it is 354 K. 1/T, the slope is 1. 11.86 (a) There 30 double bonds.

a liquid crystal is rigid and has its nid crystal is fluid. ryl benzoate has a diate between those uid-crystalline ansition temperarature is increased. Vematic and smetic es aligned with their some additional orules are stacked in ct to molecules in a second subal intermolecular es present in the solute-liquid crysorder, and very few fore the stability yed. 12.11 Polyar mass formed by ll molecules with

$$\begin{array}{c} CH_3 \\ -O \\ -O \\ -n \end{array} + nH_2O$$

ases hardness; rdness; (e) deier is a polymer
eased from a disier can be shaped
or pressure. (c)
reshaped once set
Is that crosslink
ceramics are

more resistant to heat than are plastics, are significantly less dense than metals, are resistant to corrosion and wear, and are not easily deformed by stress. 12.25 Each Si is bound to four C atoms, and each C is bound to four Si atoms in a tetrahedral arrangement, producing an exended three-dimensional network. The extended threedimensional nature of the structure produces the excepional hardness, and the covalent character of the bonding network provides the great thermal stability. 12.27 Ceramic materials typically have rigid three-dimensional lattices; movements of atoms with respect to one another require the breaking of chemical bonds. As bonds in a ceramic are broken under stress, the break tends to propagate itself by applying stress to adjacent atoms and bonds. 12.29 If we begin with solid metal hydroxide and add the appropriate solvents, we have little control over the particle size of the suspended solid or the uniformity of the sol. These characteristics of the sol are very important in determining the ultimate purity, particle size, and fracture resistance of the ceramic produced. 12.31 A composite is a material in which ceramic fibers have been embedded in a host ceramic matrix; the composite will be much more fracture-resistant than the pure host ceramic. 12.33 (a) Limited electrical conductivity hat changes reproducibly with temperature: (b) hardness and fracture resistance due to fiber reinforcement; (c) structural stability and electrical insulation; (d) heat resistance and low density. 12.35 A superconducting material exhibits no resistance to the flow of an electrical current. A related property, known as the Meissner effect, is that all magnetic field lines are excluded from the volume of the material. 12.37 A thin film is a very thin (0.1- to 300-\mum) coating of a material deposited on a substrate. 12.39 A tantalum carbide thin film on a cutting tool should be heat- and fracture-resistant, adhere well to the metal substrate of the tool, have a uniform thickness, be of precisely known composition, and be free of imperfections or dislocations. 12.41 Vacuum deposition, sputtering, and chemical vapor deposition. 12.43 In order to show liquid-crystalline behavior, a substance must be ordered in one or more directions. Molecules with strictly C—C backbones have so much flexibility that long-range ordering is unlikely, even in one direction. 12.46 Because hydrogen bonding is a much stronger intermolecular interaction than London dispersion forces, nylon has stronger interactions between polymer chains and is a harder material than polyethylene. 12.49 (a) Polymer; (b) ceramic; (c) ceramic; (d) polymer; (e) liquid crystal.

12.53 (a)
$$\begin{array}{c|c} CH_3 \\ \hline Si \\ CH_3 \end{array} \xrightarrow{400^{\circ}C} \begin{array}{c} H \\ \hline Si \\ CH_3 \end{array} \xrightarrow{1200^{\circ}C} \begin{bmatrix} IH \\ CH_3 \end{bmatrix} \xrightarrow{n} \\ \hline \begin{bmatrix} IH \\ CH_3 \end{bmatrix} \xrightarrow{n} & \frac{1200^{\circ}C}{1200^{\circ}C} & \frac{1200^{\circ}C}{12$$

(b) $2\text{NbBr}_5(g) + 5\text{H}_2(g) \longrightarrow 2\text{Nb}(s) + 10\text{HBr}(g)$ (c) $SiCl_4(l) + C_2\text{H}_5\text{OH}(l) \longrightarrow Si(OC_2\text{H}_5)_4(s) + 4\text{HCl}(g)$

(d)
$$n \leftarrow CH = CH_2 \rightarrow CH = CH_2 \rightarrow H$$

$$\downarrow C \rightarrow CH = CH_2 \rightarrow H$$

$$\downarrow H \rightarrow H$$

$$\downarrow H \rightarrow H$$

12.56 These compounds cannot be vaporized without destroying their chemical identities. Under the conditions of vacuum deposition, anions with names ending in *ite* or *ate* tend to chemically decompose to form gaseous nonmetal oxides.

