American Book Company's

PASSING THE

Nevada HSPE Test

in

Science

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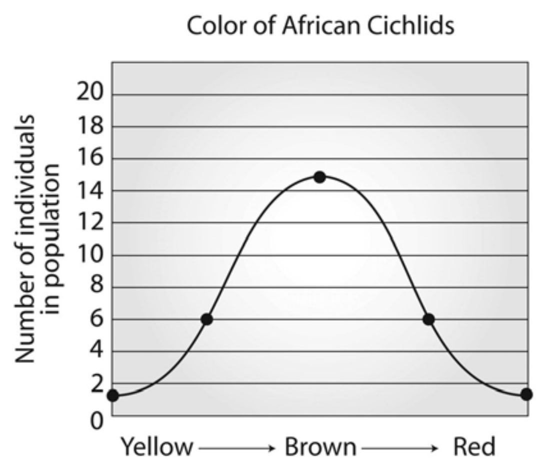
Diagnostic Test
NV HSPE[1]

1 Mitochondria are present in most eukoryotic cells. What is their function? L.12.B.1 (A2)

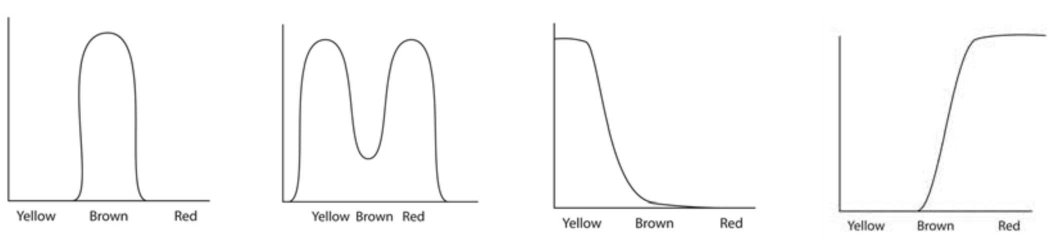
A to conduct photosynthesis
B to provide mobility
C to conduct cellular respiration
D to store water

Use the following information to answer question 2.

Predators and prey interact in the environment in very complex ways. Scientists often select traits in prey populations and observe the effects of predators and environmental change over many generations. A type of African cichlid is observed having a variety of colors. The average wild type fish is brown (see graph). Over several years, a new water pollutant is released into water systems, causing the plants in the environment to become more red in color.



2 Which graph below would you expect to correctly reflect the effect of the pollutant on the African cichlid population? L.12.C.2 (A3)



A **B** **C** **D**

1. The NV HSPE contains 60 core questions and 15 field test items. The student will therefore take a 75 question exam, but will be graded only on 60 questions. The student will not know which items are core and which are field test.

SCIENTIFIC INVESTIGATION AND TECHNOLOGICAL DESIGN

In the last section, we examined a scientific methodology. Through hypothetical observations and research, we developed a hypothesis and then set up an experiment. We were in luck because someone had already performed our experiment, and we had the opportunity to examine the data and draw conclusions from it. There is something interesting about the hot air balloon example, though. Each hot air balloonist was testing not only a theory about how high or how far a balloon could go, he was also testing the technological design of the balloons. Clearly, a poorly designed and manufactured balloon would not go as high or as far, but which kind of balloon will go the highest or the farthest cannot be known until different designs are tested under controlled scientific conditions.

The very first thing that one would need to know is the variations in balloon design that are possible. Look at Figure 1.15.

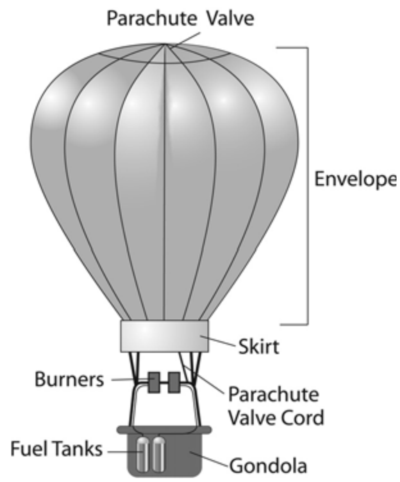


Figure 1.15 Elements of Balloon Design

- The balloon consists of the envelope and the gondola that it carries connected by some kind of lashing or frame.
- The envelope may be made of a variety of different materials including nylon, mylar and polyester; the primary requirement is that material be strong and heat resistant.
- The balloon may be lifted by air, a lighter-than-air gas like helium or hydrogen, or a combination of air with lighter-than-air gas. Whatever lifting gas is used, it is usually heated by an on-board fuel for greater buoyancy. The greater the volume of the envelope, the more lifting gas it can accommodate.
- The gondola may vary in size to accommodate one or several people and their supplies, as well as the necessary fuel tanks, instrumentation and communications devices.
- Notice that there is no steering wheel on the gondola or the envelope. The balloon must travel with air currents by heating (to rise) and turning off the heat (to descend).

These are the main points to consider when designing the balloon. Knowing even these few things, you can already evaluate the following questions.

– If the lifting gas to be used is air, is a heater needed? Why or why not?

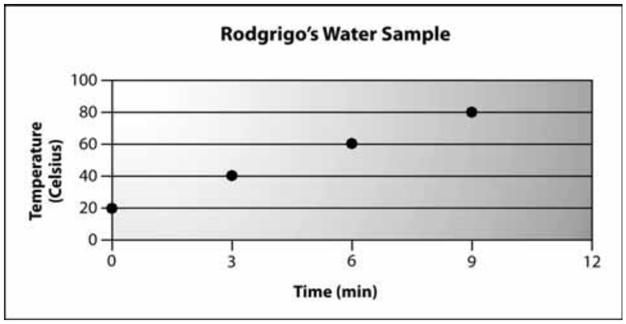
– Hydrogen is a flammable gas. Should hydrogen be used as the lifting gas in a balloon equipped with a propane fuel burner? Why or why not?

THINK WHILE YOU WORK

The ability to **infer causes** and **predict outcomes** should not only be applied to your experiments. You must apply these skills in life also! They will help you make reasonable decisions about many things, including safe behavior in the lab. The following activities will show you how.

Challenge Activity

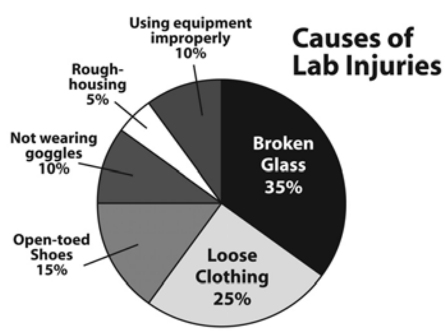
Rodrigo fills a glass beaker with distilled water and places it on a hotplate. He heats the water, measuring the temperature every three minutes. His results are shown in the graph below.



1. What temperature did the water sample start at? Was it warm or cold?
2. What do you predict the temperature will be at 12 minutes?
3. When the experiment is over, should Rodrigo remove the beaker from the hot plate with his bare hands?
4. Is it safe to breathe around the boiling sample, or should Rodrigo wear a face mask?

Challenge Activity

Circle graphs (or pie charts) are another way of presenting data. They show parts of a whole. For instance, let's look at the data from an imaginary study. The study shows the percentage of all laboratory injuries that are caused by certain unsafe activities. Each activity is a slice of the pie. The results are shown below.



1. Based on this graph, what can you infer to be the greatest threat to student safety?
2. Look back at Figure 2.1 on page 47. Which students are practicing the unsafe behaviors shown in this circle graph?
3. Make a circle graph of your own. How many students are practicing each unsafe behavior?
4. Does your circle graph show the same patterns as the national study? Why do you think there are differences?

Unit 1 Review – Nature of Science
Chapters 1 – 4

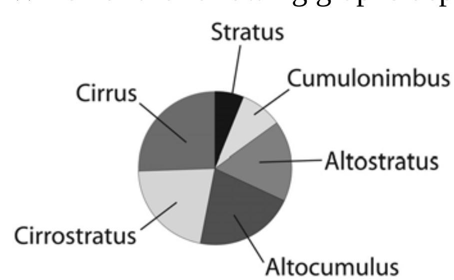
Choose the best answer.

