Chemistry 6C: General Chemistry
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Sequence Number

University of California, San Diego
Spring 2007

6C Exam 2
120 pts

Name (Print): _____ **UCSD ID: _____**

TA: _____

INSTRUCTIONS

- **RECORD THE "A" IN YOUR ID NUMBER AS "1" ON THE SCANTRON**
- **MARK TEST VERSION IN "TEST FORM" FIELD ON SCANTRON**
- **PUT SEQUENCE NUMBER IN THE EXAM NUMBER FIELD!**
- **ALL MULTIPLE CHOICE ANSWERS MUST BE ON THE SCANTRON SHEET PROVIDED.**
- **TURN IN BOTH YOUR SCANTRON SHEET AND THIS EXAM AT THE END OF THE PERIOD.**
- **KEEP YOUR EXAM COVERED AT ALL TIMES.**
- **SCRATCH PAPER AND A PERIODIC TABLE/EQUATION SHEET ARE PROVIDED; A TABLE OF MASS MULTIPLES IS ON THE PERIODIC TABLE**
- **GRAPHING CALCULATORS ARE ALLOWED BUT MAY NOT BE SHARED. NO TEXT MAY BE STORED IN YOUR CALCULATOR. IF VIOLATED, FAILURE OF THIS EXAM WILL RESULT**
- **PAY ATTENTION TO THE MAGNITUDE OF YOUR UNITS**
- **SCANTRONS WILL NOT BE RETURNED**

The Sequence Number AT THE TOP OF THIS PAGE is to be bubbled in on your Scantron in the "EXAM NUMBER" field on the Scantron!

THE FINAL EXAM IS MONDAY, JUNE 11th FROM 11:30 AM-2:30 PM IN *LOCATIONS TO BE ANNOUNCED IN CLASS*. BRING YOUR UCSD ID;
REMEMBER:
NO ID = NO FINAL = YOU FAIL

PART 1: Written questions (point values as indicated). Answer the following questions and show all your work. Pay CLOSE attention to the instructions for each question. For all calculations that require N_A and R, please use 6.022 x 1023 and 8.314, respectively.

1. (a) (**10 pts**) Consider the following reaction:

$$2H_2(g) + 2NO(g) \rightleftharpoons N_2(g) + 2H_2O(g)$$

Given the following mechanism, what would the rate law be if Step 2 were the slow step? Be sure to show all the individual k_x's and be clear as to how you arrived at your answer! ***No credit will be given for unclear work!***

Mechanism I:

$H_2 + NO \underset{k_{S1}}{\overset{k_1}{\rightleftharpoons}} H_2O + N$ (Step 1)

$N + NO \underset{k_{S2}}{\overset{k_2}{\rightleftharpoons}} N_2 + O$ (Step 2)

$O + H_2 \underset{k_{S3}}{\overset{k_3}{\rightleftharpoons}} H_2O$ (Step 3)

(b) (**5 pts**) Two other <u>possible</u> mechanisms have been proposed for this reaction (*Mechanism II* OR *Mechanism III*). Given that the observed rate law is rate = $k_{obs}[H_2][NO]^2$.can either of these mechanisms be ruled out? Why or why not? Be clear as to how you arrived at your answer! ***<u>No credit will be given for unclear work!</u>***

Mechanism II: $H_2 + 2NO \xrightarrow{k_1} N_2O + H_2O$ (slow)

$N_2O + H_2 \xrightarrow{k_2} N_2 + H_2O$ (fast)

OR

Mechanism III: $2NO \underset{k_{š1}}{\overset{k_1}{\rightleftharpoons}} N_2O_2$ (fast equilibrium)

$N_2O_2 + H_2 \xrightarrow{k_2} N_2O + H_2O$ (slow)

$N_2O + H_2 \xrightarrow{k_3} N_2 + H_2O$ (fast)

2. (a) (**10 pts**) Palladium-107 undergoes β decay ($t_{1/2} = 6.5 \times 10^5$ yr) to form silver-107. How long will it take for 0.150 mol of silver-107 to form from 1.25 mol of palladium-107?

(b) (**5 pts**) If an original ore sample contained 1.000×10^{-19} mole of Pd-107, how long would it take until only 1000. atoms of Pd-107 remained? Your answer must be expressed to FOUR significant figures to be correct!