Chapter 13

13.1 The solubility of a solute in a particular solvent depends on the strength of the "new" solute-solvent interactions relative to the strengths of "old" solute-solute and solvent-solvent interactions. 13.3 (a) Ion-dipole; (b) London dispersion; (c) hydrogen bonding; (d) dipoledipole. 13.5 A solute is more likely to dissolve in a solvent if the strengths of the solute-solute, solvent-solvent. and solute-solvent interactions are similar. 13.7 (a) There are no solute-solvent interactions between ionic KCl and nonpolar covalent C₆H₆ strong enough to compete with the ionic lattice forces in KCl. (b) Because the molar masses of CCl₄ and Br₂ are very similar, the London dispersion forces in Br₂ are more similar to those in CCl₄. 13.9 (a) Since the solute and solvent in this case experience very similar London dispersion forces, the energy required to separate them individually and the energy released when they are mixed are approximately equal. $\Delta H_1 + \Delta H_2 \approx -\Delta H_3$. Thus, ΔH_{soln} is nearly zero. (b) Since no strong intermolecular forces prevent the molecules from mixing, they do so spontaneously because of the increase in disorder. 13.11 (a) 5.66% Na_2SO_4 by mass; (b) 5.5 ppm Au. 13.13 (a) $X_{CH_3OH} =$ 6.98×10^{-3} ; (b) $X_{\text{CH},\text{OH}} = 0.290$. **13.15** (a) $0.513 \, M$ NaCl; (b) $2.03 \, M \, \text{LiClO}_4 \cdot 3 \text{H}_2 \text{O}$; (c) $0.120 \, M$ HNO₃. 13.17 (a) 9.79 m C₆H₆; (b) 0.402 m NaCl. 13.19 (a) $X_{\text{CH},\text{OH}} = 0.205$; (b) 6.28 m CH₃OH; (c) 4.12 M CH₃OH. 13.21 (a) 41.1% H₂O by mass; (b) $X_{\text{H},\text{O}} = 0.691$; (c) 38.6 m H₂O; (d) 21.1 M H₂O. 13.23 16 M HNO₃. 13.25 (a) 2.61 × 10⁻² mol MgCl₂; (b) 7.00×10^{-6} mol HCl; (c) 7.10×10^{-3} mol $(NH_4)_2CrO_4$. 13.27 (a) Weigh 2.50 g KBr, dissolve in water, dilute with stirring to 1.40 L. (b) Weigh 11.4 g KBr, dissolve in 238.6 g H₂O to make 250 g of solution. (c) Weigh 198 g KBr, dissolve in 1452 g H₂O to make 1.50 L of solution. (d) Weigh 13.3 g KBr, dissolve in a small amount of H₂O, dilute to 0.560 L. 13.29 (a) 0.282 N; (b) $0.0675 M H_3 PO_4$. 13.31 (a) A saturated solution is one that is in equilibrium with undissolved solute. (b) A supersaturated solution contains more dissolved solute than is needed to form a saturated solution. (c) A supersaturated solution can be prepared by saturating a solution at high temperature and then carefully cooling it. 13.33 (a) Not saturated; (b) saturated; (c) saturated; (d) not saturated. 13.35 The aqueous solubility of most ionic solids increases with increasing temperature, and the solubility of most gases decreases with increasing temperature. 13.37 $9.2 \times 10^{-4} M$ He, $1.5 \times 10^{-4} M$

