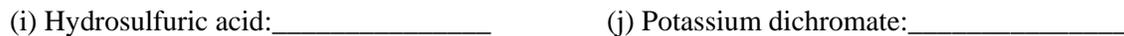
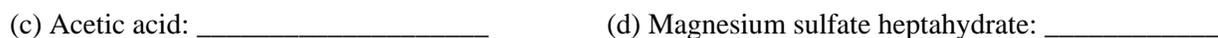
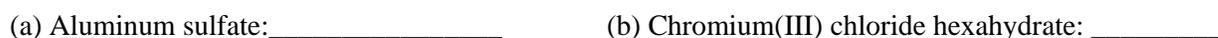


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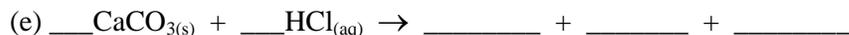
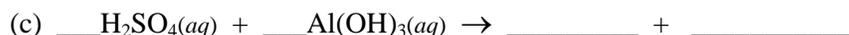
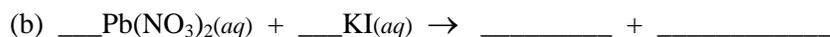
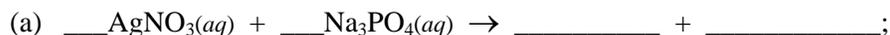
1. Give the systematic name of each of the following compounds:



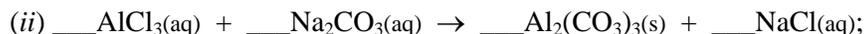
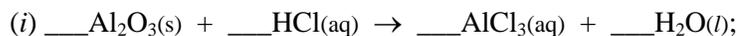
2. Write the correct formula for each of the following compounds:



3. Complete and balance the following equation and write a balanced net ionic equation for each reaction:

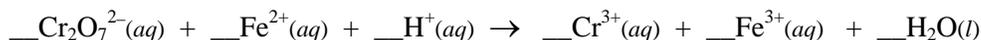


4. (a) Balance the following molecular equations using the smallest integer coefficients.:



(b) For each equation, write the total ionic and net ionic equations.

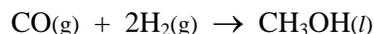
5. (a) Balance the following net ionic equations for redox reactions in acidic solution:



- (b) Balance the following equation for redox reaction in basic solution:

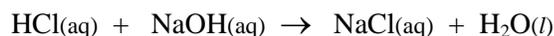


6. The following reaction is employed for the production of methanol:

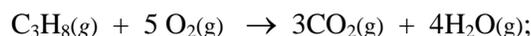


550 L of CO gas at 45 atm and 25°C and 750 L of H<sub>2</sub> gas at 55 atm and 25°C are simultaneously pumped into the reactor that produce methanol. (a) Which is the limiting reactant? (b) If the limiting reactant is completely reacted and the yield is 100%, how many kilograms of methanol is produced? (c) If 23 kg of CH<sub>3</sub>OH were produced from this reaction, calculate its percentage yield.

