Appendix A

Properties of Common Substances

KEY TO SYMBOLS:
Common names of substances are enclosed in parentheses.
(*) **water solution of a pure substance** (e) **element** (c) **compound**

Name	Formula	Melting Point (°C)	Boiling Point (°C)	Density (g/cm³ or g/mL)
acetic acid (vinegar) (c)	CH_3COOH	16.6	118.1	—
aluminum (e)	Al	659.7	2519	2.7
ammonia (c)	NH_3	−77.8	−33.4	less dense than air
ammonium nitrate (c)	NH_4NO_3	169.6	210	1.73
argon (e)	Ar	−189	−185	denser than air
arsenic (e)	As	—	—	5.727 (grey), 4.25 (black), 2.0 (yellow)
barium (e)	Ba	727	1897	3.62
beryllium (e)	Be	1280	2471	1.85
boron (e)	B	2075	4000	2.37(brown), 2.34 (yellow)
bromine (e)	Br_2	−7.2	58.8	3.12
calcium (e)	Ca	845	1484	1.55
calcium carbonate (limestone) (c)	$CaCO_3$	decomposes at 900°C	—	2.93
calcium hydroxide (slaked lime) (c)	$Ca(OH)_2$	decomposes at 522°C	—	2.24
calcium oxide (lime) (c)	CaO	2580	2850	3.3
carbon (diamond) (e)	C	3500	3930	3.51
carbon (graphite) (e)	C	4492	4492	2.25
carbon dioxide (c)	CO_2	—	—	—
chlorine (e)	Cl_2	−101.6	−34.6	denser than air
copper (e)	Cu	1084	2562	8.95
copper(II) nitrate (c)	$Cu(NO_3)_2$	—	—	—
copper(II) sulfate (bluestone) (c)	$CuSO_4{\bullet}5H_2O$	decomposes at 150°C	—	2.28
ethanol (ethyl alcohol) (c)	C_2H_5OH	−114.5	78.4	0.789
fluorine (e)	F_2	−270	−188	—
gold (e)	Au	1063	2856	19.3
glucose (c)	$C_6H_{12}O_6$	146	decomposes before it boils	1.54
helium (e)	He	−272.2	−268.93	—
hematite (c)	Fe_2O_3	1565	—	5.24
hydrochloric acid (*)	HCl	varies	varies	varies
hydrogen (e)	H_2	−259	−253	much less dense than air
hydrogen peroxide (c)	H_2O_2	−0.4	150.2	1.45
iodine (e)	I_2	114	184	4.95
iron (e)	Fe	1535	2861	7.86
lead (e)	Pb	327.4	1750	11.34
lithium (e)	Li	179	1340	0.534
magnesium (e)	Mg	651	1107	1.74
magnesium chloride (c)	$MgCl_2$	708	1412	2.3
magnetite (c)	Fe_3O_4	—	—	5.18
mercury (e)	Hg	−38.9	356.6	13.6
methane (c)	CH_4	−182.5	−161.5	—
neon (e)	Ne	−248	−246	—
nickel (e)	Ni	1455	2913	8.90
nitrogen (e)	N_2	−209.9	−195.8	slightly less dense than air
nitrogen dioxide (c)	NO_2	—	—	—
oxygen (e)	O_2	−218	−183	slightly denser than air
ozone (e)	O_3	−192.5	−112	denser than air
platinum (e)	Pt	1769	3824	21.41
polyethylene (polythene) (c)	$(C_2H_4)n$	—	—	—
potassium (e)	K	63.5	759	0.86
propane (c)	C_3H_8	—	−42.17	—
selenium (e)	Se	217	684.9	4.81
silicon (e)	Si	1410	3265	2.33
silicon dioxide (silica) (c)	SiO_2	1600	—	—
silver (e)	Ag	961	2162	10.5
sodium (e)	Na	97.5	892	0.971
sodium chloride (table salt) (c)	NaCl	801	1465	2.16
sodium fluoride (c)	NaF	988	1695	2.56
sucrose (sugar) (c)	$C_{12}H_{22}O_{11}$	170	decomposes at 186°C	1.59
sulfur (brimstone) (e)	S_8	112.8	444.6	2.07
tin (e)	Sn	231.9	2602	7.31
titanium (e)	Ti	1666	3287	4.5
uranium (e)	U	1130	4131	19.05
water (c)	H_2O	0	100	1.00
xenon (e)	Xe	−111.9	−107.1	—
zinc (e)	Zn	419	907	7.14