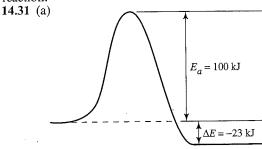
 $10^{-3} M N_2$. 13.39 The total number, or concentration, of particles in a solution. 13.41 For a solution with a nonvolatile solute, the vapor pressure of the solution is equal to the mole fraction of the solvent times the vapor pressure of the pure solvent. Nonvolatile solute molecules inhibit escape of solvent molecules to the vapor phase, reducing the vapor pressure above the solution. 13.43 (a) $119 \text{ g C}_2\text{H}_6\text{O}_2$; (b) 125 g KBr. 13.45 (a) $X_{\text{eth}} = 0.281$; (b) $P_{\text{soln}} = 238 \text{ torr}$; (c) X_{eth} in vapor = 0.471. 13.47 (a) $T_f = -115.5^{\circ}\text{C}$, $T_b = 79.0^{\circ}$; (b) $T_f = -65.1^{\circ}\text{C}$, $T_b = 62.5^{\circ}\text{C}$; (c) $T_f = -1.4^{\circ}\text{C}$, $T_b = 100.4^{\circ}\text{C}$. 13.49 0.03 m glycerin < 0.03 m benzoic acid < 0.02 m KBr. 13.51 $T_b = 102.5$ °C. 13.53 $\pi =$ 4.40 atm. 13.55 $\mathcal{M} = 1.8 \times 10^2$ g/mol adrenaline. 13.57 $\mathcal{M} = 1.39 \times 10^4$ g/mol lysozyme. 13.59 (a) i =2.75. (b) As the solution becomes more concentrated, the value of i decreases. 13.61 A solution has very small dispersed solute particles, does not scatter light, and is transparent. A colloid has much larger dispersed particles, scatters light, and is usually cloudy. White vinegar is a solution; milk is a colloid. 13.63 (a) Hydrophobic; (b) hydrophilic; (c) hydrophobic. 13.65 Colloids do not coalesce because of electrostatic repulsions between groups at the surface of the dispersed particles. Hydrophilic colloids can be coagulated by adding electrolytes, and some colloids can be coagulated by heating. 13.67 For ionic solids, the exothermic part of the solution process is ΔH_3 , the enthalpy released when solute and solvent particles interact. In hydrated salts, the ions are already interacting with water molecules; therefore, less enthalpy is released during solvation, and the overall enthalpy of solution is more positive. 13.69 (a) 1.90 m NaCl; (b) 1.83 M NaCl. 13.71 2.72×10^3 g $CuSO_4 \cdot 5H_2O$, 1.36 M $CuSO_4$. 13.75 (a) The solution is saturated. (b) 3.60 m SmCl₃. 13.79 7.4 kg C_2H_5OH . 13.81 (a) $T_f = -0.558$ °C; (b) $T_f = -0.432$ °C. 13.84 (a) $K_b = 2.3$ °C/m; (b) $M = 2.5 \times 10^2$ g/mol. 13.88 The nonelectrolyte beaker contains 18.2 mL; the NaCl(aq) beaker holds 21.8 mL.

Chapter 14

14.1 (a) $-\Delta[H_2O]/2\Delta t = \Delta[H_2]/2\Delta t = \Delta[O_2]\Delta t$; (b) $-\Delta[CO]/\Delta t = -\Delta[H_2]/2\Delta t = \Delta[CH_3OH]/\Delta t$; (c) $-\Delta[S_2O_8^{2-}]\Delta t = -\Delta[I^{-}]/2\Delta t = [SO_4^{2-}]/2\Delta t = \Delta[I_2]/\Delta t$. **14.3** (a) $-\Delta[O_2]/\Delta t = 2.3 \text{ mol/s}$; $\Delta[H_2O]/\Delta t = 4.6 \text{ mol/s}$; (b) $\Delta P_T/\Delta t = -15 \text{ torr/min}$.

1.5	Time (min)	Time interval (min)	Concentration (M)	ΔM	Rate (M/min)
	0		1.85	0.10	2 2 3 4 10-3
	79	.79	1.67	0.18	2.3×10^{-3}
		79		0.15	1.9×10^{-3}
	158	158	1.52	0.22	1.4×10^{-3}
	316		1.30		-
	632	316	1.00	0.30	0.95×10^{-3}

