

# CHEM 102, SPRING 2010

## 2<sup>nd</sup> Examination (1 hr 40 min)

DO NOT BEGIN TO WORK ON THE EXAMINATION UNTIL  
THE PROCTOR TELLS YOU TO DO SO!

**INSTRUCTIONS:** Before you begin the examination, please fill-in the identification information requested on the answer sheet. **You must use a No. 2 pencil** to fill in this information. In the STUDENT ENROLLMENT SHEET section of the form, fill in the I.D. NUMBER (your person number, format = 12345678--, *i.e.*, left adjusted with one blank space on the right), NAME (your last name, first name, M.I.), and CODE (your recitation section code, format = 01) fields. Be sure to fill in the correct circles completely. Your examination score cannot be credited to the correct person if the computer cannot read the *bubbled in* information. In the SCORE SHEET section of the form, sign your name on the line for NAME on side 1.



For each question you are to fill in the circle on the answer sheet that corresponds to the BEST answer. Make sure the answer number used is the same as the question number! **Use a No. 2 pencil; make heavy marks that fill-in the circle;** erase completely any answer you wish to change. Questions with more than one answer marked will be graded as incorrect. Each question is worth 4 points. (TOTAL = 100) **The only answers that will be accepted are those which appear on the bubble sheet.**

Check that you have a complete examination (12 pages – including Formula Sheet & Periodic Table). Please place your name on the top of every page. Do not leave any answers blank. Do not make any stray marks on the answer sheet! Use the space between the problems on the examination pages for your scratch work. Raise your hand if you have a question or need a pencil.

PLEASE READ AND SIGN THE ACADEMIC HONESTY STATEMENT BELOW.

I hereby certify that the answers given represent my own unaided work.

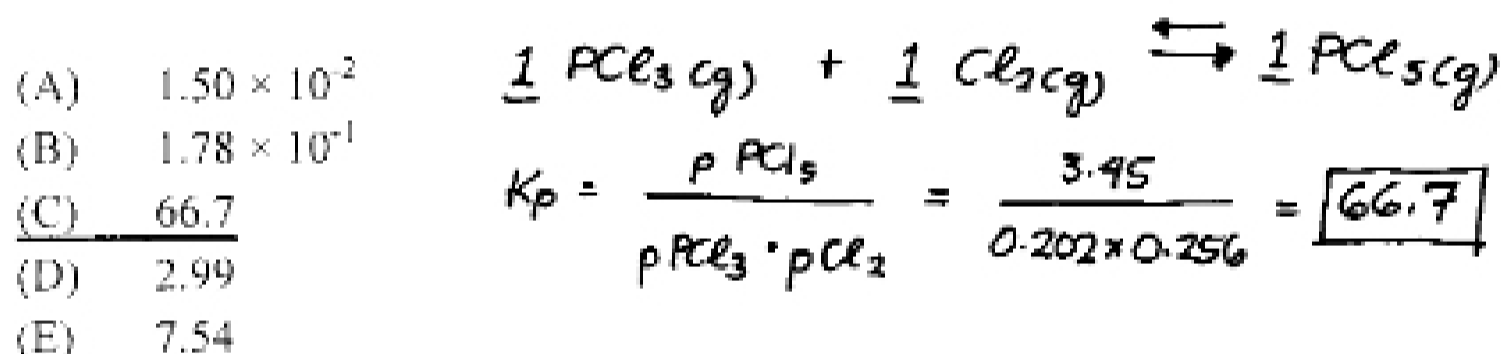
Signed \_\_\_\_\_ Key #1 \_\_\_\_\_ Person Number \_\_\_\_\_

Printed Name \_\_\_\_\_ Recitation Section Code \_\_\_\_\_  
*first last*

Name \_\_\_\_\_

**Instructions:** Mark the **BEST** answer (A - E) to each of the questions below on the separate answer sheet provided.

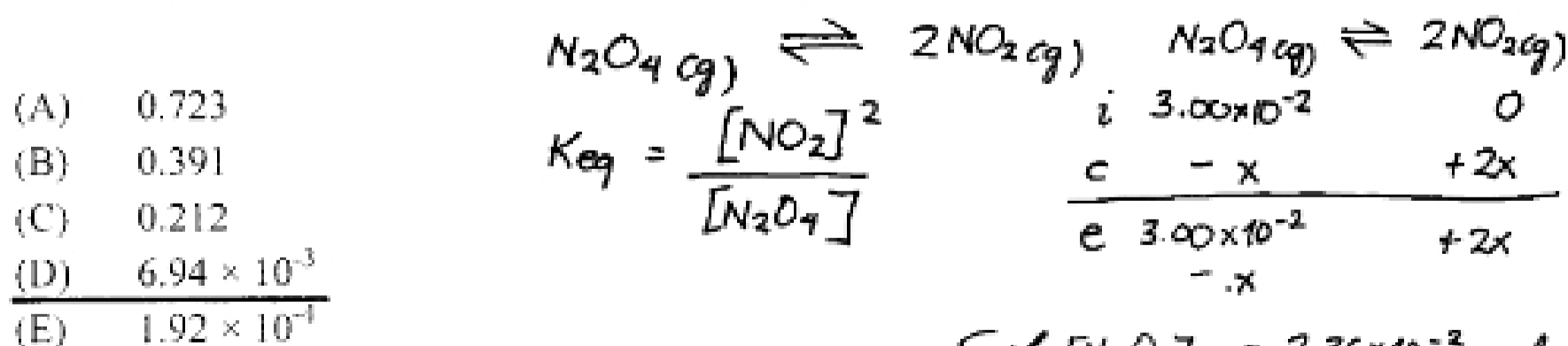
1. Which of the following statements accurately describes **equilibrium**?
- (A) All chemical reactions have ceased  
 (B) The rates of forward and reverse reactions are equal  
 (C) The rate constants of forward and reverse reactions are equal  
 (D) The value of the reaction quotient (Q) is 1  
 (E) The limiting reagent has been consumed
2. Phosphorus trichloride and phosphorus pentachloride equilibrate in the presence of chlorine:  $\text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons \text{PCl}_5(\text{g})$ . At equilibrium, the pressures of the individual species are as follows: 0.202 atm for  $\text{PCl}_3(\text{g})$ , 3.45 atm for  $\text{PCl}_5(\text{g})$  and 0.256 atm for  $\text{Cl}_2(\text{g})$ . What is the value of  $K_p$  for this reaction?



