2000 AD has exponentially increased over the last few centuries (Figure below).

Graph 1

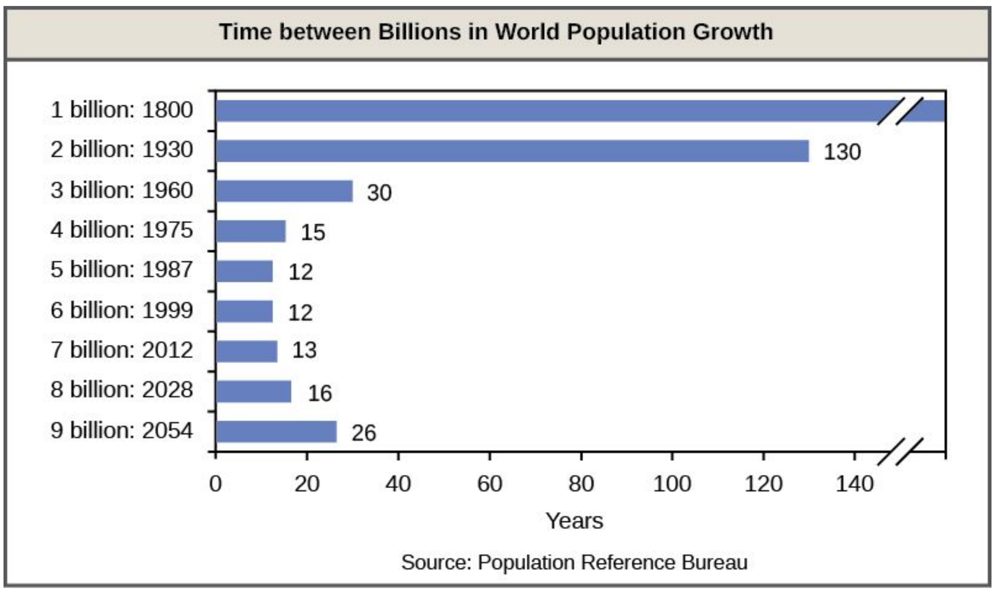
- 5 million in 8000 B.C.
- 300 million in A.D. 1
- 1 billion in 1802
- 3 billion in 1961
- 7 billion in 2011



As the human population continues to grow, different factors limit population in different parts of the world. Space, clean air, clean water, and food to feed everyone are limiting in some locations.

Not only has the population increased, but the rate of population growth has increased (Figure below). Estimates were that the population will reach 7 billion in 2012, 13 years after reaching 6 billion. The global population *actually* reached 7 billion in 2011, with current worldwide population in 2020 at 7.8 billion. Demographers expect our population to reach the 8 billion milestone in 2023, with global population projected to reach 9 billion by 2037 and 10 billion by 2056.

Graph 2



The amount of time between the addition of each one billion people to the planet's population, including speculation about the future.

Check for Understanding:

10. Graph 2 no longer represents current population predictions. Recreate the section of the graph from a population of 6 billion: 1999 through a population of 10 billion: 2056 with the updated predictions.

11. During what time frame was the fastest addition of a billion people to the human population?

12. Examine graph 1. In what time period did human population grow exponentially?

13. Examine graph 1 and graph 2. Predict why the human population was so slow to grow in the 1800s and early 1900s and then quickly skyrocketed in more recent decades.

14. Think about the limiting factors in developed countries (U.S., Germany, South Korea) verus those in the developing world (Kuwait, India, Bangladesh). How might the limiting factors in developed countries be different from those in developing countries?

EARTH'S CARRYING CAPACITY FOR HUMANS

What is Earth's carrying capacity for humans? Are humans now exceeding Earth's carrying capacity for our species? Many anthropologists say that the carrying capacity of humans on the planet without agriculture is about 10 million (Figure below). *This population was reached about 10,000 years ago.* At the time, people lived together in small bands of hunters and gatherers. Typically men hunted and fished; women gathered nuts and vegetables.

In a hunter-gatherer society, people relied on the resources they could find where they lived.

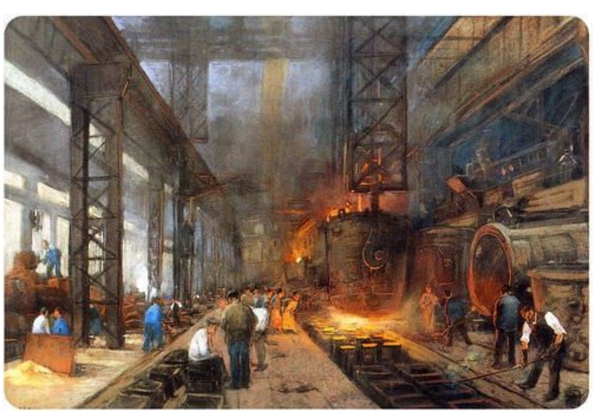
Obviously, human populations have blown past this hypothetical carrying capacity. By using our brains, our erect posture, and our hands, we have been able to manipulate our environment in ways that no other species has ever done.

About 10,000 years ago, we developed the ability to grow our own food. Farming increased the yield of food plants and allowed people to have food available year round. Animals were domesticated to provide meat. With agriculture, people could settle down, so that we no longer needed to carry all of our possessions. We developed better farming practices and stored food for when it was difficult to grow. Agriculture allowed us to settle in towns and cities.

More advanced farming practices allowed a single farmer to grow food for many more people. When advanced farming practices allowed farmers to grow more food than they needed for their families (Figure below), some people were then able to do other types of work, such as crafts or shop keeping.

Farming increasingly depended on machines. Rows of a single crop and heavy machinery are normal sights on modern-day farms.

The next major stage in the growth of the human population was the Industrial Revolution, which started in the late 1700s (Figure below). This major historical event marks when products were first mass produced and when fossil fuels were first widely used for power.



Early in the Industrial Revolution, large numbers of people who had been freed from food production were available to work in factories.

Every major advance in agriculture has allowed the global population to increase. Irrigation, the ability to clear large swaths of land for farming efficiently, and the development of farm machines powered by fossil fuels allowed people to grow more food and transport it to where it was needed.
The Green Revolution has allowed the addition of billions of people to the population in the past few decades. The Green Revolution has improved agricultural productivity by:

- Improving crops by selecting for traits that promote productivity; recently genetically engineered crops have been introduced.
- Increasing the use of artificial fertilizers and chemical pesticides. About 23 times more fertilizer and 50 times more pesticides are used around the world than were used just 50 years ago.
- Agricultural machinery: plowing, tilling, fertilizing, picking, and transporting are all done by machines. About 17% of the energy used each year in the United States is for agriculture.
- Increasing access to water. Many farming regions depend on groundwater, which is not a renewable resource. Some regions will eventually run out of this water source. Currently about 70% of the world's freshwater is used for agriculture.

Rows of a single crop and heavy machinery are normal sights for modern day farms.

The Green Revolution has increased the productivity of farms immensely. A century ago, a single farmer produced enough food for 2.5 people, but now a farmer can feed more than 130 people. The Green Revolution is credited for feeding 1 billion people that would not otherwise have been able to live.

Manhattan is one of the most heavily populated regions in the world.

In the eighteenth century, Thomas Malthus predicted that the human population would continue to grow until we had exhausted our resources. At that point, humans would become victims of famine, disease, or war. This has not happened, at least not yet. Some scientists think that the carrying capacity of the planet is about 1 billion people, *not* the almost 7 billion people we have today. The limiting factors have changed as our intelligence has allowed us to expand our population. *Can we continue to do this indefinitely into the future?*

Check for Understanding:

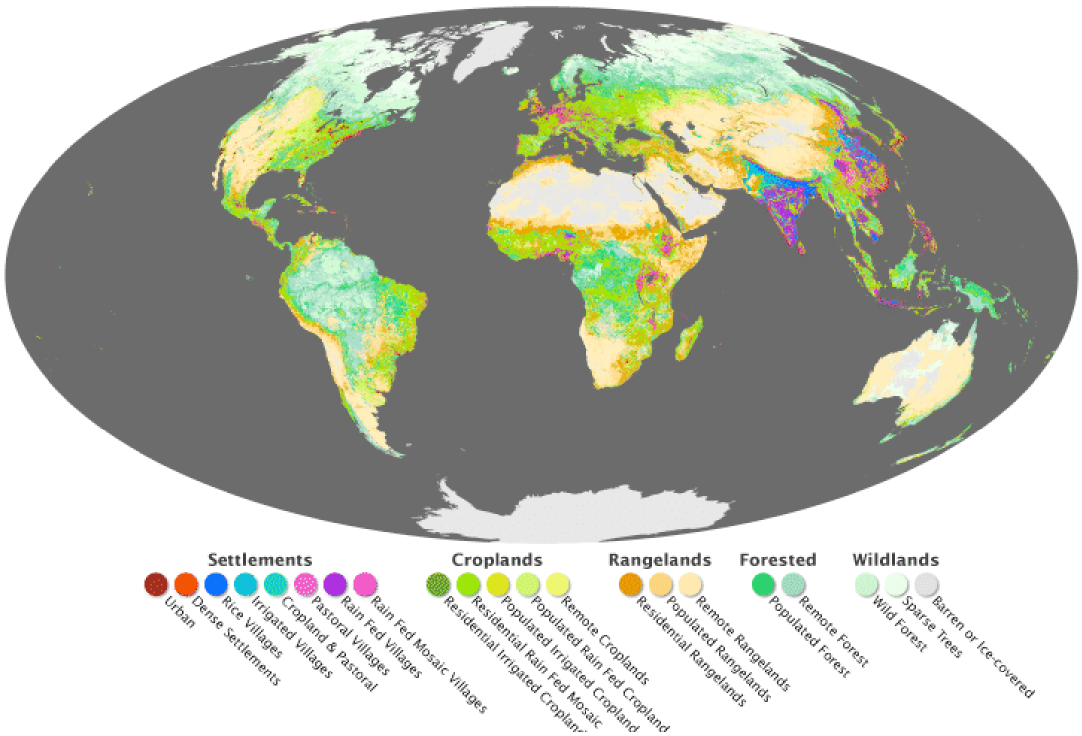
15. What are the important developments that have been made that increased the carrying capacity for humans on earth?

16. What must humans do to sustain the increase in population that is predicted?

Humans and the Environment

The Green Revolution has brought enormous impacts to the planet. Natural landscapes have been altered to create farmland and cities. Already, half of the ice-free lands have been converted to human uses (Figure below). Estimates are that by 2030, that number will be more than 70%. Forests and other landscapes have been cleared for farming or urban areas. Rivers have been dammed and the water is transported by canals for irrigation and domestic uses.

Ecologically sensitive areas have been altered: wetlands are now drained and coastlines are developed.

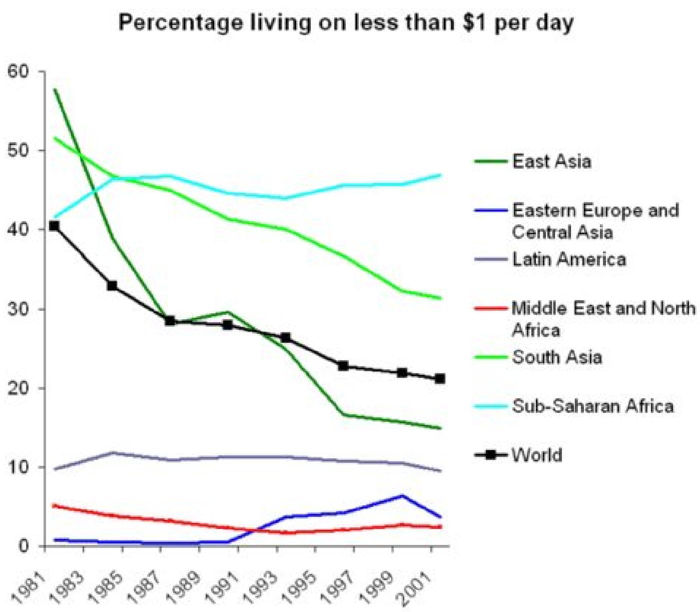


Similar to the biomes map in the Climate chapter, this map shows human ecosystems. Much of the planet's surface is populated and used by humans.

Modern agricultural practices produce a lot of pollution (Figure below). Some pesticides are toxic. Dead zones grow as fertilizers drain off farmland and introduce nutrients into lakes and coastal areas. Farm machines and vehicles used to transport crops produce air pollutants. Pollutants enter the air, water, or are spilled onto the land. Moreover, many types of pollution easily move between air, water, and land. As a result, no location or organism — not even polar bears in the remote Arctic — is free from pollution.

Pesticides are hazardous in large quantities and some are toxic in small quantities.

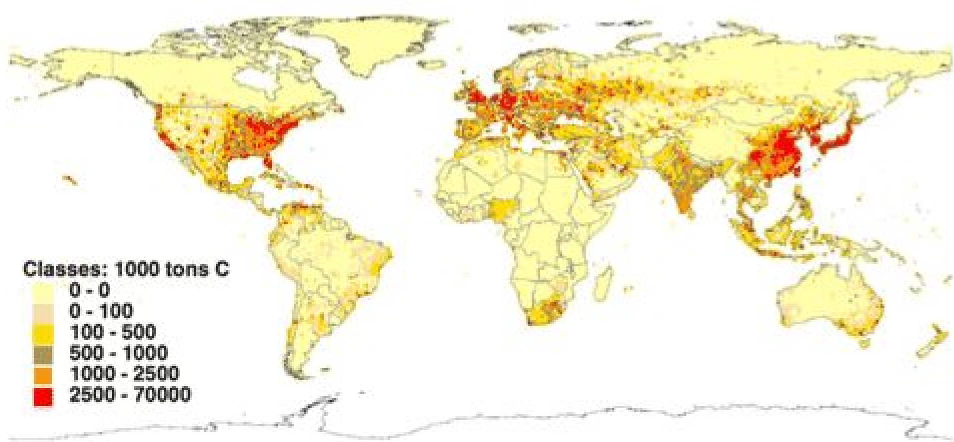
The increased numbers of people have other impacts on the planet. Humans do not just need food. They also need clean water, secure shelter, and a safe place for their wastes. These needs are met to different degrees in different nations and among different socioeconomic classes of people. For example, about 1.2 billion of the world's people do not have enough clean water for drinking and washing each day (Figure below).



The percentage of people in the world that live in abject poverty is decreasing somewhat globally, but increasing in some regions, such as Sub-Saharan Africa.

A large percentage of people expect much more than to have their basic needs met. For about one-quarter of people there is an abundance of food, plenty of water, and a secure home. Comfortable temperatures are made possible by heating and cooling systems, rapid transportation is available by motor vehicles or a well-developed public transportation system, instant communication takes place by smartphones, and many other luxuries are available that were not even dreamed of only a few decades ago. All of these need resources to produce, and fossil fuels to power (Figure below). Their production, use, and disposal all produce wastes.

Many people refer to the abundance of luxury items in these people's lives as **over-consumption**. People in developed nations use 32 times more resources than people in the developing countries of the world.



Since CO_2 is a waste product from fossil fuel burning, CO_2 emissions tell which countries are using the most fossil fuels, which means that the population has a high standard of living.

Many problems worldwide result from overpopulation and overconsumption. One such problem is the advance of farms and cities into wild lands, which diminishes the habitat of many organisms. In addition, water also must be transported for irrigation and domestic uses.

This means building dams on rivers or drilling wells to pump groundwater. Large numbers of people living together need effective sanitation systems. Many developing countries do not have the resources to provide all of their citizens with clean water. It is not uncommon for some of these children to die of diseases related to poor sanitation. Improving sanitation in many different areas — sewers, landfills, and safe food handling — are important to prevent disease from spreading.

Wildlife is threatened by fishing, hunting, and trading as population increases. Besides losing their habitat as land is transformed, organisms are threatened by hunting and fishing as human population grows. Hunting is highly regulated in developed nations, but many developing nations are losing many native animals because of hunting. Wild fish are being caught at too high a rate and many ocean-fish stocks are in peril.

Humans also cause problems with ecosystems when they introduce species that do not belong in a habitat. Invasive species are sometimes introduced purposefully, but often they arrive by accident, like rats on a ship. Invasive species often have major impacts in their new environments. A sad example is the Australian Brown Tree Snake that has wiped out 9 of the 13 native bird species on the island of Guam (Figure below).

An Australian Brown Tree Snake

Pollution is a by-product of agriculture, urbanization, and the production and consumption of goods. Global warming is the result of fossil fuel burning.

As China industrializes, its cities have become among the most polluted in the world.

With all of these innovations, use of resources, and consequences, have humans exceeded Earth's carrying capacity for our species?

Carrying capacity is exceeded if:

- resources are being used faster than they are being replenished.
- the environment is being damaged.

Seen this way: The answer appears to be yes.