14.7 From the slopes of the tangents to the graph, the rates are: $t = 100 \text{ min}, 1.9 \times 10^{-3} M/\text{min}; t = 500 \text{ min},$ $9.4 \times 10^{-4} M/\text{min.}$ **14.9** (a) Rate = $k[N_2O_5]$; (b) rate = $6.08 \times 10^{-5} M/s$. (c) When the concentration of N_2O_5 doubles, the rate of the reaction doubles. 14.11 (a, b) $k = 2.8 \times 10^2 M^{-1} \text{s}^{-1}$. (c) If [OH⁻] is tripled, the rate triples. **14.13** (a) Rate = k[A]; (b) rate = [A][B]². **14.15** Rate = k[NO]²[O₂]; $k = 7.11 \times 10^3 M^{-2} \text{s}^{-1}$. **14.17** (a) Rate = $k[NO]^2[Br_2]$; (b) $k = 1.2 \times 10^4$ $M^{-2}s^{-1}$; (c) $\Delta[NOBr]/2\Delta t = -\Delta[Br_2]/\Delta t$; (d) $\Delta [NOBr]/\Delta t = 68 M/s;$ (e) $-\Delta [Br_2]/\Delta t = 6.2 M/s.$ 14.19 Half-life is the time required to reduce the concentration of a reactant to one-half of its initial value. For first-order reactions, half-life depends only on the value of the rate constant, k. 14.21 $t_{1/2} = 1.4 \times 10^3$ s. 14.23 (a) 0.162 mol N₂O₅; (b) 5.63 min; (c) $t_{1/2} = 102$ s = 1.69 min. 14.25 Plot ln $P_{SO_2Cl_2}$ vs. time, slope = $k = 2.19 \times 10^{-5}$ s⁻¹. 14.27 (a) The reaction is firstorder in N₂O₅; (b) $k = 6.0 \times 10^{-4} \text{ s}^{-1}$. 14.29 The kinetic energies of the colliding particles and their orientation determines whether a collision leads to a chemical



(b) +123 kJ/mol. 14.33 Reaction (a) is fastest, and reaction (c) is slowest. 14.35 No. The value of A, related to frequency and effectiveness of collisions, is different for each reaction, and k is proportional to A. 14.37 (a) k at 600° C = $1.19 \times 10^{-4} M/s$; (b) k at 800° C = $1.28 \times 10^{-4} M/s$; $10^{-2} M/s$. 14.39 A plot of $\ln k$ vs. 1/T has a slope of -5.6×10^3 ; $E_a = -R(\text{slope}) = 47 \text{ kJ/mol.}$ 14.41 $E_a =$ 53.6 kJ/mol. 14.43 A unimolecular process has one reactant molecule, a bimolecular process has two reactant molecules, and a termolecular process has three reactant molecules. Termolecular processes are rare because it is highly unlikely that three molecules will collide effectively to form an activated complex. 14.45 (a) Bimolecular, rate = $k[N_2O][Cl]$; (b) unimolecular, rate = $k[Cl_2]$; (c) bimolecular, rate = $k[NO][Cl_2]$. 14.47 (b) First step: $-\Delta[NO]/\Delta t = k[NO]^2$; second step: $-\Delta[H_2]/\Delta t = k[NO]^2$ $\Delta t = k[H_2][N_2O_2]$. (c) N_2O_2 is the intermediate. (d) The second step is slow relative to the first. 14.49 Both (b) and (d) are consistent with the observed rate law. 14.51 A catalyst increases the rate of reaction by decreasing the activation energy, E_a , or increasing the frequency factor, A. 14.53 A homogeneous catalyst is in the same physical state as the reactants, while a heterogeneous catalyst is in a different state. 14.55 (a) $2N_2O(g)$ $2N_2(g) + O_2(g)$. (b) A catalyst is present when a reaction sequence begins and after the last step is completed. In this reaction, NO is the catalyst and NO2 is the intermediate. (c) homogeneous; (d) rate = $k[\tilde{N}_2O][NO]$. 14.57 Finely ground iron filings would be a more effective catalyst because the area and provide a great 14.59 As illustrated in] that exist on each carbo before adsorption are re single D atom is added rather than H₂). To put it is necessary that one bonds in ethylene be bı sorbed, so that the H a atom and is replaced b activation energy than ing one D atom to eacl large biomolecule that action by distorting the distribution of the read the specific location of bound. 14.63 The bo wound contain an enz tion of hydrogen pero $10^{-7} M/s$. **14.68** (a) $k = 7.5 \times 10^{-3} M^{-2} s^{-1}$ 14.70 (a) The reactic 10^{-3} s^{-1} ; (b) $t_{1/2} = 40$ linear with a slope of kJ/mol. 14.75 (a) F $2H_2O_2(aq) \longrightarrow 2H_2O_2(aq)$ mediate. 14.78 The mately 10 kJ/mol for body. 14.80 Enzym carbonic acid (H2CC cules/s.