DEFINITIONS:
deliquescent: able to absorb water from the air to form a concentrated solution
sublime: to form a vapour directly from a solid

Appearance (at room temperature: 20°C)	Comments
colourless liquid with pungent smell	used in the manufacture of cellulose ethanoate; vinegar is a 5 to 7 percent solution in water
silver-white metal	used in aircraft, cooking utensils, and electrical apparatus
very soluble gas with pungent smell	used as refrigerant and in manufacture of resins, explosives, and fertilizers
white, soluble, crystalline salt	used in explosives and as a fertilizer
inert gas	used in electric lights
grey, black, or yellow solid	used in semiconductors and alloys; compounds are very poisonous and are used in medicine and as pesticides
silver-white solid	used in X-ray diagnosis
hard, white metal	used for corrosion-resistant alloys
brown, amphorous powder or yellow crystals	used for hardening steel and for producing enamels and glasses
red-brown liquid	used to make certain pain-relieving drugs; liquid causes severe chemical burns; vapour is harmful to lungs
soft, white metal that tarnishes easily	very abundant; essential to life
white solid	main ingredient in chalk and marble
white solid	aqueous solution used to test for CO_2
white solid	used in cement and for marking lines on playing fields
colourless, solid crystals	very hard; used for drilling through rock
grey-black solid	very soft; used in lubricants, pencil leads, and electrical apparatus
colourless gas with a faint tingling smell and taste	does not support combustion and is denser than air; used in fire extinguishers and as a refrigerant at −78.5°C
green gas	poisonous; used to kill harmful organisms in water
shiny, reddish solid	soft metal; good conductor of heat
blue, solid crystals	used in pesticides
colourless liquid	derived from fermentation of sugar; used as solvent or fuel; found in wine
greenish yellow gas	similar to chlorine
shiny, yellow solid	very soft metal; highly resistant to tarnishing
white solid	simple sugar; human body converts most sugars and starches to glucose
nonflammable inert gas	used as refrigerant; provides inert atmosphere for welding; used to fill air ships and balloons
rusty red colour	found in iron ore and rusted iron
colourless liquid	corrosive acid; properties vary according to concentration
colourless gas	highly flammable; liquid form used as rocket fuel
colourless liquid	thick and syrupy when pure; an antiseptic
violet-black, solid crystals	crystals sublime readily to form poisonous violet vapour
shiny, silver solid	rusts readily; soft when pure
shiny, blue-white solid	soft metal; forms poisonous compounds
silver-white metal (least dense solid known)	used in alloys; its salts have various medical uses
light, silvery-white metal that tarnishes easily in air	used in alloys and photography; compounds used in medicine; essential to life
white, deliquescent substance	
shiny, black, crystalline solid	strongly magnetic
shiny, silvery liquid	only liquid metal; forms poisonous compounds
odourless, flammable gas formed from decaying organic matter	main constituent in natural gas
colourless, odourless gas	discharge of electricity at low pressures through neon produces an intense orange-red glow
silvery-white, magnetic metal that resists corrosion	used for nickel plating and coinage, in alloys, and as a catalyst
colourless gas	will not burn or support burning; makes up 80 percent of air
brown gas	causes reddish-brown colour in smog
colourless gas	must be present for burning to take place; makes up 20 percent of air
bluish gas	used for purifying air and water and in bleaching; atmospheric layer blocks most of the Sun's ultraviolet light
silver-white solid	used in jewellery; alloyed with cobalt, used in pacemakers
tough, waxy, thermoplastic material	polymer of ethylene; used as insulating material; flexible and chemically resistant
silvery-white, soft, highly reactive, alkali metal	essential to all life; found in all living matter; salts used in fertilizers
colourless gas	flammable; used as fuel
non-metal resembling sulfur; silvery-grey, crystalline solid	used in manufacture of rubber and ruby glass; used in photoelectric cells and semiconductors
steel-grey metalloid similar to carbon in its chemical properties	used in pure form in semiconductors and alloys and in the form of silicates in glass
hard, granular powder; insoluble in water	main constituent of sand; used in clocks and watches as quartz
shiny, white solid	soft metal; best-known conductor of electricity
soft, silvery-white metal; very reactive	used in preparation of organic compounds, as coolant, and in some types of nuclear reactors
white, crystalline solid	used to season or preserve foods
colourless, crystalline substance	used in water fluoridation and as an insecticide
white solid	made from sugar cane or sugar beets
yellow solid	used to make dyes, pesticides, and other chemicals
shiny, slightly yellow solid	soft metal; rust resistant
lustrous white solid	alloys are widely used in the aerospace industry
metallic grey solid	used as a nuclear fuel (usually converted into plutonium)
colourless liquid	good solvent for non-greasy matter
inert gas	used in fluorescent tubes and light bulbs
hard, bluish-white metal	used in alloys such as brass and galvanized iron