- Many resources are being used far in excess of the rate at which they are being replaced.
- The best farmland is already in use and more marginal lands are being developed.
- Many rivers are already dammed as much as they can be.
- Groundwater is being used far more rapidly than it is being replaced.
- Fossil fuels and mineral resources are being used faster than they are being replaced.
- Forests are being chopped down in developed and developing nations.
- Wild fish are being overharvested.
- The environment is certainly being damaged
- Pollution is discussed in the coming chapters.
- Temperatures are rising and the effects are being seen worldwide.
- Humans have caused the rate of extinction of wild species to increase to about at least 100 times the normal extinction rate.

Although many more people are alive in the world than ever before, many of these people do not have secure lives. Many people in the world live in poverty, with barely enough to eat. They often do not have safe water for drinking and bathing (Figure below). Diseases kill many of the world's children before they reach five years of age.

Nearly half of the people living in Africa do not have access to clean water.

Check for Understanding:

17. Write about it! In 2-4 paragraphs explain your agreement or disagreement with Thomas Malthus who "predicted that the human population would continue to grow until we had exhausted our resources. At that point, humans would become victims of famine, disease, or war." Even though we have increased the carrying capacity of the planet, have we now exceeded it? Are humans on Earth experiencing overpopulation? Write about your position on this next page. You must reference the graphs and data in this section to support your stance. You may also utilize relevant news or information to support your position.

Sustainable Development

A topic generating a great deal of discussion these days is sustainable development. The goals of sustainable development are to:

- help people out of poverty.
- protect the environment.
- use resources no faster than the rate at which they are regenerated.

One of the most important steps to achieving a more sustainable future is to reduce human population growth. This has been happening in recent years. Studies have shown that the birth rate decreases as women become educated, because educated women tend to have fewer, and healthier, children.

Science can be an important part of sustainable development. When scientists understand how Earth's natural systems work, they can recognize how people are impacting them. Scientists can work to develop technologies that can be used to solve problems wisely. An example of a practice that can aid sustainable development is fish farming, as long as it is done in environmentally sound ways. Engineers can develop cleaner energy sources to reduce pollution and greenhouse gas emissions.

Citizens can change their behavior to reduce the impact they have on the planet by demanding products that are produced sustainably. When forests are logged, new trees should be planted. Mining should be done so that the landscape is not destroyed. People can consume less and think more about the impacts of what they do consume.

Check for Understanding: Think about it: 18. Will producing all that we need to keep the population growing result in a planet so polluted that the quality of life will be greatly diminished?

19. Will warming temperatures cause problems for human populations?

20. What would happen to the abiotic and other biotic factors on Earth if humans suddenly disappeared?

PRACTICE:

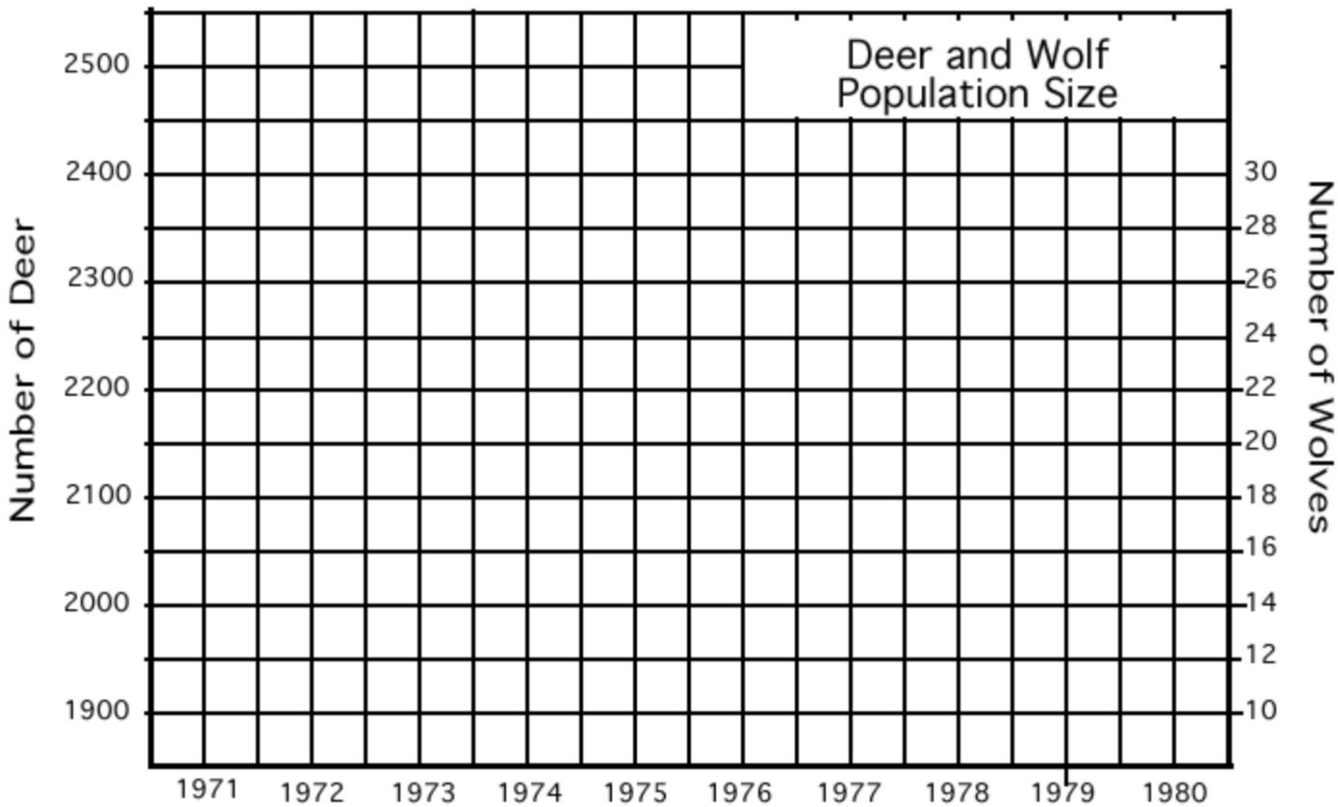
Deer: Predation or Starvation?

In 1970 the deer population of an island forest reserve was about 2000 animals. Although the island had excellent vegetation for feeding, the food supply obviously had limits. Thus, the forest management personnel feared that overgrazing might lead to mass starvation. Since the area was too remote for hunters, the wildlife service decided to bring in natural predators to control the deer population. It was hoped that natural predation would keep the deer population from becoming too large and also increase the deer quality (or health), as predators often eliminate the weaker members of the herd. In 1971, ten wolves were flown into the island.

The results of this program are shown in the following table. The population change is the number of deer born minus the number of deer that died during that year. The herd population started at 2000 when this study began.

1. Calculate the number of deaths (predation + starvation).
2. To determine the deer population change, subtract the number of deaths from births (births - deaths), this can be a positive number, indicating growth, or a negative number which indicates a population decline.
3. Calculate the deer population by adding/subtracting the population change from the population the year before
4. The first row (1971) has been completed for you as an example.
5. Graph the deer and wolf populations as two lines (color and label)

Year	Wolf Population	Deer Births	Predation	Starvation	Number of deaths	Deer Population Change	Deer Population
1970	starting population, data unknown for prior year.						*<2000*
1971	10	800	400	100	*500*	*+300*	*2300*
1972	12	920	480	240			
1973	16	1,000	640	500			
1974	22	944	880	180			
1975	28	996	1,120	26			
1976	24	836	960	2			
1977	21	788	840	0			
1978	18	766	720	0			
1979	19	780	760	0			
1980	19	790	760	0			



Analysis

1. Describe what happened to the deer population between 1971 and 1980.

2. When was the wolf population the highest? What is the relationship between the number of wolves and the number of deer?

3. What do you think would have happened to the deer on the island had wolves NOT been introduced?

4. **Zero population growth** occurs when a population has the same number of individuals entering the population (births) as those leaving the population (deaths). This results in very little change in the overall population numbers. In which year, was the deer population closest to ZPG? How do you know?

5. Most biology textbooks describe that predators and prey exist in a balance. This "**balance of nature**" hypothesis has been criticized by some scientists because it suggests a relationship between predators and prey that is good and necessary. Opponents of this hypothesis propose the following questions:

> Why is death by predators more natural or "right" then death by starvation?
>
> How does one determine when an ecosystem is in "balance"?
>
> Do predators really kill only the old and sick prey? What evidence is there for this statement?

What is your opinion of the balance of nature hypothesis? Would the deer on the island be better off, worse off, or about the same without the wolves. Defend your position.

