## Activity Series of Metals in Aqueous Solution

<table>
<thead>
<tr>
<th>Metal</th>
<th>Oxidation Reaction</th>
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</thead>
<tbody>
<tr>
<td>Lithium</td>
<td>Li(s) $\rightarrow$ Li$^+(aq)$ + e$^-$</td>
</tr>
<tr>
<td>Potassium</td>
<td>K(s) $\rightarrow$ K$^+(aq)$ + e$^-$</td>
</tr>
<tr>
<td>Barium</td>
<td>Ba(s) $\rightarrow$ Ba$^{2+}(aq)$ + 2e$^-$</td>
</tr>
<tr>
<td>Calcium</td>
<td>Ca(s) $\rightarrow$ Ca$^{2+}(aq)$ + 2e$^-$</td>
</tr>
<tr>
<td>Sodium</td>
<td>Na(s) $\rightarrow$ Na$^+(aq)$ + e$^-$</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mg(s) $\rightarrow$ Mg$^{2+}(aq)$ + 2e$^-$</td>
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<tr>
<td>Aluminum</td>
<td>Al(s) $\rightarrow$ Al$^{3+}(aq)$ + 3e$^-$</td>
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<tr>
<td>Manganese</td>
<td>Mn(s) $\rightarrow$ Mn$^{2+}(aq)$ + 2e$^-$</td>
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<tr>
<td>Zinc</td>
<td>Zn(s) $\rightarrow$ Zn$^{2+}(aq)$ + 2e$^-$</td>
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<tr>
<td>Chromium</td>
<td>Cr(s) $\rightarrow$ Cr$^{3+}(aq)$ + 3e$^-$</td>
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<tr>
<td>Iron</td>
<td>Fe(s) $\rightarrow$ Fe$^{2+}(aq)$ + 2e$^-$</td>
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<tr>
<td>Cobalt</td>
<td>Co(s) $\rightarrow$ Co$^{2+}(aq)$ + 2e$^-$</td>
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<tr>
<td>Nickel</td>
<td>Ni(s) $\rightarrow$ Ni$^{2+}(aq)$ + 2e$^-$</td>
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<tr>
<td>Tin</td>
<td>Sn(s) $\rightarrow$ Sn$^{2+}(aq)$ + 2e$^-$</td>
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<tr>
<td>Lead</td>
<td>Pb(s) $\rightarrow$ Pb$^{2+}(aq)$ + 2e$^-$</td>
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<tr>
<td>Hydrogen</td>
<td>H$_2$(g) $\rightarrow$ 2H$^+(aq)$ + 2e$^-$</td>
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<tr>
<td>Copper</td>
<td>Cu(s) $\rightarrow$ Cu$^{2+}(aq)$ + 2e$^-$</td>
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<tr>
<td>Silver</td>
<td>Ag(s) $\rightarrow$ Ag$^+(aq)$ + e$^-$</td>
</tr>
<tr>
<td>Mercury</td>
<td>Hg(l) $\rightarrow$ Hg$^{2+}(aq)$ + 2e$^-$</td>
</tr>
<tr>
<td>Platinum</td>
<td>Pt(s) $\rightarrow$ Pt$^{2+}(aq)$ + 2e$^-$</td>
</tr>
<tr>
<td>Gold</td>
<td>Au(s) $\rightarrow$ Au$^{3+}(aq)$ + 3e$^-$</td>
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Part I- (3 points each) - Please write your correct answer next to each question number, DO NOT CIRCLE.

