# 10th Grade Textbook Packet

## 4/6/2020-4/10/2020

## CHAPTER GOALS

*Among the questions we will answer are the following:*

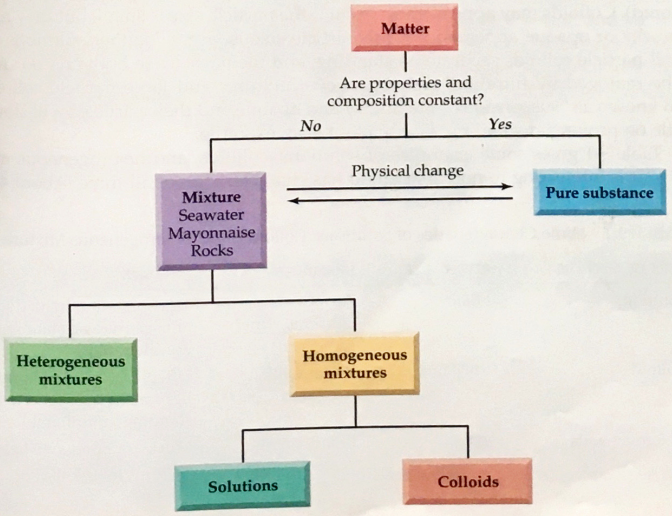
1. **What are solutions, and what factors affect solubility?**
   **THE GOAL:** Be able to define the different kinds of mixtures and explain the influence on solubility of solvent and solute structure, temperature, and pressure.
2. **How is the concentration of a solution expressed?**
   **THE GOAL:** Be able to define, use, and convert between the most common ways of expressing solution concentrations.
3. **How are dilutions carried out?**
   **THE GOAL:** Be able to calculate the concentration of a solution prepared by dilution and explain how to make a desired dilution.
4. **What is an electrolyte?**
   **THE GOAL:** Be able to recognize strong and weak electrolytes and nonelectrolytes, and express electrolyte concentrations.
5. **How do solutions differ from pure solvents in their behavior?**
   **THE GOAL:** Be able to explain vapor pressure lowering, boiling point elevation, and freezing point depression for solutions.
6. **What is osmosis?**
   **THE GOAL:** Be able to describe osmosis and some of its applications.

Up to this point, we have been concerned primarily with pure substances, both elements and compounds. In day-to-day life, however, most of the materials we come in contact with are mixtures. Air, for example, is a gaseous mixture of primarily oxygen and nitrogen; blood is a liquid mixture of many different components; and many rocks are solid mixtures of different minerals. In this chapter, we look closely at the characteristics and properties of mixtures, with particular attention to the uniform mixtures we call *solutions*.

## 9.1 Mixtures and Solutions

As we saw in Section 1.3, a *mixture* is an intimate combination of two or more substances, both of which retain their chemical identities. (, p. 6) Mixtures can be classified as either *heterogeneous* or *homogeneous* as indicated in Figure 9.1, depending on their appearance. **Heterogeneous mixtures** are those in which the mixing is not uniform and which therefore have regions of different composition. Rocky Road ice cream, for example, is a heterogeneous mixture, with something different in every spoonful. Granite and many other rocks are also heterogeneous, having a grainy character due to the heterogeneous mixing of different minerals. **Homogeneous mixtures** are those in which the mixing *is* uniform and that therefore have the same composition throughout. Seawater, a homogeneous mixture of soluble ionic compounds in water, is an example.

**Heterogeneous mixture** A nonuniform mixture that has regions of different composition.




◀ **FIGURE 9.1 Classification of mixtures.** The components in heterogeneous mixtures are not uniformly mixed, and the composition varies with location. In homogeneous mixtures, the components are uniformly mixed at the molecular level.



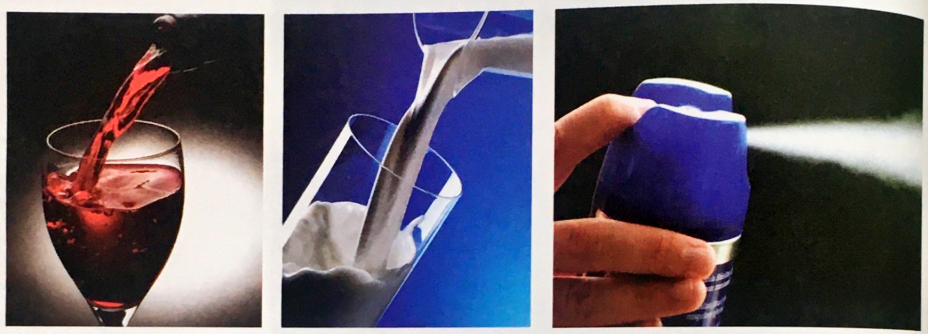


**Homogeneous mixture** A uniform mixture that has the same composition throughout.

**Solution** A homogeneous mixture that contains particles the size of a typical ion or small molecule.

**Colloid** A homogeneous mixture that contains particles that range in diameter from 2 to 500 nm.

Homogeneous mixtures can be further classified as either *solutions* or *colloids* according to the size of their particles. **Solutions**, the most important class of homogeneous mixtures, contain particles the size of a typical ion or small molecule—roughly 0.1–2 nm in diameter. **Colloids**, such as milk and fog, are also homogeneous in appearance but contain larger particles than solutions—in the range 2–500 nm diameter.



(a) (b) (c)

▲ (a) Wine is a solution of dissolved molecules, and (b) milk is a colloid with fine particles that do not separate out on standing. (c) An aerosol spray, by contrast, is a heterogeneous mixture of small particles visible to the naked eye.

Liquid solutions, colloids, and heterogeneous mixtures can be distinguished in several ways. For example, liquid solutions are transparent (although they may be colored). Colloids may appear transparent if the particle size is small, but they have a murky or opaque appearance if the particle size is larger. Neither solutions nor small-particle colloids separate on standing, and the particles in both are too small to be removed by filtration. Heterogeneous mixtures and large-particle colloids, also known as "suspensions," are murky and opaque and their particles will slowly settle on prolonged standing. House paint is an example.

Table 9.1 gives some examples of solutions, colloids, and heterogeneous mixtures. It is interesting to note that blood has characteristics of all three. About 45%

TABLE 9.1 Some Characteristics of Solutions, Colloids, and Heterogeneous Mixtures

| TYPE OF MIXTURE | PARTICLE SIZE | EXAMPLES | CHARACTERISTICS |
|---|---|---|---|
| Solution | <2.0 nm | Air, seawater, gasoline, wine | Transparent to light; does not separate on standing; nonfilterable |
| Colloid | 2.0–500 nm | Butter, milk, fog, pearl | Often murky or opaque to light; does not separate on standing; nonfilterable |
| Heterogeneous | >500 nm | Blood, paint, aerosol sprays | Murky or opaque to light; separates on standing; filterable |

by volume of blood consists of suspended red and white cells, which settle slowly on standing; the remaining 55% is *plasma*, which contains ions in solution and colloidal protein molecules.

Although we usually think of solids dissolved in liquids when we talk about solutions, solutions actually occur in all three phases of matter (Table 9.2). Metal alloys like 14-karat gold (58% gold with silver and copper) and brass (10–40% zinc with copper), for instance, are solutions of one solid with another. For solutions in which a gas or solid is dissolved in a liquid, the dissolved substance is called the **solute** and the liquid is called the **solvent**. When one liquid is dissolved in another, the minor component is usually considered the solute and the major component is the solvent.

**Solute** A substance dissolved in a liquid.

**Solvent** The liquid in which another substance is dissolved.

TABLE 9.2 Some Different Types of Solutions

| TYPE OF SOLUTION | EXAMPLE |
|---|---|
| Gas in gas | Air ($O_2$, $N_2$, Ar, and other gases) |
| Gas in liquid | Seltzer water ($CO_2$ in water) |
| Gas in solid | $H_2$ in palladium metal |
| Liquid in liquid | Gasoline (mixture of hydrocarbons) |
| Liquid in solid | Dental amalgam (mercury in silver) |
| Solid in liquid | Seawater (NaCl and other salts in water) |
| Solid in solid | Metal alloys such as 14-karat gold (Au, Ag, and Cu) |

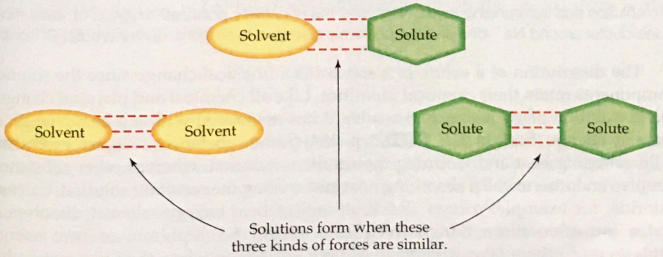
**PROBLEM 9.1**

Classify the following liquid mixtures as heterogeneous or homogeneous. Further classify each homogeneous mixture as a solution or colloid.

**(a)** Orange juice **(b)** Apple juice
**(c)** Hand lotion **(d)** Tea

## 9.2 The Solution Process

What determines whether a substance is soluble in a given liquid? Solubility depends primarily on the strength of the attractions between solute and solvent particles relative to the strengths of the attractions within the pure substances. Ethyl alcohol is soluble in water, for example, because hydrogen bonding (Section 8.11) is nearly as strong between water and ethyl alcohol molecules as it is between water molecules alone or ethyl alcohol molecules alone. (, p. 238)




A good rule of thumb for predicting solubility is that "like dissolves like," meaning that substances with similar intermolecular forces form solutions with one another, whereas substances with different intermolecular forces do not (Section 8.11). (, p. 235)



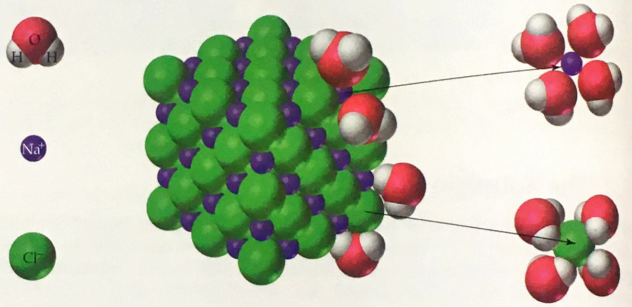
▲ Oil and water do not mix because they have different intermolecular forces, resulting in the formation of oil slicks.

Polar solvents dissolve polar and ionic solutes; nonpolar solvents dissolve nonpolar solutes. Thus, a polar, hydrogen-bonding compound like water dissolves ethyl alcohol and sodium chloride, whereas a nonpolar organic compound like hexane ($C_6H_{14}$) dissolves other nonpolar organic compounds like fats and oils. Water and oil, however, do not dissolve one another, as summed up by the old saying, "Oil and water don't mix." The intermolecular forces between water molecules are so strong that after an oil–water mixture is shaken, the water layer re-forms, squeezing out the oil molecules.

Water solubility is not limited to ionic compounds and ethyl alcohol. Many polar organic substances, such as sugars, amino acids, and even some proteins, dissolve in water. In addition, small, moderately polar organic molecules such as chloroform ($CHCl_3$) are soluble in water to a limited extent. When mixed with water, a small amount of the organic compound dissolves, but the remainder forms a separate liquid layer. As the number of carbon atoms in organic molecules increases, though, water solubility decreases.

The process of dissolving an ionic solid in a polar liquid can be visualized as shown in Figure 9.2 for sodium chloride. When NaCl crystals are put in water, ions at the crystal surface come into contact with polar water molecules. Positively charged $Na^+$ ions are attracted to the negatively polarized oxygen of water, and negatively charged $Cl^-$ ions are attracted to the positively polarized hydrogens. The combined forces of attraction between an ion and several water molecules pull the ion away from the crystal, exposing a fresh surface, until ultimately the crystal dissolves. Once in solution, $Na^+$ and $Cl^-$ ions are completely surrounded by solvent molecules, a phenomenon called **solvation** (or, specifically for water, *hydration*). The water molecules form a loose shell around the ions, stabilizing them by electrical attraction.

**Solvation** The clustering of solvent molecules around a dissolved solute molecule or ion.




▲ **FIGURE 9.2 Dissolution of an NaCl crystal in water.** Polar water molecules surround the individual $Na^+$ and $Cl^-$ ions at an exposed edge or corner, pulling them from the crystal surface into solution and surrounding them. Note how the negatively polarized oxygens of water molecules cluster around $Na^+$ ions and the positively polarized hydrogens cluster around $Cl^-$ ions.


▲ Instant cold packs used to treat muscle strains and sprains often take advantage of the endothermic enthalpy of a solution of salts such as ammonium nitrate.

The dissolution of a solute in a solvent is a physical change since the solution components retain their chemical identities. Like all chemical and physical changes, the dissolution of a substance in a solvent has associated with it a heat change, or *enthalpy* change (Section 7.2). (, p. 184) Some substances dissolve exothermically, releasing heat and warming the resultant solution, whereas other substances dissolve endothermically, absorbing heat and cooling the resultant solution. Calcium chloride, for example, *releases* 19.4 kcal/mol of heat energy when it dissolves in water, but ammonium nitrate ($NH_4NO_3$) *absorbs* 6.1 kcal/mol of heat energy. Athletes and others take advantage of both situations when they use instant hot packs or cold packs to treat injuries. Both hot and cold packs consist of a pouch of water and a dry chemical, such as $CaCl_2$ or $MgSO_4$ for hot packs and $NH_4NO_3$ for cold packs. Squeezing the pack breaks the pouch and the solid dissolves, either raising or lowering the temperature.

**WORKED EXAMPLE 9.1** Formation of Solutions

Which of the following pairs of substances would you expect to form solutions?

**(a)** Carbon tetrachloride ($CCl_4$) and hexane ($C_6H_{14}$).

**(b)** Octane ($C_8H_{18}$) and methyl alcohol ($CH_3OH$).

ANALYSIS Identify the kinds of intermolecular forces in each substance (Section 8.11). Substances with similar intermolecular forces tend to form solutions.

SOLUTION

**(a)** Hexane contains only C—H and C—C bonds, which are nonpolar. Carbon tetrachloride contains polar C—Cl bonds, but they are distributed symmetrically in the tetrahedral molecule so that it too is nonpolar. The major intermolecular force for both compounds is London dispersion forces, so they will form a solution.

**(b)** Octane contains only C—H and C—C bonds and so is nonpolar; the major intermolecular force is dispersion. Methyl alcohol contains polar C—O and O—H bonds; it is polar and forms hydrogen bonds. The intermolecular forces for the two substances are so dissimilar that they do not form a solution.

**PROBLEM 9.2**

Which of the following pairs of substances would you expect to form solutions?

**(a)** $CCl_4$ and water

**(b)** Benzene ($C_6H_6$) and $MgSO_4$

**(c)** Hexane ($C_6H_{14}$) and heptane ($C_7H_{16}$)

**(d)** Ethyl alcohol ($C_2H_5OH$) and heptanol ($C_7H_{15}OH$)

## 9.3 Solid Hydrates

Some ionic compounds attract water strongly enough to hold onto water molecules even when crystalline, forming what are called *solid hydrates*. For example, the plaster of Paris used to make decorative objects and casts for broken limbs is calcium sulfate hemihydrate, $CaSO_4 \cdot \frac{1}{2}H_2O$. The dot between $CaSO_4$ and $\frac{1}{2}H_2O$ in the formula indicates that for every two $CaSO_4$ formula units in the crystal there is also one water molecule present.

$CaSO_4 \cdot \frac{1}{2}H_2O$ A solid hydrate

After being ground up and mixed with water to make plaster, $CaSO_4 \cdot \frac{1}{2}H_2O$ gradually changes into the crystalline dihydrate $CaSO_4 \cdot 2\,H_2O$, known as *gypsum*. During the change, the plaster hardens and expands in volume, causing it to fill a mold or shape itself closely around a broken limb. Table 9.3 lists some other ionic compounds that are handled primarily as hydrates.

Still other ionic compounds attract water so strongly that they pull water vapor from humid air to become hydrated. Compounds that show this behavior, such as calcium chloride ($CaCl_2$), are called **hygroscopic** and are often used as drying agents. You might have noticed a small bag of a hygroscopic compound (probably silica gel, $SiO_2$ ) included in the packing material of a new MP3 player, camera, or other electronic device to keep humidity low during shipping.

**Hygroscopic** Having the ability to pull water molecules from the surrounding atmosphere.

▲ Plaster of Paris ($CaSO_4 \cdot \frac{1}{2}H_2O$) slowly turns into gypsum ($CaSO_4 \cdot 2\,H_2O$) when added to water. In so doing, the plaster hardens and expands, causing it to fill a mold.



TABLE 9.3 Some Common Solid Hydrates

| FORMULA | NAME | USES |
|---|---|---|
| $AlCl_3 \cdot 6\,H_2O$ | Aluminum chloride hexahydrate | Antiperspirant |
| $CaSO_4 \cdot 2\,H_2O$ | Calcium sulfate dihydrate (gypsum) | Cements, wallboard molds |
| $CaSO_4 \cdot \frac{1}{2}H_2O$ | Calcium sulfate hemihydrate (plaster of Paris) | Casts, molds |
| $CuSO_4 \cdot 5\,H_2O$ | Copper(II) sulfate pentahydrate (blue vitriol) | Pesticide, germicide, topical fungicide |
| $MgSO_4 \cdot 7\,H_2O$ | Magnesium sulfate heptahydrate (epsom salts) | Laxative, anticonvulsant |
| $Na_2B_4O_7 \cdot 10\,H_2O$ | Sodium tetraborate decahydrate (borax) | Cleaning compounds, fireproofing agent |
| $Na_2S_2O_3 \cdot 5\,H_2O$ | Sodium thiosulfate pentahydrate (hypo) | Photographic fixer |

**PROBLEM 9.3**

Write the formula of sodium sulfate decahydrate, known as Glauber's salt and used as a laxative.

**PROBLEM 9.4**

What masses of Glauber's salt must be used to provide 1.00 mol of sodium sulfate?

## 9.4 Solubility

**Miscible** Mutually soluble in all proportions.

**Saturated solution** A solution that contains the maximum amount of dissolved solute at equilibrium.

**Solubility** The maximum amount of a substance that will dissolve in a given amount of solvent at a specified temperature.

We saw in Section 9.2 that ethyl alcohol is soluble in water because hydrogen bonding is nearly as strong between water and ethyl alcohol molecules as it is between water molecules alone or ethyl alcohol molecules alone. So similar are the forces in this particular case, in fact, that the two liquids are **miscible**, or mutually soluble in all proportions. Ethyl alcohol will continue to dissolve in water no matter how much is added.

Most substances, however, reach a solubility limit beyond which no more will dissolve in solution. Imagine, for instance that you are asked to prepare a saline solution (aqueous NaCl). You might measure out some water, add solid NaCl, and stir the mixture. Dissolution occurs rapidly at first but then slows down as more and more NaCl is added. Eventually the dissolution stops because an equilibrium is reached when the numbers of $Na^+$ and $Cl^-$ ions leaving a crystal and going into solution are equal to the numbers of ions returning from solution to the crystal. At this point, the solution is said to be **saturated**. A maximum of 35.8 g of NaCl will dissolve in 100 mL of water at 20 °C. Any amount above this limit simply sinks to the bottom of the container and sits there.

The equilibrium reached by a saturated solution is like the equilibrium reached by a reversible reaction (Section 7.7). (, p. 198) Both are dynamic situations in which no *apparent* change occurs because the rates of forward and backward processes are equal. Solute particles leave the solid surface and reenter the solid from solution at the same rate.

$$\text{Solid solute} \underset{\text{Crystallize}}{\overset{\text{Dissolve}}{\rightleftharpoons}} \text{Solution}$$

The maximum amount of a substance that will dissolve in a given amount of a solvent at a given temperature, usually expressed in grams per 100 mL (g/100 mL), is called the substance's **solubility**. Solubility is a characteristic property of a specific

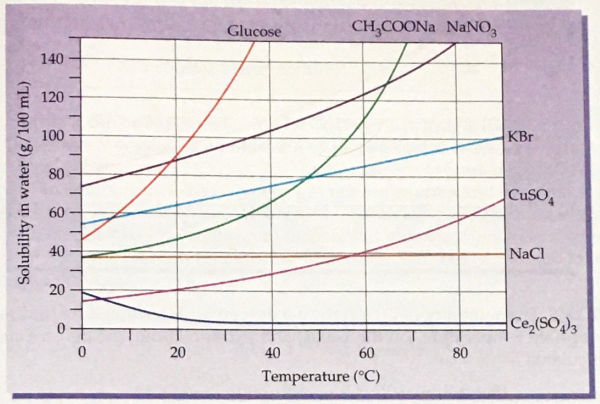
solute–solvent combination, and different substances have greatly differing solubilities. Only 9.6 g of sodium hydrogen carbonate will dissolve in 100 mL of water at 20 °C, for instance, but 204 g of sucrose will dissolve under the same conditions.

## 9.5 The Effect of Temperature on Solubility

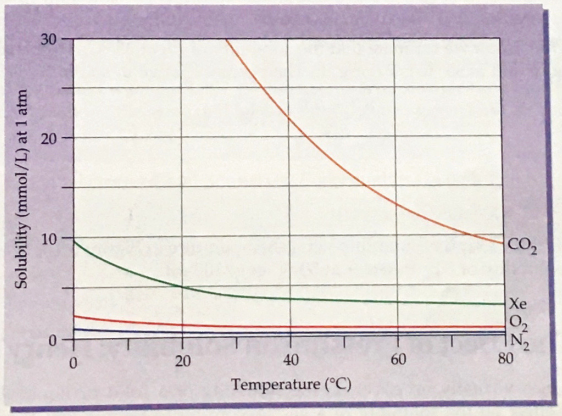
As anyone who has ever made tea or coffee knows, temperature often has a dramatic effect on solubility. The compounds in tea leaves or coffee beans, for instance, dissolve easily in hot water but not in cold water. The effect of temperature is different for every substance, however, and is usually unpredictable. As shown in Figure 9.3(a), the solubilities of most molecular and ionic solids increase with increasing temperature, but the solubilities of others (NaCl) are almost unchanged, and the solubilities of still others [$Ce_2(SO_4)_3$] decrease with increasing temperature.

Solids that are more soluble at high temperature than at low temperature can sometimes form what are called **supersaturated solutions**, which contain even more solute than a saturated solution. Suppose, for instance, that a large amount of a substance is dissolved at a high temperature. As the solution cools, the solubility decreases and the excess solute should precipitate to maintain equilibrium. But if the cooling is done very slowly, and if the container stands quietly, crystallization might not occur immediately and a supersaturated solution might result. Such a solution is unstable, however, and precipitation can occur dramatically when a tiny seed crystal is added to initiate crystallization (Figure 9.4).

**Supersaturated solution** A solution that contains more than the maximum amount of dissolved solute; a nonequilibrium situation.




(a)




(b)

**◀ FIGURE 9.3 Solubilities of some (a) solids and (b) gases, in water as a function of temperature.** Most solid substances become more soluble as temperature rises (although the exact relationship is usually complex), while the solubility of gases decreases.

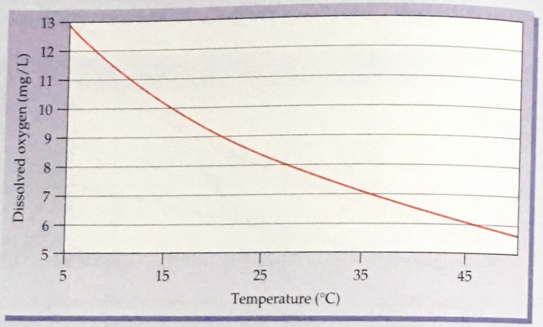



**▲ FIGURE 9.4 A supersaturated solution of sodium acetate in water.** When a tiny seed crystal is added, larger crystals rapidly grow and precipitate from the solution until equilibrium is reached.

Unlike solids, the influence of temperature on the solubility of gases is predictable: Addition of heat decreases the solubility of most gases, as seen in Figure 9.3(b) (helium is the only common exception). One result of this temperature-dependent decrease in gas solubility can sometimes be noted in a stream or lake near the outflow of warm water from an industrial operation. As water temperature increases, the concentration of dissolved oxygen in the water decreases, killing fish that cannot tolerate the lower oxygen levels.

**WORKED EXAMPLE 9.2** Solubility of Gases: Effect of Temperature

From the following graph of solubility versus temperature for $O_2$, estimate the concentration of dissolved oxygen in water at 25 °C and at 35 °C. By what percentage does the concentration of $O_2$ change?




ANALYSIS The solubility of $O_2$ (on the *y*-axis) can be determined by finding the appropriate temperature (on the *x*-axis) and extrapolating. The percent change is calculated as

$$\frac{(\text{Solubility at 25 °C}) - (\text{Solubility at 35 °C})}{(\text{Solubility at 25 °C})} \times 100$$

SOLUTION

From the graph we estimate that the solubility of $O_2$ at 25 °C is approximately 8.3 mg/L and at 35 °C is 7.0 mg/L. The percent change in solubility is

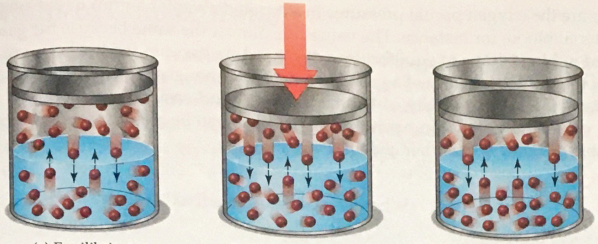
$$\frac{8.3 - 7.0}{8.3} \times 100 = 16\%$$

**PROBLEM 9.5**

Look at the graph of solubility versus temperature in Figure 9.3, and estimate the solubility of KBr in water at 50 °C in g/100 mL.

## 9.6 The Effect of Pressure on Solubility: Henry's Law

Pressure has virtually no effect on the solubility of a solid or liquid, but it has a strong effect on the solubility of a gas. According to **Henry's law**, the solubility (or concentration) of a gas in a liquid is directly proportional to the partial pressure



(a) Equilibrium (b) Pressure increase (c) Equilibrium restored

◀ **FIGURE 9.5 Henry's law.** The solubility of a gas is directly proportional to its partial pressure. An increase in pressure causes more gas molecules to enter solution until equilibrium is restored between the dissolved and undissolved gas.

of the gas over the liquid. (Recall from Section 8.10 that each gas in a mixture exerts a partial pressure independent of other gases present (, p. 233). If the partial pressure of the gas doubles, solubility doubles; if the gas pressure is halved, solubility is halved (Figure 9.5).

**Henry's law** The solubility (or concentration) of a gas is directly proportional to the partial pressure of the gas if the temperature is constant. That is, concentration (C) divided by pressure ($P$) is constant when $T$ is constant,

$$\text{or} \quad \frac{C}{P_{gas}} = k \quad \text{(At a constant temperature)}$$

Henry's law can be explained using Le Châtelier's principle (Section 7.9), which states that when a system at equilibrium is placed under stress, the equilibrium shifts to relieve that stress. (, p. 203) In the case of a saturated solution of a gas in a liquid, an equilibrium exists whereby gas molecules enter and leave the solution at the same rate. When the system is stressed by increasing the pressure of the gas, more gas molecules go into solution to relieve that increase. Conversely, when the pressure of the gas is decreased, more gas molecules come out of solution to relieve the decrease.

$$\text{Gas} + \text{Solvent} \underset{\text{[Pressure} \longrightarrow\text{]}}{\rightleftharpoons} \text{Solution}$$

As an example of Henry's law in action, think about the fizzing that occurs when you open a bottle of soft drink or champagne. The bottle is sealed under greater than 1 atm of $CO_2$ pressure, causing some of the $CO_2$ to dissolve. When the bottle is opened, however, $CO_2$ pressure drops and gas comes fizzing out of solution.

Writing Henry's law in the form $P_{gas} = C/k$ shows that partial pressure can be used to express the concentration of a gas in a solution, a practice especially common in health-related sciences. Table 9.4 gives some typical values and illustrates the convenience of having the same unit for concentration of a gas in both air and blood.

TABLE 9.4 Partial Pressures and Normal Gas Concentrations in Body Fluids

| SAMPLE | PARTIAL PRESSURE (mmHg) | | | |
|---|---|---|---|---|
| | $P_{N_2}$ | $P_{O_2}$ | $P_{CO_2}$ | $P_{H_2O}$ |
| Inspired air (dry) | 597 | 159 | 0.3 | 3.7 |
| Alveolar air (saturated) | 573 | 100 | 40 | 47 |
| Expired air (saturated) | 569 | 116 | 28 | 47 |
| Arterial blood | 573 | 95 | 40 | |
| Venous blood | 573 | 40 | 45 | |
| Peripheral tissues | 573 | 40 | 45 | |

▲ The $CO_2$ gas dissolved under pressure comes out of solution when the bottle is opened and the pressure drops.



Compare the oxygen partial pressures in saturated alveolar air (air in the lungs) and in arterial blood, for instance. The values are almost the same because the gases dissolved in blood come to equilibrium with the same gases in the lungs.

If the partial pressure of a gas over a solution changes while the temperature is constant, the new solubility of the gas can be found easily. Because $C/P$ is a constant value at constant temperature, Henry's law can be restated to show how one variable changes if the other changes:

$$\frac{C_1}{P_1} = \frac{C_2}{P_2} = k \quad \text{(Where } k \text{ is constant at a fixed temperature)}$$

Worked Example 9.3 gives an illustration of how to use this equation.

**WORKED EXAMPLE 9.3** Solubility of Gases: Henry's Law

At a partial pressure of oxygen in the atmosphere of 159 mmHg, the solubility of oxygen in blood is 0.44 g/100 mL. What is the solubility of oxygen in blood at 11,000 ft, where the partial pressure of $O_2$ is 56 mmHg?

**ANALYSIS** According to Henry's law, the solubility of the gas divided by its pressure is constant:

$$\frac{C_1}{P_1} = \frac{C_2}{P_2}$$

Of the four variables in this equation, we know $P_1$, $C_1$, and $P_2$, and we need to find $C_2$.

**BALLPARK ESTIMATE** The pressure drops by a factor of about 3 (from 159 mmHg to 56 mmHg). Since the ratio of solubility to pressure is constant, the solubility must also drop by a factor of 3 (from 0.44 g/100 mL to about 0.15 g/100 mL).

**SOLUTION**

**STEP 1: Identify known information.** We have values for $P_1$, $C_1$, and $P_2$.

$P_1 = 159$ mmHg
$C_1 = 0.44$ g/100 mL
$P_2 = 56$ mmHg

**STEP 2: Identify answer and units.** We are looking for the solubility of $O_2$ ($C_2$) at a partial pressure $P_2$.

Solubility of $O_2$, $C_2$ = ?? g/100 mL

**STEP 3: Identify conversion factors or equations.** In this case, we restate Henry's law to solve for $C_2$.

$$\frac{C_1}{P_1} = \frac{C_2}{P_2} \quad \Rightarrow \quad C_2 = \frac{C_1 P_2}{P_1}$$

**STEP 4: Solve.** Substitute the known values into the equation and calculate $C_2$.

$$C_2 = \frac{C_1 P_2}{P_1} = \frac{(0.44 \text{ g/100 mL})(56 \cancel{\text{mmHg}})}{159 \cancel{\text{mmHg}}} = 0.15 \text{ g/100 mL}$$

**BALLPARK CHECK:** The calculated answer matches our estimate.

**PROBLEM 9.6**

At 20 °C and a partial pressure of 760 mmHg, the solubility of $CO_2$ in water is 0.169 g/100 mL. What is the solubility of $CO_2$ at $2.5 \times 10^4$ mmHg?

**PROBLEM 9.7**

At a total atmospheric pressure of 1.00 atm, the partial pressure of $CO_2$ in air is approximately $4.0 \times 10^{-4}$ atm. Using the data in Problem 9.6, what is the solubility of $CO_2$ in an open bottle of seltzer water at 20 °C?

## 9.7 Units of Concentration

Although we speak casually of a solution of, say, orange juice as either "dilute" or "concentrated," laboratory work usually requires an exact knowledge of a solution's concentration. As indicated in Table 9.5, there are several common methods for expressing concentration. The units differ, but all the methods describe how much solute is present in a given quantity of solution.