PROJECT!

Due Friday 4/24

You will utilize all the information and graphs in our study of human population to complete your project. By April 24, you will submit a presentation, speech, discussion, poster, file, etc. to demonstrate your understanding of mathematical and/or computational representations of population dynamics.

You will:

1. Analyze and use the given mathematical and/or computational resources (graphs, tables, info, etc.) in this module to:
    a. To identify and explain the interdependence of factors (both living and nonliving) and resulting effect on carrying capacity of humans.
    b. Use the resources to provide evidence to support the explanation and identify the factors that have the largest effect on the carrying capacity of an ecosystem for humans.

CHEMISTRY MODULE 2: CHEMICAL EQUILIBRIUM
DISTANCE LEARNING FOR APRIL 21-28

NAME: ________________________________ **TEACHER:** _________________ **PERIOD:** ____

INSTRUCTIONS FOR PARENTS AND STUDENTS: Students should spend about 30 minutes per day learning material in this packet and additional time reviewing material, working on projects, and explaining content to others at home to make sure students meet their learning objectives.

If you have questions: email your teacher or email Dr. Jennifer Miller (milleje3@tulsaschools.org) for help. You may also call your teacher or 918.925.1118 if you need help and do not have internet access.

GOAL: Utilize Le Chatelier's Principle to manipulate shifts through applying stressors in equilibrium reactions.

BIG QUESTION: How can we use equilibrium chemistry to analyze the effects of pollution?

STANDARD:
HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

LEARNING OBJECTIVES:
By the end of this module you should be able to:

- ❏ Explain Le Chatelier's principle, including:
    - ❏ How, at a molecular level, a stress involving a change to one component of an equilibrium system affects other components;
    - ❏ That changing the concentration of one of the components of the equilibrium system will change the rate of the reaction (forward or backward) in which it is a reactant, until the forward and backward rates are again equal; and
    - ❏ A description of a system at equilibrium that includes the idea that both the forward and backward reactions are occurring at the same rate, resulting in a system that appears stable at the macroscopic level.
- ❏ Identify and describe potential changes in a component of the given chemical reaction system that will increase the amounts of particular species at equilibrium.
- ❏ Evaluate a real-world problem and propose a possible improvement or solution to the problem.
- ❏ Evaluate the constraints in the problem-solving process (cost, time, etc.).
- ❏ Demonstrate an understanding of Equilibrium in regards to Le Chatelier's principle and applied stress using discussion of real world problems and molecular level interactions
- ❏ Model on a molecular level the change that occurs under a given stress.

❑ Construct a speech, paper, presentation, or media resource to explain a real-world problem explaining equilibrium and explicitly using Le Chatelier's principle to discuss the topic.

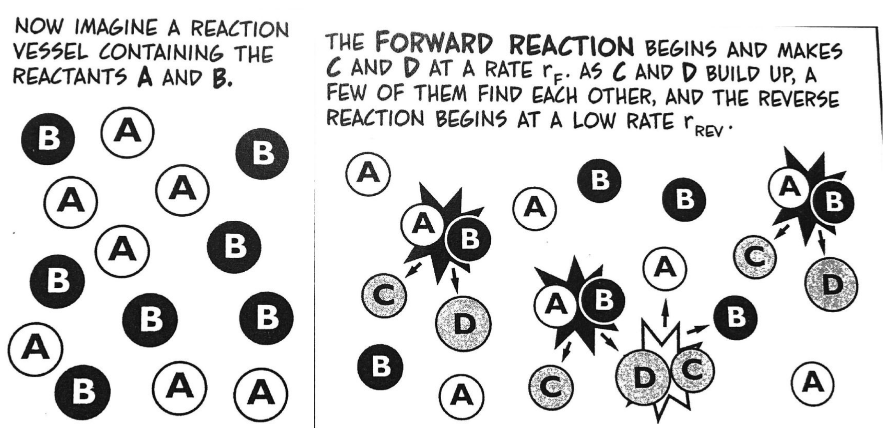
Part of Week 2 & Week 3: April 21-28

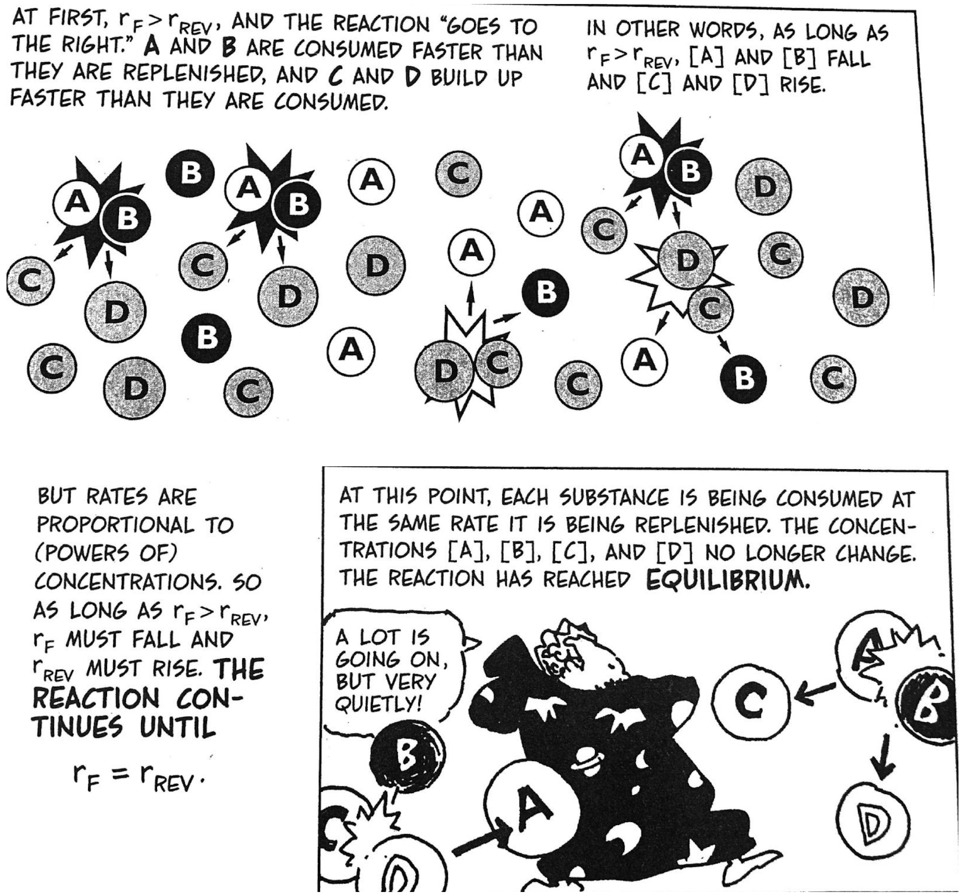
Pull Hard!

A tug of war involves two teams at the ends of a rope. The goal is to pull the other team over a line in the middle. At first, there is a great deal of tension on the rope, but no apparent movement. A bystander might think that there is nothing happening. In reality, there is a great deal of tension on the rope as the two teams pull in opposite directions at the same time. The same idea is true when we think about chemical equilibrium.

Chemical Equilibrium

Think about the generic equilibrium reaction: A + B ↔ C + D

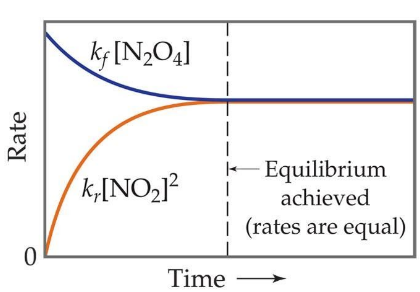




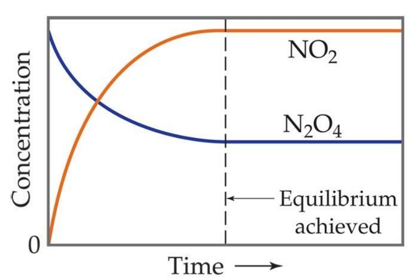
In dynamic equilibrium, the forward and reverse reactions occur at the same rate.
Once equilibrium is achieved, the amount of each reactant and product remains constant (note: constant does NOT mean equal!)