Chapter 15

15.1 (a) At equilibr tions proceed at equ concentrations of re not necessarily equa $K_c = [HCl]^2 / [H_2][C$ $[NO_2]^2[O_2]/[N_2O_5]^2$ [CS₂][H₂]⁴/[CH₄][F [CO₂], heterogeneoi neous. 15.7 (a) K favors SO3 at this te 15.11 (a) $[H_2] = 0$ 0.138 M; (b) $K_c =$ (b) $K_c = 0.11$. 15 rium favors produc 0.30 atm. (b) $K_p =$ the mixture is at ec reaction will proce the reaction will pi $2.8 \times 10^{-3} M$. 15 $2.82 \times 10^{-3} M$, 0.0 atm. 15.27 [H₂S 15.29 $[I_2] = [Br_2]$ 15.31 (a) Increase effect; (e) no effe (b) no effect; (c) effect. 15.35 (a) much more plent

1

cations migrate in the opposite direction. The electrode in the iron-containing beaker has a negative sign; that in the MnO₄⁻ beaker has a positive sign. (b) $E^{\circ} = 0.74 \text{ V}$. **20.71** (a) $2Rh^{3+}(aq) + 3Cd(s) \longrightarrow 2Rh(s) + 3Cd^{2+}(aq)$; (b) anode, Cd(s); cathode, Rh(s); (c) $E_{\text{cathode}}^{\circ} = +0.80 \text{ V}$; (d) $\Delta G_{\text{cell}}^{\circ} = -695 \text{ kJ}$. 20.73 (a) Spontaneous; (b) nonspontaneous; (c) spontaneous; (d) nonspontaneous. **20.75** $E_{\text{cell}} = 0.033 \text{ V}$; the anode is in the compartment containing the dilute $(0.040 \text{ M}) \text{ Cr}^{3+}(aq)$ solution. **20.78** $K_{\text{sp}} = 9.69 \times 10^{-13}$. **20.81** (a) 10 mol Cr(s) deposited, 5.9 × 10⁶ C required; (b) 9.8 × 10⁵ amps. $\hat{2}0.83$ (a) 1.2×10^2 hr; (b) 20 kWh. 20.85 732 g NaBO₃. 20.87 (a) $w_{\text{max}} \approx 2 \text{ kWh}$; (b) This maximum amount of work is never realized because of internal resistance of the battery; because the cell voltage does not remain constant; because the vehicle is not capable of completely converting electrical energy into work. 20.89 The ship's hull should be made negative. The ship, as a negatively charged "electrode," becomes the site of reduction, rather than oxidation, in an electrolytic process.

