(f) decreases rate of reaction

(g) increases rate of reaction

(h) decreases rate of reaction

(i) increases rate of reaction

(j) increases rate of reaction

2.

	Situation X	Situation Y	Situation with a higher reaction rate (X or Y)	Factor affecting the rate of reaction
(a)	1 g of sugar (cubes)	1 gram of sugar (grains)	**Y**	**surface area**
(b)	5O°C	O°C	**X**	**temperature**
(c)	low number of particles = few collisions	high number of particles = more collisions	**Y**	**concentration**
(d)	enzyme added	no enzyme added	**X**	**catalyst**
(e)	twigs	logs	**X**	**surface area**

Applying Knowledge

Four factors affecting the rate of reactions
Page 118

1. (a) line Y

(b) line X

(c) line Y

(d) line X

(e) line Y

(f) line X

(g) line Y

(h) line X

2. (a) surface area

(b) catalyst

(c) temperature

(d) concentration

Assessment

Factors affecting the rate of chemical reactions
Page 119

1. D **2.** C **3.** A **4.** B **5.** E **6.** F **7.** D **8.** B **9.** D **10.** B

Chapter 7 The atomic theory explains radioactivity.

Section 7.1 Atomic Theory Isotopes, and Radioactive Decay

Applying Knowledge

Isotopes
Page 123

1. different atoms of a particular element that have the same number of protons but different numbers of neutrons

2. mass number

3. mass number

4. number of neutrons

5. “13” represents the mass number; “5” represents the atomic number

6. boron-13 or B-13

7. (a) 5

(b) 5

(c) 8

8. (a) neon with 11 neutrons

(b) sulphur with 16 neutrons

(c) actinium with 141 neutrons

(d) thorium with 144 neutrons

9.

Isotope	Standard atomic notation	Atomic number	Mass number	Number of protons	Number of neutrons
carbon-14	$^{14}_{6}C$	6	14	6	8
cobalt-52	**$^{52}_{27}Co$**	27	52	**27**	**25**
nickel-60	$^{60}_{28}Ni$	**28**	**60**	**28**	**32**
nitrogen-14	**$^{14}_{7}N$**	**7**	14	7	**7**
thallium-201	**$^{201}_{81}Tl$**	**81**	**201**	**81**	**120**
radium-226	$^{226}_{88}Ra$	**88**	**226**	**88**	**138**
lead-208	**$^{208}_{82}Pb$**	**82**	**208**	82	126

Comprehension

Alpha, beta, and gamma radiation
Page 125

1. diagram labelling: alpha particle (on the first line); beta particle (on the second line); gamma ray (on the third line)

2. (a) gamma ray

(b) beta particle

(c) alpha particle

(d) gamma ray

(e) beta particle

(f) alpha particle

(g) alpha particle

(h) beta particle

(i) alpha particle, beta particle, and gamma ray

(j) beta particle

(k) alpha particle

(l) beta particle

(m) gamma ray

(n) alpha particle and beta particle

(o) gamma ray

(p) gamma ray

(q) gamma ray

(r) alpha particle

(s) gamma ray

Applying Knowledge

Radioactive decay and nuclear equations

Page 126

1. $^{32}_{15}\text{P} \rightarrow \text{S} + ^{32}_{16}\text{e}$ or $^{0}_{-1}\beta$ $^{0}_{-1}$ BETA DECAY

2. $^{218}_{84}\text{Po} \rightarrow \text{Pb} + ^{214}_{82}\text{He}$ $^{4}_{2}$ ALPHA DECAY

3. $^{35}_{17}\text{Cl} \rightarrow \text{Ar} + ^{35}_{5}\text{e}$ $^{0}_{-1}$ BETA DECAY

4. $^{24}_{12}\text{Mg}^* \rightarrow \text{Mg} + ^{24}_{12}\gamma$ $^{0}_{0}$ GAMMA DECAY

5. $^{234}_{91}\text{Pa} \rightarrow \text{Ac} + ^{230}_{89}\alpha$ $^{4}_{2}$ ALPHA DECAY

6. $^{141}_{58}\text{Ce} \rightarrow \text{Pr} + \text{e}$ $^{141}_{59}$ $^{0}_{-1}$ BETA DECAY

7. $^{216}_{84}\text{Po} \rightarrow \text{At} + \beta$ $^{216}_{85}$ $^{0}_{-1}$ BETA DECAY

8. $^{20}_{9}\text{F} \rightarrow \text{Ne} + ^{20}_{10}\text{e}$ or $^{0}_{-1}\beta$ $^{0}_{-1}$ BETA DECAY

9. $^{58}_{26}\text{Fe}^* \rightarrow \text{Fe} + \gamma$ $^{58}_{26}$ $^{0}_{0}$ GAMMA DECAY

10. $^{225}_{89}\text{Ac} \rightarrow \text{Fr} +$ $^{221}_{87}\alpha$ $^{4}_{2}$ ALPHA DECAY