____ 1. Which of the following are nonelectrolytes in water?
   (i) HF           (ii) ethanol, \text{C}_2\text{H}_5\text{OH}   (iii) \text{CH}_3\text{OCH}_3   (iv) \text{KClO}_3
   A. ii and iii   B. i, ii, and iii    C. iii only    D. ii only

____ 2. How many milliliters of 1.50 M KOH solution are needed to supply 0.125 mole of KOH?
   A. 0.0833 ml   B. 0.188 ml    C. 12.0 ml   D. 83.3 ml

____ 3. Which of the following is/are soluble in water?
   (i) \text{NiCl}_2   (ii) \text{Ag}_2\text{S}   (iii) \text{Cs}_3\text{PO}_4   (iv) (\text{NH}_4)_2\text{SO}_4
   A. iv only    B. i, ii, and iii    C. i, ii, and iv    D. i, iii and iv

____ 4. Which of the following reactions will occur?
   (i) \text{Ni(s)} + \text{Zn}^{2+}(\text{aq}) \rightarrow
   (ii) \text{Pb(s)} + \text{Ag}^{+}(\text{aq}) \rightarrow
   (iii) \text{Zn(s)} + \text{Ca}^{2+}(\text{aq}) \rightarrow
   (iv) \text{Al}(s) + \text{Fe}^{2+}(\text{aq}) \rightarrow
   A. i only    B. ii only    C. ii and iv only    D. i and iii only

____ 5. Which of the following is a weak base?
   A. \text{NaOH}   B. \text{Ca(OH)}_2   C. \text{NH}_4\text{OH}   D. \text{RbOH}

____ 6. How many kJ of heat must be removed from 1.0\times10^3 g of water (heat capacity of 4.184 J/g/K) to lower the temperature from 18.0°C to 12.0°C?
   A. 2.5\times10^{-2} kJ   B. 1.4 kJ    C. 4.2 kJ   D. 25 kJ

____ 7. From the following heats of reaction,
   \[
   2\text{C (graphite)} + \text{H}_2 (\text{g}) \rightarrow \text{C}_2\text{H}_2 (\text{g}) \quad \Delta H = 227 \text{kJ/mole}
   \]
   \[
   6\text{C (graphite)} + 3\text{H}_2 (\text{g}) \rightarrow \text{C}_6\text{H}_6 (\text{l}) \quad \Delta H = 49 \text{kJ/mole}
   \]
calculate the heat for the reaction
   \[
   3\text{C}_2\text{H}_2 (\text{g}) \rightarrow \text{C}_6\text{H}_6 (\text{l})
   \]
   A. 632 kJ/mole   B. -632 kJ/mole   C. -178 kJ/mole   D. 178 kJ/mole
8. The heat of combustion of fructose, C₆H₁₂O₆, is -2812 kJ. Using the following information, calculate △H° for fructose.

\[
C₆H₁₂O₆(s) + 6 O₂(g) \rightarrow 6 CO₂(g) + 6 H₂O (l)
\]

\[\Delta H° (CO₂) = -393.5 \text{ KJ/mole} \quad \Delta H° (H₂O) = -285.83 \text{ KJ/mole}\]

A. -210.3 kJ/mol  
B. 210.3 kJ/mol  
C. -1264 kJ/mol  
D. 1264 kJ/mol

9. What is the kinetic energy in J and cal of a 45-g golf ball moving at 61 m/s?

A. 168 J, 40 cal  
B. 84 J, 20 cal  
C. 84 J, 350 cal  
D. 84 kJ, 20 kcal

10. Consider the combustion reaction of ethane gas, C₂H₆(g):

\[
C₂H₆(g) + 7/2O₂(g) \rightarrow 2CO₂(g) + 3H₂O(g) , \quad \Delta H = -1430 \text{ kJ}
\]

What is the enthalpy change for the reverse reaction if whole number of coefficients are used?