TABLE 9.5 Some Units for Expressing Concentration

| CONCENTRATION MEASURE | SOLUTE MEASURE | SOLUTION MEASURE |
|---|---|---|
| Molarity, M | Moles | Volume (L) |
| Weight/volume percent, (w/v)% | Weight (g) | Volume (mL) |
| Volume/volume percent, (v/v)% | Volume* | Volume* |
| Parts per million, ppm | Parts* | $10^6$ parts* |

*Any units can be used as long as they are the same for both solute and solution.

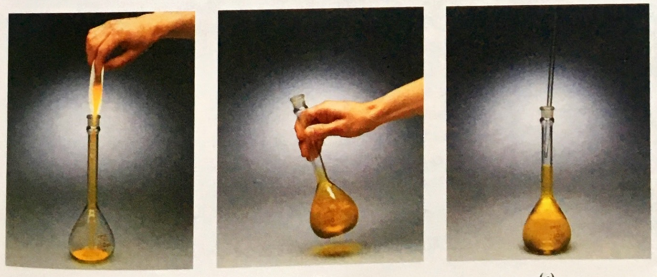
Let us look at each of the four concentration measures listed in Table 9.5 individually, beginning with *molarity*.

### Mole/Volume Concentration: Molarity

We saw in Chapter 6 that the various relationships between amounts of reactants and products in chemical reactions are calculated in *moles* (Sections 6.4–6.6). Thus, the most generally useful means of expressing concentration in the laboratory is **molarity (M)**, the number of moles of solute dissolved per liter of solution. For example, a solution made by dissolving 1.00 mol (58.5 g) of NaCl in enough water to give 1.00 L of solution has a concentration of 1.00 mol/L, or 1.00 M. The molarity of any solution is found by dividing the number of moles of solute by the number of liters of solution (solute + solvent):

$$\text{Molarity (M)} = \frac{\text{Moles of solute}}{\text{Liters of solution}}$$

Note that a solution of a given molarity is prepared by dissolving the solute in enough solvent to give a *final* solution volume of 1.00 L, not by dissolving it in an *initial* volume of 1.00 L. If an initial volume of 1.00 L were used, the final solution volume might be a bit larger than 1.00 L because of the additional volume of the solute. In practice, the appropriate amount of solute is weighed and placed in a *volumetric flask*, as shown in Figure 9.6. Enough solvent is then added to dissolve the solute, and further solvent is added until an accurately calibrated final volume is reached. The solution is then shaken until it is uniformly mixed.



(a) (b) (c)

◀ **FIGURE 9.6 Preparing a solution of known molarity.** (a) A measured number of moles of solute is placed in a volumetric flask. (b) Enough solvent is added to dissolve the solute by swirling. (c) Further solvent is carefully added until the calibration mark on the neck of the flask is reached, and the solution is shaken until uniform.



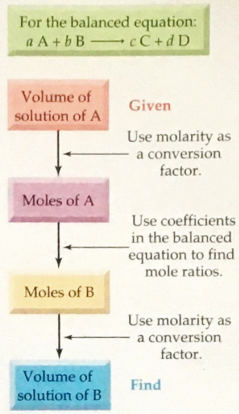
Molarity can be used as a conversion factor to relate the volume of a solution to the number of moles of solute it contains. If we know the molarity and volume of a solution, we can calculate the number of moles of solute. If we know the number of moles of solute and the molarity of the solution, we can find the solution's volume.

$$\text{Molarity} = \frac{\text{Moles of solute}}{\text{Volume of solution (L)}}$$

$$\text{Moles of solute} = \text{Molarity} \times \text{Volume of solution}$$

$$\text{Volume of solution} = \frac{\text{Moles of solute}}{\text{Molarity}}$$

The flow diagram in Figure 9.7 shows how molarity is used in calculating the quantities of reactants or products in a chemical reaction, and Worked Examples 9.5 and 9.6 show how the calculations are done. Note that Problem 9.10 employs *millimolar* (mM) concentrations, which are useful in healthcare fields for expressing low concentrations such as are often found in body fluids (1 mM = 0.001 M).




▶ **FIGURE 9.7 Molarity and conversions.** A flow diagram summarizing the use of molarity for conversions between solution volume and moles to find quantities of reactants and products for chemical reactions in solution.

**WORKED EXAMPLE 9.4** Solution Concentration: Molarity

What is the molarity of a solution made by dissolving 2.355 g of sulfuric acid ($H_2SO_4$) in water and diluting to a final volume of 50.0 mL? The molar mass of $H_2SO_4$ is 98.1 g/mol.

ANALYSIS Molarity is defined as moles of solute per liter of solution: M = mol/L. Thus, we must first find the number of moles of sulfuric acid by doing a mass to mole conversion, and then divide the number of moles by the volume of the solution.

BALLPARK ESTIMATE The molar mass of sulfuric acid is about 100 g/mol, so 2.355 g is roughly 0.025 mol. The volume of the solution is 50.0 mL, or 0.05 L, so we have about 0.025 mol of acid in 0.05 L of solution, which is a concentration of about 0.5 M.

SOLUTION

STEP 1: **Identify known information.** We know the mass of sulfuric acid and the final volume of solution.

Mass of $H_2SO_4$ = 2.355 g

Volume of solution = 50.0 mL

STEP 2: **Identify answer including units.** We need to find the molarity (M) in units of moles per liter.

STEP 3: **Identify conversion factors and equations.** We know both the amount of solute and the volume of solution, but first we must make two conversions: convert mass of $H_2SO_4$ to moles of $H_2SO_4$, using molar mass as a conversion factor, and convert volume from milliliters to liters:

$$\text{Molarity} = \frac{\text{Moles } H_2SO_4}{\text{Liters of solution}}$$

$$(2.355\ \text{g } \cancel{H_2SO_4})\left(\frac{1\ \text{mol } H_2SO_4}{98.1\ \text{g } \cancel{H_2SO_4}}\right) = 0.0240\ \text{mol } H_2SO_4$$

$$(50.0\ \cancel{\text{mL}})\left(\frac{1\ \text{L}}{1000\ \cancel{\text{mL}}}\right) = 0.0500\ \text{L}$$

STEP 4: **Solve.** Substitute the moles of solute and volume of solution into the molarity expression.

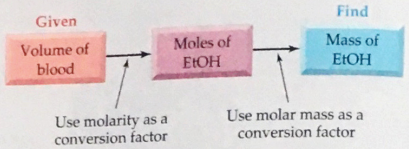
$$\text{Molarity} = \frac{0.0240\ \text{mol } H_2SO_4}{0.0500\ \text{L}} = 0.480\ \text{M}$$

BALLPARK CHECK: The calculated answer is close to our estimate, which was 0.5 M.

**WORKED EXAMPLE 9.5** Molarity as Conversion Factor: Molarity to Mass

A blood concentration of 0.065 M ethyl alcohol (EtOH) is sufficient to induce a coma. At this concentration, what is the total mass of alcohol (in grams) in an adult male whose total blood volume is 5.6 L? The molar mass of ethyl alcohol is 46.0 g/mol. (Refer to the flow diagram in Figure 9.7 to identify which conversions are needed.)

ANALYSIS We are given a molarity (0.065 M) and a volume (5.6 L), which allows us to calculate the number of moles of alcohol in the blood. A mole to mass conversion then gives the mass of alcohol.




SOLUTION

$$(5.6\ \cancel{\text{L blood}})\left(\frac{0.065\ \text{mol EtOH}}{1\ \cancel{\text{L blood}}}\right) = 0.36\ \text{mol EtOH}$$

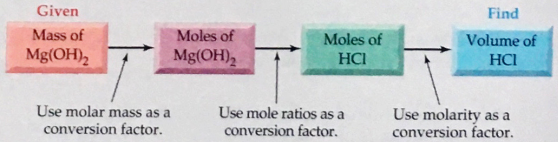
$$(0.36\ \cancel{\text{mol EtOH}})\left(\frac{46.0\ \text{g EtOH}}{1\ \cancel{\text{mol EtOH}}}\right) = 17\ \text{g EtOH}$$

**WORKED EXAMPLE 9.6** Molarity as Conversion Factor: Molarity to Volume

In our stomachs, gastric juice that is about 0.1 M in HCl aids in digestion. How many milliliters of gastric juice will react completely with an antacid tablet that contains 500 mg of magnesium hydroxide? The molar mass of $Mg(OH)_2$ is 58.3 g/mol, and the balanced equation is

$$2\ HCl(aq) + Mg(OH)_2(aq) \longrightarrow MgCl_2(aq) + 2\ H_2O(l)$$

ANALYSIS We are given the molarity of HCl and need to find the volume. We first convert the mass of $Mg(OH)_2$ to moles and then use the coefficients in the balanced equation to find the moles of HCl that will react. Once we have the moles of HCl and the molarity in moles per liter, we can find the volume. These conversions are summarized in the following flow diagram.




SOLUTION

$$[500\ \cancel{\text{mg Mg(OH)}_2}]\left(\frac{1\ \cancel{\text{g}}}{1000\ \cancel{\text{mg}}}\right)\left[\frac{1\ \text{mol Mg(OH)}_2}{58.3\ \cancel{\text{g Mg(OH)}_2}}\right] = 0.008\,58\ \text{mol Mg(OH)}_2$$

$$[0.008\,58\ \cancel{\text{mol Mg(OH)}_2}]\left[\frac{2\ \cancel{\text{mol HCl}}}{1\ \cancel{\text{mol Mg(OH)}_2}}\right]\left(\frac{1\ \text{L HCl}}{0.1\ \cancel{\text{mol HCl}}}\right) = 0.2\ \text{L (200 mL)}$$

**PROBLEM 9.8**

What is the molarity of a solution that contains 50.0 g of vitamin $B_1$ hydrochloride (molar mass = 337 g/mol) in 160 mL of solution?

**PROBLEM 9.9**

How many moles of solute are present in the following solutions?

**(a)** 175 mL of 0.35 M $NaNO_3$ **(b)** 480 mL of 1.4 M $HNO_3$



**PROBLEM 9.10**

The concentration of cholesterol ($C_{27}H_{46}O$) in blood is approximately 5.0 mM. How many grams of cholesterol are in 250 mL of blood?

**PROBLEM 9.11**

What mass (in grams) of calcium carbonate is needed to react completely with 65 mL of 0.12 M HCl according to the following equation?

$$2\ HCl(aq) + CaCO_3(aq) \longrightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

## Weight/Volume Percent Concentration, (w/v)%

One of the most common methods for expressing percent concentration is to give the number of grams (weight) as a percentage of the number of milliliters (volume) of the final solution—called the **weight/volume percent concentration, (w/v)%**. Mathematically, (w/v)% concentration is found by taking the number of grams of solute per milliliter of solution and multiplying by 100%:

$$\text{(w/v)\% concentration} = \frac{\text{Mass of solute (g)}}{\text{Volume of solution (mL)}} \times 100\%$$

For example, if 15 g of glucose is dissolved in enough water to give 100 mL of solution, the glucose concentration is 15 g/100 mL or 15% (w/v):

$$\frac{15\ \text{g glucose}}{100\ \text{mL solution}} \times 100\% = 15\%\ \text{(w/v)}$$

To prepare 100 mL of a specific weight/volume solution, the weighed solute is dissolved in just enough solvent to give a final volume of 100 mL, not in an initial volume of 100 mL solvent. (If the solute is dissolved in 100 mL of *solvent*, the final volume of the *solution* will likely be a bit larger than 100 mL, since the volume of the solute is included.) In practice, solutions are prepared using a volumetric flask, as shown previously in Figure 9.5. Worked Example 9.7 illustrates how weight/volume percent concentration is found from a known mass and volume of solution.

**WORKED EXAMPLE 9.7** Solution Concentration: Weight/Volume Percent

A solution of heparin sodium, an anticoagulant for blood, contains 1.8 g of heparin sodium dissolved to make a final volume of 15 mL of solution. What is the weight/volume percent concentration of this solution?

ANALYSIS Weight/volume percent concentration is defined as the mass of the solute in grams divided by the volume of solution in milliliters and multiplied by 100%.

BALLPARK ESTIMATE The mass of solute (1.8 g) is smaller than the volume of solvent (15 mL) by a little less than a factor of 10. The weight/volume percent should thus be a little greater than 10%.

SOLUTION

$$\text{(w/v)\% concentration} = \frac{1.8\ \text{g heparin sodium}}{15\ \text{mL}} \times 100\% = 12\%\ \text{(w/v)}$$

BALLPARK CHECK: The calculated (w/v)% is reasonably close to our original estimate of 10%.

**WORKED EXAMPLE 9.8** Weight/Volume Percent as Conversion Factor: Volume to Mass

How many grams of NaCl are needed to prepare 250 mL of a 1.5% (w/v) saline solution?

ANALYSIS We are given a concentration and a volume, and we need to find the mass of solute by rearranging the equation for (w/v)% concentration.

BALLPARK ESTIMATE The desired (w/v)% value, 1.5%, is between 1 and 2%. For a volume of 250 mL, we would need 2.5 g of solute for a 1% (w/v) solution and 5.0 g of solute for a 2% solution. Thus, for our 1.5% solution, we need a mass midway between 2.5 and 5.0 g, or about 3.8 g.

SOLUTION

$$\text{Since} \quad (\text{w/v})\% = \frac{\text{Mass of solute in g}}{\text{Volume of solution in mL}} \times 100\%$$

$$\text{then} \quad \text{Mass of solute in g} = \frac{(\text{Volume of solution in mL})[(\text{w/v})]\%}{100\%}$$

$$= \frac{(250)(1.5\%)}{100\%} = 3.75 \text{ g} = 3.8 \text{ g NaCl}$$

(2 significant figures)

BALLPARK CHECK: The calculated answer matches our estimate.

**WORKED EXAMPLE 9.9** Weight/Volume Percent as Conversion Factor: Mass to Volume

How many milliliters of a 0.75% (w/v) solution of the food preservative sodium benzoate are needed to obtain 45 mg?

ANALYSIS We are given a concentration and a mass, and we need to find the volume of solution by rearranging the equation for (w/v)% concentration. Remember that 45 mg = 0.045 g.

BALLPARK ESTIMATE A 0.75% (w/v) solution contains 0.75 g (750 mg) for every 100 mL of solution, so 10 mL contains 75 mg. To obtain 45 mg, we need a little more than half this volume, or a little more than 5 mL.

SOLUTION

$$\text{Since (w/v)}\% = \frac{\text{Mass of solute in g}}{\text{Volume of solution in mL}} \times 100\%$$

$$\text{then} \quad \text{Volume of solution in mL} = \frac{(\text{Mass of solute in g})(100\%)}{(\text{w/v})\%}$$

$$= \frac{(0.045 \text{ g})(100\%)}{0.75\%} = 6.0 \text{ mL}$$

BALLPARK CHECK: The calculated answer is consistent with our estimate of a little more than 5 mL.

**PROBLEM 9.12**

In clinical lab reports, some concentrations are given in mg/dL. Convert a $Ca^{2+}$ concentration of 8.6 mg/dL to weight/volume percent.



**PROBLEM 9.13**

What is the weight/volume percent concentration of a solution that contains 23 g of potassium iodide in 350 mL of aqueous solution?

**PROBLEM 9.14**

How many grams of solute are needed to prepare the following solutions?

**(a)** 125.0 mL of 16% (w/v) glucose ($C_6H_{12}O_6$)
**(b)** 65 mL of 1.8% (w/v) KCl

## Volume/Volume Percent Concentration, (v/v)%

The concentration of a solution made by dissolving one liquid in another is often given by expressing the volume of solute as a percentage of the volume of final solution—the **volume/volume percent concentration, (v/v)%**. Mathematically, the volume of the solute (usually in milliliters) per milliliter of solution is multiplied by 100%:

$$\text{(v/v)\% concentration} = \frac{\text{Volume of solute (mL)}}{\text{Volume of solution (mL)}} \times 100\%$$

For example, if 10.0 mL of ethyl alcohol is dissolved in enough water to give 100.0 mL of solution, the ethyl alcohol concentration is (10.0 mL/100.0 mL) × 100% = 10.0% (v/v).

**WORKED EXAMPLE 9.10** Volume Percent: Volume of Solution to Volume of Solute

How many milliliters of methyl alcohol are needed to prepare 75 mL of a 5.0% (v/v) solution?

ANALYSIS We are given a solution volume (75 mL) and a concentration [5.0% (v/v), meaning 5.0 mL solute/100 mL solution]. The concentration acts as a conversion factor for finding the amount of methyl alcohol needed.

BALLPARK ESTIMATE A 5% (v/v) solution contains 5 mL of solute in 100 mL of solution, so the amount of solute in 75 mL of solution must be about three-fourths of 5 mL, which means between 3 and 4 mL.

SOLUTION

$$(75 \text{ mL solution})\left(\frac{5.0 \text{ mL methyl alcohol}}{100 \text{ mL solution}}\right) = 3.8 \text{ mL methyl alcohol}$$

BALLPARK CHECK: The calculated answer is consistent with our estimate of between 3 and 4 mL.

**PROBLEM 9.15**

How would you use a 500.0 mL volumetric flask to prepare a 7.5% (v/v) solution of acetic acid in water?

**PROBLEM 9.16**

What volume of solute (in milliliters) is needed to prepare the following solutions?

**(a)** 100 mL of 22% (v/v) ethyl alcohol **(b)** 150 mL of 12% (v/v) acetic acid

### Parts per Million (ppm)

The concentration units weight/volume percent, (w/v)%, and volume/volume percent, (v/v)%, can also be defined as *parts per hundred* (pph) since 1% means one item per 100 items. When concentrations are very small, as often occurs in dealing with trace amounts of pollutants or contaminants, it is more convenient to use **parts per million (ppm)** or **parts per billion (ppb)**. The "parts" can be in any unit of either mass or volume as long as the units of both solute and solvent are the same:

$$\text{ppm} = \frac{\text{Mass of solute (g)}}{\text{Mass of solution (g)}} \times 10^6 \quad \text{or} \quad \frac{\text{Volume of solute (mL)}}{\text{Volume of solution (mL)}} \times 10^6$$

$$\text{ppb} = \frac{\text{Mass of solute (g)}}{\text{Mass of solution (g)}} \times 10^9 \quad \text{or} \quad \frac{\text{Volume of solute (mL)}}{\text{Volume of solution (mL)}} \times 10^9$$

To take an example, the maximum allowable concentration in air of the organic solvent benzene ($C_6H_6$) is currently set by government regulation at 1 ppm. A concentration of 1 ppm means that if you take a million "parts" of air in any unit—say, mL—then 1 of those parts is benzene vapor and the other 999,999 parts are other gases:

$$1 \text{ ppm} = \frac{1 \text{ mL}}{1{,}000{,}000 \text{ mL}} \times 10^6$$

Because the density of water is approximately 1.0 g/mL at room temperature, 1.0 L (or 1000 mL) of an aqueous solution weighs 1000 g. Therefore, when dealing with very dilute concentrations of solutes dissolved in water, ppm is equivalent to mg solute/L solution, and ppb is equivalent to $\mu$g solute/L solution. To demonstrate that these units are equivalent, the conversion from ppm to mg/L is as follows:

$$1 \text{ ppm} = \left(\frac{1 \text{ g solute}}{10^6 \text{ g solution}}\right)\left(\frac{1 \text{ mg solute}}{10^{-3} \text{ g solute}}\right)\left(\frac{10^3 \text{ g solution}}{1 \text{ L solution}}\right) = \frac{1 \text{ mg solute}}{1 \text{ L solution}}$$

**WORKED EXAMPLE 9.11** ppm as Conversion Factor: Mass of Solution to Mass of Solute

The maximum allowable concentration of chloroform, $CHCl_3$, in drinking water is 100 ppb. What is the maximum amount (in grams) of chloroform allowed in a glass containing 400 g (400 mL) of water?

**ANALYSIS** We are given a solution amount (400 g) and a concentration (100 ppb). This concentration of 100 ppb means

$$100 \text{ ppb} = \frac{\text{Mass of solute (g)}}{\text{Mass of solution (g)}} \times 10^9$$

This equation can be rearranged to find the mass of solute.

**BALLPARK ESTIMATE** A concentration of 100 ppb means there are $100 \times 10^{-9}$ g ($1 \times 10^{-7}$ g) of solute in 1 g of solution. In 400 g of solution, we should have 400 times this amount, or $400 \times 10^{-7} = 4 \times 10^{-5}$ g.

**SOLUTION**

$$\text{Mass of solute (g)} = \frac{\text{Mass of solution (g)}}{10^9} \times 100 \text{ ppb}$$

$$= \frac{400 \text{ g}}{10^9} \times 100 \text{ ppb} = 4 \times 10^{-5} \text{ g (or 0.04 mg)}$$

**BALLPARK CHECK:** The calculated answer matches our estimate.



**PROBLEM 9.17**

What is the concentration in ppm of sodium fluoride in tap water that has been fluoridated by the addition of 32 mg of NaF for every 20 kg of solution?

**PROBLEM 9.18**

The maximum amounts of lead and copper allowed in drinking water are 0.015 mg/kg for lead and 1.3 mg/kg for copper. Express these values in parts per million, and tell the maximum amount of each (in grams) allowed in 100 g of water.

## 9.8 Dilution

▲ Orange juice concentrate is diluted with water before drinking.

Many solutions, from orange juice to chemical reagents, are stored in high concentrations and then prepared for use by *dilution*—that is, by adding additional solvent to lower the concentration. For example, you might make up 1/2 gal of orange juice by adding water to a canned concentrate. In the same way, you might buy a medicine or chemical reagent in concentrated solution and dilute it before use.

The key fact to remember about dilution is that the amount of *solute* remains constant; only the *volume* is changed by adding more solvent. If, for example, the initial and final concentrations are given in molarity, then we know that the number of moles of solute is the same both before and after dilution, and can be determined by multiplying molarity times volume:

$$\text{Number of moles} = \text{Molarity (mol/L)} \times \text{Volume (L)}$$

Because the number of moles remains constant, we can set up the following equation, where $M_1$ and $V_1$ refer to the solution before dilution, and $M_2$ and $V_2$ refer to the solution after dilution:

$$\text{Moles of solute} = M_1V_1 = M_2V_2$$

This equation can be rewritten to solve for $M_2$, the concentration of the solution after dilution:

$$M_2 = M_1 \times \frac{V_1}{V_2} \quad \text{where} \quad \frac{V_1}{V_2} \quad \text{is a } \textit{dilution factor}$$

The equation shows that the concentration after dilution ($M_2$) can be found by multiplying the initial concentration ($M_1$) by a **dilution factor**, which is simply the ratio of the initial and final solution volumes ($V_1/V_2$). If, for example, the solution volume *increases* by a factor of 5, from 10 mL to 50 mL, then the concentration must *decrease* to 1/5 its initial value because the dilution factor is 10 mL/50 mL, or 1/5. Worked Example 9.12 shows how to use this relationship for calculating dilutions.

**Dilution factor** The ratio of the initial and final solution volumes ($V_1/V_2$).

The relationship between concentration and volume can also be used to find what volume of initial solution to start with to achieve a given dilution:

$$\text{Since} \quad M_1V_1 = M_2V_2$$

$$\text{then} \quad V_1 = V_2 \times \frac{M_2}{M_1}$$

In this case, $V_1$ is the initial volume that must be diluted to prepare a less concentrated solution with volume $V_2$. The initial volume is found by multiplying the final volume ($V_2$) by the ratio of the final and initial concentrations ($M_2/M_1$). For example, to decrease the concentration of a solution to 1/5 its initial value, the initial volume must be 1/5 the desired final volume. Worked Example 9.13 gives a sample calculation.

Although the preceding equations and following examples deal with concentration units of molarity, it is worth noting that the dilution equation can be generalized to the other concentration units presented in this section, or

$$C_1V_1 = C_2V_2$$

**WORKED EXAMPLE 9.12** Dilution of Solutions: Concentration

What is the final concentration if 75 mL of a 3.5 M glucose solution is diluted to a volume of 450 mL?

**ANALYSIS** The number of moles of solute is constant, so

$$M_1V_1 = M_2V_2$$

Of the four variables in this equation, we know the initial concentration $M_1$ (3.5 M), the initial volume $V_1$ (75 mL), and the final volume $V_2$ (450 mL), and we need to find the final concentration $M_2$.

**BALLPARK ESTIMATE** The volume increases by a factor of 6, from 75 mL to 450 mL, so the concentration must decrease by a factor of 6, from 3.5 M to about 0.6 M.

**SOLUTION**

Solving the above equation for $M_2$ and substituting in the known values gives

$$M_2 = \frac{M_1V_1}{V_2} = \frac{(3.5\text{ M glucose})(75\text{ mL})}{450\text{ mL}} = 0.58\text{ M glucose}$$

**BALLPARK CHECK:** The calculated answer is close to our estimate of 0.6 M.

**WORKED EXAMPLE 9.13** Dilution of Solutions: Volume

Aqueous NaOH can be purchased at a concentration of 1.0 M. How would you use this concentrated solution to prepare 750 mL of 0.32 M NaOH?

**ANALYSIS** The number of moles of solute is constant, so

$$M_1V_1 = M_2V_2$$

Of the four variables in this equation, we know the initial concentration $M_1$ (1.0 M), the final volume $V_2$ (750 mL), and the final concentration $M_2$ (0.32 M), and we need to find the initial volume $V_1$.

**BALLPARK ESTIMATE** We want the solution concentration to decrease by a factor of about 3, from 1.0 M to 0.32 M, which means we need to dilute the 1.0 M solution by a factor of 3. This means the final volume must be about 3 times greater than the initial volume. Because our final volume is to be 750 mL, we must start with an initial volume of about 250 mL.

**SOLUTION**

Solving the above equation for $V_1$ and substituting in the known values gives

$$V_1 = \frac{V_2M_2}{M_1} = \frac{(750\text{ mL})(0.32\text{ M})}{1.0\text{ M}} = 240\text{ mL}$$

To prepare the desired solution, dilute 240 mL of 1.0 M NaOH with water to make a final volume of 750 mL.

**BALLPARK CHECK:** The calculated answer (240 mL) is reasonably close to our estimate of 250 mL.



**PROBLEM 9.19**

Hydrochloric acid is normally purchased at a concentration of 12.0 M. What is the final concentration if 100.0 mL of 12.0 M HCl is diluted to 500.0 mL?

**PROBLEM 9.20**

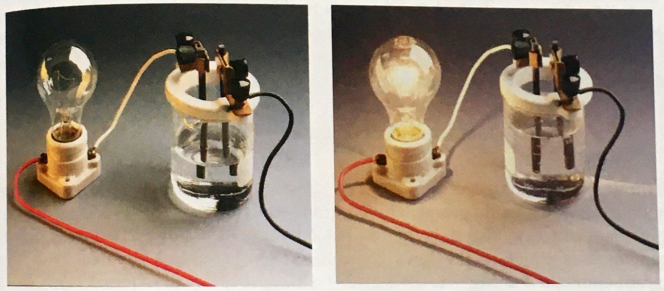
Aqueous ammonia is commercially available at a concentration of 16.0 M. How much of the concentrated solution would you use to prepare 500.0 mL of a 1.25 M solution?

**PROBLEM 9.21**

The Environmental Protection Agency has set the limit for arsenic in drinking water at 0.010 ppm. To what volume would you need to dilute 1.5 L of water containing 5.0 ppm arsenic to reach the acceptable limit?

## 9.9 Ions in Solution: Electrolytes

Look at Figure 9.8, which shows a light bulb connected to a power source through a circuit that is interrupted by two metal strips dipped into a beaker of liquid. When the strips are dipped into pure water, the bulb remains dark, but when they are dipped into an aqueous NaCl solution, the circuit is closed and the bulb lights. As mentioned previously in Section 4.1, this simple demonstration shows that ionic compounds in aqueous solution can conduct electricity. (, p. 79)



(a) (b)

▲ **FIGURE 9.8 A simple demonstration shows that electricity can flow through a solution of ions.** (a) With pure water in the beaker, the circuit is incomplete, no electricity flows, and the bulb does not light. (b) With a concentrated NaCl solution in the beaker, the circuit is complete, electricity flows, and the light bulb glows.

Substances like NaCl that conduct an electric current when dissolved in water are called **electrolytes**. Conduction occurs because negatively charged $Cl^-$ anions migrate through the solution toward the metal strip connected to the positive terminal of the power source, whereas positively charged $Na^+$ cations migrate toward the strip connected to the negative terminal. As you might expect, the ability of a solution to conduct electricity depends on the concentration of ions in solution. Distilled water contains virtually no ions and is nonconducting; ordinary tap water contains low concentrations of dissolved ions (mostly $Na^+$, $K^+$, $Mg^{2+}$, $Ca^{2+}$, and $Cl^-$) and is weakly conducting; and a concentrated solution of NaCl is strongly conducting.

**Electrolyte** A substance that produces ions and therefore conducts electricity when dissolved in water.

Economic and Philosophical Manuscripts of 1844. Karl Marx

# Estranged Labour

||XXII| We have proceeded from the premises of political economy. We have accepted its language and its laws. We presupposed private property, the separation of labor, capital and land, and of wages, profit of capital and rent of land â€“ likewise division of labor, competition, the concept of exchange value, etc. On the basis of political economy itself, in its own words, we have shown that the worker sinks to the level of a commodity and becomes indeed the most wretched of commodities; that the wretchedness of the worker is in inverse proportion to the power and magnitude of his production; that the necessary result of competition is the accumulation of capital in a few hands, and thus the restoration of monopoly in a more terrible form; and that finally the distinction between capitalist and land rentier, like that between the tiller of the soil and the factory worker, disappears and that the whole of society must fall apart into the two classes â€“ property owners and propertyless workers.

Political economy starts with the fact of private property; it does not explain it to us. It expresses in general, abstract formulas the material process through which private property actually passes, and these formulas it then takes for laws. It does not comprehend these laws â€“i.e., it does not demonstrate how they arise from the very nature of private property. Political economy throws no light on the cause of the division between labor and capital, and between capital and land. When, for example, it defines the relationship of wages to profit, it takes the interest of the capitalists to be the ultimate cause, i.e., it takes for granted what it is supposed to explain. Similarly, competition comes in everywhere. It is explained from external circumstances. As to how far these external and apparently accidental circumstances are but the expression of a necessary course of development, political economy teaches us nothing. We have seen how exchange itself appears to it as an accidental fact. The only wheels which political economy sets in motion are greed, and the war amongst the greedy â€“ competition.

Precisely because political economy does not grasp the way the movement is connected, it was possible to oppose, for instance, the doctrine of competition to the doctrine of monopoly, the doctrine of craft freedom to the doctrine of the guild, the doctrine of the division of landed property to the doctrine of the big estate – for competition, freedom of the crafts and the division of landed property were explained and comprehended only as accidental, premeditated and violent consequences of monopoly, of the guild system, and of feudal property, not as their necessary, inevitable and natural consequences.





Now, therefore, we have to grasp the intrinsic connection between private property, greed, the separation of labor, capital and landed property; the connection of exchange and competition, of value and the devaluation of man, of monopoly and competition, etc. – the connection between this whole estrangement and the money system.

Do not let us go back to a fictitious primordial condition as the political economist does, when he tries to explain. Such a primordial condition explains nothing; it merely pushes the question away into a grey nebulous distance. The economist assumes in the form of a fact, of an event, what he is supposed to deduce – namely, the necessary relationship between two things –between, for example, division of labor and exchange. Thus the theologian explains the origin of evil by the fall of Man – that is, he assumes as a fact, in historical form, what has to be explained.

We proceed from an actual economic fact.

The worker becomes all the poorer the more wealth he produces, the more his production increases in power and size. The worker becomes an ever cheaper commodity the more commodities he creates. The devaluation of the world of men is in direct proportion to the increasing value of the world of things. Labor produces not only commodities; it produces itself and the worker as a commodity – and this at the same rate at which it produces commodities in general.

This fact expresses merely that the object which labor produces – labor's product – confronts it as something alien, as a power independent of the producer. The product of labor is labor which has been embodied in an object, which has become material: it is the objectification of labor. Labor's realization is its objectification. Under these economic conditions this realization of labor appears as loss of realization for the workers[18]; objectification as loss of the object and bondage to it; appropriation as estrangement, as alienation.[19]

So much does the labor's realization appear as loss of realization that the worker loses realization to the point of starving to death. So much does objectification appear as loss of the object that the worker is robbed of the objects most necessary not only for his life but for his work. Indeed, labor itself becomes an object which he can obtain only with the greatest effort and with the most irregular interruptions. So much does the appropriation of the object appear as estrangement that the more objects the worker produces the less he can possess and the more he falls under the sway of his product, capital.

