

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!!

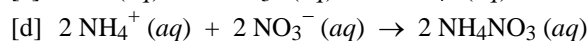
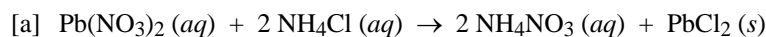
PART I: True-false statements (3 points each)

1. A weak acid or a weak base partially ionizes in water. **T**
2. There are **4** unpaired electrons in a Cr atom. **F**
3. In an exothermic reaction, heat flows from the surroundings to the system. **F**
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. **F**

PART II: Multiple Choice (3 points each)

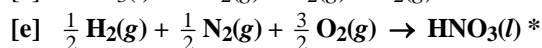
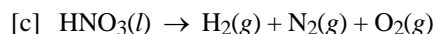
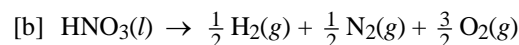
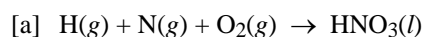
5. What is the **molarity** of a solution prepared by dissolving 5.65 grams of NaCl in 250 mL of solution?
[a] $3.87 \times 10^{-4} M$ [b] 58.4 M [c] 0.0967 M [d] **0.387 M *** [e] 0.0226
6. What **volume** of 1.1 M Li_2SO_4 is needed to prepare 200 mL of a 0.20 M Li_2SO_4 solution?
[a] $1.1 \times 10^{-3} \text{ mL}$ [b] **36 mL *** [c] 64 mL [d] $1.1 \times 10^3 \text{ mL}$ [e] none of these
7. Consider the reaction of potassium hydroxide, KOH, with sulfuric acid, H_2SO_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 NH_4Cl are mixed?

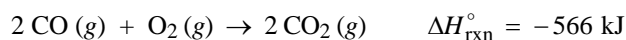


[e] There is no reaction when the solutions are mixed.

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



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



[a] -29.8 kJ

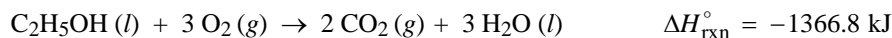
[b] -283 kJ

[c] +283 kJ

[d] **-192 kJ ***

[e] -384 kJ

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



Given that: $\Delta H_f^\circ [\text{CO}_2(g)] = -393.5 \text{ kJ/mol}$

$\Delta H_f^\circ [\text{H}_2\text{O}(l)] = -285.8 \text{ kJ/mol}$

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

[a] 3,010 kJ

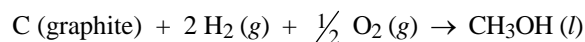
[b] -687.6 kJ

[c] **-277.6 kJ ***

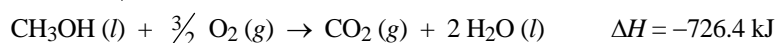
[d] 687.6 kJ

[e] 1,367 kJ

12. Calculate the enthalpy change, ΔH , for the reaction



using the following information:



[a] -1691.5 kJ

[b] -47.1 kJ

[c] 1691.5 kJ

[d] 47.1 kJ

[e] **-238.7 kJ ***

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

[a] **19.5 J ***

[b] 22.8 J

[c] 6.88 J

[d] 15.2 J

[e] none of these

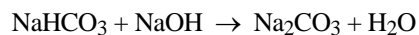
14. Which of the following regions of the electromagnetic spectrum has the **highest energy**?
- [a] **Ultra-violet light** * [b] Visible light [c] Infrared light
[d] Light with the longest wavelength [e] Light with the lowest frequency
15. Calculate the **wavelength** (in nm) of a photon that has a frequency of 5.49×10^{14} Hz.
- [a] 6.07×10^3 nm [b] **546 nm** * [c] 0.126 nm [d] 1.83×10^6 nm [e] 1.65×10^{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] 1.45×10^{-9} nm [e] 1.94×10^{-18} nm
18. What is the **velocity** (in m/s) of an electron if it has a wavelength of 6.4×10^{-12} m?
[mass electron = 9.109×10^{-31} kg]
- [a] **1.14×10^8 m/s** * [b] 8.79×10^{-9} m/s [c] 2.15×10^{14} m/s
[d] 6.87×10^{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] $ns^2 np^4$ [d] $ns^2 np^5$ [e] $ns^2 np^6 (n - 1)d^6$
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]