7. How many grams of NaOH are required to prepare 1.50 L of 0.250 M solution of NaCl. Briefly outline how you would prepare this solution.
8. (a) Calculate the molar mass of CoCl<sub>2</sub>·6H<sub>2</sub>O. (b) Suppose that you weigh accurately 16.45 g of pure CoCl<sub>2</sub>·6H<sub>2</sub>O solid and transfer the solid quantitatively into a 250-mL volumetric flask; then you add about 200 mL of de-ionized water and stir the mixture to dissolve the solid. When the solid has completely dissolved, you add more de-ionized water until the total volume is 250.0 mL and shake the mixture to homogenize the solution. What is the molar concentration of CoCl<sub>2</sub> in the solution?
9. A 20.00-mL sample of vinegar is diluted to 100.0 mL with de-ionized water; then a 25.00-mL portion of the dilute vinegar is transferred into a clean Erlenmeyer flask and titrated with 0.2025 M NaOH solution using phenolphthalein indicator. The titration was found to require 21.00 mL of the base to reach end-point. (a) Write a balanced equation for the reaction that takes place in this titration. (b) Determine the molar concentration of acetic acid, HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub> in dilute vinegar solution. (c) What is the molarity of acetic acid in the original (undiluted) vinegar? (c) If the density of vinegar is 1.0 g/mL, what is the percentage (by mass) of acetic acid in the undiluted vinegar?
10. A balloon is filled with 454 g of helium gas at 1.00 atm and 22°C. (a) What is the volume of the balloon under this condition? (b) Suppose the balloon rises to an altitude where the atmospheric pressure and temperature are 470 torr and -5.0°C, respectively, and the balloon is made of material that allows for a volume expansion of only 5.0%, what is the final volume of the balloon and the final gas pressure?
11. 50.0 mL of 2.0 M NaOH and 50.0 mL of 2.0 M HCl solutions are reacted in a Styrofoam cup calorimeter and the temperature of solution increases from 22.0°C to 35.5°C. (a) If the density of the solution is 1.0 g/mL, calculate the heat absorbed by solution (specific heat = 4.18 J/g·°C). (b) How much heat is absorbed by the calorimeter if its heat capacity is 10. J/°C? (c) Calculate the enthalpy change (ΔH; in kJ/mol) for the following reaction:



12. (a) Calculate the enthalpy change ( $\Delta H_{\text{rxn}}$ ) for the following reaction:



$$[\Delta H_f^\circ \text{ (kJ/mol): } \text{C}_3\text{H}_8 = -104; \text{CO}_2(g) = -394; \text{H}_2\text{O}(g) = -242]$$

- (b) How much energy (in kJ) is produced if 1.00 g of propane gas ( $\text{C}_3\text{H}_8$ ) is completely burned?

What volume of propane gas, measured at STP, must be combusted to provide enough energy to heat 1.00 L of water (density = 1.0 g/mL) from 22.0°C to 100.0°C? (Specific heat of water = 4.184 J/g·°C)

13. Name the primary intermolecular forces found in the liquid state of each of the following substances:

- (a)  $\text{SiH}_4$ : \_\_\_\_\_;                      (b)  $\text{CH}_3\text{OH}$ : \_\_\_\_\_  
(c)  $\text{CO}$ : \_\_\_\_\_;                      (d)  $\text{N}_2\text{H}_4$ : \_\_\_\_\_  
(e)  $\text{HCl}$ : \_\_\_\_\_;                      (f)  $\text{CO}_2$ : \_\_\_\_\_  
(g)  $\text{CH}_3\text{CH}_3$ : \_\_\_\_\_;                      (h)  $\text{CH}_3\text{NH}_2$ : \_\_\_\_\_

14. Explain the following liquid properties. How does hydrogen bonding influence these properties of water?

- (a) Surface tension  
(b) Capillary action  
(c) Enthalpy of vaporization

15. List the following compounds in increasing order of vapor pressure:

- (a)  $\text{CH}_4$ ,  $\text{CH}_3\text{F}$ ,  $\text{CF}_4$ ,  $\text{CCl}_4$ ,  $\text{SiF}_4$ ;                      (b)  $\text{HF}$ ,  $\text{HCl}$ ,  $\text{HBr}$ ,  $\text{HI}$ ;  
(c)  $\text{CH}_3\text{OH}$ ,  $\text{CH}_3\text{CH}_2\text{OH}$ ,  $\text{H}_2\text{CO}$ ;                      (d)  $\text{H}_2\text{O}$ ,  $\text{H}_2\text{S}$ ,  $\text{H}_2\text{Se}$ ,  $\text{H}_2\text{Te}$ ;

