

CH1

1. State whether the following properties of matter are physical or chemical.

- (a) An iron nail is attracted to a magnet.
- (b) A piece of paper spontaneously ignites when its temperature reaches 451 °F.
- (c) A bronze statue develops a green coating (patina) over time.
- (d) A block of wood floats on water.

Ans: a. Physical b. Chemical c. Chemical d. Physical

2. Express each number in exponential notation. (a) 8950.; (b) 10,700.; (c) 0.0240; (d) 0.0047; (e) 938.3; (f) 275,482.

Ans: a. 8.950×10^3 b. 1.0700×10^4 c. 2.40×10^{-2} d. 4.7×10^{-3} e. 9.383×10^2 f. 2.75482×10^5

3. Express each value in exponential form. Where appropriate, include units in your answer.

- (a) speed of sound (sea level): 34,000 centimeters per second
- (b) equatorial radius of Earth: 6378 kilometers
- (c) the distance between the two hydrogen atoms in the hydrogen molecule: 74 trillionths of a meter

(d) $\frac{(2.2 \times 10^3) + (4.7 \times 10^2)}{5.8 \times 10^{-3}} =$

Ans: a. 3.4×10^4 cm/s b. 6.378×10^3 km c. 7.4×10^{-11} m d. 4.6×10^5

4. Express each of the following to *four* significant figures.

- (a) 3984.6; (b) 422.04; (c) 186,000; (d) 33,900; (e) 6.321×10^{-3} ; (f) 5.0472×10^3 .

Ans: a. 3985 b. 422.0 c. 1.860×10^5 d. 3.390×10^4 e. 6.321×10^{-3} f. 5.047×10^3

5. An American press release describing the 1986 nonstop, round-the-world trip by the ultra-lightweight aircraft *Voyager* included the following data: flight distance: 25,012 mi flight time: 9 days, 3 minutes, 44 seconds fuel capacity: nearly 9000 lb fuel remaining at end of flight: 14 gal To the maximum number of significant figures permitted, calculate

- (a) the average speed of the aircraft in kilometers per hour
- (b) the fuel consumption in kilograms per kilogram of fuel (assume a density of for the fuel)

Ans: a. 186.30 km/h b. 9.95 km/kg

6. Perform the following conversions from non-SI to SI units. (Use information from the inside back cover, as needed.)

(a) 68.4 in. = ___ cm

(b) 94 ft = ___ m

(c) 1.42 lb = ___ g

(d) 248 lb = ___ kg

(e) 1.85 gal = ___ dm³

(f) 3.72 qt = ___ mL

Ans: a. 174 cm b. 29 m c. 644 g d. 112 kg e. 7.00 dm³

7. We want to mark off a thermometer in both Celsius and Fahrenheit temperatures. On the Celsius scale, the lowest temperature mark is at -10 °C and the highest temperature mark is at 50 °C. What are the equivalent Fahrenheit temperatures?

Ans: Low: 14 °F ,high: 122 °F

8. You decide to establish a new temperature scale on which the melting point of mercury (-38.9 °C) is 0 °M, and the boiling point of mercury (356.9 °C) is 100 °M. What would be (a) the boiling point of water in °M; and (b) the temperature of absolute zero in °M?

Ans: a. 35.1 °M b. 59.2 °M

9. A fertilizer contains 21% nitrogen by mass. What mass of this fertilizer, in kilograms, is required for an application requiring 225 g of nitrogen?

Ans: 1.07 kg fertilizer

10. A solution of sucrose in water is 28.0% sucrose by mass and has a density of 1.118g/mL What mass of sucrose, in grams, is contained in 3.50 L of this solution?

Ans: 1.10×10^3 g sucrose

CH2

1. A 0.406 g sample of magnesium reacts with oxygen, producing 0.674 g of magnesium oxide as the only product. What mass of oxygen was consumed in the reaction?

Ans: 0.268 g oxygen

2. In one experiment, the burning of 0.312 g sulfur produced 0.623 g sulfur dioxide as the sole product of the reaction. In a second experiment, 0.842 g sulfur dioxide was obtained. What mass of sulfur must have been burned in the second experiment?