$$\begin{aligned} -q_{\text{Cu}} &= +q_{\text{water}} \\ -m_{\text{Cu}}s_{\text{Cu}}\Delta T_{\text{Cu}} &= +m_{\text{w}}s_{\text{w}}\Delta T_{\text{w}} \\ -(104.4 \text{ g})s_{\text{Cu}}(28.8 - 100)^\circ\text{C} &= +(180 \text{ g})(4.184 \text{ J/g}\cdot^\circ\text{C})(28.8 - 25^\circ\text{C}) \\ s_{\text{Cu}} &= \mathbf{0.385 \text{ J/g}\cdot^\circ\text{C}} \end{aligned}$$

24. A sample containing sodium bicarbonate (NaHCO_3) was titrated with a NaOH standard solution.



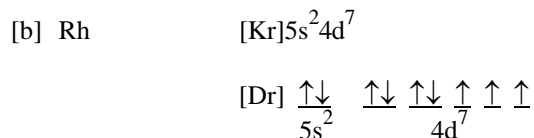
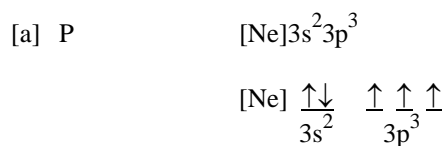
It took 23.07 mL of 0.1576 M NaOH to reach the equivalence point of the titration. Calculate the number of **grams** of NaHCO_3 in the sample. [5 pts]

$$\text{mol NaOH} = \frac{0.1576 \text{ mol NaOH}}{1 \text{ L soln}} \times 0.02307 \text{ L} = 0.003636 \text{ mol NaOH}$$

$$\text{mol NaHCO}_3 = 0.003636 \text{ mol NaOH} \times \frac{1 \text{ mol NaHCO}_3}{1 \text{ mol NaOH}} = 0.003636 \text{ mol NaHCO}_3$$

$$\mathbf{\text{g NaHCO}_3} = 0.003636 \text{ mol NaHCO}_3 \times \frac{84.01 \text{ g NaHCO}_3}{1 \text{ mol NaHCO}_3} = \mathbf{0.3055 \text{ g NaHCO}_3}$$

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



Potentially Useful Information

$$q = ms\Delta t$$

$$c = \lambda\nu$$

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

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

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

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

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

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

$$\Delta E = E_f - E_i$$

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

$$\Delta t = t_f - t_i$$

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

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

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

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

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

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

$$M_1V_1 = M_2V_2$$

SOLUBLE COMPOUNDS	EXCEPTIONS
Compounds containing alkali metal ions (Li^+ , Na^+ , K^+ , Rb^+ , Cs^+) and the ammonium ion (NH_4^+)	
Nitrates (NO_3^-), bicarbonates (HCO_3^-), and chlorates (ClO_3^-)	
Halides (Cl^- , Br^- , I^-)	Halides of Ag^+ , Hg_2^{2+} , and Pb^{2+}
Sulfates (SO_4^{2-})	Sulfates of Ag^+ , Ca^{2+} , Sr^{2+} , Ba^{2+} , and Pb^{2+}
INSOLUBLE COMPOUNDS	EXCEPTIONS
Carbonates (CO_3^{2-}), phosphates (PO_4^{3-}), chromates (CrO_4^-), and sulfides (S^{2-})	Compounds containing alkali metal ions and the ammonium ion
Hydroxides (OH^-)	Compounds containing alkali metal ions and the Ba^{2+} ion