All these consequences are implied in the statement that the worker is related to the product of labor as to an alien object. For on this premise it is clear that the more the worker spends himself, the more powerful becomes the alien world of objects which he creates over and against himself, the poorer he himself – his inner world – becomes, the

less belongs to him as his own. It is the same in religion. The more man puts into God, the less he retains in himself. The worker puts his life into the object; but now his life no longer belongs to him but to the object. Hence, the greater this activity, the more the worker lacks objects. Whatever the product of his labor is, he is not. Therefore, the greater this product, the less is he himself. The alienation of the worker in his product means not only that his labor becomes an object, an external existence, but that it exists outside him, independently, as something alien to him, and that it becomes a power on its own confronting him. It means that the life which he has conferred on the object confronts him as something hostile and alien.

||XXIII/ Let us now look more closely at the objectification, at the production of the worker; and in it at the estrangement, the loss of the object, of his product.

The worker can create nothing without nature, without the sensuous external world. It is the material on which his labor is realized, in which it is active, from which, and by means of which it produces.

But just as nature provides labor with [the] means of life in the sense that labor cannot live without objects on which to operate, on the other hand, it also provides the means of life in the more restricted sense, i.e., the means for the physical subsistence of the worker himself.

Thus the more the worker by his labor appropriates the external world, sensuous nature, the more he deprives himself of the means of life in two respects: first, in that the sensuous external world more and more ceases to be an object belonging to his labor – to be his labor's means of life; and, second, in that it more and more ceases to be a means of life in the immediate sense, means for the physical subsistence of the worker.

In both respects, therefore, the worker becomes a servant of his object, first, in that he receives an object of labor, i.e., in that he receives work, and, secondly, in that he receives means of subsistence. This enables him to exist, first as a worker; and second, as a physical subject. The height of this servitude is that it is only as a worker that he can maintain himself as a physical subject and that it is only as a physical subject that he is a worker.

(According to the economic laws the estrangement of the worker in his object is expressed thus: the more the worker produces, the less he has to consume; the more values he creates, the more valueless, the more unworthy he becomes; the better formed his product, the more deformed becomes the worker; the more civilized his object, the more barbarous becomes the worker; the more powerful labor becomes, the more powerless becomes the worker; the more ingenious labor becomes, the less ingenious becomes the worker and the more he becomes nature's slave.)





Political economy conceals the estrangement inherent in the nature of labor by not considering the direct relationship between the worker (labor) and production. It is true that labor produces for the rich wonderful things – but for the worker it produces privation. It produces palaces – but for the worker, hovels. It produces beauty – but for the worker, deformity. It replaces labor by machines, but it throws one section of the workers back into barbarous types of labor and it turns the other section into a machine. It produces intelligence –but for the worker, stupidity, cretinism.

The direct relationship of labor to its products is the relationship of the worker to the objects of his production. The relationship of the man of means to the objects of production and to production itself is only a consequence of this first relationship – and confirms it. We shall consider this other aspect later. When we ask, then, what is the essential relationship of labor we are asking about the relationship of the worker to production.

Till now we have been considering the estrangement, the alienation of the worker only in one of its aspects , i.e., the workerâ€™s relationship to the products of his labor. But the estrangement is manifested not only in the result but in the act of production, within the producing activity, itself. How could the worker come to face the product of his activity as a stranger, were it not that in the very act of production he was estranging himself from himself?The product is after all but the summary of the activity, of production. If then the product of labor is alienation, production itself must be active alienation, the alienation of activity, the activity of alienation. In the estrangement of the object of labor is merely summarized the estrangement, the alienation, in the activity of labor itself.

What, then, constitutes the alienation of labor?

First, the fact that labor is external to the worker, i.e., it does not belong to his intrinsic nature; that in his work, therefore, he does not affirm himself but denies himself, does not feel content but unhappy, does not develop freely his physical and mental energy but mortifies his body and ruins his mind. The worker therefore only feels himself outside his work, and in his work feels outside himself. He feels at home when he is not working, and when he is working he does not feel at home. His labor is therefore not voluntary, but coerced; it is forced labor. It is therefore not the satisfaction of a need; it is merely a means to satisfy needs external to it. Its alien character emerges clearly in the fact that as soon as no physical or other compulsion exists, labor is shunned like the plague. External labor, labor in which man alienates himself, is a labor of self-sacrifice, of mortification. Lastly, the external character of labor for the worker appears in the fact that it is not his own, but someone elseâ€™s, that it does not belong to him, that in it he belongs, not to himself, but to another. Just as in religion the spontaneous activity of the human imagination, of the human brain and the human heart, operates on the individual

independently of him – that is, operates as an alien, divine or diabolical activity – so is the worker's activity not his spontaneous activity. It belongs to another; it is the loss of his self.

As a result, therefore, man (the worker) only feels himself freely active in his animal functions – eating, drinking, procreating, or at most in his dwelling and in dressing-up, etc.; and in his human functions he no longer feels himself to be anything but an animal. What is animal becomes human and what is human becomes animal.

Certainly eating, drinking, procreating, etc., are also genuinely human functions. But taken abstractly, separated from the sphere of all other human activity and turned into sole and ultimate ends, they are animal functions.

We have considered the act of estranging practical human activity, labor, in two of its aspects.(1) The relation of the worker to the product of labor as an alien object exercising power over him. This relation is at the same time the relation to the sensuous external world, to the objects of nature, as an alien world inimically opposed to him. (2) The relation of labor to the act of production within the labor process. This relation is the relation of the worker to his own activity as an alien activity not belonging to him; it is activity as suffering, strength as weakness, begetting as emasculating, the workerâ€™s own physical and mental energy, his personal life â€“ for what is life but activity? as an activity which is turned against him, independent of him and not belonging to him. Here we have self-estrangement, as previously we had the estrangement of the thing.

||XXIV| We have still a third aspect of estranged labor to deduce from the two already considered.

Man is a species-being [~~20~~], not only because in practice and in theory he adopts the species (his own as well as those of other things) as his object, but – and this is only another way of expressing it – also because he treats himself as the actual, living species; because he treats himself as a universal and therefore a free being.

The life of the species, both in man and in animals, consists physically in the fact that man (like the animal) lives on organic nature; and the more universal man (or the animal) is, the more universal is the sphere of inorganic nature on which he lives. Just as plants, animals, stones, air, light, etc., constitute theoretically a part of human consciousness, partly as objects of natural science, partly as objects of art â€“ his spiritual inorganic nature, spiritual nourishment which he must first prepare to make palatable and digestible â€“ so also in the realm of practice they constitute a part of human life and human activity. Physically man lives only on these products of nature, whether they appear in the form of food, heating, clothes, a dwelling, etc. The universality of man appears in practice precisely in the universality which makes all nature his inorganic body both inasmuch





as nature is (1) his direct means of life, and (2) the material, the object, and the instrument of his life activity. Nature is man's inorganic body – nature, that is, insofar as it is not itself human body. Man lives on nature – means that nature is his body, with which he must remain in continuous interchange if he is not to die. That man's physical and spiritual life is linked to nature means simply that nature is linked to itself, for man is a part of nature.

In estranging from man (1) nature, and (2) himself, his own active functions, his life activity, estranged labor estranges the species from man. It changes for him the life of the species into a means of individual life. First it estranges the life of the species and individual life, and secondly it makes individual life in its abstract form the purpose of the life of the species, likewise in its abstract and estranged form.

For labor, life activity, productive life itself, appears to man in the first place merely as a means of satisfying a need – the need to maintain physical existence. Yet the productive life is the life of the species. It is life-engendering life. The whole character of a species, its species-character, is contained in the character of its life activity; and free, conscious activity is man's species-character. Life itself appears only as a means to life.

The animal is immediately one with its life activity. It does not distinguish itself from it. It is its life activity. Man makes his life activity itself the object of his will and of his consciousness. He has conscious life activity. It is not a determination with which he directly merges. Conscious life activity distinguishes man immediately from animal life activity. It is just because of this that he is a species-being. Or it is only because he is a species-being that he is a conscious being, i.e., that his own life is an object for him. Only because of that is his activity free activity. Estranged labor reverses the relationship, so that it is just because man is a conscious being that he makes his life activity, his essential being, a mere means to his existence.

In creating a world of objects by his personal activity, in his work upon inorganic nature, man proves himself a conscious species-being, i.e., as a being that treats the species as his own essential being, or that treats itself as a species-being. Admittedly animals also produce. They build themselves nests, dwellings, like the bees, beavers, ants, etc. But an animal only produces what it immediately needs for itself or its young. It produces one-sidedly, whilst man produces universally. It produces only under the dominion of immediate physical need, whilst man produces even when he is free from physical need and only truly produces in freedom therefrom. An animal produces only itself, whilst man reproduces the whole of nature. An animalâ€™s product belongs immediately to its physical body, whilst man freely confronts his product. An animal forms only in accordance with the standard and the need of the species to which it belongs, whilst man knows how to produce in accordance with the standard of every

species, and knows how to apply everywhere the inherent standard to the object. Man therefore also forms objects in accordance with the laws of beauty.

It is just in his work upon the objective world, therefore, that man really proves himself to be a species-being. This production is his active species-life. Through this production, nature appears as his work and his reality. The object of labor is, therefore, the objectification of man's species-life: for he duplicates himself not only, as in consciousness, intellectually, but also actively, in reality, and therefore he sees himself in a world that he has created. In tearing away from man the object of his production, therefore, estranged labor tears from him his species-life, his real objectivity as a member of the species and transforms his advantage over animals into the disadvantage that his inorganic body, nature, is taken from him.

Similarly, in degrading spontaneous, free activity to a means, estranged labor makes man's species-life a means to his physical existence.

The consciousness which man has of his species is thus transformed by estrangement in such a way that species[-life] becomes for him a means.

Estranged labor turns thus:

(3) Man's species-being, both nature and his spiritual species-property, into a being alien to him, into a means of his individual existence. It estranges from man his own body, as well as external nature and his spiritual aspect, his human aspect.

(4) An immediate consequence of the fact that man is estranged from the product of his labor, from his life activity, from his species-being, is the estrangement of man from man. When man confronts himself, he confronts the other man. What applies to a man's relation to his work, to the product of his labor and to himself, also holds of a man's relation to the other man, and to the other man's labor and object of labor.

In fact, the proposition that man's species-nature is estranged from him means that one man is estranged from the other, as each of them is from man's essential nature.

The estrangement of man, and in fact every relationship in which man [stands] to himself, is realized and expressed only in the relationship in which a man stands to other men.

Hence within the relationship of estranged labor each man views the other in accordance with the standard and the relationship in which he finds himself as a worker.

||XXV| We took our departure from a fact of political economy â€“ the estrangement of the worker and his production. We have formulated this fact in conceptual terms as





estranged, alienated labor. We have analyzed this concept â€“ hence analyzing merely a fact of political economy.

Let us now see, further, how the concept of estranged, alienated labor must express and present itself in real life.

If the product of labor is alien to me, if it confronts me as an alien power, to whom, then, does it belong?

To a being other than myself.

Who is this being?

The gods? To be sure, in the earliest times the principal production (for example, the building of temples, etc., in Egypt, India and Mexico) appears to be in the service of the gods, and the product belongs to the gods. However, the gods on their own were never the lords of labor. No more was nature. And what a contradiction it would be if, the more man subjugated nature by his labor and the more the miracles of the gods were rendered superfluous by the miracles of industry, the more man were to renounce the joy of production and the enjoyment of the product to please these powers.

The alien being, to whom labor and the product of labor belongs, in whose service labor is done and for whose benefit the product of labor is provided, can only be man himself.

If the product of labor does not belong to the worker, if it confronts him as an alien power, then this can only be because it belongs to some other man than the worker. If the worker’s activity is a torment to him, to another it must give satisfaction and pleasure. Not the gods, not nature, but only man himself can be this alien power over man.

We must bear in mind the previous proposition that man’s relation to himself becomes for him objective and actual through his relation to the other man. Thus, if the product of his labor, his labor objectified, is for him an alien, hostile, powerful object independent of him, then his position towards it is such that someone else is master of this object, someone who is alien, hostile, powerful, and independent of him. If he treats his own activity as an unfree activity, then he treats it as an activity performed in the service, under the dominion, the coercion, and the yoke of another man.

Every self-estrangement of man, from himself and from nature, appears in the relation in which he places himself and nature to men other than and differentiated from himself. For this reason religious self-estrangement necessarily appears in the relationship of the layman to the priest, or again to a mediator, etc., since we are here dealing with the intellectual world. In the real practical world self-estrangement can only become manifest

through the real practical relationship to other men. The medium through which estrangement takes place is itself practical. Thus through estranged labor man not only creates his relationship to the object and to the act of production as to powers [in the manuscript Menschen (men) instead of Machte (powers). - Ed.] that are alien and hostile to him; he also creates the relationship in which other men stand to his production and to his product, and the relationship in which he stands to these other men. Just as he creates his own production as the loss of his reality, as his punishment; his own product as a loss, as a product not belonging to him; so he creates the domination of the person who does not produce over production and over the product. Just as he estranges his own activity from himself, so he confers upon the stranger an activity which is not his own.

We have until now considered this relationship only from the standpoint of the worker and later on we shall be considering it also from the standpoint of the non-worker.

Through estranged, alienated labor, then, the worker produces the relationship to this labor of a man alien to labor and standing outside it. The relationship of the worker to labor creates the relation to it of the capitalist (or whatever one chooses to call the master of labor). Private property is thus the product, the result, the necessary consequence, of alienated labor, of the external relation of the worker to nature and to himself.

Private property thus results by analysis from the concept of alienated labor, i.e., of alienated man, of estranged labor, of estranged life, of estranged man.

True, it is as a result of the movement of private property that we have obtained the concept of alienated labor (of alienated life) in political economy. But on analysis of this concept it becomes clear that though private property appears to be the reason, the cause of alienated labor, it is rather its consequence, just as the gods are originally not the cause but the effect of man's intellectual confusion. Later this relationship becomes reciprocal.

Only at the culmination of the development of private property does this, its secret, appear again, namely, that on the one hand it is the product of alienated labor, and that on the other it is the means by which labor alienates itself, the realization of this alienation.

This exposition immediately sheds light on various hitherto unsolved conflicts.

(1) Political economy starts from labor as the real soul of production; yet to labor it gives nothing, and to private property everything. Confronting this contradiction, Proudhon has decided in favor of labor against private property[21]. We understand, however, that this apparent contradiction is the contradiction of estranged labor with itself, and that political economy has merely formulated the laws of estranged labor.

"Just take him, then!" the encouraged tradesman picked up. "Why did he come about *that?* What's on his mind, eh?"

"God knows, maybe he's drunk, maybe he's not," the workman muttered.

"But what do you want?" the caretaker shouted again, beginning to get seriously angry. "Quit pestering us!"

"Scared to go to the police?" Raskolnikov said to him mockingly.

"Why scared? Quit pestering us!"

"Scofflaw!" cried the woman.

"Why go on talking to him?" shouted the other caretaker, a huge man in an unbuttoned coat and with keys on his belt. "Clear out! . . . Yes, he's a scofflaw! . . . Clear out!"

And seizing Raskolnikov by the shoulder, he threw him into the street. Raskolnikov nearly went head over heels, but did not fall. He straightened himself up, looked silently at all the spectators, and walked away.

"A weird man," the workman let fall.

"People turned weird lately," the woman said.

"We still should've taken him to the police," the tradesman added.

"No point getting involved," the big caretaker decided. "He's a scofflaw for sure! You could see he was foisting himself on us, but once you get involved, there's no getting out . . . Don't we know it!"

"Well now, shall I go or not?" thought Raskolnikov, stopping in the middle of the street, at an intersection, and looking around as if he were waiting for the final word from someone. But no reply came from anywhere; everything was blank and dead, like the stones he was walking on, dead for him, for him alone . . . Suddenly, in the distance, about two hundred paces away, at the end of the street, in the thickening darkness, he made out a crowd, voices, shouts . . . In the midst of the crowd stood some carriage . . . A small light started flickering in the middle of the street. "What's going on?" Raskolnikov turned to the right and went towards the crowd. It was as if he were snatching at anything, and he grinned coldly as he thought of it, because he had firmly decided about the police and knew for certain that now it was all going to end.



# VII

In the middle of the street stood a jaunty, high-class carriage, harnessed to a pair of fiery gray horses; there were no passengers, and the coachman, having climbed down from his box, was standing by; the horses were being held by their bridles. A great many people were crowding around, the police in front of them all. One of them was holding a lantern and bending down, directing the light at something on the pavement, just by the wheels. Everyone was talking, shouting, gasping; the coachman looked bewildered and kept repeating every so often:

"What a shame! Lord, what a shame!"

Raskolnikov pushed his way through as well as he could and finally glimpsed the object of all this bustle and curiosity. A man just run over by the horses was lying on the ground, apparently unconscious, very poorly dressed, but in "gentleman's" clothes, and all covered with blood. Blood was flowing from his face, from his head. His face was all battered, scraped, and mangled. One could see that he had been run over in earnest.

"Saints alive!" wailed the coachman, "how could I help it! If I'd been racing, or if I hadn't hollered to him . . . but I was driving at a slow, steady pace. Everybody saw it, as true as I'm standing here. A drunk can't see straight, who doesn't know that! . . . I saw him crossing the street, reeling, nearly falling over—I shouted once, then again, then a third time, and then I reined in the horses; but he fell right under their feet! Maybe on purpose, or else he was really so drunk . . . The horses are young, skittish; they reared up, he gave a shout, they took off again . . . and so we came to grief."

"That's exactly how it was!" some witness responded from the crowd.

"He did shout, it's true, he shouted three times to him," another voice responded.

"Three times exactly, everybody heard it!" cried a third.

The coachman, however, was not very distressed or frightened. One could see that the carriage belonged to a wealthy and important owner, who was awaiting its arrival somewhere; how to see to this last circum-

stance was no small part of the policemen's concern. The trampled man had to be removed to the police station and then to the hospital. No one knew his name.

Meanwhile Raskolnikov pushed ahead and bent down closer. Suddenly the lantern shone brightly on the unfortunate man's face. He recognized him.

"I know him! I know him!" he cried, pushing all the way to the front. "He's an official, a retired official, a titular councillor, Marmeladov! He lives near here, in Kozel's house . . . A doctor, quickly! Here, I'll pay!" He pulled the money from his pocket and showed it to the policeman. He was surprisingly excited.

The police were pleased to have found out who the trampled man was. Raskolnikov gave his own name and address as well, and began doing his utmost to persuade them, as if it were a matter of his own father, to transport the unconscious Marmeladov to his lodgings.

"It's here, three houses away," he urged, "the house belongs to Kozel, a German, a rich man . . . He must have been trying to get home just now, drunk . . . I know him; he's a drunkard . . . He has a family, a wife, children, there's a daughter. It'll take too long to bring him to the hospital, and I'm sure there's a doctor there in the house! I'll pay, I'll pay . . . Anyway they'll take care of him, they'll help him at once, otherwise he'll die before he gets to the hospital . . ."

He even managed to slip them something unobserved; it was, however, a clear and lawful case, and in any event help was closer here. The trampled man was picked up and carried; people lent a hand. Kozel's house was about thirty steps away. Raskolnikov walked behind, carefully supporting the head and showing the way.

"This way, this way! Carry him head first up the stairs; turn him around . . . there! I'll pay, I'll thank you well for it," he muttered.

Katerina Ivanovna, as soon as she had a free moment, would immediately begin pacing her small room, from window to stove and back, her arms crossed tightly on her chest, talking to herself and coughing. Lately she had begun talking more and more often to her older daughter, the ten-year-old Polenka, who, though she understood little as yet, still understood very well that her mother needed her, and therefore always followed her with her big, intelligent eyes, and used all her guile to pretend that she understood everything. This time Polenka



was undressing her little brother, who had not been feeling very well all day, getting him ready for bed. The boy, waiting for her to change his shirt, which was to be washed that same night, was sitting silently on the chair, with a serious mien, straight-backed and motionless, his little legs stretched out in front of him, pressed together, heels to the public and toes apart. He was listening to what his mama was saying to his sister, with pouting lips and wide-open eyes, sitting perfectly still, as all smart little boys ought to do when they are being undressed for bed. The even smaller girl, in complete rags, stood by the screen waiting her turn. The door to the stairs was open, to afford at least some protection from the waves of tobacco smoke that issued from the other rooms and kept sending the poor consumptive woman into long and painful fits of coughing. Katerina Ivanovna seemed to have grown even thinner over the past week, and the flushed spots on her cheeks burned even brighter than before.

"You wouldn't believe, you can't even imagine, Polenka," she was saying, pacing the room, "how great was the gaiety and splendor of our life in papa's house, and how this drunkard has ruined me and will ruin you all! Father had the state rank of colonel[24] and was nearly a governor by then, he only had one more step to go, so that everyone that called on him used to say, 'Even now, Ivan Mikhailovich, we already regard you as our governor!' When I . . . hem! . . . when I . . . hem, hem, hem . . . oh, curse this life!" she exclaimed, coughing up phlegm and clutching her chest. "When I . . . ah, at the marshal's last ball[25] . . . when Princess Bezzemelny saw me—the one who blessed me afterwards when I was marrying your father, Polya—she asked at once: 'Isn't this that nice young lady who danced with a shawl at the graduation?' . . . That rip should be mended; why don't you take the needle and darn it now, the way I taught you, otherwise tomorrow . . . hem, hem, hem! . . . it'll tear wo-o-orse!" she cried, straining herself. "At that same time, a kammerjunker, Prince Shchegolskoy,[26] had just come from Petersburg . . . he danced a mazurka with me, and the very next day wanted to come with a proposal; but I thanked him personally in flattering terms and said that my heart had long belonged to another. That other was your father, Polya; papa was terribly cross with me . . . Is the water ready? Now, give me the shirt; and the stockings? . . . Lida," she turned to the little daughter, "you'll just have to

sleep without your shirt tonight, somehow . . . and lay out your stockings, too . . . so they can be washed together . . . Why doesn't that ragtag come home, the drunkard! He's worn his shirt out like some old dustcloth, it's all torn . . . I could wash it with the rest and not have to suffer two nights in a row! Lord! Hem, hem, hem, hem! Again! What's this?" she cried out, looking at the crowd in the entryway and the people squeezing into her room with some burden. "What's this? What are they carrying? Lord!"

"Is there somewhere to put him?" the policeman asked, looking around, when the bloodstained and unconscious Marmeladov had already been lugged into the room.

"On the sofa! Lay him out on the sofa, head this way," Raskolnikov pointed.

"Run over in the street! Drunk!" someone shouted from the entryway.

Katerina Ivanovna stood all pale, breathing with difficulty. The children were completely frightened. Little Lidochka cried out, rushed to Polenka, threw her arms around her, and began shaking all over.

Having laid Marmeladov down, Raskolnikov rushed to Katerina Ivanovna.

"For God's sake, calm yourself, don't be afraid!" he spoke in a quick patter. "He was crossing the street and was run over by a carriage; don't worry, he'll come round; I told them to bring him here . . . I was here once, you remember . . . He'll come round, I'll pay!"

"He finally got it!" Katerina Ivanovna cried desperately, and rushed to her husband.

Raskolnikov quickly noted that she was not one of those women who immediately fall into a faint. Instantly there was a pillow under the unfortunate man's head, something no one had thought of yet; Katerina Ivanovna began undressing him, examining him, fussing over him, not losing her presence of mind, forgetting herself, biting her trembling lips, and suppressing the cries that were about to burst from her breast.

Raskolnikov meanwhile persuaded someone to run and get a doctor. As it turned out, there was a doctor living two houses away.

"I've sent for a doctor," he kept saying to Katerina Ivanovna, "don't worry, I'll pay. Is there any water? . . . And bring a napkin, a towel,



something, quickly; we don't know yet what his injuries are . . . He's been injured, not killed . . . rest assured . . . The doctor will say!"

Katerina Ivanovna rushed to the window; there, on a broken-seated chair, in the corner, a big clay bowl full of water had been set up, ready for the nighttime washing of her children's and husband's linen. This nighttime washing was done by Katerina Ivanovna herself, with her own hands, at least twice a week and sometimes more often, for it had reached a point where they no longer had any changes of linen, each member of the family had only one, and Katerina Ivanovna, who could not bear uncleanliness, preferred to wear herself out at night and beyond her strength, while everyone was asleep, so that the laundry would have time to dry on the line by morning and she could give them all clean things, rather than to see dirt in the house. She tried to lift the bowl and bring it over, as Raskolnikov had requested, but almost fell with the burden. But he had already managed to find a towel, and he wet it and began washing Marmeladov's bloodstained face. Katerina Ivanovna stood right there, painfully catching her breath and clutching her chest with her hands. She herself was in need of help. Raskolnikov began to realize that he had perhaps not done well in persuading them to bring the trampled man there. The policeman also stood perplexed.

"Polya!" Katerina Ivanovna cried, "run to Sonya, quickly. If you don't find her there, never mind, tell them that her father has been run over by a carriage and that she should come here at once . . . as soon as she gets back. Quickly, Polya! Here, put on a kerchief!"

"Run fas' as you can!" the boy suddenly cried from his chair, and, having said it, relapsed into his former silent, straight-backed sitting, wide-eyed, heels together, toes apart.

Meanwhile the room had become so crowded that there was no space for an apple to fall. The police had left, except for one who stayed for a time and tried to chase the public thronging in from the stairs back out to the stairs again. In their stead, almost all of Mrs. Lippewechsel's tenants came pouring from the inner rooms, crowding in the doorway at first, but then flooding into the room itself. Katerina Ivanovna flew into a rage.

"You might at least let him die in peace!" she shouted at the whole crowd. "A fine show you've found for yourselves! With cigarettes!

Hem, hem, hem! Maybe with your hats on, too! . . . Really, there's one in a hat . . . Out! At least have respect for a dead body!"

Coughing stopped her breath, but the tongue-lashing had its effect. Obviously, Katerina Ivanovna even inspired some fear; the tenants, one by one, squeezed back through the door, with that strange feeling of inner satisfaction which can always be observed, even in those who are near and dear, when a sudden disaster befalls their neighbor, and which is to be found in all men, without exception, however sincere their feelings of sympathy and commiseration.

Outside the door, however, voices were raised about the hospital, and how one ought not to disturb people unnecessarily.

"So one ought not to die!" cried Katerina Ivanovna, and she rushed for the door, to loose a blast of thunder at them, but in the doorway she ran into Mrs. Lippewechsel herself, who had just managed to learn of the accident and came running to re-establish order. She was an extremely cantankerous and disorderly German woman.

"Ach, my God!" she clasped her hands. "Your trunken husband has a horse trampled! To the hospital mit him! I am the landlady!"

"Amalia Ludwigovna! I ask you to consider what you are saying," Katerina Ivanovna began haughtily. (She always spoke in a haughty tone with the landlady, so that she would "remember her place," and even now she could not deny herself the pleasure.) "Amalia Ludwigovna . . ."

"I have told you how-many-times before that you muss never dare say to me Amal Ludwigovna. I am Amal-Ivan!"

"You are not Amal-Ivan, you are Amalia Ludwigovna, and since I am not one of your base flatterers, like Mr. Lebezyatnikov, who is now laughing outside the door" (outside the door there was indeed laughter, and someone cried: "A cat-fight!"), "I shall always address you as Amalia Ludwigovna, though I decidedly fail to understand why you so dislike this appellation. You see for yourself what has happened to Semyon Zakharovich; he is dying. I ask you to close this door at once and not allow anyone in. Let him at least die in peace! Otherwise, I assure you, tomorrow your action will be made known to the governor-general himself. The prince knew me as a young girl, and very well remembers Semyon Zakharovich, to whom he has shown favor many times. Everyone knows that Semyon Zakharovich had many



friends and protectors, whom he himself abandoned out of noble pride, aware of his unfortunate weakness, but now" (she pointed to Raskolnikov) "we are being helped by a magnanimous young man who has means and connections, and whom Semyon Zakharovich knew as a child, and rest assured, Amalia Ludwigovna . . ."

All this was spoken in a rapid patter, faster and faster, but coughing all at once interrupted Katerina Ivanovna's eloquence. At that moment the dying man came to and moaned, and she ran to him. He opened his eyes and, still without recognition or understanding, began peering at Raskolnikov, who was standing over him. He breathed heavily, deeply, rarely; blood oozed from the corners of his mouth; sweat stood out on his forehead. Not recognizing Raskolnikov, he began looking around anxiously. Katerina Ivanovna looked at him sadly but sternly, and tears flowed from her eyes.

"My God! His whole chest is crushed! And the blood, so much blood!" she said in despair. "We must take all his outer clothes off! Turn over a little, Semyon Zakharovich, if you can," she cried to him.

Marmeladov recognized her.

"A priest!" he said in a hoarse voice.

Katerina Ivanovna went over to the window, leaned her forehead against the window frame, and exclaimed in desperation:

"Oh, curse this life!"

"A priest!" the dying man said again, after a moment's silence.

"They've go-o-one!" Katerina Ivanovna cried at him; he obeyed the cry and fell silent. He was seeking for her with timid, anguished eyes; she went back to him and stood by his head. He calmed down somewhat, but not for long. Soon his eyes rested on little Lidochka (his favorite), who was shaking in the corner as if in a fit and stared at him with her astonished, childishly attentive eyes.

"A . . . a . . ." he pointed to her worriedly. He wanted to say something.

"What now?" cried Katerina Ivanovna.

"Barefoot! Barefoot!" he muttered, pointing with crazed eyes at the girl's bare little feet.

"Be quiet!" Katerina Ivanovna cried irritably. "You know very well why she's barefoot!"

"Thank God, the doctor!" Raskolnikov cried joyfully.

The doctor came in, a trim little old man, a German, looking about him with mistrustful eyes; he went over to the sick man, took his pulse, carefully felt his head, and with Katerina Ivanovna's help unbuttoned his shirt, all soaked with blood, and bared the sick man's chest. His whole chest was torn, mangled, mutilated; several ribs on the right side were broken. On the left side, just over the heart, there was a large, ominous yellowish-black spot, the cruel blow of a hoof. The doctor frowned. The policeman told him that the injured man had been caught in a wheel and dragged, turning, about thirty paces along the pavement.

"It's surprising that he recovered consciousness at all," the doctor whispered softly to Raskolnikov.

"What is your opinion?" the latter asked.

"He will die now."

"There's no hope at all?"

"Not the slightest! He is at his last gasp . . . Besides, his head is dangerously injured . . . Hm. I could perhaps let some blood . . . but . . . it would be no use. In five or ten minutes he will certainly die."

"Try letting some blood, then!"

"Perhaps . . . However, I warn you it will be perfectly useless."

At that point more steps were heard, the crowd in the entryway parted, and a priest, a gray-haired old man, appeared on the threshold with the Holy Gifts.[27] A policeman had gone to fetch him while they were still in the street. The doctor immediately gave way to him, and they exchanged meaningful glances. Raskolnikov persuaded the doctor to stay at least for a little while. The doctor shrugged and stayed.

Everyone stepped aside. The confession lasted a very short time. The dying man probably did not understand much of anything; and he could utter only abrupt, inarticulate sounds. Katerina Ivanovna took Lidochka, got the boy down from his chair, went to the corner near the stove, knelt, and made the children kneel in front of her. The little girl went on shaking; but the boy, upright on his bare little knees, raised his hand regularly, making a full sign of the cross, and bowed to the ground, bumping with his forehead, which seemed to give him special pleasure. Katerina Ivanovna was biting her lips and holding back her tears; she, too, was praying, straightening the boy's shirt from time to time, and she managed to throw a kerchief over the girl's bare



shoulders, taking it from the top of the chest of drawers as she prayed and without getting up from her knees. Meanwhile, curious people began opening the door from the inner rooms again. And more and more spectators, tenants from all down the stairs, crowded into the entryway, but without crossing the threshold. The whole scene was lighted by just one candle-end.

