

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

CHEMISTRY DEPARTMENT

CHEM 102-111

MAJOR EXAM II

STUDENT NUMBER: _____

NAME : _____

SECTION NUMBER: _____

INSTRUCTIONS

1. Write your student number, name, and section number on the *EXAM COVER* page.
2. Write your student number, section number, and your name on your *EXAM ANSWER FORM*.
3. **Bubble in pencil** your student number and your section number on the *EXAM ANSWER FORM*.
4. **Bubble in pencil** on your *EXAM ANSWER FORM* the correct answer to each of the questions. .
You must not give more than *ONE* answer per question.
5. At the end of the exam return the *EXAM ANSWER FORM* to the proctor.
6. The exam contains **20 multiple choice questions** and the time allowed is **80 min (1 hrs and 20 min)**. Time will be announced after **40** minutes and again **10** minutes before the end of the exam.

Important constants

| | | |
|-----------------------------------|---------------------------|--|
| Gas Constant (R) | = 0.0821 | L.atm/(mol.K) |
| | = 8.314 | J/(mol.K) |
| | = 8.31×10^7 | g.cm ² /(sec ² .mol.K) |
| Planck's Constant (h) | = 6.626×10^{-34} | J.sec/particle |
| | = 6.626×10^{-34} | kg.m ² /(sec.particle) |
| Velocity of light (c) | = 2.998×10^8 | m/sec |
| Avogadro's number (N) | = 6.022×10^{23} | particles/mole |
| Bohr's Constant (R _H) | = 2.179×10^{-18} | J/particle |
| Faraday (F) | = 96485 | Coulombs |
| Specific heat of H ₂ O | = 4.18 | J/(g.°C) |

Name: _____ Date: _____

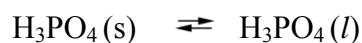
1. A 40.0-mL sample of 0.100 M HNO_2 is titrated with 0.200 M KOH. Calculate the pH after adding 5.00 mL of KOH (K_a for HNO_2 is 4.5×10^{-4})
 - A) 2.75
 - B) 3.75
 - C) 1.70
 - D) 3.95

2. When a strong acid is titrated with a strong base, the pH at the equivalence point is
 - A) greater than 7.0
 - B) equal to 7.0
 - C) equal to the $\text{p}K_a$ of the acid
 - D) equal to 3.5

3. The molar solubility of Ag_2SO_4 is 1.2×10^{-5} M. What is K_{sp} for this compound?
 - A) 1.7×10^{-15}
 - B) 1.4×10^{-10}
 - C) 6.9×10^{-15}
 - D) 2.9×10^{-19}

4. Methyl red is a common acid-base indicator. It has a K_a equal to 6.3×10^{-6} . Its un-ionized form is red and its anionic form is yellow. What color would a methyl red solution have at $\text{pH} = 7.8$?
 - A) Red
 - B) Blue
 - C) Green
 - D) Yellow

5. For the process,

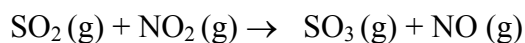


Use the following thermodynamic data to determine at what temperature this process reaches equilibrium at 1.0 atm.

| | | |
|------------------------------|-----------------------------------|-----------------------------------|
| Substance: | $\text{H}_3\text{PO}_4(\text{s})$ | $\text{H}_3\text{PO}_4(\text{l})$ |
| ΔH°_f (kJ/mol): | -1284.4 | -1271.7 |
| ΔG°_f (kJ/mol): | -1124.3 | -1123.6 |
| S° (J/K·mol): | 110.5 | 150.8 |

- A) 286 K
- B) 305 K
- C) 315 K
- D) 347 K

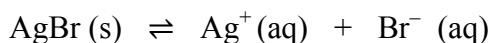
6. Calculate K_p at 298 K for the reaction,



| | ΔG°_f |
|-------------------------|--------------------|
| $\text{SO}_2(\text{g})$ | -300.4 kJ/mol |
| $\text{SO}_3(\text{g})$ | -370.4 kJ/mol |
| $\text{NO}(\text{g})$ | 86.7 kJ/mol |
| $\text{NO}_2(\text{g})$ | 51.8 kJ/mol |

- A) 6.99×10^{-7}
- B) 14.2
- C) 1.42×10^6
- D) 475

7. For the reaction,



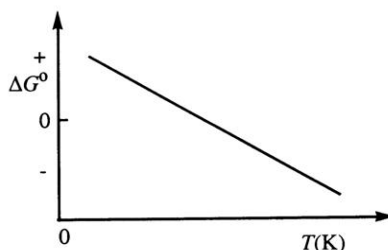
the equilibrium constant is the solubility product constant, $K_{\text{sp}} = 7.7 \times 10^{-13}$ at 25°C . Calculate ΔG when $[\text{Ag}^+] = 1.0 \times 10^{-2} \text{ M}$ and $[\text{Br}^-] = 1.0 \times 10^{-3} \text{ M}$. Is the reaction spontaneous or nonspontaneous at these concentrations?

