

SCIENTIFIC MEASUREMENT

Chapter Test A

A. Matching

Match each description in Column B with the correct term in Column A. Write the letter of the correct description on the line.

Column A

1. error
2. precision
3. 1 liter
4. temperature
5. density
6. conversion factor
7. dimensional analysis
8. weight
9. 1 kilogram
10. accuracy

Column B

- a. a measure of the pull of gravity on a given mass
- b. concerned with the reproducibility of measurements
- c. a ratio of equivalent measurements
- d. originally defined as the mass of 1 L of water at 4°C
- e. a way to analyze and solve problems, using the units of a measurement
- f. the ratio of the mass of an object to its volume
- g. the degree of hotness or coldness of an object
- h. closeness of a measurement to the true value
- i. difference between the experimental value and the accepted value
- j. the volume of a cube 10 cm on each edge

1. b
2. b
3. g
4. g
5. c
6. e
7. e
8. g
9. d
10. h

B. Multiple Choice

Choose the best answer and write its letter on the line.

11. How many significant figures are in the measurement 2103.2 g?
 - a. 2
 - b. 3
 - c. 4
 - d. 5
12. Which of these equalities is not correct?
 - a. 100 cg = 1 g
 - b. 1000 mm = 1 m
 - c. 1 cm³ = 1 mL
 - d. 10 kg = 1 g
13. How many of the zeros in the measurement 0.000 040 200 m are significant?
 - a. 2
 - b. 3
 - c. 7
 - d. 8

11. d
12. d
13. b

14. How many milligrams are in 2.5 kg?
 - a. 2.5×10^3 mg
 - b. 25 mg
 - c. 2.5×10^{-4} mg
 - d. 2.5×10^2 mg
15. The closeness of a measurement to its true value is a measure of its:
 - a. usefulness.
 - b. precision.
 - c. accuracy.
 - d. reproducibility.
16. Which of these measurements is expressed to three significant figures?
 - a. 0.070 mm
 - b. 7.30×10^{-7} km
 - c. 7007 mg
 - d. 0.007 m
17. A metric unit of volume is the:
 - a. L.
 - b. mg
 - c. km.
 - d. K.
18. The number of seconds in a 40-hour work week can be calculated as follows:
 - a. $60 \text{ s} \times \frac{1 \text{ min}}{60 \text{ s}} \times \frac{1 \text{ h}}{60 \text{ min}} =$
 - b. $1 \text{ s} \times \frac{1 \text{ min}}{60 \text{ s}} \times \frac{40 \text{ h}}{60 \text{ min}} =$
 - c. $40 \text{ h} \times \frac{60 \text{ min}}{1 \text{ h}} \times \frac{60 \text{ s}}{1 \text{ min}} =$
 - d. $40 \text{ h} \times \frac{60 \text{ min}}{40 \text{ h}} \times \frac{60 \text{ s}}{60 \text{ min}} =$
19. The metric prefix kilo- means:
 - a. 100 times smaller.
 - b. 1000 times larger.
 - c. 1000 times smaller.
 - d. 100 times larger.
20. What is the volume of 60.0 g of ether if the density of ether is 0.70 g/mL?
 - a. 86 mL
 - b. 1.2×10^{-2} mL
 - c. 2.4×10^{-4} mL
 - d. 42 mL
21. The temperature reading of -14°C corresponds to a Kelvin reading of:
 - a. 297.6 K.
 - b. -287 K.
 - c. 287 K.
 - d. 259 K.
22. Concentrated hydrochloric acid has a density of 1.19 g/mL. What is the mass, in grams, of 2.00 liters of this acid?
 - a. 2.38×10^3 g
 - b. 2.38 g
 - c. 4.20×10^{-4} g
 - d. 4.20×10^{-4} g
23. A conversion factor:
 - a. is equal to 1.
 - b. is a ratio of equivalent measurements.
 - c. does not change the value of a measurement.
 - d. all of the above
24. Chlorine boils at 239 K. What is the boiling point of chlorine expressed in degrees Celsius?
 - a. 93°C
 - b. 34°C
 - c. -61°C
 - d. -34°C
25. A student measures a volume as 25 mL, whereas the correct volume is 23 mL. What is the percent error?
 - a. 0.087%
 - b. 8.7%
 - c. 0.92%
 - d. 8.0%

4 ATOMIC STRUCTURE

Practice Problems

In your notebook, solve the following problems.

SECTION 4.1 DEFINING THE ATOM

- According to Figure 4.1, 100,000,000 copper atoms would form a line 1 cm long. How long would a line formed by 1×10^7 copper atoms be? Express your answer in millimeters.

