

The City College of New York
Department of Chemistry
Chemistry 103.01

Final Examination

May 26th, 2005

Last Name: _____ First Name: _____ ID: _____
(Last 4 digits)

Course section: _____ Workshop Leader: _____

Please Circle the name of your professor:

Prof. Box

Prof. McKelvie

Prof. Salame

Instructions:

Please do not cheat during this examination. Disciplinary action may be taken.

Write clearly. Exams will not be regarded if the work and answer are not legible.

You may tear off the last page which contains the periodic table. Do not write any answers or work on this page.

Useful Data:

$$\begin{aligned}R &= 0.0821 \text{ L.atm/mol.K} \\ \text{Avogadro's number } N_A &= 6.0221 \times 10^{23} \text{ atoms/mol} \\ c &= 2.9979 \times 10^8 \text{ m/s} \\ h &= 6.626 \times 10^{-34} \text{ Js} \\ 1 \text{ atm} &= 760 \text{ torr} \\ R_H &= 1.096776 \times 10^7 \text{ m}^{-1} = 2.18 \times 10^{-18} \text{ J}\end{aligned}$$

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- | | | | |
|-------------|-------------|-------------|-------------|
| 1. _____/4 | 2. _____/8 | 3. _____/7 | 4. _____/8 |
| 5. _____/7 | 6. _____/12 | 7. _____/9 | 8. _____/6 |
| 9. _____/7 | 10. _____/5 | 11. _____/7 | 12. _____/8 |
| 13. _____/4 | 14. _____/4 | 15. _____/4 | |

Total _____

1. (4 pts) A diesel truck has a tank that is 16 in. × 24 in. × 42 in. Determine the volume of the tank in cubic meters.

Given: 1 in. = 2.54 cm; 1 m = 100 cm

2. Consider the following electron transitions of a hydrogen atom:

$$\Delta E = (-2.18 \times 10^{-18} \text{ J}) \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

	n_{initial}	n_{final}
(a)	1	2
(b)	2	9
(c)	3	2
(d)	7	5

(a) (2 pts) For which transition does the atom lose the greatest quantity of energy?

(b) (2 pts) Which transition corresponds to the lowest frequency?

(c) (2 pts) Which transition corresponds to the gain of a photon of smallest wavelength?

(d) (2 pts) Which transition corresponds to a gain of a photon of the highest energy?

3. (7 pts) A sample of naturally occurring magnesium consists of ^{24}Mg (23.98504 amu), ^{25}Mg (24.98584 amu), and ^{26}Mg (25.98259 amu). If the atomic mass of magnesium is 24.3050 amu and the natural abundance of ^{24}Mg is 78.99%, what are the natural abundances of ^{25}Mg and ^{26}Mg ?

4.

a) (2 pts) Circle the species with the largest atomic radius:

C F I Sn

b) (2 pts) Circle the species with the smallest ionic radius:

Al^{3+} Mg^{2+} Na^+ Ne

c) (2 pts) Circle the most electronegative element:

Zn Cl B Br

d) (2 pts) Circle the species with the highest ionization energy:

Mg S Ca Se

5. (7 pts) TNT is an explosive that has the composition of 37.01% C, 2.22% H, 18.50% N, and 42.27% O by mass. Determine its empirical formula.

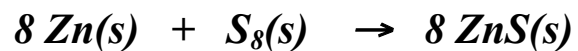
6. Draw the Lewis structure, and predict the ideal bond angles and hybridization of the central atom of the following molecules:

a) (4 pts) FCN (Carbon is the central atom)

b) (4 pts) Cl₂CO (carbon is the central atom)

c) (4 pts) H₂SO₄ (sulfur is the central atom and hydrogen atoms are bonded to oxygen)

7. (9 pts) Zinc Sulfide, ZnS, can be formed by the reaction of zinc metal with sulfur. How many grams of zinc sulfide can be made from the reaction of 10.00 g of zinc and 10.00 grams of sulfur.



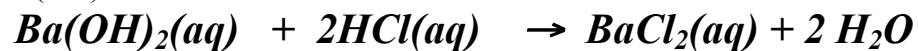
8. Write the condensed or abbreviated ground-state electron configuration for the following:

a) (2 pts) Br

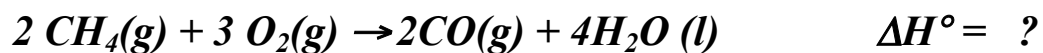
b) (2 pts) Se^{2-}

c) (2 pts) Si^{2+}

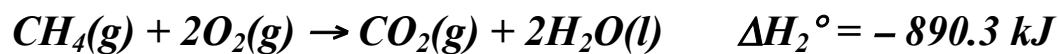
9. (7 pts) A 20.00-mL sample of an aqueous solution of barium hydroxide, Ba(OH)₂, is titrated to the end point by 46.60 mL of 0.0400 M HCl. Calculate the molarity of Ba(OH)₂.



10. (5 pts) Use Hess's Law to calculate the standard enthalpy of formation, ΔH° for the following reaction:



Use the following data:



11. (7 pts) Diacetyl, is a substance that contributes to the characteristic flavor and aroma of butter. In the gas phase at 100°C and 747 torr, a 0.3060-g sample of diacetyl occupies a volume of 0.111 L. Calculate the molar mass of diacetyl.

12. (8 pts) When compounds of barium, Ba, are heated in a flame, green light of wavelength 554 nm is emitted. How much energy is lost when 27.4654 grams of barium atoms are heated and emit one photon per molecule of this wavelength?

13. (4 pts) A sample of nitrogen occupies a 5.00 L under pressure of 1.20 atm and a temperature of 25 °C. What volume would it occupy at 1.80 atm and 190 °C?

14. Determine the oxidation number of the sulfur atom in each of the following:

(a) (2 pts) SO_4^{2-}

(b) (2 pts) $\text{H}_2\text{S}_2\text{O}_8$

15. (2 pts) (a) Write a balanced equation for the metathesis (double displacement) reaction that occurs between $\text{Ba}(\text{NO}_3)_2$ and Na_2SO_4 in aqueous solution.

(2 pts) (b) Write the net ionic equation.