Chapter 1 Atoms and Elements

Practice Problems C

1.1 Only (a) is neutral. The charges on (b) and (c) are +1 and −1, respectively.

1.2 (a) $Z = 6$, C; (b) $Z = 3$, Li; (c) $Z = 8$, O.

1.3

(a) potassium	K	19	20	19
(b) beryllium	Be	4	5	4
(c) bromine	Br	35	46	35

1.4 B: main-group, metalloid
Zn: transition element, metal
K: main-group, metal, alkali metal

1.5 N-14 or ^{14}N, 7 neutrons, 7 protons, 7 electrons
^{23}N, sodium, 12 neutrons, 11 electrons

1.6 (a) 2000 g; (b) 1500 g; (c) No, the mass of a 50:50 mix would be 1750 g. Average mass of a 50:50 mix would be 175 g/apple. (d) 155 g.

1.7 287.9786 amu

Key Skills

1.1 a, 1.2 a, 1.3 c, 1.4 c.

Questions and Problems

1.1. A theory (or model) is developed after a hypothesis has been tested extensively through experimentation. It is something that describes observations and is used to predict the outcomes of future experiments.

1.2. A scientific law is a concise statement of an observed pattern of behavior/phenomena.

1.3. A hypothesis is an attempt to explain an observation and is testable.

1.4. A law describes the pattern observed in a collection of data. It leads to a hypothesis and further experimentation. A theory is a unifying principle that explains a body of experimental observations and the law or laws that are based upon them. A theory explains past experimental observations and can be used to predict future observations.

1.5. Yes, an atom can be broken down into electrons, neutrons, and protons. If this is done, the "parts" do not have the same properties as the atom that we started with.

1.6. Only answer (a) shows cancelled charges because the number of negative and positive charges is equal.

b. These charges do not cancel—there is one extra negative charge (21 negative – 20 positive = 1 negative left).

c. These charges do not cancel—there are three extra negative charges (18 negative – 15 positive = 3 negative left).

d. These charges do not cancel—there are three extra positive charges (16 positive – 13 negative = 3 positive left).

1.7. There would be 2 protons, 2 electrons, and 2 neutrons.

1.8. Protons (+1 charge each) and neutrons (no charge) make up the nucleus of an atom. A "cloud" of electrons (–1 charge each) make up the largest volume of the atom, outside of the nucleus.

1.9. a. False. A neutral atom always contains the same number of protons and electrons, but the number of neutrons can vary, depending on the isotope.
b. True.
c. True.
d. False. An atom is the smallest identifiable piece of an element that retains the properties of that element.

1.10. Look for the sets of data that contain the same number of protons and electrons. The number of neutrons does NOT matter because they have no charge.
Only set (a) contains an equal number of protons and electrons and is therefore a neutral atom.

1.11. Look for the sets of data that contain the same number of protons and electrons. The number of neutrons does NOT matter because they have no charge.
Answers (b) and (c) represent neutral atoms.

1.12. Remember that green spheres represent electrons (–), blue spheres are protons (+), and red spheres are neutrons (no charge). If there are the same number of electrons and protons, the image represents a neutral atom. Images (a) and (c) show neutral atoms. Image (b) has two protons and five electrons, so the net charge is 3–.

1.13. a. Ca = calcium, C = carbon
b. B = boron, Br = bromine
c. correct
d. correct

1.14. a. K = potassium, Kr = krypton
b. S = sulfur, Si = silicon
c. correct
d. correct

1.15. a. Pt = platinum, Pu = plutonium
b. Ni = nickel, N = nitrogen
c. correct
d. correct

1.16. a. Mg = magnesium, Mn = manganese
b. correct
c. Xe = xenon; element xerxes does not exist
d. correct

1.17. Look up the element symbol or *Z*, the number of protons, or the number of electrons, because these are all the same as the atomic number in a neutral atom. Once located on the periodic table, the symbol and/or the numbers of protons and electrons can be determined. Added answers in **bold**.

Element Symbol	Element Name	Atomic Number (*Z*)	Number of Protons	Number of Electrons
Si	**silicon**	14	14	**14**
Mg	magnesium	**12**	12	12
P	**phosphorus**	15	15	15
Zn	zinc	**30**	30	**30**
I	**iodine**	**53**	**53**	53

1.18. Look up the element symbol or *Z*, the number of protons, or the number of electrons, because these are all the same as the atomic number in a neutral atom. Once located on the periodic table, the symbol and/or the numbers of protons and electrons can be determined. Added answers in **bold**.

Element Symbol	Element Name	Atomic Number (*Z*)	Number of Protons	Number of Electrons
K	**potassium**	**19**	**19**	**19**
N	nitrogen	**7**	**7**	**7**
S	**sulfur**	16	**16**	**16**
Sr	**strontium**	**38**	38	**38**
Ar	**argon**	**18**	**18**	18

1.19. Green elements = metals, yellow elements = metalloids, blue elements = nonmetals
The main-group elements are the first two columns on the left and the last six columns on the right.