SECTION 4.2 STRUCTURE OF THE NUCLEAR ATOM

- A sulfur-32 atom contains 16 protons, 16 neutrons, and 16 electrons. What is the mass (in grams) of a sulfur-32 atom?
- The mass of a neutron is 1.67×10^{-24} g. Approximately what number of neutrons would equal a mass of one gram?
- Which statement is consistent with the results of Rutherford's gold foil experiment?
 - All atoms have a positive charge.
 - Atoms are mostly empty space.
 - The nucleus of an atom contains protons and electrons.
 - Mass is spread uniformly throughout an atom.

5.33 x 10⁻²³
6.810 x 10⁻²³ g

SECTION 4.3 DISTINGUISHING BETWEEN ATOMS

- How many protons are found in an atom of each of the following?
 - boron 5
 - sulfur 16
 - neon 10
 - lithium 3
- Complete the table for the following elements.

Element	Number of Protons	Number of Electrons	Number of Neutrons	Atomic Number	Mass Number
Manganese	25	25	30	25	55
Sodium	11	11	12	11	23
Bromine	35	35	45	35	80
Yttrium	39	39	50	39	89
Arsenic	33	33	42	33	75
Actinium	89	89	138	89	227

C. True-False

Classify each of these statements as always true, AT, sometimes true, ST, or never true, NT.

26. Precise measurements are also accurate measurements. ST
27. Zeros in a measurement are significant. ST
28. In converting between units, it is necessary to use more than one conversion factor. AT
29. When converting complex units, you should check that the units cancel, the conversion factors are correct, and the answer has the correct units. ST
30. The weight of an object changes with its location. NT
31. A kilogram is the mass of 1 mL of water at 4°C. NT
32. The density of a substance decreases as its temperature increases. ST
33. Heat transfers from objects at high temperatures to objects at low temperatures. AT
34. To convert density from g/cm^3 to kg/m^3 , one of the conversion factors you could use is mg^3/kg . NT

D. Problems

Solve the problems in the space provided. Show your work.

36. A cube of gold-colored metal with a volume of 64 cm^3 has a mass of 980 g. The density of pure gold is 19.3 g/cm^3 . Is the metal pure gold?

7.50 cm²
36. Perform the following operations. Make sure that your answers have the correct number of significant digits.
 - $4.15 \text{ cm} \times 1.8 \text{ cm}$
12.46 cm
 - $13.00 \text{ m} - 0.54 \text{ m}$
 $6.3 \times 10^{-9} \text{ m}$
 - $(1.7 \times 10^{-5} \text{ m}) \times (3.72 \times 10^{-4} \text{ m})$

ATOMIC STRUCTURE

4

Vocabulary Review

Match the correct vocabulary term to each numbered statement. Write the letter of the correct term on the line.

Column A

- defined as $\frac{1}{12}$ the mass of a carbon-12 atom
- central core of an atom, which contains most of the atom's mass
- a vertical column of elements in the periodic table
- subatomic particles with no charge
- positively charged subatomic particles
- the smallest particle of an element that retains its identity in a chemical reaction
- the number of protons in the nucleus of an element
- negatively charged subatomic particles
- atoms with the same number of protons but different numbers of neutrons
- an arrangement of elements according to similarities in their properties

f a g b i j e d g i j

Column B

- isotopes
- neutrons
- atom
- electrons
- atomic number
- atomic mass unit
- group
- nucleus
- periodic table
- protons

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- How many neutrons are in each atom?
 a. $^{23}_{11}\text{Na}$ 12
 b. $^{238}_{92}\text{U}$ 146
 c. $^{80}_{35}\text{Br}$ 46
 d. ^{19}F 10
- The two most abundant isotopes of carbon are carbon-12 (mass = 12.00 amu) and carbon-13 (mass = 13.00 amu). Their relative abundances are 98.9% and 1.10%, respectively. Calculate the atomic mass of carbon.
- Element X has two isotopes: X-100 and X-104. If the atomic mass of X is 101 amu, what is the relative abundance of each isotope in nature?

12.011 amu
 75% 100
 25% 104

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ATOMIC STRUCTURE

4

Chapter Quiz

Fill in the word(s) that will make each statement true.

