

Before doing anything, fill in the following on your ParSCORE form:

- 1) Write your name
- 2) Bubble in **FORM A**
- 3) Bubble in your **PERM** number (7 digits only—no extra numbers)

Instructions: No hats or hoods allowed. No books or notes allowed. No sharing of calculators. Cell phones, iPods, headsets/headphones, and any other electronic devices must be turned off and put away.

There are a total of seven pages (18 questions) on the exam. **Not every question is worth the same number of points--** point values are indicated for each question.

You may work out the problems and write your answers on this exam; however, you must completely fill in the appropriate bubble(s) on your ParSCORE form. Turn in the ParSCORE form only. **Only the answers indicated on your ParSCORE will be graded**, so please be very careful bubbling in your ParSCORE. No credit will be awarded for an incorrectly-bubbled answer. The correct answers to the exam will be posted on our course web page.

1. (5 pts) Determine the major species in a solution prepared by mixing 15 mL of 1.0 M HCl with 25 mL of 1.0 M NH_3 .
 - a) HCl , NH_3 , H_2O
 - b) H^+ , Cl^- , NH_4^+ , H_2O
 - c) NH_4^+ , Cl^- , H_2O
 - d) NH_4^+ , NH_3 , H_2O
 - e) NH_4^+ , Cl^- , NH_3 , H_2O

2. (5 pts) The pK_b of a weak base A^- is 5.63 at 25°C . What can be said about the conjugate acid HA ?
 - a) HA is a stronger acid than CH_3COOH
 - b) HA is a weaker acid than HCN
 - c) HA is a stronger acid than H_2CO_3
 - d) HA is a weaker acid than H_2S
 - e) More than one of these are true

3. (5 pts) For a particular reaction, decreasing temperature (at a constant volume) increases the value of K. We can therefore conclude that _____

- a) the reaction must be exothermic
- b) the reaction must be endothermic
- c) the number of moles of gas must increase in the reaction
- d) the number of moles of gas must decrease in the reaction
- e) more than one of these

4. (5 pts) Consider the following reaction: $\text{CaCO}_3(\text{s}) \rightleftharpoons \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$

At equilibrium at a given temperature, $P_{\text{CO}_2} = 1.5 \text{ atm}$. The volume of the container is then doubled at constant temperature. Which of the following will be true when equilibrium is re-established? Assume the solids occupy negligible volume.

- a) $P_{\text{CO}_2} > 1.5 \text{ atm}$
- b) $P_{\text{CO}_2} < 1.5 \text{ atm}$
- c) $P_{\text{CO}_2} = 1.5 \text{ atm}$

5. (5 pts) Determine K for the following reaction at 25°C: $\text{NH}_4^+ + \text{OH}^- \rightleftharpoons \text{NH}_3 + \text{H}_2\text{O}$

- a) 5.6×10^{-10}
- b) 1.8×10^9
- c) 1.8×10^{-5}
- d) 1.0×10^{-14}
- e) 5.6×10^4

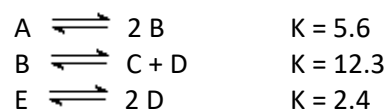
6. (5 pts) Write the net ionic equation for the neutralization of HClO with KOH.

- a) $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$
- b) $\text{H}^+ + \text{ClO}^- + \text{K}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O} + \text{K}^+ + \text{ClO}^-$
- c) $\text{HClO} + \text{OH}^- \rightarrow \text{H}_2\text{O} + \text{ClO}^-$
- d) $\text{HClO} + \text{KOH} \rightarrow \text{H}_2\text{O} + \text{KClO}$
- e) $\text{H}^+ + \text{KOH} \rightarrow \text{H}_2\text{O} + \text{K}^+$

7. (5 pts) At 25°C, a 1.0 M aqueous solution of NH_4ClO will be

- a) Acidic
- b) Basic
- c) Neutral

8. (5 pts) Consider the following information:



Determine K for the reaction $\text{A} \rightleftharpoons 2 \text{ C} + \text{E}$

- a) 27.8
- b) 165
- c) 28.7
- d) 353
- e) 0.0888

9. (6 pts) A 2.30 gram sample of KOH is added to enough water to make 2.50 L of solution. What is the pH of this solution at 25°C?

