

AP Chemistry Semester Exam review

CALVIN

For questions 1 to 4

- A.  $1s^2 2s^2 2p^6$     B.  $1s^2 2p^1$     C.  $1s^2 2s^2 2p^6 3s^2$     D.  $1s^2 2s^2 2p^7 3s^1$
- Corresponds to a Noble gas **A**
  - Represents an impossible configuration **D**
  - Ground state configuration for Mg **C**
  - Represents an atom in an excited state **B**
5. As you move from right to left between elements 11 and 17
- Atomic radius decreases
  - Ionization energy decreases
  - Electronegativity decreases
- A.** I only  
 B. II only  
 C. III only  
 D. I and III

6. A certain color of light has a wavelength of 550 nm. What is the energy possessed by a photon of such light?

- A.  $2.42 \times 10^{-19}$  J **(2nd)**  
 B.  $5.45 \times 10^{14}$  J  
 C.  $3.61 \times 10^{-14}$  J  
**D.**  $3.61 \times 10^{-19}$  J
- $E = h \cdot \nu$   
 $E = (6.626 \times 10^{-34} \text{ J} \cdot \text{s}) (5.45 \times 10^{14} \text{ /s})$
- $\nu = \frac{c}{\lambda} = \frac{(3.00 \times 10^8 \text{ m/s})}{(5.50 \times 10^{-7} \text{ m})} = 5.45 \times 10^{14} \text{ Hz}$

7. Calculate the molar solubility of barium sulfate,  $\text{BaSO}_4$ , in 0.020 M sodium sulfate,  $\text{Na}_2\text{SO}_4$ .  $K_{sp}$  for  $\text{BaSO}_4$  is  $1.08 \times 10^{-10}$

- ~~A.  $1.04 \times 10^{-5}$~~   
~~B.  $5.4 \times 10^{-5}$~~   
~~C.  $7.87 \times 10^{-8}$~~   
~~D.  $5.4 \times 10^{-9}$~~
- OMIT**

8. Determine the standard enthalpy of reaction for the combustion of hydrogen sulfide gas, which proceeds according to the reaction shown:



The standard enthalpies for the constituents are as follows:

Formula	$\Delta H_f^\circ$ (kJ mol <sup>-1</sup> )
$\text{H}_2\text{S}_{(g)}$	-20
$\text{H}_2\text{O}_{(l)}$	-285.8
$\text{SO}_{2(g)}$	-296.8

$$[(2 \cdot -296.8) + (2 \cdot -285.8)] - (2 \cdot -20) = -1125.2 \text{ kJ}$$

- A. -575 kJ    B. -726 kJ    C. -963 kJ    D. -1125 kJ
9. Which bond would be the longest?
- A.** Single  
 B. Double  
 C. Triple  
 D. Savings

10.  $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g})$   
 In the above reaction, 3.10 g of  $\text{NH}_3$  reacts with 2.50 g of  $\text{O}_2$ . What is the theoretical yield of  $\text{NO}$ ?

- A. 1.88 g  
 B. 5.46 g  
 C. 8.20 g  
 D. 24.0 g

Handwritten calculation for question 10:

$$\frac{3.10 \text{ g NH}_3}{17.04 \text{ g NH}_3} \times \frac{1 \text{ mol NH}_3}{4 \text{ mol NO}} \times \frac{30.01 \text{ g NO}}{1 \text{ mol NO}} = 5.46 \text{ g NO}$$

11. What is the trend in Ionization energy across a period?

- A. Increase  
 B. Decrease  
 C. Not enough information  
 D. Too much information

Handwritten calculation for question 11:

$$\frac{2.50 \text{ g O}_2}{32.00 \text{ g O}_2} \times \frac{1 \text{ mol O}_2}{5 \text{ mol NO}} \times \frac{30.01 \text{ g NO}}{1 \text{ mol NO}} = 1.88 \text{ g NO}$$

12. Which molecule has a Lewis structure that does not obey the octet rule?

- A. NO      B.  $\text{CS}_2$       C.  $\text{PF}_3$       D. HCN

13. Which of the following molecules has a trigonal pyramidal shape?

- A.  $\text{PCl}_5$       B.  $\text{N}_2\text{O}$       C.  $\text{NH}_3$       D.  $\text{CCl}_4$

14. Which of the following explains why  $\text{CH}_3\text{-O-CH}_3$  has a lower boiling temperature than  $\text{CH}_3\text{CH}_2\text{OH}$ ?