1.20. I = alkali metals, II = alkaline earth metals, III = chalcogens, IV = halogens, V = noble gases

1.21. Li, Ba, Cu, V

1.22. C, Cl, Ar, I, Kr, O, F, S

1.23. None of these elements are metalloids.

1.24. Cl, I, F

1.25. Ar, Kr

1.26. Li

1.27. Ba

1.28. Fe, Ni, K, Sr, Pb

1.29. Br, Xe, Se, P, N

1.30. As, Si

1.31. Br

1.32. Xe

1.33. K

1.34. Sr

1.35. Added answers in **bold**.

Symbol	Main-group element	Transition element	Metal	Non-metal	Metalloid	Alkali metal	Alkaline earth metal	Halogen	Noble gas
Rb	X		X			X			
Be	**x**		**x**				**x**		
Ag		**x**	**x**						
Zn		**x**	**x**						

1.36. Added answers in **bold**.

Symbol	Main-group element	Transition element	Metal	Non-metal	Metalloid	Alkali metal	Alkaline earth metal	Halogen	Noble gas
Fe		x	x						
Pb	x		x						
Se	x			x					

1.37. Added answers in **bold**.

Symbol	Main-group element	Transition element	Metal	Non-metal	Metalloid	Alkali metal	Alkaline earth metal	Halogen	Noble gas
Cl	x			x				x	
P	x			x					
Mg	x		x				x		

1.38. Added answers in **bold**.

Symbol	Main-group element	Transition element	Metal	Non-metal	Metalloid	Alkali metal	Alkaline earth metal	Halogen	Noble gas
S	x			x					
Ne	x			x					x
Si	x				x				

1.39. Added answers in **bold**.

Symbol	Main-group element	Transition element	Metal	Non-metal	Metalloid	Alkali metal	Alkaline earth metal	Halogen	Noble gas
I	x			x				x	
Ar	x			x					x
K	x		x			x			

1.40. Remember that the mass number (protons + neutrons) is given in the isotope symbol. The number of protons determines the identity of the element.

a. $^{15}_{7}N$

b. $^{19}_{9}F$

c. $^{13}_{6}C$

1.41. Remember that the mass number (protons + neutrons) is given in the isotope symbol. The number of protons determines the identity of the element.

a. $^{9}_{4}Be$

b. $^{25}_{12}Mg$

c. $^{40}_{20}Ca$

1.42. a. Your sketch should show 10 protons and 12 neutrons in the nucleus, and 10 electrons surrounding it.
b. Your sketch should show 3 protons and 4 neutrons in the nucleus, and 3 electrons surrounding it.
c. Your sketch should show 5 protons and 6 neutrons in the nucleus, and 5 electrons surrounding it.

1.43. a. Your sketch should show 4 protons and 5 neutrons in the nucleus, and 4 electrons surrounding it.
b. Your sketch should show 2 protons and 2 neutrons in the nucleus, and 2 electrons surrounding it.
c. Your sketch should show 5 protons and 5 neutrons in the nucleus, and 5 electrons surrounding it.

1.44. Look up the element symbol, the number of protons, or the number of electrons because these are all the same as the atomic number in a neutral atom. Once located on the periodic table, the symbol and/or the number of protons and electrons can be determined. The mass number represents the number of neutrons and protons added together. Added answers in **bold.**

Isotope Symbol	Element Name	Mass Number (*A*)	Neutrons (n°)	Protons (p^+)	Electrons (e^-)
C-13	carbon	13	7	6	6
C-12 or ^{12}C	carbon	12	**6**	**6**	**6**
Zn-66 or ^{66}Zn	**zinc**	66	**36**	30	**30**
^{65}Cu	**copper**	**65**	**36**	**29**	**29**

1.45. Look up the element symbol, the number of protons, or the number of electrons because these are all the same as the atomic number in a neutral atom. Once located on the periodic table, the symbol and/or the number of protons and electrons can be determined. The mass number represents the number of neutrons and protons added together. Added answers in **bold.**

Isotope Symbol	Element Name	Mass Number (*A*)	Neutrons (n°)	Protons (p^+)	Electrons (e^-)
^{109}Ag	**silver**	**109**	**62**	**47**	**47**
Si-28	**silicon**	**28**	**14**	**14**	**14**
Ar-40	**argon**	40	22	**18**	18

1.46. Look for two atoms that have the same number of protons and electrons, but differ in their number of neutrons. Answer (a) has the only pair of atoms that are isotopes of one another.

1.47. Look for two atoms that have the same number of protons and electrons, but differ in their number of neutrons. Answer (b) is the only one.

