American Book Company's

Integrated Physics and Chemistry Review

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Diagnostic Test

1 Madras held positively charged bits of paper. She sprinkled them over several other charged objects. Predict which object will attract the most bits of paper. 4G, 2D

A positively charged silk shirt

B neutral piece of steel

C negatively charged piece of plastic wrap

D None of these items will attract bits of paper.

2 Which situation **best** represents kinetic energy? 5A

F a falling meteor

G a car in the garage

H a student reading a book

J a picnic on top of a hill

3 Describe the conversion of energy in the following process: Nuclear power reactors utilize the process of uranium fission to produce heat. This heat creates steam that turns an electrical turbine. 7E

A nuclear to electrical

B nuclear to thermal to electrical

C nuclear to mechanical to thermal to electrical

D nuclear to thermal to mechanical to electrical

4 In which of the following media will sound waves travel **fastest**? 5G

F outer space

G hot, humid air

H red Georgia clay

J ocean water

Is bias the only reason that false information is published?

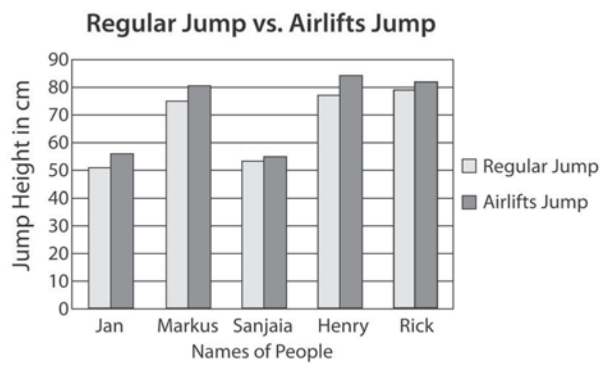
When a few different researchers all interpret the data differently, bias could be a factor. On the other hand, sometimes people just naturally look at things in different ways. It could also be that the experiment was poorly designed, giving unclear data.

There is a final complicating factor that is especially important to consider. There might be factors affecting the experiment that are not known, despite the best efforts of scientists. In the next chapter, we will examine experimental methods to hopefully avoid as many errors and unknowns as possible.

Activity

A competitor of the *Airlifts Shoe* wanted to dispute their advertised claims (seen in Figure 1.5). The data presented below is from an experiment they conducted. The jump height of five people was measured with a meter stick. The people were then asked to put on *Airlifts Shoes,* and their jump height was re-measured. The table below describes the people used in the experiment and the bar graph shows their jump heights.

Name	Gender
Jan	Female
Markus	Male
Sanjaia	Female
Henry	Male
Rick	Male



Use this information to write a paragraph supporting or refuting the claims of the *Airlifts Shoe* advertisement. How truthful is the advertisement based on this experiment?

What does the data reveal?

How are the claims of the *Airlifts Shoe* Company affected by the data of this experiment?

What other reasonable explanations can be given for the differences seen in the data?

Activity

Use reputable Internet sources to gather data on a controversial scientific topic, like global warming. Gather raw data, and use your computer to help analyze and present the data. Make a poster showing your findings. Explain your poster to your classmates.

CHANGING THE MAGNITUDE

The SI system is also called the **metric system**. This term is probably familiar to you. Metric system units are defined in multiples of 10 from the **base unit**. The metric prefixes indicate which multiple of 10 — 10, 100 or 1,000 — the base unit should be multiplied or divided by. The table below is set up to help you know how far and in which direction to move a decimal point when making conversions from one unit to another.

Table 3.2 Changing the Magnitude of a Unit

Prefix	kilo (k)	hecto (h)	deka (da)	Base Unit	deci (d)	centi (c)	milli (m)
Abbreviation	km	hm	dam	**meter**	dm	cm	mm
	kL	hL	daL	**Liter**	dL	cL	mL
	kg	hg	dag	**gram**	dg	cg	mg
Multiplication Factor (from the base unit)	1000	100	10	**1**	0.1	0.01	0.001

Multiply when changing from a larger unit to a smaller one. Divide when changing from a smaller unit to a larger one. (Remember, dividing is the same as multiplying by a fraction.) Let's look at two examples.

