

BROOKLYN COLLEGE  
Department of Chemistry

Chemistry 1

Second Lecture Exam

Nov. 27, 2002

Name \_\_\_\_\_

Page 1 of 5

Circle the name of your lab instructor

Kobrak, Zhou, Girotto, Hussey, Du

Before you begin the exam, write your name on this page and on the answer booklet.

Answer Questions 1-14 on the question sheet. Do questions 15-27 in the exam booklet.

For questions 15-27, show all work. Express answers with the proper units and to the correct number of significant figures. You have 90 minutes. Do not spend too much time on one question.

This exam has 5 pages. Make sure you have all of them. Calculators may be inspected.

PERIODIC CHART OF THE ELEMENTS

IA	IIA											IIIA	IVA	VA	VIA	VIIA	0
1 H 1.0079																1 H 1.0079	2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.179
11 Na 22.989	12 Mg 24.305											13 Al 26.981	14 Si 28.086	15 P 30.974	16 S 32.06	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.08	21 Sc 44.956	22 Ti 47.88	23 V 50.941	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.22	41 Nb 92.905	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 * La 138.90	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0	89 # Ac 227.03															

* Lanthanides	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
# Actinides	90 Th 232.03	91 Pa 231.03	92 U 238.03	93 Np 237.05	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (257)	102 No (255)	103 Lr (256)

$$R = 0.08206 \text{ L atm mol}^{-1} \text{ K}^{-1} \quad 1 \text{ atm} = 760 \text{ torr}$$

$$c = 3.00 \times 10^8 \text{ m/s} \quad h = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}$$

Answer Questions 1–14 on these sheets.

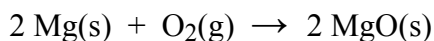
- (2 pts) What is the molarity of the  $\text{K}^+$  ion in 0.60 M  $\text{K}_3\text{PO}_4(\text{aq})$ ?
- (6 pts) State whether each of the following is true or false.
  - If you add 2.000 moles of  $\text{NaCl}$  to 1.000 L of water, you will have a 2.000 M  $\text{NaCl}(\text{aq})$  solution.
  - The electron in the ground state of the H atom moves on a circle of fixed radius around the nucleus.
  - The 2s and 2p subshells have the same energy in the H atom but in other atoms the 2s lies below the 2p.
- (2 pts) What is the maximum number of electrons that can go into the 5f subshell?
- (2 pts) In a certain process, 500 J of heat flows into a gas and the gas expands and does 200 J of work on the surroundings. What is  $\Delta E$  for this process?
- (2 pts) How many unpaired electrons does an atom of N have in its ground electronic state?
- (3 pts) Classify the bonding in each of the following as ionic, nonpolar covalent, or polar covalent. (No credit for "covalent").
  - $\text{K}_3\text{N}$
  - $\text{NH}_3$
- (2 pts.) Write the balanced chemical reaction between calcium and water.
- (1 pt) The letter f in  $\Delta H_f^\circ$  stands for what word?
- (2 pts) How many 4d orbitals are there for an atom?
- (2 pts) Which one of these molecules has the most polar bond?
  - $\text{H}_2$
  - $\text{HF}$
  - $\text{HCl}$

11. ( 4 pts) Write the name of the person who did each of the following. Choose answers from Rutherford, de Broglie, Einstein, Millikan, Bohr, Pauli, Planck, Heisenberg, Schrödinger, Ehrenfest, Thomson.
- (a) Discovered the equation that allows the correct energy levels of electrons in all atoms and molecules to be calculated.
- (b) Discovered that two electrons in the same atom cannot have the same set of values for all four quantum numbers.
12. (2 pts) Which one of the following elements is the most metallic?
- (a) Be    (b) B    (c) Ca
13. (4 pts) Consider the three elements N, O, S.
- (a) Which one of these three is the most electronegative?
- (b) Which one of these three has the smallest atomic radius?
14. (3 pts.) Box 1 contains  $\text{H}_2(\text{g})$  and Box 2 contains  $\text{N}_2(\text{g})$ . Both boxes are held at the same constant temperature of  $25^\circ\text{C}$ . Which one of the following statements is true?
- (a) All the molecules in Box 1 travel at the same speed and this speed is greater than the speed of molecules in Box 2.
- (b) All the molecules in Box 1 travel at the same speed and this speed is less than the speed of molecules in Box 2.
- (c) All the molecules in Box 1 travel at the same speed and this speed is the same as the speed of molecules in Box 2.
- (d) The molecules in Box 1 travel at many different speeds and the average speed in Box 1 is greater than the average speed in Box 2.
- (e) The molecules in Box 1 travel at many different speeds and the average speed in Box 1 is less than the average speed in Box 2.
- (f) The molecules in Box 1 travel at many different speeds and the average speed in Box 1 is the same as the average speed in Box 2.