Ans: 0.422 g sulfur

3. There are two oxides of copper. One oxide has 20% oxygen, by mass. The second oxide has a *smaller* percent of oxygen than the first. What is the probable percent of oxygen in the second oxide?

Ans: $\approx 11\%$

4. The following radioactive isotopes have applications in medicine. Write their symbols in the form ${}^A_Z\text{E}$ (a) cobalt-60; (b) phosphorus-32; (c) iron-59; (d) radium-226.

Ans: a. ${}^{60}_{27}\text{Co}$ b. ${}^{32}_{15}\text{P}$ c. ${}^{59}_{26}\text{Fe}$ d. ${}^{226}_{88}\text{Ra}$

5. Iodine has many radioactive isotopes. Iodine-123 is a radioactive isotope used for obtaining images of the thyroid gland. Iodine-123 is administered to patients in the form of sodium iodide capsules that contain ${}^{123}\text{I}^-$ ions. Determine the number of neutrons, protons, and electrons in a single ${}^{123}\text{I}^-$ ion.

Ans: 53 protons, 54 electrons, 70 neutrons.

6. Americium-241 is a radioactive isotope that is used in high-precision gas and smoke detectors. How many neutrons, protons, and electrons are there in an atom of americium-241?

Ans: 95 protons, 95 electrons, 146 neutrons.

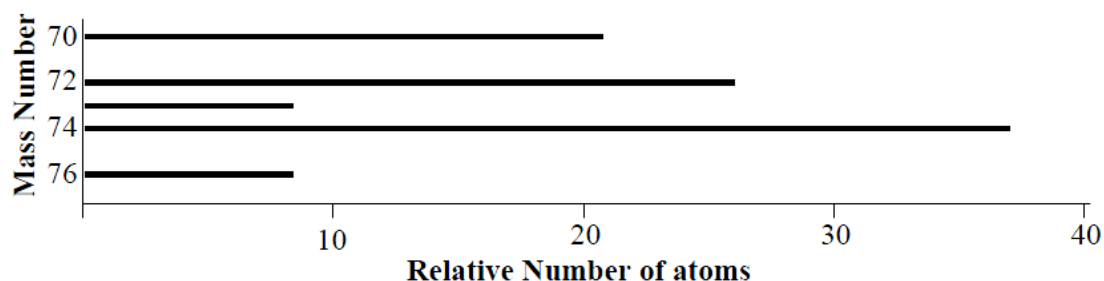
7. There are three naturally occurring isotopes of magnesium. Their masses and percent natural abundances are 23.985042 u, 78.99%; 24.985837 u, 10.00%; and 25.982593 u, 11.01%. Calculate the weighted-average atomic mass of magnesium.

Ans: 24.31 u

8. A mass spectrum of germanium displayed peaks at mass numbers 70, 72, 73, 74, and 76, with relative heights of 20.5, 27.4, 7.8, 36.5, and 7.8, respectively. (a) In the manner of Figure 2-14, sketch this mass spectrum. (b) Estimate the weighted-average atomic mass of germanium, and state why this result is only approximately correct.

Ans:

a.



b. Average atomic mass of germanium = 72.6 . The result is only approximately correct because the isotopic masses are given to only two significant figures.

9. Refer to the periodic table inside the front cover and identify

- (a) the element that is in group 14 and the fourth period
- (b) one element similar to and one unlike sulfur
- (c) the alkali metal in the fifth period
- (d) the halogen element in the sixth period

Ans: a. Ge b. Other elements in group 16(6A) are similar to S: O, Se, and Te. Most of the elements in the periodic table are unlike S, but particularly metals such as Na, K, and Rb. c. Rb d. At

10. How many Cu atoms are present in a piece of sterling silver jewelry weighing 33.24 g? (Sterling silver is a silver–copper alloy containing 92.5% Ag by mass.)

Ans: 2.4×10^{22} Cu atoms

CH3

1. The amino acid methionine, which is essential in human diets, has the molecular formula

$C_5H_{11}NO_2S$ Determine

- (a) its molecular mass;
- (b) the number of moles of H atoms per mole of methionine;
- (c) the number of grams of C per mole of methionine;
- (d) the number of C atoms in 9.07 mol methionine.