Using Star Maps

Star maps help you find your way around the night sky, just like road maps help you find your way around a city. The three star maps on these pages show the night sky in fall, winter, and spring. Notice that each star map is a circle. The circumference of the circle represents the horizon. The centre of the circle is the point directly overhead, called the zenith.

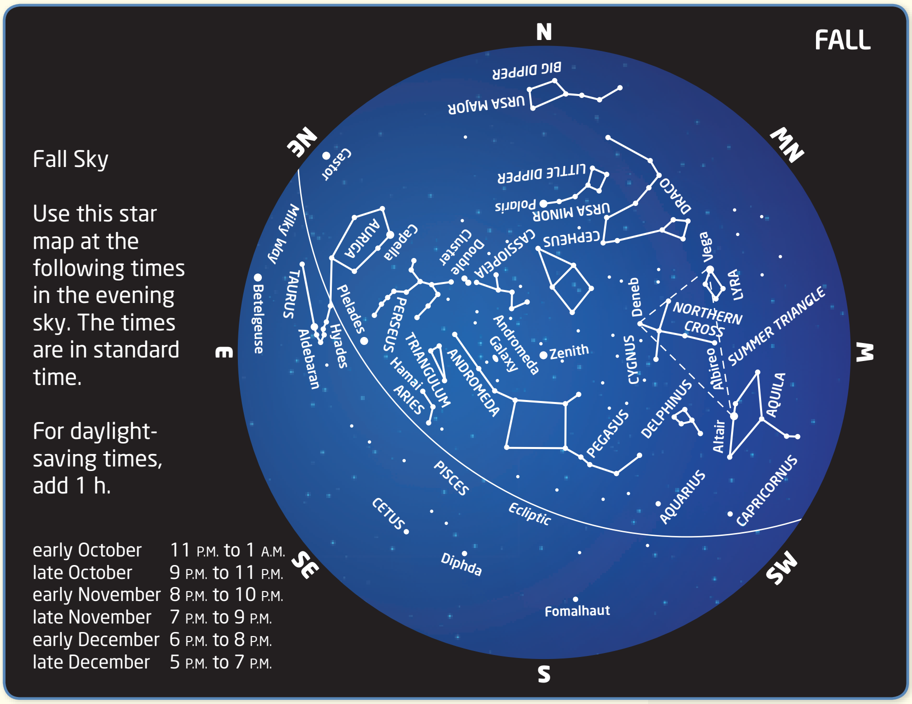
Choosing and Orienting a Star Map

To use a star map, first choose the star map that is appropriate for the season. Then, match its direction to the sky. For example, if you are facing east, rotate the map so that E is at the bottom. The time of night is important, too. The maps tell you what time to look at the sky so the map matches what you see.

Locating Stars and Constellations

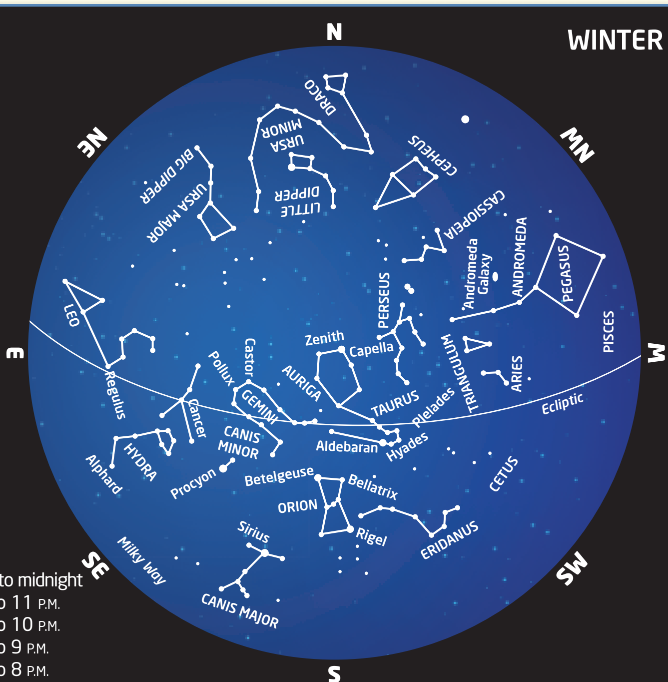
Suppose that you are facing north in the fall. Rotate the fall map so that N is at the bottom. The area of the sky just above the N is the northern sky. Start by identifying bright constellations. Here, you can see the constellations Ursa Major (the Big Dipper), Ursa Minor (the Little Dipper), and Cassiopeia. Once you can identify the bright constellations, try to identify their fainter neighbours.