A. +1430 kJ  
B. -1430 kJ  
C. -2860 kJ  
D. +2860 kJ

11. What is the frequency of radiation that has a wavelength of 0.589 pm?

A. \(1.96 \times 10^{-21} \text{ s}^{-1}\)  
B. \(5.09 \text{ s}^{-1}\)  
C. \(5.09 \times 10^8 \text{ s}^{-1}\)  
D. \(5.09 \times 10^{20} \text{ s}^{-1}\)

12. Statement, electrons fill the orbital singlet, then double up is called ............

A. Aufba principle  
B. Hund’s rule  
C. Pauli’s exclusion principle  
D. none of these

13. For \(n = 4\), what are the possible values of \(l\)?

A. 3, 2, 1  
B. 4, 3, 2, 1  
C. 3, 2, 1, 0  
D. 4, 3, 2, 1, 0

14. What is the maximum number of electrons that can occupy the subshell 3d?

A. 1  
B. 3  
C. 5  
D. 10

15. Write the electron configuration for the atom Cu, using the appropriate noble-gas inner core for abbreviation.

A. [Ar]4s²3d¹⁰  
B. [Ar]4s²4d⁹  
C. [Ar]4s¹3d¹⁰  
D. [Kr]4s¹3d¹⁰

16. Which of the following gas has higher density at STP condition?

A. CH₄  
B. Cl₂  
C. CO₂  
D. O₂

17. How many moles of N₂ gas occupy 11.2 liters volume at a STP condition?

A. 1.0 mol  
B. 2.0 mol  
C. 0.50 mol  
D. cannot be determined
18. Which of the following is/are not characteristic of gases?
   I. high density   II. formation of homogeneous mixtures   III. low intermolecular forces
   A. I only   B. I and III   C. I, II, and III   D. II and III

19. An unknown gas "X" effuses two times faster than a sample of SO$_3$(g) through a porous container. Which of the following is the unknown gas?
   A. H$_2$   B. CH$_4$   C. Ne   D. Ar

20. Which of the following is not a statement of Boyle's law? All statements assume constant temperature and amount of gas.
   A. P = constant/V   B. V $\alpha$ 1/P   C. P/V = constant   D. PV = constant

---

**PART II** - (5 points each) Please show all your work.

21. Write a complete ionic and net-ionic equation for the following reaction.

   \[ \text{K}_2\text{CO}_3 (aq) + \text{H}_2\text{SO}_4 (aq) \rightarrow \]

22. a) What volume(ml) of 0.115 M HClO$_4$ solution is required to neutralize 50.00 ml of 0.0875 M Ca(OH)$_2$?
   b) A solution contains 3.2 g NaOH (MW = 40) in 20.0 ml of solution. What is the molarity of the solution?

23. A 44.0 g sample of an unknown metal at 99.0 °C was placed in a constant-pressure calorimeter of negligible heat capacity containing 80.0 mL water at 24.0 °C. The final temperature of the system was found to be 28.4 °C. Calculate the Specific heat of the metal if density of water is 1.00 g/ml.

24. From the following heats of reaction,

   I) \[ \text{N}_2(g) + 2\text{O}_2(g) \rightarrow 2\text{NO}_2(g) \quad \Delta H = +67.6 \text{ kJ} \]

   II) \[ 2\text{NO}(g) + \text{O}_2(g) \rightarrow 2\text{NO}_2(g) \quad \Delta H = -113.2 \text{ kJ} \]

   calculate the heat of the reaction, \[ \text{N}_2(g) + \text{O}_2(g) \rightarrow 2\text{NO}(g) \]
25. For the electronic transition from n = 3 to n = 5 in the hydrogen atom, calculate the energy, and wavelength (in nm).

26. Write electron and core configuration for Bromine atom and determine the total number of unpaired electrons.

27. 2.50 g CO₂ gas occupies 5.60 liters at 789 torr.
   a) Calculate the temperature of gas in °C.  
   b) What is the density of CO₂ gas at STP condition?