16. Rank the following compounds in increasing order of boiling points:

- (a)  $\text{CH}_4$ ,  $\text{CH}_3\text{F}$ ,  $\text{CF}_4$ ,  $\text{CCl}_4$ ,  $\text{SiF}_4$ ;                      (b)  $\text{HF}$ ,  $\text{HCl}$ ,  $\text{HBr}$ ,  $\text{HI}$ ;  
(c)  $\text{CH}_3\text{OH}$ ,  $\text{CH}_3\text{CH}_2\text{OH}$ ,  $\text{H}_2\text{CO}$ ;                      (d)  $\text{H}_2\text{O}$ ,  $\text{H}_2\text{S}$ ,  $\text{H}_2\text{Se}$ ,  $\text{H}_2\text{Te}$ ;

17. A certain amount of ice at 0.0°C is added to 100.0 g of warm water at 35.0°C in a Styrofoam cup calorimeter and the final temperature of the mixture is 16.5°C. What is the mass of ice? (Specific heat of water = 4.184 J/g·°C; enthalpy of fusion of ice,  $\Delta H_{\text{fus}} = 6.02 \text{ kJ/mol}$ .)

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18. The boiling point of water at 1.00 atm is 100.°C and its enthalpy of vaporization is 40.6 kJ/mol. (a) At what pressure would water boil at 120.°C? (b) What is the boiling point of water in Denver, Colorado where the atmospheric pressure is 600. torr? (Assume the enthalpy of vaporization remains constant. ( $R = 8.314 \text{ J/mol.K}$ )
19. Tungsten crystallizes in a body-centered cubic arrangement and the measurement of each side of the unit cell is 321 pm long. Calculate the atomic radius and the density of tungsten. (Atomic mass of tungsten = 183.85 u;  $1 \text{ u} = 1.66 \times 10^{-24} \text{ g}$ ;  $1 \text{ pm} = 10^{-10} \text{ cm}$ )
20. Calcium metal forms a cubic closest-packed lattice crystal with the unit cell edge length of 549 pm. Calculate the atomic radius of calcium in pm and its density in  $\text{g/cm}^3$ . ( $1 \text{ u} = 1.6605 \times 10^{-24} \text{ g}$ ;  $1 \text{ pm} = 10^{-10} \text{ cm}$ )
21. The solubility of  $\text{KNO}_3$  is 28 g per 100 g of water at 20°C. How many grams of  $\text{KNO}_3$  will dissolve in 225 g of water at the same temperature? (b) What is the mass percent of  $\text{KNO}_3$  in the saturated solution at 20°C? (c) Calculate the *molal* concentration of  $\text{KNO}_3$  in the saturated solution at 20°C.
22. The Henry's law constant for  $\text{O}_2$  gas in fresh water at 20°C is  $1.3 \times 10^{-3} \text{ mol/L-atm}$ . (a) Calculate the concentration of  $\text{O}_2$  in a fresh water lake at 20°C when the partial pressure of oxygen over the water is 0.21 atm. (b) What is the concentration of  $\text{O}_2$  in ppm? (Assume the density of water = 1.0 g/mL)
23. Benzene ( $\text{C}_6\text{H}_6$ ) and toluene ( $\text{C}_7\text{H}_8$ ) form an ideal solution in any proportion. The vapor pressure of pure benzene and pure toluene at 25°C are 95.1 torr and 28.4 torr, respectively. (a) Calculate the mole fraction of benzene and toluene, respectively, in a mixture composed of 275 g benzene and 275 g toluene. (b) What is the total vapor pressure above the solution at 25°C? (c) What is the mole percent of toluene in the vapor at 25°C?
24. A radiator fluid is prepared by mixing 1.00 L of water (density = 1.00 g/mL) and 1.00 L of ethylene glycol (EG =  $\text{HOCH}_2\text{CH}_2\text{OH}$ ; density = 1.12 g/mL). Calculate the molal concentration of EG, the freezing and the boiling point of the solution? (For water,  $K_f = 1.86^\circ\text{C}/m$ , and  $K_b = 0.512^\circ\text{C}/m$ )
25. A 0.638-g sample of an organic compound is dissolved in 20.0 mL of cyclohexane (density = 0.779 g/mL) and the freezing point of the solution is found to be 2.40°C. The freezing point of pure cyclohexane is 7.00°C and its freezing point depression constant,  $K_f = 20.5^\circ\text{C}/m$ . (a) Determine the molar mass of the organic compound. (b) If the empirical formula is CH, calculate the molecular formula of the compound.
26. A 50.0-mL solution containing 0.525 g of polymer in carbon tetrachloride has an osmotic pressure of 34.0 torr at 25°C. Calculate the molar mass of the polymer. ( $R = 0.08206 \text{ L.atm/mol.K}$ )