- A. Hydrogen bonding  
 B. Dipole-dipole bonding  
 C. Ionic bonding  
 D. London dispersion forces

15. Which of the following explains why, at room temperature,  $\text{I}_2$  is a solid,  $\text{Br}_2$  is a liquid and  $\text{Cl}_2$  is a gas?

- A. Hydrogen bonding  
 B. Dipole-dipole bonding  
 C. Ionic bonding  
 D. London dispersion forces

16. Which of the following reactions involves the largest increase in entropy?

- A.  $\text{AgNO}_3(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{HNO}_3(\text{aq})$   
 B.  $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g})$   
 C.  $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}_2(\text{g})$   
 D.  $2\text{KClO}_3(\text{s}) \rightarrow 2\text{KCl}(\text{s}) + 3\text{O}_2(\text{g})$

17. You are supposed to prepare 250 ml of a 0.1 M solution of  $\text{Pb}(\text{NO}_3)_2$  solution (molar mass = 331.2 g). You would need to mix \_\_\_\_\_ of  $\text{Pb}(\text{NO}_3)_2$  with enough water to make 250 ml of solution.

- A. 331.2 g      B. 33.12 g      C. 8.28 g      D. 3.312 g

Handwritten calculation for question 17:

$$\left(\frac{0.1 \text{ mol}}{\text{L}}\right) \times (250 \text{ mL}) = 0.025 \text{ mol} \times \frac{331.2 \text{ g/mol}}{1} = 8.28 \text{ g}$$

18. What is the hybridization around the central atom in  $\text{SiCl}_4$ ?

- A.  $\text{sp}^3$       B.  $\text{sp}^2$       C.  $\text{sp}$       D. no hybridization

19. Find the sum of the coefficients when Butane ( $\text{C}_4\text{H}_{10}$ ) undergoes combustion.

- A. 17      B. 25      C. 33      D. 47

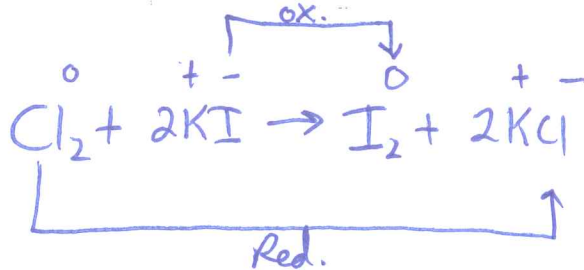


20.  $1 \text{ C}_6\text{H}_5\text{OH} + 7 \text{ O}_2 \rightarrow 6 \text{ CO}_2 + 3 \text{ H}_2\text{O}$   
 When the equation above is balanced, how many water molecules will be produced?  
 A. 1                      B. 2                      C. 3                      D. 4
21. What is the percentage composition of Mg in the compound  $\text{Mg}_3(\text{PO}_4)_2$ ?  $\frac{72.93}{262.87} \times 100 = 27.74\% \text{ Mg}$   
 A. 21.92%              B. 23.57%              C. 27.74%              D. 32.32%
22. Which molecule listed has two sigma ( $\sigma$ ) and two pi ( $\pi$ ) bonds?  
 A.  $\text{N}_2$                       B.  $\text{C}_2\text{H}_4$                       C.  $\text{N}_2\text{F}_2$                       D.  $\text{HCN}$
23. How many resonance structures for Carbon Dioxide?  
 A. 0  
 B. 1 (OK Zero...)  
 C. 2  
 D. 3
24. What is the oxidation state of Carbon in Barium Carbonate?  
 A. +3  
 B. +4  
 C. -4  
 D. -3  

$$\begin{matrix} (+2) & (+4) & (-6) & = & 0 \\ 2 & + & 4 & + & 2- \\ \text{BaCO}_3 \end{matrix}$$
25. Which one of the following electron configurations for the species in their ground state is NOT correct?  
 A. Ca:  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$   
 B. Bi:  $[\text{Xe}] 6s^2 4f^{14} 5d^{10} 6p^3$   
 C. As:  $[\text{Ar}] 4s^2 3d^{10} 4p^3$   
 D. P:  $1s^2 2s^2 2p^6 3p^5$   