28. What volume of O₂(g), measured at 22 °C and 763 torr, is consumed in the combustion of 7.50 L of C₂H₆(g), measured at STP?
   \[2 \text{C}_2\text{H}_6(g) + 7 \text{O}_2(g) \rightarrow 4 \text{CO}_2(g) + 6 \text{H}_2\text{O}(l)\]

**Bonus Question (10 points) - Please show all your work**

Phosphorous pentachloride is used in the industrial preparation of many organic phosphorous compounds. Equation I shows its preparation from PCl₃ and Cl₂:

(I) \(\text{PCl}_3(l) + \text{Cl}_2(g) \rightarrow \text{PCl}_5(s)\)

Use equation II and III to calculate \(\Delta H_{\text{rxn}}\) of equation I:

(II) \(\text{P}_4(s) + 6 \text{Cl}_2(g) \rightarrow 4 \text{PCl}_3(l)\) \(\Delta H = -1280 \text{ KJ}\)

(III) \(\text{P}_4(s) + 10 \text{Cl}_2(g) \rightarrow 4 \text{PCl}_5(s)\) \(\Delta H = -1774 \text{ KJ}\)
PART - I

1. A
2. D \[ n = M \cdot V_L \Rightarrow V_L = (n / M) = (0.125 \text{ mol} / 1.50 \text{ mol/L}) = 0.0833 \text{ L} \Rightarrow x 1000 = 83.3 \text{ mL} \]

6. \[ q = m \cdot s \cdot \Delta T = (1.0 \times 10^3 \text{ g})(4.184 \text{ J/g.K})(18.0 - 12.0 \degree \text{C}) = 25104 \text{ J} = 25100 \text{ J} / 1000 = 25 \text{ kJ} \]

7. B Reaction I (3 x rev.) \[ 3C_2H_2 (g) \rightarrow 6C \text{ (graphite)} + 3H_2 (g) \quad \Delta H = 3(-227) \text{ kJ/mol} \]

   Reaction II (same) \[ 6C \text{ (graphite)} + 3H_2 (g) \rightarrow C_6H_6 (l) \quad \Delta H = 49 \text{ kJ/mole} \]

   Overall reaction \[ 3C_2H_2 (g) \rightarrow C_6H_6 (l) \quad \Delta H = -632 \text{ kJ/mol} \]

8. C \[ \Delta H = \Delta H^\circ_{f} \text{ (reactants)} - \Delta H^\circ_{f} \text{ (products)} \]

\[ -2812 = [6(-285.83) + 6(-393.5)] - [ 6 (0) + \Delta H^\circ_{f} \text{ (fructose)}] \Rightarrow \Delta H^\circ_{f} \text{ (fructose)} = -1264 \text{ kJ/mol} \]

9. B K.E. = (mV^2)/2 = (.045 \text{ kg} ) (61 \text{ m/s})^2 / 2 = 84 \text{ J} / 4.184 = 20 \text{ cal} \]

10. D For reverse reaction with whole number \(-2x (\Delta H) = -2(-1430 \text{ kJ}) = +2860 \text{ kJ} \)

11. D \[ v = (c / \lambda ) = (3.00 \times 10^8 \text{ m/s}) / 0.589 \times 10^{-12} \text{ m} ) = 5.09 \times 10^{20} s^{-1} \text{ or Hz} \]


16. B \[ \text{Cl}_2 \text{ has highest molecular weight} = 71.0 \text{ gr/mol} \]

17. C \[ (11.2 \text{ L}) (1 \text{ mol} / 22.4 \text{ L}) = 0.50 \text{ mol N}_2 \]

18. A

19. C \[ \text{rate(X) / rate (SO}_3) = (M_{SO3}/M_X)^{1/2} \Rightarrow 2 = (80 / M_X)^{1/2} \Rightarrow 4 = 80 / M_X \Rightarrow M_X = 80/4 = 20 \text{ Neon} \]