FIgure1: Reaction $N_2O_4 \leftrightarrow NO_2$

Note: [ ] means "concentration"



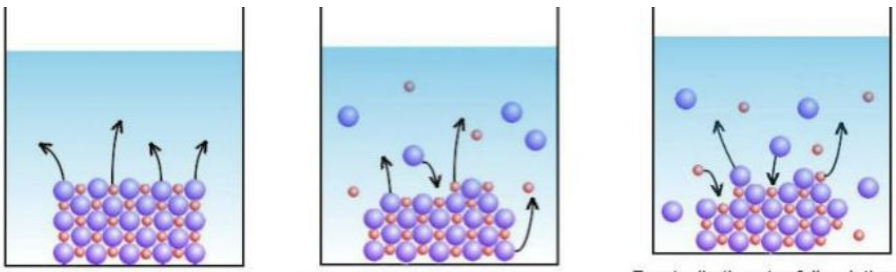
Rates are **equal** in equilibrium.



Concentrations become **constant** at equilibrium (not equal)

Just because you can't see it doesn't mean it's not happening!

Look at the molecular level for NaCl. Figure 2



Salt is initially put into the water and begins dissolving.

Salt continues to dissolve; however, dissolved ions will also precipitate. Because the salt dissolves faster than its ions precipitate, the net movement is towards dissolution.

Eventually, the rate of dissolution will equal the rate of precipitation. The solution will be in equilibrium, but the ions wil continue to dissolve and precipitate.

CHECK FOR UNDERSTANDING:

1. What symbol in a chemical equation shows a reaction is in equilibrium?

2. For the generic reaction: $A + B \leftrightarrow C + D$
    a. What happens to the concentration of A and B as the reaction moves forward?

    b. What happens to the concentration of C and D as the reaction moves forward?

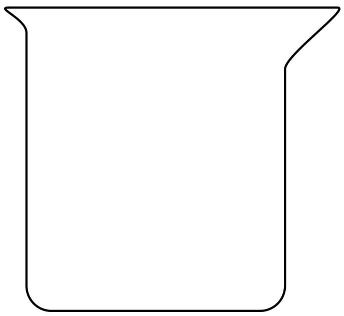
    c. What happens to the reaction rate when this reaction reaches equilibrium?

    d. What happens to the concentration of A+B and C+D as the reaction reaches equilibrium?

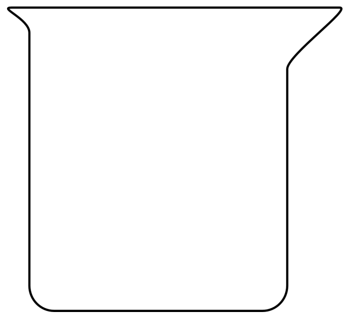
3. Answer the following for Figure 1.
    a. When is the rate of the forward reaction the fastest? Why would this make sense based on your knowledge of kinetics?
    b. When is the rate of the reverse reaction the fastest?
    c. How could you use the rate graph to determine when equilibrium is reached.
    d. How could you use the concentration graph to determine when equilibrium is reached?
    e. Which compound has the greatest concentration when the reaction is at equilibrium?

4. Create three molecular level drawings for the reaction in FIgure1: $N_2O_4 \leftrightarrow NO_2$ (review those seen in the comic/ Figure 2). Each drawing should show 6 TOTAL molecules.
    a. The reaction at time 0
    b. The reaction after time zero but before equilibrium.
    c. The reaction at equilibrium

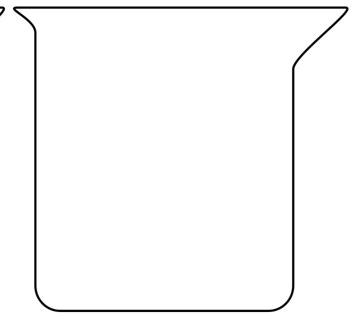
a.



b.



c.



5. Does a reaction stop when equilibrium is reached? Explain.

Common Misconceptions:

1. A system at equilibrium does not mean that the concentrations of reactants and products are equal. The vast majority of the time, concentrations are NOT equal, but are CONSTANT!
2. A reaction at equilibrium is ALWAYS reacting. The reaction NEVER stops!
3. Either side could be the reactants/ products, it just depends on how you write it!

Let's examine Hydrogen reacting with Iodine:

Hydrogen and iodine gases react to form hydrogen iodide according to the following reaction:

$$H_2(g)+I_2(g)\rightleftarrows 2HI(g)$$

Forward reaction: $H_2(g)+I_2(g) \longrightarrow 2HI(g)$

Reverse reaction: $2HI(g) \longrightarrow H_2(g)+I_2(g)$

Initially, only the forward reaction occurs because no HI is present. As soon as some HI has formed, it begins to decompose back into H_2 and I_2. Gradually, the rate of the forward reaction decreases while the rate of the reverse reaction increases (just like the comic we saw above). Eventually the rate of combination of H_2 and I_2 to produce HI becomes equal to the rate of decomposition of HI into H_2 and I_2. When the rates of the forward and reverse reactions have become equal to one another, the reaction has achieved a state of equilibrium. Chemical equilibrium is the state of a system in which the rate of the forward reaction is equal to the rate of the reverse reaction.

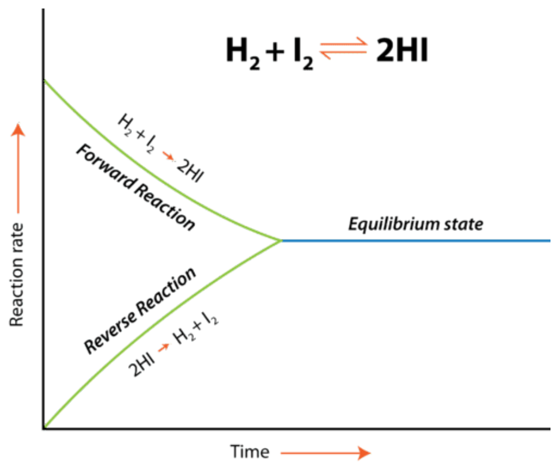


Figure 4

Equilibrium in reaction: $H_2(g) + I_2(g) \rightleftarrows 2HI(g)$.

Chemical equilibrium can be attained whether the reaction begins with all reactants and no products, all products and no reactants, or some of both.

Figure 5 below shows changes in concentration of H_2, I_2, and HI for two different reactions.

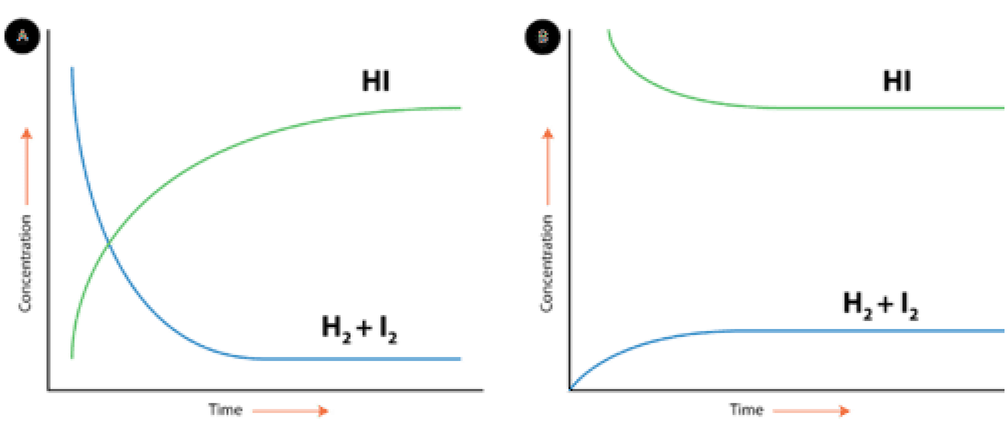


Figure 5: Equilibrium between reactants and products.

In the reaction depicted by the graph on the left (A), the reaction begins with only H_2 and I_2 present. There is no HI initially. As the reaction proceeds towards equilibrium, the concentrations of the H_2 and I_2 gradually decrease, while the concentration of the HI gradually increases. When the curve levels out and the concentrations all become constant, equilibrium has been reached. At equilibrium, concentrations of all substances are constant.

In reaction B, the process begins with only HI and no H_2 or I_2. In this case, the concentration of HI gradually decreases while the concentrations of H_2 and I_2 gradually increase until equilibrium is reached. Notice that in both cases, the relative position of equilibrium is the same, as shown by the relative concentrations of reactants and products. The concentration of HI at equilibrium is significantly higher than the concentrations of H_2 and I_2. This is true whether the reaction began with all reactants or all products. The position of equilibrium is a property of each different reversible reaction and does not depend upon how equilibrium was achieved.