Chapter 21

21.1 (a) 26 protons, 30 neutrons; (b) 38 protons, 50 neutrons; (c) 15 protons, 16 neutrons. 21.3 (a) $_{-1}^{0}$ e; $\begin{array}{lll} \text{(a)} & \stackrel{1}{10}\text{(e)} & \stackrel{1}{10}\text{(e)} & \stackrel{1}{10}\text{(e)} & \stackrel{1}{10}\text{(f)} & \stackrel{1}{10}\text{(e)} & \stackrel{1}{10}\text{(f)} & \stackrel{1}{$ alpha emissions, 4 beta emissions. 21.9 (a) Positron emission (for low atomic numbers, positron emission is more common than electron capture); (b) beta emission; (c) beta emission; (d) beta emission. 21.11 (a) No (low neutron/proton ratio, should be a positron emitter); (b) no (low neutron/proton ratio, should be a positron emitter or possibly undergo orbital electron capture); (c) no (high neutron/proton ratio, should be a beta emitter); (d) no (high atomic number, should be an alpha emitter). 21.13 (a) Stable: ³⁹₁₉K, 20 neutrons is a magic number; (b) stable: ²⁰⁹₈₃Bi, 126 neutrons is a magic number; (c) stable: $^{25}_{12}$ Mg, $^{24}_{10}$ Ne has a much higher neutron/proton ratio. 21.15 $^{4}_{2}$ He, $^{16}_{8}$ O, $^{40}_{20}$ Ca. 21.17 Radioactive: (b), low neutron/proton ratio, (c), low neutron/ proton ratio, and (e), atomic number greater than 83. Stable: (a) and (d). 21.19 Protons and alpha particles are positively charged and must be moving very fast to overcome electrostatic repulsions that would repel them from the target nucleus. Neutrons are electrically neutral and more easily captured by a target nucleus. 21.21 (a) 32P; (b) ${}_{3}^{1}\text{Li}$; (c) ${}_{7}^{18}\text{Re}$; (d) ${}_{99}^{97}\text{Tc}$; (e) ${}_{38}^{98}\text{Sr}$. 21.23 (a) ${}_{99}^{238}\text{U} + {}_{0}^{1}\text{n} \longrightarrow {}_{99}^{239}\text{U} + {}_{0}^{1}\text{n} \longrightarrow {}_{99}^{12}\text{F} + {}_{0}^{1}\text{e}$. 21.25 The suggestion is not reasonable. The energies of nuclear states are very large relative to ordinary temperatures. Merely changing the temperature by less than 100 K would not significantly affect the behavior of nuclei with regard to nuclear decay rates. 21.27 ${}_{31}^{68}$ Ga $\longrightarrow {}_{30}^{68}$ Zn $+ {}_{1}^{0}$ e; 9.78×10^{-6} g ⁶⁸Ga remain. **21.29** $k = 0.0307 \text{ yr}^{-1}, t_{1/2} = 22.6 \text{ yr}.$ 21.31 Taking only the spontaneous radioactive decay of ¹³¹I into account, the activity after 32 days should be 5.7

counts/min, which is the observed activity. The plants do not absorb iodide. 21.33 4.0×10^{-12} g 226 Ra decays in 1.0 min, 1.1×10^{10} alpha particles emitted. 21.35 k = $1.21 \times 10^{-4} \text{ yr}^{-1}$; $1.70 \times 10^{3} \text{ yr}$. **21.37** $k = 1.5 \times 10^{-10}$ yr⁻¹; the original rock contained 66.2 mg ²³⁸U and is 1.9×10^9 yr old. **21.39** 9.317×10^{-12} J/nucleus; $5.611 \times 10^{12} \text{ J/mol.}$ 21.41 (a) $\Delta m = 8.25 \times 10^{-3}$ amu/nucleon; $\Delta E = 1.23 \times 10^{-12}$ J/nucleon; (b) $\Delta m =$ 9.41×10^{-3} amu/nucleon; $\Delta E = 1.41 \times 10^{-12}$ J/nucleon; (c) $\Delta m = 8.46 \times 10^{-3}$ amu/nucleon; $\Delta m = 1.26 \times 10^{-12}$ J/nucleon. 21.43 1.71×10^5 kg/day; 2.10×10^8 g 235 U. 21.45 (a) ⁵⁹Co; it has the largest binding energy per nucleon, and binding energy gives rise to mass defect. 21.47 (a) 4_{0}^{1} n; (b) ${}_{36}^{94}$ Kr. 21.49 The 59 Fe is incorporated into the diet component and fed to the rabbits. Blood samples are removed from the animals, the red blood cells separated, and the radioactivity of the sample measured. If the iron in the dietary compounds has been incorporated into blood hemoglobin, the blood cell sample should show beta emission. Samples can be taken at various times to determine the rate of iron uptake, rate of loss of iron from the blood, and so forth. 21.51 The extremely high temperature is required to overcome the electrostatic charge repulsions between the nuclei so that they can come together to react. 21.53 (a) Control rods control neutron flux so that there are enough neutrons to sustain the chain reaction but not so many that the core overheats. (b) A moderator slows neutrons so that they are more easily captured by fissioning nuclei. 21.55 The becquerel; the curie (Ci). 21.57 $^{210}_{84}\text{Po} \longrightarrow ^{206}_{82}\text{Pb} + ^{4}_{2}\text{He}$. 21.59 An electron. 21.62 (a) $^{36}_{17}\text{Cl} \longrightarrow ^{36}_{18}\text{Ar} +$ $_{-1}^{0}$ e. (b) $_{-1}^{36}$ Cl has an odd number of protons and neutrons (17p, 19n), and so it is less stable than the other two isotopes. 21.64 The source will last 1.69 yr; it needs to be replaced in early July 1995. 21.68 3.7×10^4 disintegrations/s; 4.8×10^{13} 90Sr nuclei or 7.2×10^{-9} g 90Sr. 21.71 12 alpha particles (disintegrations)/s. 21.73 The mole fraction of ${}_{1}^{3}H$ atoms in the sample is 4.82×10^{-13} . 21.75 ⁷Be, 8.63×10^{-13} J/nucleon; ⁹Be, 1.04×10^{-12} J/nucleon; 10 Be, 1.04×10^{-12} J/nucleon. The binding energies per nucleon for 9Be and 10Be are very similar; the value for ¹⁰Be is slightly higher.