20. C

PART - II

21. molecular equation: \[ \text{K}_2\text{CO}_3 (aq) + \text{H}_2\text{SO}_4 (aq) \rightarrow \text{K}_2\text{SO}_4(aq) + \text{H}_2\text{CO}_3(aq) \]

   ionic equation : \[ 2\text{K}^+ (aq) + \text{CO}_3^{2-} (aq) + 2\text{H}^+ (aq) + \text{SO}_4^{2-} (aq) \rightarrow 2\text{K}^+ (aq) + \text{SO}_4^{2-} (aq) + \text{H}_2\text{O(l)} + \text{CO}_2(g) \]

   net-ionic equation : \[ 2\text{H}^+ (aq) + \text{CO}_3^{2-} (aq) \rightarrow \text{H}_2\text{O(l)} + \text{CO}_2(g) \]

   spectator ions : \[ 2 \text{K}^+ \text{ and SO}_4^{2-} \]
22. a) \[ V_a = \frac{n_b M_b V_b}{n_a M_a} = \frac{(2)(50.00)(0.0875)}{0.115} = 76.1 \text{ ml} \]
\[(3.2/40 \text{ mole})\]
b) \[ M = \frac{4 \text{ mol/L (mol.L}^{-1})}{20.0/1000 \text{ L}} \]

23. \[ C \Delta T (\text{metal}) = C \Delta T (\text{water}) \Rightarrow ms \Delta T (\text{metal}) = ms \Delta T (\text{water}) \]
\[(44.0)(s_{\text{metal}}) (99.0-28.4) = (80.0)(4.184)(28.4 -24) \Rightarrow s_{\text{metal}} = 0.474 \text{ J/g.}^\circ C \]

24. \[ N_2 + 2O_2 \rightarrow 2NO \quad \Delta H = +67.6 \text{ kJ} \]
\[ 2NO_2 \rightarrow 2NO + O_2 \quad \Delta H = +113.2 \text{ kJ} \]
\[ N_2 + O_2 \rightarrow 2NO \quad \Delta H = +180.8 \text{ kJ} \]

25. \[ \Delta E = 2.18 \times 10^{-18} \left(1/3^2 - 1/5^2\right) = 1.55 \times 10^{-19} \text{ J} \]
\[ \Delta E = \frac{hc}{\lambda} \]
\[(6.63 \times 10^{-34})(3.00 \times 10^8) \]
\[ \lambda = \frac{1.28 \times 10^{-6} \text{ m}}{(1.55 \times 10^{-19})} = 1280 \text{ nm} \]

26. \[ \text{Br}_3 = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5 = [Ar] 4s^2 3d^{10} 4p^5 \]
One unpaired electron
\[
\begin{array}{ccc}
\uparrow & \updownarrow & \uparrow \\
\end{array}
\]

27. a) \[ PV = nR T \Rightarrow PV = (m/M) RT \Rightarrow T = \frac{(MPV/m R)}{1246 \text{ K} = 973^\circ C 102 \text{ K}} \]
\[ \text{b) D(CO}_2\text{)_{STP}} = \frac{M}{22.4} = 44/22.4 = 1.96 \text{ g/L} \]

28. \[ (7.50 \text{ L} \text{ C}_2\text{H}_6)(1 \text{ mol C}_2\text{H}_6/22.4 \text{ L}) \quad (7 \text{ mol O}_2 / 2 \text{ mol C}_2\text{H}_6) = 1.17 \text{ mol. O}_2 \]
\[ V = (nRT/P) = (1.17)(0.0821)(273+22)(760)/(763) = 28.2 \text{ L} \]

Bonus
Rev x 1/4 (ii) \[ \text{PCl}_3 \rightarrow 1/4 \text{ P}_4 + 6/4 \text{ Cl}_2 \quad ; \Delta H = +320 \text{ kJ} \]
\[1/4 \text{ (iii)} \quad 1/4 \text{ P}_4 + 10/4 \text{ Cl}_2 \rightarrow \text{PCl}_5 \quad ; \Delta H = -443.5 \text{ kJ} \]
\[ \text{PCl}_3 + \text{Cl}_2 \rightarrow \text{PCl}_5 \quad ; \Delta H = -123.5 \text{ kJ} \]
Chemistry 1411

EXAM # 2B Sample

- s Orbital
- $p_x$ Orbital
- $p_y$ Orbital
- $p_z$ Orbital
- All $p$ orbitals full
Directions- please answer the following multiple-choice questions next to each number. Please show all your work for bonus question and part (2) questions in the space provided.

