CHEM099 Final Exam Review

Expected Outcomes

1. Use dimensional analysis to perform calculations and express results of calculations with correct units and number of significant figures.
2. Identify the various states of matter and describe the common physical properties of each state.
3. Identify and distinguish physical and chemical properties and changes.
4. Describe the major components of the atom and write symbols for atoms, ions, and isotopes.
5. Determine nomenclature and formulas for ionic and covalent compounds.
6. Convert moles, masses, and numbers of particles.
7. Determine percent composition and understand and apply mole concept to determine empirical and molecular formulas.
8. Balance chemical equations, classify reaction types, and determine products of reactions.
9. Use stoichiometry and balanced equations to determine amounts and masses of substances used up and produced in reactions as well as percent yields.
10. Determine solution concentrations and calculate the amounts of materials involved in solution reactions.
11. Analyze and solve problems that include a combination of concepts from various chapters.

Review Questions

1. Which of the following is a chemical change?
   (A) methane gas is burned (B) paper is shredded
   (C) water is vaporized (D) salt is dissolved in water

2. How many significant figures are in the measurement, 0.0005890 g?
   (A) 3 (B) 4 (C) 5 (D) 7

3. 850 nm is equal to:
   (A) 8.5×10^{9} m (B) 8.5×10^{-9} m (C) 8.5×10^{-7} m (D) 8.5×10^{-10} m

4. What answer should be reported, with the correct number of significant figures, for the following calculation?

   $$(433.621 - 333.9) \times 11.90 =$$

   (A) 1.19×10^{3} (B) 1.187×10^{3} (C) 1.1868×10^{3} (D) 1.18680×10^{3}

5. A temperature of −31.0 °C is equivalent to
   (A) −304.2 K (B) 304.24 K (C) 242.2 K (D) 329.2 K

6. A piece of metal ore weighs 8.25 g. When placed into a graduated cylinder containing water, the liquid level rises from 21.25 mL to 26.47 mL. What is the density of the ore?
   (A) 0.312 g/mL (B) 0.633 g/mL (C) 1.58 g/mL (D) 3.21 g/mL

7. The density of mercury is 13.6 g/mL, calculate the volume of a 20.0 g sample of mercury.
   (A) 0.680 mL (B) 6.40 mL (C) 272 mL (D) 1.47 mL

8. A substance with a melting point of −218 °C and a boiling point of −182 °C is a _____ at 20 °C.
   (A) Gas (B) Liquid (C) Solid (D) not enough info given

9. Which of these elements is an alkaline earth metal?
A) Na (B) Ca (C) Cu (D) Br

10. Which of these elements is halogen?
A) I (B) K (C) Kr (D)Ba

11. Which of the following elements is a metalloid?
(A)Al (B) Ge (C) C (D) Sn

12. Which of these elements exists as diatomic molecules under ordinary conditions?
(A) C (B) P (C) He (D) N

13. Which of the following statements is NOT true?
(A) The neutron has a charge of +1. (B) The electron has a charge of −1.
(C) The proton has a relative mass of ~1 amu. (D) The neutron has no electrical charge.

14. Atom X has 6 protons and 6 neutrons, atom Z has 6 protons and 7 neutrons. These atoms are:
(A) Isotopes (B) Isomers (C) Isobars (D) None of these

15. An atom containing 19 protons, 20 neutrons, and 19 electrons has a mass number of
(A) 58 (B) 39 (C) 20 (D) 19

16. Calculate the atomic mass of silver if silver has 2 naturally occurring isotopes with the following masses and natural abundances:
Ag-107 (106.90509 amu, 51.84%)
Ag-109 (108.90476 amu, 48.46%)
(A) 107.90 amu (B) 108.00 amu (C) 107.79 amu (D) 108.19 amu

17. What species is represented by the following information?

$p^+ = 12$ n = 14 $e^- = 10$

(A) Si^{4+} (B) Mg^{2+} (C) Si^{2+} (D) Mg

18. Calculate the mass percent composition of lithium in Li_3PO_4.
(A) 26.75 % (B) 17.98 % (C) 30.72 % (D) 55.27 %

19. Which of the following compounds is ionic?
A) PH_3 (B) CCl_4 (C) NaCN (D) NO_2

20. One mole of hydrogen gas contains...
(A) 1 g of H (B) 1 atom of H (C) 6.02×10^{23} atoms of H (D) 1.20×10^{24} atoms of H

