

Name \_\_\_\_\_

ID # \_\_\_\_\_

**INSTRUCTIONS:**

- PRINT your name and ID# above.
- Code the answers to the True-False and Multiple-Choice questions on the scantron form. Mark **A** for true and **B** for false. There is only *one* correct answer for each multiple choice question. There is no partial credit given for this section.
- Show all work on the problems section because partial credit is awarded for this section.
- On the scantron form, write the color of your exam above your name.
- Below your ID# above, answer the following question. What is your favorite band or solo artist? You will receive 1 bonus pt.
- There are **84** points on this exam.

GOOD LUCK! ENJOY!!

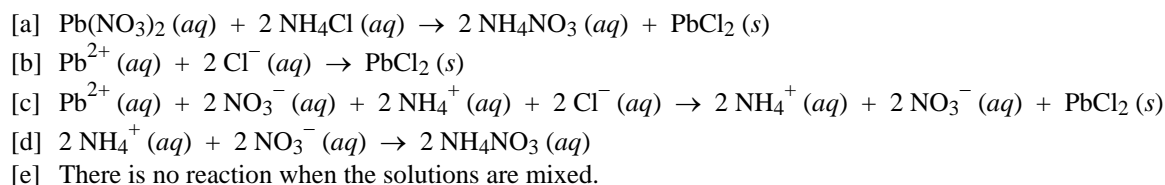
**PART I: True-false statements** (3 points each)

1. A weak acid or a weak base partially ionizes in water.
2. There are **4** unpaired electrons in a Cr atom.
3. In an exothermic reaction, heat flows from the surroundings to the system.
4. Consider the following reaction:  $\text{Zn}(s) + \text{Cu}^{2+}(aq) \rightarrow \text{Zn}^{2+}(aq) + \text{Cu}(s)$ . In this reaction,  $\text{Zn}(s)$  is reduced.

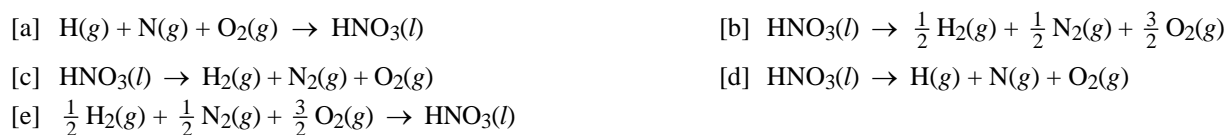
**PART II: Multiple Choice** (3 points each)

5. What is the **molarity** of a solution prepared by dissolving 5.65 grams of NaCl in 250 mL of solution?  
[a]  $3.87 \times 10^{-4} M$  [b] 58.4 M [c] 0.0967 M [d] 0.387 M [e] 0.0226
6. What **volume** of 1.1 M  $\text{Li}_2\text{SO}_4$  is needed to prepare 200 mL of a 0.20 M  $\text{Li}_2\text{SO}_4$  solution?  
[a]  $1.1 \times 10^{-3}$  mL [b] 36 mL [c] 64 mL [d]  $1.1 \times 10^3$  mL [e] none of these
7. Consider the reaction of potassium hydroxide, KOH, with sulfuric acid,  $\text{H}_2\text{SO}_4$ . Balance the equation with the smallest whole number coefficients. What is the **balancing coefficient** for water?  
[a] 0 [b] 1 [c] 2 [d] 3 [e] 4

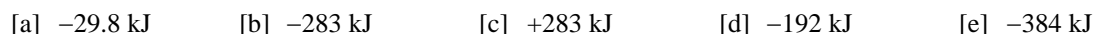
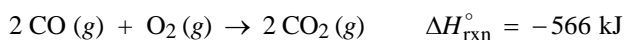
8. Which of the following is the correct **net ionic** equation for the reaction that occurs when solutions of  $\text{Pb}(\text{NO}_3)_2$  and  $\text{NH}_4\text{Cl}$  are mixed?



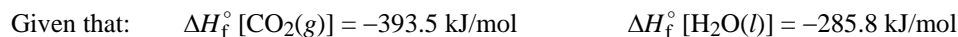
9. Which one of the following reactions occurring at  $25^\circ\text{C}$  does the symbol  $\Delta H_f^\circ$  for  $\text{HNO}_3(l)$  refer to?