11. $^{149}_{64}\text{Gd}^* \rightarrow \text{Gd} + ^{149}_{64}\gamma$ $^{0}_{0}$ GAMMA DECAY

12. $^{226}_{88}\text{Ra} \rightarrow \text{Rn} +$ $^{222}_{86}\alpha$ or He^{4}_{2} $^{4}_{2}$ ALPHA DECAY

13. $^{212}_{81}\text{Tl} \rightarrow \text{Pb} + ^{212}_{82}\beta$ $^{0}_{-1}$ BETA DECAY

14. $^{214}_{83}\text{Bi} \rightarrow \text{Tl} + ^{210}_{81}\alpha$ or $^{4}_{2}\text{He}$ $^{4}_{2}$ ALPHA DECAY

15. $^{254}_{98}\text{Cf}^* \rightarrow \text{Cf} + ^{254}_{98}\gamma$ $^{0}_{0}$ GAMMA DECAY

Assessment

Atomic theory, isotopes, and radioactive decay

Page 127

1. D **2.** A **3.** C **4.** C **5.** B **6.** B **7.** C **8.** A **9.** A **10.** A **11.** A **12.** C **13.** C **14.** D **15.** A **16.** C

Section 7.2 Half-Life

Applying Knowledge

Radioactive decay

Page 132

1. (a) the time required for half the nuclei in a sample of a radioactive isotope to decay; a constant for any radioactive isotope

(b) a curved line on a graph that shows the rate at which radioisotopes decay

(c) the isotope that undergoes radioactive decay

(d) the stable product of radioactive decay

2.

Half-life	Percent of parent isotope	Percent of daughter isotope
0	100	0
1	50	50
2	25	75
3	12.5	87.5
4	6.25	93.75

Half-life	Fraction of parent isotope	Fraction of daughter isotope
0	1	0
1	$\frac{1}{2}$	$\frac{1}{2}$
2	$\frac{1}{4}$	$\frac{3}{4}$
3	$\frac{1}{8}$	$\frac{7}{8}$
4	$\frac{1}{16}$	$\frac{15}{16}$

3. (a)

Half-life	Time (a)	Mass (g)
0	0	**120**
1	5	**60**
2	10	**30**
3	15	**15**
4	20	**7.5**
5	25	**3.75**

(b) 3.75 g

(c) 3 half-lives

(d) 20 years

(e) The graph should show a decay curve.

4. (a)

Half-life	Time (a)	Mass of parent isotope (g)	Mass of daughter isotope (g)
0	0	**80**	**0**
1	20	**40**	**40**
2	40	**20**	**60**
3	60	**10**	**70**
4	80	**5**	**75**
5	100	**2.5**	**77.5**

(b) 5 g

(c) 2.5 g

(d) 70 g

(e) 100 years

(f) 1:3

Comprehension

Calculating half-life

Page 134

1. (a) $\frac{1}{8}$

(b) 6.25%

(c) $\frac{3}{4}$

(d) 96.875%

2. 18 g

3. 12.5%

4. 48 g

5. 1420 million years old

6. 3.9 billion years old

7. 9 billion years

8. 5 years

9. 10 g

Analyzing Information

Decay curves

Page 135

1. (a) 2 days

(b) 20 g

(c) 70 g

(d) $\frac{1}{16}$

(e) 8 days

2. (a) potassium-40 and argon-40

(b) 1.3 billion years

(c) equal amounts of daughter and parent isotopes

(d) $\frac{15}{16}$

(e) 1:3

Assessment

Half-life

Page 136

1. D **2.** C **3.** B **4.** A **5.** C **6.** A **7.** C **8.** D **9.** B **10.** C **11.** B

12. C

Section 7.3 Nuclear Reactions

Cloze Activity

Radioactivity

Page 140

1. nuclear fission

2. unstable

3. energy

4. nuclear reaction; isotope

5. subatomic particles

6. induced

7. proton

8. neutron

9. chain reaction

10. CANDU reactor

11. nuclear fusion; Sun

Comprehension

Comparing nuclear fission and fusion

Page 141

1.

	Nuclear fission	Nuclear fusion
Give a description of the process.	one heavy unstable nucleus splits up into lighter nuclei	two small nuclei combine to form one large nucleus
What is produced as a result of this nuclear process?	huge amounts of energy; neutrons; radioactive isotopes	huge amounts of energy; neutron(s)
Are the products radioactive?	products are often radioactive	products are not often radioactive
What is needed for this nuclear reaction to occur?	a neutron	high temperature and sufficient pressure
Where does this process occur?	induced fission in nuclear fission reactors; atom bombs	Sun; stars; hydrogen bombs
Give an example of a nuclear equation.	answers may vary ${}^{1}_{0}n + {}^{235}_{92}\mathrm{U} \rightarrow {}^{92}_{36}\mathrm{Kr} + {}^{141}_{56}\mathrm{Ba} + 3\,{}^{1}_{0}n$ + energy	answers may vary ${}^{2}_{1}\mathrm{H} + {}^{3}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{1}_{0}n$ + energy