21. The molar mass of $(NH_4)_2SO_4$ is
(A) 70 g/mol (B) 92 g/mol (C) 114 g/mol (D)132 g/mol

22. 80.16 g of Ca contains___atoms of Ca.
(A) 6.02×10^{23} (B) 1.500×10^{23} (C) 1.204×10^{24} (D) 2.400×10^{24}

23. How many moles of Cu are contained in 2.54 g Cu?
(A) 0.0847 (B) 25.0 (C) 161 (D) 0.0400

24. How many grams of Ag are contained in 4.52 moles of $AgNO_3$?
(A) 488 g (B) 37.6 g (C) 23.9 g (D) 768 g

#25 and #26 refers to the following chemical equation.

$2C_4H_{10}\ (g) + 13O_2\ (g) \rightarrow 8CO_2\ (g) + 10\ H_2O\ (l)$

25. How many moles of H_2O are produced when 5.0 moles of C_4H_{10} react?
(A) 5.0 (B) 10 (C) 25 (D) 50

26. How many molecules of CO_2 are produced from 5.0 moles of C_4H_{10}?
(A) 8 (B) 1.20×10^{25} (C) 80 (D) 4.82×10^{24}

27. What is the type of the following reaction? $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$
(A) synthesis reaction (B) decomposition reaction
(C) single replacement reaction (D) double replacement reaction

28. What is the volume of a 20.0 mL solution in cubic millimeter (mm^3)?
(A) 20 mm^3 (B) 0.020 mm^3 (C) 20000 mm^3 (D) 0.00002 mm^3

29. How many moles of oxygen atoms are in 2 moles of $Ca(NO_3)_2$?
(A) 6 moles (B) 12 moles (C) 3 moles (D) 2 moles

30. A nonmetal element, X, combines with Mg to form an ionic compound with formula Mg_3X_2. What would be the ionic formula formed between Al and X?
(A) Al_3X_2 (B) Al_3X_3 (C) Al_2X_3 (D) AlX

31. Which of the following is <u>NOT</u> a mixture?
(A)salt water (B) tea (C) air (D) ice

32. Chlorine has two stable isotopes, Cl–35 and Cl–37. If their exact masses are 34.9689 amu and 36.9695 amu, respectively, what is the natural abundance of Cl–35? (The atomic mass of chlorine is 35.45 amu.)
(A) 75.95% (B) 24.05% (C) 50.00% (D) 35.00% (E) 37.00%

33. What is the volume of a cube with dimensions 11.0 cm × 11.0 cm × 11.0 cm in m^3?
(A) 1.331×10^{-3} (B) 1.33×10^{3} (C) 1.33×10^{-3}
(D) 1.3×10^{3}

34. Convert 25.0 mi/hr to cm/sec. (1 mi = 1.61 km)

35. Complete the following table. Use the symbol format given in the first row.

Symbol	# Protons	# Neutrons	# Electrons	Mass Number
$^{90}Mo^{+6}$				
	54		55	133

36. Balance the following equations.

a) ____ C_6H_{14} + ____ $O_2 \rightarrow$ ____ CO_2 + ___ H_2O

b) _____ $KClO_3$ + ____ $HCl \rightarrow$ ____ KCl + ____ Cl_2 + ___ H_2O

37. Complete the following chemical equations by predicting the products.

a) $Na + FeBr_3 \longrightarrow$

(B) $NaOH + H_2SO_4(aq) \longrightarrow$

c) $C_2H_4O_2 + O_2 \longrightarrow$

(D) $PbSO_4 + AgNO_3 \longrightarrow$

e) $PBr_3 \longrightarrow$

f) $HBr + Al \longrightarrow$

38. Complete the following table by providing chemical formula for given names and vice versa.

Chemical Name	**Chemical Formula**
zinc hydroxide	
	NiS
boric acid	
	$Mg(CN)_2$
potassium fluoride	
	B_2O_3
gold (III) nitrate	
	$H_3PO_4(aq)$
tetraphosphorus hexasulfide	
	$CuCO_3$
iodic acid	

39. Consider the reaction represented by the following unbalanced equation

$$Fe_2O_3 + CO \rightarrow Fe + CO_2$$

a) If 27.5 g of Fe_2O_3 is reacted with 18.6 g of CO, what is the theoretical yield of Fe in grams?
b) If the reaction produced 14.8 g of Fe, what was its percent yield?
c) What is the limiting reactant?
d) How many grams of the excess reactant is left over at the end of the reaction?