At that moment Polenka, who had run to fetch her sister, squeezed quickly through the crowd in the entryway. She came in, almost breathless from running hard, took off her kerchief, sought out her mother with her eyes, went to her, and said: "She's coming! I met her in the street!" Her mother pulled her down and made her kneel beside her. Timidly and inaudibly, a girl came in, squeezing through the crowd, and her sudden appearance was strange in that room, in the midst of poverty, rags, death, and despair. She, too, was in rags, a two-penny costume, but adorned in street fashion, to suit the taste and rules established in that special world, with a clearly and shamefully explicit purpose. Sonya stood in the entryway, just at the threshold but not crossing it, with a lost look, unconscious, as it seemed, of everything, forgetting her gaudy silk dress with its long and absurd train, bought at fourth hand and so unseemly here, and her boundless crinoline that blocked the entire doorway, and her light-colored shoes, and the little parasol, useless at night, which she still carried with her, and her absurd round straw hat with its flame-colored feather. From under this hat, cocked at a boyish angle, peered a thin, pale, and frightened little face, mouth open and eyes fixed in terror. Sonya was of small stature, about eighteen years old, thin but quite pretty, blond, and with remarkable blue eyes. She stared at the bed, at the priest; she, too, was breathless from walking quickly. Finally, certain whispered words from the crowd probably reached her. She looked down, took a step over the threshold, and stood in the room, though still just by the door.

Confession and communion were over. Katerina Ivanovna again went up to her husband's bed. The priest withdrew and, as he was leaving, tried to address a few words of admonition and comfort to Katerina Ivanovna.

"And what am I to do with these?" she interrupted sharply and irritably, pointing to the little ones.

"God is merciful; hope for help from the Almighty," the priest began.

"Ehh! Merciful, but not to us!"

"That is sinful, madam, sinful," the priest observed, shaking his head.

"And is this not sinful?" cried Katerina Ivanovna, pointing to the dying man.

"Perhaps those who were the inadvertent cause will agree to compensate you, at least for the loss of income . . ."

"You don't understand!" Katerina Ivanovna cried irritably, waving her hand. "What is there to compensate? He was drunk; he went and got under the horses himself! And what income? There wasn't any income from him, there was only torment. The drunkard drank up everything. He stole from us, and took it to the pot-house; he wasted their lives and mine in the pot-house! Thank God he's dying! We'll have fewer losses!"

"You would do better to forgive him in the hour of death. Such feelings are a sin, madam, a great sin!"

Katerina Ivanovna was bustling around the sick man, giving him water, wiping the sweat and blood from his head, straightening his pillow, as she talked with the priest, and only turned to him from time to time while doing other things. But now she suddenly fell upon him almost in a frenzy.

"Eh, father! Words, nothing but words! Forgive him! And what if he didn't get run over? He'd come home drunk, wearing his only shirt, all dirty and ragged, and flop down and snore, and I'd be sloshing in the water till dawn, washing his and the children's rags, and then I'd hang them out the window to dry, and as soon as it was dawn, I'd sit down right away to mend them—that's my night! . . . So what's all this talk about forgiveness! As if I hadn't forgiven him!"

Deep, terrible coughing interrupted her words. She spat into her handkerchief and thrust it out for the priest to see, holding her other hand to her chest in pain. The handkerchief was all bloody . . .

The priest hung his head and said nothing.

Marmeladov was in his final agony; he would not take his eyes from the face of Katerina Ivanovna, who again bent over him. He kept wanting to say something to her; he tried to begin, moving his tongue



with effort and uttering unintelligible words, but Katerina Ivanovna, understanding that he wanted to ask her forgiveness, at once shouted at him peremptorily:

"Be quiet! Don't! . . . I know what you want to say! . . ." And the sick man fell silent; but at that same moment his wandering eyes rested on the doorway, and he saw Sonya . . .

He had not noticed her until then: she was standing in the corner, in the shadows.

"Who's there? Who's there?" he said suddenly, in a hoarse, breathless voice, all alarmed, in horror motioning with his eyes towards the doorway where his daughter stood, and making an effort to raise himself.

"Lie down! Lie do-o-own!" cried Katerina Ivanovna.

But with an unnatural effort he managed to prop himself on one arm. He gazed wildly and fixedly at his daughter for some time, as though he did not recognize her. And indeed he had never seen her in such attire. All at once he recognized her—humiliated, crushed, bedizened, and ashamed, humbly waiting her turn to take leave of her dying father. Infinite suffering showed in his face.

"Sonya! Daughter! Forgive me!" he cried, and tried to hold out his hand to her, but without its support he slipped from the sofa and went crashing face down on the floor; they rushed to pick him up, laid him out again, but by then he was almost gone. Sonya cried out weakly, ran and embraced him, and remained so in that embrace. He died in her arms.

"So he got it!" Katerina Ivanovna cried, looking at her husband's corpse. "Well, what now? How am I going to bury him! And how am I going to feed them tomorrow, all of them?"

Raskolnikov went up to Katerina Ivanovna.

"Katerina Ivanovna," he began, "last week your deceased husband told me all about his life and his circumstances . . . You may be sure that he spoke of you with rapturous respect. Since that evening, when I learned how devoted he was to all of you, and how he respected and loved you especially, Katerina Ivanovna, in spite of his unfortunate weakness, since that evening we became friends . . . Permit me now . . . to assist . . . to pay what is due to my deceased friend. Here are . . . twenty roubles, I think—and if this can serve to

help you, then . . . I . . . in short, I'll come again—I'll be sure to come . . . maybe even tomorrow . . . Good-bye!"

And he quickly left the room, hastening to squeeze through the crowd and reach the stairs; but in the crowd he suddenly ran into Nikodim Fomich, who had learned of the accident and wished to take a personal hand in the arrangements. They had not seen each other since that scene in the office, but Nikodim Fomich recognized him instantly.

"Ah, it's you?" he asked.

"He's dead," Raskolnikov answered. "The doctor was here, a priest was here, everything's in order. Don't trouble the poor woman too much, she's consumptive as it is. Cheer her up with something, if you can . . . You're a kind man, I know . . ." he added with a smirk, looking him straight in the eye.

"But, really, you're all soaked with blood," Nikodim Fomich remarked, making out by the light of the lantern several fresh spots of blood on Raskolnikov's waistcoat.

"Soaked, yes . . . I've got blood all over me!" Raskolnikov said, with some peculiar look; then he smiled, nodded his head, and went down the stairs.

He went down slowly, unhurriedly, all in a fever, and filled, though he was not aware of it, with the new, boundless sensation of a sudden influx of full and powerful life. This sensation might be likened to the sensation of a man condemned to death who is suddenly and unexpectedly granted a pardon.[28] Halfway down he was overtaken by the priest on his way home. Raskolnikov silently let him pass, exchanging wordless bows with him. But as he was going down the last few steps, he suddenly heard hurried footsteps behind him. Someone was running after him. It was Polenka; she was running after him and calling: "Listen! Listen!"

He turned to her. She ran down the last flight and stopped very close to him, just one step higher. A dim light came from the courtyard. Raskolnikov made out the girl's thin but dear little face, smiling and looking at him with childish cheerfulness. She had come running with an errand, which apparently pleased her very much.

"Listen, what is your name? . . . and also, where do you live?" she asked hurriedly, in a breathless little voice.

He put his two hands on her shoulders and looked at her with



something like happiness. It gave him such pleasure to look at her—he did not know why himself.

"Who sent you?"

"My sister Sonya sent me," the girl replied, smiling even more cheerfully.

"I just knew it was your sister Sonya."

"Mama sent me, too. When my sister Sonya was sending me, mama also came over and said: 'Run quickly, Polenka!' "

"Do you love your sister Sonya?"

"I love her most of all!" Polenka said with some special firmness, and her smile suddenly became more serious.

"And will you love me?"

Instead of an answer, he saw the girl's little face coming towards him, her full little lips naively puckered to kiss him. Suddenly her arms, thin as matchsticks, held him hard, her head bent to his shoulder, and the girl began crying softly, pressing her face harder and harder against him.

"I'm sorry for papa!" she said after a minute, raising her tear-stained face and wiping away the tears with her hands. "We've had so many misfortunes lately," she added unexpectedly, with that especially solemn look children try so hard to assume when they suddenly want to talk like "big people."

"And did papa love you?"

"He loved Lidochka most of all," she went on, very seriously and no longer smiling, just the way big people speak, "he loved her because she's little, and because she's sick, and he always brought her treats, and us he taught to read, and me he taught grammar and catechism," she added with dignity, "and mama didn't say anything, but we still knew she liked that, and papa knew it, and mama wants to teach me French, because it's time I got my education."

"And do you know how to pray?"

"Oh, of course we do, since long ago! I pray to myself, because I'm big now, and Kolya and Lidochka pray out loud with mother; first they recite the 'Hail, Mary' and then another prayer: 'God forgive and bless our sister Sonya,' and then 'God forgive and bless our other papa,' because our old papa died already and this one is the other one, but we pray for that one, too."

"Polechka, my name is Rodion; pray for me, too, sometimes: 'and for the servant of God, Rodion'—that's all."

"I'll pray for you all the rest of my life," the girl said ardently, and suddenly laughed again, rushed to him, and again held him hard.

Raskolnikov told her his name, gave her the address, and promised to come the next day without fail. The girl went away completely delighted with him. It was past ten when he walked out to the street. Five minutes later he was standing on the bridge, in exactly the same spot from which the woman had thrown herself not long before.

"Enough!" he said resolutely and solemnly. "Away with mirages, away with false fears, away with spectres! . . . There is life! Was I not alive just now? My life hasn't died with the old crone! May the Lord remember her in His kingdom, and—enough, my dear, it's time to go! Now is the kingdom of reason and light and . . . and will and strength . . . and now we shall see! Now we shall cross swords!" he added presumptuously, as if addressing some dark force and challenging it. "And I had already consented to live on a square foot of space!

" . . . I'm very weak at the moment, but . . . all my illness seems to have gone. And I knew it would when I went out today. By the way, Pochinkov's house is just two steps away. To Razumikhin's now, certainly, even if it weren't two steps away . . . let him win the bet! . . . Let him have his laugh—it's nothing, let him! . . . Strength, what's needed is strength; without strength you get nowhere; and strength is acquired by strength—that's something they don't know," he added proudly and self-confidently, and he left the bridge barely able to move his legs. Pride and self-confidence were growing in him every moment; with each succeeding moment he was no longer the man he had been the moment before. What special thing was it, however, that had so turned him around? He himself did not know; like a man clutching at a straw, he suddenly fancied that he, too, "could live, that there still was life, that his life had not died with the old crone." It was perhaps a rather hasty conclusion, but he was not thinking of that.

"I did ask her to remember the servant of God, Rodion, however," suddenly flashed in his head. "Well, but that was . . . just in case!" he added, and laughed at once at his own schoolboy joke. He was in excellent spirits.

He had no trouble finding Razumikhin; the new tenant of Pochinkov's house was already known, and the caretaker immediately showed him the way. From halfway up the stairs one could already hear the noise and animated conversation of a large gathering. The door to the stairs was wide open; shouts and arguing could be heard. Razumikhin's room was quite big, and about fifteen people were gathered in it. Raskolnikov stopped in the anteroom. There, behind a partition, two of the landlady's serving-girls busied themselves with two big samovars, bottles, plates and platters with pies and hors d'oeuvres brought from the landlady's kitchen. Raskolnikov asked for Razumikhin. He came running out, delighted. One could tell at a glance that he had drunk an unusual amount, and though Razumikhin was almost incapable of getting really drunk, this time the effect was somewhat noticeable.



"Listen," Raskolnikov hurried, "I only came to tell you that you've won the bet, and that indeed nobody knows what may happen to him. But I can't come in; I'm so weak I'm about to fall over. So, hello and good-bye! Come and see me tomorrow . . ."

"You know what, I'm going to take you home! If you yourself say you're so weak, then . . ."

"What about your guests? Who's that curly one who just peeked out here?"

"Him? Devil knows! Must be some acquaintance of my uncle's, or maybe he came on his own . . . I'll leave my uncle with them, a most invaluable man, too bad you can't meet him right now. But devil take them all anyway! They've forgotten about me now, and besides, I need some cooling off, because you came just in time, brother: another two minutes and I'd have started a fight in there, by God! They pour out such drivel . . . You can't imagine to what extent a man can finally get himself wrapped up in lies! But why can't you imagine it? Don't we lie ourselves? Let them lie, then; and afterwards they won't lie . . . Sit down for a minute, I'll get Zossimov."

Zossimov fell upon Raskolnikov even with a sort of greediness; some special curiosity could be seen in him; soon his face brightened.

"To bed without delay," he decided, having examined the patient as well as he could, "and take a bit of something for the night. Will you? I've already prepared it . . . a little powder."

"Or two, even," Raskolnikov replied.

The powder was taken at once.

"It will be very good if you go with him," Zossimov remarked to Razumikhin. "We'll see what may happen tomorrow, but today it's not bad at all: quite a change from this morning. Live and learn . . ."

"You know what Zossimov whispered to me just now, as we were leaving?" Razumikhin blurted out as soon as they stepped into the street. "I'll tell you everything straight out, brother, because they're fools. Zossimov told me to chat you up on the way and get you to chat back, and then tell him, because he's got this idea . . . that you're . . . mad, or close to it. Imagine that! First, you're three times smarter than he is; second, if you're not crazy, you'll spit on him having such drivel in his head; and third, this hunk of meat—a surgeon by profession—has now gone crazy over mental illnesses, and what finally turned him around about you was your conversation today with Zamyotov."

"Zamyotov told you everything?"

"Everything, and it's an excellent thing he did. I now understand it all inside and out; Zamyotov understands it, too . . . Well, in short, Rodya . . . the point is . . . I'm a bit drunk now . . . but that doesn't matter . . . the point is that this notion . . . you understand? . . . was really hatching in them . . . you understand? That is, none of them dared to say it aloud, because it's the most absurd drivel, and especially once they'd picked up that house-painter, it all popped and went out forever. But how can they be such fools? I gave Zamyotov a bit of a beating then—that's between us, brother, don't let out even a hint that you know; I've noticed he's touchy; it was at Laviza's—but today, today it all became clear. This Ilya Petrovich, mainly! He took advantage of your fainting in the office that time, but afterwards he felt ashamed himself, that I know . . ."

Raskolnikov listened greedily. Razumikhin was drunk and telling all.

"I fainted that time because it was stuffy and smelled of oil paint," Raskolnikov said.

"He keeps explaining! And it wasn't only the paint: that inflammation had been coming on for a whole month; Zossimov is here to testify! But how mortified the boy is now, you can't even imagine! 'I'm not worth his little finger!' he says—meaning yours. He occasionally



has decent feelings, brother. But the lesson, the lesson today in the 'Crystal Palace,' that tops them all! You really scared him at first, nearly drove him to convulsions! You really almost convinced him again about all that hideous nonsense, and then suddenly—stuck your tongue out at him: 'Take that!' Perfect! Now he's crushed, destroyed! By God, you're an expert; it serves them right! Too bad I wasn't there! He's been waiting terribly for you now. Porfiry also wants to make your acquaintance . . ."

"Ah . . . him, too . . . And why have I been put down as mad?"

"Well, not mad, exactly. It seems I've been spouting off too much, brother . . . You see, it struck him today that you were interested only in just that one point; now it's clear why you were interested; knowing all the circumstances . . . and how it irritated you then, and got tangled up with your illness . . . I'm a little drunk, brother, only devil knows about him, he's got some idea in his head . . . I tell you, he's gone crazy over mental illnesses. But you can spit . . ."

They were silent for half a minute or so.

"Listen, Razumikhin," Raskolnikov started to say, "I want to tell you straight out: I'm just coming from a dead man's house, some official who died . . . I gave them all my money . . . and besides, I was just kissed by a being who, even if I had killed someone, would still . . . in short, I saw another being there, too . . . with a flame-colored feather . . . but I'm getting confused; I'm very weak, hold me up . . . here's the stairs . . ."

"What is it? What is it?" asked the alarmed Razumikhin.

"I'm a little dizzy, only that's not the point, but I feel so sad, so sad!—like a woman . . . really! Look, what's that? Look! Look!"

"What?"

"Don't you see? A light in my room, see? Through the crack . . ."

They were standing before the last flight, next to the landlady's door, and looking up one could indeed see that there was a light in Raskolnikov's closet.

"Strange! Nastasya, maybe," observed Razumikhin.

"She never comes to my room at this hour; besides, she's long been asleep, but . . . I don't care! Farewell!"

"But what is it? I'll take you up, we'll go in together!"

"I know we'll go in together, but I want to shake your hand here

and say farewell to you here. So, give me your hand, and farewell!"

"What's got into you, Rodya?"

"Nothing; let's go; you'll be a witness . . ."

They began climbing the stairs, and the thought flashed through Razumikhin's mind that Zossimov might be right after all. "Eh, I upset him with all my babbling!" he muttered to himself. Suddenly, coming up to the door, they heard voices in the room.

"What's going on here?" Razumikhin cried out.

Raskolnikov took the door first and flung it wide open, flung it open and stood rooted to the threshold.

His mother and sister were sitting on the sofa, and had already been waiting there for an hour and a half. Why was it that he had expected them least of all, and had thought of them least of all, even in spite of the earlier repeated news that they had left, were on their way, would arrive any moment? For the entire hour and a half they had been vying with each other in questioning Nastasya, who was standing before them even now and had managed to tell them the whole story backwards and forwards. They were beside themselves with fear when they heard that "he ran away today," sick, and, as appeared from the story, certainly delirious. "God, what's become of him!" They both wept, they both endured the agony of the cross during that hour and a half of waiting.

A cry of rapturous joy greeted Raskolnikov's appearance. Both women rushed to him. But he stood like a dead man; a sudden, unbearable awareness struck him like a thunderbolt. And his arms would not rise to embrace them; they could not. His mother and sister hugged him tightly, kissed him, laughed, wept . . . He took a step, swayed, and collapsed on the floor in a faint.

Alarm, cries of terror, moans . . . Razumikhin, who was standing on the threshold, flew into the room, took the sick man up in his powerful arms, and in an instant had him lying on the sofa.

"It's nothing, nothing!" he cried to the mother and sister, "he's just fainted, it's all rubbish! The doctor just said he was much better, completely well! Water! See, he's already recovering; see, he's come to! . . ."

And grabbing Dunechka's arm so hard that he almost twisted it, he bent her down to see how "he's already come to." The mother and



sister both looked upon Razumikhin with tenderness and gratitude, as on Providence itself; they had already heard from Nastasya what he had been for their Rodya throughout his illness—this "efficient young man," as he was referred to that same evening, in an intimate conversation with Dunya, by Pulcheria Alexandrovna Raskolnikov herself.

# *Part Three*

# I

RASKOLNIKOV raised himself and sat up on the sofa.

He waved weakly at Razumikhin to stop the whole stream of incoherent and ardent consolations he was addressing to his mother and sister, took both of them by the hand, and for about two minutes peered silently now at the one, now at the other. His mother was frightened by his look. A strong feeling, to the point of suffering, shone in his eyes, but at the same time there was in them something fixed, even as if mad. Pulcheria Alexandrovna began to cry.

Avdotya Romanovna was pale; her hand trembled in her brother's hand.

"Go home . . . with him," he said in a broken voice, pointing at Razumikhin, "till tomorrow; tomorrow everything . . . Did you arrive long ago?"

"In the evening, Rodya," Pulcheria Alexandrovna answered. "The train was terribly late. But, Rodya, I won't leave you now for anything! I'll spend the night here, beside . . ."

"Don't torment me!" he said, waving his hand irritably.

"I'll stay with him!" cried Razumikhin. "I won't leave him for a moment; devil take all the people at my place, let them climb the walls! They've got my uncle for a president."

"How can I ever thank you!" Pulcheria Alexandrovna tried to begin, again pressing Razumikhin's hands, but Raskolnikov interrupted her once more.

"I can't, I can't," he kept repeating irritably, "don't torment me! Enough, go away . . . I can't! . . ."

"Come, mama, let's at least leave the room for a moment," Dunya whispered, frightened. "You can see we're distressing him."

"But can I really not even look at him after three years!" Pulcheria Alexandrovna began to cry.

"Wait!" he stopped them again. "You keep interrupting me, and my thoughts get confused . . . Have you seen Luzhin?"

"No, Rodya, but he already knows of our arrival. We have heard, Rodya, that Pyotr Petrovich was so good as to visit you today," Pulcheria Alexandrovna added, somewhat timidly.

"Yes . . . was so good . . . Dunya, I told Luzhin I'd kick him down the stairs today, and threw him the hell out of here . . ."

"Rodya, what are you saying! Surely you . . . you don't mean . . ." Pulcheria Alexandrovna began fearfully, but stopped, looking at Dunya.

Avdotya Romanovna peered intently at her brother and waited to hear more. They had both been forewarned of the quarrel by Nastasya, as far as she had been able to understand and convey it, and had suffered in perplexity and anticipation.

"Dunya," Raskolnikov continued with effort, "I do not want this marriage, and therefore you must refuse him tomorrow, first thing, so that he won't drag his face here again."

"My God!" cried Pulcheria Alexandrovna.

"Brother, think what you are saying!" Avdotya Romanovna began hot-temperedly, but at once restrained herself. "Perhaps you're in no condition now, you're tired," she said meekly.

"Raving? No . . . You're marrying Luzhin for my sake. And I do not accept the sacrifice. And therefore, by tomorrow, write a letter . . . of refusal . . . Give it to me to read in the morning, and there's an end to it!"

"I cannot do that!" the offended girl cried out. "What right have you . . ."

"Dunechka, you're too hot-tempered yourself; stop now; tomorrow . . . Don't you see . . ." the frightened mother rushed to Dunya. "Ah, we'd better go!"

"He's raving!" the drunk Razumikhin shouted. "Otherwise how would he dare! Tomorrow all this foolishness will leave him . . . But he really did throw him out today. Just like he said. Well, and the other one got angry . . . He was playing the orator here, showing off his knowledge, and then he left with his tail between his legs . . ."

"So it's true?" Pulcheria Alexandrovna cried out.

"Until tomorrow, brother," Dunya said with compassion. "Come, mama . . . Good-bye, Rodya!"

"Listen, sister," he repeated to her back, summoning a last effort,



"I'm not raving; this marriage is a vile thing. Maybe I'm vile myself, but you mustn't . . . one is enough . . . and though I may be vile, I will not regard such a sister as a sister. It's either me or Luzhin! Go, both of you . . ."

"You're out of your mind! Despot!" Razumikhin roared, but Raskolnikov no longer answered, and was perhaps unable to answer. He lay back on the sofa and turned to the wall, completely exhausted. Avdotya Romanovna gave Razumikhin a curious look; her dark eyes flashed; Razumikhin even jumped under her glance. Pulcheria Alexandrovna stood as if stunned.

"I cannot possibly leave!" she whispered to Razumikhin, almost in despair. "I'll stay here, somewhere . . . Take Dunya home."

"You'll spoil the whole thing!" Razumikhin also whispered, losing his temper. "Let's at least go out to the stairs. Nastasya, a light! I swear to you," he continued in a half whisper, once they were on the stairs, "he almost gave us a beating earlier, the doctor and me! Do you understand? The doctor himself! And he gave in and left so as not to irritate him, and I stayed to keep watch downstairs, but he got dressed and slipped out. And he'll slip out now if you irritate him, in the dark, and do something to himself . . ."

"Ah, what are you saying!"

"Besides, it's impossible for Avdotya Romanovna to be in that place without you! Just think where you're staying! As if that scoundrel Pyotr Petrovich couldn't have found you better . . . You know, I'm a bit drunk, though; that's why I'm . . . calling names; don't pay any . . ."

"But I shall go to the landlady here," Pulcheria Alexandrovna insisted. "I shall plead with her to give me and Dunya a corner for tonight. I cannot leave him like this, I cannot!"

They were standing on the stairway as they spoke, on the landing just outside the landlady's door. Nastasya held the light for them from the bottom step. Razumikhin was extremely agitated. Half an hour earlier, as he was taking Raskolnikov home, though he had been unnecessarily talkative and he knew it, he had felt completely alert and almost fresh, despite the terrible quantity of wine he had drunk that evening. But now his condition even bordered on a sort of ecstasy, and at the same time it was as if all the wine he had drunk came rushing

to his head again, all at once, and with twice the force. He stood with the two ladies, grasping them both by the hand, persuading them and presenting his arguments with amazing frankness, and at almost every word, probably for added conviction, he painfully squeezed their hands, very tightly, as in a vise, and he seemed to devour Avdotya Romanovna with his eyes, without being the least embarrassed by it. Once or twice the pain made them try to free their hands from his huge and bony grip, but he not only did not notice the reason for it, but drew them to him even more tightly. If at that moment they had ordered him to throw himself headlong down the stairs, as a service to them, he would have carried out the order at once, without argument or hesitation. Pulcheria Alexandrovna, alarmed as she was by the thought of her Rodya, though she felt that the young man was being much too eccentric and was pressing her hand too painfully, at the same time, since he was like her Providence, did not wish to notice all these eccentric details. But Avdotya Romanovna, who shared her alarm, though far from fearful by nature, was amazed and almost frightened to meet the eyes of her brother's friend, flashing with wild fire, and only the boundless trust inspired by Nastasya's stories about this strange man held her back from the temptation of running away from him and dragging her mother with her. She also understood that now, perhaps, they even could not run away from him. However, after about ten minutes she felt considerably reassured: Razumikhin had the property of speaking the whole of himself out at once, whatever mood he was in, so that everyone soon knew with whom they were dealing.

"It's impossible to go to the landlady, and it's terrible nonsense!" he cried out, reasoning with Pulcheria Alexandrovna. "You may be his mother, but if you stay, you'll drive him into a fury, and then devil knows what will happen! Listen, here's what I'll do: Nastasya will sit with him now, and I'll take you both to your place, because you can't go through the streets by yourselves; our Petersburg, in that respect . . . Well, spit on it! . . . Then I'll run back here at once, and in a quarter of an hour, on my greatest word of honor, I'll bring you a report: how he is, whether he's sleeping, and all the rest of it. Then—listen!—then from you I'll go straight to my place—I have guests there, all drunk—I'll pick up Zossimov—that's the doctor who's treating him, he's at my place now, not drunk; no, he's not drunk, he never gets drunk! I'll drag



him to Rodka, and then straight to you, so within an hour you'll get two reports on him—one from the doctor, you understand, from the doctor himself; that's a whole lot better than from me! If he's bad, I swear I'll bring you here myself; if he's well, you can go to sleep. And I'll spend the whole night here, in the entryway, he won't hear me, and I'll tell Zossimov to sleep at the landlady's, so as to be on hand. So, what's better for him now, you or the doctor? The doctor is much more useful, much more. So go home, then! And staying with the landlady's impossible; possible for me, but impossible for you—she won't let you, because . . . because she's a fool. She'll get jealous of Avdotya Romanovna on account of me, if you want to know, and of you as well . . . And of Avdotya Romanovna certainly. She's a totally, totally unexpected character! However, I'm a fool myself . . . Spit on it! Let's go! Do you believe me? Well, do you believe me or not?"

"Come, mama," said Avdotya Romanovna, "he will surely do as he's promised. He already resurrected my brother, and if it's true that the doctor is willing to spend the night here, what could be better?"

"So you . . . you . . . you understand me, because you're an angel!" Razumikhin cried out rapturously. "Let's go! Nastasya! Upstairs this minute, and sit there by him, with a light; I'll be back in a quarter of an hour . . ."

Pulcheria Alexandrovna, though not fully convinced, no longer resisted. Razumikhin took both women by the arm and dragged them down the stairs. Nevertheless, she worried about him: "He may be efficient and kind, but is he capable of carrying out his promise? He's in such a state! . . ."

"Ah, I see you're thinking what a state I'm in!" Razumikhin interrupted her thoughts, having guessed them, and went striding along the sidewalk with his enormously long steps, so that the two ladies could barely keep up with him—which fact, however, he did not notice. "Nonsense! That is . . . I'm drunk as a dolt, but that's not the point; I'm drunk, but not with wine. The moment I saw you, it went to my head . . . But spit on me! Don't pay any attention: I'm talking nonsense; I'm unworthy of you . . . I'm unworthy of you in the highest degree! . . . But as soon as I've taken you home, I'll come straight here to the canal, and pour two tubs of water over my head, and be ready to go . . . If only you knew how I love you both! . . . Don't laugh, and

don't be angry! . . . Be angry with everyone else, but don't be angry with me! I'm his friend, so I'm your friend, too. I want it that way . . . I had a presentiment . . . last year, there was a certain moment . . . Not a presentiment at all, however, because it's as if you fell from the sky. And maybe I won't even sleep all night . . . This Zossimov was afraid today that he might lose his mind . . . That's why he shouldn't be irritated."

"What are you saying!" the mother cried out.

"Did the doctor really say so himself?" Avdotya Romanovna asked, frightened.

"He did, but it's not that, not that at all. And he gave him some sort of medication, a powder, I saw it, and then you arrived . . . Eh! . . . If only you could have come a day later! It's a good thing we left. And in an hour Zossimov himself will give you a full report. He's certainly not drunk! And I won't be drunk either . . . Why did I get so cockeyed? Because they dragged me into an argument, curse them! I swore I wouldn't argue! . . . They pour out such hogwash! I almost got into a fight! I left my uncle there as chairman . . . Well, so they insist on total impersonality, can you believe it? And that's just where they find the most relish! Not to be oneself, to be least of all like oneself! And that they consider the highest progress. If only they had their own way of lying, but no, they . . ."

"Listen," Pulcheria Alexandrovna interrupted timidly, but she only added fuel to the fire.

"What do you think?" Razumikhin shouted, raising his voice even more. "You think it's because they're lying? Nonsense! I like it when people lie! Lying is man's only privilege over all other organisms. If you lie—you get to the truth! Lying is what makes me a man. Not one truth has ever been reached without first lying fourteen times or so, maybe a hundred and fourteen, and that's honorable in its way; well, but we can't even lie with our own minds! Lie to me, but in your own way, and I'll kiss you for it. Lying in one's own way is almost better than telling the truth in someone else's way; in the first case you're a man, and in the second—no better than a bird! The truth won't go away, but life can be nailed shut; there are examples. Well, so where are we all now? With regard to science, development, thought, invention, ideals, aspirations, liberalism, reason, experience, and everything,



everything, everything, we're all, without exception, still sitting in the first grade! We like getting by on other people's reason—we've acquired a taste for it! Right? Am I right?" Razumikhin shouted, shaking and squeezing both ladies' hands. "Am I right?"

"Oh, my God, I don't know," said poor Pulcheria Alexandrovna.

"Yes, you're right . . . though I don't agree with you in everything," Avdotya Romanovna added seriously, and immediately cried out, so painfully did he squeeze her hand this time.

"Right? You say I'm right? Well, then you . . . you . . ." he cried rapturously, "you are a wellspring of kindness, purity, reason, and . . . perfection! Give me your hand, give it to me . . . you give me yours, too; I want to kiss your hands, here and now, on my knees!"

And he knelt in the middle of the sidewalk, which at that hour was fortunately deserted.

"Stop, I beg you! What are you doing?" Pulcheria Alexandrovna cried out, extremely alarmed.

"Get up, get up!" Dunya was alarmed, too, but laughing.

"Never! Not until you give me your hands! There, and enough now! I get up, and we go! I'm a miserable dolt, I'm unworthy of you, and drunk, and ashamed . . . I'm not worthy to love you, but to worship you is every man's duty, unless he's a perfect brute! So, I have worshipped . . . Here's your rooming house—and for this alone Rodion was right to throw your Pyotr Petrovich out today! How dared he place you in such rooms? It's a scandal! Do you know who they let in here? And you're his fiancée! You are his fiancée, aren't you? Well, let me tell you in that case that your fiancé is a scoundrel!"

"Listen, Mr. Razumikhin, you are forgetting yourself . . ." Pulcheria Alexandrovna tried to begin.

"Yes, yes, you're right, I'm forgetting myself, shame on me!" Razumikhin suddenly checked himself. "But . . . but . . . you cannot be angry with me for speaking this way! For I'm speaking sincerely, and not because . . . hm! that would be base; in short, not because I'm . . . hm . . . with you . . . well, never mind, let's drop it, I won't tell you why, I don't dare! . . . And we all realized as soon as he came in today that he was not a man of our kind. Not because he came with his hair curled by a hairdresser, not because he was in a hurry to show off his intelligence, but because he's a stool pigeon and a speculator; because he's

a Jew and a mountebank, and it shows. You think he's intelligent? No, he's a fool, a fool! So, is he a match for you? Oh, my God! You see, ladies," he suddenly stopped, already on the way up to their rooms, "they may all be drunk at my place, but they're all honest, and though we do lie—because I lie, too—in the end we'll lie our way to the truth, because we're on a noble path, while Pyotr Petrovich . . . is not on a noble path. And though I just roundly denounced them, I do respect them all—even Zamyotov; maybe I don't respect him, but I still love him, because he's a puppy! Even that brute Zossimov, because he's honest and knows his business . . . but enough, all's said and forgiven. Forgiven? Is it? So, let's go. I know this corridor, I was here once; here, in number three, there was a scandal . . . Well, which is yours? What number? Eight? So, lock your door for the night and don't let anyone in. I'll be back in a quarter of an hour with news, and in another half an hour with Zossimov—you'll see! Good-bye, I'm running!"