Conditions for Equilibrium

It may be tempting to think that once equilibrium has been reached, the reaction stops. Chemical equilibrium is a *dynamic* process. This means that the forward and reverse reactions continue to occur even after equilibrium has been reached. However, because the rates of the reactions are the same, there is no change in the relative concentrations of reactants and products for a reaction that is at equilibrium. The conditions and properties of a system at equilibrium are summarized below.

1. The system must be closed, meaning no substances can enter or leave the system.
2. Equilibrium is a dynamic process. Even though we don't necessarily see the reactions, both forward and reverse are taking place at all times.
3. The rates of the forward and reverse reactions must be equal.
4. The amount of reactants and products do not have to be equal. However, after equilibrium is attained, the amounts of reactants and products will be constant.

The description of equilibrium in this concept refers primarily to equilibrium between reactants and products in a chemical reaction. Other types of equilibrium include phase equilibrium and solution equilibrium. A phase equilibrium occurs when a substance is in equilibrium between two states. For example, a stoppered flask of water attains equilibrium when the rate of evaporation is equal to the rate of condensation. A solution equilibrium occurs when a solid substance is in a saturated solution. At this point, the rate of dissolution is equal to the rate of recrystallization. Although these are all different types of transformations, most of the rules regarding equilibrium apply to any situation in which a process occurs reversibly.

CHECK FOR UNDERSTANDING:

6. Why is it important that the system be closed for monitoring an equilibrium reaction?

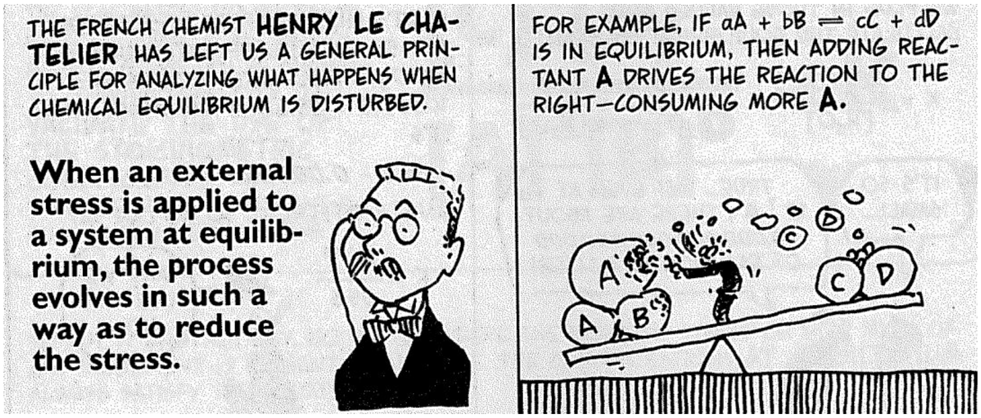
7. What do we mean when we say equilibrium is a “dynamic process?”

8. Examine figure 5. What do you notice about equilibrium concentrations if we start with reactants vs. if we start with products?

9. How does your answer in question 3 support the idea that either the reactants or the products can be written first in equilibrium equations?

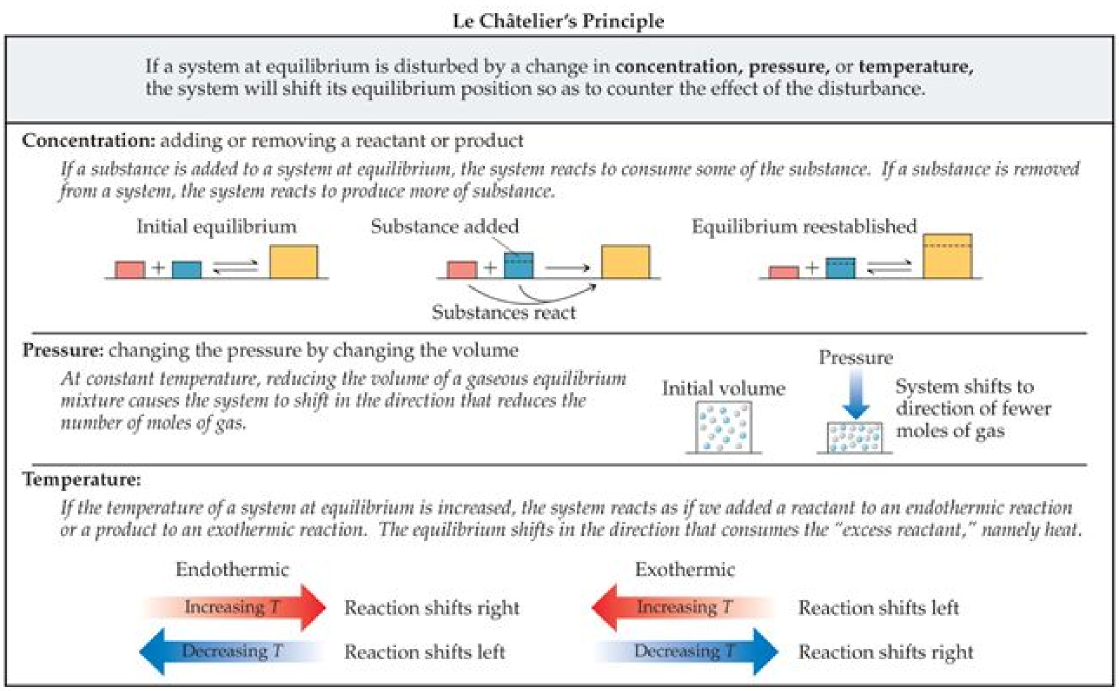
10. Rewrite the reaction between Hydrogen and iodine gases if we started with HI.

LE CHATELIER'S PRINCIPLE (PRONOUNCED: LE-SHA-TEL-LEE-YAY)



If a change (called a STRESS) occurs to a system in dynamic equilibrium, the system will shift to counteract the change in efforts to maintain equilibrium.

Le Chatelier's principle can be used to predict the behavior of a system due to changes in Concentration, Pressure, or Temperature



Factors that shift reactions are called STRESSORS.

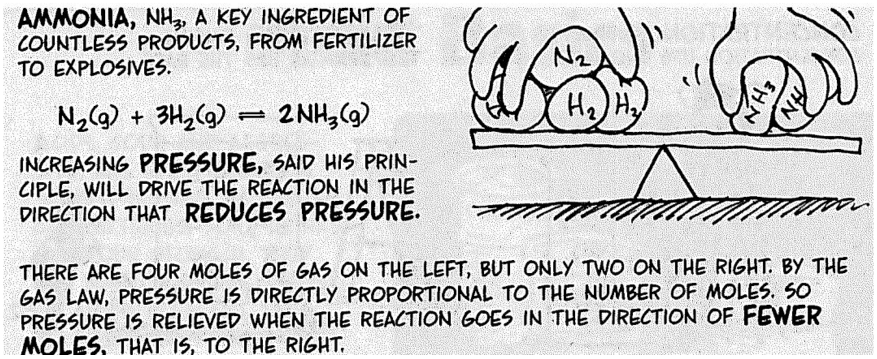
Three Stressors:

1. **[Concentration] of reactants and products**

   Conclusion: *According to Le Chatelier's Principle, if concentration of the reactants increases the reaction will shift right toward the products and vice versa.*

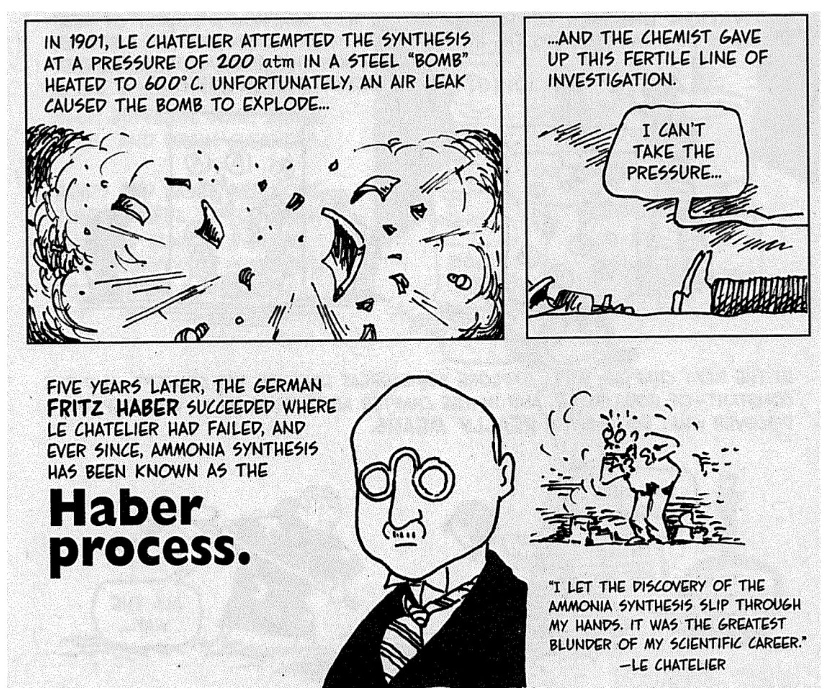
2. **Pressure (for gases only)**

   Conclusion: *According to Le Chatelier's Principle, if pressure increases the reaction will shift to the side with the least number of moles of gas.*



