

Practical Exam

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Student Number: _____

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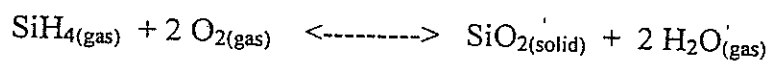
CHEMISTRY 1420

SECOND EXAM

100 POINTS

Each multiple choice test question is worth 3 points. Read each question very carefully. There is no partial credit for the multiple choice test questions. The four numerical questions on the exam are worth 10 points each. On the four numerical questions (i.e., non-multiple choice questions) partial credit will be past upon the work shown. **NOTE: TO RECEIVE PARTIAL CREDIT FOR ANY NON-MULTIPLE CHOICE PROBLEM, THE WORK SHOWN MUST BE CONSISTENT WITH THE ANSWER GIVEN!!**

Question 1: Which of the following mathematical relationships is true for the reaction of SiH_4 gas with oxygen gas to solid SiO_2 and water vapor



[The double arrow \rightleftharpoons indicates an equilibrium sign.]

(a) $K_c = \frac{[\text{SiO}_2][\text{H}_2\text{O}]^2}{[\text{SiH}_4][\text{O}_2]^2}$

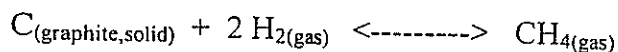
(b) $K_c = \frac{[\text{SiH}_4][\text{O}_2]^2}{[\text{SiO}_2][\text{H}_2\text{O}]^2}$

(c) $K_c = \frac{[\text{H}_2\text{O}]^2}{[\text{O}_2]^2}$

(d) $K_c = \frac{[\text{O}_2]^2}{[\text{H}_2\text{O}]^2}$

(e) None of the above expressions are correct

Question 2: What is the equilibrium constant for the reaction of graphite with hydrogen gas to form methane?



[The double arrow \rightleftharpoons indicates an equilibrium sign.]

(a) $K_c = \frac{[\text{H}_2]^2}{[\text{CH}_4]}$

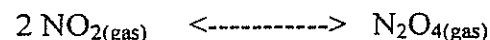
(b) $K_c = \frac{[CH_4]}{[H_2]^2}$

(c) $K_c = \frac{[H_2]^2[C]}{[CH_4]}$

(d) $K_c = \frac{[CH_4]}{[H_2]^2[C]}$

(e). None of the above answers are correct

Question 3: The equilibrium experimental equilibrium concentrations that were determined for the dimerization of NO_2 (gas) to form N_2O_4 (gas)



Are $[NO_2] = 0.05$ Molar and $[N_2O_4] = 1.50$ Molar. What is the numerical value of K_c ?

(a) 600

(b) 0.0033333

(c) 0.00001111

(d) 6×10^4

(e) 9×10^4

Question 4: Which of the following statements is not true

(a) At equilibrium the rate of the forward reaction exactly equals the rate of the reverse reaction

(b) For a specific reaction at a specific temperature, the equilibrium will be the same, no matter what the direction of approach to equilibrium

(c) If there is an increase in entropy when a reaction occurs, this factor favors the products

- (d) If a system is at equilibrium and the conditions are changed so that the system is no longer at equilibrium, the system will react to give a new equilibrium in a way that partially counteracts the change.
- (e) For an exothermic reaction, the reaction will become more product-favored at a higher temperature

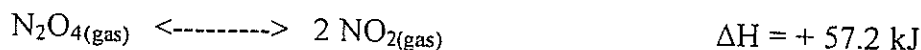
Question 5: Le Chatelier's Principle states

- (a) If two chemical reactions can be assumed to a third reaction, the equilibrium constant for the overall reaction equals the product of the equilibrium constants that were summed
- (b) If a system is at equilibrium and the conditions are changed so that the system is no longer at equilibrium, the system will react to give a new equilibrium in a way that partially counteracts the change.
- (c) That in proposing any reaction mechanism, the proposed steps must always sum to give the overall chemical reaction
- (d) The solubility of a gas in a liquid is directly proportional to the pressure of the gas above the solution.
- (e) states that a catalyst affects the rate of the reaction by decreasing the energy of activation for the forward reaction

Question 6: Which of the following solutions has the lowest boiling point temperature?