**Answers:**

- (a) Silver chromate; (b) Potassium permanganate;  
(c) Barium chloride dehydrate; (d) Dinitrogen pentoxide;  
(e) Nickel(II) sulfate hexahydrate; (f) Lead(II) acetate  
(g) Phosphoric acid (h) Sulfur tetrafluoride
- (a)  $\text{Al}_2(\text{SO}_4)_3$ ; (b)  $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$ ; (c)  $\text{HC}_2\text{H}_3\text{O}_2$ ; (d)  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$   
(e)  $\text{B}_2\text{O}_3$  (f)  $\text{HNO}_3$  (g)  $\text{Ca}(\text{OCl})_2$ ; (h)  $\text{Na}_2\text{HPO}_4$ ;  
(i)  $\text{HF}$  (j)  $\text{K}_2\text{Cr}_2\text{O}_7$ .
- (a)  $3 \text{AgNO}_3(\text{aq}) + \text{Na}_3\text{PO}_4(\text{aq}) \rightarrow \text{Ag}_3\text{PO}_4(\text{s}) + 3 \text{NaNO}_3(\text{aq})$ ;  
(b)  $\text{Pb}(\text{NO}_3)_2(\text{aq}) + 2 \text{KI}(\text{aq}) \rightarrow \text{PbI}_2(\text{s}) + 2 \text{KNO}_3(\text{aq})$   
(c)  $3 \text{H}_2\text{SO}_4(\text{aq}) + 2 \text{Al}(\text{OH})_3(\text{aq}) \rightarrow \text{Al}_2(\text{SO}_4)_3(\text{aq}) + 3 \text{H}_2\text{O}(\text{l})$   
(d)  $\text{Ni}(\text{NO}_3)_2(\text{aq}) + 2 \text{NaOH}(\text{aq}) \rightarrow \text{Ni}(\text{OH})_2(\text{s}) + 2 \text{NaNO}_3(\text{aq})$   
(e)  $\text{CaCO}_3(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
- (a) (i)  $\text{Al}_2\text{O}_3(\text{s}) + 6 \text{HCl}(\text{aq}) \rightarrow 2 \text{AlCl}_3(\text{aq}) + 3 \text{H}_2\text{O}(\text{l})$ ;  
(ii)  $2 \text{AlCl}_3(\text{aq}) + 3 \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{Al}_2(\text{CO}_3)_3(\text{s}) + 6 \text{NaCl}(\text{aq})$ ;  
(b) (i) t.i.e.:  $\text{Al}_2\text{O}_3(\text{s}) + 6 \text{H}^+(\text{aq}) + 6 \text{Cl}^-(\text{aq}) \rightarrow 2 \text{Al}^{3+}(\text{aq}) + 6 \text{Cl}^-(\text{aq}) + 3 \text{H}_2\text{O}(\text{l})$ ;  
n.i.e.:  $\text{Al}_2\text{O}_3(\text{s}) + 6 \text{H}^+(\text{aq}) \rightarrow 2 \text{Al}^{3+}(\text{aq}) + 3 \text{H}_2\text{O}(\text{l})$ ;  
(ii) t.i.e.:  $2 \text{Al}^{3+}(\text{aq}) + 6 \text{Cl}^-(\text{aq}) + 6 \text{Na}^+(\text{aq}) + 3 \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{Al}_2(\text{CO}_3)_3(\text{s}) + 6 \text{Na}^+(\text{aq}) + 6 \text{Cl}^-(\text{aq})$ ;  
n.i.e.:  $2 \text{Al}^{3+}(\text{aq}) + 3 \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{Al}_2(\text{CO}_3)_3(\text{s})$ ;