Part 2. HIGH POINT Multiple Choice Problems. **Points are as indicated. Choose the correct (or closest) answer and mark it in on your scantron**

Calcium (Z = 20) has 25 different isotopic forms; some of these are provided in the table below. ANSWER THE NEXT 4 QUESTIONS USING THE DATA BELOW

Nuclide	Isotopic Mass (amu)
Ca-39	38.970718
Ca-45	44.956186
Ca-47	46.954546
Ca-49	48.955673
Ca-50	49.95752

1. (10 pts) Calculate the binding energy of Ca-39 in MeV per nucleus

   a) 389.7 MeV b) 336.6 MeV c) 316.2 MeV d) 326.4 MeV

2. (10 pts) Which isotope, Ca-49 or Ca-45, is expected to be the MOST stable?

   a) Ca-49 b) Ca-45 c) they are of equal stability d) Not enough information

3. (10 pts) Which process, positron emission or beta decay, is a Ca-39 nucleus MOST likely to undergo?
   FYI: Sc-21 = 38.98479 amu and K-39 = 38.9637069 amu.

   a) positron emission b) beta decay c) both are equally likely d) neither will occur

4. (10 pts) Calcium-50 undergoes beta decay. Each beta particle carries 4.97 MeV of energy. How much energy will be emitted when 125 mg of calcium-50 decays?

   a. 1.20 kJ b. 1.20×10^{6} kJ c. 2.00×10^{-15} J
   d. 6.0×10^{13} J e. none of the above

5. (8 pts) A 7.85×10^{-5} mol sample of copper-61 emits 1.47×10^{19} positrons in 90.0 minutes. What is the decay constant for copper-61?

   a. 0.00230 h^{-1} b. 0.00346 h^{-1} c. 0.207 h^{-1} d. 0.311 h^{-1} e. none of the above

6. (8 pts) The decomposition of dinitrogen pentaoxide to nitrogen dioxide and oxygen follows first-order kinetics and has an activation energy of 102 kJ/mol. By what factor will the fraction of collisions with energy greater than or equal to the activation energy increase if the reaction temperature goes from 30°C to 60°C?

   a. 1.00 b. 1.10 c. 2.00 d. 4.00 e. 38.4

7. (8 pts) The decomposition of dinitrogen pentaoxide has an activation energy of 102 kJ/mol and $\Delta H°_{rxn}$ = + 55 kJ/mol. What is the activation energy for the reverse reaction?

   a. 27 kJ/mol b. 47 kJ/mol c. 55 kJ/mol d. 102 kJ/mol e. More information is needed.

Part 3. "Low Point" Multiple Choice Problems. **Select the best answer from the choices given and mark your answer on your scantron. Problems are all equal value (3 points).**

8. A certain transition element has the stable oxidation states of +2, +3, +5, and +6. In which state will the element be most likely to form an ionic bond with chlorine?

a. +2 b. +3 c. +4 d. +5 e. +6

9. The element whose deficiency has possible links to epilepsy is:

a. Ti b. V c. Cr d. Mn e. Co

10. The compound Fe_2O_3 (rust) is also known as:

a. Fool's Gold b. Venetian Red c. Glauber's Salt d. ilumenite e. Satan's Copper

11. Identify the missing species in the following nuclear transmutation.

$$^{246}_{96}\text{Cm} + {}^{12}_{6}\text{C} \rightarrow 4\ {}^{1}_{0}\text{n} + ?$$

a. $^{258}_{102}$No b. $^{254}_{102}$No c. $^{238}_{98}$Cf d. $^{238}_{90}$Th e. none of these is correct

12. Which of the following pairs do not have about the same atomic radius?

a) Au and Ag b) Co and Rh c) Mn and Re d) Cd and Hg e) Ru and Os

13. The average lifetime of an Mg-28 nucleus ($t_{1/2}$ = 21 h) is *approximately*:

a. 11 h b. 30 h c. 21 h d. 2 min e. none of these

14. Which of the following should be the strongest reducing agent?

a) Fe b) Ru c) Os d) Re e) Cu

15. Chromium and manganese are among the transitions elements that form several different oxides. Which of the following statements characterize these oxides?

a. As the oxidation number on the metal increases, the valence-state electronegativity increases and the oxides change from acidic to basic.
b. As the oxidation number on the metal increases, the valence-state electronegativity increases and the oxides change from basic to acidic.
c. As the oxidation number on the metal increases, the valence-state electronegativity decreases and the oxides change from acidic to basic.
d. As the oxidation number on the metal increases, the valence-state electronegativity decreases and the oxides change from basic to acidic.
e. None of the above statements is correct.

16. The radioactive isotope tritium decays with a first-order rate constant *k* of 0.056 year^{-1}. What fraction of the tritium initially in a sample is still present 30 years later?

a. 0.19 b. 0.60 c. 0.15 d. 2.8×10^{-38} e. none of the above

17. A catalyst accelerates a reaction because

a. it increases the number of molecules with energy equal to or greater than the activation energy.
b. it lowers the activation energy for the reaction.
c. it increases the number of collisions between molecules.
d. it increases the temperature of the molecules in the reaction.
e. it supplies energy to reactant molecules.

18. This is Version A. Mark "A" as the answer to this question ***and*** in the "TEST FORM" box on your scantron (below ID number): (3 points ONLY if you do ***BOTH***)

VERSION A = a