

Chemistry 105, Review Exercises for the Comprehensive Final Exam

Nomenclature

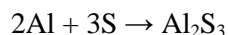
- Provide the missing names and formulas for the following (answers at the end):
 - $\text{Ni}_3(\text{PO}_4)_2$
 - chromium (III) sulfate
 - CCl_4
 - H_2SO_3 (name this as an acid)
 - HI (name this as an acid)
 - perchloric acid
 - Na_2O_2

Counting by weighing, empirical and molecular formulas

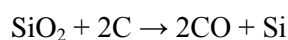
- Calculate the number of N atoms in 127.2 g of TNT, $\text{C}_7\text{H}_5(\text{NO}_2)_3$ (molar mass 227. g). *Ans. 1.01×10^{24} N atoms*
- Dimethylhydrazine, the fuel used in the Apollo lunar descent modules, is made of carbon, hydrogen, and nitrogen atoms. The combustion of 2.859 g of the material in oxygen gives 4.190 g of CO_2 and 3.428 g H_2O . What is the empirical formula? If the molar mass is 60.10 g, what is the molecular formula?
Ans. CH_4N $\text{C}_2\text{H}_8\text{N}_2$

Stoichiometry

- For the following reaction 32.0 g of Al and 72.0 g of S react.



- What's the theoretical yield of Al_2S_3 ? *Ans. 89.1 g*
 - If the actual yield is 80.0 g what's the percent yield? *Ans. 89.8 %*
- The following equation represents the reaction used to obtain Si from sand. Sand consists mostly of SiO_2 .

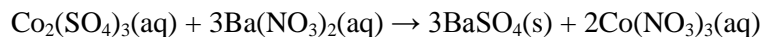


- How many grams of C are needed to react with 1000. g of SiO_2 ? *Ans. 399. g*
- How many grams of Si are produced? *Ans. 468. g*
- How many moles of CO are produced? *Ans. 33.3 moles*

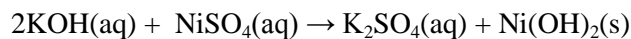
Reactions in Solution and Solution Stoichiometry

- Use the half reaction method to balance the following reaction in acid solution (answer at the end).
 $\text{Cr}_2\text{O}_7^{2-} + \text{SO}_3^{2-} \rightarrow \text{Cr}^{+3} + \text{SO}_4^{2-}$
- Use the half reaction method to balance the following reactions in basic solution (answer at the end).
 $\text{Fe}(\text{OH})_3 + \text{Cr}^{3+} \rightarrow \text{Fe}(\text{OH})_2 + \text{CrO}_4^{2-}$
- How many milliliters of a 0.8500 M $\text{Al}(\text{NO}_3)_3$ solution are needed to furnish 2.000 g of $\text{Al}(\text{NO}_3)_3$?
Ans. 11.0 mL
- How many grams of CuCl_2 would be needed to prepare 500. mL of a 2.0 M solution? *Ans. 135. g*
- How many grams of CuCl_2 would be needed to prepare 1.00 L of a 0.750 M Cl^- solution? *Ans. 50.4 g*

11. What volume of 0.733 M Ba(NO₃)₂ is required to react completely with 20.0 mL of 0.937M Co₂(SO₄)₃? How many grams of precipitate will form? *Ans. 0.0767 L 13.12 g*



12. A solution of 100.0 mL of 0.200 M KOH is mixed with a solution of 200.0 mL of 0.150 M NiSO₄. How many grams of precipitate form? Molar mass for Ni(OH)₂ = 92.7 g. *Ans. 0.927 g*

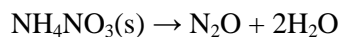


Gases

13. A 25.00L-flask has 1.35 mol of hydrogen gas at 25.°C and a pressure of 1.05 atm. Nitrogen gas is added to the flask at the same temperature until the pressure rises to 1.64 atm. How many moles of nitrogen gas are added? *Ans. 0.76 moles*

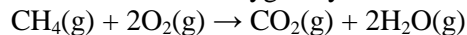
14. A balloon filled with helium has a volume of 1.28 x 10³ L at sea level where the pressure is 0.998 atm and temperature is 31.0°C. The balloon is taken to the top of a mountain where the pressure is 0.753 atm and the temperature is -25.0°C. What is the volume of the balloon at the top of the mountain? *Ans. 1.38 x 10³ L*

15. Dinitrogen monoxide, also called nitrous oxide, is used as a propellant gas for whipped-cream dispensers. It is prepared by heating ammonium nitrate to 250.°C.



What volume of dinitrogen monoxide gas is formed at 250.°C and 1.0 atm when 5.00 g of NH₄NO₃ is heated? *Ans. 2.7 L*

16. Methane burns in oxygen by the following reaction



When 8.00 L of methane at 125.°C and 1.00 atm is burned in an excess of oxygen, the products are collected into a separate 10.0-L flask.

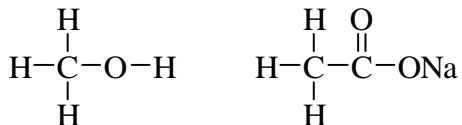
- a. What is the total pressure of the products in the flask at 125.°C? *Ans. 2.40 atm*
b. What is the partial pressure of each of the products in the flask? *Ans. P_{CO2} = 0.800 atm P_{H2O} = 1.60 atm*

Electronic Structure and Periodicity

17. A photon of violet light has a wavelength of 423. nm. Calculate:
a. the frequency. *Ans. 7.09 x 10¹⁴s⁻¹*
b. the energy in joules per photon. *Ans. 4.70 x 10⁻¹⁹J*
c. the energy in kilojoules per mole of photons. *Ans. 283. KJ/mol*
18. Write the ground state electron configuration and the abbreviated ground state electron configuration for each of the following. Also, indicate the number of unpaired electrons for each (answers at the end).
a. P b. V c. Se
19. Which of the four atoms Na, P, Cl or K (answers at the end)
a. has the largest atomic radius?
b. has the highest ionization energy?
c. is the most electronegativity?