Paolo performed Internet research to discover the average height of 6 different types of clouds. His data is below. Use it to answer questions 1 and 2.

Cloud Type	Altitude (m)
Stratus	1800
Cumulonimbus	2500
Altostratus	4800
Altocumulus	6000
Cirrostratus	6100
Cirrus	7200

1. Which of the following graphs depicts Paolo's data most clearly?

A



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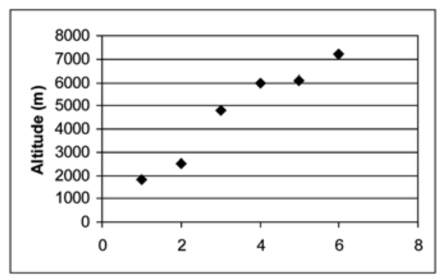

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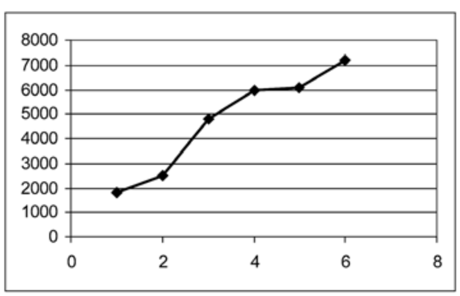
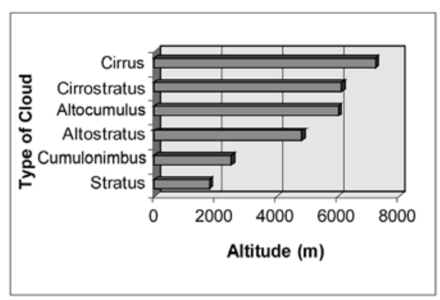


D



2. Select a correct inference from the following statements.
   - A. No clouds form beneath 1800 meters.
   - B. No stratus clouds can be found at 2000 meters.
   - C. All cirrus clouds are found at 7200 meters.
   - D. Altocumulus clouds form at air pressures similar to cirrostratus clouds.

BONDING OF ATOMS

An element is a substance composed of identical atoms. A **compound** is the result of two or more different *atoms* joined by chemical bonds. A **molecule** is the result of two or more atoms joined by chemical bonds; the atoms may be from the same element or different elements. Atoms of different elements can combine chemically to form molecules by sharing or by transferring valence electrons. Valence electrons are either lost, gained or shared when bonds are formed.

IONIC BONDS

An **ion** is an atom with a charge. It is formed by the *transfer* of electrons. When one atom "takes" electrons from another atom, both are left with a charge. The atom that "took" electrons has a negative charge (recall that electrons have a negative charge). The atom that "gave" electrons has a positive charge. The bond formed by this transfer is called an **ionic bond**. Ionic bonds are very strong. Ionic compounds have high melting points and high boiling points. These compounds tend to have ordered crystal structures and are usually solids at room temperature. Ionic compounds will usually dissolve in water, and they have the ability to conduct electricity in an **aqueous** (dissolved in water) or a molten state.

Aluminum oxide is an example of a compound with an ionic bond. In aluminum oxide, two atoms of aluminum react with three atoms of oxygen. The two aluminum atoms give up three electrons each to form positive ions with +3 charges. The three oxygen atoms gain two each of the six electrons given up by the two aluminum atoms to form negative ions with –2 charges. Figure 5.10 illustrates this electron transfer. Note that the orbital shape (circular) has been simplified for clarity.

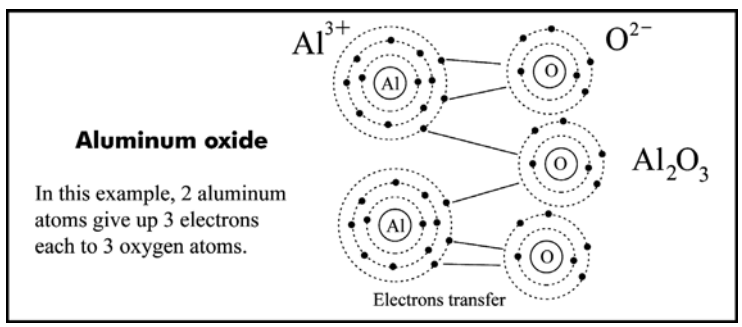


Figure 5.10 Ionic Bonding in Aluminum Oxide

COVALENT BONDS

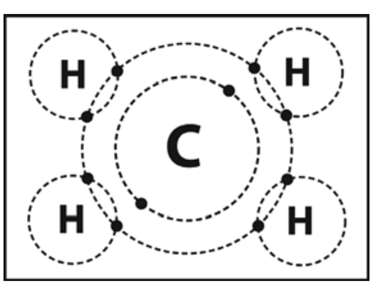


Figure 5.11 Methane Molecule (CH_4)

Covalent bonds are formed when two or more elements *share* valence electrons in such a way that their valence electron orbital is filled. The sharing arrangement creates a more stable outer electron structure in the bound elements than was present in their elemental state.

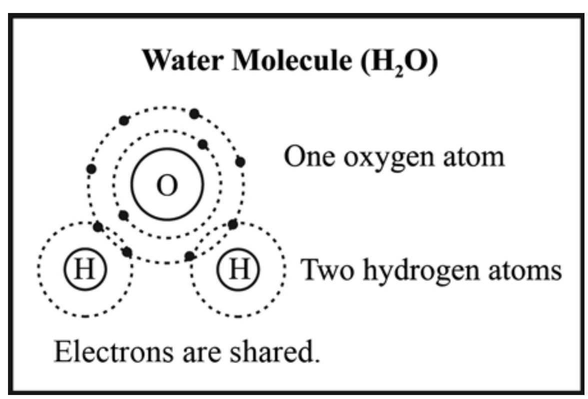


Figure 5.12 Water Molecule

NUCLEAR ENERGY

When a nucleus splits, or fissions, a great deal of energy is also released. In fact, the scientific world was surprised by how much energy was generated. **Neils Bohr**, the Danish physicist who first modeled the atom, wrote to Lise Meitner to comment on how unexpectedly large the energy release was, much larger than calculations had predicted. Up until this point, fission research had been performed simply to understand more about the atom. Now, though, the stakes began to rise: a new energy source had been found.

How much energy are we talking about, though? The **nuclear energy** produced by fission and fusion reactions requires only a small amount of matter. After all, an atom is a very small amount of matter. Einstein's famous **mass-energy equation**, $\mathbf{E = mc^2}$, states this fact very simply. Einstein's equation, written in word form, is Energy = mass $\times$ speed of light $\times$ speed of light. Since the speed of light is 3×10^8 meters per second and this term is squared, we can still have a very small amount of matter and end up with a large amount of energy. A nuclear fission reaction, utilizing one U-235 atom, will produce 50 million times more energy than the combustion (burning) of a carbon atom.

Today we use nuclear reactors to harness this power for the production of electricity. Figure 6.5 shows the process. Fissile material, like uranium-235, is manufactured into pellets that are bound together into long rods, called **fuel rods**. Fuel rods are bundled together with **control rods** and placed in the reactor core. Here is what happens.