**Part (1) - Multiple Choice - (3 points each)**

_____ 1. All of the following are weak acids except

   A. HCNO   
   B. HBr      
   C. HF     
   D. HNO2   
   E. HCN

_____ 2. How many grams of NaCl are contained in 350.ml of a 0.250 M solution of sodium chloride?

   A. 41.7g   
   B. 5.12g   
   C. 14.6g   
   D. 87.5g   
   E. None of these

_____ 3. Consider the reaction:  Zn + H\textsubscript{2}SO\textsubscript{4} → ZnSO\textsubscript{4} + H\textsubscript{2} . Which element (if any) is oxidized?

   A. zinc   
   B. hydrogen   
   C. sulfur   
   D. oxygen   
   E. None of these

_____ 4. In which of the following does nitrogen have an oxidation state of +4?

   A. HNO\textsubscript{3}   
   B. NO\textsubscript{2}   
   C. N\textsubscript{2}O   
   D. NH\textsubscript{4}Cl   
   E. NaNO\textsubscript{2}

_____ 5. In the balanced molecular equation for the neutralization of sodium hydroxide with sulfuric acid, the products are:

   A. NaSO\textsubscript{4} + H\textsubscript{2}O   
   B. NaSO\textsubscript{3} + 2H\textsubscript{2}O   
   C. 2NaSO\textsubscript{4} + H\textsubscript{2}O   
   D. Na\textsubscript{2} +2 H\textsubscript{2}O   
   E. Na\textsubscript{2}SO\textsubscript{4} + 2H\textsubscript{2}O

_____ 6. What volume of 18.0 M sulfuric acid must be used to prepare15.5L of 0.195 M H\textsubscript{2}SO\textsubscript{4}?

   A. 168 ml   
   B. 0.336L   
   C. 92.3 ml   
   D. 226 ml   
   E. None of these

_____ 7. For a particular process q = - 17 kJ and w = 21 kJ. Which of the following statement is false?

   A. Heat flows from the system to the surroundings   
   B. The system does work on the surroundings   
   C. \(\Delta E = + 4\) kJ   
   D. The process is exothermic   
   E. None of the above is false

_____ 8. Consider the reaction  \(\text{H}_2 (g) + (1/2) \text{O}_2 (g) \rightarrow \text{H}_2\text{O} (l)\), \(\Delta H = - 286\) kJ; which of the following is true?

   A. The reaction is exothermic   
   B. The reaction is endothermic   
   C. The enthalpy of the products is less than that of the reactants.   
   D. Heat is absorbed by the system   
   E. Both A and C are true
9. How much heat is required to raise the temperature of a 6.21 g sample of iron from 25.0 °C to 79.8 °C? (specific heat of iron is 0.450 J /g . °C)
   A. 70.0 J   B. 101 J   C. 386 J   D. 756 J   E. 153 J

10. Consider the following atoms and ions; which is(are) isoelectronic with Argon?
    I. Cl⁻   II. Mg   III. P   IV. K⁺   V. Ce
   A. only I   B. I and IV   C. Only IV   D. II, III, and V   E. none of these

11. Which of the following quantum number combinations is incorrect for an orbital designation?
    A. n = 2, l = 0   B. n = 1, l = 0, m = 0
    C. n = 2, l = 1, m = -1   D. n = 2, l = 0, m = -1, s = + ½
    E. All incorrect

12. What volume is occupied by 19.6 g of methane (CH₄) at 27 °C and 1.59 atm?
    A. 1.71 L   B. 18.9 L   C. 27.7 L   D. 302 L   E. Not enough data to calculate