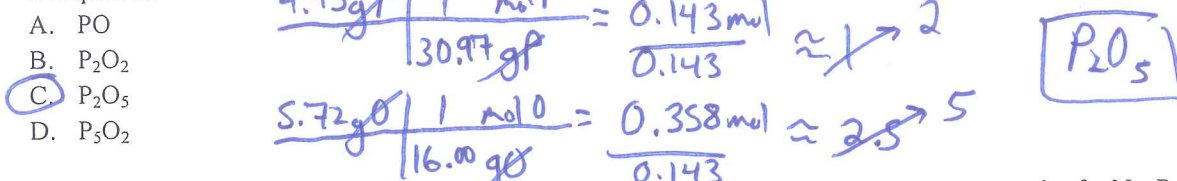
$$\begin{matrix} (+2) & (+2) & (-4) & = & 0 \\ \text{K}^+ & \text{Cr}^+ & \text{O}^{2-} \\ \text{K}_2\text{Cr}_2\text{O}_7 \end{matrix}$$
26. What is the oxidation number of Cr in the compound  $\text{K}_2\text{Cr}_2\text{O}_7$ ?  
 A. +2                      B. +3                      C. +5                      D. +6
27. A 0.4647 g sample of a compound containing only carbon, hydrogen and oxygen was burned in an excess of pure oxygen to yield 0.8635 g of  $\text{CO}_2$  and 0.1767 g of  $\text{H}_2\text{O}$ . What is the empirical formula of the compound?  
 A. ~~CHO~~  
 B.  ~~$\text{C}_2\text{H}_2\text{O}$~~   
 C.  ~~$\text{C}_3\text{H}_7\text{O}_2$~~   
 D.  ~~$\text{C}_6\text{H}_3\text{O}_2$~~
28. Two gases A and B, where A has 3 times the molar mass of B, are released on either end of a 1.2 m tube. Where will they mix?  
 A. Closer to A  
 B. Closer to B  
 C. Right in the middle  
 D. None of these
29. A crystal of  $\text{NaCl}$  is  
 A. Soft, has a low melting temperature, and is a good conductor of electricity  
 B. Hard, has a high melting temperature, and is a good conductor of electricity  
 C. Soft, has a low melting temperature, and is a poor conductor of electricity  
 D. Hard, has a high melting temperature, and is a poor conductor of electricity

30.  $\text{MnO}_4^- + \text{I}^- \rightarrow \text{I}_2 + \text{Mn}^{2+}$   
 Chlorine Manganese is \_\_\_\_\_ and Iodine is \_\_\_\_\_  
 A. Oxidized, reduced  
 B. Reduced, oxidized



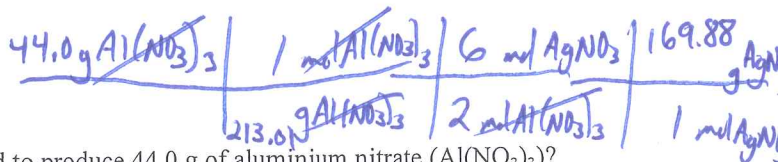
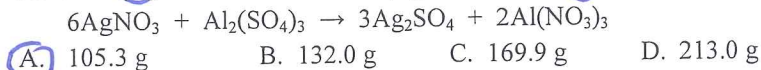
31. What geometry does the molecule  $\text{BF}_3$  exhibit?  
 A. Pyramidal B. Trigonal bipyramidal C. Bent D. Trigonal planar

32. What is the empirical formula when 10.15g of a sample containing Phosphorus and Oxygen is found to have 4.43 g of Phosphorus.



33. Which of the following shows the correct ranking of the highest to lowest first ionization energies for Na, P, Cl, K, Rb?  
 A.  $\text{Na} > \text{P} > \text{Cl} > \text{K} > \text{Rb}$   
 B.  $\text{Na} > \text{Cl} > \text{P} > \text{Rb} > \text{K}$   
 C.  $\text{Cl} > \text{P} > \text{Na} > \text{K} > \text{Rb}$   
 D.  $\text{Cl} > \text{P} > \text{Rb} > \text{K} > \text{Na}$

34. How many grams of silver nitrate ( $\text{AgNO}_3$ ) are required to produce 44.0 g of aluminium nitrate ( $\text{Al}(\text{NO}_3)_3$ )?