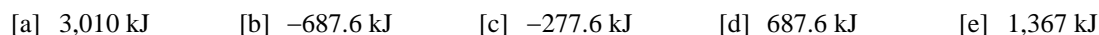
10. Given the balanced equation below, what is the  $\Delta H$  for the combustion of 19.0 grams of  $\text{CO}(g)$  in an excess of oxygen?



11. Ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , undergoes combustion according to the equation



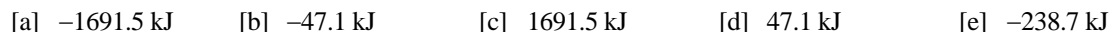
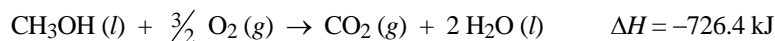
What is the **standard enthalpy of formation** of ethanol ( $\Delta H_f^\circ[\text{C}_2\text{H}_5\text{OH}(l)]$ )?



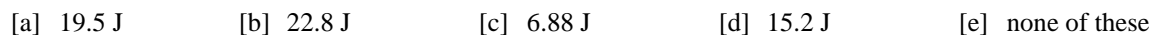
12. Calculate the enthalpy change,  $\Delta H$ , for the reaction



using the following information:



13. How much **heat** needs to be added to an 8.77 gram piece of nickel to raise its temperature from  $22.0^\circ\text{C}$  to  $27.0^\circ\text{C}$ ? [ $s_{\text{Ni}} = 0.444 \text{ J/g}\cdot^\circ\text{C}$ ]

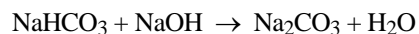


14. Which of the following regions of the electromagnetic spectrum has the **highest energy**?
- [a] Ultra-violet light                      [b] Visible light                      [c] Infrared light  
[d] Light with the longest wavelength    [e] Light with the lowest frequency
15. Calculate the **wavelength** (in nm) of a photon that has a frequency of  $5.49 \times 10^{14}$  Hz.
- [a]  $6.07 \times 10^3$  nm    [b] 546 nm                      [c] 0.126 nm                      [d]  $1.83 \times 10^6$  nm    [e]  $1.65 \times 10^{14}$  nm
16. Of the following transitions in the hydrogen atom, which transition results in the *emission* of a photon with the *lowest* frequency.
- [a]  $n = 1 \rightarrow n = 8$                       [b]  $n = 6 \rightarrow n = 1$                       [c]  $n = 5 \rightarrow n = 1$   
[d]  $n = 6 \rightarrow n = 5$                       [e]  $n = 1 \rightarrow n = 2$
17. What is the **wavelength** (in nm) of light emitted by a hydrogen atom during the transition of its electron from the  $n = 3$  to the  $n = 1$  energy level?
- [a] 102.6 nm                      [b] 136.9 nm                      [c] 365.0 nm                      [d]  $1.45 \times 10^{-9}$  nm    [e]  $1.94 \times 10^{-18}$  nm
18. What is the **velocity** (in m/s) of an electron if it has a wavelength of  $6.4 \times 10^{-12}$  m?  
[mass electron =  $9.109 \times 10^{-31}$  kg]
- [a]  $1.14 \times 10^8$  m/s                      [b]  $8.79 \times 10^{-9}$  m/s                      [c]  $2.15 \times 10^{14}$  m/s  
[d]  $6.87 \times 10^{10}$  m/s                      [e] none of these
19. Which of the following is **TRUE**?
- [a] An orbital is a region of space where an electron is most likely to reside.  
[b] In the usual order of filling electrons in orbitals of atoms, the  $(n + 1)s$  orbital is filled before the  $nd$  orbital.  
[c] There are two possible spins for an electron,  $+1/2$  or  $-1/2$ .  
[d] An orbital can hold at most two electrons.  
[e] All of the above are true.
20. Three sets of quantum numbers are listed below. Pick the best answer.
- I.  $n = 3, l = 3, m_l = 2$                       II.  $n = 4, l = 2, m_l = 0$                       III.  $n = 1, l = 0, m_l = 0$
- [a] I and II are allowed sets, III is not  
[b] only III is an allowed set  
[c] II and III are allowed sets, I is not  
[d] all three sets are allowed  
[e] only II is an allowed set
21. Which of the following is the general electron configuration for the outermost electrons for elements in the *alkaline earth metal* family?
- [a]  $ns^1$                       [b]  $ns^2$                       [c]  $ns^2np^4$                       [d]  $ns^2np^5$                       [e]  $ns^2np^6(n-1)d^6$
22. An atom of vanadium (V) has \_\_\_\_\_ unpaired electrons and is \_\_\_\_\_.
- [a] 0, diamagnetic    [b] 2, diamagnetic    [c] 3, paramagnetic    [d] 5, paramagnetic    [e] 7 paramagnetic