- A) $\Delta G = +69.1 \text{ kJ/mol}$, nonspontaneous
- B) $\Delta G = -69.1 \text{ kJ/mol}$, spontaneous
- C) $\Delta G = -40.6 \text{ kJ/mol}$, spontaneous
- D) $\Delta G = +40.6 \text{ kJ/mol}$, nonspontaneous

8. Which species will have the greatest absolute entropy at 25°C ?

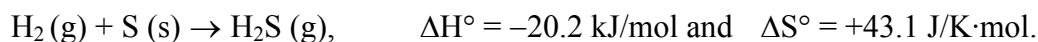
- A) Ne (g)
- B) C_4H_{10} (g)
- C) H_2O (l)
- D) C_2H_2 (g)

9. Consider the figure below which shows ΔG° for a chemical process plotted against absolute temperature. From this plot, it is reasonable to conclude that:



- A) $\Delta H^\circ > 0$, $\Delta S^\circ > 0$
- B) $\Delta H^\circ > 0$, $\Delta S^\circ < 0$
- C) $\Delta H^\circ < 0$, $\Delta S^\circ > 0$
- D) $\Delta H^\circ < 0$, $\Delta S^\circ < 0$

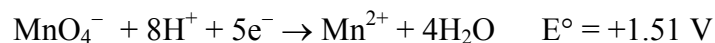
10. For the reaction,



Which of the following statements is *TRUE*?

- A) The reaction is only spontaneous at low temperatures.
- B) The reaction is spontaneous at all temperatures.
- C) ΔG° becomes less favorable as temperature increases.
- D) The reaction is spontaneous only at high temperatures.

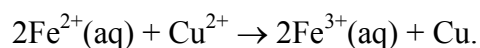
11. Consider the following standard reduction potentials in acid solution:



The *strongest reducing agent* listed above is

- A) Cr^{3+}
- B) Cr
- C) Mn^{2+}
- D) Co

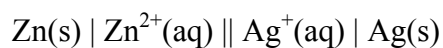
12. Consider the following reaction,



When the reaction comes to equilibrium, what is the cell voltage? ($E^{\circ}_{\text{Fe}^{+3}/\text{Fe}^{+2}} = 0.77$ V, $E^{\circ}_{\text{Cu}^{+2}/\text{Cu}} = 0.34$ V)

- A) 0.43 V
- B) 1.11 V
- C) 0 V
- D) -0.43 V

13. For the following Cell,



Calculate what $[\text{Ag}^{+}]$ if $[\text{Zn}^{2+}] = 0.010$ M and $E_{\text{Cell}} = 1.37$ V at 25°C ($E^{\circ}_{\text{Ag}^{+}/\text{Ag}} = 0.80$ V, $E^{\circ}_{\text{Zn}^{+2}/\text{Zn}} = -0.76$ V)

- A) 2.5 M
- B) 6.2×10^{-3} M
- C) 4.0×10^{-9} M
- D) 6.2×10^{-5} M

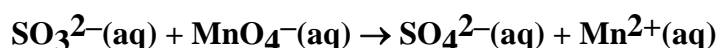
14. If a constant current of 5.0 amperes is passed through a cell containing Cr^{3+} for 1.0 hour, how many grams of Cr will plate out onto the cathode? (The atomic mass of Cr is 51.996.)

- A) 0.054 g
- B) 9.7 g
- C) 3.2 g
- D) 1.6 g

15. Which of the following statements about the fuel cell is FALSE?

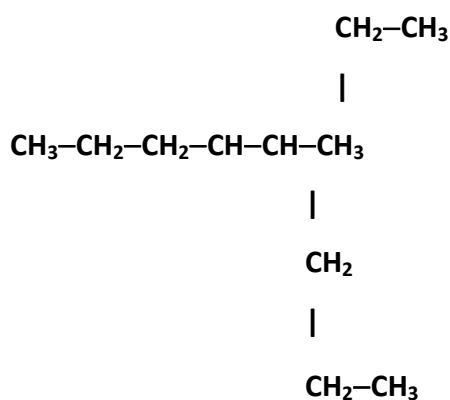
- A) The cell reactants in a fuel cell are continuously supplied from an external source.
- B) A fuel cell is a galvanic cell.
- C) Modern fuel cells can be easily regenerated using household current.
- D) One of the reactants in a fuel cell is a traditional fuel.

16. How many electrons are transferred in the following reaction?



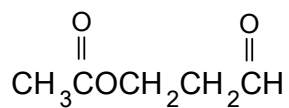
- A) 6
- B) 2
- C) 10
- D) 4

17. The systematic name for the compound represented below is

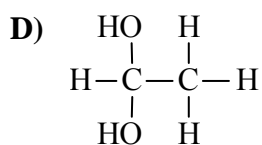
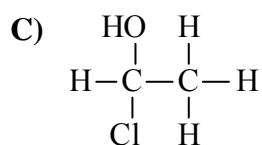
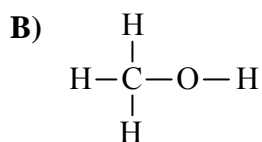
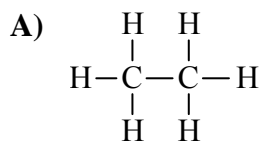


- A) 4,5-diethylheptane
- B) 3-propyl-4-ethylhexane
- C) 3-ethyl-4-propylhexane
- D) 3-methyl-4-propylheptane

18. Identify all the functional groups present in the following organic compound. 1) ketone, 2) aldehyde, 3) acid, 4) alcohol, 5) ether, 6) ester, 7) amine



- A) 2, 6
B) 2, 5
C) 3, 4
D) 1, 2, 5
19. Which of the following has a double C-O bond and a single C-O bond?
- A) ketone
B) ester
C) alcohol
D) aldehyde
20. Pick the optically active molecule among the following:



Answer Key

- 1. A**
- 2. B**
- 3. C**
- 4. D**
- 5. C**
- 6. C**
- 7. D**
- 8. B**
- 9. A**
- 10. B**
- 11. B**
- 12. C**
- 13. D**
- 14. C**
- 15. C**
- 16. C**
- 17. D**
- 18. A**
- 19. B**
- 20. C**