40. An organic compound contains carbon, hydrogen and oxygen and has a molar mass of ~306 g/mole. If it contains 47.01% of carbon and 5.99% hydrogen, what is its empirical **AND** molecular formula?

41. Consider the reaction between hydrochloric acid and zinc to produce zinc chloride and hydrogen gas.

a) How many grams of zinc is needed to completely react with 25 mL of 4.0 M hydrochloric acid?
b) How many mL of 0.35 M hydrochloric acid is needed to produce 0.234 kg of hydrogen gas?

42. An unknown element, X, has a molar mass of 112.45 g/mole and a density of 2.34 g/mL.

a) If an 123 mL solution is 0.45 M in element X, how many actual number of X atoms does it contain?
b) How many moles of element X is in a 6.70 L sample of element X?

ANSWERS

1. (A)	2. (B)	3. (C)	4. (A)	5. (C)
6. (C)	7. (D)	8. (A)	9. (B)	10. (A)
11. (B)	12. (D)	13. (A)	14. (A)	15. (B)
16. (D)	17. (B)	18. (B)	19. (C)	20. (D)
21. (D)	22. (C)	23. (D)	24. (A)	25. (C)
26. (B)	27. (A)	28. (C)	29. (B)	30. (D)
31. (D)	32. (A)	33. (C)		

34. $\frac{25.0\ mi}{hr} \times \frac{1.61\ km}{mi} \times \frac{10^3\ m}{1\ km} \times \frac{10^2\ cm}{1\ m} \times \frac{1\ hr}{60\ min} \times \frac{1\ min}{60\ sec} = 1.12\ x\ 10^3\ cm/sec$

35.

Symbol	# Protons	# Neutrons	# Electrons	Mass Number
$^{90}Mo^{+6}$	42	48	36	90
$^{133}Xe^{-}$	54	79	55	133

36. (a) **2** C_6H_{14} + **19** $O_2 \rightarrow$ **12** CO_2 + **14** H_2O

b) $KClO_3$ + **6** HCl → ___ KCl + **3** Cl_2 + **3** H_2O

37. (a) Na + $FeBr_3$ → **NaBr + Fe**

(b) NaOH + H_2SO_4(aq) → **Na_2SO_4 + H_2O**

(c) $C_2H_4O_2$ + O_2 → **CO_2 + H_2O**

(d) $PbSO_4$ + $AgNO_3$ → **$Pb(NO_3)_2$ + Ag_2SO_4**

(e) PBr_3 → **P + Br_2**

(f) HBr + Al → **$AlBr_3$ + H_2**

38.

Chemical Name	Chemical Formula
zinc hydroxide	**$Zn(OH)_2$**
nickel (II) sulfide	NiS
boric acid	**H_3BO_3(aq)**
magnesium cyanide	$Mg(CN)_2$
potassium fluoride	**KF**
diboron trioxide	B_2O_3
gold (III) nitrate	**$Au(NO_3)_3$**
phosphoric acid	H_3PO_4(aq)
tetraphosphorus hexasulfide	**P_4S_6**
copper (II) carbonate	$CuCO_3$
iodic acid	**HIO_3(aq)**

39. Balanced Reaction: $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

a) $27.5\ g\ Fe_2O_3 \times \frac{1\ mole\ Fe2O3}{159.7g\ Fe2O3} \times \frac{2\ mole\ Fe}{1\ mole\ Fe2O3} \times \frac{55.85\ g\ Fe}{1\ mole\ Fe} = 19.2345\ g\ Fe =$ **19.2 g Fe**

