

CHEMISTRY 104  
Hour Exam II  
Summer 2023

Name \_\_\_\_\_

Net ID \_\_\_\_\_

### Free Response Questions

|                 |           |      |
|-----------------|-----------|------|
| <b>GRADING:</b> | TF _____  | (10) |
|                 | MC _____  | (69) |
|                 | 34. _____ | (12) |
|                 | 35. _____ | (6)  |
|                 | 36. _____ | (10) |
|                 | 37. _____ | (10) |
|                 | 38. _____ | (9)  |
|                 | 39. _____ | (6)  |
|                 | 40. _____ | (12) |
|                 | 41. _____ | (6)  |

Total \_\_\_\_\_ **150**

Please show all steps or logic on the free response questions so partial credit can be awarded.

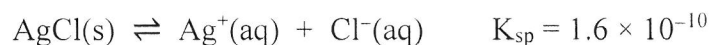
**WRITTEN OUT PROBLEMS – Show all work for partial credit.**

34. Consider a standard cell based on the following half-reactions:  
**12 pts.**



- a) Draw this cell under **standard** conditions labeling the anode, the cathode, the direction of electron flow, the concentrations of ions, the electrodes, and the direction of flow of cations and anions through the salt bridge.

- b) 1.0 M HCl is added to the silver compartment of the standard cell constructed above. The  $\text{Cl}^-$  reacts with some of the  $\text{Ag}^+$  present to produce  $\text{AgCl(s)}$ . After all the precipitate has formed, the  $[\text{Cl}^-]_e = 1.0 \text{ M}$ . Given:



calculate the cell potential,  $E$ , at  $25^\circ\text{C}$ . Note: the same anode and cathode reactions occur as in the standard cell.

35. Consider the electrolysis of a molten metal chloride having the general formula  $MCl_2$ . A current of 5.00 amps is applied for 748 seconds. This results in 0.471 g of the metal M plating out at the cathode. Identify the metal M.

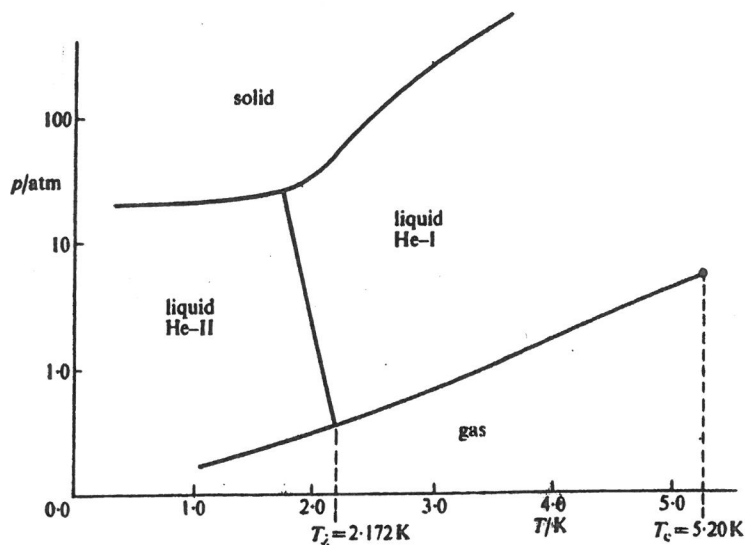
**6 pts.**

36. There are 9 structural isomers having the  $C_7H_{16}$  formula. Name the structural isomers of  $C_7H_{16}$  that have a base name of pentane.

**10 pts.**

37. The phase diagram for helium shows four phases: solid, gas, and two liquid phases (I and II). Using the phase diagram for helium given below, answer the following questions. The phase diagram is plotted P (in atm) vs. T (in K)

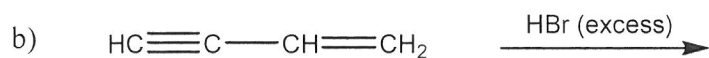
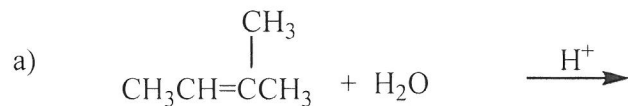
10 pts.



- Circle the triple point(s) on the phase diagram.
- Place the four phases in order of increasing density (smallest to largest).
- What is the approximate normal boiling point for helium?
- A sample of helium is heated at a constant pressure of 10 atm from 1 K to 273 K. What phase changes will occur when the helium is heated? Note: 5.20 K is the critical temperature.
- Can helium at 3.0 K sublime? Explain.

38. Write the structural formula for the major organic product in each of the following chemical reactions.

9 pts.



c) Name the major product in part b.

39. When HCl is reacted with 1-methyl-1-cyclopentene, two products are obtained. Propose a detailed mechanism for the major product formed from this reaction. Explain why the major product is preferred over the minor product.

6 pts.

40. a) How does MO theory explain that  $H_2$  is stable while  $He_2$  is not stable?  
**12 pts.**

b) How does MO theory explain that the  $H_2$  molecule has a larger ionization energy than an H atom?

c) How does MO theory explain that  $NO^+$  is more stable than  $NO^-$ ?

41. Give a detailed explanation of the bonding in benzene,  $C_6H_6$ . In your explanation, indicate the orbitals that overlap to form the various bonds and the type of bond formed ( $\sigma$  or  $\pi$ ). Why are the carbon-carbon bonds in the ring equivalent in length and in strength?

**6 pts.**