- Dalton's atomic theory included the idea that the atoms of different elements can chemically combine in 1 ratios.
- An atom is the smallest particle of an element that retains its identity in a 2.
- 3 are subatomic particles with a negative charge.
- The nucleus of an atom is composed of 4 and protons.
- A neutron has no charge, but its mass is almost the same as that of a 5.
- The number of protons in an atom is called its 6 number.
- There are 10 neutrons and 7 electrons in an atom of oxygen-18.
- Isotopes of an element have different numbers of neutrons. They also have different 8 numbers.
- The total number of protons, neutrons, and electrons in an atom of silver-109 (atomic number 47) is 9.
- The mass number of an element with 14 electrons and 16 neutrons is 10.
- The horizontal rows of the periodic table are called 11.
- The elements in the periodic table are listed in order of increasing 12.

- Simple whole #
- Chemical rxn
- electrons
- neutrons
- proton
- atomic #
- 8
- mass
- 136
- 30
- periods
- atomic #

ATOMIC STRUCTURE

4

Chapter Test A

A. Matching

Match each description in Column B with the correct term in Column A. Write the letter of the correct description on the line.

Column A

- proton
- atom
- mass number
- atomic mass unit
- electron
- isotopes
- atomic number
- atomic mass
- period
- neutron

Column B

- the total number of protons and neutrons in the nucleus of an atom
- the weighted average mass of the atoms in a naturally occurring sample of an element
- $\frac{1}{12}$ the mass of a carbon-12 atom
- the number of protons in the nucleus of an element
- atoms with the same number of protons but different numbers of neutrons
- negatively charged subatomic particle
- the smallest particle of an element that retains its identity in a chemical reaction
- a horizontal row of the periodic table
- subatomic particle with no charge
- positively charged subatomic particle

- j _____
 a _____
 g _____
 d _____
 f _____
 e _____
 d _____
 b _____
 h _____
 i _____

B. Multiple Choice

Choose the best answer and write its letter on the line.

- C 11. Which of the following is not a part of Dalton's atomic theory?
 a. All elements are composed of atoms.
 b. Atoms of the same element are alike.
 c. Atoms are always in motion.
 d. Atoms that combine do so in simple whole-number ratios.
- d 12. The nucleus of an atom is
 a. negatively charged and has a low density.
 b. negatively charged and has a high density.
 c. positively charged and has a low density.
 d. positively charged and has a high density.

ORGANIZING THE ELEMENTS

6.1

Section Review

Objectives

- Explain how elements are organized in a periodic table
- Compare early and modern periodic tables
- Identify three broad classes of elements

Vocabulary

- periodic law
- metals
- nonmetals
- metalloids

Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

1. Chemists used the 1 of elements to sort them into groups. properties
2. The periodic table organizes the elements into vertical 2 and horizontal 3 in order of increasing 4. The table is constructed so that elements that have similar chemical properties are in the same 5. 6 have a high luster, or sheen, when cut. Most nonmetals are 7 at room temperature. Metals
3. Elements with properties that are similar to those of metals and nonmetals are called 8. Groups/families
4. Across the periodic table, the properties of elements become 9 metallic and 10 nonmetallic. Groups/families
5. atomic #
6. atomic #
7. Metals
8. Groups/families
9. less
10. more

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- C 13. Dalton theorized that atoms are indivisible and that all atoms of an element are identical. Scientists now know that
- a. Dalton's theories are completely correct.
 - b. atoms of an element can have different numbers of protons.
 - c. atoms are all divisible.
 - d. all atoms of an element are not identical but they all have the same mass.

- C 14. The number of neutrons in the nucleus of an atom can be calculated by
- a. adding together the numbers of electrons and protons.
 - b. subtracting the number of protons from the number of electrons.
 - c. subtracting the number of protons from the mass number.
 - d. adding the mass number to the number of protons.

- d 15. The sum of the protons and neutrons in an atom equals the
- a. atomic number.
 - b. number of electrons.
 - c. mass number.
 - d. mass.

- a 16. All atoms of the same element have the same:
- a. number of protons.
 - b. number of neutrons.
 - c. mass number.
 - d. mass.

- b 17. Which of these statements is false?
- a. Electrons have a negative charge.
 - b. Electrons have a mass of 1 amu.
 - c. The nucleus of an atom is positively charged.
 - d. The neutron is found in the nucleus of an atom.

- a 18. An atom of an element with atomic number 48 and mass number 120 contains
- a. 48 protons, 48 electrons, and 72 neutrons.
 - b. 72 protons, 48 electrons, and 48 neutrons.
 - c. 120 protons, 48 electrons, and 72 neutrons.
 - d. 72 protons, 72 electrons, and 48 neutrons.

- b 19. How do the isotopes hydrogen-2 and hydrogen-3 differ?
- a. Hydrogen-3 has one more electron than hydrogen-2.
 - b. Hydrogen-3 has two neutrons.
 - c. Hydrogen-2 has three protons.
 - d. Hydrogen-2 has no protons.