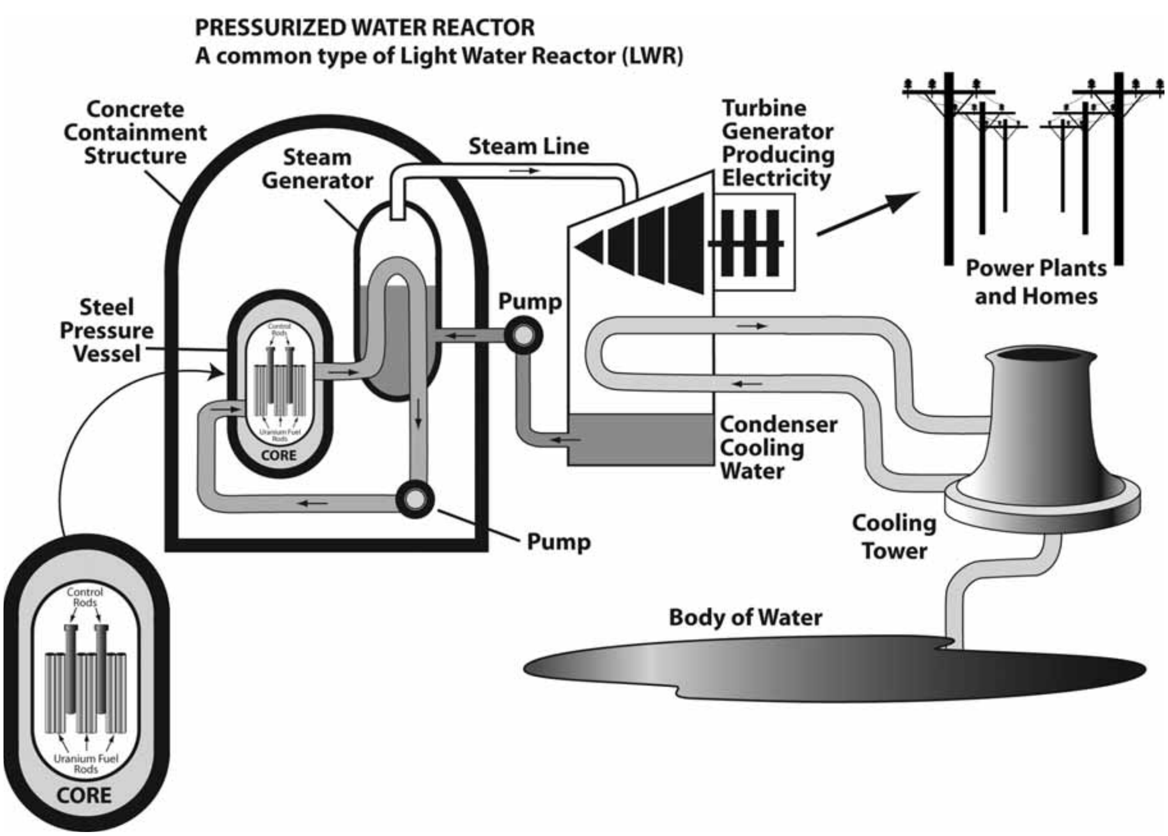


Figure 6.5 Nuclear Power Reactor

PHASE CHANGES

The phase of matter is determined by the physical condition of that matter. When the physical conditions change, a phase change may occur. Two physical conditions of primary importance are temperature and pressure. To determine how temperature and pressure changes affect phase, we must define **phase barriers** — that is, the point at which matter changes phase. These are illustrated in Figure 7.8.

The **freezing point** of a substance is the temperature at which a liquid becomes a solid or freezes. The **melting point** of a substance is the temperature at which a solid becomes a liquid or melts. The freezing point and the melting point for a given substance are the same temperature. For example, liquid water begins to freeze at 0°C. Likewise, a cube of ice begins to melt at 0°C. So the difference between the freezing and melting points has to do with the initial and the final states of matter. In other words, the different names reflect the direction of change as the specific temperature which the change occurs at.

The **boiling point** of a substance is the temperature at which a liquid becomes a gas. The **condensation point** is the temperature at which a gas becomes a liquid. The boiling point and the condensation point for a given substance are the same temperature. For example, water boils at 100°C, and water vapor (steam) cooled to 100°C begins to condense. Again, the difference between the boiling and condensation points is the direction of change.

Sublimation is the evaporation of a substance directly from a solid to a gas without melting (or going through the liquid phase). For example, mothballs and air fresheners sublime from a solid to a gas. Dry ice, which is frozen carbon dioxide, is also a common example of sublimation because the solid dry ice immediately sublimes into carbon dioxide gas (looking like "fog"). In fact, if you have ever had ice cubes in a tray become smaller while they sit for days in the freezer, you have already seen sublimation in action.

Deposition is the condensation of a substance directly from a vapor to a solid without going through the liquid phase. This term is mostly used in meteorology (the study of weather) when discussing the formation of ice from water vapor.

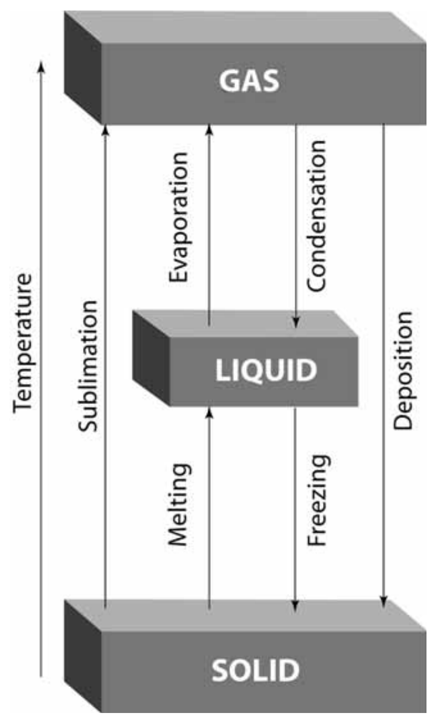


Figure 7.8 Possible Phase Changes

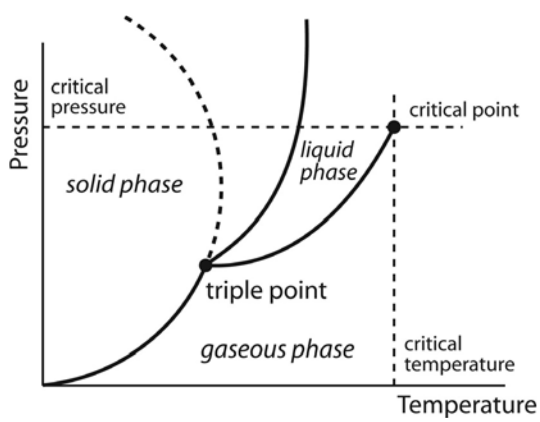


Figure 7.9 Phase Diagram

Figure 7.9 shows a common way to illustrate these transitions, called a **phase diagram**.

The **triple point** is the exact temperature and pressure at which the solid, liquid and gas phases can exist simultaneously. When there is more than one solid phase form (an allotrope), there will be more than one triple point. The **critical point** is the point at which the liquid phase ceases to be distinguishable from the gas phase.

Our next simple machine is the **lever**. When you think about it, just about everything that has a handle attached to it has a lever. When you first look at a lever, all you probably see is a stick. Now…think like the scientist you are and expand that idea. Two things must be considered when using a lever — the length of the "stick" and the place where it pivots. The point on which the lever pivots is called the **fulcrum**. A crowbar pivots on the very end, but a see-saw usually pivots in the middle. By changing where you put the fulcrum, you make it easier or harder to lift a heavy load. The closer to the load you put the fulcrum, the easier the load is to lift. Where's the trade-off? Lengthening the lifting arm without moving the fulcrum (that is, getting a longer stick) also makes the load easier to lift, the longer the lifting arm becomes, the greater the distance you must move it to lift the object.

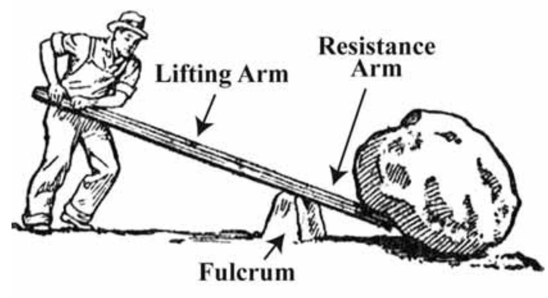


Figure 8.21 The Lever

The Pulley

In the simplest arrangement, a pulley is **fixed** and **immovable** (Figure 8.22). In this arrangement, a 100 N load will require a 100 N of effort. The usefulness of the fixed pulley is that it changes the direction that you apply a force.

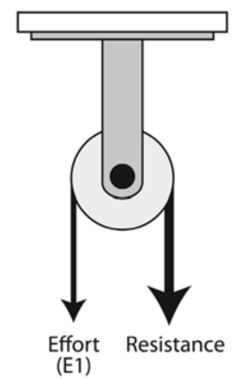


Figure 8.22 The Fixed Pulley

A **moveable** pulley is more versatile. This type of pulley hangs from a rope attached at one end. The effort force is split, as shown in Figure 8.23.