13. Which gas has the highest density?
    A. He   B. Cl₂   C. CH₄   D. NH₃   E. All gases the same.

14. The mass of 1.12 liters of gas Y is found to be 6.23 g. The density of gas Y is:
    A. 10.6 g/L   B. 5.56 g/L   C. 15.6 g/L   D. 0.200 g/L   E. 0.180 g/L

15. The density of Nitrogen at STP is:
    A. 1.60 g/L   B. 0.800 g/L   C. 1.25 g/L   D. 0.625 g/L   E. Not enough information

16. Order the following in increasing rate of effusion: F₂, Cl₂, NO, NO₂, CH₄
    A. Cl₂ < NO₂ < F₂ < NO < CH₄   B. Cl₂ < F₂ < NO₂ < CH₄ < NO
    C. CH₄ < NO₂ < NO < F₂ < Cl₂   D. CH₄ < NO < F₂ < NO₂ < Cl₂
    E. F₂ < NO < Cl₂ < NO₂ < CH₄

17. Which of the following frequencies corresponds to light with the longest wavelength?
    A. 3.00 × 10¹³ s⁻¹   B. 4.12 × 10⁵ s⁻¹   C. 8.50 × 10²⁰ s⁻¹   D. 9.12 × 10¹² s⁻¹   E. 3.20 × 10⁹ s⁻¹

18. How many electrons in an atom can have the quantum numbers n=3, l=2?
    A. 2   B. 5   C. 10   D. 18   E. 6

19. An element has the electron configuration [Kr] 5s² 4d¹⁰. The element is a(n):
    A. non-metal   B. metalloid   C. metal
    D. transition element   E. two of these
20. How many of the following electron configurations for the species in their ground state are correct?
   i. Ca: \(1s^22s^22p^63s^23p^64s^2\)
   ii. Mg: \(1s^22s^22p^63s^1\)
   iii. V: [Ar] \(3s^23d^3\)
   iv. As: [Ar] \(4s^23d^{10}4p^3\)
   v. P: \(1s^22s^22p^63p^5\)

   A. 1                     B. 2                     C. 3                     D. 4                     E. 5

**Part (2) - Show all your work. (8 points each)**

21. Calculate the wavelength and frequency of light that is emitted when an excited electron in the hydrogen atom falls from \(n=5\) to \(n=2\).

22. A 25.0 g piece of aluminum (which has a molar heat capacity of 24.03 J/°C. mol) is heated 82.4 °C and dropped into a calorimeter containing water (specific heat capacity of water is 4.18 J/g.°C) initially at 22.3 °C. The final temperature of the water is 24.9 °C. Calculate the mass of water in the calorimeter.
23. Consider the following standard heats of formation:
\[ \text{P}_4\text{O}_{10(s)} = -3110 \text{ kJ/mol} \quad \text{H}_2\text{O}_{(l)} = -286 \text{ kJ/mol} \quad \text{H}_3\text{PO}_4(s) = -1279 \text{ kJ/mol} \]

Calculate the change in enthalpy for the following process:
\[ \text{P}_4\text{O}_{10(s)} + 6\text{H}_2\text{O}_{(l)} \rightarrow 4\text{H}_3\text{PO}_4(s) \]

24. What volume of CO\(_2\)(g), produced at 27 °C and 778 torr from the combustion of 10.50 L of C\(_2\)H\(_6\)(g), measured at STP?
\[ 2 \text{C}_2\text{H}_6(g) + 7 \text{O}_2(g) \rightarrow 4 \text{CO}_2(g) + 6 \text{H}_2\text{O}(l) \]

25. Write the ground state electron configurations (or core configurations) for the followings and determine the total number of unpaired electrons and magnetic properties (paramagnetic or diamagnetic) in each.

   a) Chromium (Cr) ________________________________ . ______ . ______

   b) Zinc (Zn) ________________________________ . ______ . ______
**BONUS question-Show all your work.(10 points)**