How would you find the bright star Betelgeuse in the fall? The fall star map shows Betelgeuse close to the horizon in the east. Therefore, make sure that you are facing east. Hold the fall star map so that E is at the bottom. You will see Betelgeuse just above the horizon.



Winter Sky

Use this star map at the following times in the evening sky. The times are in standard time.

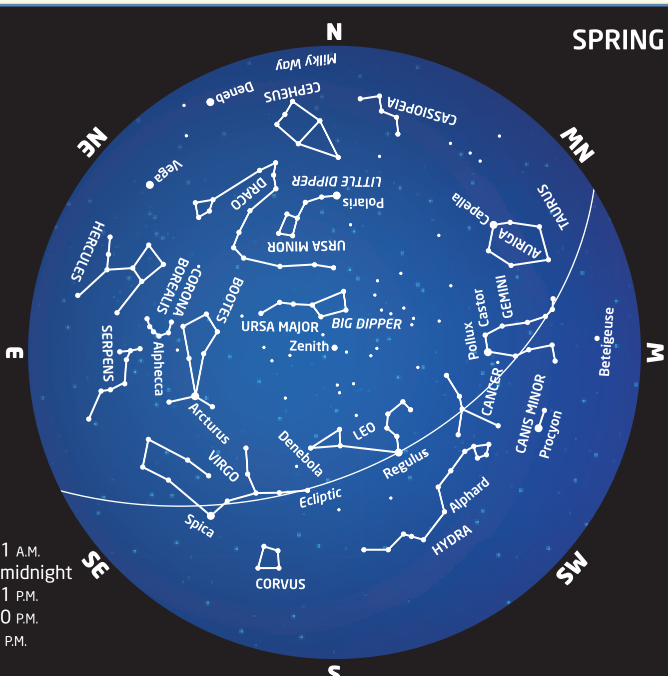


early January	10 P.M. to midnight
late January	9 P.M. to 11 P.M.
early February	8 P.M. to 10 P.M.
late February	7 P.M. to 9 P.M.
early March	6 P.M. to 8 P.M.

Spring Sky

Use this star map at the following times in the evening sky. The times are in standard time.

For daylight-saving times, add 1 h.



late March	11 P.M. to 1 A.M.
early April	10 P.M. to midnight
late April	9 P.M. to 11 P.M.
early May	8 P.M. to 10 P.M.
late May	7 P.M. to 9 P.M.
early June	dusk

Instant Practice—Star Maps

1. Which direction would you face if you wanted to see Leo in January?
2. Name two constellations that you can see in the winter but not in the spring.
3. Write an e-mail to a friend, describing how to use a star map to locate the star Deneb in the spring.