Although this does not reduce the effort required to lift heavy loads, it does allow you to change the direction that you must lift. Instead of lifting an object up, you can pull down in order to lift up. This lets you use your body weight to help in the lifting.

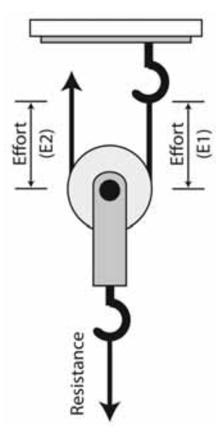


Figure 8.23 A Movable Pulley

A moveable pulley has a greater mechanical advantage than a fixed pulley because both sides of the rope exert an equal effort force on the load. That means that the man pulling on one side of the rope is only exerting half of the effort force.

More complex pulley systems can be designed by attaching pulley to one another. This is known as the "**block and tackle**." Figure 8.24 consists of a block and tackle that combines a fixed and moveable pulley. The MA of this set-up is the same as that of the movable pulley, but the difference is that the addition of the fixed pulley allows the rope to be pulled downward, rather than upward, to lift the load.

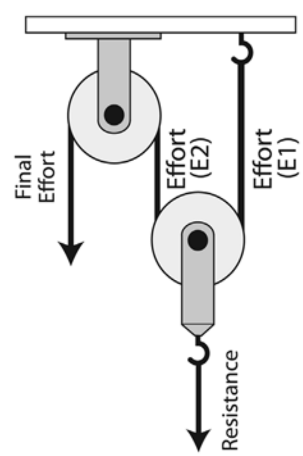


Figure 8.24 Fixed + Movable Block and Tackle System

BEHAVIOR OF WAVES

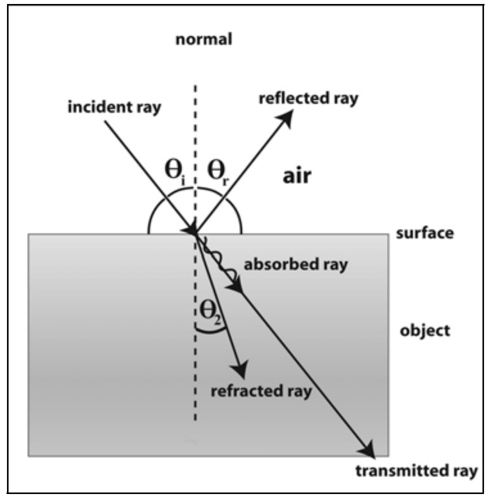


Figure 9.5 Interaction of Waves With a Surface

Whether you are aware of it or not, you have quite a bit of experience with waves. Let's see if we can clarify those experiences a little. In the story at the beginning of this chapter, your voice echoed off the hills as you yelled "I got one!" In terms of waves, what is an echo anyway? An echo is the sound waves bouncing off a surface. This same phenomenon is occurring when you look into a mirror: electromagnetic waves are bouncing off the mirror and hitting your eyes. This bouncing of waves off of a surface is called **reflection**.

If the wave is only partially reflected by the surface, the leftover wave energy is **absorbed.** Think about being inside a quiet car when another car pulls up next playing loud music. If you roll up the windows of the car, the sound waves are partially absorbed and the sound becomes muffled. But let's say that you can still hear the bass beats, even with your windows rolled up. You can still hear the music because some sound waves were **transmitted** through the solid matter of the car. So, when a wave hits a surface, it can be reflected or transmitted.

Refraction is the bending of a wave by the change in density of the medium. (Recall that density is a measure of the amount of matter in a particular volume. It has SI units of g/cm^3.) The bending of the wave is due to the reduced velocity of the wave as it enters a medium of higher density. The higher the density of the medium, the higher its **index of refraction** (*n*). Refraction often occurs when light passes from the air to some liquid or solid. Air has an *n* value of 1.00. Glass has an *n* value of 1.54. So, light going from air to glass is bent toward the normal line.

The diagram in Figure 9.5 shows the waves as straight lines called **rays** for the sake of simplicity. The type of behavior the wave shows depends on the medium it is traveling in, the material it is entering and the energy of the wave itself. Table 9.1 describes the possible responses of a wave when it hits a surface.

Table 9.1 Possible Interactions of a Wave with an Object

Behavior	**Description of Wave Motion**
Reflection	bounces off the surface at the same angle it hit with
Transmission	travels through the material at the same angle it entered with
Refraction	travels through the material, but at an altered angle
Diffraction	travels through the material until it encounters an obstacle, which it then bends around
Absorption	cannot travel all the way through the material

WHERE DOES ELECTRICITY COME FROM?

As you know from learning about the Law of Conservation of Energy, energy is not made or created. The word that we use to describe where electrical energy comes from is **generated**. Electrical energy is generated by a generator.

A **generator** is a machine that converts mechanical energy into electrical energy. The process is based on the relationship between magnetism and electricity, which we first discussed in Chapter 8.

The generator has a series of insulated coils of wire that form a cylinder. Inside the cylinder is a rotating (turning) shaft. When the shaft rotates (turns), the magnet is moved in and out of the coils. The presence of the moving magnetic field induces movement in the electrons of the conducting coil. A **conductor** is a material that will allow electrons to pass through. The electrons move through the wire, forming a **current**. The bigger the generator, the greater the current. This is the electrical current that you eventually use in your house. [Recall that it is an alternating current (AC).]

TURBINES

So, what turns the rotating shaft? A mechanical force, often water or air, is used to turn the shaft. A **turbine** converts the kinetic energy of a moving fluid (liquid or gas) into the mechanical energy that moves the magnets in the generator to make electricity. Turbines have a series of blades mounted on the shaft. The fluid is forced past the curved blades, causing them to turn the rotating shaft that is connected to the generator. When water is used to turn the turbine, it is called **hydroelectric power**. When air is used, it is called **wind power**.

USING WATER AND WIND TO TURN TURBINES

Hydroelectric power is generated when flowing water is used to spin a turbine connected to a generator. Flowing water accumulates in reservoirs created by the use of dams. The water pushes past the turbine blades, driving the generator to produce electricity. The force of a river current can be used in place of dammed water to apply pressure to the turbine blades.

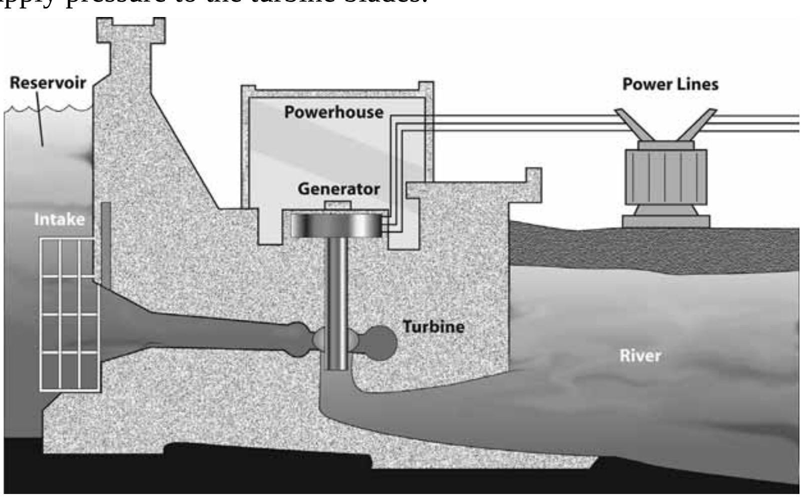


Figure 10.6 Hydroelectric Energy

Practice Exercise 1
Examine again the following mRNA chain. AUG ACA GAU UAG 1. How many codons does it contain? 2. AUG stands for which nucleotide bases? 3. If you had not been told, how could you tell whether this was a segment of RNA or DNA? 4. AUG is a common start codon, and codes for the amino acid methionine. In the above mRNA chain, which codon segment is the stop codon? 5. If this mRNA strand was complete, how many amino acids would the resulting protein contain?

There are many proteins within every cell. Proteins make up **enzymes** that help to carry out reactions within the cell. Hormones are comprised of proteins. **Hormones** are chemical messengers that regulate some body functions. Proteins provide structure and act as energy sources. They transport other molecules and are part of our bodies' defenses against disease. In short, proteins are essential for survival because almost everything that happens in the cell involves proteins.