- b 20. The number 80 in the name bromine-80 represents
- a. the atomic number.
 - b. the mass number.
 - c. the sum of protons and electrons.
 - d. none of the above

- C 21. Which of these statements is *not* true?
- a. Atoms of the same elements can have different masses.
 - b. The nucleus of an atom has a positive charge.
 - c. Atoms of isotopes of an element have different numbers of protons.
 - d. Atoms are mostly empty space.

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NUCLEAR TRANSFORMATIONS

252

Section Review

Objectives

- Describe the type of decay a radioisotope undergoes
- Make calculations that involve half-life
- Explain the two ways transmutations can occur

Vocabulary

- band of stability
- positron
- half-life
- transmutation
- transuranium elements

Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

- Nuclei that lie outside the 1. band of stability undergo spontaneous radioactive decay. Nuclei with too many neutrons undergo 2. beta emission as neutrons are converted to protons. A 3. positron is a particle with a positive charge and the mass of an electron.
- Every radioisotope decays at a characteristic 4. rate.
5. half-life is the time required for one half of the nuclei in a radioisotope to decay. The product nuclei may or may not be 6. radioactive.
- Half-lives vary from fractions of a second to 7. billions of years.
- The conversion of atoms of one element to atoms of another is called 8. transmutation.
- This process can occur by 9. radioactive decay or when particles bombard the nucleus of an atom. All of the elements with 10. atomic # > 82 above 92 have been 11. synthesized or accelerators.

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Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

- ST Beta radiation is emitted when a radioisotope decays.
- NT Gamma radiation has a negative charge.
- AT Gamma radiation is high-energy electromagnetic radiation.
- NT $^{238}_{92}\text{U} + {}^0_{-1}\text{e} \rightarrow ^{239}_{92}\text{U}$
- AT When a beta particle is emitted, the atomic number increases by 1, and the mass number stays the same.

Part C Matching

Match each description in Column B to the correct term in Column A.

- | | |
|--------------------------------|---|
| Column A | Column B |
| <u>b</u> 21. radioisotopes | a. the process in which an unstable nucleus releases energy by emitting radiation |
| <u>a</u> 22. radioactive decay | b. isotopes that have unstable nuclei and undergo radioactive decay |
| <u>c</u> 23. gamma ray | c. high-energy photon with no mass or electrical charge |
| <u>e</u> 24. alpha particles | d. electrons resulting from the breaking apart of a neutron in an atom |
| <u>d</u> 25. beta particles | e. helium nuclei emitted from a radioactive source |

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Part D Problems

Answer the following in the space provided.

- Write nuclear equations for these processes.
 - The alpha decay of $^{210}_{82}\text{Po}$
 $^{210}_{82}\text{Po} \rightarrow ^{206}_{82}\text{Pb} + ^4_2\text{He}$
 - The beta decay of $^{210}_{82}\text{Pb}$
 $^{210}_{82}\text{Pb} \rightarrow ^{210}_{83}\text{Bi} + ^0_{-1}\text{e}$

FISSION AND FUSION OF ATOMIC NUCLEI

25.3

Section Review

Objectives

- Describe what happens in a nuclear chain reaction
- Explain the role of water in the storage of spent fuel rods
- Compare and contrast fission and fusion reactions

Vocabulary

- fission
- neutron absorption
- neutron moderation
- fusion

Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

- Nuclear 1 occurs when fissionable isotopes are bombarded with 2. The 3 breaks into two fragments of about the same size, and in the process they release more neutrons and 4.
 Nuclear 1 FISSION
 The 2 NEUTRONS
 The 3 FISSIONABLE ATOM
 They release more 4 ENERGY
- Neutron 5 is the process that reduces the speed of neutrons. Neutron 6 is the process that decreases the number of slow-moving neutrons. In nuclear 7, nuclei combine to make nuclei of greater 8. The sun's 9 is produced when 10 nuclei fuse to make 11 nuclei. Fusion releases even more energy than fission.
 Neutron 5 MODERATION
 Neutron 6 ADSORPTION
 Nuclear 7 FUSION
 Greater 8 MASS
 The sun's 9 ENERGY
 Nuclei 10 HYDROGEN
 Make 11 HELIUM

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

- ST 12. Water is used as a moderator in nuclear reactors.
NT 13. In nuclear fusion, the nuclei of two large atoms fuse together.

