

JUNE 2023
CHE 208SW
PHYSICAL CHEMISTRY II
2 HOURS

Candidate's Index Number
Signature:

UNIVERSITY OF CAPE COAST
COLLEGE OF EDUCATION STUDIES
SCHOOL OF EDUCATIONAL DEVELOPMENT AND OUTREACH
INSTITUTE OF EDUCATION

FIVE-SEMESTER BACHELOR OF EDUCATION (SANDWICH) PROGRAMME
LEVEL 400, END-OF-FIRST SEMESTER EXAMINATIONS, JUNE 2023

21ST JUNE 2023

PHYSICAL CHEMISTRY II

2:00 PM - 2:30 PM

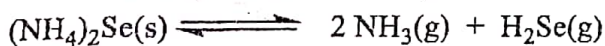
This paper consists of two sections, A and B. Answer ALL the questions in Section A and TWO questions from Section B. Section A will be collected after the first 30 minutes.

SECTION A
(20 MARKS)

Answer ALL the questions in this Section.

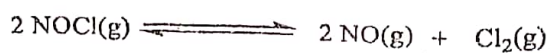
For items 1 to 18, each stem is followed by four options lettered A to D. Read each item carefully and circle the letter of the correct or best option.

1. What is the pH of a solution prepared by dissolving 0.32 g HCl in 100 mL of solution?
A. 2.4
B. 4.1
C. 5.4
D. 6.7
2. The relationship between K_b and pK_b of a weak base is that
A. $pK_b = \log K_b$
B. the higher the K_b , the lower the pK_b
C. the lower the K_b , the higher the pK_b
D. they are the same.
3. What is the expression for the K_p of the following reaction?



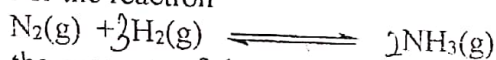
- A. $K_p = \frac{(P_{NH_3})^2 \cdot P_{H_2Se}}{P_{(NH_4)_2Se}}$
B. $K_p = \frac{[NH_3]^2 \cdot [H_2Se]}{[(NH_4)_2Se]^2}$
C. $K_p = (P_{NH_3})^2 \cdot P_{H_2Se}$
D. $K_p = P_{NH_3} \cdot P_{H_2Se}$

4. The reaction for the decomposition of nitrosyl chloride is given as



What will be the direction of equilibrium when the temperature is increased?

- A. Equal amount of both products and reactants will be formed.
~~B.~~ More NO and Cl₂ will be formed.
 C/ More NOCl will be formed.
 D. There will be no effect on the equilibrium constant.
5. What is the pH of a buffer solution prepared from 0.65 M NH₃(aq) and 0.25 M NH₄Cl(aq) (Given K_b = 1.8 × 10⁻⁵).
- A. 3.52
~~B.~~ 5.16
 C. 8.84
 D. 10.48
6. The pH of rainwater collected from a certain town in the Greater Accra region was found to be 3.10. Calculate the OH⁺ ion concentration in the rainwater.
- ~~A.~~ 1.3 × 10⁻¹¹ M.
 B. 5.3 × 10⁻⁵ M.
 C. 9.4 × 10⁻³ M
 D. 2.3 × 10⁻² M
7. For the reaction



the amounts of the species were found to be; 0.225 mol N₂(g), 0.03 mol H₂(g) and 0.112 mol NH₃(g) in a 2.5 L container. Calculate Q_c for this equilibrium reaction.

- A. 2064.86
~~B.~~ 12905.53
 C. 1403.27
 D. 32351.99
8. The K_a of HCOOH is 1.7 × 10⁻⁴. Calculate the pH of a methanoic acid solution containing 0.0042 M HCOO⁻ ions
- A. 2.4
~~B.~~ 3.8
 C. 5.3
 D. 7.5
- pc = \sqrt{K_a c} = \sqrt{1.7 \times 10^{-4}}*

9. Given the following compounds and their respective acid dissociation constants, choose the strongest acid.

Compound	K _a
H ₂ C ₂ O ₄	6.5 × 10 ⁻²
H ₂ SO ₃	1.3 × 10 ⁻²
H ₂ CO ₃	4.2 × 10 ⁻⁷
H ₃ PO ₄	7.5 × 10 ⁻³

- A. H₃PO₄
 B. H₂SO₃
 C. H₂CO₃
~~D.~~ H₂C₂O₄

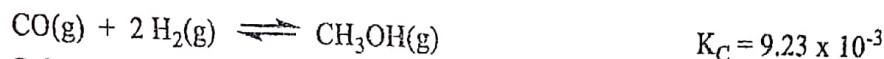
10. What is the pOH of a solution if the $[\text{OH}^-] = 0.003 \text{ M}$?