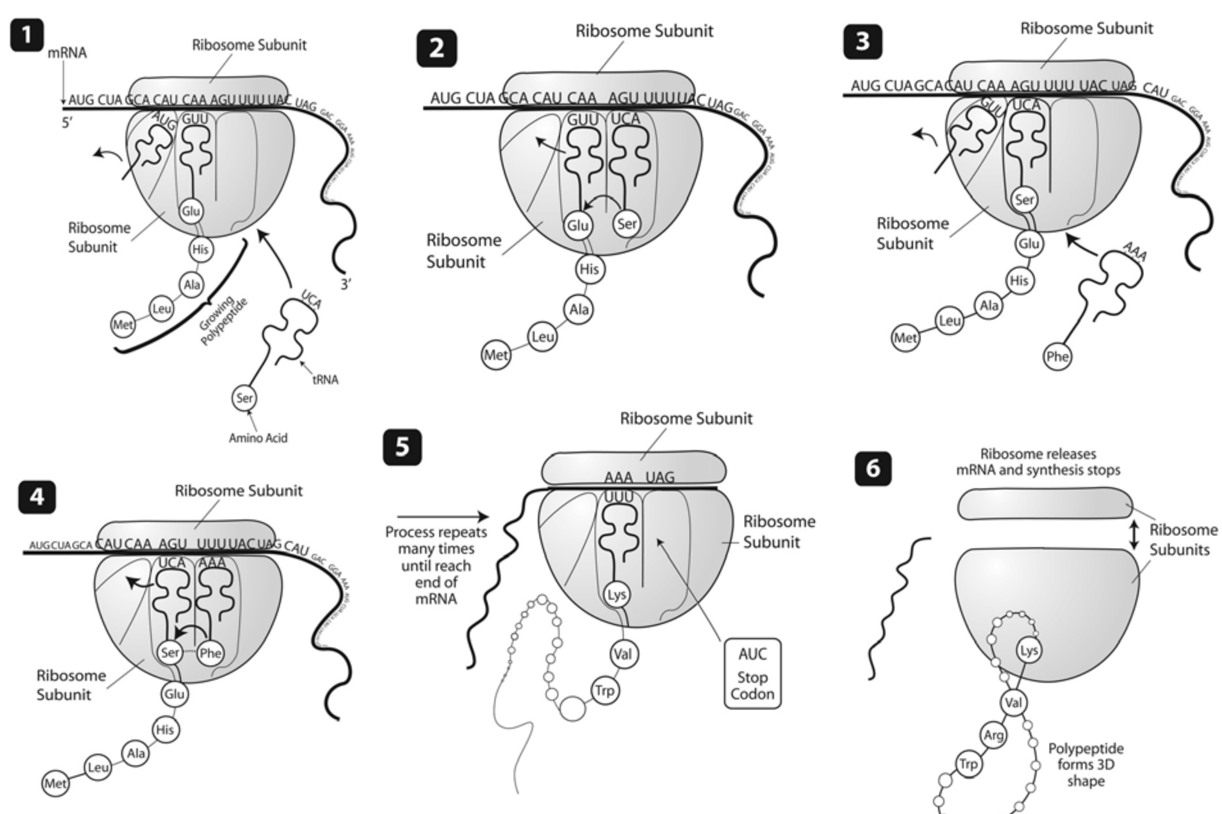


Figure 11.4 Translation

As a result, Mendel developed his **principle of segregation**. This principle states that when forming sex cells, the paired alleles separate so that each egg or sperm only carries one form of the allele. The two forms of the allele come together again during fertilization.

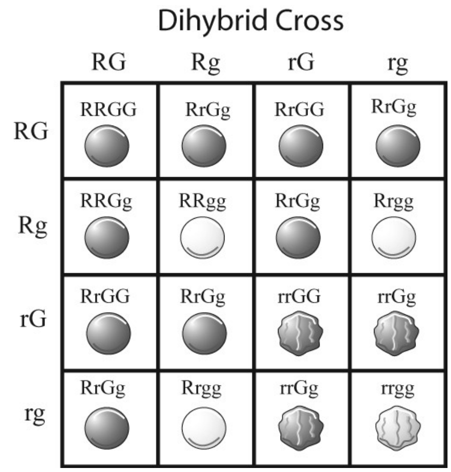


Figure 12.3 Dihybrid Cross of F_1 Heterozygous Offspring

PRINCIPLE OF INDEPENDENT ASSORTMENT

When Mendel began to study **dihybrid crosses**, which involve two traits, he noticed another interesting irregularity. Mendel crossed plants that were homozygous for two traits, seed color and seed texture. Round seed texture and green color are both dominant traits. Mendel assigned the dominant homozygous P generation the genotype of (RRGG). Wrinkled seed texture and yellow color are both recessive traits. The recessive homozygous P generation seeds were assigned the genotype (rrgg). When (RRGG) was crossed with (rrgg) the resulting F_1 generation was entirely heterozygous (RrGg). The F_1 generation was then allowed to self-pollinate, resulting in an F_1 dihybrid cross of (RrGg) with (RrGg). The result is an F_2 generation with a distinct distribution of traits, as depicted in Figure 12.3. Counting up the genotypes of the F_2 generation should give you the result that 9/16 of them will have the round, green phenotype, 3/16 will have the round, yellow phenotype, 3/16 will have the wrinkled, green phenotype and 1/16 will have the wrinkled, yellow phenotype.

The consistent observation of this trend led to the development of the **principle of independent assortment**. This principle states that each pair of alleles segregates independently during the formation of the egg or sperm. For example, the allele for green seed color may be accompanied by the allele for round texture in some gametes and by wrinkled texture in others. The alleles for seed color segregate independently of those for seed texture.

Activity

Use the given genotypes to determine the probable genotypes of offspring from each mating.

1. GG (male), Gg (female)
2. Jj (male), jj (female)
3. pp (male), PP (female)

THE CELL MEMBRANE AND CELLULAR TRANSPORT

Individual cells move fluids and nutrients in and out through the semi-permeable cell membrane. They can move these materials by either passive or active transport mechanisms to maintain homeostasis.

CELL MEMBRANE

The main purpose of the cell membrane is to regulate the movement of materials into and out of the cell. The cell membrane is **semi-permeable**, or selectively permeable, meaning that only certain substances can go through.

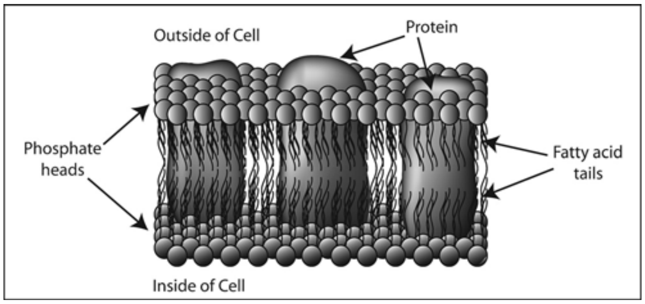


Figure 13.4 Phospholipid Bilayer

The cell membrane is composed of a phospholipid bilayer as shown in Figure 13.4. Each layer consists of phosphate groups (phosphorous bonded with oxygen) attached to two fatty acid tails. The layers arrange themselves so that the phosphate heads are on the outer edges of the membrane, and the fatty acid tails compose the interior of the membrane. Globular proteins used for various functions, such as transporting substances through the membrane, are embedded in the cell membrane. The phospholipids are free to move around, allowing the membrane to stretch and change shape.

PASSIVE TRANSPORT

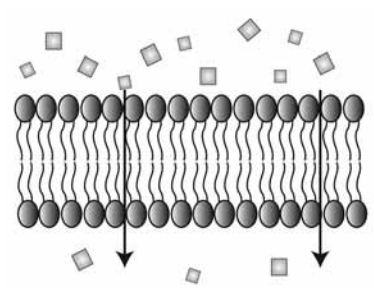


Figure13.5 Simple Diffusion

Passive transport is spontaneous and does not require energy. In passive transport, molecules move spontaneously through the cell membrane from areas of higher concentration to areas of lower concentration; they are said to move "with the **concentration gradient**." The three types of passive transport are diffusion, facilitated diffusion and osmosis.