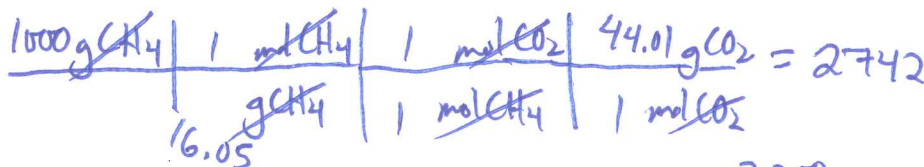
35. A 2.50 kg piece of copper metal is heated from  $25^\circ\text{C}$  to  $225^\circ\text{C}$ . How much heat, in kJ, is absorbed by the copper? The specific heat capacity of copper is  $0.384 \text{ J/g}^\circ\text{C}$ .

- A. 124 kJ B. 156 kJ C. 192 kJ D. 212 kJ

$$q = (2,500 \text{ g})(200^\circ\text{C})(0.384 \text{ J/g}^\circ\text{C}) = 192 \text{ kJ}$$

36.  $\text{CH}_4 + 2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{CO}_2$   
 Calculate percentage yield of carbon dioxide if 1000.g of methane react with excess oxygen to produce 2300.g of carbon dioxide.

- A. 25.2%  
 B. 48.6%  
 C. 83.9%  
 D. 119.0%



$$\frac{2300}{2742} \times 100 = 83.9\%$$

37. What are responsible for the high electrical conductivity of metals?  
 A. Delocalized positive ions  
 B. Delocalized valence electrons  
 C. Delocalized atoms  
 D. Delocalized negative ions

38. What type of solid materials are typically hard, have high melting points and poor electrical conductivities?

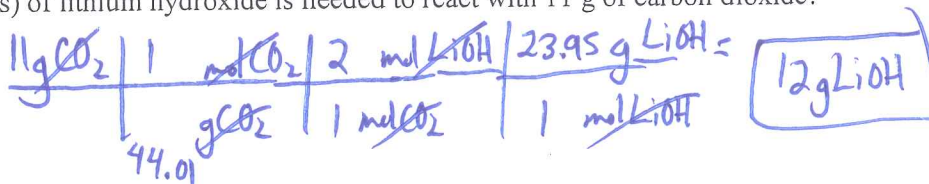
- I. Ionic  
 II. Metallic  
 III. Covalent-network  
 A. I and II only  
 B. I and III only  
 C. II and III only  
 D. I, II and III

39. What will happen to the volume of a fixed mass of gas when its pressure and temperature (in Kelvin) are both doubled?
- A. It will not change.  
 B. It will increase.  
 C. It will decrease.  
 D. The change cannot be predicted.

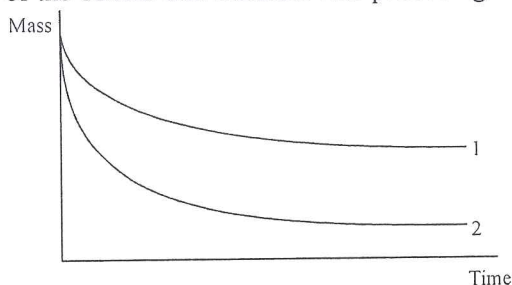
40. Lithium hydroxide reacts with carbon dioxide as follows.
- $$2\text{LiOH} + \text{CO}_2 \rightarrow \text{Li}_2\text{CO}_3 + \text{H}_2\text{O}$$

What mass (in grams) of lithium hydroxide is needed to react with 11 g of carbon dioxide?

- A. 6  
 B. 12  
 C. 24  
 D. 48



41. Excess magnesium was added to a beaker of aqueous hydrochloric acid on a balance. A graph of the mass of the beaker and contents was plotted against time (line 1).



What change in the experiment could give line 2?

- I. The same mass of magnesium but in smaller pieces  
 II. The same volume of a more concentrated solution of hydrochloric acid  
 III. A lower temperature
- A. I only  
 B. II only  
 C. III only  
 D. None of the above

42. When 40 joules of heat are added to a sample of solid  $\text{H}_2\text{O}$  at  $-16.0^\circ\text{C}$  the temperature increases to  $-8.0^\circ\text{C}$ . What is the mass of the solid  $\text{H}_2\text{O}$  sample?