Let's say you have a bowling ball with a mass of 4.54 kilograms (kg). To convert kg to grams (g), move three spaces to the right on the table. Each of those spaces represents a multiplication factor of 10. Since $10 \times 10 \times 10 = 1000$, you multiply by 1000.

$$\mathbf{4.54\ kg} \times 1000 = 4{,}540\ \mathbf{g}$$

Here's another example. A soda can has a volume of 355 milliliters (mL). To convert mL to deciliters (dL), you move two spaces to the left. Since $10 \times 10 = 100$, you divide by 100, which is the same as multiplying by 0.01.

$$\mathbf{355\ mL} \div 100 = 355\ \mathbf{mL} \times 0.01 = 3.55\ \mathbf{dL}$$

Some abbreviations, like the deciliter (dL), may be unfamiliar to you. In the science lab, and in most real-life applications, kilo-, centi- and milli- will be the abbreviations that you most often encounter. However, all these units are correct, and some of the lesser-known ones are even common in particular industries. The hectometer (hm), for instance, is a commonly used unit in agriculture and forestry.

PRECISION AND ACCURACY

What is the difference between precision and accuracy? Many people use these terms interchangeably, but they are not the same. **Accuracy** refers to how "correct" a measurement is. If Tariq measured his classroom's length as 16.7 feet (5.09 meters), but a blueprint of the building indicated that is was actually 16.1 feet, then the measurement was not accurate.

Precision refers to how small a scale is being used to make a measurement. The smaller the scale, the more precise the measurement. For example, a measurement made to the nearest eighth of an inch is more precise than a measurement that is rounded to the nearest inch. There is a practical limit to this concept. For example, if Tariq measured the room down to the nearest nanometer (0.000000001 meter), it really wouldn't have more practical meaning than measuring it to the nearest millimeter (0.001 meter), would it?

Chapter 5
Laboratory Safety

This chapter covers standards:
1A, 1B

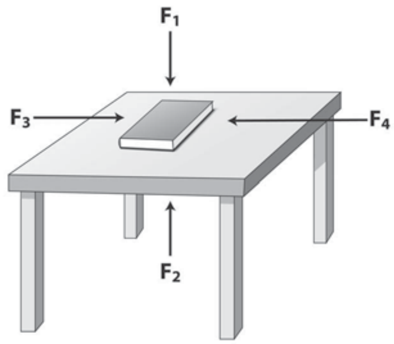
Walking into science class on Monday morning, you see that materials are all set up for a lab. *Yes*! You love lab days because you get to actually *do* science. You observe the classroom on the way to your seat. Before doing anything else, you draw a picture of what you see going on in the classroom. The picture looks something like the one below.

Figure 5.1 A Classroom in Chaos

Your teacher sees your drawing and is horrified! Clearly, many students have forgotten the lab safety rules that were reviewed on Friday. She asks your permission to photocopy it for the class. Then, she passes it out for homework the next day as a part of the following assignment:

Challenge Activity

This vector diagram corresponds to the discussion in the chapter. Use the diagram to answer the following questions.



1. Define the four forces in the diagram, according to the discussion in the text.

____

2. If F_1 equals 9.81 N, what does F_2 equal?

____

3. Describe what must happen to the forces, in order for the book to move to the left.

____

4. Describe what must happen to the forces, in order for the book to move up.

____

Kinetic energy can be converted to potential energy and back again. Think about riding your bike. Say you were pedalling along and you came to a hill. You decided not to pedal while going uphill, instead you peddled really fast at the bottom and coasted uphill. At the bottom of the hill, your kinetic energy is high and your potential energy is low. At the top of the hill, your kinetic energy is low while your potential energy is high. Figure 7.1 demonstrates this idea.

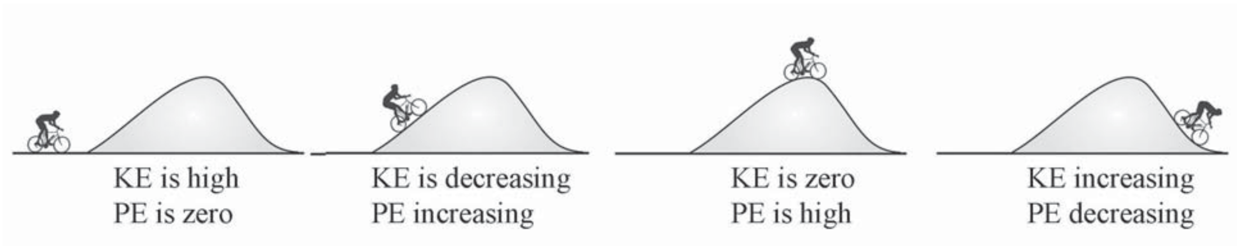


Figure 7.1 Energy Transfer Up and Down Hill

Now that we know more forms of energy, we can describe the bike ride more accurately. Chemical energy from the food you ate that morning fueled your trip up the hill. You used that chemical energy to generate motion and thermal energy. The thermal energy took the form of heat from your body and the heat resulting from the friction of the bike wheels on the pavement. Once you got to the top of the hill, you achieved a position that lent you gravitational energy, which you then expended during the victory ride down the hill.