1.48. Look at the atomic mass of the element on the periodic table. If the value is closer to the mass of one of the two isotopes, it must be present in a higher abundance.
a. Ti has an average atomic mass of 47.88 amu. Therefore, Ti-48 is present in a higher abundance (larger portion).
b. Ca has an average atomic mass of 40.08 amu. Therefore, Ca-40 is present in a higher abundance (larger portion).
c. Ba has an average atomic mass of 137.33 amu. Therefore, Ba-138 is present in a higher abundance (larger portion).

1.49. Look at the atomic mass of the element on the periodic table. If the value is closer to the mass of one of the two isotopes, it must be present in a higher abundance.
a. Ni has an average atomic mass of 58.69 amu. Therefore, Ni-58 is present in a higher abundance (larger portion).
b. K has an average atomic mass of 39.10 amu. Therefore, K-39 is present in a higher abundance (larger portion).
c. Fe has an average atomic mass of 55.85 amu. Therefore, Fe-56 is present in a higher abundance (larger portion).

1.50. Look at the atomic mass of the element on the periodic table. If the value is closer to the mass of one of the two isotopes, it must be present in a higher abundance.
a. Si has an average atomic mass of 28.09 amu. Therefore, Si-28 is present in a higher abundance (larger portion). This statement is true.
b. Ar has an average atomic mass of 39.95 amu. Therefore, Ar-40 is present in a higher abundance (larger portion). It is not a 50:50 mix of Ar-36 and Ar-40.
c. Sr has an average atomic mass of 87.62 amu. Therefore, Sr-86 is not the highest abundance isotope.
d. Ne has an average atomic mass of 20.18 amu. Therefore, Ne-20 is in higher abundance and neon is not an equal mix of Ne-20 and Ne-21.

1.51. Look at the atomic mass of the element on the periodic table. If the value is closer to the mass of one of the two isotopes, it must be present in a higher abundance. If the two isotopes are present in nearly equal amounts, the mass on the periodic table would be an average of the two isotope masses. None of the statements could be true, based on the average atomic mass shown for each element on the periodic table.

1.52. $78.9183 \times 0.5070 = \mathbf{40.01}15781$

$\underline{+\ 80.9163 \times 0.4932 = \mathbf{39.90}791916}$

79.92 amu

1.53. $38.96370 \times 0.93258 = \mathbf{36.336}76735$

$+ \ 40.96183 \times 0.06730 = \mathbf{2.756}731159$

39.093 amu

1.54. $23.9850 \times 0.7899 = \mathbf{18.94}57515$

$+ \ 24.9858 \times 0.1000 = \mathbf{2.498}58$

$+ \ 25.9826 \times 0.1101 = \mathbf{2.860}68426$

24.31 amu

1.55. $27.9769265 \times 0.92223 = \mathbf{25.801}16093$

$+ \ 28.9764947 \times 0.04685 = \mathbf{1.357}548777$

$+ \ 29.9737702 \times 0.03092 = \mathbf{0.926}788975$

28.085 amu

1.56. $85.9092607 \times 0.09861 = \mathbf{8.471}512198$

$+ \ 86.9088775 \times 0.07001 = \mathbf{6.084}490514$

$+ \ 87.9056122 \times 0.82581 = \mathbf{72.593}33361$

87.149 amu

1.57. $53.9396 \times 0.05845 = \mathbf{3.152}76962$

$+ \ 55.9349 \times 0.91754 = \mathbf{51.322}50815$

$+ \ 56.9354 \times 0.02119 = \mathbf{1.206}461126$

55.682 amu

1.58. $106.9051 \times Y = 106.9051Y$

$+ \ 108.9048 \times (1 - Y) = 108.9048 - 108.9048Y$

107.9 amu (this value is obtained on the periodic table)

Solve for Y:

$106.9051Y + 108.9048 - 108.9048Y = 107.9$

$1.9997Y = 1.0048$

$Y = 0.50247$ or 50.247% of the Ag-107 isotope and

$1 - Y = 0.49752$ or 49.752% of the Ag-109 isotope

1.59. $10.01294 \times Y = 10.01294Y$

$\underline{+\ 11.00931 \times (1 - Y)\ = 11.00931 - 11.00931Y}$

10.81 amu (this value is obtained on the periodic table)

Solve for Y:

$10.01294Y + 11.00931 - 11.00931Y = 10.81$

$0.99637Y = 0.19931$

$Y = 0.200036$ or 20.00% of the B-10 isotope and

$1 - Y = 0.799963$ or 80.00% of the B-11 isotope

1.60. White: $314.965 \times \frac{15}{20} = 236.22375$

$+$ Black: $317.985 \times \frac{5}{20} = 79.49625$

315.720 amu

1.61. Green: $229.969 \times \frac{4}{12} = 76.656333$

$+$ Orange: $233.995 \times \frac{8}{12} = 155.9966667$

232.653 amu