

Review for Midterm I

This study guide is meant to be comprehensive but not exhaustive. Make sure to review all old midterms, practice exams, quizzes, book problems, ALEKS, iClickers and Before Class Questions for a complete list of the material covered in this course. Use this review and the end-of-chapter slides to see what you know and what you should practice for the midterm. Good luck and happy studying! -Kevin

Some of the topics to know:

Chapter 1 – (1) Scientific Law & Theory

(2) Significant Figures & Dimensional Analysis

Chapter 2 – (3) Laws of Definite & Multiple Proportions

(4) Identifying Isotopes and Ions

(5) Converting between A_ZX and protons, neutrons, and electrons.

(6) Groups of the Periodic Table

(7) Naming Compounds and Writing Chemical Formulas

Chapter 3 - (8) Converting between grams and moles and atoms of substance.

(9) Calculating Average Atomic Mass from Isotope Masses.

(10) Balancing Chemical Reaction Equations

(11) Limiting Reagents & Theoretic Yields

(12) Composition of Compounds / Empirical & Molecular Formulas

For the Midterm on Friday, I need to bring:

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I can start my midterm at what time?

(1) Scientific Law & Theory

- What is the difference between law and theory?
- Which of the following statements is most like a scientific theory?
 - A gas sample has a mass of 15.8 g and a volume of 10.5 liters.
 - When the pressure on a sample of oxygen gas is increased 10%, the volume of the gas decreases 10%.
 - A gas is composed of small particles in constant motion.
 - The volume of a gas is inversely proportional to its pressure.

(2) Significant Figures & Dimensional Analysis

- Complete the following table.

	# of Significant Figures
0.00004520090	
23,098,000	
200.	

- $12.5849 / 2.4 =$
- $432.5 - 24.3984 =$
- $12.0(11.90-11.8) =$

(3) Laws of Definite and Multiple Proportions

- Which of the following pairs of compounds can be used to illustrate the law of multiple proportions?

(A) NH_3 and NCl_3 (B) ZnO and ZnCl_2 (C) H_2O and HI (D) NO and NO_2 (E) CH_4 and CO_2

- A reaction of 1 L of chlorine gas (Cl_2) with 5 L of fluorine gas (F_2) yields 2 L of a gaseous product. All gas volumes are at the same temperature and pressure. What is the formula of the gaseous product?
- When 3.0 L of hydrogen gas (H_2) reacts with 1.0 L of nitrogen gas (N_2), 2.0 L of gaseous product is formed and there are no left-over reactants. All volumes of gases are measured at the same temperature and pressure, What is the formula of the product?
(A) NH_4 (B) NH (C) N_3H (D) N_2H_5 (E) None of the above
- Two elements, R and Q, combine to form two binary compounds. In the first compound, 14.0 g of R combines with 3.00 g of Q. In the second compound, 7.00 g of R combines with 4.50 g of Q. Show that these data are in accord with the law of multiple proportions. If the formula of the second compound is RQ , what is the formula of the first compound?
- The following data was collected. If it is known that experiment 1 has the formula XY , what is the formula of experiment 2.

Experiment	Mass of X	Mass of Y
1	2.55g	12.75g
2	1.70g	4.25g

- (A) XY_3 (B) X_3Y (C) X_2Y (D) XY_2 (E) None of the above.

(4) Identifying Isotopes and Ions

- Which among the following represent a set of isotopes? Atomic nuclei containing
 - 20 protons and 20 neutrons.
 - 21 protons and 19 neutrons.
 - 22 neutrons and 18 protons.
 - 20 protons and 22 neutrons.
 - 21 protons and 20 neutrons.
 (A) I, II, III (B) III, IV (C) I, V (D) I, IV and II, V (E) No isotopes are indicated.

- An ion is formed

- by either adding protons to or subtracting protons from the atom.
 - by either adding electrons to or subtracting electrons from the atom.
 - by either adding neutrons to or subtracting neutrons from the atom.
- (A) Only I is true. (B) Only II is true. (C) Only III is true.
(D) All of the statements are true. (E) Two of the statements are true.

(5) Converting between ${}^A_Z\text{X}$ and protons, neutrons, and electrons.

- Complete the following table.

Atom/Ion	Protons	Neutrons	Electrons	Mass Number
${}^{120}_{50}\text{Sn}$				
	12		10	25
		30	24	56
${}^{79}_{34}\text{Se}$				
	17	18	18	
${}^{63}_{29}\text{Cu}$				

- Which of the following atomic symbols is incorrect?