"My God, Dunechka, what will come of this?" said Pulcheria Alexandrovna, turning anxiously and fearfully to her daughter.

"Calm yourself, mama," Dunya answered, taking off her hat and cape, "God Himself has sent us this gentleman, though he may have come straight from some binge. We can rely on him, I assure you. And with all he's already done for my brother . . ."

"Ah, Dunechka, God knows if he'll come back! How could I bring myself to leave Rodya! And this is not at all, not at all how I imagined finding him! He was so stern, as if he weren't glad to see us . . ."

Tears came to her eyes.

"No, mama, it's not so. You didn't look closely, you kept crying. He's very upset from this great illness—that's the reason for it all."

"Ah, this illness! What will come of it, what will come of it! And how he spoke with you, Dunya!" her mother said, peeking timidly into her daughter's eyes in order to read the whole of her thought, and already half comforted by the fact that Dunya herself was defending Rodya and had therefore forgiven him. "I'm sure he'll think better of it tomorrow," she added, trying to worm it all out of her.

"And I am sure he'll say the same thing tomorrow . . . about that," Avdotya Romanovna cut her off, and here, of course, was the snag, because this was the point which Pulcheria Alexandrovna was simply too afraid to bring up now. Dunya went over and kissed her mother.



Her mother hugged her tightly and said nothing. Then she sat down, anxiously awaiting Razumikhin's return, and began timidly to watch her daughter who, also in expectation, crossed her arms and began to pace the room back and forth, thinking to herself. Such thoughtful pacing from corner to corner was a usual habit with Avdotya Romanovna, and her mother was somehow always afraid to interrupt her thinking at such times.

Razumikhin was of course ridiculous, with the sudden, drunken flaring up of his passion for Avdotya Romanovna; but one look at Avdotya Romanovna, especially now, as she paced the room with her arms crossed, sad and thoughtful, and many would perhaps have excused him, quite apart from his eccentric state. Avdotya Romanovna was remarkably good-looking—tall, wonderfully trim, strong, self-confident, as showed in her every gesture, but without in the least detracting from the softness and grace of her movements. She resembled her brother in looks, and could even be called a beauty. Her hair was dark blond, a little lighter than her brother's; her eyes were almost black, flashing, proud, and at the same time, occasionally, for moments, remarkably kind. She was pale, but not sickly pale; her face shone with freshness and health. Her mouth was somewhat small, and her lower lip, fresh and red, protruded slightly, as did her chin—the only irregularity in this beautiful face, but which lent it a specially characteristic quality and, incidentally, a trace of arrogance. The expression of her face was always serious and thoughtful rather than gay; but how becoming was her smile, how becoming her laughter—gay, young, wholehearted! It was understandable that Razumikhin, ardent, sincere, simple, honest, strong as a folk hero, and drunk, who had never seen anything like that, lost his head at first sight. Moreover, as if by design, chance showed him Dunya for the first time in a beautiful moment of love and joy at seeing her brother. Then he noticed how her lower lip trembled indignantly in response to her brother's impertinent and ungratefully cruel orders—and lost all resistance.

He was telling the truth, however, when he let out that drunken nonsense earlier, on the stairs, about Raskolnikov's eccentric landlady, Praskovya Pavlovna, becoming jealous on his account not only of Avdotya Romanovna, but perhaps of Pulcheria Alexandrovna as well. Although Pulcheria Alexandrovna was already forty-three years old,

her face still kept the remnants of its former beauty, and besides, she looked much younger than her age, as almost always happens with women who keep their clarity of spirit, the freshness of their impressions, and the honest, pure ardor of their hearts into old age. Let us say parenthetically that keeping all this is the only means of preserving one's beauty even in old age. Her hair was already thinning and starting to turn gray, little radiating wrinkles had long since appeared around her eyes, her cheeks were sunken and dry from worry and grief, and still her face was beautiful. It was a portrait of Dunechka's face, only twenty years later, and lacking the expression of the protruding lower lip. Pulcheria Alexandrovna was sentimental, though not to the point of being saccharine; she was timid and yielding, but only up to a limit: she would yield much, would agree to much, even to something that went against her convictions, but there was always a limit of honesty, principle, and ultimate conviction beyond which no circumstances could make her step.

Exactly twenty minutes after Razumikhin left, there came two soft but hurried knocks on the door; he was back.

"No time to come in!" he began hastily, when they opened the door. "He's snoring away excellently, peacefully, and God grant he sleeps for ten hours. Nastasya's with him; I told her not to leave before I get back. Now I'll go and drag Zossimov there, he'll give you a report, and then you, too, should turn in; I see you're impossibly worn out."

And he set off again down the corridor.

"What an efficient and . . . devoted young man!" Pulcheria Alexandrovna exclaimed, exceedingly glad.

"He seems to be a nice person!" Avdotya Romanovna answered with some warmth, again beginning to pace the room back and forth.

Almost an hour later steps were heard in the corridor and there was another knock at the door. Both women were waiting, this time, with complete faith in Razumikhin's promise; and indeed he had managed to drag Zossimov along. Zossimov had agreed at once to leave the feast and go to have a look at Raskolnikov, but he came to the ladies reluctantly and with great mistrust, not trusting the drunken Razumikhin. Yet his vanity was immediately set at ease, and even flattered: he realized that he was indeed being awaited like an oracle. He stayed for exactly ten minutes and managed to convince Pulcheria Alexandrovna



and set her at ease completely. He spoke with extraordinary sympathy, but with restraint and with a somehow eager seriousness, precisely like a twenty-seven-year-old doctor in an important consultation, not deviating from the subject by a single word or revealing the least desire to enter into more private and personal relations with the two ladies. Having noted upon entering how dazzlingly beautiful Avdotya Romanovna was, he immediately tried not to pay her any notice during the whole time of his visit, and addressed himself to Pulcheria Alexandrovna alone. All this gave him great inner satisfaction. About the patient himself he was able to say that at the present moment he found his condition quite satisfactory. Also, from his observations, the patient's illness had, apart from the poor material circumstances of the recent months of his life, some moral causes as well, "being, so to speak, a product of many complex moral and material influences, anxieties, apprehensions, worries, certain ideas . . . and other things." Having noted in passing that Avdotya Romanovna had begun to listen with special attentiveness, Zossimov expanded somewhat further on this subject. To Pulcheria Alexandrovna's anxious and timid question concerning "some supposed suspicions of madness," he replied, with a calm and frank smile, that his words had been overly exaggerated; that, of course, some fixed idea could be observed in the patient, something suggesting monomania—since he, Zossimov, was now especially following this extremely interesting branch of medicine—but it was also to be remembered that the patient had been delirious almost up to that day, and . . . and, of course, the arrival of his family would strengthen, divert, and have a salutary effect upon him, "if only it is possible to avoid any special new shocks," he added significantly. Then he got up, bowed his way out sedately and cordially, to the accompaniment of blessings, warm gratitude, entreaties, and even, without his having sought it, the offer of Avdotya Romanovna's little hand to shake, and left extremely pleased with his visit and still more with himself.

"And we'll talk tomorrow; go to bed, right now, you must!" Razumikhin clinched, following Zossimov out. "Tomorrow, as early as possible, I'll come with a report."

"But what a ravishing girl that Avdotya Romanovna is!" Zossimov observed, all but licking his chops, as they came out to the street.

"Ravishing? Did you say ravishing!" Razumikhin bellowed, and he

suddenly flew at Zossimov and seized him by the throat. "If you ever dare . . . Understand? Understand?" he shouted, shaking him by the collar and pushing him against the wall. "Do you hear?"

"Let go, you drunken devil!" Zossimov fought him off and, when Razumikhin finally let go, looked at him closely and suddenly burst out laughing. Razumikhin stood before him, his arms hanging down, in dark and serious thought.

"I'm an ass, of course," he said, dark as a storm cloud, "but then . . . so are you."

"No, brother, not me. I don't have such foolish dreams."

They walked on silently, and only as they were nearing Raskolnikov's house did Razumikhin, who was greatly preoccupied, break the silence.

"Listen," he said to Zossimov, "you're a nice fellow, but, on top of all your other bad qualities, you're also a philanderer, I know that, and a dirty one. You're a piece of nervous, weak-willed trash, you're whimsical, you've grown fat and can't deny yourself anything—and I call that dirty, because it leads straight to dirt. You've pampered yourself so much that, I confess, the thing I'm least able to understand is how with all that you can still be a good and even selfless physician. You sleep on a feather bed (you, a doctor!), yet you get up in the night for a sick man! In three years or so you won't be getting up for any sick man . . . But, the devil, that's not the point; the point is that you'll be spending the night in the landlady's apartment (it took a lot to convince her!), and I in the kitchen—so here's a chance for you to get more closely acquainted! It's not what you're thinking! Not a shadow of it, brother . . ."

"But I'm not thinking anything."

"What you have here, brother, is modesty, reticence, shyness, fierce chastity, and for all that—a few sighs and she melts like wax, just melts away! Deliver me from her, in the name of all the devils in the world! She's such a winsome little thing! . . . I'll earn it, I'll earn it with my head!"

Zossimov guffawed more than ever.

"Well, you've really got it bad! But what do I need her for?"

"I guarantee it won't be much trouble; just talk whatever slop you like, just sit next to her and talk. Besides, you're a doctor, you can start



treating her for something. I swear you won't regret it. She has a piano there; I can strum a little, you know; there's one song I sing, a Russian song, a real one: 'I'll bathe myself in bitter tears . . .' She likes the real ones—well, so it started with a little song; but you are a piano virtuoso, a maestro, a Rubinstein[1] . . . I guarantee you won't regret it."

"Why, did you give her some sort of promise? A formal receipt or something? Maybe you promised to marry . . ."

"Nothing, nothing, absolutely nothing of the sort! And she's not like that at all; Chebarov tried to . . ."

"Just drop her, then!"

"But I can't just drop her like that!"

"But why can't you?"

"Well, somehow I can't, that's all! There's a sucking-in principle here, brother."

"Then why have you been leading her on?"

"But I haven't been leading her on at all; maybe I got led on myself, in my stupidity; and for her it makes absolutely no difference whether it's you or me, as long as somebody sits next to her and sighs. Look, brother . . . I don't know how to phrase it for you, but look—you know a lot about mathematics, for instance, and you're still studying it, I know . . . so, start teaching her integral calculus—by God, I'm not joking, I'm serious, it'll be decidedly all the same to her; she'll look at you and sigh, and so on for a whole year. I, incidentally, spent a very long time, two days in a row, telling her about the Prussian House of Lords[2] (because otherwise what can you talk to her about?)—and she just sighed and stewed! Only don't start talking about love—she's shy to the point of convulsions—but still make it look as if you can't leave her side—and that's enough. It's terribly comfortable, just like home—read, sit, lie down, write . . . You can even kiss her, if you do it carefully . . ."

"But what do I need her for?"

"Eh, really, I can't seem to explain it to you! You see, the two of you suit each other perfectly! I even thought about you before . . . You'll end up with it anyway! Do you care whether it's sooner or later? Here, brother, there's this feather-bed principle—eh, and not only a feather-bed principle! It sucks you in, it's the end of the world, an anchor, a quiet haven, the navel of the earth, the three-fish foundation

of the world, the essence of pancakes, rich meat pies, evening samovars, soft sighs and warm vests, heated beds on the stove—well, just as if you died and were alive at the same time, both benefits at once! Well, the devil, brother, I've talked enough rot, it's time for bed! Listen, I sometimes wake up at night, so I'll go and look in on him. Only it's nothing, nonsense, everything's fine. You needn't worry especially, but if you want, you can look in once. But if you notice anything, delirium, for instance, or a fever, or whatever, wake me up immediately. It's not possible, though . . ."

## II

Preoccupied and serious, Razumikhin woke up the next day between seven and eight. In the morning he suddenly turned out to have many new and unforeseen perplexities. He had never before imagined that he would wake up like that one day. He recalled every last detail of the previous day, realizing that something uncommon had befallen him, and that he had received into himself a certain impression heretofore unknown to him and unlike any other. At the same time he clearly understood that the dream that had begun burning in his head was in the highest degree unrealizable—so unrealizable that he was even ashamed of it, and he hurried on to other, more urgent cares and perplexities bequeathed him by that "thrice-cursed yesterday."

His most terrible recollection was of how "base and vile" he had turned out to be, not only because he was drunk, but because, taking advantage of the girl's situation, he had abused her fiancé before her, out of stupidly hasty jealousy, not only knowing nothing of their mutual relations and commitments but not even knowing the man himself properly. And what right did he have to judge him so hastily and rashly? And who had invited him to be a judge! Was such a being as Avdotya Romanovna indeed capable of giving herself to an unworthy man for money? So there must be some worth in him. The rooms? But how, in fact, could he have known they were that sort of rooms? He was having an apartment made ready, after all . . . pah, how base it all was! He was drunk, but what sort of justification was that? A silly excuse, which humiliated him even more! The truth is in wine, and so this whole truth told itself—"that is, all the filth of his envious,



boorish heart!" And was such a dream in any degree permissible for him, Razumikhin? Who was he compared with such a girl—he, a drunken brawler and yesterday's braggart? "Is such a cynical and ridiculous juxtaposition possible?" Razumikhin blushed desperately at the thought of it, and suddenly, as if by design, at the same moment he clearly recalled standing on the stairs yesterday, telling them that the landlady would be jealous of Avdotya Romanovna on account of him . . . that was really unbearable. He swung with all his might and hit the kitchen stove with his fist, hurting his hand and knocking out a brick.

"Of course," he muttered to himself after a moment, with some feeling of self-abasement, "of course, now I can never paint or smooth over all those nasty things . . . so there's no point in thinking about it, I must simply go silently and . . . do my duty . . . also silently . . . and not apologize or say anything, and . . . and, of course, all is lost now!"

Nevertheless, as he was getting dressed, he looked over his outfit more carefully than usual. He had no other clothes, and even if he had, he would perhaps not have put them on—"just so, I wouldn't, on purpose." But all the same he could not go on being a cynic and a dirty sloven: he had no right to offend other people's feelings, all the more so in that those others needed him and were calling him to them. He gave his clothes a careful brushing. And the linen he wore was always passable; in that sense he was particularly clean.

He washed zealously that morning—Nastasya found him some soap—washed his hair, his neck, and especially his hands. But when it came to the question of whether or not to shave his stubble (Praskovya Pavlovna had excellent razors, still preserved from the late Mr. Zarnitsyn), the question was resolved, even with a vengeance, in the negative: "Let it stay as it is! What if they should think I shaved in order to . . . and that's certainly what they would think! No, not for anything in the world!"

And . . . and, above all, he was so coarse, so dirty, with his tavern manners; and . . . and suppose he knew that he was still, let us say, a decent man at least . . . well, what was there to be proud of in being a decent man? Everyone ought to be a decent man, and even better than that, and . . . and still (now he remembered) there were some little

BY THE LATE 1790s, the French people, especially property owners, who now included the peasants, longed for stability. The Directory was not providing it. Only the army was able to take charge of the nation as a symbol of both order and the popular values of the revolution. The most politically astute general was Napoleon Bonaparte, who had been a radical during the early revolution, a victorious commander in Italy, and a supporter of the repression of revolutionary disturbances after Thermidor.

Once in power, Napoleon consolidated many of the achievements of the revolution. He also repudiated much of it by establishing an empire. Thereafter, his ambitions drew France into wars of conquest and liberation across the Continent. For over a decade, Europe was at war, with only brief periods of armed truce. Through his conquests Napoleon spread many of the ideas and institutions of the revolution and overturned much of the old political and social order. He also provoked popular nationalism outside of France in opposition to French domination. This new force and the great alliances that opposed France eventually defeated Napoleon.

Throughout these Napoleonic years, new ideas and sensibilities, known by the term *Romanticism*, grew across Europe. Many of the ideas had originated in the eighteenth century, but they flourished in the turmoil of the French Revolution and the Napoleonic Wars. The revolution spurred the imagination of poets, painters, and philosophers. Some Romantic ideas, such as nationalism, supported the revolution; others, such as the emphasis on history and religion, opposed its values.

## ▼ The Rise of Napoleon Bonaparte

The chief threat to the Directory came from royalists, who hoped to restore the Bourbon monarchy by legal means. Many of the *émigrés* had returned to France. Their plans for a restoration drew support from devout Catholics and from those citizens horrified by the excesses of the revolution. Monarchy, they thought, promised a return to stability. The spring elections of 1797 replaced most incumbents with constitutional monarchists and their sympathizers, who now commanded a majority in the national legislature.

**Read** the **Document** "Madame de Remusat on the Rise of Napoleon" on **MyHistoryLab.com**

To preserve the republic and prevent a peaceful restoration of the Bourbons, the antimonarchist Directory staged a *coup d'état* on 18 Fructidor (September 4, 1797). They put their own supporters into the legislative seats their opponents had won. They then imposed censorship and exiled some of their enemies. At the request of the Directors, Napoleon Bonaparte, the general in charge of the French invasion of Italy, had sent a subordinate to Paris to guarantee the success of the coup. In 1797, as in 1795, the army and Bonaparte had saved the day for the government installed in the wake of the Thermidorian Reaction.

Napoleon Bonaparte was born in 1769 to a poor family of lesser nobles at Ajaccio, on the Mediterranean island of Corsica. Because France had annexed Corsica in 1768, he went to French schools and, in 1785, obtained a commission as a French artillery officer. He favored the revolution and was a fiery Jacobin. In 1793, he played a leading role in recovering the port of Toulon from the British. As a reward for his service, he was appointed a brigadier general. During the Thermidorian Reaction, his defense of the new regime on 13 Vendémiaire won him a command in Italy.

### Early Military Victories

By 1795, French arms and diplomacy had shattered the enemy coalition, but France's annexation of Belgium guaranteed continued fighting with Britain and Austria. The invasion of the Italian peninsula aimed to deprive Austria of its rich northern Italian province of Lombardy. In a series of lightning victories, Bonaparte crushed the Austrian and Sardinian armies. On his own initiative, and against the wishes of the government in Paris, he concluded the Treaty of Campo Formio in October 1797. The treaty took Austria out of the war and crowned Napoleon's campaign with success. Before long, France dominated all of the Italian peninsula and Switzerland.

In November 1797, the triumphant Bonaparte returned to Paris as a hero and to confront France's only remaining enemy, Britain. He judged it impossible to cross the Channel and invade England at that time. Instead, he chose to attack British interests through the eastern Mediterranean by capturing Egypt from the Ottoman Empire. By this strategy, he hoped to drive the British fleet from the Mediterranean, cut off British communications with India, damage British trade, and threaten the British Empire.

Napoleon easily overran Egypt, but the invasion was a failure. Admiral Horatio Nelson (1758–1805) destroyed the French fleet at Abukir on August 1, 1798. The French army was cut off from France. To make matters worse, the situation in Europe was deteriorating. The invasion of Egypt had alarmed Russia, which had its own ambitions in the Near East. Russia, Austria, and the Ottomans joined Britain to form the Second Coalition against France. In 1799, the Russian and Austrian armies defeated the French in Italy and Switzerland and threatened to invade France.

Napoleon's venture into Egypt in 1798 and 1799 marked the first major Western European assault on the Ottoman Empire. It occurred less than a quarter century after Russia, under Catherine the Great, had taken control of the Crimea in the Treaty of Kuchuk-Kainardji. (See Chapter 17.) Significantly, British, not

Ottoman forces, drove the French out of Egypt. As shall be seen in Chapter 22, after Napoleon's invasion, the Ottoman Empire realized that it had to reform itself if it was to resist other European encroachments.

**Read** the **Document** "Louis Antoine Fauvelet de Bourrienne, *Memoirs of Napoleon Bonaparte*" on **MyHistoryLab.com**

## The Constitution of the Year VIII

Economic troubles and the dangerous international situation eroded the Directory's fragile support. One of the Directors, the Abbé Siéyès (1748–1836), proposed a new constitution. The author of the pamphlet *What Is the Third Estate?* (1789) now wanted an executive body independent of the whims of electoral politics, a government based on the principle of "confidence from below, power from above." The change would require another *coup d'état* with military support. News of France's domestic troubles had reached Napoleon in Egypt. Without orders and leaving his army behind, he returned to France in October 1799 to popular acclaim. Soon he joined Siéyès. On 19 Brumaire (November 10, 1799), his troops ensured the success of the coup.

Siéyès appears to have thought that Napoleon could be used and then dismissed, but he misjudged his man. The proposed constitution divided executive authority among three consuls. Bonaparte quickly pushed Siéyès aside, and in December 1799, he issued the Constitution of the Year VIII. Behind a screen of universal male suffrage that suggested democratic principles, a complicated system of checks and balances that appealed to republican theory, and a Council of State that evoked memories of Louis XIV, the new constitution established the rule of one man—the First Consul, Bonaparte. In an age of widespread interest in classical analogies, Napoleon's takeover was reminiscent of Caesar and Augustus in ancient Rome, and to the Greek tyrants of the sixth century B.C.E. From the perspective of the twenty-first century, however, Bonaparte's career points forward to the dictators of the twentieth century. He was the first modern political figure to use the rhetoric of revolution and nationalism, to back it with military force, and to combine these elements into a mighty weapon of imperial expansion in the service of his own power.

# ▼ The Consulate in France (1799–1804)

The **Consulate** in effect ended the revolution in France. The leading elements of the Third Estate—that is, officials, landowners, doctors, lawyers, and financiers—had achieved most of their goals by 1799. They had abolished hereditary privilege, and the careers thus opened to talent allowed them to achieve wealth, status, and security for their property. The peasants were also satisfied. They had gained the land they had always wanted and had destroyed oppressive feudal privileges. The newly established dominant classes had little or no desire to share their new privileges with the lower social orders. Bonaparte seemed just the person to give them security. When he submitted his constitution to the voters in a plebiscite, they overwhelmingly approved it.

## Suppressing Foreign Enemies and Domestic Opposition

Throughout much of the 1790s, the pressures of warfare, particularly conscription, had accounted for much French internal instability. Bonaparte justified the public's confidence in himself by making peace with France's enemies. Russia had already left the Second Coalition. A campaign in Italy brought another victory over Austria at Marengo in 1800. The Treaty of Luneville early in 1801 took Austria out of the war. Britain was now alone and, in 1802, concluded the Treaty of Amiens, which brought peace to Europe.

Bonaparte also restored peace and order at home. He used generosity, flattery, and bribery to win over enemies. He issued a general amnesty and employed men from all political factions, requiring only that they be loyal to him. Men who had been radicals during the Reign of Terror, or who had fled the Terror and favored constitutional monarchy, or who had been high officials under Louis XVI occupied some of the highest offices.

Bonaparte, however, ruthlessly suppressed opposition. He established a highly centralized administration in which prefects responsible to the government in Paris managed all departments. He employed secret police. He stamped out the royalist rebellion in the west and made the rule of Paris effective in Brittany and the Vendée for the first time in years.

Napoleon also invented and used opportunities to destroy his enemies. A plot on his life in 1804 provided an excuse to attack the Jacobins, though it was the work of the royalists. Also in 1804, he violated the sovereignty of the German state of Baden to seize and execute the Bourbon duke of Enghien (1772–1804). The duke was accused of participation in a royalist plot, though Bonaparte knew him to be innocent. The action was a flagrant violation of international law and of due process. Charles Maurice de Talleyrand-Périgord (1754–1838), Bonaparte's foreign minister, later termed the act "worse than a crime—a blunder" because it provoked foreign opposition. It was popular with the former Jacobins, however, for it seemed to preclude the possibility of a Bourbon restoration. The executioner of a Bourbon was not likely to restore the royal family. The execution also seems to have put an end to royalist plots.

Document

## NAPOLEON ANNOUNCES HIS SEIZURE OF POWER

*On November 10, 1799 (19 Brumaire, Year VIII), the day after his successful coup, Napoleon announced his own version of what had taken place. Although he was theoretically only one of three consuls, Napoleon's proclamation showed his assumption of personal responsibility for carrying out what he considered to be the true spirit of the Revolution, and laid the groundwork for his later assumption of sole imperial power.*

**Which of his personal qualities does Napoleon emphasize, and how does he expect the French people to evaluate them? How does Napoleon try to present his seizure of power as legitimate? Whom does he claim to represent? Do his actions, as he describes them, defend rule by majority, or undermine it?**

On my return to Paris, I found a division reigning amongst all the constituted authorities. There was no agreement but on this single point—that the constitution was half destroyed, and could by no means effect the salvation of our liberties. All the parties came to me . . . and demanded my support. I refused to be a man of any party. A council of elders invited me, and I answered to their call. [Their] plan demanded a calm and liberal examination, free from every influence and every fear. The council of elders resolved, in consequence, that the sittings of the legislative body should be removed to St. Cloud, and charged me with the disposition of the force necessary to secure its independence, I owed it, my fellow-citizens, to the soldiers who are perishing in our armies, and the national glory, acquired at the price of their blood, to accept of this command. The councils being assembled at St. Cloud, the republican troops guaranteed their safety from without; but within, assassins had established the reign of terror. . . . The majority was disorganized, the most intrepid orators were disconcerted, and the inutility of every wise proposition was made evident. I bore my indignation and my grief to the council of elders, I demanded of them to ensure the execution of their generous designs. I represented to them the maladies of their country, from which those designs originated. . . . I then repaired to the council of five hundred without arms, and my head uncovered. . . . I wished to recall to the majority their wishes, and to assure them of their power. . . . Twenty assassins threw themselves upon me, and sought my breast. The grenadiers of the legislative body, whom I had left at the door of the hall, came up and placed themselves between me and my assassins. . . . They succeeded in bearing me away. I gave orders to rescue [the president, Napoleon's brother] from their power, and six grenadiers of the legislative body brought him out of the hall. . . . The factious were intimidated, and dispersed themselves. The majority, released from their blows, entered freely and peaceably into the hall of sitting, heard the propositions which were made to them for the public safety deliberated, and prepared the salutary resolution which is to become the new and provisional law of the republic. Frenchmen! you will recognize, without doubt, in this conduct, the zeal of a soldier of liberty, and of a citizen devoted to the republic. The ideas of preservation, protection, and freedom, immediately resumed their places on the dispersion of the faction who wished to oppress the councils, and who, in making themselves the most odious of men, never cease to be the most contemptible.

From *The Annual Register, or, A View of the History, Politics, and Literature for the Year 1799* (London: Otridge & Sons, 1801), p. 253.

## Concordat with the Roman Catholic Church

No single set of revolutionary policies had aroused as much domestic opposition as those regarding the French Catholic Church; nor were there any other policies to which fierce supporters of the revolution seemed so attached. When the French armies had invaded Italy, they had driven Pope Pius VI (r. 1775–1799) from Rome, and he eventually died in exile in France. In 1801, to the shock and dismay of his anticlerical supporters, Napoleon concluded a concordat with Pope Pius VII (r. 1800–1823). The agreement was possible because Pius VII, before becoming pope, had written that Christianity was compatible with

the ideals of equality and democracy. The concordat gave Napoleon what he most wanted. The agreement required both the refractory clergy and those who had accepted the revolution to resign. Their replacements received their spiritual investiture from the pope, but the state named the bishops and paid their salaries and the salary of one priest in each parish. In return, the church gave up its claims to its confiscated property.

The concordat declared, "Catholicism is the religion of the great majority of French citizens." This was merely a statement of fact and fell far short of what the pope had wanted: religious dominance for the Roman Catholic Church. The clergy had to swear an oath of loyalty to the state. The Organic Articles of 1802, which the government issued on its own authority without consulting the pope, established the supremacy of state over church. Similar laws were applied to the Protestant and Jewish communities, reducing still further the privileged position of the Catholic Church.

## The Napoleonic Code

In 1802, a plebiscite ratified Napoleon as consul for life, and he soon produced another constitution that granted him what amounted to full power. He thereafter set about reforming and codifying French law. The result was the Civil Code of 1804, usually known as the Napoleonic Code.

The Napoleonic Code safeguarded all forms of property and tried to secure French society against internal challenges. All the privileges based on birth that the revolution had overthrown remained abolished.

The conservative attitudes toward labor and women that had emerged during the revolution also received full support. Workers' organizations remained forbidden, and workers had fewer rights than their employers. Fathers were granted extensive control over their children and husbands over their wives. However, primogeniture—the right of an eldest son to inherit most or all of his parents' property—remained abolished, and property was distributed among all children, males and females. Married women needed their husbands' consent to dispose of their own property. Divorce remained more difficult for women than for men. Before this code, French law had differed from region to region. That confused set of laws had given women opportunities to protect their interests. The universality of the Napoleonic Code ended that.

## Establishing a Dynasty

In 1804, Bonaparte seized on a bomb attack on his life to make himself emperor. He argued that establishing a dynasty would make the new regime secure and make further attempts on his life useless. Another new constitution declared Napoleon Bonaparte Emperor of the French, instead of First Consul of the Republic. A plebiscite also overwhelmingly ratified this constitution.

To conclude the drama, Napoleon invited Pope Pius VII to Notre Dame to take part in the coronation. At the last minute, however, Napoleon convinced the pope to agree that the new emperor should crown himself. Napoleon would not allow anyone to think his power and authority depended on the church. Henceforth, he was called Napoleon I.

Toussaint L'Ouverture (1746–1803) began the revolt that led to Haitian independence in 1804. Library of Congress

# Madame de Remusat, *Memoirs* (excerpts)

Now that I am about to commence these Memoirs, I think it well to precede them by some observations on the character of the Emperor, and the various members of the family respectively. These observations will help me in the difficult task I am about to undertake, by aiding me to recall the impressions of the last twelve years. I shall begin with Bonaparte himself. I am far from saying that he always appeared to me in the light in which I see him now; my opinions have progressed, even as he did; but I am so far from being influenced by personal feelings, that I do not think it is possible for me to deviate from the exact truth.

Napoleon Bonaparte is of low stature, and rather ill-proportioned; his bust is too long, and so shortens the rest of his figure. He has thin chestnut hair, his eyes are grayish blue, and his skin, which was yellow while he was slight, became in later years a dead white without any color. His forehead, the setting of his eye, the line of his nose—all that is beautiful, and reminds one of an antique medallion. His mouth, which is thin-lipped, becomes agreeable when he laughs; the teeth are regular. His chin is short, and his jaw heavy and square. He has well-formed hands and feet; I mention them particularly, because he thought a good deal of them.

He has an habitual slight stoop. His eyes are dull, giving in his face when in repose a melancholy and meditative expression. When he is excited with anger his looks are fierce and menacing. Laughter becomes him; it makes him look more youthful and less formidable. It is difficult not to like him when he laughs, his countenance improves so much. He was always simple in his dress, and generally wore the uniform of his own guard. He was cleanly rather from habit than from a liking for cleanliness; he bathed often, sometimes in the middle of the night, because he thought the practice good for his health. But, apart from this, the precipitation with which he did everything did not admit of his clothes being put on carefully; and on gala days and full-dress occasions his servants were obliged to consult together as to when they might snatch a moment to dress him.

He could not endure the wearing of ornaments; the slightest constraint was insupportable to him. He would tear off or break anything that gave him the least annoyance; and sometimes the poor valet who had occasioned him a passing inconvenience would receive violent proof of his anger. I have said there was a sort of fascination in the smile of Bonaparte; but, during all the time I was in the habit of seeing him, he rarely put forth that charm. Gravity was the foundation of his character; not the gravity of a dignified and noble manner, but that which arises from profound thought. In his youth he was a dreamer; later in life he became a moody, and later still an habitually ill-tempered man. When I first began to know him well, he was exceedingly fond of all that induces reverie—Ossian, the twilight, melancholy music. I have seen him enraptured by the murmur of the wind, I have heard him talk with enthusiasm of the moaning of the sea, and he was tempted sometimes to believe that nocturnal apparitions were not beyond the bounds of possibility; in fact, he had a leaning to certain superstitions. When, on leaving his study in the evening, he went into Mme. Bonaparte's drawing-room, he would sometimes have the candles shaded with white gauze, desire us to keep

profound silence, and amuse himself by telling or hearing ghost stories: or he would listen to soft, sweet music executed by Italian singers, accompanied only by a few instruments lightly touched. Then he would fall into a reverie which all respected, no one venturing to move or stir from his or her place. When he aroused himself from that state, which seemed to procure him a sort of repose, he was generally more serene and more communicative. He liked then to talk about the sensations he had experienced. He would explain the effect music had upon him; he always preferred that of Paisiello, because he said it was monotonous, and that impressions which repeat themselves are the only ones that take possession of us. The geometrical turn of his mind disposed him to analyze even his emotions. No man has ever meditated more deeply than Bonaparte on the "wherefore" that rules human actions. Always aiming at something, even in the least important acts of his life, always laying bare to himself a secret motive for each of them, he could never understand that natural nonchalance which leads some persons to act without a project and without an aim. He always judged others by himself, and was often mistaken, his conclusions and the actions which ensued upon them both proving erroneous.