- A. 11.5
- B. 8.4
- C. 7.0
- D. 2.5

11. Which of the following species of oxalic acid ($\text{C}_2\text{H}_2\text{O}_4$) can act as both an acid and a base?

- A. $\text{C}_2\text{H}_2\text{O}_4$ and HC_2O_4^-
- B. HC_2O_4^- only
- C. $\text{C}_2\text{O}_4^{2-}$ only
- D. $\text{C}_2\text{H}_2\text{O}_4$ only

12. The equilibrium constant, K_c , for the formation of methanol from carbon monoxide and hydrogen gas is given as



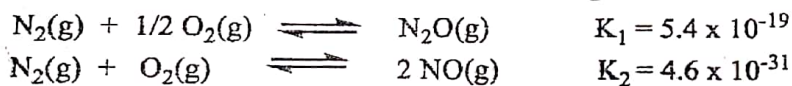
Calculate K_p for this process at 400 K.

- A. 1.03×10^{-3}
- B. 9.23×10^{-3}
- C. 8.6×10^{-6}
- D. 2.41×10^{12}

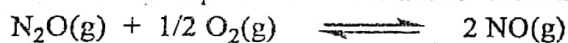
13. A species which produces hydroxonium ions in solution is likely to be a(n)

- A. Arrhenius acid.
- B. Bronsted base.
- C. Lewis' acid.
- D. Lewis' base.

14. Given the equilibrium constants for the following reactions

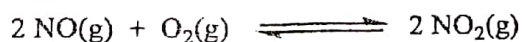


Determine the equilibrium constant for the reaction



- A. 8.52×10^{-13}
- B. 5.0×10^{-25}
- C. 4.12×10^{-30}
- D. 2.28×10^{-49}

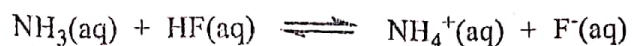
15. The following equilibrium reaction was found to occur at 300°C



If the concentration of the species are found to be $[\text{NO}] = 0.45 \text{ M}$, $[\text{O}_2] = 0.61 \text{ M}$ and $[\text{NO}_2] = 1.5 \text{ M}$. calculate the equilibrium constant (K_c) for the reaction at 300°C

- A. 5.5×10^{-2}
- B. 1.8×10^1
- C. 4.5×10^2
- D. 9.3×10^3

16. For the reaction



What is the conjugate base of $\text{NH}_4^+(\text{aq})$?

- A. $\text{NH}_3(\text{aq})$
- B. $\text{NH}_4^+(\text{aq})$
- C. $\text{F}^-(\text{aq})$
- D. None of the above

17. For the equilibrium reaction



The equilibrium constant (K_p) was found to be 1.4×10^{83} at 298 K. What could account for this high K_p value?

- A. $\text{H}_2\text{O}(\text{l})$ is thermodynamically more stable than $\text{H}_2(\text{g})$ and $\text{O}_2(\text{g})$ at 298 K.
- B. The K_p value increases with temperature.
- C. The rate of decomposition of $\text{H}_2\text{O}(\text{l})$ is highly favourable at 298 K.
- D. Water is more stable as a liquid than a gas at 298 K.

18. Identify the acid-base conjugate pair in the following species; H_2PO_4^- , NH_3 , HPO_4^{2-} , NH_4^+

- A. H_2PO_4^- - NH_3
- B. $\text{H}_2\text{PO}_4^{2-}$ - HPO_4^-
- C. HPO_4^- - H_2PO_4^-
- D. NH_4^+ - NH_3

Items 19 and 20 are statements followed by True and False options. Read each statement carefully and indicate whether it is True or False by circling the letter of the correct option.

19. Sulfuric acid (H_2SO_4) is a strong diprotic acid. Its first acid dissociation constant is always greater than the second acid dissociation constant.

- A. True
- B. False

20. If the K_c of an equilibrium reaction is greater than one, it means the reaction is spontaneous in only one direction.

- A. True
- B. False