There are many other examples of energy transfer between different forms of energy. A match, for example, has potential energy in the form of chemical energy. Once the match is struck, the chemical energy is converted to radiant and thermal energy as light and heat. Clearly, chemical potential energy cannot be described by Equation 7.1. This type of potential energy is based on the energy of the bonds broken and formed during the chemical reaction. Water behind a dam has potential energy due to the position of the water it blocks. Once the water is released from the dam, its potential energy is converted to kinetic energy. More specifically, gravitational energy is transferred to energy of motion, just like a bike going downhill.

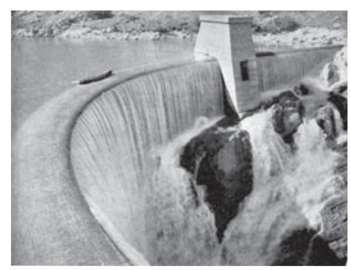


Figure 7.2 A Dam

If the dam is part of a hydroelectric plant, the falling water will turn the turbines of an electric generator. The motion energy of the turning turbine is converted to electrical energy by the generator. As the generator turns, thermal energy is created and dispersed into the environment. The main product of the generator is electrical energy.

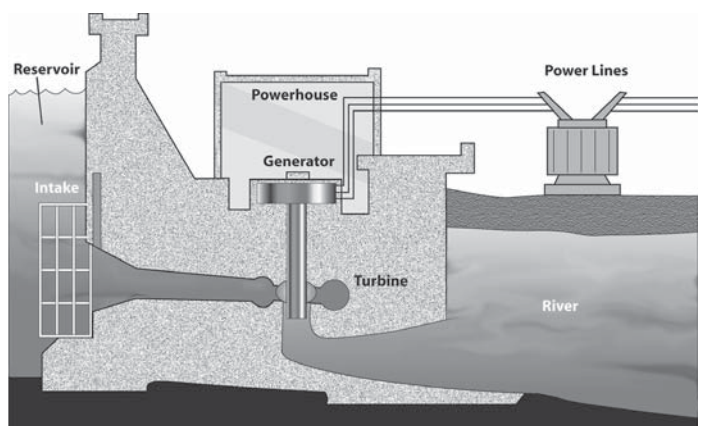


Figure 7.3 Hydroelectric Plant

Electric and Magnetic Forces

The **electrostatic force** occurs between two charged particles. Recall in Chapter 6 we discussed electromagnetic forces. Although often discussed separately, these two forces are intimately linked. The important points to remember are

- charged particles exert forces on each other,
- like charges repel, opposite charges attract, and
- the greater the distance between charges, the less force they will exert on each other.

While the electrostatic force can be attractive or repulsive, the gravitational force can only be attractive.

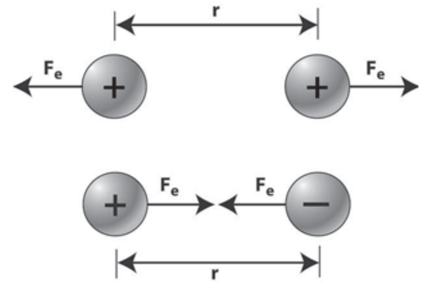


Figure 7.27 Electrostatic Force Between Two Charged Particles

When the two charges have the same sign, they repel one another. When they have opposite signs, they attract each other. Recall that atoms are made of a positively charged nucleus surrounded by negatively charged electrons. The attractive electrical force between these charges is what holds the atom together.

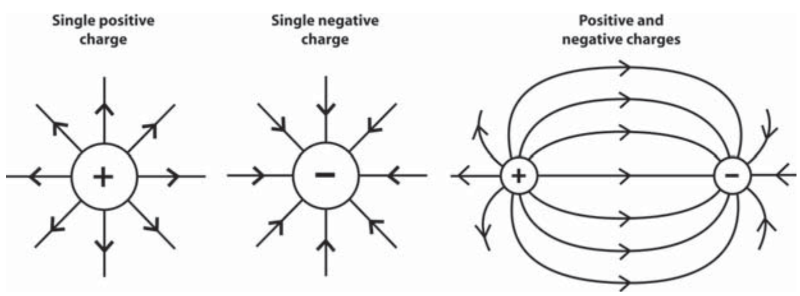


Figure 7.28 Electric Field Lines

An **electric field** surrounds every electric charge. If a test charge (a small, charged particle) were placed in the electric field of a charged particle, a force would be exerted upon it. The **electric field lines** point in the direction that a positive charge would move when in the presence of an electric field. A positively charged particle would be repelled by a positive charge and attracted by a negative charge. Thus, electric field lines always point away from positive source charges and towards negative source charges. Electric field lines do not actually exist in the physical world; they are simply used to illustrate the direction of the electric force exerted on charged particles. The strength of the field surrounding a charged particle is dependent on how charged the particle generating the field is and separation distance between the charged objects.