3. **Temperature** (endothermic & exothermic)

   Conclusion: *According to Le Chatelier's Principle, if heat is added to a chemical reaction in equilibrium, the reaction will shift to reduce the amount of heat. If heat is removed, the reaction will shift to produce heat.*



CHECK FOR UNDERSTANDING:

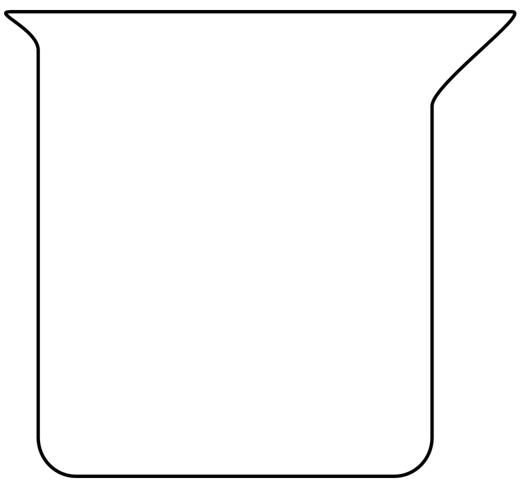
The equilibrium equation is given below for carbon dioxide reacting with water to form carbonic acid. This reaction is exothermic (releases heat)

$$CO_2(g) + H_2O(l) \Leftrightarrow H_2CO_3(aq)$$

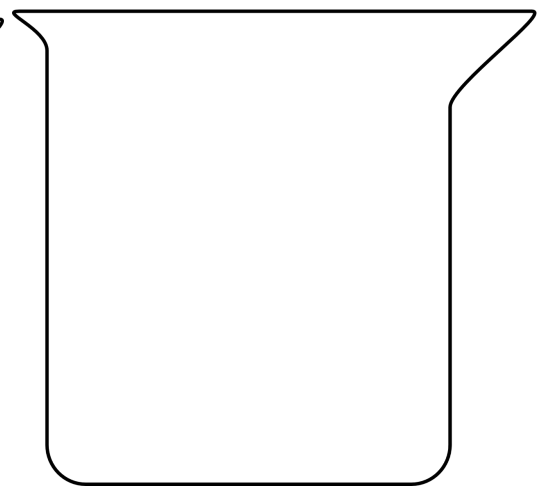
For the above reaction, which way will the reaction shift? Right, left, no shift?

11. $[CO_2]$ is increased: ______________________
12. Water is removed from the container: ______________________
13. Carbonic acid is added to the container: ___________________
14. Sodium chloride solid is added to the container (does not react) _______________
15. The reaction vessel is heated: ____________________
16. Pressure of the container is increased: ___________________

    - Draw an molecular image of the scenario above at equilibrium and after the stressor.



@EQUILIBRIUM



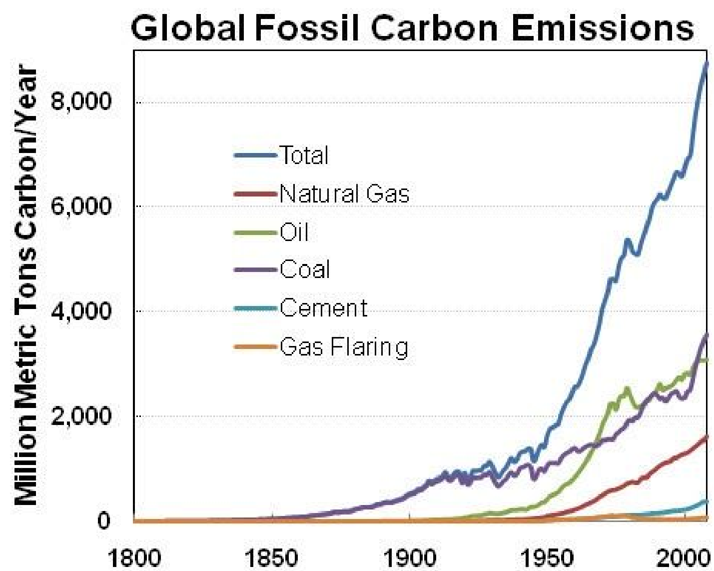
IMMEDIATELY AFTER STRESSOR

Le Chatelier's Principle and Climate Change: How do our actions as Humans affect the Earth?

Future Warming

The amount CO_2 levels will rise in the next decades is unknown. In developed nations it will depend on technological advances or lifestyle changes that decrease emissions. In the developing nations, it will depend on how much their lifestyles improve and how these improvements are made.

If nothing is done to decrease the rate of CO_2 emissions, by 2030, CO_2 emissions are projected to be 63% greater than they were in 2002.



Global CO2 emissions are rising rapidly. The industrial revolution began about 1850 and industrialization has been accelerating causing increased CO_2

Temperature Scenarios

Computer models are used to predict the effects of greenhouse gas increases on climate for the planet as a whole and also for specific regions. If nothing is done to control greenhouse gas emissions and they continue to increase at current rates, the surface temperature of the Earth can be expected to increase between 0.5°C and 2.0°C (0.9°F and 3.6°F) by 2050 and between 2° and 4.5°C (3.5° and 8°F) by 2100, with CO2 levels over 800 parts per million (ppm). On the other hand, if severe limits on CO_2 emissions begin soon, temperatures could rise less than 1.1°C (2°F) by 2100.

Check for Understanding:

17. What are some contributors to atmospheric CO_2?

18. What is the highest individual producer of CO_2 currently?

Why is increased carbon dioxide a problem? **Let's look at the chemistry as it relates to Le Chatelier's principle.**

As the amount of CO_2 in the atmosphere increases, Le Chatelier's principle applied to reaction (1) shows that, $CO_2(aq)$, the amount in the oceans, also increases.

Reaction 1: $CO_2(g) \Leftrightarrow CO_2(aq)$

Le Chatelier's principle applied to reaction (2) shows that increasing $CO_2(aq)$ favors the forward reaction, increasing the $HCO_3^-(aq)$ and $H^+(aq)$ concentrations.

Reaction 2: $CO_2(aq) + H_2O(l) \Leftrightarrow HCO_3^-(aq) + H^+(aq)$

Similarly, Le Chatelier's principle applied to reaction (3) shows that increasing $CO_2(aq)$ favors the reverse reaction, increasing $Ca^{2+}(aq)$ and $HCO_3^-(aq)$, while decreasing $CaCO_3$ concentrations. $CO_2(aq)$ is acidic, so reacts with the strongest base present in significant concentration, $CO_3^{2-}(aq)$, and upsets the carbonate buffer system.

Reaction 3: $Ca^{2+}(aq) + 2\ HCO_3^-(aq) \Leftrightarrow CaCO_3 + CO_2(aq) + H_2O(l)$

The White Cliffs of Dover and South Foreland Lighthouse (which are composed of Calcium Carbonate) on the southeast coast of Britain.

Source: Wikimedia Commons, by Rémi Jouan

The net result of these shifts in equilibrium concentrations is increased $H^+(aq)$ and decreased availability of $CaCO_3$ and $CO_3^{2-}(aq)$. The experimental observation is that the pH of the top layer of the ocean has decreased by 0.1 unit, from 8.2 to 8.1 during the past century or so due to increased CO_2 dissolved in the oceans.

Real World Analysis:

Thinking about climate change:

19. Draw a **concentration vs. time** graph and a **rate vs. time graph** for the equilibrium process shown in reaction 2.

20. Review the equilibrium equations. As atmospheric CO_2 increases, what is the effect on our oceans?

Bivalves are part of the phylum Mollusca and contain organisms such as scallops, mussels, clams, and the opihi commonly found in Hawaiʻi. Their shells are composed of calcium carbonate, the same compound found in marble and limestone.