**Answer Questions 15-27 in the answer booklet. Show all work.**

15. (6 pts) What volume of 0.372 M NaOH(aq) is needed to titrate 24.8 mL of 0.164 M H<sub>2</sub>SO<sub>4</sub>(aq) to the neutralization point?
16. (6 pts) If we add 56.5 mL of 3.50 M HCl(aq) to nine million grams of Al, what mass of aluminum will react according to
- $$2 \text{ Al} + 6 \text{ HCl(aq)} \rightarrow 3 \text{ H}_2 + 2 \text{ AlCl}_3$$
17. (5 pts) Give the **complete** electron configuration of each of the following. (Do not use the inert-gas abbreviation).
- (a) Fe      (b) S<sup>2-</sup>
18. (6 pts) 35.0 g of a metal is heated to 100.0°C and then dropped into 85.0 g of H<sub>2</sub>O that is at 24.0°C. The final temperature of the system is 28.8°C. The specific heat of water is 4.18 J/(g °C).
- (a) Find the amount of heat that flowed into the water.
- (b) Find the specific heat of the metal.
19. (10 pts) Draw the Lewis electron-dot structure of each of the following.
- (a) SO<sub>2</sub>      (b) ClF<sub>3</sub>      (c) H<sub>3</sub>O<sup>+</sup>
20. (2 pts) Find the formal charge on the C atom in the Lewis structure :C≡O:
21. (6 pts)  $\Delta H^\circ = -6535 \text{ kJ}$  for the reaction  $2 \text{ C}_6\text{H}_6(l) + 15 \text{ O}_2(g) \rightarrow 12 \text{ CO}_2(g) + 6 \text{ H}_2\text{O}(l)$ .  
Find  $\Delta H_f^\circ$  of C<sub>6</sub>H<sub>6</sub>(l) given the following  $\Delta H_f^\circ$  values:  
-394 kJ/mol for CO<sub>2</sub>(g); -286 kJ/mol for H<sub>2</sub>O(l); 0 for O<sub>2</sub>(g).
22. (6 pts) The volume of 236.7 g of gas X at 45°C and 0.545 atm is 381 L. Find the molecular weight of gas X.
23. (4 pts) Find the energy of one photon of light whose wavelength is 400 nm. One nm = 10<sup>-9</sup> m.

24. (4 pts)  $\Delta H^\circ$  is  $-1204 \text{ kJ}$  at  $25^\circ\text{C}$  for the reaction



(a) Find the amount of heat transferred when  $16.5 \text{ g}$  of  $\text{Mg}$  reacts at  $25^\circ\text{C}$  and  $1 \text{ atm}$ .

(b) Does this heat flow to the surroundings or into the system?

25. (2 pts)  $\Delta H_f^\circ$  for  $\text{H}_2\text{O(l)}$  is the enthalpy change for a certain chemical reaction. Write this reaction. You must include  $s$ ,  $l$ ,  $g$  for the substances.

26. (1 pt) What is the main cause of the current increase in the amount of carbon dioxide in the earth's atmosphere?

27. (5 pts) The rotational energy levels of a certain molecule are given by the formula

$$E = K(K + 1)(3.50 \times 10^{-22} \text{ J})$$

where the quantum number  $K$  has the possible values  $K = 0, 1, 2, 3, 4, 5, \dots$

Find the frequency of light emitted when this molecule goes from the  $K = 4$  level to the  $K = 3$  level. Since this problem is not the hydrogen atom, do **NOT** use the energy-level formula for the H atom. (If you do, you will get no credit.)

Extra credit – Answers go in the exam booklet

EC1 (1 pt) List the three most abundant gases in dry air in order of decreasing abundance (most abundant listed first). (Dry air means that all water vapor has been removed.)

EC2 (1 pt) Give the last name of each scientist who had these middle names:

(a) Henrik David      (b) Karl Ernst Ludwig

Partial answers to Chem 1 second lecture test Fall 02

4. 300 J

15. 21.9 mL

16. 1.78 g

18. (a) 1705 J or 1.7 kJ (b) 0.68 J/(g °C)

20. -1

21. 46 kJ/mol

22. 29.7 amu

23.  $4.97 \times 10^{-19}$  J

24. (a) 409 kJ (b) to surroundings

27.  $4.22 \times 10^{12}$  s<sup>-1</sup>