$18.6g\ CO \times \frac{1\ mole\ CO}{28.011g\ CO} \times \frac{2\ mole\ Fe}{3\ mole\ CO} \times \frac{55.85\ g\ Fe}{1\ mole\ Fe} = 24.724\ g\ Fe$

b) $\frac{14.8\ g\ Fe}{19.23g\ Fe} \times 100 = 76.96\ \% =$ **77.0%**

c) **Fe_2O_3**

d) $27.5\ \text{g } Fe_2O_3 \times \frac{1\ \text{mole } Fe_2O_3}{159.7\ \text{g } Fe_2O_3} \times \frac{3\ \text{mole CO}}{1\ \text{mole } Fe_2O_3} \times \frac{28.011\ \text{g CO}}{1\ \text{mole CO}} = 14.\underline{4}70\ \text{g CO used}$

18.6 g CO – 14.470 g CO = 4.13 g CO = **4.19 g CO left**

40. % O = 100% ─ 47.01% – 5.99% = 47.00% oxygen

$47.01\ \text{g C} \times \frac{1\ \text{mole C}}{12.011\ \text{g C}} = 3.91\ \text{mole C} = \frac{3.91\ \text{mole C}}{2.94} \approx 1.33 \times 3 = 4\ \text{C}$

$5.99\ \text{g H} \times \frac{1\ \text{mole H}}{1.0079\ \text{g H}} = 5.94\ \text{mole H} = \frac{5.94\ \text{mole C}}{2.94} \approx 2.0 \times 3 = 6\ \text{H}$

$47.00\ \text{g O} \times \frac{1\ \text{mole O}}{16.00\ \text{g O}} = 2.94\ \text{mole O} = \frac{2.94\ \text{mole O}}{2.94} \approx 1.0 \times 3 = 3\ \text{O}$

Empirical formula: $C_4H_6O_3$

$C_4H_6O_3$: 102.09 g/mole

$n = \frac{molar\ mass}{empirical\ formula\ mass} = \frac{306\ \text{g/mole}}{102.09\ \text{g/mole}} \cong 3$

Molecular formula = $C_4H_6O_3 \times 3$ = **$C_{12}H_{18}O_9$**

41. Balanced Reaction: $2\ HCl\ (aq) + Zn \rightarrow ZnCl_2 + H_2$

a) $(25\ \text{mL} \times \frac{1\text{L}}{1000\ \text{mL}})\ (4.0\ \text{M}) = 0.10\ \text{mole HCl}$

$0.10\ \text{mole HCl} \times \frac{1\ \text{mole Zn}}{2\ \text{mole HCl}} \times \frac{65.39\ \text{g Zn}}{1\text{mole Zn}} = 3.\underline{2}695\ \text{g Zn} =$ **3.3 g Zn**

b) $0.234\ \text{kg } H_2 \text{ x } \frac{1000\text{g}}{1\ \text{kg}} \times \frac{1\ \text{mole } H_2}{2.0158\ \text{g } H_2} \times \frac{2\ \text{mole HCl}}{1\ \text{mole } H_2} = 23\underline{2}.17\ \text{mole HCl}$

$\frac{232.17\ \text{mole HCl}}{\text{x}} = 0.35\ \text{M}$ x = 6$\underline{6}$3.3 L

$663.3\ \text{L} \times \frac{1000\ \text{mL}}{1\ \text{L}} = 663300\ \text{mL} =$ **660000 mL**

42. (A) 0.123 L (0.45 M) = 0.123 L × 0.45 mole/L = 0.05$\underline{5}$35 mole X

$0.05\underline{5}35\ \text{mole X} \times \frac{6.02 \times 10^{23}\ \text{atom X}}{1\ \text{mole X}} = 3.33 \times 10^{22}\ \text{atom X}$

= **3.3×10^{22} atom X**

c) $6.70\ \text{L} \times \frac{1000\ \text{mL}}{1\ \text{L}} \times \frac{2.34\ \text{g}}{1\ \text{mL}} \times \times \frac{1\ \text{mole}}{112.45\ \text{g}} = 139.42\ \text{mole}$

= **139 mole X**