3. Dinitrogen tetroxide ( $\text{N}_2\text{O}_4$ ) dissociates via the reaction:  $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ .  $3.00 \times 10^{-2}$  mol  $\text{N}_2\text{O}_4(\text{g})$  is introduced into a 1.000L flask.

At equilibrium,  $2.36 \times 10^{-2}$  mol  $\text{N}_2\text{O}_4(\text{g})$  remains.

What is the equilibrium constant for this reaction?



$$K_{eq} = \frac{1.638 \times 10^{-9}}{2.36 \times 10^{-2}}$$

$$\boxed{K_{eq} = 6.94 \times 10^{-3}}$$

$$\left\{ \begin{array}{l} \checkmark [\text{N}_2\text{O}_4]_{eq} = 2.36 \times 10^{-2} \text{ mol} \\ x = 3.00 \times 10^{-2} - 2.36 \times 10^{-2} \text{ mol} \\ x = 6.4 \times 10^{-3} \\ \checkmark [\text{NO}_2]_{eq}^2 = (2x)^2 \\ = 1.638 \times 10^{-9} \end{array} \right.$$

4. Consider the equation:  $\text{Ti (s)} + 2\text{Cl}_2 \text{ (g)} \rightleftharpoons \text{TiCl}_4 \text{ (l)}$ . Which of the answers below gives the correct expression for the equilibrium constant for this reaction?

- (A)  $\frac{[\text{TiCl}_4 \text{ (l)}]}{[\text{Ti (s)}][\text{Cl}_2 \text{ (g)}]^2}$  }  $\times$  *l and s states should not be included*
- (B)  $\frac{[\text{Ti (s)}][\text{Cl}_2 \text{ (g)}]^2}{[\text{TiCl}_4 \text{ (l)}]}$  }
- (C)  $\frac{[\text{TiCl}_4 \text{ (l)}]}{[\text{Cl}_2 \text{ (g)}]^2}$  }
- (D)  $\frac{1}{[\text{Cl}_2 \text{ (g)}]^2}$
- (E)  $\frac{[\text{TiCl}_4 \text{ (l)}]}{[\text{Ti (s)}][\text{Cl}_2 \text{ (g)}]}$  }  $\times$  *l and s states should not be included*

5. Consider the exothermic reaction:  $2\text{SO}_2 \text{ (g)} + \text{O}_2 \text{ (g)} \rightleftharpoons 2\text{SO}_3 \text{ (g)}$ .  
Le Chatelier's Principle predicts an increase in the number of moles of  $\text{SO}_3 \text{ (g)}$  for which of the following changes?

- (A) Increasing the pressure
- (B) Decreasing the pressure  $\times$
- (C) Increasing the temperature  $\rightarrow$  ENDO OR EXO?
- (D) Removing some oxygen  $\rightarrow$  TO REACTANT SIDE
- (E) Increasing the volume of the container  $\equiv$  DECREASE THE PRESSURE
- $$\underbrace{2\text{SO}_2 \text{ (g)} + \text{O}_2 \text{ (g)}}_{3 \text{ moles}} \rightleftharpoons \underbrace{2\text{SO}_3}_{2 \text{ moles}}$$
- $\checkmark$  less # of gas moles  
 $\checkmark$   $\uparrow P$  will be accommodated at this side

6. Consider the reaction:  $\text{XeF}_2 \text{ (g)} + \text{F}_2 \text{ (g)} \rightleftharpoons \text{XeF}_4 \text{ (g)}$ . For which of these starting combinations is it impossible to establish the equilibrium condition for the reaction above?

- (A) 0.25 mol  $\text{XeF}_2 \text{ (g)}$  and 0.25 mol  $\text{F}_2 \text{ (gas)}$   $\rightarrow$  both reactants present  $\checkmark$
- (B) 0.25 mol  $\text{XeF}_2 \text{ (g)}$   $\rightarrow$  needs  $\text{F}_2$  to equilibrate with  $\text{XeF}_4$ !
- (C) 0.25 mol  $\text{XeF}_2 \text{ (g)}$  and 0.25 mol  $\text{XeF}_4 \text{ (g)}$   $\rightarrow$  1 reactant + 1 product  $\checkmark$
- (D) 0.25 mol  $\text{XeF}_4 \text{ (g)}$   $\rightarrow$  product (the only product!)  $\checkmark$
- (E) 0.25 mol  $\text{XeF}_4 \text{ (g)}$  and 0.25 mol  $\text{F}_2 \text{ (gas)}$   $\rightarrow$  1 reactant + the product  $\checkmark$