Much like an electric field, a **magnetic field** surrounds a magnet such that a magnetic test particle (or a compass needle) will orient along the lines of force. A magnet has two poles, "north" and "south," and the invisible lines, called **magnetic field lines**, help us visualize the magnetic field. This magnetic field consists of magnetic force that extends through space from the north to the south pole. In fact, an electrical current creates a magnetic field. Likewise, a changing magnetic field will causes electrons to flow. This property is due to a force, one of the four fundamental forces, known as the electromagnetic force. This is a strange and mysterious property of matter but it is one of the most important observations made in modern science. Since the Earth has a magnetic field, an electric current must be present in the Earth. It is believed that the electric currents are present in the mostly iron core of the Earth.

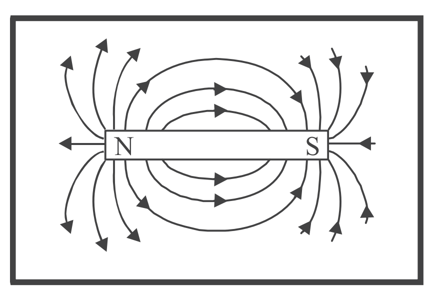


Figure 7.29 Field Lines in a Magnet

SOLUBILITY OF MATTER

A solution can contain dissolved molecules or ions or a combination of the two. The solubility of a substance is one property that is used to distinguish one substance from another. The solubility is measured by the **concentration** of the solute in the solvent. The concentration is a measure of the number of grams of solute dissolved per volume of solvent. Some factors that affect the solubility of solutes in solvent are: nature of solute, temperature, pressure, pH, surface area, agitation and concentration.

NATURE OF SOLUTE AND SOLVENT

There is a saying among scientists that explains why a solute will dissolve in some solvents but not in others. The saying is: **Like Dissolves Like**. It means that solutes and solvents that have similar molecular polarity will interact. These molecules interact according to certain polarity rules, which are ultimately related to the electrical force fields surrounding each molecule. Recall partial positive and partial negative charges? These forces are either attractive or repulsive. So, “like dissolves like” really is a description of the solvent and solute’s electrical properties. Let’s look at a few examples. Figure 8.21 shows the dissolution of NaCl in water. NaCl separates into the ions Na^+ and Cl^- when in water. Water molecules are polar, so they have a **dipole** — that is, they are neutral molecules that have an imbalance in the distribution of charge. Negative charge is distributed around the oxygen atom, and positive charge around the hydrogen atoms. Since opposite charges attract, the oxygen portion of the water will be attracted to the Na^+ ion, while the hydrogen portion of water will be attracted to the Cl^- ion. These attractions are the reason that NaCl dissolves in water. If the interactions between the Na^+ and Cl^- were stronger than their interaction with water, it would not dissolve.

The following scenarios summarize solubility based on common substances of different polarity.

Polar/Polar: Water is a polar solvent and easily dissolves the polar NaC1 molecule, as in Figure 8.21.

Polar/Nonpolar: Water will not dissolve wax, a non-polar solute.
Nonpolar/Polar: The nonpolar solvent gasoline will not dissolve polar sugar molecules.
Nonpolar/Nonpolar: Gasoline will dissolve the nonpolar solute oil, like the oil stains on a driveway.

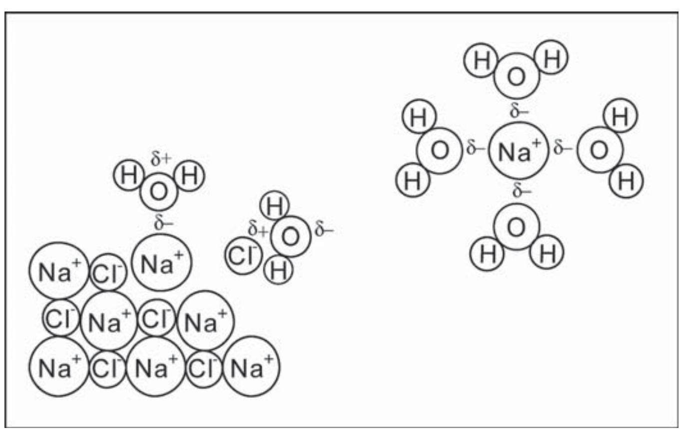


Figure 8.21 Salt Dissolving in Water

Radium-226 decays by alpha particle emission, as shown in the following equation.

$$^{226}_{88}\text{Ra} \longrightarrow ^{222}_{86}\text{Rn} + ^{4}_{2}\alpha$$

By releasing an alpha particle, the radium-226 atom has lowered its energy and transformed itself into a radon-222 atom.