[Specific heat capacity of  $\text{H}_2\text{O}(\text{s}) = 2.0 \text{ J g}^{-1}\text{K}^{-1}$ ]

- A. 2.5 g  
 B. 5.0 g  
 C. 10 g  
 D. 160 g

Handwritten calculation for question 42:

$$q = m \Delta T \cdot c_p$$

$$m = \frac{(40 \text{ J})}{(8.0^\circ\text{C})(2.0 \text{ J/g}\cdot^\circ\text{C})} = 2.5 \text{ g}$$

43. The percentage by mass of the elements in a compound is C = 72%, H = 12%, O = 16%.

What is the mole ratio of C:H in the empirical formula of this compound?

- A. 1 : 1  
 B. 1 : 2  
 C. 1 : 6  
 D. 6 : 1

Handwritten calculation for question 43 (Carbon):

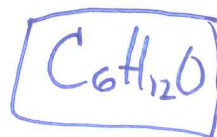
$$\frac{72 \text{ g C}}{12.01 \text{ g C}} = \frac{6.00 \text{ mol}}{1.00} \approx 6$$

Handwritten calculation for question 43 (Hydrogen):

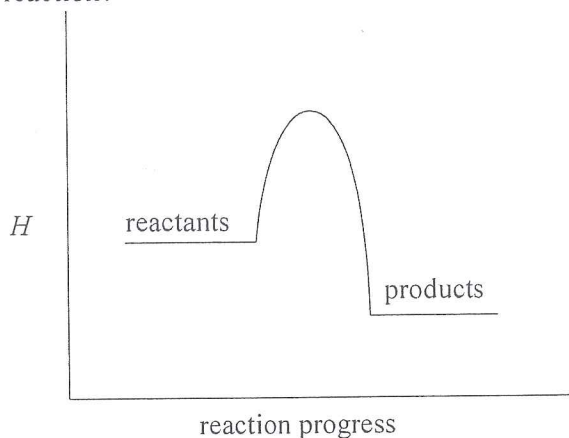
$$\frac{12 \text{ g H}}{1.01 \text{ g H}} = \frac{11.9 \text{ mol}}{1.00} \approx 12$$

Handwritten calculation for question 43 (Oxygen):

$$\frac{16 \text{ g O}}{16.00 \text{ g O}} = \frac{1.00 \text{ mol}}{1.00} \approx 1$$



48. According to the enthalpy level diagram below, what is the sign for  $\Delta H$  and what term is used to refer to the reaction?

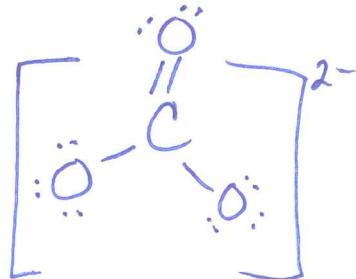


	$\Delta H$	reaction
A.	positive	endothermic
<b>B.</b>	negative	exothermic
C.	positive	exothermic
D.	negative	endothermic

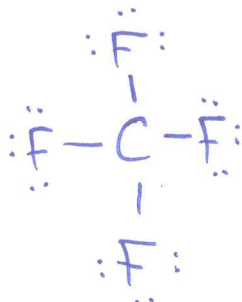
**Short Answer**

Answer the following questions using the principles of chemical bonding and molecular structure.

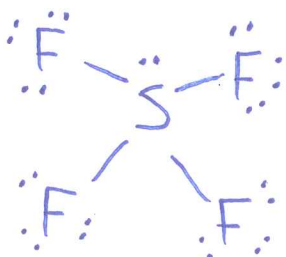
- Consider the carbon dioxide molecule,  $\text{CO}_2$ , and the carbonate ion,  $\text{CO}_3^{2-}$ .
  - Draw the complete Lewis electron-dot structure for each species.
  - Account for the fact that the carbon-oxygen bond length in  $\text{CO}_3^{2-}$  is greater than the carbon-oxygen bond length in  $\text{CO}_2$ .
- Consider the molecules  $\text{CF}_4$  and  $\text{SF}_4$ .
  - Draw the complete Lewis electron-dot structure for each molecule.
  - In terms of the molecular geometry, account for the fact that the  $\text{CF}_4$  molecule is non-polar, whereas the  $\text{SF}_4$  molecule is polar.



\* double bonds are shorter



\* symmetrical



\* not symmetrical