Appendix C

Chemistry References

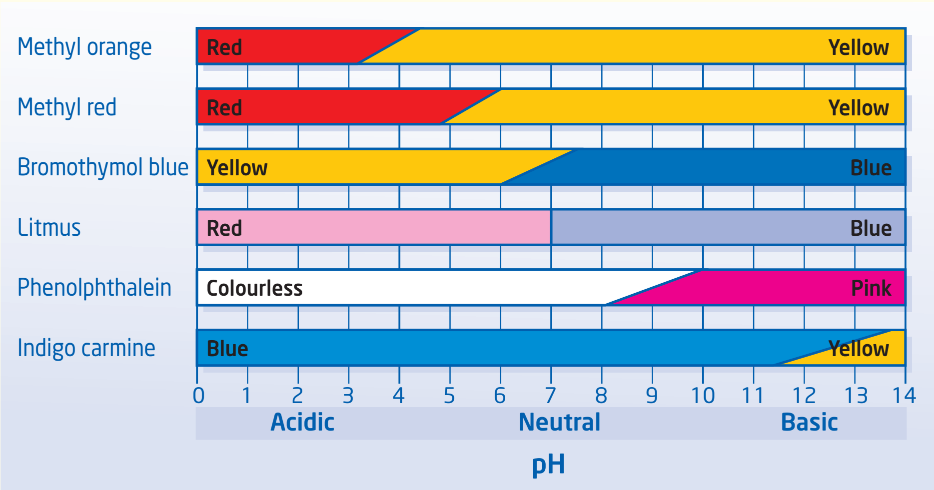
Names, Formulas, and Charges of Some Polyatomic Ions

Name	Formula
Acetate	CH_3COO^-
Ammonium	NH_4^+
Carbonate	CO_3^{2-}
Chlorate	ClO_3^-
Chlorite	ClO_2^-
Chromate	CrO_4^{2-}
Cyanide	CN^-
Dichromate	$Cr_2O_7^{2-}$
Hydrogen carbonate, bicarbonate	HCO_3^-
Hydrogen sulfate, bisulfate	HSO_4^-
Hydrogen sulfide, bisulfide	HS^-
Hydrogen sulfite, bisulfite	HSO_3^-
Hydroxide	OH^-
Hypochlorite	ClO^-
Nitrate	NO_3^-
Nitrite	NO_2^-
Perchlorate	ClO_4^-
Permanganate	MnO_4^-
Phosphate	PO_4^{3-}
Phosphite	PO_3^{3-}
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}

Electron Arrangements of the First 20 Elements

Atom			Ion		
H	1 p	1	H^+	1 p	0
			H^-	1 p	2
He	2 p	2	He	Does not form an ion	
Li	3 p	2, 1	Li+	3 p	2
Be	4 p	2, 2	Be^{2+}	4 p	2
B	5 p	2, 3	B^{3+}	5 p	2
C	6 p	2, 4	C^{4-}	6 p	2, 8
N	7 p	2, 5	N^{3-}	7 p	2, 8
O	8 p	2, 6	O^{2-}	8 p	2, 8
F	9 p	2, 7	F^-	9 p	2, 8
Ne	10 p	2, 8	Ne	Does not form an ion	
Na	11 p	2, 8, 1	Na^+	11 p	2, 8
Mg	12 p	2, 8, 2	Mg^{2+}	12 p	2, 8
Al	13 p	2, 8, 3	Al^{3+}	13 p	2, 8
Si	14 p	2, 8, 4	Si^{4-}	14 p	2, 8, 8
P	15 p	2, 8, 5	P^{3-}	15 p	2, 8, 8
S	16 p	2, 8, 6	S^{2-}	16 p	2, 8, 8
Cl	17 p	2, 8, 7	Cl^-	17 p	2, 8, 8
Ar	18 p	2, 8, 8	Ar	Does not form an ion	
K	19 p	2, 8, 8, 1	K^+	19 p	2, 8, 8
Ca	20 p	2, 8, 8, 2	Ca^{2+}	20 p	2, 8, 8

Acid-Base Indicators



Appendix D

Numerical Answers and Answers to Practice Problems

Unit 1

Section 1.2 Review page 27

5. bunchgrass, 2543 units; grasshopper, 254.3 units; spotted frog, 25.43 units; red-tailed hawk, 2.543 units

Section 2.1 Review page 55

3. 121

Chapter 2 Review pages 84-85

12. 60 years
13. 111.1 days

Chapter 3 Review pages 122-123

12. 65 million years ago

Unit 1 Review pages 128-131

1. d **2.** d **3.** a **4.** c **5.** a
32. b **33.** b. **34.** d **35.** b

Unit 2

Section 4.2 Review page 159

6. 5.02 g/cm^3

Chapter 4 Review pages 174-175

10. 105 g
17. a. 7.13 g/cm^3
b. 0.001 43 g/cm^3
c. 2.70 g/cm^3
22. d = 1.36 g/cm^3

Section 5.2 Review page 193

5. 3 levels

Section 5.4 Review page 211

2. 5 valence electrons

Chapter 5 Review pages 216-217

13. a. 3 p, 4 n, 3 e; metal
b. 15 p, 15 n, 15 e; non-metal
c. 13 p, 15 n, 13 e; metal
d. 6 p, 7 n, 6 e; non-metal
e. 14 p, 14 n, 14 e; metalloid
f. 17 p, 18 n, 17 e; non-metal
18. a. 1 **b.** 3 **c.** 7 **d.** 2
e. 5 **f.** 2 **g.** 4 **h.** 6

Chapter 6 Review pages 254-255

9. a. 2 electrons lost
b. 3 electrons lost
c. 2 electrons gained
d. 1 electron gained
17. a. 2 **b.** 5 **c.** 6 **d.** 9
28. b.