So, you have seen that unstable nuclei can emit an α particle, β particle or γ ray to become more stable. However, there is another way for an unstable nucleus to lower its energy: the process of nuclear fission.

FISSION

Fission occurs when the nucleus of an atom that has many protons and neutrons becomes so unstable that it splits into two smaller atoms. Fission may be spontaneous or induced.

Spontaneous fission is a natural process that occurs mostly in the transactinide elements, like rutherfordium (Rf). However, some of the actinides (which are a little bit lighter than the transactinides) decay partially by spontaneous fission, including isotopes of uranium (U) and plutonium (Pu). For example, a ^{235}U atom has 92 protons and 143 neutrons. When fission occurs, it may split into a krypton atom and a barium atom, plus 2 neutrons, as shown in the following equation and in Figure 9.9.

$$^{235}_{92}\text{U} \longrightarrow ^{94}_{36}\text{Kr} + ^{139}_{56}\text{Ba} + 2^{1}_{0}\text{n}$$

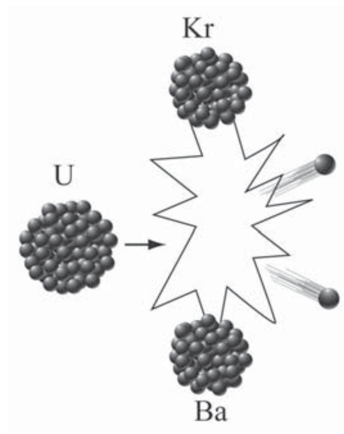


Figure 9.9 Spontaneous Fission

The process of spontaneous fission wasn't well-known or understood until fairly recently. In fact, it was only discovered as a by-product of the investigation into induced fission. **Induced fission** is the process of firing neutrons at heavy atoms, to induce them to split. It was first investigated by **Enrico Fermi** in the 1930s. The theory was proven in 1939, with the discovery by **Lise Meitner** and **Otto Frisch** that the use of neutron projectiles had actually caused a uranium nucleus to split into two pieces, as shown in Figure 9.10 (except that more neutrons were emitted). Meitner and Frisch named the process nuclear fission. Fermi proceeded to co-invent the first nuclear reactor. This design led to the invention of nuclear reactors found in nuclear power plants, as well as nuclear bombs.

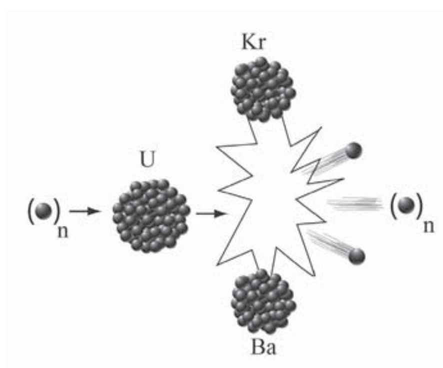
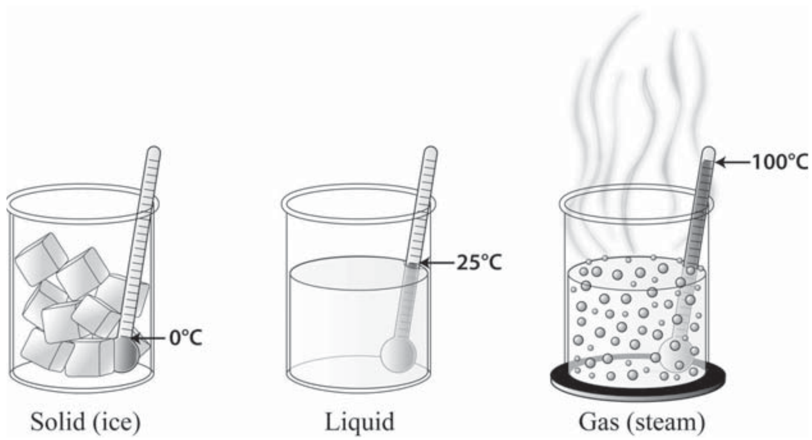


Figure 9.10 Induced Fission

Practice Test



1 In the picture above, several phases of water are shown. Which phase has the **highest** kinetic energy? 6A

A solid

B liquid

C gas

D ice