

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

CHEMISTRY DEPARTMENT

CHEM 102-111

MAJOR EXAM I

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)

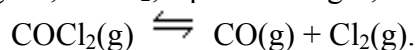
PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10												
IA 1 H 1.0079	IIA 4 Be 9.0122	11 Na 22.990	12 Mg 24.305	19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29				
55 Cs 132.91	56 Ba 137.33	57 La* 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)				
87 Fr (223)	88 Ra (226)	89 Ac** (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (265)	109 Mt (268)	110 Uun (269)	111 Uuu (272)	112 Uub (277)	113	114	115	116	117	118				
58 *Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 165.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97								
90 **Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)								

1. 1.75 moles of H_2O_2 were placed in a 2.50 L reaction chamber at 307°C . After equilibrium was reached, 1.20 moles of H_2O_2 remained. Calculate the equilibrium constant, K_c , for the reaction $2\text{H}_2\text{O}_2(\text{g}) \rightleftharpoons 2\text{H}_2\text{O}(\text{g}) + \text{O}_2(\text{g})$.

- A) 2.3×10^{-2}
- B) 2.0×10^{-4}
- C) 2.4×10^{-3}
- D) 5.5×10^{-3}

2. Phosgene, COCl_2 , a poisonous gas, decomposes according to the equation



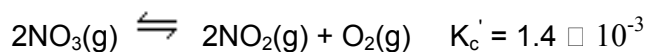
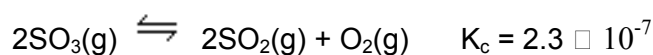
If $K_c = 0.083$ at 900°C , calculate K_p at the same temperature.

- A) 8.0
- B) 0.125
- C) 6.1
- D) 0.16

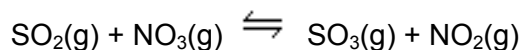
3. K is the equilibrium constant and Q is reaction quotient. Which of the following statement is correct?

- A) If $Q=K$ then the system is at equilibrium.
- B) If $Q>K$ then reactants must be converted to products.
- C) If $Q<K$ then products must be converted to reactants.
- D) If $Q<K$ then more reactants are produced.

4. Consider the following equilibria:

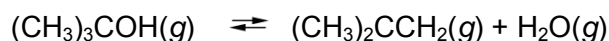


Calculate the equilibrium constant for the reaction



- A) 78
- B) 1.3×10^{-2}
- C) 1.6×10^{-4}
- D) 3.2×10^{-10}

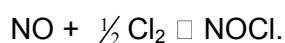
5. At 450°C, *tert*-butyl alcohol decomposes into water and isobutene.



A reaction vessel contains these compounds at equilibrium. What will happen if the volume of the container is reduced by 50% at constant temperature?

- A) The reverse reaction will proceed to reestablish equilibrium.
- B) The forward reaction will proceed to reestablish equilibrium.
- C) The equilibrium constant will increase.
- D) The equilibrium constant will decrease.

6. Nitric oxide gas (NO) reacts with chlorine gas according to the equation



The following initial rates of reaction have been measured for the given reagent concentrations.

<u>Expt. #</u>	<u>Rate (M/hr)</u>	<u>NO (M)</u>	<u>Cl₂ (M)</u>
1	1.19	0.50	0.50
2	4.76	1.00	0.50
3	9.52	1.00	1.00

Which of the following is the rate law (rate equation) for this reaction?

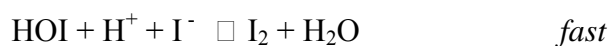
- A) Rate = $k[\text{NO}]^2[\text{Cl}_2]$
- B) Rate = $k[\text{NO}]$
- C) Rate = $k[\text{NO}][\text{Cl}_2]^{1/2}$
- D) Rate = $k[\text{NO}][\text{Cl}_2]$

7. The thermal decomposition of acetaldehyde, $\text{CH}_3\text{CHO} \rightarrow \text{CH}_4 + \text{CO}$, is a second-order reaction. The following data were obtained at 518°C .

time, s	Pressure CH_3CHO , atm
0	364
42	330
105	290
720	132

Calculate the rate constant for the decomposition of acetaldehyde from the above data.