Chapter 22

22.1 Metals: Sr, Ce, Rh; nonmetals: Se, Kr; metalloid: Sb. 22.3 Metals have high melting points and large thermal and electrical conductivity, whereas nonmetals have much lower melting points and are poor conductors. Metals react with nonmetals to produce ionic solids that melt at high temperatures; nonmetals react with other nonmetals to form covalent compounds that can be solids, liquids, or gases. Oxides of metals produce basic aqueous solutions, whereas oxides of nonmetals produce acidic aqueous solutions. 22.5 Bismuth should be the most metallic. It has a metallic luster and a relatively low ionization energy. Bi₂O₃ is soluble in acid but not in base, characteristic of the basic properties of the oxide of a metal rather than of the oxide of a nonmetal. 22.7 (a)

N: (b) K; (c) K in t ergy), Li in aqueous s (d) N has the smalles compare because it de 22.9 (a) IF₃; (b) B₂^t N is too small a centi and it does not have: accommodate more t readily form π bonds octet rule for both at lower electronegativi gives up electrons to dized. 22.13 (a) Na $Na^{+}(aq) + OH^{-}(aq);$ $6\text{CO}_2(g) + 8\text{H}_2\text{O}(l);$ Ni(s) or 2NiO(s) + 0 AIP(s) + 3H₂O(l) - $Na_2S(s) + 2HCl(aq)$ 2Cl⁻(aq). 22.15 H tritium. 22.17 Like gen has only one val group 7A, hydrogen its valence shell. 22 $Mg^{2+}(aq) + H_2(g);$ $H_2(g)$; (c) $CH_4(g)$ -22.21 (a) Ionic; (b) $NaH(s) + H_2O(l) - H_2SO_4(aq) \longrightarrow Fe^2$ $H_2(g) + Br_2(g) \longrightarrow$ 2NaH(s); (e) PbO($22.25 7.9 \times 10^8 \text{ kg}$ steel making; to ble torches; in medicine

22.29

Ozone has two reso is bent, with an O-120°. The π bond i molecule; neither i bond, and so the o greater than the 1.2 O-O double bone $Ca^{2+}(aq) + 2OH^{-}(aq)$ $2A1^{3+}(aq) + 3H_2O$ $2Na^{+}(aq) + 2OH^{-}$ $H_2O(l) \longrightarrow 2HN^{(l)}$ $2K^{+}(aq) + 2OH^{-}(aq)$ $O_3(g) \xrightarrow{f} NO_2(g)$ acidic; (c) basic; the reactions occur $S^{2-}(aq) \longrightarrow 2OH^{-}$ $2OH^{-}(aq) + H_2O_2$ $NO_{2}^{-}(aq) + H_{2}O_{2}$ $A_{S_2}O_3(s) + 2H_2O_2$ $5H_2O(l)$. (e) This solution, because were basic. 2Fe²⁺($2\text{Fe}^{3+}(aq) + 2\text{H}_2\text{C}$ NH₃, and fertilize