Diffusion is the process by which substances move directly through the cell membrane as shown in Figure 13.5. **Facilitated diffusion** sometimes involves the help of a channel protein to move a substance from one side of the cell membrane to the other.

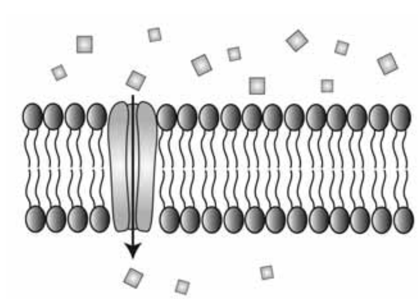


Figure 13.6 Facilitated Diffusion

MUSCULAR SYSTEM

The **muscular system** works together with the skeletal system and the nervous system to enable appropriate movement. It also facilitates the function of internal organs. Energy in the form of ATP is used to make a muscle contract. The nervous system directs this muscular movement. For instance, if you touch something hot, a nerve impulse makes you jerk back, and muscle allows that movement to take place. This nerve to muscle reflex is a protective mechanism. Most muscle tissue is **skeletal**; it is attached to the bones of our skeletons and moves our bodies. These muscles are **voluntary**, meaning we can decide when and how to make them move. A second type of muscle is smooth muscle. **Smooth muscle** is found in the internal organs and makes up the walls of blood vessels. It is involuntary muscle, meaning we do not have conscious control over its movements. Without smooth muscle, food would be unable to pass through the digestive tract. The third type of muscle is **cardiac muscle** and is found in the heart. It is specialized to be able to withstand many contractions without becoming fatigued. Cardiac muscle is also **involuntary**. Imbalances in the muscular system can be caused by damage or diseases in the nervous and endocrine system. These problems can cause weakness in the muscle tissue, spasm, atrophy or paralysis.

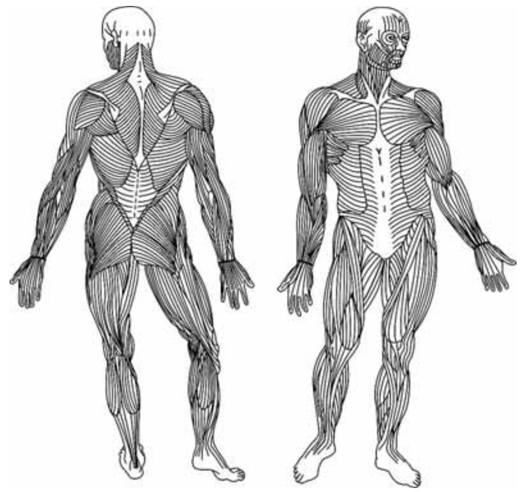


Figure 14.8 Muscular System

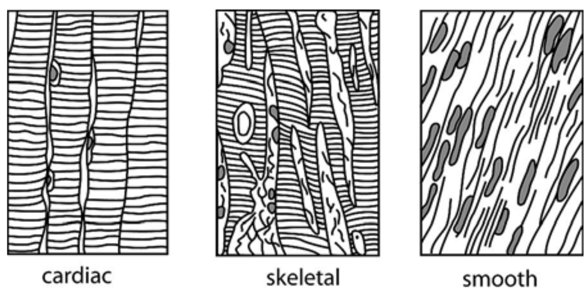
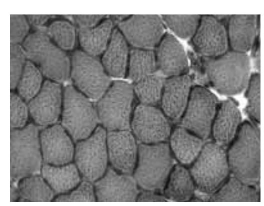


Figure 14.9 Muscle Types

Activity

Read each description or examine each picture below. Determine if the item is a cell, tissue, organ or organ system. Mark (C) for cell, (T) for tissue, (O) for organ and (S) for organ system.

1. Cause movement of internal organs and blood vessels. _______
2. Attaches to the skeleton to enable organism movement. _____
3. Found only in the heart. _____
4.



_____

5. Works closely with the nervous system to create appropriate coordinated movement of the skeleton and organs. _____

NEVADA'S BIOREGIONS

Figure 15.19 Nevada Ecoregions

Nevada has four bioregions: Sierra Nevada, Mojave Basin and Range, Central Basin & Range (also called the Great Basin) and Northern Basin & Range. A **bioregion** is a distinct area of land that contains unique geologic, hydrologic and biological characteristics. Bioregions tend to be large areas of land that contain very unique plant and animals. Bioregions are also sometimes called ecoregions. Because of Nevada's unique geologic history, many distinct microbioregions are also present. These microbioregions support a wide variety of species found nowhere else on Earth. This contributes to the high biodiversity found in Nevada. The distinguishing characteristics of Nevada's bioregions are discussed below.

SIERRA NEVADA


Figure 15.20 Subalpine-Rockies

This bioregion is a mountain range that briefly touches the western portion of Nevada, with the majority of the range residing in California. This mountain range is made mostly of granite. This mountain range is made from large pieces of granite called batholith. A **batholith**, is a large igneous rock formation that occurs when magma has pushed through the Earth's crust underground. This magma cools slowly and the surrounding crustal materials are eventually weathered away exposing the igneous rock. The steep granite slopes located along the eastern edge of this range produces many mountain streams. These streams feed Lake Tahoe and three main rivers which provide the majority of the water used in Nevada for recreation, farming, urban and industrial development. The entire Sierra Nevada range is approximately 400 miles long and is 14,500 ft at its highest point. The **alpine forest** is located in this bioregion. The alpine forest is a forest made up of mostly conifers, found at high elevations with persistent snow through most of the year. The types of plants found in the Sierra Nevada include several conifer species: *white fir*, *lodgepole pine*, *red fur* and *mountain hemlock* along with other species of shrubs, grasses and herbs. Animals found in the Sierra Nevada include many types of insects, reptiles, amphibians and birds as well as mammals like *deer*, *fox*, *mountain lion*, *jackrabbit* and *chipmunk*.

MOJAVE BASIN AND RANGE


Figure 15.21 Mojave Basin and Range

This bioregion is a desert that touches California, Arizona, Utah and the southern portion of Nevada. The Mojave Basin and Range is also sometimes called the high desert. This desert has elevations between 3,000 and 5,000 feet and receives around 10 inches of rain every year. The Tehachapi together with the San Gabriel and San Bernardino mountain ranges border the Mojave Basin and Range. The Colorado River, Amargosa, Muddy, Virgin, Meadow Valley and White rivers all flow through this bioregion. The hottest and lowest place on

GENE FLOW

Gene flow is the change in the occurrence of genes in a population. Population refers to the group of organisms of the same species in a given geographic area. Gene flow occurs when an individual leaves a population or a new individual joins a population. Gene flow tends to increase the similarity of individuals from different populations, since these individuals share their genes with each other through reproduction.

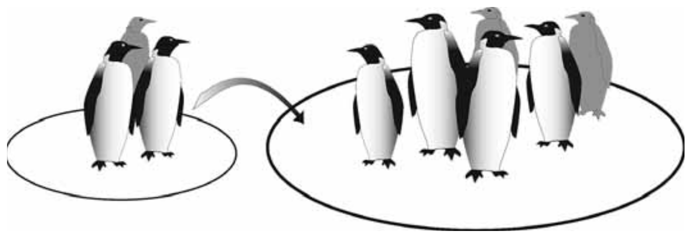


Figure 16.17 Organisms Enter a Population

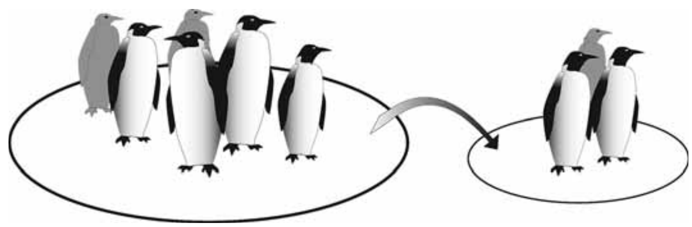


Figure 16.18 Organisms Leave a Population

Gene flow happens easily in plants that have seeds carried by wind. The wind carries the seeds of a plant from one population to another population. When these new seeds grow into plants, the plants can cross-pollinate with the existing plants, and genes from different populations are shared.