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

- NT 12. If you start with one mole of a radioisotope, after 10 half-lives, there will be none of the isotope left.
NT 13. A radioisotope has a half-life of 12 minutes. After 36 minutes only one third of the radioactive atoms initially present will remain.
AT 14. Transuranium elements have atomic numbers greater than 92.
ST 15. Transmutation reactions occur spontaneously.
ST 16. Positively charged particles have the mass of an electron.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A

- c 17. band of stability
e 18. positron
b 19. half-life
a 20. transmutation
d 21. transuranium elements

Column B

- a. conversion of an atom of one element to an atom of another element
 b. time required for one half of the nuclei of a radioisotope to decay to products
 c. region containing stable nuclei in a neutron vs. proton plot
 d. elements with atomic numbers higher than 92
 e. particle with the same mass as an electron but with a positive charge

Part D Questions

Answer the following in the space provided.

22. Sodium-24 has a half-life of 15 hours. How much sodium-24 will remain in an 18.0-g sample after 60 hours?

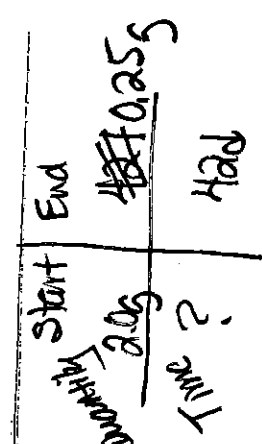
$$\frac{60}{15} = 4 \text{ half-lives}$$

HL #	0	1	2	3	4
REMAINING	180	90	45	22.5	11.25

$$180 \times 0.0625 = 11.25$$
23. After 42 days, a 2.0-g sample of phosphorus-32 contains only 0.125 g of isotope. What is the half-life of phosphorus-32?

$$3.0g \rightarrow 1.0g \rightarrow 0.5g \rightarrow 0.25g$$

$$\frac{42 \text{ days}}{3 \text{ half-lives}} = 14 \text{ days/half-life}$$



14. Moderation of neutrons is used to slow nuclear fission.
 15. Nuclear fusion can be easily produced under laboratory conditions.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A

- A 16. fission
C 17. neutron moderation
E 18. neutron absorption
B 19. fusion
D 20. uranium-235

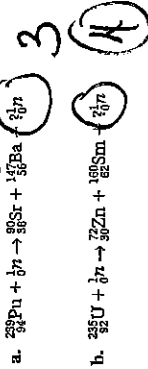
Column B

- a. the splitting of an atomic nucleus into smaller fragments
 b. combination of two nuclei to produce a nucleus of greater mass
 c. process used to reduce the speed of neutrons
 d. isotope capable of fission
 e. process used to decrease the number of slow-moving neutrons

Part D Questions and Problems

Answer the following in the space provided.

21. How many neutrons are produced in each of the following fission reactions?



22. What is the role in a nuclear reactor of
 a. neutron moderation?
 b. neutron absorption?

slow fast-moving neutrons so can be absorbed by the fuel atoms
 decrease the # of slow moving neutrons and slow the chain reaction

NUCLEAR CHEMISTRY

25

Practice Problems

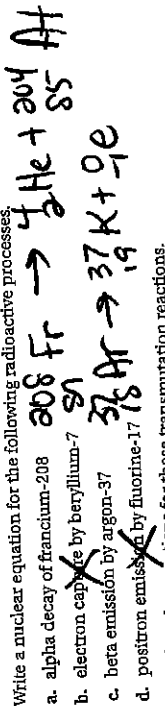
In your notebook, solve the following problems.

SECTION 25.1 NUCLEAR RADIATION

1. What happens to the mass number and atomic number of an atom that undergoes beta decay? **Atomic # increases by 1, mass # stays same.**
 2. A radioisotope of an element undergoes alpha particle decay. How do the atomic number and mass number of the particle change? **Atomic # decreases by 2, mass # decreases by 4.**
 3. Give the composition of the nucleus of the following isotopes.
 a. $^{64}_{28}\text{Ni}$ **28p 36n**
 b. $^{99}_{43}\text{Tc}$ **43p 56n**
 c. $^{195}_{78}\text{Au}$ **78p 116n by 4**
 4. Complete each of the following equations.
 a. $^{14}_6\text{C} \rightarrow \frac{0}{-1}e + ?$ **$^{14}_7\text{N}$**
 b. $^{241}_{95}\text{Am} \rightarrow ^4_2\text{He} + ?$ **$^{237}_{93}\text{Np}$**
 c. $^{15}_7\text{N} \rightarrow ^{15}_8\text{O} + ?$ **$^{0}_{-1}e$**

SECTION 25.2 NUCLEAR TRANSFORMATIONS

1. Write a nuclear equation for the following radioactive processes.



2. Complete the equations for these transmutation reactions.