- A) ${}^{20}_{10}\text{Ne}$ B) ${}^{32}_{16}\text{S}$ C) ${}^{28}_{14}\text{Si}$ D) ${}^{40}_{20}\text{Ca}$ E) ${}^{12}_8\text{C}$

(6) Groups of the Periodic Table

- On the blank periodic table below, indicated where the metals, nonmetals, and metalloids are found. Also show which columns are the noble gases, alkali metals, alkaline earth metals, halogens, and transition metals.

1 H Hydrogen 1.00794																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012182											5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.00674	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
11 Na Sodium 22.989770	12 Mg Magnesium 24.3050											13 Al Aluminum 26.981538	14 Si Silicon 28.0855	15 P Phosphorus 30.973761	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955910	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938049	26 Fe Iron 55.845	27 Co Cobalt 58.933200	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.92160	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.29
55 Cs Cesium 132.90545	56 Ba Barium 137.327	57 La Lanthanum 138.9055	58 Hf Hafnium 178.49	59 Ta Tantalum 180.9479	60 W Tungsten 183.84	61 Re Rhenium 186.207	62 Os Osmium 190.23	63 Ir Iridium 192.2217	64 Pt Platinum 195.078	65 Au Gold 196.96655	66 Hg Mercury 200.59	67 Tl Thallium 204.3833	68 Pb Lead 207.2	69 Bi Bismuth 208.98038	70 Po Polonium (209)	71 At Astatine (210)	72 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 (269)	111 (272)	112 (277)						
58 Ce Cerium 140.116	59 Pr Praseodymium 140.90766	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967				
90 Th Thorium 232.0381	91 Pa Protactinium 231.03588	92 U Uranium 238.0289	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)				

- Which of the following are alkaline earth halides? (A) NaI, KBr, LiF

(B) CaF₂, MgBr₂, SrI₂ (C) PbI₂, PbBr₂, CdF₂ (D) MgO, MgS, CaO (E) Al₂O₃, In₂O₃, Ga₂S₃

(7) Naming Compounds and Writing Chemical Formulas

- Fill out the table below with names or formulas.

Compound Name	Formula
Carbon tetrabromide	
Calcium nitrate	
Cobalt(II) phosphate	
	AsF ₅
	LiCN
	K ₂ SO ₃
	Co(NO ₂) ₂
Magnesium chloride	
	Li ₃ N
	PbCrO ₄
Nickel(II) acetate	

(8) Converting between Grams and Moles and Atoms of Substance

- A sample of iron weighing 16.8 g contains how many moles of iron atoms?
- What is the mass (in grams) of one molecule of phosphorus pentachloride?
- How many molecules of hydrogen are present in 4.0 g of ammonia?

- The mass of 0.82 mol of a diatomic molecule is 131.3 g. Identify the molecule.
- Phosphorus has the molecular formula P_4 and sulfur has the molecular formula S_8 . How many grams of phosphorus contain the same number of molecules as 6.41 g of sulfur?

(9) Calculating Average Atomic Mass from Isotope Masses

- For a new element, 67.16% is an isotope with mass 280.8 amu, 2.76% is an isotope with mass 283.7 amu, and 30.08% is an isotope with mass 284.8 amu. Calculate the average atomic mass of this new element.
- The atomic mass of rhenium is 186.2. Given that 37.1% of natural rhenium is rhenium-185, what is the other stable isotope?
 (A) ${}^{183}_{75}\text{Re}$ (B) ${}^{187}_{75}\text{Re}$ (C) ${}^{189}_{75}\text{Re}$ (D) ${}^{181}_{75}\text{Re}$ (E) ${}^{190}_{75}\text{Re}$
- Indium has atomic number 49 and atomic mass 114.8 g. Naturally occurring indium contains a mixture of indium-112 and indium-115 in an atomic ratio of approximately
 (A) 6/94. (B) 25/75. (C) 50/50. (D) 75/25. (E) 94/6.

(10) Balancing Chemical Reaction Equations

- Balance the following equations:
 $\underline{\hspace{1cm}}\text{PCl}_5 + \underline{\hspace{1cm}}\text{H}_2\text{O} \rightarrow \underline{\hspace{1cm}}\text{POCl}_3 + \underline{\hspace{1cm}}\text{HCl}$
 $\underline{\hspace{1cm}}\text{C}_{10}\text{H}_{22} + \underline{\hspace{1cm}}\text{O}_2 \rightarrow \underline{\hspace{1cm}}\text{CO}_2 + \underline{\hspace{1cm}}\text{H}_2\text{O}$
 $\underline{\hspace{1cm}}\text{FeCr}_2\text{O}_4 + \underline{\hspace{1cm}}\text{K}_2\text{CO}_3 + \text{O}_2 \rightarrow \underline{\hspace{1cm}}\text{K}_2\text{CrO}_4 + \underline{\hspace{1cm}}\text{Fe}_2\text{O}_3 + \underline{\hspace{1cm}}\text{CO}_2$