GENETIC DRIFT

Genetic drift provides random changes in the occurrence of genes through chance events. Genetic drift is the result of chance events on allele in a population. Genetic drift can cause some alleles to be more common or to be eliminated from the population. Sometimes genetic drift can occur very quickly or more slowly. Genetic drift is most often *the* evolutionary force acting on small populations. Chance events can be any force that acts on a population like disease, famine, environmental change, natural disaster, new food source or extinction of another species. The peppered moth population in England experienced this phenomena when the predominant color changed from white to black. If a large proportion of the population is killed, it is called **bottlenecking**. A large population is reduced to a few individuals, and the genes of subsequent generations become very similar.

Inbreeding between these few individuals can lead to populations that have very few genetic differences. It is believed that African cheetahs went through two bottlenecks, one about 10,000 years ago and one about 100 years ago. All African cheetahs alive today are descendents of a few cheetahs, and possibly only three females. Because cheetahs are genetically similar, they have become very susceptible to diseases.

Figure 16.19
Bottleneck

THE LIFE CYCLE OF STARS

Though no one has ever seen a star born, the universe has provided so many examples of stars that astronomers have been able to piece together the various stages of the stellar life cycle. Throughout the universe, gases and dust collect into larger clouds known as **nebulas**. They are almost completely hydrogen (97%) with some helium and other elements. Nebulae have regions of varying density within them and when regions become sufficiently dense, the gravitational forces cause the gases to pool. This accretion process will continue in spite of the increasing pressure and heating occurring until larger and much denser structures begin to form called **protostars**. As the density increases, so does the pressure and heating which prevents complete collapse of the protostar under its own gravity.

Examine the diagram below showing the lifecycle of typical stars. Start in the center, at the point of protostar formation from the nebula. The top cycle and bottom cycle are separate, and indicate two different kinds of star lifecycle.

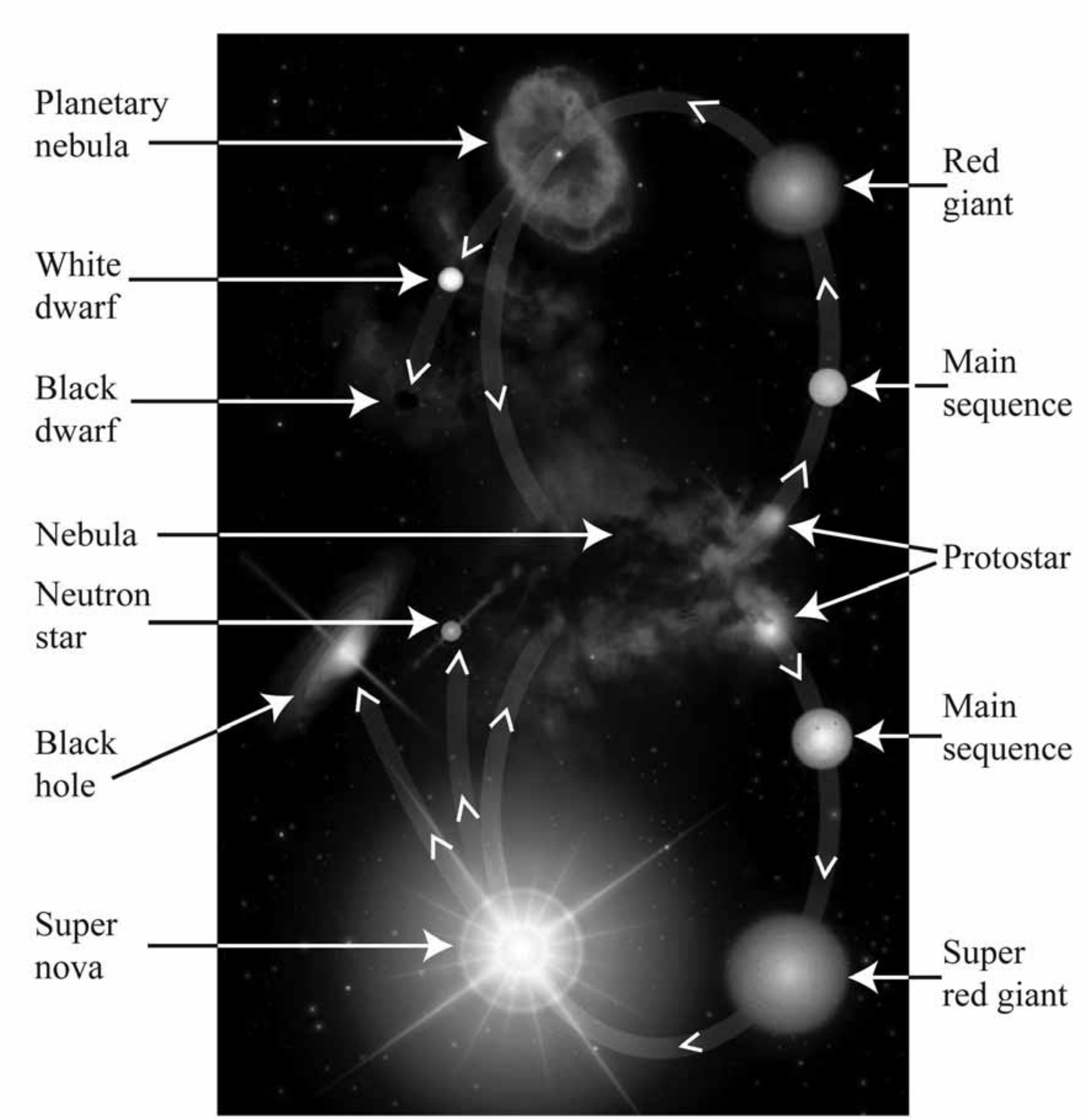


Figure 17.8 Life Cycle of Stars

The Changing Atmosphere of the Earth

Looking up at the blue sky on a clear day, it is hard to imagine that the atmosphere is dynamic and turbulent for hundreds of miles above us. Throughout this apparent stillness, changes are occurring — some immediate, and some having taken quite a long time. Earth's atmosphere is mostly an open system, so it is affected by what enters it, what leaves it and what is going on at the surface. This has been true since the planet came into existence.

Development of the Current Atmosphere

Scientists generally agree that in the past the atmosphere of the Earth was quite different than it is today. The early Earth atmosphere lacked a significant amount of oxygen gas. Models describing the early Earth suggest that hydrogen and helium dominated the atmosphere until volcanoes spewed out various gases such as water, carbon dioxide, ammonia and methane (which occurs even today). This early atmosphere is know as a **reducing atmosphere**.

Figure 18.7 Volcano

The idea of an ancient reducing atmosphere is supported by rock samples drilled from different layers of Earth's crust. These rocks were deposited during ancient volcanic eruptions. These rock samples contain iron that would oxidize in the presence of oxygen to form rust. The samples show no sign of rust or oxidation. As a result, scientists speculate that there was no free oxygen in Earth's early atmosphere.

Over time, organisms that could develop in this oxygen-free atmosphere, such as plants, protists and bacteria absorbed the carbon dioxide and released the oxygen that now makes up 21% of our atmosphere. This also explains the very small amount of carbon dioxide that is currently present (0.036%). Today's oxidizing atmosphere contains nitrogen, oxygen, carbon dioxide and water vapor. As the concentration of oxygen increased, organisms requiring oxygen to survive could thrive. This is supported in part by the fossil record.

Current Changes

Scientists have learned a great deal about the atmosphere by monitoring changes over time. Since the Industrial Revolution of the late 1800s, concern over humankind's impact has steadily grown. Today, scientists look for the evidence of atmospheric damage in four areas:

Crustal plates floating on the convection currents interact with other plates at plate boundaries. Three types of plate boundaries have been identified, each characterized by the type of motion they exhibit. **Divergent boundaries** are areas where plates move away from each other, creating fractures between the rock units. As the rocks separate, magma from below rises to fill the fracture, creating new crustal plate. This type of tectonic activity, known as **seafloor spreading**, occurs in oceanic crust, and the new magma forms undersea mountain ranges oriented in a linear pattern. These underwater mountain ranges are called **mid-ocean ridges**.