Bonaparte was deficient in education and in manners; it seemed as if he must have been destined either to live in a tent where all men are equal, or upon a throne where everything is permitted. He did not know how either to enter or to leave a room; he did not know how to make a bow, how to rise, or how to sit down. His questions were abrupt, and so also was his manner of speech. Spoken by him, Italian loses all its grace and sweetness. Whatever language he speaks, it seems always to be a foreign tongue to him; he appears to force it to express his thoughts. And then, as any rigid rule becomes an insupportable annoyance to him, every liberty which he takes pleases him as though it were a victory, and he would never yield even to grammar. He used to say that in his youth he had liked reading romances as well as studying the exact sciences; and probably he was influenced by so incongruous a mixture. Unfortunately, he had met with the worst kind of romances, and retained so keen a remembrance of the pleasure they had given him that, when he married the Archduchess Marie Louise, he gave her "Hippolyte, Comte de Douglas," and "Les Contemporains," so that, as he said, she might form an idea of refined feeling, and also of the customs of society.

In trying to depict Bonaparte, it would be necessary, following the analytical forms of which he was so fond, to separate into three very distinct parts his soul, his heart, and his mind; for no one of these ever blended completely with the others. Although very remarkable for certain intellectual qualities, no man, it must be allowed, was ever less lofty of soul. There was no generosity, no true greatness in him. I have never known him to admire, I have never known him to comprehend, a fine action. He always regarded every indication of a good feeling with suspicion; he did not value sincerity; and he did not hesitate to say that he recognized the superiority of a man by the greater or less degree of cleverness with which he used the art of lying. On the occasion of his saying this, he added, with great complacency, that when he was a child one of his uncles had predicted that he should govern the world, because he was an habitual liar. "M. de Metternich," he added, "approaches to being a statesman—he lies verywell."

All Bonaparte's methods of government were selected from among those which have a tendency to debase men. He dreaded the ties of affection; he endeavored to isolate every one; he never sold a favor without awakening a sense of uneasiness, for he held that the true way to attach the recipients to himself was by compromising them, and often even by blasting them in public opinion. He could not pardon virtue until he had succeeded in weakening its effect by ridicule. He can not be said to have truly loved glory, for he never hesitated to prefer success to it; thus, although he was audacious in good fortune, and although he pushed it to its utmost limits, he was timid and troubled when threatened with reverses. Of generous courage he was not capable; and, indeed, on that head one would hardly venture to tell the truth so plainly as he has told it himself, by an admission recorded in an anecdote which I have never forgotten. One day, after his defeat at Leipsic, and when, as he was about to return to Paris, he was occupied in collecting the remains of his army for the defense of our frontiers, he was talking to M. de Talleyrand of the ill success of the Spanish war, and of the difficulty in which it had involved him. He spoke openly of his own position, not with the noble frankness that does not fear to own a fault, but with that haughty sense of superiority which releases one from the necessity of dissimulation. At this interview, in the midst of his plain speaking, M. de Talleyrand said to him suddenly, "But how is it? You consult me as if we had not quarreled."

Bonaparte answered, "Ah, circumstances! circumstances! Let us leave the past and the future alone. I want to hear what you think of the present moment."

"Well," replied M. de Talleyrand, "there is only one thing you can do. You have made a mistake: you must say so; try to say so nobly. Proclaim, therefore, that being a King by the choice of the people, elected by the nations, it has never been your design to set yourself against them. Say that, when you began the war with Spain, you believed you were about to deliver the people from the yoke of an odious minister, who was encouraged by the weakness of his prince; but that, on closer observation, you perceive that the Spaniards, although aware of the faults of their King, are none the less attached to his dynasty, which you are therefore about to restore to them, so that it may not be said you ever opposed a national aspiration. After that proclamation, restore King Ferdinand to liberty, and withdraw your troops. Such an avowal, made in a lofty tone, and when the enemy are still hesitating on our frontier, can only do you honor; and you are still too strong for it to be regarded as a cowardly act."

"A cowardly act!" replied Bonaparte; "what does that matter to me? Understand that I should not fail to commit one, if it were useful to me. In reality, there is nothing really noble or base in this world; I have in my character all that can contribute to secure my power, and to deceive those who think they know me. Frankly, I am base, essentially base. I give you my word that I should feel no repugnance to commit what would be called by the world a dishonorable action; my secret tendencies, which are, after all, those of nature, opposed to certain affectations of greatness with which I have to adorn myself, give me infinite resources with which to baffle every one. Therefore, all I have to do now is to consider whether your advice agrees with my present policy, and to try and find out besides," he added (says M. de Talleyrand), with a satanic smile, "whether you have not some private interest in urging me to take this step."

Another anecdote which bears on the same characteristic will not be out of place here. Bonaparte, when on the point of setting out for Egypt, went to see M. de Talleyrand, then Minister of Foreign Affairs under the Directory. "I was in bed, being ill," said M. de Talleyrand. "Bonaparte sat down near me, and divulged to me all the dreams of his youthful imagination. I was interested in him because of the activity of his mind, and also on account of the obstacles which I was aware would be placed in his way by secret enemies of whom I knew. He told me of the difficulty in which he was placed for want of money, and that he did not know where to get any. 'Stay,' I said to him; 'open my desk. You will find there a hundred thousand francs that belong to me. They are yours for the present; you may repay the money when you return,' Bonaparte threw himself on my neck, and I was really delighted to witness his joy. When he became Consul, he gave me back the money I had lent him; but he asked me one day, 'What interest could you have had in lending me that money? I have thought about it a hundred times since then, and have never been able to make out your object.' 'I had none,' I replied. 'I was feeling very ill: it was quite possible I might never see you again; but you were young, you had impressed me very strongly, and I felt impelled to render you a service without any afterthought whatsoever.' 'In that case,' said Bonaparte, 'and if it was really done without any design, you acted a dupe's part.' "

According to the order I have laid down, I ought now to speak of Bonaparte's heart; but, if it were possible to believe that a being, in every other way similar to ourselves, could exist without that portion of our organization which makes us desire to love and to be loved, I should say that in his creation the heart was left out. Perhaps, however, the truth was that he succeeded in suppressing it completely. He was always too much engrossed by himself to be influenced by any sentiment of affection, no matter of what kind. He almost ignored the ties of blood and the rights of nature; I do not know that even paternity weighed with him. It seemed, at least, that he did not regard it as his primary relation with his son. One day, at breakfast, when, as was often the case, Talma had been admitted to see him, the young Napoleon was brought to him. The Emperor took the child on his knee, and, far from caressing, amused himself by slapping him, though not so as to hurt him; then, turning to Talma, he said, "Talma, tell me what I am doing?" Talma, as may be supposed, did not know what to say. "You do not see it," continued the Emperor; "I am slapping a King."

Notwithstanding his habitual hardness, Bonaparte was not entirely without experience of love. But, good heavens! what manner of sentiment was it in his case? A sensitive person forgets self in love, and becomes almost transformed; but to a man of the stamp of Bonaparte it only supplies an additional sort of despotism. The Emperor despised women, and contempt can not exist together with love. He regarded their weakness as an unanswerable proof of their inferiority, and the power they have acquired in society as an intolerable usurpation—a result and an abuse of the progress of that civilization which, as M. de Talleyrand said, was always his personal enemy. On this account Bonaparte was under restraint in the society of women; and, as every kind of restraint put him out of humor, he was always awkward in their presence, and never knew how to talk to them. It is true that the women with whom he was acquainted were not calculated to change his views of the sex. We may easily imagine the nature of his youthful experiences. In Italy morals were utterly depraved, and the

general licentiousness was augmented by the presence of the French army. When he returned to France society was entirely broken up and dispersed. The circle that surrounded the Directory was a corrupt one, and the Parisian women to whose society he was admitted were vain and frivolous, the wives of men of business and contractors. When he became Consul, and made his generals and his aides-de-camp marry, or ordered them to bring their wives to Court, the only women he had about him were timid and silent girls, newly married, or the wives of his former comrades, suddenly withdrawn from obscurity by the good fortune of their husbands, and ill able to conform to the change in their position.

I am disposed to believe that Bonaparte, almost always exclusively occupied by politics, was never awakened to love except by vanity. He thought nothing of a woman except while she was beautiful, or at least young. He would probably have been willing to subscribe to the doctrine that, in a well-organized country, we should be killed—just as certain kinds of insects are destined by nature to a speedy death, so soon as they have accomplished the task of maternity. Yet Bonaparte had some affection for his first wife; and, if he was ever really stirred by any emotion, it was by her and for her. Even a Bonaparte can not completely escape from every influence, and a man's character is composed, not of what he is always, but of what he is most frequently.

Bonaparte was young when he first made the acquaintance of Mme. de Beauharnais, who was greatly superior to the rest of the circle in which she moved, both by reason of the name she bore and from the elegance of her manners. She attached herself to him, and flattered his pride; she procured him a step in rank; he became accustomed to associate the idea of her influence with every piece of good fortune which befell him. This superstition, which she kept up very cleverly, exerted great power over him for a long time; it even induced him more than once to delay the execution of his projects of divorce. When he married Mme. de Beauharnais, Bonaparte believed that he was allying himself to a very great lady; his marriage, therefore, was one conquest the more. I shall give further details of the charm she exercised over him when I have to speak more particularly of her.

Notwithstanding his preference for her, I have seen him in love two or three times, and it was on these occasions that he exhibited the full measure of the despotism of his character. How irritated he became at the least obstacle! How roughly he put aside the jealous remonstrances of his wife! "It is your place," he said, "to submit to all my fancies, and you ought to think it quite natural that I should allow myself amusements of this kind. I have a right to answer all your complaints by an eternal I. I am a person apart; I will not be dictated to by any one." But he soon began to desire to exercise over the object of his passing preference an authority equal to that by which he silenced his wife. Astonished that any one should have any ascendancy over him, he speedily became angry with the audacious individual, and he would abruptly get rid of the object of his brief passion, having let the public into the transparent secret of his success.

The intellect of Bonaparte was most remarkable. It would be difficult, I think, to find among men a more powerful or comprehensive mind. It owed nothing to education; for, in reality, he was ignorant, reading but little, and that hurriedly. But he quickly seized upon the little he learned, and his imagination developed it so extensively that he might easily have passed for a well-educated man.

His intellectual capacity seemed to be vast, from the number of subjects he could take in and classify without fatigue. With him one idea gave birth to a thousand, and a word would lift his conversation into elevated regions of fancy, in which exact logic did not indeed keep him company, but in which his intellect never failed to shine.

It was always a great pleasure to me to hear him talk, or rather to hear him hold forth, for his conversation was composed generally of long monologues; not that he objected to replies when he was in a good humor, but, for many reasons, it was not always easy to answer him. His Court, which for a long time was entirely military, listened to his least word with the respect that is paid to the word of command; and afterward it became so numerous that any individual undertaking to refute him, or to carry on a dialogue with him, felt like an actor before an audience. I have said that he spoke badly, but his language was generally animated and brilliant; his grammatical inaccuracies sometimes lent his sentences an unexpected strength, very suitable to the originality of his ideas. He required no interlocutor to warm him up. He would dash into a subject, and go on for a long time, careful to notice, however, whether he was followed, and pleased with those who comprehended and applauded him. Formerly, to know how to listen to him was a sure and easy way of pleasing him. Like an actor who becomes excited by the effect he produces, Bonaparte enjoyed the admiration he watched for closely in the faces of his audience. I remember well how, because he interested me very much when he spoke, and I listened to him with pleasure, he proclaimed me a woman of intellect, although at that time I had not addressed two consecutive sentences to him.

He was very fond of talking about himself, and criticised himself on certain points, just as another person might have done. Rather than fail to make the most out of his own character, he would not have hesitated to subject it to the most searching analysis. He used often to say that a real politician knows how to calculate even the smallest profits that he can make out of his defects; and M. de Talleyrand carried that reflection even further. I once heard him say, "That devil of a man deceives one on all points. His very passions mislead, for he manages to dissemble them even when they really exist." I can recall an incident which will show how, when he found it useful, he could pass from the most complete calm to the most violent anger.

A little while before our last rupture with England, a rumor was spread that war was about to recommence, and that the ambassador, Lord Whitworth, was preparing to leave Paris. Once a month the First Consul was in the habit of receiving, in Mme. Bonaparte's apartments, the ambassadors and their wives. This reception was held in great pomp. The foreigners were ushered into a drawing-room, and when they were all there the First Consul would appear, accompanied by his wife. Both were attended by a prefect and a lady of the palace. To each of them the ambassadors and their wives were introduced by name. Mme. Bonaparte would take a seat; the First Consul would keep up the conversation for a longer or a shorter time, according to his convenience, and then withdraw with a slight bow. A few days before the breach of the peace, the Corps Diplomatique had met as usual at the Tuileries. While they were waiting, I went to Mme. Bonaparte's apartment, and entered the dressing-room, where she was finishing her toilet.

The First Consul was sitting on the floor, playing with little Napoleon, the eldest son of his brother Louis. He presently began to criticise his wife's dress, and also mine, giving us his opinion on every detail of our costume. He seemed to be in the best possible humor. I remarked this, and said to him that, judging by appearances, the letters the ambassadors would have to write, after the approaching audience, would breathe nothing but peace and concord. Bonaparte laughed, and went on playing with his little nephew.

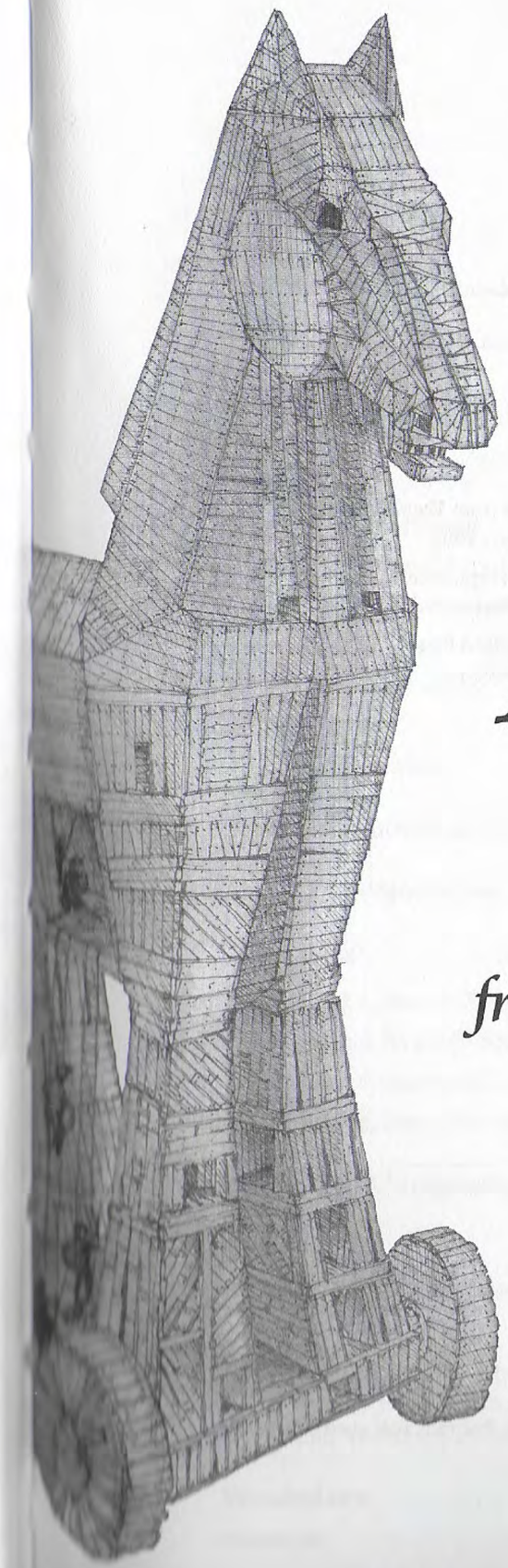
By-and-by he was told that the company had arrived. Then he rose quickly, the gayety vanished from his face, and I was struck by the severe expression that suddenly replaced it: he seemed to grow pale at will, his features contracted; and all this in less time than it takes me to describe it. "Let us go, mesdames," said he, in a troubled voice; and then he walked on quickly, entered the drawing-room, and, without bowing to any one, advanced to the English ambassador. To him he began to complain bitterly of the proceedings of his Government. His anger seemed to increase every minute; it soon reached a height which terrified the assembly; the hardest words, the most violent threats, were poured forth by his trembling lips. No one dared to move. Mme. Bonaparte and I looked at each other, dumb with astonishment, and every one trembled. The impassibility of the Englishman was even disconcerted, and it was with difficulty he could find words to answer.

. . .

I will now resume my sketch. Bonaparte carried selfishness so far that it was not easy to move him about anything that did not concern himself. He was, however, occasionally surprised, as it were, into impulses of tenderness; but they were very fugitive, and always ended in ill humor. It was not uncommon to see him moved even to the point of shedding a few tears; they seemed to arise from nervous irritation, of which they became the crisis. "I have," he said, "very unmanageable nerves, and at these times, if my blood did not always flow slowly, I think I should be very likely to go mad." I know, indeed, from Corvisart, that his pulse beat more slowly than is usual for a man's. Bonaparte never felt what is commonly called giddiness, and he always said that the expression, "My head is going round," conveyed no meaning to him. It was not only from the ease with which he yielded to all his impulses that he often used language which was painful and distressing to those whom he addressed, but also because he felt a secret pleasure in exciting fear, and in harassing the more or less trembling individuals before him. He held that uncertainty stimulates zeal, and therefore he rarely displayed satisfaction with either persons or things. Admirably served, always obeyed on the moment, he would still find fault, and keep everybody in the palace in dread of his displeasure about some small detail. If the easy flow of his conversation had established for the time a sense of ease, he would suddenly imagine that it might be abused, and by a hard and imperious word put the person whom he had welcomed and encouraged in his or her place—that is to say, in fear. He hated repose for himself and grudged it to others. When M. de Rémusat had arranged one of those magnificent fêtes where all the arts were laid under contribution for his pleasure, I was never asked whether the Emperor was pleased, but whether he had grumbled more or less. His service was the severest of toil. He has been heard to

say, in one of those moments when the strength of conviction appeared to weigh upon him, "The truly happy man is he who hides from me in the country, and when I die the world will utter a great '*Ouf!*' "

I have said that Bonaparte was incapable of generosity; and yet his gifts were immense, and the rewards he bestowed gigantic. But, when he paid for a service, he made it plain that he expected to buy another, and a vague uneasiness as to the conditions of the bargain always remained. There was also a good deal of caprice in his gifts, so that they rarely excited gratitude. Moreover, he required that the money he distributed should all be expended, and he rather liked people to contract debts, because it kept them in a state of dependence. His wife gave him complete satisfaction in the latter particular, and he would never put her affairs in order, so that he might keep the power of making her uneasy in his hands. At one time he settled a considerable revenue on M. de Rémusat, that we might keep what is called open house, and receive a great many foreigners. We were very exact in the first expenses demanded by a great establishment. A little while after, I had the misfortune to lose my mother, and was forced to close my house. The Emperor then rescinded all his gifts, on the ground that we could not keep the engagement we had made, and he left us in what was really a position of embarrassment, caused entirely by his fugitive and burdensome gifts. I pause here. If I carry out the plan I have formed, my memory, carefully consulted, will furnish me by degrees with other anecdotes which will complete this sketch. What I have already written will suffice to convey an idea of the character of him with whom circumstances connected the best years of my life.



# *Vergil's* Aeneid

## *Selected Readings from Books 1, 2, 4, and 6*

by Barbara Weiden Boyd

Bolchazy-Carducci Publishers, Inc.

*bella* gerō. *Et* quisquam *nūmen Iūnōnis* adōrat
49 praetereā *aut* supplex *ārīs* impōnet *honōrem?*"

**adōrō** (1) worship, adore, honor
**gerō, ere, gessī, gestus** carry (on), wage
**impōnō, ere, posuī, positus** place on (+ *dat.*)
**praetereā** *adv.* besides, hereafter
**quisquam, quaequam, quicquam** any(one), any(thing)
**supplex, icis** suppliant, humble

**48. gerō:** of past action continued into the pres.; App. 351, 1, *b*. **Et quisquam:** Juno thinks to herself, "Can any one hereafter respect me, if I show myself such a weakling?" Her use of the pron. **quisquam** implies that the answer, if expressed, would be "no." This figure is called a RHETORICAL QUESTION; Juno does not really expect an answer. **Iūnōnis = meum:** Juno is speaking, but the use of her own name is more picturesque and effective than the use of the possessive adj.

**49. supplex:** *(as a) suppliant.* **ārīs:** dat. with compound verb; App. 298. **honōrem:** *honor,* i.e., an *offering* which would honor Juno.



*Tālia* flammātō *sēcum dea* corde volūtāns
nimbōrum *in* patriam, *loca* fēta *furentibus* Austrīs,
Aeoliam *venit. hīc vastō rēx* Aeolus antrō
luctantēs *ventōs* tempestātēs*que* sonōrās
*imperiō* premit *ac* vinclīs *et* carcere frēnat.
55 *Illī* indignantēs *magnō cum* murmure *montis*
*circum* claustra fremunt; celsā sedet Aeolus *arce*
scēptra *tenēns* mollit*que animōs et* temperat *īrās.*

**Aeolia, ae** *f.* one of the Liparian Islands near Sicily
**Aeolus, ī** *m.* god of the winds
**antrum, ī** *n.* cave, cavern
**Auster, trī** *m.* (south) wind
**carcer, eris** *m.* prison, inclosure
**celsus, a, um** lofty, high, towering
**claustrum, ī** *n.* bar(rier), bolt
**cor, cordis** *n.* heart, spirit, feelings
**fētus, a, um** teeming, pregnant
**flammō** (1) inflame, kindle
**fremō, ere, uī, itus** murmur, roar
**frēnō** (1) curb, check, restrain
**indignor, ārī, ātus** be angry, chafe
**luctor, ārī, ātus** wrestle, struggle
**molliō, īre, īvī (iī), ītus** soothe, tame
**murmur, uris** *n.* murmur, roar, rumble
**nimbus, ī** *m.* storm cloud, rainstorm
**patria, ae** *f.* homeland, country
**premō, ere, pressī, pressus** (re)press, control
**scēptrum, ī** *n.* staff, scepter, power
**sedeō, ēre, sēdī, sessus** sit
**sonōrus, a, um** roaring, howling
**temperō** (1) control, calm, refrain
**tempestās, ātis** *f.* tempest, storm
**vinc(u)lum, ī** *n.* bond, chain
**volūtō** (1) roll, revolve, ponder

50–80. Juno persuades Aeolus, god of the winds, to send forth a storm to prevent Aeneas and the Trojans from reaching Italy.

**50. Tālia:** used substantively, as obj. of **volūtāns**; *such things*, i.e., *such thoughts.* **(in) flammātō corde:** abl. of place where; App. 319. **sēcum = cum sē**, as in 37; App. 321, *a*.

**51. patriam:** with the first syllable short; App. 17. **Austrīs:** abl. with **fēta**, lit., *south winds*, but often meaning *winds* in general; App. 433. **fēta furentibus:** note the ALLITERATION.

**51–52. loca . . . Aeoliam:** both nouns in apposition with **patriam**. **Hīc:** adv., *here.* **(in) vastō antrō:** abl. of place where; App. 319.

**54. vinclīs:** the syncopated form of **vinculīs**, which because of its central short syllable can not be used in hexameter. **imperiō, vinc(u)līs, carcere:** abls. of means; App. 331. The two nouns **vinclīs** and **carcere** may be understood as a true pair, or may be translated as an example of HENDIADYS: "by means of the restraints of their prison"; App. 425. **frēnat:** a picture drawn from managing spirited horses, as in 63, **premere et dare laxās habēnās.**

**55. magnō cum murmure montis:** ALLITERATION and ONOMATOPOEIA; **murmure** is abl. of manner; App. 328.

**56. (in) celsā arce:** abl. of place, apparently a lofty seat within the cave or just outside on a mountain top.

**57. scēptra:** for the use of the poetic plural see the note on **īrae** (11). **animōs (ventōrum) et īrās (ventōrum).**

nī *faciat, maria ac terrās caelumque* profundum
quippe *ferant* rapidī *sēcum* verrant*que per aurās;*
*sed pater* omnipotēns spēluncīs abdidit *ātrīs*
*hoc* metuēns mōlem*que et montēs* īnsuper *altōs*
imposuit, *rēgem**que dedit quī* foedere certō
*et* premere *et* laxās scīret *dare iussus* habēnās.
*Ad quem tum* iūnō supplex *hīs vōcibus* ūsa *est:*
"Aeole (*nam**que tibī dīvum pater atque* hominum *rēx*
*et* mulcēre *dedit* fluctūs *et tollere ventō*),

**abdō, ere, didī, ditus** put away, hide
**Aeolus, ī** *m.* god of the winds
**certus, a, um** fixed, sure
**foedus, eris** *n.* agreement, condition, treaty
**habēna, ae** *f.* rein
**homō, inis** *m. (f.)* man, mortal, human
**impōnō, ere, posuī, positus** place upon
**īnsuper** *adv.* above, besides
**laxus, a, um** loose, free, lax
**metuō, ere, uī** fear, dread
**mōlēs, is** *f.* mass, burden, structure
**mulceō, ēre, lsī, lsus** calm, soothe
**nī, nisi** if not, unless
**omnipotēns, entis** almighty, all-powerful
**premō, ere, pressī, pressus** (re)press, control
**profundus, a, um** deep, high, vast
**quippe** indeed, surely
**rapidus, a, um** swift, whirling, consuming
**sciō, īre, īvī (iī), ītus** know (how), understand
**spēlunca, ae** *f.* cave, cavern
**supplex, icis** suppliant, humble
**ūtor, ī, ūsus** use, employ (+ *abl.*)
**verrō, ere, ī, versus** sweep

**58. nī (Aeolus id) faciat: nī molliat; faciat** is pres. subjunctive in a pres. contrary-to-fact condition (as opposed to the more usual imperf. subjunctive); the result is a far more vivid scene; App. 382, *c.*

**59. (ventī) rapidī:** *the winds in their madness.* **sēcum = cum sē**; App. 301, *a.* **ferant, verrant (maria ac terrās caelumque profundum).** Both pres. subjunctives continue the condition begun in 58, **nī faciat.**

**60. pater omnipotēns: Iuppiter. (in) spēluncīs ātrīs = antrō** (52), abl. of place where; App. 319. **abdidit (illōs ventōs).**

**61. hoc:** obj. of **metuēns. mōlem et montēs:** ALLITERATION. This is an example of HENDIADYS (a pair of nouns translated as a single idea).

**62. rēgem (Aeolum) dedit (ventīs). foedere certō:** abl. of manner or of means; App. 328, 331.

**63. premere:** obj. of **scīret**, *would know (how) to grasp tightly*, so as to draw in the reins. For the figure of horsemanship see the note on **frēnat** (54). **scīret**, rel. clause of purpose or characteristic; App. 388, 389. **dare:** also obj. of **scīret. iussus (ā Iove):** *(when) ordered (by Jupiter).*

**64. hīs vōcibus:** abl. with **ūtor**; App. 342.

**65. Aeole:** voc. **dīv(ōr)um pater atque hominum rēx: Iuppiter. tibī:** for the length of the final **-i**, see the note on **mihi** (8).

**66. mulcēre, tollere (flūctūs):** infs. used as objs. of **dedit**, *has granted.* **ventō:** abl. of means; App. 331.



*gēns* inimīca *mihī* Tyrrhēnum nāvigat *aequor*
Īlium *in Ītaliam* portāns *victōsque* penātēs:
incute *vim ventīs* submersās*que* obrue *puppēs,*
*aut age* dīversōs *et* dissice *corpora* pontō.
*Sunt mihi* bis septem praestantī *corpore* Nymphae,
*quārum quae* formā pulcherrima Dēiopēa,

**bis** twice
**Dēiopēa, ae** *f.* a nymph
**dis(s)iciō, ere, iēcī, iectus** scatter, disperse
**dīversus, a, um** scattered, diverse
**forma, ae** *f.* beauty, shape, form
**Īlium, (i)ī** *n.* Ilium, Troy, a city of Asia Minor
**incutiō, ere, cussī, cussus** strike (into) (+ *dat.*)
**inimīcus, a, um** hostile, unfriendly
**nāvigō** (1) sail, navigate
**Nympha, ae** *f.* nymph, one of the minor divinities of nature represented as beautiful maidens dwelling in the forests, streams, meadows, mountains, etc.
**obruō, ere, uī, utus** overwhelm, crush
**penātēs, ium** *m.* household gods
**pontus, ī** *m.* sea
**portō** (1) carry, bear, bring
**praestāns, antis** surpassing, excellent
**pulcher, chra, chrum** beautiful, handsome, illustrious
**septem** seven
**summergō (subm-), ere, rsī, rsus** sink
**Tyrrhēnus, a, um** Tyrrhenian, of Etruria, a district of northwestern Italy

**67. gēns inimīca mihī:** i.e., *Teucrī.* **Tyrrhēnum aequor:** that part of the Mediterranean west of Italy, east of Corsica and Sardinia, and north of Sicily.

**68. Īlium . . . portāns victōsque penātēs:** see note on **īnferret deōs** (6). They were *bearing Ilium* in their plan to found a new city, which was to continue the people and the customs of the **Īlium** (Troy) which had been destroyed. The worship of the penates, household gods at Rome, was an essential part of Roman daily life, and was seen as a link to the Romans' Trojan past. **victōs**: *defeated* by the Greeks in the Trojan War.

**69. incute:** imperat. **vim ventīs:** ALLITERATION; App. 411. **ventīs:** dat. with a compound; App. 298. **submersās obrue puppēs:** *overwhelm the sunken ships*, i.e., *sink and overwhelm the ships*, a good example of the figure known as PROLEPSIS, or *anticipation.*

**70. age:** imperat. **dīversōs (Teucrōs):** i.e., drive the Trojans in different directions and scatter their corpses over the sea; another example of PROLEPSIS. **dissice:** usually written with one **-s-**; the doubled consonant here gives Juno's words an extra hissing sound, perhaps not coincidentally. **pontō:** abl. of place where; App. 319.

**71. mihi:** dat. of possession; App. 299. **bis septem:** *twice seven*; more poetic than to say simply *fourteen.* **praestantī corpore:** abl. of quality; App. 330.

**72. formā:** abl. of respect; App. 325; dependent on **pulcherrima. Dēiopēa:** nom. by attraction into the case of the rel. pron., **quae**; the accusative would be expected, as obj. of **iungam**; App. 242, *a.* **quārum:** use the English demonstrative in translation, and read accordingly: **Dēiopēam, quae (est) eārum (nymphārum) pulcherrima formā, iungam (tibi) stabilī cōnūbīo et (eam) dicābō (tuam) propriam.**

cōnūbiō iungam stabilī propriam*que* dicābō,
*omnēs ut tēcum* meritīs prō *tālibus* annōs
exigat *et* pulchrā *faciat tē* prōle *parentem.*"
Aeolus *haec* contrā: "*Tuus, Ō rēgīna, quid* optēs
explōrāre *labor; mihi* iussa capessere fās *est.*
*Tū mihi* quodcumque *hoc rēgnī, tū* scēptra *Iovemque*
conciliās, *tū dās* epulīs accumbere *dīvum*
nimbōrum*que facis* tempestātum*que* potentem."