- A) $6.7 \times 10^{-6}/\text{atm}\cdot\text{s}$
 B) $2.2 \times 10^{-3}/\text{s}$
 C) 0.70 atm/s
 D) $2.2 \times 10^{-3}/\text{atm}\cdot\text{s}$
8. The rate constant for a reaction at 40.0°C is exactly three times that at 20.0°C . Calculate the Arrhenius energy of activation for the reaction.
- A) 41.9 kJ/mol
 B) 366 kJ/mol
 C) 3.00 kJ/mol
 D) 3.20 kJ/mol
9. The rate law for the reaction $\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{I}^- \rightarrow \text{I}_2 + 2\text{H}_2\text{O}$ is $\text{rate} = k[\text{H}_2\text{O}_2][\text{I}^-]$. The following mechanism has been suggested.

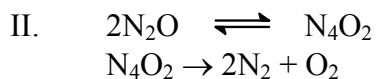
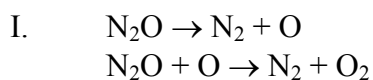


Identify all intermediates included in this mechanism

- A) HOI and OH^-
 B) H^+ only
 C) H^+ and HOI
 D) H^+ and I^-

10. The experimental rate law for the decomposition of N_2O to N_2 and O_2 is $\text{rate} = k[\text{N}_2\text{O}]^2$.

Two mechanisms are proposed:



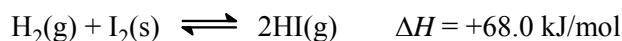
Which of the following could be a correct mechanism?

- A) Mechanism II with the second step as the rate-determining step if the first step is a fast equilibrium step.
B) Mechanism I with the second step as the rate-determining step as long as the first step is a fast equilibrium step.
C) Mechanism I with the first step as the rate-determining step.
D) The two proposed mechanism are not correct.
11. For a certain reaction $A \rightarrow \text{products}$, the rate constant is $5.0 \times 10^{-2} \text{ M.s}$. What will happen to the rate of reaction if the concentration of A is doubled?
- A) The rate will remained the same
B) The rate will will be halved
C) The rate will be doubled.
D) The rate will be three times.
12. What is the pH of a solution prepared by mixing 10.0 mL of a strong acid solution with pH = 2.00 and 10.0 mL of a strong acid solution with pH = 6.00?
- A) 2.3
B) 2.0
C) 4.0
D) 8.0
13. Which solution will have the lowest pH?
- A) 0.10 M HCl
B) 0.10 M HCN
C) 0.10 M H_2CO_3
D) 0.10 M NaOH

14. Acid strength increases in the series: $\text{HCN} < \text{HF} < \text{HSO}_4^-$. Which of the following species is the strongest base?

- A) CN^-
- B) HSO_4^-
- C) SO_4^{2-}
- D) F^-

15. Consider the following equilibrium



Which of the following statements about the equilibrium is false?

- A) Adding more $\text{H}_2(\text{g})$ increases the equilibrium constant
- B) If the system is heated, the right side is favored
- C) This is a heterogeneous equilibrium
- D) If the pressure on the system is increased by changing the volume, the left side is favored

16. Which of the following is a Lewis base?

- A) Cl^-
- B) BCl_3
- C) Mn^{2+}
- D) NH_4^+

17. Calculate the pH of a 0.50 M NH_3 ($K_b = 1.8 \times 10^{-5}$) solution

- A) 11.48
- B) 13.72
- C) 4.78
- D) 2.52

18. What happens to the solution if sodium acetate is added to a solution of acetic acid?

- A) An increased concentration of acetate ions
- B) Equilibrium shifts to the right.
- C) Increase in percent ionization of acetic acid
- D) Less of hydrogen ion is consumed.

19. A 1.0-liter solution contains 0.25 M HF and 0.60 M NaF (K_a for HF is 7.2×10^{-4}). What is the pH of this solution?
- A) 3.52
 - B) 1.40
 - C) 4.63
 - D) 1.81
20. A solution is prepared by adding 0.10 mol of iron(III) nitrate, $\text{Fe}(\text{NO}_3)_3$, to 1.00 L of water. Which statement about the solution is correct?
- A) The solution is acidic
 - B) The solution is basic.
 - C) The value of K_a for the species in solution must be known before a prediction can be made.
 - D) The value of K_b for the species in solution must be known before a prediction can be made.

Answer Key

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