- (a)  $\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 6 \text{Fe}^{2+}(\text{aq}) + 14 \text{H}^+(\text{aq}) \rightarrow 2 \text{Cr}^{3+}(\text{aq}) + 6 \text{Fe}^{3+}(\text{aq}) + 7 \text{H}_2\text{O}(\text{l})$   
(b)  $2 \text{Cr}(\text{OH})_3(\text{s}) + 3 \text{H}_2\text{O}_2(\text{aq}) + 4 \text{OH}^-(\text{aq}) \rightarrow 2 \text{CrO}_4^{2-}(\text{aq}) + 8 \text{H}_2\text{O}(\text{l})$
- (a) limiting reactant is  $\text{H}_2$ ; (b) 27 kg; (c) 85%
- 15.0 g
- (a) 237.94 g/mol; (b) 0.2765 M
- (a) 0.1701 M; (b) 0.8505 M; (c) 5.1%
- (a)  $2.75 \times 10^3 \text{ L}$ ; (b) 658 torr
- (a)  $5.64 \times 10^3 \text{ J}$ ; (b) 135 J; (c) ( $\Delta H = -58 \text{ kJ/mol}$ )
- (a)  $\Delta H = -2046 \text{ kJ/mol}$ ; (b) 46.4 kJ/g; (c) 3.6 L
- (a) London Dispersion; (b) Hydrogen bonding (c) Dipole-dipole  
(d) Hydrogen bonding; (e) Dipole-dipole; (f) London Dispersion  
(g) London dispersion (h) Hydrogen bonding
- (a)  $\text{CCl}_4 < \text{SiF}_4 < \text{CF}_4 < \text{CH}_3\text{F} < \text{CH}_4$ ; (b)  $\text{HF} < \text{HI} < \text{HBr} < \text{HCl}$ ;  
(c)  $\text{CH}_3\text{CH}_2\text{OH} < \text{CH}_3\text{OH} < \text{H}_2\text{CO}$ ; (d)  $\text{H}_2\text{O} < \text{H}_2\text{Te} < \text{H}_2\text{Se} < \text{H}_2\text{S}$
- (a)  $\text{CH}_4 < \text{CH}_3\text{F} < \text{CF}_4 < \text{SiF}_4 < \text{CCl}_4$ ; (b)  $\text{HCl} < \text{HBr} < \text{HI} < \text{HF}$ ;  
(c)  $\text{H}_2\text{CO} < \text{CH}_3\text{OH} < \text{CH}_3\text{CH}_2\text{OH}$ ; (d)  $\text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te} < \text{H}_2\text{O}$ ;

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17. 19.2 g
18. (a) 1.95 atm; (b) 93.4°C
19. Atomic radius = 139 pm; density = 18.4 g/cm<sup>3</sup>
20. Atomic radius = 194 pm; density = 1.61 g/cm<sup>3</sup>
21. (a) 63 g; (b) 22%; (c) *molality* = 2.8 *m*
22. (a) 2.8 x 10<sup>-4</sup> mol/L; (b) 9.0 ppm
23. (a)  $X_{\text{Bz}} = 0.541$ ;  $X_{\text{Tol}} = 0.459$ ; (b)  $P_{\text{Bz}} = 51.4$  torr;  $P_{\text{Tol}} = 13.0$  torr;  $P_{\text{T}} = 64.4$  torr;  
(c) 20.2% tol in vapor
24. *molality* = 18.0 *m*;  $T_{\text{f}} = -33.6^{\circ}\text{C}$ ;  $T_{\text{b}} = 109.2^{\circ}\text{C}$
25. (a) Molar mass = 182 g/mol; (b) Empirical formula = C<sub>14</sub>H<sub>14</sub>
26. Molar mass = 5740 g/mol