**accumbō, ere, cubuī, cubitus** recline (at) (+ *dat.*)
**Aeolus, ī** *m.* god of the winds
**annus, ī** *m.* year
**capessō, ere, īvī, ītus** (under)take, perform
**conciliō** (1) win over, unite
**contra** opposite, against, in reply (+ *acc.*)
**cōnūbium, (i)ī** *n.* marriage, wedlock
**dicō** (1) consecrate, dedicate
**epulae, ārum** *f.* banquet, feast
**exigō, ere, ēgī, āctus** complete, pass
**explōrō** (1) examine, search out
**fās** *n. indecl.* right, divine law, duty
**iungō, ere, iūnxī, iūnctus** join, yoke, unite
**iussum, ī** *n.* command, order
**meritum, ī** *n.* reward, merit
**nimbus, ī** *m.* storm cloud, rainstorm
**optō** (1) desire, choose, hope (for)
**potēns, entis** powerful, ruling (+ *gen.*)
**prō** before, for (+ *abl.*)
**prōlēs, is** *f.* offspring, progeny
**proprius, a, um** one's own, permanent
**pulcher, chra, chrum** beautiful, handsome, illustrious
**quīcumque, quaecumque, quodcumque** whoever, whatever
**scēptrum, ī** *n.* staff, scepter, power
**stabilis, e** firm, lasting, stable
**tempestās, ātis** *f.* tempest, storm; time

**73. cōnūbiō:** *in wedlock,* abl. of place where or means; App. 319, 331. **cōnūbiō** is either trisyllabic by SYNIZESIS, and pronounced as though written **cōnūbyō** (i.e., consonantal **-i-**), or quadrisyllabic, with the variable syllable **-nub-** scanned as short. **iungam (tibi) dicābō (eam) propriam:** *I shall dedicate her (Deiopea) to you (as) your very own.* Juno was goddess of marriage. **propriam:** with the first syllable short; App. 17.

**74. tēcum = cum tē**; App. 321, *a.*

**75. prōle:** abl. of quality; App. 330, or means; App. 331. **pulchrā prōle parentem:** ALLITERATION. **exigat, faciat:** subjunctives of result or purpose; App. 364, 388. **parentem = patrem.**

**76. haec (dīxit). optēs:** indir. quest.; App. 349. **Tuus (est) labor:** *yours (is) the task.* Aeolus thus absolves himself from responsibility, if his obedience to Juno gets him into trouble.

**77. mihi:** dat. of reference; App. 301. **iussa (tua).**

**78. quodcumque hoc (est) rēgnī:** *whatever this is (in the way) of a kingdom,* an expression of modesty. **rēgnī:** partitive gen. with **quodcumque**; App. 286. **Tū:** always emphatic, and an example of ANAPHORA, the repetition of a single word at the beginning of successive clauses or phrases.

**79. conciliās:** this one verb should be translated twice, first with its obj. **quodcumque hoc rēgnī** ("win for") and then with its objs. **scēptra Iovemque** ("win over"). **epulīs:** dat. with compound; App. 298. The ancient Romans regularly reclined at meals. **dīv(ōr)um:** App. 37, *d.* **accumbere:** inf. used as obj. of **dās**, *you grant (me) the privilege of reclining.* As one of the lesser gods, Aeolus was dependent upon the favor of the more powerful divinities.

**80. facis (mē) potentem nimbōrum tempestātumque.**



*Haec ubi dicta,* cavum conversā cuspide *montem*
impulit *in* latus; *ac ventī* velut *agmine factō,*
quā *data* porta, *ruunt et terrās* turbine perflant.
Incubuēre *marī tōtumque ā sēdibus īmīs*
ūnā Eurus*que* Notus*que ruunt* crēber*que* procellīs
Āfricus, *et vastōs volvunt ad lītora flūctūs.*
Īnsequitur *clāmorque virum* strīdor*que* rudentum;
*ēripiunt* subitō nūbēs *caelumque diemque*

**Āfricus, ī** *m.* (southwest) wind
**cavus, a, um** hollow, vaulted
**convertō, ere, ī, rsus** turn (around), reverse
**crēber, bra, brum** frequent, crowded
**cuspis, idis** *f.* point, spear
**Eurus, ī** *m.* (east) wind
**impellō, ere, pulī, pulsus** drive, strike (against)
**incumbō, ere, cubuī, cubitus** lie upon, brood over (+ *dat.*)
**īnsequor, ī, secūtus** follow, pursue
**latus, eris** *n.* side, flank
**Notus, ī** *m.* (south) wind
**nūbēs, is** *f.* cloud, fog, mist
**perflō** (1) blow (over, through)
**porta, ae** *f.* gate, door, opening
**procella, ae** *f.* blast, gust
**quā** *adv.* where, in any way
**rudēns, entis** *m.* rope, cable
**strīdor, ōris** *m.* creaking, grating, whirring
**subitō** *adv.* suddenly
**turbō, inis** *m.* whirl(wind, pool), storm
**ūnā** *adv.* together, at the same time
**velut(ī)** (even) as, just as

81–123. A storm wrecks some of the Trojan ships and scatters the rest. The entire scene is indebted to the description of a storm at sea given by Homer in *Odyssey* 5.

**81. ubi haec dicta (sunt ab Aeolō). cavum conversā cuspide:** observe the ALLITERATION.

**82. impulit:** Aeolus thus opens the barriers and lets out the winds. **agmine factō:** abl. abs.; App. 343; a SIMILE (**velut**) drawn from the imagery of military life.

**83.** Observe the ALLITERATION: every word but one in this line contains a **t. data (est). turbine:** abl. of manner; App. 328; or means.

**84. Incubuēre = incubuērunt,** from **incumbō.** The perfect, after a series of presents, denotes rapid or instantaneous action; *they have fallen upon the sea.* **marī:** dat. with compound; App. 298. **tōtum (mare):** obj. of **ruunt** (85).

**85. ruunt:** *overturn.* **Eurus, Notus, Āfricus:** all the winds blow at once, and in their struggles produce a mighty storm. **procellīs:** abl. of respect or means with **crēber**; App. 325, 331. **-que, -que, -que:** POLYSYNDETON; App. 439.

**86. vastōs volvunt:** ALLITERATION, employed very effectively here to evoke the noise of the storm.

**87. vir(ōr)um:** Aeneas and the other Trojans. **-que, -que:** POLYSYNDETON.

**88. diem = lūcem diēī;** alternatively, **caelumque diemque** may be construed as an instance of HENDIADYS, = **caelum diēī. -que, -que:** POLYSYNDETON.

### Example 5 Using Newton's Law of Cooling

A cheesecake is taken out of the oven with an ideal internal temperature of 165°F, and is placed into a 35°F refrigerator. After 10 minutes, the cheesecake has cooled to 150°F. If we must wait until the cheesecake has cooled to 70°F before we eat it, how long will we have to wait?

Solution Because the surrounding air temperature in the refrigerator is 35 degrees, the cheesecake's temperature will decay exponentially toward 35, following the equation

$$T(t) = Ae^{kt} + 35$$

We know the initial temperature was 165, so $T(0) = 165$.

$$\begin{aligned} 165 &= Ae^{k0} + 35 && \text{Substitute (0, 165).} \\ A &= 130 && \text{Solve for } A. \end{aligned}$$

We were given another data point, $T(10) = 150$, which we can use to solve for $k$.

$$\begin{aligned} 150 &= 130e^{k10} + 35 && \text{Substitute (10, 150).} \\ 115 &= 130e^{k10} && \text{Subtract 35.} \\ \frac{115}{130} &= e^{10k} && \text{Divide by 130.} \\ \ln\left(\frac{115}{130}\right) &= 10k && \text{Take the natural log of both sides.} \\ k &= \frac{\ln\left(\frac{115}{130}\right)}{10} \approx -0.0123 && \text{Divide by the coefficient of } k. \end{aligned}$$

This gives us the equation for the cooling of the cheesecake: $T(t) = 130e^{-0.0123t} + 35$.

Now we can solve for the time it will take for the temperature to cool to 70 degrees.

$$\begin{aligned} 70 &= 130e^{-0.0123t} + 35 && \text{Substitute in 70 for } T(t). \\ 35 &= 130e^{-0.0123t} && \text{Subtract 35.} \\ \frac{35}{130} &= e^{-0.0123t} && \text{Divide by 130.} \\ \ln\left(\frac{35}{130}\right) &= -0.0123t && \text{Take the natural log of both sides} \\ t &= \frac{\ln\left(\frac{35}{130}\right)}{-0.0123} \approx 106.68 && \text{Divide by the coefficient of } t. \end{aligned}$$

It will take about 107 minutes, or one hour and 47 minutes, for the cheesecake to cool to 70°F.

*Try It #17*

A pitcher of water at 40 degrees Fahrenheit is placed into a 70 degree room. One hour later, the temperature has risen to 45 degrees. How long will it take for the temperature to rise to 60 degrees?

## Using Logistic Growth Models

Exponential growth cannot continue forever. Exponential models, while they may be useful in the short term, tend to fall apart the longer they continue. Consider an aspiring writer who writes a single line on day one and plans to double the number of lines she writes each day for a month. By the end of the month, she must write over 17 billion lines, or one-half-billion pages. It is impractical, if not impossible, for anyone to write that much in such a short period of time. Eventually, an exponential model must begin to approach some limiting value, and then the growth is forced to slow. For this reason, it is often better to use a model with an upper bound instead of an exponential growth model, though the exponential growth model is still useful over a short term, before approaching the limiting value.

The **logistic growth model** is approximately exponential at first, but it has a reduced rate of growth as the output approaches the model's upper bound, called the **carrying capacity**. For constants $a$, $b$, and $c$, the logistic growth of a population over time $x$ is represented by the model

$$f(x) = \frac{c}{1 + ae^{-bx}}$$

The graph in **Figure 6** shows how the growth rate changes over time. The graph increases from left to right, but the growth rate only increases until it reaches its point of maximum growth rate, at which point the rate of increase decreases.

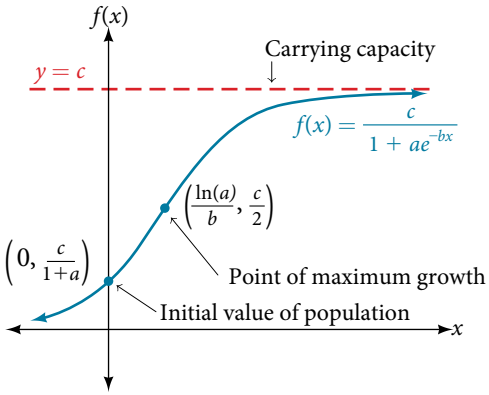



Figure 6

***logistic growth***

The logistic growth model is

$$f(x) = \frac{c}{1 + ae^{-bx}}$$

where

- $\frac{c}{1 + a}$ is the initial value
- $c$ is the *carrying capacity, or limiting value*
- $b$ is a constant determined by the rate of growth.

## Example 6 Using the Logistic-Growth Model

An influenza epidemic spreads through a population rapidly, at a rate that depends on two factors: The more people who have the flu, the more rapidly it spreads, and also the more uninfected people there are, the more rapidly it spreads. These two factors make the logistic model a good one to study the spread of communicable diseases. And, clearly, there is a maximum value for the number of people infected: the entire population.

For example, at time $t = 0$ there is one person in a community of 1,000 people who has the flu. So, in that community, at most 1,000 people can have the flu. Researchers find that for this particular strain of the flu, the logistic growth constant is $b = 0.6030$. Estimate the number of people in this community who will have had this flu after ten days. Predict how many people in this community will have had this flu after a long period of time has passed.

Solution We substitute the given data into the logistic growth model

$$f(x) = \frac{c}{1 + ae^{-bx}}$$

Because at most 1,000 people, the entire population of the community, can get the flu, we know the limiting value is $c = 1000$. To find $a$, we use the formula that the number of cases at time $t = 0$ is $\frac{c}{1 + a} = 1$, from which it follows that $a = 999$. This model predicts that, after ten days, the number of people who have had the flu is $f(x) = \frac{1000}{1 + 999e^{-0.6030x}} \approx 293.8$. Because the actual number must be a whole number (a person has either had the flu or not) we round to 294. In the long term, the number of people who will contract the flu is the limiting value, $c = 1000$.

*Analysis* *Remember that, because we are dealing with a virus, we cannot predict with certainty the number of people infected. The model only approximates the number of people infected and will not give us exact or actual values. The graph in* ***Figure 7*** *gives a good picture of how this model fits the data.*

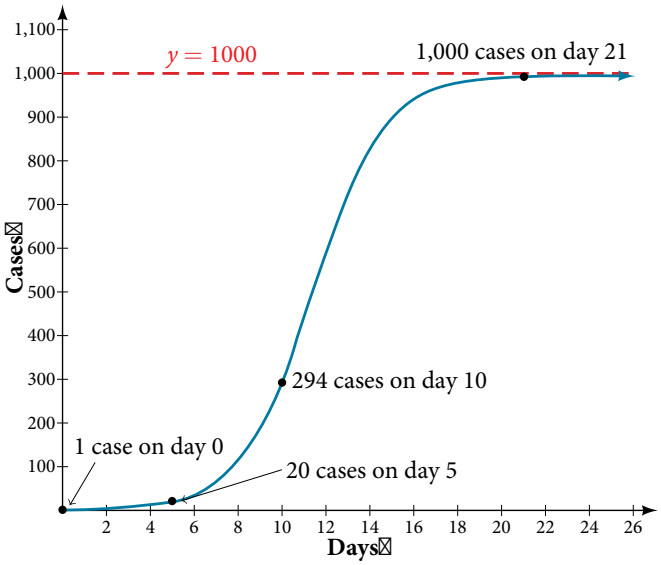



**Figure 7** The graph of $f(x) = \dfrac{1000}{1 + 999e^{-0.6030x}}$

*Try It #18*

Using the model in **Example 6**, estimate the number of cases of flu on day 15.

## Choosing an Appropriate Model for Data

Now that we have discussed various mathematical models, we need to learn how to choose the appropriate model for the raw data we have. Many factors influence the choice of a mathematical model, among which are experience, scientific laws, and patterns in the data itself. Not all data can be described by elementary functions. Sometimes, a function is chosen that approximates the data over a given interval. For instance, suppose data were gathered on the number of homes bought in the United States from the years 1960 to 2013. After plotting these data in a scatter plot, we notice that the shape of the data from the years 2000 to 2013 follow a logarithmic curve. We could restrict the interval from 2000 to 2010, apply regression analysis using a logarithmic model, and use it to predict the number of home buyers for the year 2015.

Three kinds of functions that are often useful in mathematical models are linear functions, exponential functions, and logarithmic functions. If the data lies on a straight line, or seems to lie approximately along a straight line, a linear model may be best. If the data is non-linear, we often consider an exponential or logarithmic model, though other models, such as quadratic models, may also be considered.

In choosing between an exponential model and a logarithmic model, we look at the way the data curves. This is called the concavity. If we draw a line between two data points, and all (or most) of the data between those two points lies above that line, we say the curve is concave down. We can think of it as a bowl that bends downward and therefore cannot hold water. If all (or most) of the data between those two points lies below the line, we say the curve is concave up. In this case, we can think of a bowl that bends upward and can therefore hold water. An exponential curve, whether rising or falling, whether representing growth or decay, is always concave up away from its horizontal asymptote. A logarithmic curve is always concave away from its vertical asymptote. In the case of positive data, which is the most common case, an exponential curve is always concave up, and a logarithmic curve always concave down.

A logistic curve changes concavity. It starts out concave up and then changes to concave down beyond a certain point, called a point of inflection.

After using the graph to help us choose a type of function to use as a model, we substitute points, and solve to find the parameters. We reduce round-off error by choosing points as far apart as possible.

### Example 7 Choosing a Mathematical Model

Does a linear, exponential, logarithmic, or logistic model best fit the values listed in **Table 1**? Find the model, and use a graph to check your choice.

| $x$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| $y$ | 0 | 1.386 | 2.197 | 2.773 | 3.219 | 3.584 | 3.892 | 4.159 | 4.394 |

**Table 1**

Solution First, plot the data on a graph as in **Figure 8**. For the purpose of graphing, round the data to two significant digits.

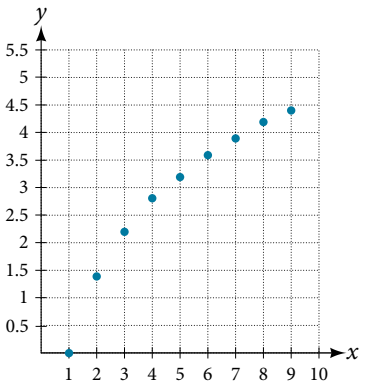



**Figure 8**

Clearly, the points do not lie on a straight line, so we reject a linear model. If we draw a line between any two of the points, most or all of the points between those two points lie above the line, so the graph is concave down, suggesting a logarithmic model. We can try $y = a\ln(bx)$. Plugging in the first point, (1,0), gives $0 = a\ln b$.

We reject the case that $a = 0$ (if it were, all outputs would be 0), so we know $\ln(b) = 0$. Thus $b = 1$ and $y = a\ln(x)$. Next we can use the point (9,4.394) to solve for $a$:

$$y = a\ln(x)$$
$$4.394 = a\ln(9)$$
$$a = \frac{4.394}{\ln(9)}$$

Because $a = \dfrac{4.394}{\ln(9)} \approx 2$, an appropriate model for the data is $y = 2\ln(x)$.

To check the accuracy of the model, we graph the function together with the given points as in **Figure 9**.

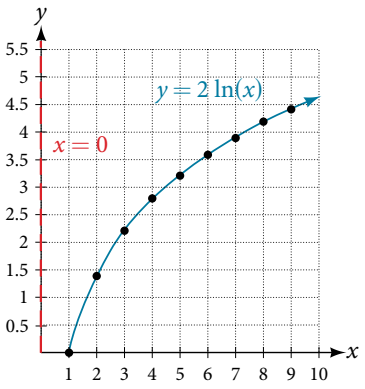



**Figure 9** The graph of $y = 2\ln x$.

We can conclude that the model is a good fit to the data.

Compare **Figure 9** to the graph of $y = \ln(x^2)$ shown in **Figure 10**.

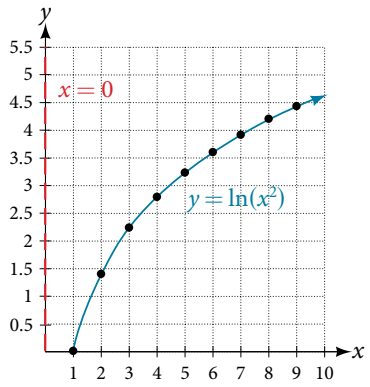



**Figure 10** The graph of $y = \ln(x^2)$

The graphs appear to be identical when $x > 0$. A quick check confirms this conclusion: $y = \ln(x^2) = 2\ln(x)$ for $x > 0$.

However, if $x < 0$, the graph of $y = \ln(x^2)$ includes a "extra" branch, as shown in **Figure 11**. This occurs because, while $y = 2\ln(x)$ cannot have negative values in the domain (as such values would force the argument to be negative), the function $y = \ln(x^2)$ can have negative domain values.

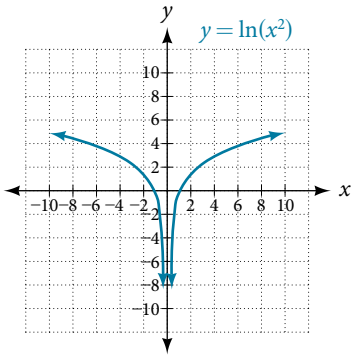



**Figure 11**

*Try It #19*

Does a linear, exponential, or logarithmic model best fit the data in **Table 2**? Find the model.

| $x$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| $y$ | 3.297 | 5.437 | 8.963 | 14.778 | 24.365 | 40.172 | 66.231 | 109.196 | 180.034 |

**Table 2**

## Expressing an Exponential Model in Base *e*

While powers and logarithms of any base can be used in modeling, the two most common bases are 10 and $e$. In science and mathematics, the base $e$ is often preferred. We can use laws of exponents and laws of logarithms to change any base to base $e$.

*How To…*

Given a model with the form $y = ab^x$, change it to the form $y = A_0e^{kx}$.

1. Rewrite $y = ab^x$ as $y = ae^{\ln(b^x)}$.
2. Use the power rule of logarithms to rewrite $y$ as $y = ae^{x\ln(b)} = ae^{\ln(b)x}$.
3. Note that $a = A_0$ and $k = \ln(b)$ in the equation $y = A_0e^{kx}$.

### Example 8 Changing to base $e$

Change the function $y = 2.5(3.1)^x$ so that this same function is written in the form $y = A_0 e^{kx}$.

**Solution**

The formula is derived as follows

$$\begin{aligned} y &= 2.5(3.1)^x \\ &= 2.5e^{\ln(3.1^x)} && \text{Insert exponential and its inverse.} \\ &= 2.5e^{x\ln 3.1} && \text{Laws of logs.} \\ &= 2.5e^{(\ln 3.1)x} && \text{Commutative law of multiplication} \end{aligned}$$

*Try It #20*

Change the function $y = 3(0.5)^x$ to one having $e$ as the base.

Access these online resources for additional instruction and practice with exponential and logarithmic models.

- Logarithm Application – pH (http://openstaxcollege.org/l/logph)
- Exponential Model – Age Using Half-Life (http://openstaxcollege.org/l/expmodelhalf)
- Newton's Law of Cooling (http://openstaxcollege.org/l/newtoncooling)
- Exponential Growth Given Doubling Time (http://openstaxcollege.org/l/expgrowthdbl)
- Exponential Growth – Find Initial Amount Given Doubling Time (http://openstaxcollege.org/l/initialdouble)

## 4.7 SECTION EXERCISES

### VERBAL

**1.** With what kind of exponential model would *half-life* be associated? What role does half-life play in these models?

**2.** What is carbon dating? Why does it work? Give an example in which carbon dating would be useful.

**3.** With what kind of exponential model would *doubling time* be associated? What role does doubling time play in these models?

**4.** Define Newton's Law of Cooling. Then name at least three real-world situations where Newton's Law of Cooling would be applied.

**5.** What is an order of magnitude? Why are orders of magnitude useful? Give an example to explain.

### NUMERIC

**6.** The temperature of an object in degrees Fahrenheit after $t$ minutes is represented by the equation $T(t) = 68e^{-0.0174t} + 72$. To the nearest degree, what is the temperature of the object after one and a half hours?

For the following exercises, use the logistic growth model $f(x) = \dfrac{150}{1 + 8e^{-2x}}$.

**7.** Find and interpret $f(0)$. Round to the nearest tenth.

**8.** Find and interpret $f(4)$. Round to the nearest tenth.

**9.** Find the carrying capacity.

**10.** Graph the model.

**11.** Determine whether the data from the table could best be represented as a function that is linear, exponential, or logarithmic. Then write a formula for a model that represents the data.

| $x$ | –2 | –1 | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|
| $f(x)$ | 0.694 | 0.833 | 1 | 1.2 | 1.44 | 1.728 | 2.074 | 2.488 |

**12.** Rewrite $f(x) = 1.68(0.65)^x$ as an exponential equation with base $e$ to five significant digits.

### TECHNOLOGY

For the following exercises, enter the data from each table into a graphing calculator and graph the resulting scatter plots. Determine whether the data from the table could represent a function that is linear, exponential, or logarithmic.

**13.**

| $x$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| $f(x)$ | 2 | 4.079 | 5.296 | 6.159 | 6.828 | 7.375 | 7.838 | 8.238 | 8.592 | 8.908 |

**14.**

| $x$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| $f(x)$ | 2.4 | 2.88 | 3.456 | 4.147 | 4.977 | 5.972 | 7.166 | 8.6 | 10.32 | 12.383 |

**15.**

| $x$ | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|
| $f(x)$ | 9.429 | 9.972 | 10.415 | 10.79 | 11.115 | 11.401 | 11.657 | 11.889 | 12.101 | 12.295 |

**16.**

| $x$ | 1.25 | 2.25 | 3.56 | 4.2 | 5.65 | 6.75 | 7.25 | 8.6 | 9.25 | 10.5 |
|---|---|---|---|---|---|---|---|---|---|---|
| $f(x)$ | 5.75 | 8.75 | 12.68 | 14.6 | 18.95 | 22.25 | 23.75 | 27.8 | 29.75 | 33.5 |

For the following exercises, use a graphing calculator and this scenario: the population of a fish farm in $t$ years is modeled by the equation $P(t) = \dfrac{1000}{1 + 9e^{-0.6t}}$.

**17.** Graph the function.

**18.** What is the initial population of fish?

**19.** To the nearest tenth, what is the doubling time for the fish population?

**20.** To the nearest whole number, what will the fish population be after 2 years?

**21.** To the nearest tenth, how long will it take for the population to reach 900?

**22.** What is the carrying capacity for the fish population? Justify your answer using the graph of $P$.

## EXTENSIONS

**23.** A substance has a half-life of 2.045 minutes. If the initial amount of the substance was 132.8 grams, how many half-lives will have passed before the substance decays to 8.3 grams? What is the total time of decay?

**24.** The formula for an increasing population is given by $P(t) = P_0 e^{rt}$ where $P_0$ is the initial population and $r > 0$. Derive a general formula for the time $t$ it takes for the population to increase by a factor of $M$.

**25.** Recall the formula for calculating the magnitude of an earthquake, $M = \frac{2}{3}\log\left(\frac{S}{S_0}\right)$. Show each step for solving this equation algebraically for the seismic moment $S$.

**26.** What is the $y$-intercept of the logistic growth model $y = \frac{c}{1 + ae^{-rx}}$? Show the steps for calculation. What does this point tell us about the population?

**27.** Prove that $b^x = e^{x\ln(b)}$ for positive $b \neq 1$.

## REAL-WORLD APPLICATIONS

For the following exercises, use this scenario: A doctor prescribes 125 milligrams of a therapeutic drug that decays by about 30% each hour.

**28.** To the nearest hour, what is the half-life of the drug?

**29.** Write an exponential model representing the amount of the drug remaining in the patient's system after $t$ hours. Then use the formula to find the amount of the drug that would remain in the patient's system after 3 hours. Round to the nearest milligram.

**30.** Using the model found in the previous exercise, find $f(10)$ and interpret the result. Round to the nearest hundredth.

For the following exercises, use this scenario: A tumor is injected with 0.5 grams of Iodine-125, which has a decay rate of 1.15% per day.

**31.** To the nearest day, how long will it take for half of the Iodine-125 to decay?

**32.** Write an exponential model representing the amount of Iodine-125 remaining in the tumor after $t$ days. Then use the formula to find the amount of Iodine-125 that would remain in the tumor after 60 days. Round to the nearest tenth of a gram.

**33.** A scientist begins with 250 grams of a radioactive substance. After 250 minutes, the sample has decayed to 32 grams. Rounding to five significant digits, write an exponential equation representing this situation. To the nearest minute, what is the half-life of this substance?

**34.** The half-life of Radium-226 is 1590 years. What is the annual decay rate? Express the decimal result to four significant digits and the percentage to two significant digits.

**35.** The half-life of Erbium-165 is 10.4 hours. What is the hourly decay rate? Express the decimal result to four significant digits and the percentage to two significant digits.

**36.** A wooden artifact from an archeological dig contains 60 percent of the carbon-14 that is present in living trees. To the nearest year, about how many years old is the artifact? (The half-life of carbon-14 is 5730 years.)

**37.** A research student is working with a culture of bacteria that doubles in size every twenty minutes. The initial population count was 1350 bacteria. Rounding to five significant digits, write an exponential equation representing this situation. To the nearest whole number, what is the population size after 3 hours?

For the following exercises, use this scenario: A biologist recorded a count of 360 bacteria present in a culture after 5 minutes and 1,000 bacteria present after 20 minutes.

**38.** To the nearest whole number, what was the initial population in the culture?

**39.** Rounding to six significant digits, write an exponential equation representing this situation. To the nearest minute, how long did it take the population to double?

For the following exercises, use this scenario: A pot of boiling soup with an internal temperature of 100° Fahrenheit was taken off the stove to cool in a 69° F room. After fifteen minutes, the internal temperature of the soup was 95° F.

**40.** Use Newton's Law of Cooling to write a formula that models this situation.

**41.** To the nearest minute, how long will it take the soup to cool to 80° F?

**42.** To the nearest degree, what will the temperature be after 2 and a half hours?

For the following exercises, use this scenario: A turkey is taken out of the oven with an internal temperature of 165° Fahrenheit and is allowed to cool in a 75° F room. After half an hour, the internal temperature of the turkey is 145° F.

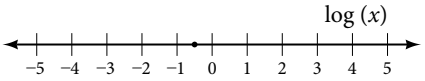
**43.** Write a formula that models this situation.

**44.** To the nearest degree, what will the temperature be after 50 minutes?

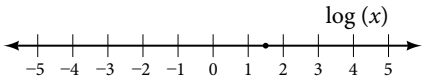
**45.** To the nearest minute, how long will it take the turkey to cool to 110° F?

For the following exercises, find the value of the number shown on each logarithmic scale. Round all answers to the nearest thousandth.

**46.**




**47.**




**48.** Plot each set of approximate values of intensity of sounds on a logarithmic scale: Whisper: $10^{-10}\frac{W}{m^2}$, Vacuum: $10^{-4}\frac{W}{m^2}$, Jet: $10^{2}\frac{W}{m^2}$

**49.** Recall the formula for calculating the magnitude of an earthquake, $M = \frac{2}{3}\log\left(\frac{S}{S_0}\right)$. One earthquake has magnitude 3.9 on the MMS scale. If a second earthquake has 750 times as much energy as the first, find the magnitude of the second quake. Round to the nearest hundredth.

For the following exercises, use this scenario: The equation $N(t) = \frac{500}{1 + 49e^{-0.7t}}$ models the number of people in a town who have heard a rumor after $t$ days.

**50.** How many people started the rumor?

**51.** To the nearest whole number, how many people will have heard the rumor after 3 days?

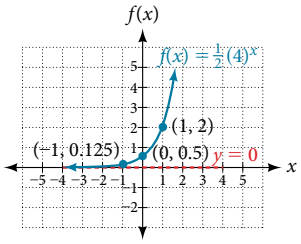
**52.** As $t$ increases without bound, what value does $N(t)$ approach? Interpret your answer.

For the following exercise, choose the correct answer choice.

**53.** A doctor and injects a patient with 13 milligrams of radioactive dye that decays exponentially. After 12 minutes, there are 4.75 milligrams of dye remaining in the patient's system. Which is an appropriate model for this situation?

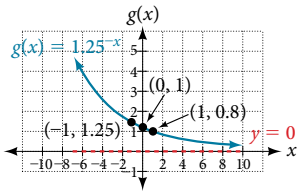
**a.** $f(t) = 13(0.0805)^t$ **b.** $f(t) = 13\,e^{0.9195t}$ **c.** $f(t) = 13\,e^{(-0.0839t)}$ **d.** $f(t) = \frac{4.75}{1 + 13e^{-0.83925t}}$

**4.**




The domain is $(-\infty, \infty)$; the range is $(0, \infty)$; the horizontal asymptote is $y = 0$.

**5.**




The domain is $(-\infty, \infty)$; the range is $(0, \infty)$; the horizontal asymptote is $y = 0$.

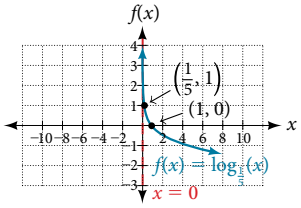
**6.** $f(x) = -\frac{1}{3}e^x - 2$; the domain is $(-\infty, \infty)$; the range is $(-\infty, 2)$; the horizontal asymptote is $y = 2$.

## Section 4.3

**1. a.** $\log_{10}(1{,}000{,}000) = 6$ is equivalent to $10^6 = 1{,}000{,}000$
**b.** $\log_5(25) = 2$ is equivalent to $5^2 = 25$ **2. a.** $3^2 = 9$ is equivalent to $\log_3(9) = 2$ **b.** $5^3 = 125$ is equivalent to $\log_5(125) = 3$
**c.** $2^{-1} = \frac{1}{2}$ is equivalent to $\log_2\left(\frac{1}{2}\right) = -1$
**3.** $\log_{121}(11) = \frac{1}{2}$ (recalling that $\sqrt{121} = 121^{\frac{1}{2}} = 11$)
**4.** $\log_2\left(\frac{1}{32}\right) = -5$ **5.** $\log(1{,}000{,}000) = 6$ **6.** $\log(123) \approx 2.0899$
**7.** The difference in magnitudes was about 3.929. **8.** It is not possible to take the logarithm of a negative number in the set of real numbers.