Ans: a. 149.213u/ $C_5H_{11}NO_2S$ molecule b. There are 11 moles of H atoms in each mole of $C_5H_{11}NO_2S$ molecules. c. 60.055g C d. 2.73×10^{25} atoms

2. Explain which of the following statement(s) is (are) correct concerning glucose (blood sugar), $C_6H_{12}O_6$.

- (a) The percentages, by mass, of C and O are the same as in CO.
- (b) The ratio of C : H : O atoms is the same as in dihydroxyacetone, $(CH_2OH)_2CO$
- (c) The proportions, by mass, of C and O are equal.
- (d) The highest percentage, by mass, is that of H.

Ans: a. False b. True c. False d. False

3. Without doing detailed calculations, arrange the following in order of increasing % Cr, by mass, and explain your reasoning: CrO, Cr_2O_3 , CrO_2 , CrO_3 .

Ans: Oxide with the largest %Cr will have the largest number of moles of Cr per mole of oxygen.

Arranged in order of increasing %Cr: $CrO_3 < CrO_2 < Cr_2O_3 < CrO$

4. Indigo, the dye for blue jeans, has a percent composition, by mass, of 73.27% C, 3.84% H, 10.68% N, and the remainder is oxygen. The molecular mass of indigo is 262.3 u. What is the molecular formula of indigo?

Ans: $C_{16}H_{10}N_2O_2$

5. A 0.1888 g sample of a hydrocarbon produces 0.6260 g CO_2 and 0.1602 g H_2O in combustion analysis. Its molecular mass is found to be 106 u. For this hydrocarbon, determine its (a) mass percent composition; (b) empirical formula; (c) molecular formula.

Ans: a. 90.49 %C, 9.495 %H . b. C_4H_5 c. C_8H_{10} d. CH_4N

6. Chromium forms three principal oxides. Write appropriate formulas for these compounds in which the oxidation states of Cr are +3, +4, and +6 respectively.

Ans: Cr_2O_3 , CrO_2 , CrO_3

7. Write formulas for the compounds: (a) aluminum sulfate; (b) ammonium dichromate; (c) silicon tetrafluoride; (d) iron(III) oxide; (e) tricarbon disulfide; (f) cobalt(II) nitrate; (g) strontium nitrite; (h) hydrobromic acid; (i) iodic acid; (j) phosphorus dichloride trifluoride.

Ans: a. $Al_2(SO_4)_3$ b. $(NH_4)_2Cr_2O_7$ c. SiF_4 d. Fe_2O_3 e. C_3S_2 f. $Co(NO_3)_2$ g. $Sr(NO_3)_2$ h. $HBr(aq)$

i. HIO_3 j. PCl_2F_3

8. Name the following compounds and specify which ones are best described as ionic: (a) OF_2 (b) XeF_2 (c) $CuSO_3$ (d) $(NH_4)_2HPO_4$.

Ans: a. oxygen difluoride, not ionic. b. xenon difluoride, not ionic. c. copper (II) sulfite, ionic. d. ammonium hydrogen phosphate, ionic.

9. A certain hydrate is found to have the composition 20.3% Cu, 8.95% Si, 36.3% F, and 34.5% H_2O by mass. What is the empirical formula of this hydrate?

Ans: $CuSiF_6 \cdot 6H_2O$

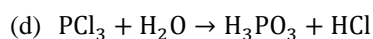
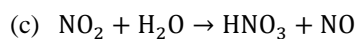
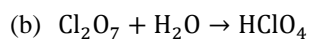
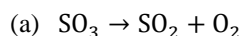
10. Write the condensed structural formulas for the organic compounds:

(a) heptane (b) propanoic acid (c) 2-methyl-1-pentanol (d) fluoroethane

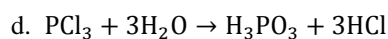
Ans: a. $CH_3(CH_2)_5CH_3$ b. $CH_3CH_2CO_2H$ c. $CH_3CH_2CH_2CH(CH_3)CO_2H$ d. CH_3CH_2F

CH4

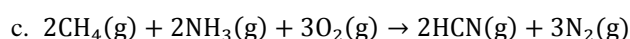
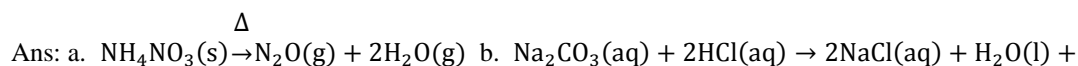
1. Balance the following equations by inspection.