- a) 1.79
- b) 12.6
- c) 12.2
- d) 1.39
- e) 11.6

10. (6 pts) Consider the following reaction: $\text{C (s)} + \text{O}_2 \text{ (g)} \rightleftharpoons \text{CO}_2 \text{ (g)}$

At 300K, the equilibrium constant K for this reaction is 32. Calculate K_p for the reaction at 300K.

- a) 788
- b) 1.3
- c) 32
- d) 1.9×10^4
- e) 5.3×10^{-2}

11. (6 pts) Calculate the mass of solid NH_4NO_3 (80.0 g/mol) that should be added to 350 mL of 0.55 M NH_3 in order to prepare a buffer with a pH of 8.66 at 25°C. Assume no volume change upon addition of the solid.

- a) 60 g
- b) 171 g
- c) 0.75 g
- d) 4.0 g
- e) 11 g

12. (6 pts) What combination of substances will give a solution buffered at a pH of 3.50 (at 25°C)?

- a) 1.26 M HNO_2 and 1.00 M NaNO_2
- b) 1.00 M HNO_2 and 1.26 M NaNO_2
- c) 1.00 M NaHCO_3 and 0.661 M Na_2CO_3
- d) 0.661 M NaHCO_3 and 1.00 M Na_2CO_3
- e) 3.16×10^{-4} M HCl and 3.16×10^{-4} M NaCl

13. (6 pts) The molar solubility of Ca(OH)_2 in 0.010 M KOH is 1.0×10^{-5} mol/L. What is the K_{sp} of Ca(OH)_2 ?

- a) 1.0×10^{-9}
- b) 4.0×10^{-15}
- c) 1.0×10^{-10}
- d) 1.0×10^{-2}
- e) 1.0×10^{-12}

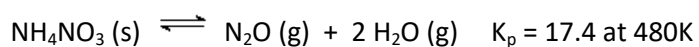
14. (6 pts) The pH of a 0.36 M solution of a weak acid is 4.3 at 25°C. Determine the percent dissociation of the weak acid in this solution at 25°C.

- a) 100%
- b) 0%
- c) 8.4%
- d) 0.014%
- e) 0.38%

15. (6 pts) A 50 mL sample of 1.0 M HCOOH is mixed with 50 mL of 1.0 M NaOH. Calculate the pH of the resulting mixture at 25°C.

- a) 5.28
- b) 5.62
- c) 7.00
- d) 8.72
- e) 8.38

16. (6 pts) Consider the following reaction for the decomposition of ammonium nitrate at 480K:



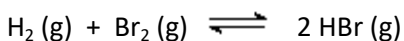
Calculate the maximum mass of NH_4NO_3 (80.0 g/mol) that can completely decompose in a 7.0 L container at 480K. Assume the solid occupies a negligible volume.

- a) 29.2 g
- b) 131 g
- c) 36.8 g
- d) 247 g
- e) 23.2 g

17. (6 pts) In an aqueous solution of NH_3 at 25°C , the equilibrium concentration of H^+ is $4.3 \times 10^{-12} \text{ M}$. Calculate the initial concentration of NH_3 used in preparing this solution.

- a) $3.3 \times 10^{-14} \text{ M}$
- b) 0.30 M
- c) 0.87 M
- d) 130 M
- e) 2.6 M

18. (6 pts) For the reaction below at a certain temperature, it is found that the equilibrium concentrations in a 10 L rigid container are $[\text{H}_2] = 3.0 \text{ M}$, $[\text{Br}_2] = 1.5 \text{ M}$, and $[\text{HBr}] = 2.5 \text{ M}$.



If 15 moles of Br_2 are added to this equilibrium mixture (assume constant volume and temperature), what will be the concentration of Br_2 when equilibrium is re-established?

- a) 0.33 M
- b) 2.7 M
- c) 3.3 M
- d) 0.66 M
- e) 3.0 M

Answers:	1) E	2) D	3) A	4) C	5) E	6) C
	7) B	8) D	9) C	10) C	11) A	12) B
	13) A	14) D	15) D	16) E	17) B	18) B