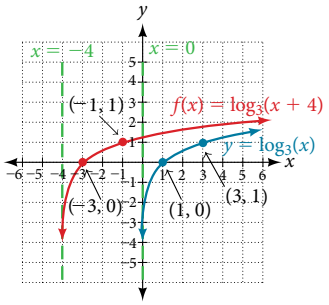
## Section 4.4

**1.** $(2, \infty)$ **2.** $(5, \infty)$
**3.**



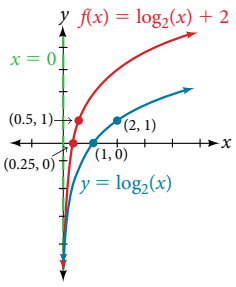

The domain is $(0, \infty)$, the range is $(-\infty, \infty)$, and the vertical asymptote is $x = 0$.

**4.**



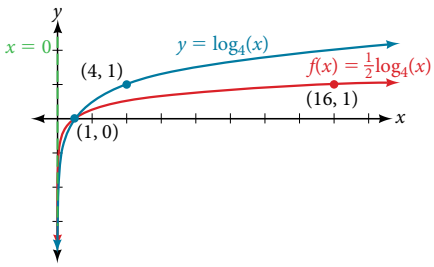

The domain is $(-4, \infty)$, the range $(-\infty, \infty)$, and the asymptote $x = -4$.

**5.**



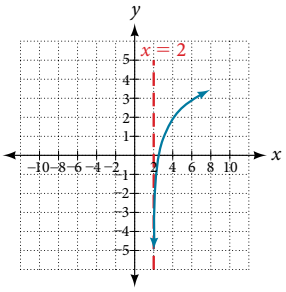

The domain is $(0, \infty)$, the range is $(-\infty, \infty)$, and the vertical asymptote is $x = 0$.

**6.**



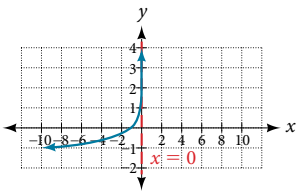

The domain is $(0, \infty)$, the range is $(-\infty, \infty)$, and the vertical asymptote is $x = 0$.

**7.**




The domain is $(2, \infty)$, the range is $(-\infty, \infty)$, and the vertical asymptote is $x = 2$.

**8.**




The domain is $(-\infty, 0)$, the range is $(-\infty, \infty)$, and the vertical asymptote is $x = 0$.
**9.** $x \approx 3.049$ **10.** $x = 1$
**11.** $f(x) = 2\ln(x + 3) - 1$

## Section 4.5

**1.** $\log_b(2) + \log_b(2) + \log_b(2) + \log_b(k) = 3\log_b(2) + \log_b(k)$
**2.** $\log_3(x + 3) - \log_3(x - 1) - \log_3(x - 2)$ **3.** $2\ln(x)$
**4.** $-2\ln(x)$ **5.** $\log_3(16)$ **6.** $2\log(x) + 3\log(y) - 4\log(z)$
**7.** $\frac{2}{3}\ln(x)$ **8.** $\frac{1}{2}\ln(x - 1) + \ln(2x + 1) - \ln(x + 3) - \ln(x - 3)$
**9.** $\log\left(\frac{3 \cdot 5}{4 \cdot 6}\right)$; can also be written $\log\left(\frac{5}{8}\right)$ by reducing the fraction to lowest terms. **10.** $\log\left(\frac{5(x-1)^3\sqrt{x}}{(7x-1)}\right)$
**11.** $\log\frac{x^{12}(x+5)^4}{(2x+3)^4}$; this answer could also be written $\log\left(\frac{x^3(x+5)}{(2x+3)}\right)^4$.
**12.** The pH increases by about 0.301. **13.** $\frac{\ln(8)}{\ln(0.5)}$
**14.** $\frac{\ln(100)}{\ln(5)} \approx \frac{4.6051}{1.6094} = 2.861$

## Section 4.6

**1.** $x = -2$ **2.** $x = -1$ **3.** $x = \frac{1}{2}$
**4.** The equation has no solution. **5.** $x = \frac{\ln(3)}{\ln\left(\frac{2}{3}\right)}$
**6.** $t = 2\ln\left(\frac{11}{3}\right)$ or $\ln\left(\frac{11}{3}\right)^2$
**7.** $t = \ln\left(\frac{1}{\sqrt{2}}\right) = -\frac{1}{2}\ln(2)$ **8.** $x = \ln(2)$ **9.** $x = e^4$
**10.** $x = e^5 - 1$ **11.** $x \approx 9.97$ **12.** $x = 1$ or $x = -1$
**13.** $t = 703{,}800{,}000 \times \frac{\ln(0.8)}{\ln(0.5)}$ years $\approx 226{,}572{,}993$ years.

## Section 4.7

**1.** $f(t) = A_0 e^{-0.0000000087t}$ **2.** Less than 230 years; 229.3157 to be exact
**3.** $f(t) = A_0 e^{\left(\frac{\ln(2)}{3}\right)t}$ **4.** 6.026 hours **5.** 895 cases on day 15
**6.** Exponential. $y = 2e^{0.5x}$ **7.** $y = 3e^{(\ln 0.5)x}$

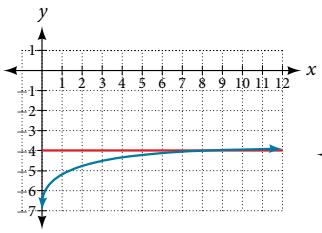
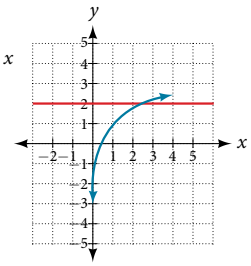
**23.** $x = \dfrac{\ln\left(\frac{3}{5}\right) - 3}{8}$ **25.** No solution **27.** $x = \ln(3)$

**29.** $10^{-2} = \dfrac{1}{100}$ **31.** $n = 49$ **33.** $k = \dfrac{1}{36}$ **35.** $x = \dfrac{9 - e}{8}$

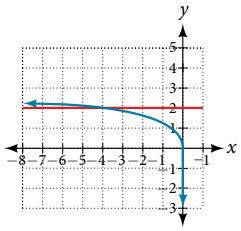
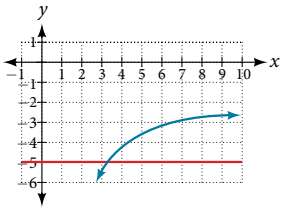
**37.** $n = 1$ **39.** No solution **41.** No solution

**43.** $x = \pm\dfrac{10}{3}$ **45.** $x = 10$ **47.** $x = 0$ **49.** $x = \dfrac{3}{4}$

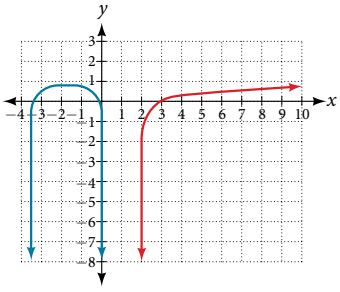
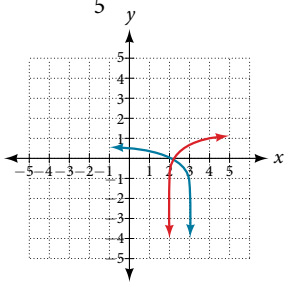
**51.** $x = 9$ **53.** $x = \dfrac{e^2}{3} \approx 2.5$

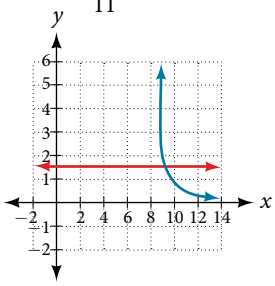
**55.** $x = -5$ **57.** $x = \dfrac{e + 10}{4} \approx 3.2$

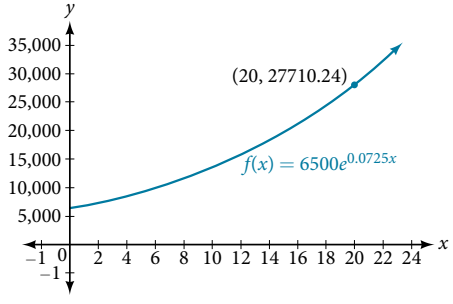
**59.** No solution **61.** $x = \dfrac{11}{5} \approx 2.2$

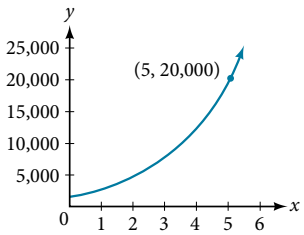
**63.** $x = \dfrac{101}{11} \approx 9.2$



**65.** About $27,710.24




**67.** About 5 years




**69.** $\approx 0.567$ **71.** $\approx 2.078$

**73.** $\approx 2.2401$

**75.** $\approx -44655.7143$

**77.** About 5.83

**79.** $t = \ln\left(\left(\dfrac{y}{A}\right)^{\frac{1}{k}}\right)$

**81.** $t = \ln\left(\left(\dfrac{T - T_s}{T_0 - T_s}\right)^{-\frac{1}{k}}\right)$

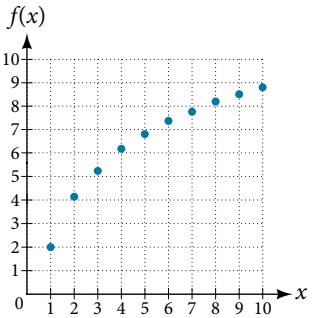
## Section 4.7

**1.** Half-life is a measure of decay and is thus associated with exponential decay models. The half-life of a substance or quantity is the amount of time it takes for half of the initial amount of that substance or quantity to decay. **3.** Doubling time is a measure of growth and is thus associated with exponential growth models. The doubling time of a substance or quantity is the amount of time it takes for the initial amount of that substance or quantity to double in size. **5.** An order of magnitude is the nearest power of ten by which a quantity exponentially grows. It is also an approximate position on a logarithmic scale; Sample response: Orders of magnitude are useful when making comparisons between numbers that differ by a great amount. For example, the mass of Saturn is 95 times greater than the mass of Earth. This is the same as saying that the mass of Saturn is about $10^2$ times, or 2 *orders of magnitude* greater, than the mass of Earth.

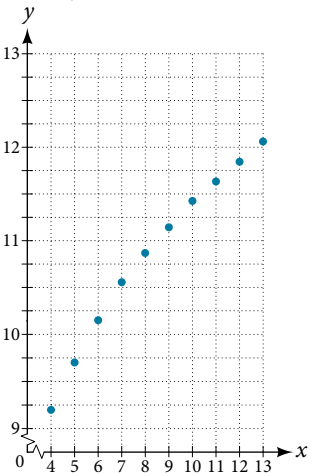
**7.** $f(0) \approx 16.7$; the amount initially present is about 16.7 units.

**9.** 150 **11.** Exponential; $f(x) = 1.2^x$

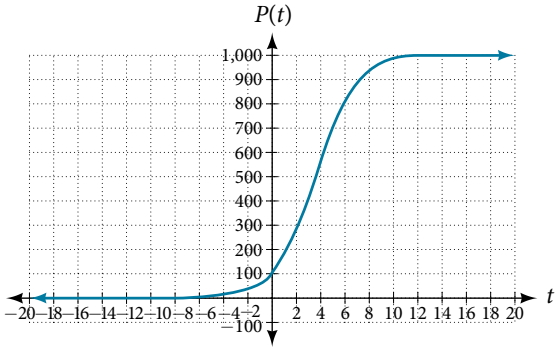
**13.** Logarithmic




**15.** Logarithmic



**17.**



**19.** About 1.4 years **21.** About 7.3 years
**23.** Four half-lives; 8.18 minutes
**25.** $M = \frac{2}{3}\log\left(\frac{S}{S_0}\right)$

$\frac{3}{2}M = \log\left(\frac{S}{S_0}\right)$

$10^{\frac{3M}{2}} = \left(\frac{S}{S_0}\right)$

$S_0 10^{\frac{3M}{2}} = S$

**27.** Let $y = b^x$ for some non-negative real number $b$ such that $b \neq 1$. Then,

$\ln(y) = \ln(b^x)$

$\ln(y) = x\ln(b)$

$e^{\ln(y)} = e^{x\ln(b)}$

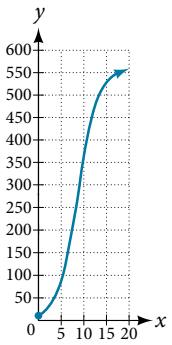
$y = e^{x\ln(b)}$

**29.** $A = 125e^{(-0.3567t)}$; $A \approx 43$mg **31.** About 60 days
**33.** $f(t) = 250e^{-0.00914t}$; half-life: about 76 minutes
**35.** $r \approx -0.0667$; hourly decay rate: about 6.67%
**37.** $f(t) = 1350\,e^{0.034657359t}$; after 3 hours; $P(180) \approx 691{,}200$
**39.** $f(t) = 256\,e^{(0.068110t)}$; doubling time: about 10 minutes
**41.** About 88minutes **43.** $T(t) = 90\,e^{(-0.008377t)} + 75$, where $t$ is in minutes **45.** About 113 minutes **47.** $\log_{10} x = 1.5$; $x \approx 31.623$
**49.** MMS Magnitude: $\approx 5.82$ **51.** $N(3) \approx 71$ **53.** C

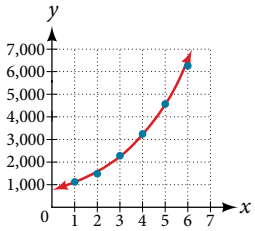
## Section 4.8

**1.** Logistic models are best used for situations that have limited values. For example, populations cannot grow indefinitely since resources such as food, water, and space are limited, so a logistic model best describes populations. **3.** Regression analysis is the process of finding an equation that best fits a given set of data points. To perform a regression analysis on a graphing utility, first list the given points using the STAT then EDIT menu. Next graph the scatter plot using the STAT PLOT feature. The shape of the data points on the scatter graph can help determine which regression feature to use. Once this is determined, select the appropriate regression analysis command from the STAT then CALC menu.
**5.** The $y$-intercept on the graph of a logistic equation corresponds to the initial population for the population model.
**7.** C **9.** B **11.** $P(0) = 22$; 175
**13.** $p \approx 2.67$ **15.** $y$-intercept: (0, 15) **17.** 4 koi
**19.** About 6.8 months.

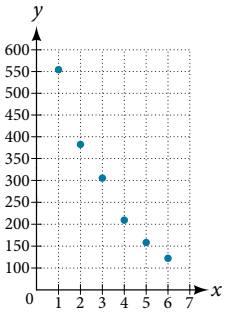
**21.**



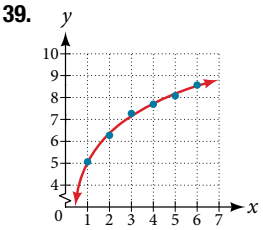

**23.** About 38 wolves
**25.** About 8.7 years
**27.** $f(x) = 776.682\,(1.426)^x$
**29.**



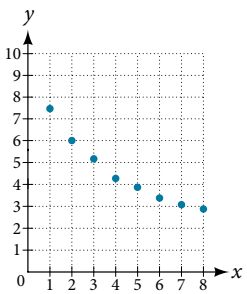

**31.**




**33.** $f(x) = 731.92e^{-0.3038x}$
**35.** When $f(x) = 250$, $x \approx 3.6$
**37.** $y = 5.063 + 1.934\log(x)$
**39.**

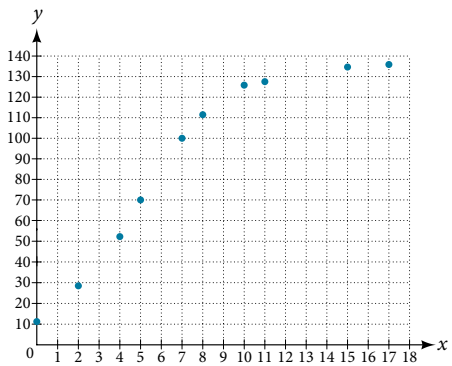



**41.**

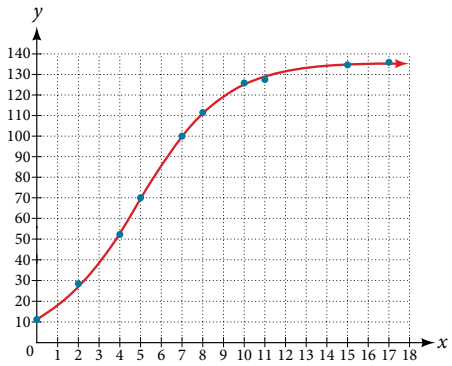



**43.** $f(10) \approx 2.3$
**45.** When $f(x) = 8$, $x \approx 0.82$
**47.** $f(x) = \dfrac{25.081}{1 + 3.182e^{-0.545x}}$
**49.** About 25

**51.**




**53.**

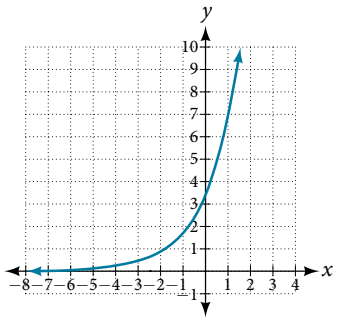



**55.** When $f(x) = 68$, $x \approx 4.9$ **57.** $f(x) = 1.034341(1.281204)^x$; $g(x) = 4.035510$; the regression curves are symmetrical about $y = x$, so it appears that they are inverse functions.

**59.** $f^{-1}(x) = \dfrac{\ln(a) - \ln\left(\frac{c}{x} - 1\right)}{b}$

## Chapter 4 Review Exercises

**1.** Exponential decay; the growth factor, 0.825, is between 0 and 1.
**3.** $y = 0.25(3)^x$ **5.** \$42,888.18 **7.** Continuous decay; the growth rate is negative
**9.** Domain: all real numbers; range: all real numbers strictly greater than zero; $y$-intercept: (0, 3.5)



## 19 Cómo era de niño(a)

**ESCRIBIR, HABLAR EN PAREJA** Escribe frases para hablar de tu niñez *(childhood)* usando las formas apropiadas del imperfecto de los verbos. Usa tus propias ideas e incluye detalles para cada frase. Después trabaja con otro(a) estudiante y lean sus frases. ¿Eran similares o diferentes sus experiencias?

1. Cuando yo *(ser)* niño(a), *(ser)* muy . . .
2. Mis amigos *(ser)* . . .
3. De vez en cuando mi familia y yo *(ir)* . . .
4. A menudo yo *(ir)* a la casa de . . .
5. Mis hermanos (o amigos) y yo *(jugar)* . . .
6. Por lo general yo *(ver)* a mis primos . . .

## 20 El (La) estudiante modelo

**ESCRIBIR, HABLAR EN GRUPO**

1. En una hoja de papel, escribe cuatro descripciones de cómo eras y qué hacías en la escuela primaria.
2. Trabaja con un grupo de tres. Lean sus descripciones de cómo eran en la escuela primaria. Apunten en una hoja de papel cómo responden los tres. Después escriban un resumen *(summary)* de cómo eran.

**Modelo**

*Era muy obediente. Siempre obedecía las reglas de la escuela.*

**Modelo**

*María y yo éramos muy buenos estudiantes y siempre escuchábamos a los profesores. Antonio era un poco desobediente y nunca escuchaba a los profesores.*

## 21 Juego

**ESCRIBIR, HABLAR EN GRUPO**

Frida Kahlo

1. Trabaja con otro(a) estudiante. Escriban una descripción del punto de vista de una persona del pasado que muchos estudiantes conocen. La descripción debe incluir detalles de cómo era, de dónde era, qué hacía para ser famoso(a), dónde vivía la persona y más.
2. Lean su descripción a otras parejas de estudiantes. Si los otros estudiantes identifican a la persona, reciben cinco puntos. Si ellos no pueden identificar a la persona, Uds. reciben cinco puntos.

**Videomodelo**

A —*Era de México. De niña a menudo estaba enferma. Cuando era mayor era artista y pintaba mucho. Diego Rivera*

# Gramática
## Repaso

**OBJECTIVES**

- Talk and write about what people used to do for others
- Exchange information about what you were allowed to do in elementary school

Go Online to practice
PEARSON realize
PearsonSchool.com/AutenticoTX
VIDEO WRITING

## Indirect object pronouns

Remember that an indirect object tells to whom or for whom an action is performed. Indirect object pronouns are used to replace or accompany an indirect object noun.

Nuestros profesores no **nos** permitían beber refrescos en clase.

Sus abuelos siempre **les** daban regalos **a los niños.**

- Because *le* and *les* have more than one meaning, you can make the meaning clear by adding *a* + name, noun, or pronoun.

Lolita siempre **les** decía la verdad a **sus padres.**

Lolita siempre **les** decía la verdad **a ellos.**

- Like direct object pronouns and reflexive pronouns, indirect object pronouns are placed right before the verb or attached to the infinitive.

Siempre **le** quería comprar dulces a su hija.

Siempre quería comprar**le** dulces a su hija.

| Singular | |
|---|---|
| **me** | (to / for) me |
| **te** | (to / for) you *(familiar)* |
| **le** | (to / for) him, her, you *(formal)* |

| Plural | |
|---|---|
| **nos** | (to / for) us |
| **os** | (to / for) you *(familiar)* |
| **les** | (to / for) them, you *(formal)* |

**Más recursos** ONLINE

- *GramActiva* Video
- **Tutorial:** Indirect objects
- *GramActiva* Activity

22

## Una tía muy generosa

**ESCRIBIR** Mi tía era muy generosa, pero siempre nos compraba los mismos regalos. Escribe frases para decir lo que compraba ella.

**Modelo**
*Por lo general ella le compraba una corbata a mi padre.*


mi padre


1. mi madre


2. mis hermanitas


3. yo


4. su esposo


5. mis primos


6. nosotros

## ¿Qué les permitían hacer?

**HABLAR EN PAREJA** Trabaja con otro(a) estudiante para hablar de lo que les permitían hacer en la escuela primaria.

1. comer y beber en la sala de clases
2. tener animales en la escuela
3. jugar en el patio de recreo
4. ver películas en clase

**¡Respuesta personal!**

**Videomodelo**

**A** —*¿Les permitían llevar gorras en la escuela primaria?*

**B** —*No, no nos permitían llevar gorras.*

**o:** —*Sí, nos permitían llevar gorras, pero sólo en los días especiales.*

## CULTURA El mundo hispano

**Juguetes mayas** Los mayas no usaban la rueda[1] para el trabajo, pero crearon juguetes de niños en forma de animales (reales e inventados), con ruedas. Estos juguetes eran similares al *pull-toy* que se usa hoy.

- ¿Son similares los juguetes de los mayas a los juguetes con los que tú jugabas de niño(a), o son diferentes? Explica las diferencias.

**Pre-AP Integration: Los temas económicos.** Explica el impacto[2] de no tener ruedas en los mayas. ¿Cómo crees que viajaban o llevaban cosas en la vida diaria[3]?

[1]wheel [2]impact [3]everyday life

## Jugando con los amigos

**LEER, ESCRIBIR, HABLAR** Estudia el cuadro, lee el párrafo y luego contesta las preguntas.

1. ¿Quiénes crees que son las personas mayores del cuadro?
2. Con otro(a) estudiante, imaginen que Uds. eran unos niños del cuadro y que ya son mayores. Hablen de los juguetes que tenían cuando eran niños(as).
3. Ahora imaginen que Uds. tienen sesenta años. Piensen en los juguetes que les

▲ "Los niños del futuro" (1998)

# Lectura

**OBJECTIVES**

- Read a fable from Mexico
- Identify main idea and supporting details from fiction texts

**Estrategia**

**Identify main idea**

What do you think might happen between a cricket and a jaguar? Read the questions at the end of the reading to help you focus on the main idea of this fiction text and identify the supporting details.

# El grillo y el jaguar

## Una fábula mexicana

Hace ya muchísimos años, sólo vivían por el mundo los animales. Y el rey de todos era el jaguar.

Un día el jaguar salió de su casa rugiendo[1] y empezó a correr al lago porque tenía sed. Como todos los animales le tenían miedo[2], se escondieron[3]. Todos menos el grillo, que no lo oyó[4] porque cantaba muy contento en su jardín.

El jaguar se sorprendió[5] cuando no vio a nadie, pero oyó la canción del grillo.

—¿Quién canta esa canción tan fea? —se preguntó el jaguar.

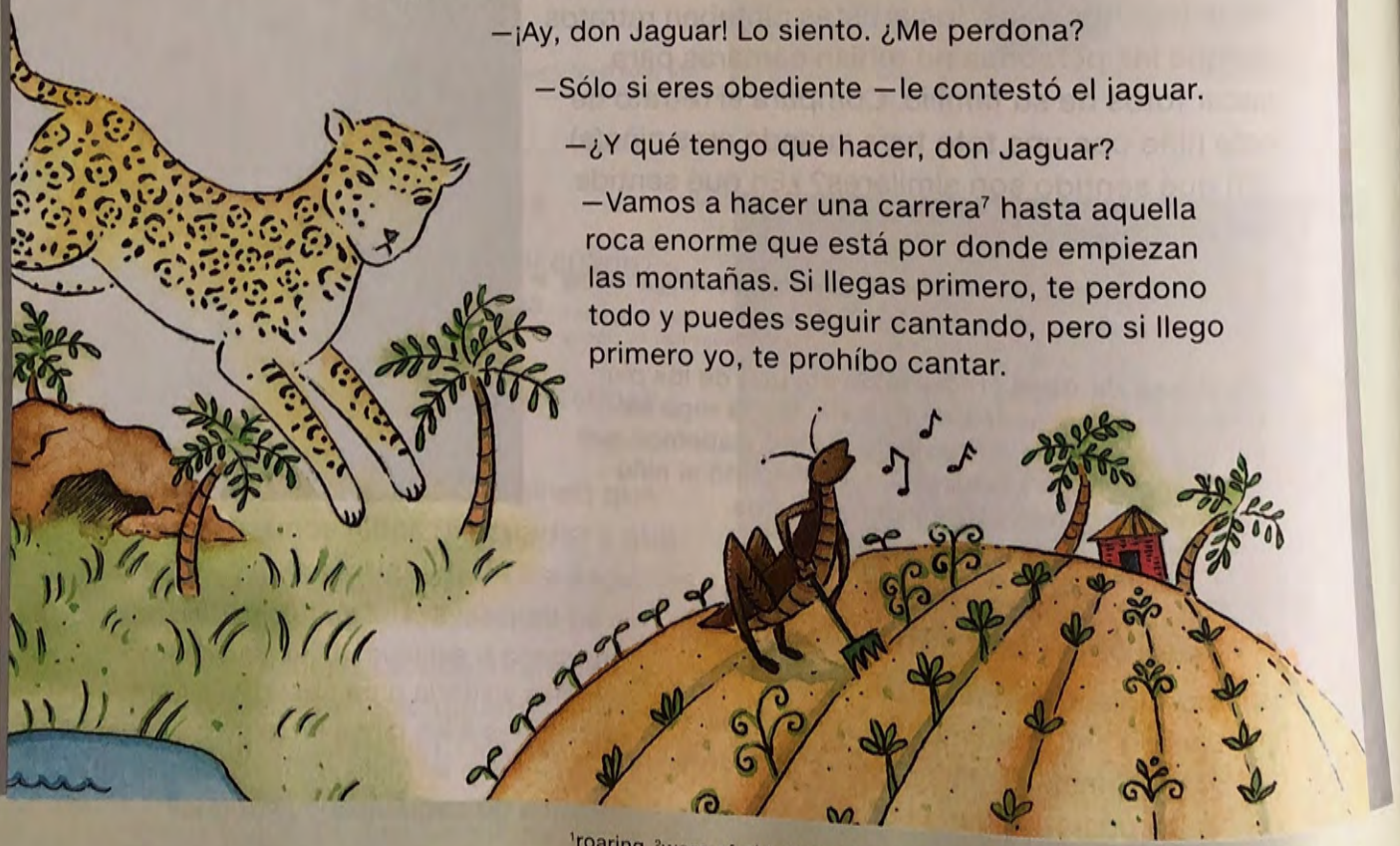
Cuando el jaguar vio al grillo, le rugió: —¡Qué mal educado eres, grillo! ¿Por qué no me saludas[6]?

—¡Ay, don Jaguar! Lo siento. ¿Me perdona?

—Sólo si eres obediente —le contestó el jaguar.

—¿Y qué tengo que hacer, don Jaguar?

—Vamos a hacer una carrera[7] hasta aquella roca enorme que está por donde empiezan las montañas. Si llegas primero, te perdono todo y puedes seguir cantando, pero si llego primero yo, te prohíbo cantar.



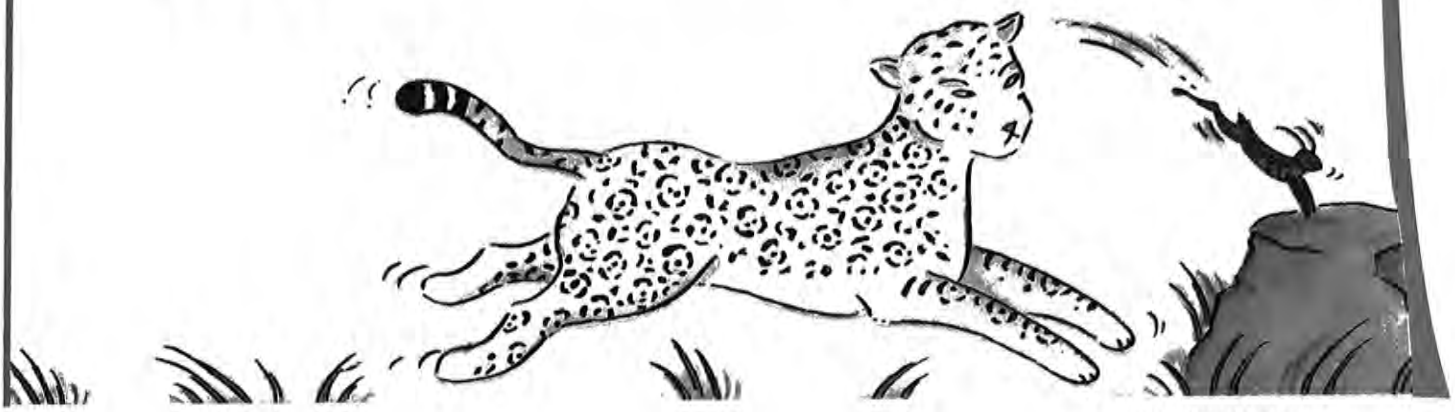
[1]roaring [2]were afraid [3]they hid [4]didn't hear him [5]was surprised [6]greet me

El grillo no contestó inmediatamente, pero por fin dijo:
—Bien. ¿Cuándo corremos?

—¡Ahora mismo! —respondió el jaguar.

Al oír "ahora mismo" el grillo saltó a la cola[8] del jaguar y muy despacito iba saltando hasta llegar a su cabeza. Así llegaron los dos a la roca enorme. Pero en ese momento (y antes de que el jaguar lo viera[9]), el grillo saltó de la cabeza del jaguar a la roca y dijo: —¡Hola, don Jaguar! Estaba esperándolo.

El jaguar no sabía qué decir, pero perdonó al grillo, y el grillo empezó a cantar otra vez.



[8]tail [9]could see

## ¿Comprendiste?

1. ¿Cuál es la idea principal de esta leyenda? ¿Cuáles son algunos detalles de apoyo?
2. Según esta leyenda, ¿quiénes vivían por el mundo hace muchos años?
3. ¿Por qué se escondieron todos los animales?
4. ¿Por qué el grillo no oyó al jaguar?
5. Según el jaguar, ¿cómo era la canción del grillo?
6. ¿Qué hizo el grillo para llegar primero a la roca?
7. Al fin, ¿quién era más inteligente, el jaguar o el grillo?

## Y tú, ¿qué dices?

Hace muchísimos años que las fábulas son importantes en muchas culturas para enseñarles a los niños y a los adultos lecciones sobre la vida. En muchas fábulas los personajes son animales. Trabaja con otro(a) estudiante. Piensen en una fábula. ¿Cuál es la idea principal? ¿Qué detalles son importantes? Describan a los animales en la fábula que eligieron.

**Modelo**

*La tortuga caminaba muy lentamente y era muy trabajadora.*

**Para decir más . . .**

**el conejo** = rabbit
**la gallina, el gallo** = hen, rooster
**el león** = lion
**el zorro** = fox