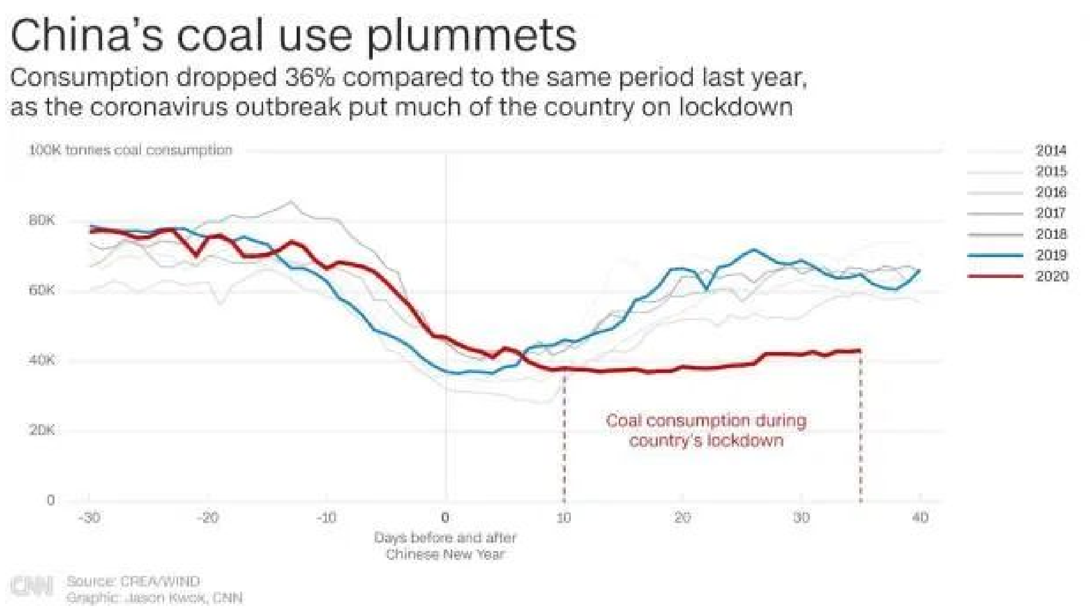
21. As atmospheric carbon dioxide increases, how would the shells of the bivalves be affected?

22. How would the effect on the bivalves affect other systems on earth? You may do some cited research to aid your answer.

PROJECT! DUE TUESDAY, APRIL 28

THE TOPIC:

Since the COVID-19 virus has spread across the world. Pollution levels have changed drastically. Review the following materials and **construct a speech, paper, presentation, or media resource** to explain why this change is occurring and the effect it could have on the earth using the reactions in the previous section and explaining equilibrium explicitly using Le Chatelier's principle to discuss the topic.



India November 3, 2019 vs. March 30, 2020
Credit: Awar Nazir / Sajjad Hussain / AFP via Getty Images

India Savors a Rare Upside to Coronavirus: Clean Air

Delhi residents are stunned by how blue the sky really is as a strict lockdown cuts back drastically on air pollution.

By Jeffrey Gettleman

April 8, 2020Updated 11:13 a.m. ET

NEW DELHI — There are countless downsides to the world's getting walloped by the coronavirus and being put under severe lockdown.

But here in one of the most polluted cities on earth, where many people routinely wear face masks to filter out the filth, something rare and wonderful has emerged: a pure blue sky.

Because there are so few cars on the road, few factories belching out black smoke and almost no active construction sites to create clouds of choking dust, pollution levels in New Delhi, India's megalopolis capital, have dropped to remarkably low levels.

At night there are stars. During the day the air is so clean that, for once, you can't taste it, free of the usual smoky metallic tang. One cruelty of the coronavirus is to be under a tight lockdown right now, with parks bolted shut, ordered to stay indoors unless vitally necessary, only to look out your windows and see this.

And the lockdown has spelled economic misery for the millions of people who have been prevented from working.

But old-timers say Delhi's air hasn't been this clear for decades.

"I look at the sky quite often and enjoy its blueness from my balcony," said Sudhir Kumar Bose, 80, a retired English professor.

"I don't know how long this will last," he added. "But right now I feel much better."

It's not just Delhi, but Chennai, Ahmedabad, Bengaluru and Ghaziabad. All across India, cities can suddenly breathe. Los Angeles, New York, Beijing, Seoul and Milan — they have experienced less pollution, too, hit hard by the virus and restrictions on people's movement.

But those places aren't nearly as polluted as India. Nowhere is. Last year, once again, India topped the charts of the worst polluted as home to 14 of the 20 cities with the most hazardous air.

Delhi is among them, but last week it recorded a pollution reading of 38 on the Air Quality Index, about as good as anywhere in the world and stunning to Delhiites who have become steeled to a reading of 150 AQI — on a good day.

Sometimes, especially in the winter, as cold air condenses car exhaust and factory smoke and wind speeds drop, Delhi's AQI (which measures different airborne pollutants) can shoot up to 500 or more. That gives many people chronic coughs and more serious lung disease.

But now sick people are savoring the reprieve.

Numerical Value	Color	Air Quality Index Levels of Health Concern	Meaning
0 - 50	Green	Good	Air quality is considered satisfactory, and air pollution poses little or no risk.
51 - 100	Yellow	Moderate	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
101 - 150	Orange	Unhealty for sensitive groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
151 - 200	Red	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
201 -300	Purple	Very unhealthy	Health alert: everyone may experience more serious health effects.
301 - 500	Maroon	Hazardous	Health warnings of emergency conditions. The entire population is more likely to be affected.

"My old patients say they can't believe it," said Dr. Arvind Kumar, a Delhi chest surgeon who has been studying the consequences of living in a place with bad air. "They are feeling lighter, they are using their inhalers less frequently, most of them are feeling better."

Of course, everyone knows this is a sign of the frozen economy. The clear skies are a consequence of a tight lockdown — the world's biggest and one of the most severe — that has shuttered factories, grounded flights, evicted taxis, rickshaws and crowded buses from the roads and brought movement to a screeching halt. Many Indians are obeying the orders to stay indoors in a lockdown that has become a national house arrest for a nation of 1.3 billion people.

Environmentalists are using these strange times to make a point. One of the most outspoken, Jai Dhar Gupta, an Ivy League-educated environmental activist and entrepreneur, has been fighting for years against the widely held belief that India is somehow doomed to suffer bad air because of its geography and climate.

"Clearly," he said, "this is not something that can't be reversed. We've just reversed it."

Towns more than a hundred miles from the Himalayas can now see snow peaks. Some people joked that they could see Canada from Punjab State. Others said the air was so clear they would soon be able to see God.

The sky over Delhi is usually smudge gray, day or night. The gauze never lifts. The sun sets mildly behind it.

Across much of China, too, air pollutants plunged after a lockdown to stifle the epidemic closed factories, cut road traffic and drastically reduced air travel.

China's restrictions from January helped cut small, health-threatening pollutants called PM 2.5 — for being less than 2.5 micrometers in diameter, the smallest and most dangerous particles that are monitored — by as much as 30 percent below normal levels, according to the Copernicus Atmosphere Monitoring Service. Levels of nitrogen dioxide, a pollutant caused by motor vehicles and industry, also fell between 10 and 20 percent.

"This is the first time I have seen such a dramatic drop-off over such a wide area for a specific event," said Fei Liu, an air quality researcher at the NASA Goddard Space Flight Center, according to a report from NASA.

But in China the near-pristine skies are already passing. There have been more bad days recently, as factories have restarted and more vehicles have returned to the roads.

In India, the lockdown is still in full effect, and it is unclear when it will be lifted. Narendra Modi, India's prime minister, imposed the strictures at the end of March, saying they would be for 21 days. But many people fear he was just lowballing to keep the public from becoming too dispirited.

With some of the world's poorest, most densely packed slums, India has a huge risk of a coronavirus crisis. Health officials are racing to contain the highly contagious disease, which could rip through areas where millions live face to face. With India's reported cases doubling around every four days and now topping 4,000, many people are bracing for a long lockdown.

At least there will be some dispensations.

There's almost no honking, no shouting, no jostling. Roads and public spaces are wide open and empty, perfect to see — and hear — birds. Delhiites are now spotting rare birds like gray hornbills and red-throated flycatchers.

The other evening, after sunset, another rare delight showed itself: Venus, shining crisp and bright and steady with nothing to obscure it. The pure black sky was bursting with stars, wrapping around us, endless but somehow consoling.

Review the learning objectives on the first page. What is your overall level of understanding for HS-PS1-6 (Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium)

Mastery Proficient Progressing Rudimentary No understanding

Why did you choose this level of understanding?

What learning objectives do you need to work on?

All Comics from *The Cartoon Guide to Chemistry* (Gonick & Criddle, 2005)