Bonding and Molecular Geometry

20. Using the periodic table classify the bonds in the following compounds as ionic or covalent. If covalent, classify the bond as polar or not (answers at the end).



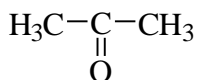
21. For the following (answers at the end):
- write the electron dot structure
 - draw the 2-D representation of the 3-D shape
 - give the molecular geometry
 - give the bond angle around the central atom
 - indicate if the molecule is polar
 - give the hybridization for each atom (except where indicated not to)

SCO (C is the central atom)

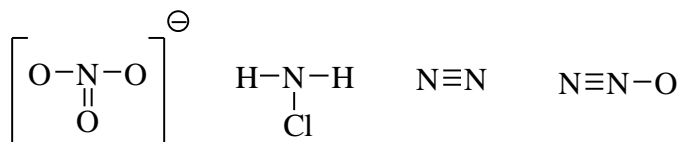
IBr₂⁻ (skip hybridization)

NO₃⁻

22. Give the hybridization for each atom (except H) in the following organic solvent. Unshared electrons are not shown. How many sigma and pi bonds are there (answers at the end)?



23. Give the hybridization for the nitrogens and oxygens in the following. Unshared electrons are not shown. How many sigma and pi bonds are there in each (answers at the end)?



Thermochemistry

24. How many kilocalories are required to convert 250. g of ice at -15.0°C to steam at 100.0°C?

Specific heats: ice 0.50 cal/g°C, water 1.0 cal/g°C

$\Delta H_{\text{vap}} = 540. \text{ cal/g}$ $\Delta H_{\text{fus}} = 79.7 \text{ cal/g}$

Ans. $1.8 \times 10^2 \text{ kcal}$

25. Fructose, C₆H₁₂O₆, is a sugar commonly found in fruit. A 4.50 g sample of fructose is burned in a bomb calorimeter. The heat capacity of the calorimeter is $2.115 \times 10^4 \text{ J/}^\circ\text{C}$. The temperature in the calorimeter rises from 23.49°C to 27.71°C.

a. Calculate the quantity of heat evolved. Ans. -89.3 kJ

b. Calculate the heat of combustion per gram and per mole. Ans. -19.8 kJ/g , $-3.57 \times 10^3 \text{ kJ/mole}$

26. When a 3.88 g sample of $\text{NH}_4\text{NO}_3(\text{s})$ dissolves in 60.0 g of water in a coffee-cup calorimeter, the temperature drops from 23.0°C to 18.4°C . Calculate ΔH for the solution process:

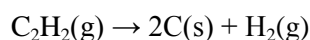


Assume that the specific heat of the solution is the same as that of pure water ($4.184 \text{ J/g}^\circ\text{C}$). *Ans. +25.3 kJ*

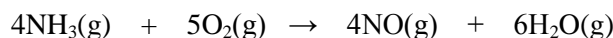
27. Given the following thermochemical equations,



calculate the ΔH for the decomposition of one mole of acetylene to its elements in their stable state at 25°C and 1 atm. *Ans. -226.7 kJ*

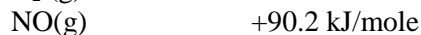
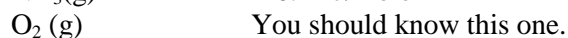


28. Using ΔH_f° 's calculate ΔH° per mole of ammonia in the following reaction. Also, calculate ΔH° per gram of ammonia. Use the data in table 8.3 in your text book. *Ans. -226.4 kJ/mole, -13.3 kJ/g*



ammonia

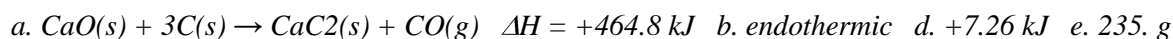
ΔH_f° 's



29. Calcium carbide, CaC_2 , is the raw material for the production of acetylene (used in welding torches). Calcium carbide is produced by reacting calcium oxide with carbon. Carbon monoxide is also produced in this reaction. When one mole of calcium carbide is formed 464.8 kJ is absorbed.

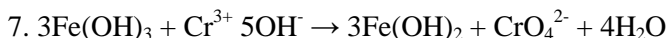
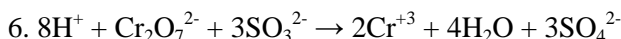
- Write a thermochemical equation for this reaction.
- Is the reaction exothermic or endothermic?
- Draw and energy diagram for this reaction.
- What is ΔH when 1.00 g of $\text{CaC}_2(\text{s})$ is formed?
- How many grams of carbon must react to produce $3.03 \times 10^3 \text{ kJ}$ of heat?

Ans.



Answers

- a. nickel (II) phosphate, b. $\text{Cr}_2(\text{SO}_4)_3$, c. carbon tetrachloride, d. sulfurous acid, e. hydroiodic acid, f. HClO_4
g. sodium peroxide



- a. P $1s^2 2s^2 2p^6 3s^2 3p^3$ [Ne] $3s^2 3p^3$ three unpaired
b. V $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$ [Ar] $4s^2 3d^3$ three unpaired
c. Se $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$ [Ar] $4s^2 3d^{10} 4p^4$ two unpaired

