DAWSON COLLEGE

DEPARTMENT OF CHEMISTRY
and LABORATORY TECHNOLOGY
Chemistry of Solutions : 202-SN2-RE

Name: _____ _____
first (print) family (print)

Test no 2
Tuesday, April 21, 2026
Room: 4H.12, 12:00 h

PLEASE turn off your cell phone

Instructions:

1. The duration of the exam is 75 minutes.
2. No extra books or paper may be used.
3. Make sure that there are no pages missing: total of 8 pages.
4. A Periodic Table of the Elements with constants has been provided.
5. Answers must be submitted in ink in order to preserve the right to grieve.
6. In order to receive full credit for your answer, your work must be shown.
7. Calculators may not be shared. Programmable calculators are not allowed.
8. Your attention is drawn to the college policy on cheating. This policy will be enforced.
9. Check you numbers twice. A calculator never does mistake, it just calculate the numbers input by the operator. If the number of digits is insufficient throughout the calculation, which gives a result different from the expected one, it will be considered as a calculation error.

For each math error or bad number transcript: −1 mark.

for questions involving calculations, write your final answer in ink in the appropriate space

Question 1 :	/ 6	Question 4 :	/ 4	Question 7 :	/ 7
Question 2 :	/ 7	Question 5 :	/ 8	Question 8 :	/ 5
Question 3 :	/ 6	Question 6 :	/ 7		

Total : / 50

Note: All pH problem of this exam are at 25 °C therefore, consider $K_w = 1.00 \times 10^{-14}$

Question 1

a. Calculate the equilibrium constant for: $2H_2O(g) \rightleftharpoons O_2(g) + 2H_2(g)$ at 25 °C using the following two equilibrium. (3 marks)

$2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$ $\quad K = 1.0 \times 10^4$

$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$ $\quad K = 4.0$

answer: _____

. . . . . .

Match each of the following "equilibrium condition" for a system, with one of the available answers. *(note: the same answer can be used more than once)* (3 marks)

Equilibrium condition		Possible answer	
b.	$Q < K$	i)	Reaction is at equilibrium.
c.	$K \approx 1$	ii)	Reaction will favour formation of reactants
d.	$Q = K$	iii)	Reaction favours formation of more product
		iv)	Reaction does not strongly favour reactants or products

answers: b. _____ c. _____ d. _____

Question 2

Consider the following equilibrium for the production of hydrogen gas from water:

$$H_2O(g) + C(s) \rightleftharpoons H_2(g) + CO(g) \qquad \Delta H = 328 \text{ kJ/mol}, \quad K_c = 0.013 \text{ at } T = 500.0 \text{ °C}.$$

100.0 g of water and 50.0 g of solid carbon are heated together (to 500.0 °C) in a 10.0 L container; calculate the mass of hydrogen gas produced once the equilibrium is reached. (4 marks)

answer: _____

. . . . . .

g. What is the K_p value for this reaction at 500.0 °C? (3 marks)

answer: _____

Question 3

Consider the same reaction as the one of the previous problem (T = 500 °C, K_c = 77): (6 marks)

$$H_2O(g) + C(s) \rightleftharpoons H_2(g) + CO(g) \qquad \Delta H = 328 \text{ kJ/mol}, \quad K_c = 0.013 \text{ at } T = 500.0 \text{ °C}.$$

Predict qualitatively the change of concentration of CO(g) after the following changes of conditions.

		CO(g) amount (number of mole)		
		decreases	no change	increases
a.	$CO_2(g)$ is added to increase the pressure	☐	☐	☐
b.	Some $H_2O(g)$ condenses to form $H_2O(\ell)$	☐	☐	☐
c.	Increasing the size of the container	☐	☐	☐
d.	the reaction is heated	☐	☐	☐
e.	removing some C(s) from the reaction mixture	☐	☐	☐
f.	A catalyst is added	☐	☐	☐

Question 4

a. Which of the following strong acid aqueous solution has a pH of 2.22 (1 mark)

i) 0.25 g HI (130.6 g/ml) dissolved in 250 mL water

ii) 25 mL of 0.036 M HNO_3 added to 125 mL water

iii) 0.0050 mol of $HClO_4$ dissolved in 750 mL water

iv) none of the above

answer: _____

. . . . . .

b. What mass of KOH is necessary to prepare 750.0 mL of a solution having pH = 12.22? (3 marks)

answer: _____

Question 5

a. Ephedrine, a central nervous system stimulant, is used in nasal sprays as a decongestant. This compound is a weak organic base:

$$C_{10}H_{15}ON(aq) + H_2O(l) \rightleftharpoons C_{10}H_{15}ONH^+(aq) + OH^-(aq)$$

A 0.0350 M solution of ephedrine has a pH of 11.33. Calculate K_b for ephedrine. (4 marks)

answer: _____ (correct answer with 2 s.f.)

. . . . . .

b. Consider a mixture of 0.0100 M HCℓ and 0.255 M acetic acid, HCH_3COO. Calculate the concentration of the acetate ion(CH_3COO^-) in this solution at equilibrium. (4 marks)

answer: _____

Question 6

a. Order the following acids from the weakest to the strongest: $HClO$, NH_4^+ , $HClO_4$ (1 mark)

_____ < _____ < _____
weakest strongest

b. Order the following bases from the weakest to the strongest: NO_3^- , NH_3 , C_5H_5N (1 mark)

_____ < _____ < _____
weakest strongest

c. Order the following salts from the most basic to the most acidic: KCN , KF , $FeCl_3$

(1 mark)

_____ _____ _____
most basic most acidic

(Only 3 good positions will be taken into account; no partial marks)

. . . . . .

Predict whether an aqueous solution of each of the following is acidic, basic or neutral: (4 mark)

		acid	neutral	basic
i	$LiNO_3$	☐	☐	☐
ii.	NH_4CH_3COO	☐	☐	☐
v.	N_2H_4	☐	☐	☐
vi.	KC_6H_5O	☐	☐	☐

Question 7

a. A buffer solution is made from the mixture of 225 mL of 0.850 M formic acid (HCOOH) with 0.500 L of a solution of sodium formate (NaCOOH). If the pH of this buffer is 3.33, calculate the sodium formate concentration in this mixture. (4 marks)

answer: _____

. . . . . .

b. You want to make a buffer by adding NaOH to a weak acid. Which of the following weak acid is most suitable for preparing a buffer solution with pH = 4? (Circle one, use data sheet) (1 mark)

i. Hydrocyanic acid
ii. Hypochlorous acid
iii. Formic acid
iv. Nitrous acid

. . . . . .

c. Which combination of equal volumes of chemicals **will not** make a buffer (circle one) (1 mark)

i. 0.25 M KF + 0.50 M HF
ii. 0.25 M KOH + 0.50 M HCN
iii. 0.50 M $HClO_4$ + 0.25 M $KClO_4$
iv. 0.50 M HClO + 0.25 M $Ba(ClO)_2$

. . . . . .

c. Which combination of equal volumes of chemicals **will make** a buffer (circle one) (1 mark)

i. 0.5 M HClO + 0.5 M HCl
ii. 0.5 M KOH + 0.5 M HCN
iii. 0.5 M $Ba(NO_2)_2$ + 1.0 M HNO_2
iv. 0.5 M KCN + 0.5 M KBr

Question 8

Calculate the pH of the buffer obtained from the reaction of 55.0 mL of 0.0470 mol/L HCl with 245 mL of 0.0264 mol/L CH_3NH_2 (methylamine, $K_b = 4.40 \times 10^{-4}$) (5 marks)

answer: _____ (correct with 3 s.f. after the dot)