Using Hess’s law of constant heat of summation and given:

I) \( \text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{O(g)} \) \( \Delta H = -44.1 \text{ kJ} \)

II) \( \text{CH}_3\text{COCH}_3(\text{l}) + 4\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 3\text{H}_2\text{O(\text{l})} \) \( \Delta H = -1787 \text{ kJ} \)

III) \( \text{CH}_3\text{COOH(l)} + 2\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 2\text{H}_2\text{O(l)} \) \( \Delta H = -835 \text{ kJ} \)

determine the enthalpy of reaction for

\( \text{CH}_3\text{COCH}_3 \text{(l)} + 2 \text{O}_2(\text{g}) \rightarrow \text{CH}_3\text{COOH(l)} + \text{CO}_2(\text{g}) + \text{H}_2\text{O(g)} \)
1411 SAMPLE EXAM # 2B (Key)

PART – 1

1. B
2. B  g (NaCl) = M. V.MW = (0.250 mol/L)(0.350 L)(58.5 g/mol) = 5.12 g , NaCl
3. A
4. B
5. E
6. A  M₁V₁ = M₂V₂  →  V₁ = (0.195)(15.5)/(18.0)  →  V₁ = 0.168 L x 1000 ml/L = 168 ml
7. C ( should be ΔE = +4 kJ)
8. E
9. E  q = mc ΔT = (6.21 g)(0.450 J/g. °C)(79.8 °C –25.0 °C) = 153 g
10.B
11. D
12. B  PV = nRT = (mRT/M)  →  V = (mRT/MP)
   = (19.6g)(0.0821 L.atm/mol.K)(300 K)/(16 g/mol)(1.59 atm) = 18.9 L
13. B ( Cl₂ = 71 g/mol , highest molecular weight)
14. B  D = m /V = (6.23 g) / 1.12 L = 5.56 g/L
15. C  g (N₂ at STP) = ( M/22.4) = (28 g /mol) / (22.4 L/mol) = 1.25 g /L
16. D
17. B largest wavelength has smallest frequency
18. C ( l = 2 is d orbital with 10 electrons )
19. E
20. B

PART – 2

21. hc/λ = 2.18x10⁻¹⁸( 1/n₁² – 1/n₂²)  →  (6.63x10⁻³⁴)(3.00x10⁸) /λ = 2.18x10⁻¹⁸( 1/5² – 1/2²)  →  λ = 4.34x10⁻⁷ m
   h v = 2.18x10⁻¹⁸( 1/n₁² – 1/n₂²)  →  (6.63x10⁻³⁴) v = 2.18x10⁻¹⁸( 1/5² – 1/2²)  →  v = 6.91 x10¹⁴ sec⁻¹
22. (mc Δt )Al = (mc Δt )water
   (25.5/27 ) (24.03)(82.4-24.9) = m water (4.18)(24.9-22.3)  →  m water = 118 g
23. Δ Hrx = ΔHf⁰ (products) - ΔHf⁰ (reactants) = [ 4(-1279)] – [ (-3110) – (6(-286))]  →  Δ Hrx = -290 kJ
24. n (mole C₂H₆) = (10.50 L)( 1 mol/22.4 L) = 0.469 mol
   (0.468 mol C₂H₆) x ( 4 mole CO₂ / 2 moles C₂H₆ ) = 0.938 mol CO₂
   V = nRT / P = ( 0.938)(0.0821)(300)(760) / 778  →  V = 22.6 L
25. Cr : [Ar] 4s¹ 3d⁵ , 6 unpaired electrons , paramagnetic
   Zn :[Ar] 4s² 3d¹⁰ , 0 unpaired electrons, diamagnetic

BONUS
\[ \Delta H = \Delta H (I) + \Delta H (II) + \text{reverse } \Delta H (III) = (-441.1) + (-1787) + (+835) = \Rightarrow \Delta H = -996 \text{ kJ} \]