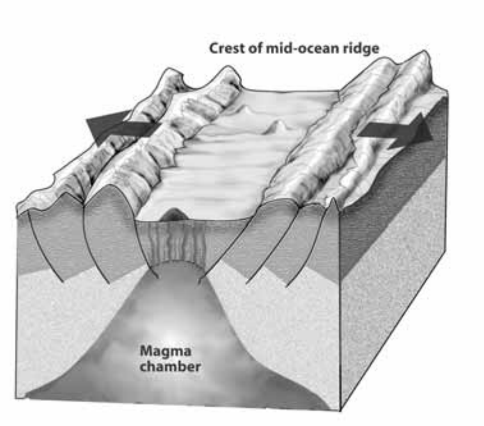


Figure 19.11 Creation of Mid-Ocean Ridges

Mid-ocean ridges are found in every ocean, and are all, in fact, connected to one another. Together, they form the largest mountain range in the world. Figure 19.11 shows the mid-ocean ridge submerged to the north of Cuba.

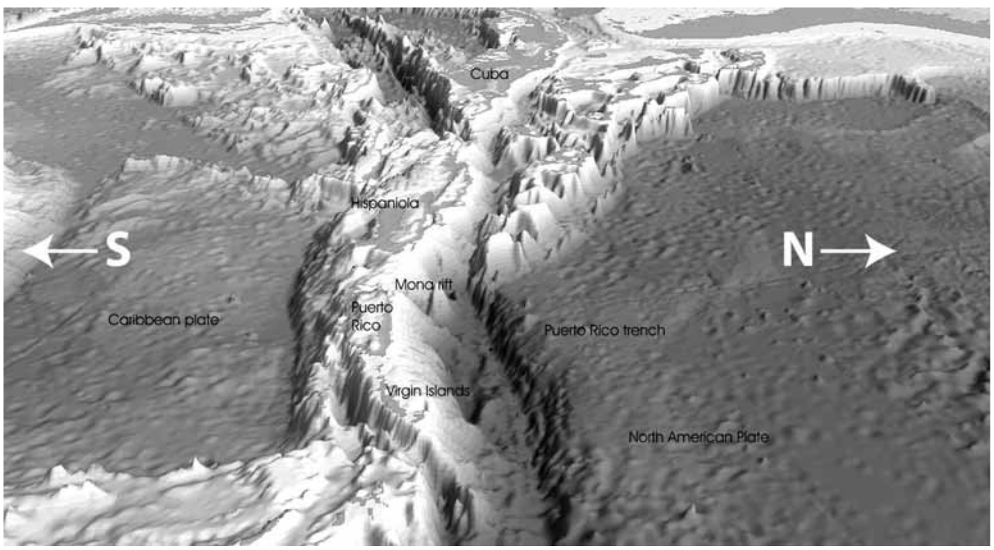


Figure 19.12 The Boundary of the North American and Caribbean Plates

The rock generated by seafloor spreading is “young” compared to the continental crust. The further away from the ridge, the older the rock.

Convergent boundaries are found in areas where crustal plates come together. In this type of boundary, a plate of denser oceanic crust sinks beneath a lighter continental plate. The area where the oceanic crust sinks is called the **subduction zone**. The sinking plate bends as it is subducted, creating a **deep ocean trench**. (Note that these features may occur alongside other topographical features on the ocean floor. For instance, Figure 19.12 shows a ridge system, the Mona rift and the Puerto Rico trench at the boundary between the Caribbean and the North American plates.) As the plate sinks into the higher temperature mantle, it is melted and the lighter material rises as volcanoes or continental **volcanic arcs**.

Transform boundaries occur where two plates slide past one another. The resulting friction creates a **fault**. These types of boundaries are more prevalent in oceanic-type crust. The San Andreas Fault system of California is a classic example of this type of fault system.

SUSTAINABLE PRACTICES

Sustainable practices are those that use natural resources in a way that does not deplete them. **Natural resources** are any resources used in their natural form, like forests, air, water or mined ore. Natural resources may be renewable or nonrenewable. They do not necessarily need to be used for energy production. Natural resources like minerals are used in industry and manufacturing for a wide variety of purposes. Natural resources like beaches are used for recreation.

Figure 20.3 Natural Resources: Forests, Oceans, Fossil Fuels and Freshwater Sources

Sustainable practices are ways that humans can behave that are in harmony with their environment. Sustainable practices can be applied in many areas of modern life including mining, oil production, water use and agriculture. Unfortunately, many human practices cannot be classified as sustainable. **Non-sustainable practices** are those that use natural resources in a way that is harmful to the environment. Let's look at one of those: the creation of excessive municipal solid waste.

MUNICIPAL SOLID WASTE

The term used for the waste thrown away by a community is **municipal solid waste** (MSW). The average American throws away an estimated five pounds of waste per day. Another way to say this is that the average American *generates* waste at the *rate* of five pounds per day. Of these five pounds of waste, about 40% is made from nonrenewable resources. Another 35% is made from paper, which comes from trees, a renewable resource on the lower end of the renewability spectrum.

Figure 20.4 Municipal Waste Dump

Aside from the waste of our resources, throwing away five pounds of waste every day can cause critical shortages in landfill space. How do we solve this problem? Three magic words: *Reduce*, *Reuse* and *Recycle*.

Post Test 1
NV HSPE

1 An animal cell is placed in a solution of distilled water. If left overnight in the distilled water, what will happen to the cell? L.12.B1 (A2)

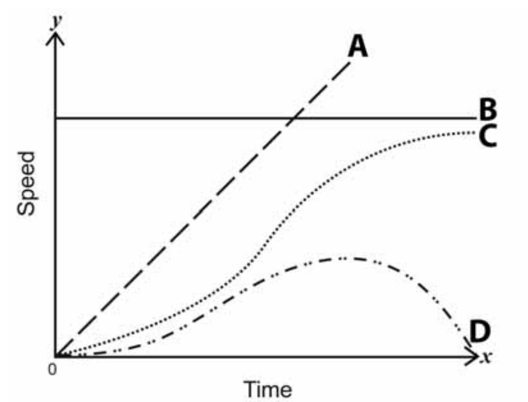
A It will swell and burst.

B It will shrivel and die.

C It will undergo chemosynthesis.

D It will remain the same, since it has a cell wall to protect it.

2 On the speed vs. time graph, identify the line or curve that represents the motion of a car driven from one stop sign to a second stop sign. P.12.B.1 (A2)



A line A **B** line B **C** curve C **D** curve D

3 A portion of mRNA has the sequence UUCAUGGGC. What was the sequence of the original DNA segment? L.12.A.1 (A2)

A AACTACCCG

B AAGUACCCG

C TTGTAGGGC

D AAGTACCCG

Post Test 2
NV HSPE

1 Amino acids are linked by peptide bonds to make proteins during the process of — L.12.A.2 (A1)

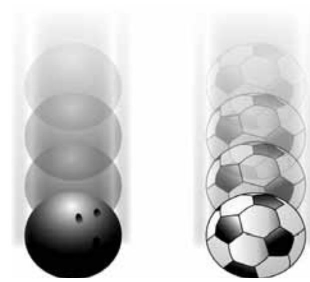
A translation.

B transcription.

C replication.

D complimentary stranding.

2 A bowling ball with a mass of 5.44 kg and a soccer ball with a mass of 0.43 kg are dropped from a 15 m platform. The platform is located in a vacuum chamber. Identify the correct description of the acceleration of the bowling ball and the force with which it hits the ground, as compared with the soccer ball. — P.12.B.4 (A2)



A The force of the bowling ball is greater, and its acceleration is greater.

B The force of the bowling ball is greater, and its acceleration is the same.

C The force of the bowling ball is the same, and its acceleration is greater.

D The force of the bowling ball is the same, and its acceleration is the same.

3 The red shift phenomena supports which scientific theory? — E.12.B.5 (A1)

A the expanding universe theory

B the contracting universe theory

C the solidified universe theory

D the homogenous universe theory