**PART III: Problems**

23. A piece of copper metal weighing 104.4 grams was heated to 100°C and then dropped into 180 grams of water at 25°C. The copper metal cooled down and the water became warmer until both were at a temperature of 28.8°C. Calculate the *specific heat* of copper. [ $s_{\text{H}_2\text{O}} = 4.184 \text{ J/g} \cdot ^\circ\text{C}$ ] [4 pts]

24. A sample containing sodium bicarbonate ( $\text{NaHCO}_3$ ) was titrated with a NaOH standard solution.



It took 23.07 mL of 0.1576 M NaOH to reach the equivalence point of the titration. Calculate the number of **grams** of  $\text{NaHCO}_3$  in the sample. [5 pts]

25. Write both an **electron configuration** and an **orbital diagram** for each of the following. You may use shorthand notation. [9 pts]

[a] P

[b] Rh

[c] Ba

### Potentially Useful Information

$$q = ms\Delta t$$

$$c = \lambda\nu$$

$$c = 3.00 \times 10^8 \text{ m/s}$$

$$E = h\nu$$

$$h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$$

$$E = \frac{hc}{\lambda}$$

$$\lambda = \frac{h}{mu}$$

$$E_n = -R_H \left( \frac{1}{n^2} \right)$$

$$\Delta E = E_f - E_i$$

$$1 \text{ Mm} = 1 \times 10^6 \text{ m}$$

$$\Delta t = t_f - t_i$$

$$\Delta H_{\text{rxn}}^\circ = \sum n\Delta H_f^\circ(\text{products}) - \sum n\Delta H_f^\circ(\text{reactants})$$

$$1 \text{ g} = 6.022 \times 10^{23} \text{ amu}$$

$$\text{Avogadro's number} = 6.022 \times 10^{23} \text{ particles/mole}$$

$$1 \text{ J} = \frac{1 \text{ kg} \cdot \text{m}^2}{\text{s}^2}$$

$$\Delta E = -R_H \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

$$R_H = 2.18 \times 10^{-18} \text{ J}$$

$$\text{Molarity} = \frac{\text{moles solute}}{\text{L of solution}}$$

$$M_1V_1 = M_2V_2$$

SOLUBLE COMPOUNDS	EXCEPTIONS
Compounds containing alkali metal ions ( $\text{Li}^+$ , $\text{Na}^+$ , $\text{K}^+$ , $\text{Rb}^+$ , $\text{Cs}^+$ ) and the ammonium ion ( $\text{NH}_4^+$ )	
Nitrates ( $\text{NO}_3^-$ ), bicarbonates ( $\text{HCO}_3^-$ ), and chlorates ( $\text{ClO}_3^-$ )	
Halides ( $\text{Cl}^-$ , $\text{Br}^-$ , $\text{I}^-$ )	Halides of $\text{Ag}^+$ , $\text{Hg}_2^{2+}$ , and $\text{Pb}^{2+}$
Sulfates ( $\text{SO}_4^{2-}$ )	Sulfates of $\text{Ag}^+$ , $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ , $\text{Ba}^{2+}$ , and $\text{Pb}^{2+}$
INSOLUBLE COMPOUNDS	EXCEPTIONS
Carbonates ( $\text{CO}_3^{2-}$ ), phosphates ( $\text{PO}_4^{3-}$ ), chromates ( $\text{CrO}_4^-$ ), and sulfides ( $\text{S}^{2-}$ )	Compounds containing alkali metal ions and the ammonium ion
Hydroxides ( $\text{OH}^-$ )	Compounds containing alkali metal ions and the $\text{Ba}^{2+}$ ion