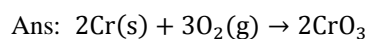
Ans: a. $2SO_3 \rightarrow 2SO_2 + O_2$ b. $Cl_2O_7 + H_2O \rightarrow 2HClO_4$ c. $3NO_2 + H_2O \rightarrow 2HNO_3 + NO$



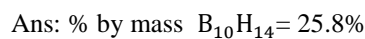
2. Write balanced equations to represent: (a) the decomposition, by heating, of solid ammonium nitrate to produce dinitrogen monoxide gas (laughing gas) and water vapor (b) the reaction of aqueous sodium carbonate with hydrochloric acid to produce water, carbon dioxide gas, and aqueous sodium chloride (c) the reaction of methane (CH_4), ammonia, and oxygen gases to form gaseous hydrogen cyanide (HCN) and water vapor



3. In an experiment, 0.689 g Cr(s) reacts completely with 0.636 g $\text{O}_2(\text{g})$ to form a single solid compound. Write a balanced chemical equation for the reaction.



4. Decaborane, $\text{B}_{10}\text{H}_{14}$, was used as a fuel for rockets in the 1950s. It reacts violently with oxygen, O_2 , to produce B_2O_3 and water. Calculate the percentage by mass of $\text{B}_{10}\text{H}_{14}$ in a fuel mixture designed to ensure that $\text{B}_{10}\text{H}_{14}$ and O_2 run out at exactly the same time. (Such a mixture minimizes the mass of fuel that a rocket must carry.)

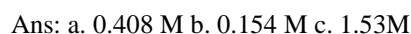


5. What are the molarities of the following solutes when dissolved in water?

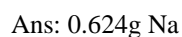
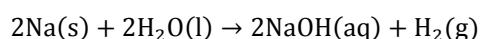
(a) 2.92 mol CH_3OH in 7.16 L of solution

(b) 7.69 mmol $\text{CH}_3\text{CH}_2\text{OH}$ in 50.00 mL of solution

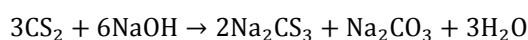
(c) 25.2 g $\text{CO}(\text{NH}_2)_2$ in 275 mL of solution



6. How many grams of sodium must react with 155 mL to produce a solution that is 0.175 M NaOH? (Assume a final solution volume of 155 mL.)



7. A side reaction in the manufacture of rayon from wood pulp is

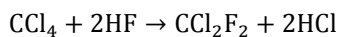


How many grams of Na_2CS_3 are produced in the reaction of 92.5 mL of liquid CS_2 (d = 1.26 g/mL) and

2.78 mol NaOH?

Ans: 143 gNa₂CS₃

8. In the reaction of 277 g CCl₄ with an excess of HF, 187 g CCl₂F₂ is obtained. What are the (a) theoretical, (b) actual, and (c) percent yields of this reaction?



Ans: a. 1.80 mol CCl₄ b. 1.55 mol CCl₂F₂ c. 86.1%yield

9. An essentially 100% yield is necessary for a chemical reaction used to *analyze* a compound, but it is almost never expected for a reaction that is used to *synthesize* a compound. Explain this difference.

Ans: A main criterion for choosing a synthesis reaction is how economically it can be run. In the analysis of a compound, on the other hand, it is essential that all of the material present be detected. Therefore, a 100% yield is required; none of the material present in the sample can be lost during the analysis.

10. How many grams of CO₂ are produced in the complete combustion of 406 g of a bottled gas that consists of 72.7% propane (C₃H₈) and 27.3% butane (C₄H₁₀) by mass?

Ans: 1.22 × 10³g CO₂