(11) Limiting Reagents & Theoretical Yields

- 28.6 g of Al and 17.8 g of Br_2 react according to the following equation: $2\text{Al} + 3\text{Br}_2 \rightarrow 2\text{AlBr}_3$
 What mass of AlBr_3 is formed, assuming 100% yield?
- A 9.22-g sample of AgNO_3 is reacted with BaCl_2 according to the equation
 $2\text{AgNO}_3(aq) + \text{BaCl}_2(aq) \rightarrow 2\text{AgCl}(s) + \text{Ba}(\text{NO}_3)_2(aq)$ to give 4.86 g of AgCl .
 What is the percent yield of AgCl ?
- Consider the following reaction:
 $4\text{NH}_3(g) + 7\text{O}_2(g) \rightarrow 4\text{NO}_2(g) + 6\text{H}_2\text{O}(l)$

Consider an experiment in which you react ammonia and oxygen. At the end of the experiment, you find that you produced 27.0 g of water, and 8.52 g of ammonia is left over. Calculate the initial mass of ammonia. Assume the reaction went to completion.

- (A) 10.8 g (B) 17.0 g (C) 25.5 g (D) 34.1 g (E) 68.0 g

(12) Composition of Compounds/ Empirical & Molecular Formulas

- Compound X_2Y is 60% X by mass. Calculate the percent Y by mass of the compound X_2Y_2 .
- What is the percent by mass of hydrogen in ammonium acetate?
- What is the empirical formula of a hydrocarbon (a compound that consists of only carbon and hydrogen) that contains 81.7% carbon by mass?
 (A) C_2H_6 (B) C_3H_8 (C) C_4H_{10} (D) C_5H_{12} (E) None of the above.
- Vitamin C contains the elements C, H, and O. It is known to contain 40.9% C and 4.58% H by mass. The molar mass of vitamin C has been found to be about 180 g/mol. The molecular formula for vitamin C is
 (A) $\text{C}_2\text{H}_3\text{O}_2$ (B) $\text{C}_3\text{H}_4\text{O}_3$ (C) $\text{C}_4\text{H}_6\text{O}_4$ (D) $\text{C}_6\text{H}_8\text{O}_6$ (E) None of the above.

5. Caffeine consists of carbon, hydrogen, oxygen, and nitrogen. When 0.1920 g of caffeine is burned in an excess of oxygen, 0.3482 g of carbon dioxide and 0.0891 g water are formed. Caffeine is 28.84% nitrogen by mass. Its molar mass is between 190 and 200 g/mol. What is the formula for caffeine?

Some more involved multistep, multi-concept problems.

1. An electric furnace produces phosphorus by the following reaction:
$$\text{Ca}_3(\text{PO}_4)_2(s) + 5\text{C}(s) + 3\text{SiO}_2(s) \rightarrow 3\text{CaSiO}_3(s) + 5\text{CO}(g) + 2\text{P}(l)$$

An initial reaction mixture contains 1500 kg calcium phosphate, 250 kg carbon, and 1000. kg SiO₂.
- What is the limiting reagent?
 - What is the theoretical yield of phosphorus?
 - After reaction the slag (solid residue) was analyzed. It contained 3.8% C, 5.8% P, and 26.6% Ca by mass. What was the actual yield of phosphorus in kg? What was the percent yield?
2. If you take Chem 1CL, you will take 1.00 g of an aspirin tablet (a compound consisting solely of carbon, hydrogen, and oxygen), burn it in air, and collect 2.20 g CO₂ and 0.400 g H₂O. You know that the molar mass of aspirin is between 170 and 190 g/mol. Reacting 1 mole of salicylic acid with 1 mole of acetic anhydride (C₄H₆O₃) gives you 1 mole of aspirin and 1 mole of acetic acid (C₂H₄O₂). Use this information to determine the molecular formula of salicylic acid.
3. Baking soda, or sodium bicarbonate (NaHCO₃), decomposes upon heating on a hot plate to form the white solid sodium carbonate, water vapor, and carbon dioxide gas. Sodium carbonate does not decompose upon further heating at this temperature. Consider a 10.00-g mixture of sodium bicarbonate and sodium carbonate, which is heated until the reaction goes to completion. After heating, 8.97 g of solid remains. Determine the mass percent of sodium bicarbonate in the original mixture.