Electron Arrangements and Bond Angles

Compound	Formula	No. of Valence Electrons in Covalent Bonds	No. of Valence Electrons Not in Covalent Bonds	Bond Angle
Methane	CH_4	8	0	109.5°
Ammonia	NH_3	6	2	107.0°
Water	H_2O	4	4	104.5°

Unit 2 Review pages 260-263

1. b **2.** c **3.** a **4.** d **5.** c
7. 2.5 g/cm^3
8. 19.7 g
15. a. 6 p, 7 n, 6 e
b. 24 p, 28 n, 24 e
c. 16 p, 16 n, 16 e
d. 7 p, 7 n, 7 e
34. b **35.** d **36.** d **37.** a **38.** d

Unit 3

Section 7.3 Review page 290

8. a. June 21
b. March 21, September 22
d. June 21

Chapter 7 Review pages 312-313

31. a. 31.4 km/s
b. 62.8 km/s
c. 1 h 46 min

Chapter 8 Review pages 356-357

12. 20% absorbed by atmosphere, 30% reflected, 50% absorbed by Earth's surface
30. a. d = 120 m, v_{max} = 8.3 cm/s

Chapter 9 Review pages 386-387

21. 71.4 km/s/Mpc
31. a. 11.7 h
b. 9.37 years
c. 26.1 years
d. 58.9 years

Unit 3 Review pages 392-395

1. c **2.** d **3.** b **4.** a **5.** b
6. a. C **b.** A **c.** D **d.** B
10.

Magnitude and Distance of Stars

Star	Apparent Magnitude	Absolute Magnitude	Distance (light-years)
Star A	−26	4.7	0.000 02
Sirius	−1.5	1.4	9.0
Alpha Centauri	−0.01	4.4	4.3
Rigel	0.1	−7.0	800
Betelgeuse	0.4	−5.0	520
Capella	0.8	−0.8	42

34. c **35.** b **36.** d **37.** a

Unit 4

Section 11.3 Review page 465

4. 3.5 V
7. a. 3 • 2.0 V, or 4 • 1.5 V
8. b. 6 J/C

Section 11.4 Review page 471

1. 15 Ω
2. 0.15 V
3. 13.5 A

Section 12.2 Review page 500

5. 39%
6. 0.0192 kW•h
8. a. incandescent, $8.45; compact fluorescent, $16.00

Section 12.3 Review page 505

4. nuclear: 50%; other: 2.5%; wind: 1%; gas: 14.5%; coal: 15%; hydro: 17%
8. 20 968 MW

Chapter 12 Review pages 518-519

12. $20.40
19. 22%
20. 7.2 kW

Unit 4 Review pages 524-527

1. d **2.** c **3.** d **4.** b
14. V_1 = 3.0 V, V_2 = V_3 = 1.5 V, V_4 = 3.0 V
16. 10 kW•h
17. $1.51
31. c **32.** d **33.** b **34.** a

Answers to Practice Problems

Chapter 4 page 157

1. 2.70 g/cm^3
2. 1.06 g/cm^3
3. 1.43 × 10^{-3} g/cm^3
4. 6.2 g/cm^3
5. D = 0.67 g/cm^3; it will float on water

Chapter 11 page 468

1. 10 Ω
2. 82.8 Ω
3. 10.6 Ω
4. When potential difference doubles, current doubles.
5. 0.15 A
6. 3.0 V

Chapter 12 page 495

1. a. 1.300 kW
b. 0.060 kW
c. 0.900 kW
2. a. 0.08 h
b. 0.33 h
c. 1.2 h
3. 3.75 kW•h
4. $65.21
5. 4¢

Chapter 12 page 498

1. 74%
2. 3.64%
3. 3036.8 MW
4. 160 kW•h