- (a) a 0.10 molal NaCl solution
- (b) a 0.10 molal NaNO₃ solution
- (c) a 0.10 molal sugar solution
- (d) a 0.10 molal Ca(NO₃)₂ solution
- (e) All of the above solutions have the same freezing point temperature

Question 7: Consider the following equilibrium



which is established in a 4.0 liter container at 50 °C. Which of the following will not cause the equilibrium to shift to the left-hand side?

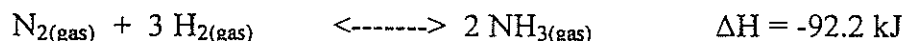
- (a) Decreasing the temperature to 25 °C

- (b) Addition of NO₂ gas
- (c) Decreasing the volume to 1 liter
- (d) Increasing the volume to 8 liters
- (e) Removal of N₂O₄ gas

Question 8: What is the molality of a solution prepared by dissolving 16 grams of NaCl in 750 grams of distilled water.

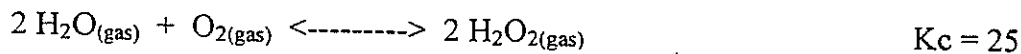
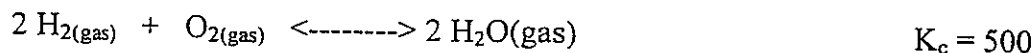
- (a) 0.1822 molal
- (b) 0.3645 molal
- (c) 0.7290
- (d) 0.0003645
- (e) Cannot be calculated unless one knows the density of water

Question 9: Which of the following statements is true for the equilibrium involving the formation of ammonia gas from nitrogen and hydrogen gas.

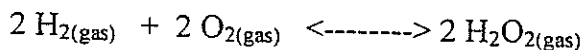


- (a) Decreasing the volume of the reaction container would shift the reaction to the right-hand side, while a decrease in the temperature would shift the reaction to the left-hand side
- (b) Increasing the volume of the reaction container would shift the reaction to the right-hand side, while a decrease in the temperature would shift the reaction to the left-hand side
- (c) Increasing the volume of the reaction container would shift the reaction to the right-hand side, while an increase in the temperature would shift the reaction to the left-hand side
- (d) Decreasing the volume of the reaction container would shift the reaction to the right-hand side, while an increase in the temperature would shift the reaction to the left-hand side
- (e) The chemical equilibrium would not be affected by changes of temperature or volume of the reaction container

Question 10: Given the following information



What is the equilibrium constant for the following reaction



- (a) $K_c = 250$
- (b) $K_c = 12500$
- (c) $K_c = 20$
- (d) $K_c = 0.894$
- (e) $K_c = 1.118$

Question 11: Distilled water freezes at a temperature 0°C and has a vapor pressure of 25.8 mm Hg at 25°C . Which of the following statements is true

- (a) The freezing point temperature of a 0.1 molal sugar solution is below 0°C and the vapor pressure of water above a 0.1 molal sugar solution is less than 25.8 mm Hg at 25°C .
- (b) The freezing point temperature of a 0.1 molal sugar solution is above 0°C and the vapor pressure of water above a 0.1 molal sugar solution is less than 25.8 mm Hg at 25°C .
- (c) The freezing point temperature of a 0.1 molal sugar solution is below 0°C and the vapor pressure of water above a 0.1 molal sugar solution is greater than 25.8 mm Hg at 25°C .
- (d) The freezing point temperature of a 0.1 molal sugar solution is above 0°C and the vapor pressure of water above a 0.1 molal sugar solution is greater than 25.8 mm Hg at 25°C .
- (e) The freezing point temperature of a 0.1 molal sugar solution is exactly 0°C and the vapor pressure of water above a 0.1 molal sugar solution is exactly 25.8 mm Hg at 25°C .

Question 12: What is the boiling point of an aqueous 0.20 molal $\text{Ca}(\text{NO}_3)_2$ solution at 760 mm of Hg. The boiling point elevation constant of water is $k_{bp} = 0.52^\circ\text{C/molal}$.

- (a) 100.104 °C
- (b) 100.000 °C
- (c) 100.208 °C
- (d) 100.312 °C
- (e) 99.688 °C

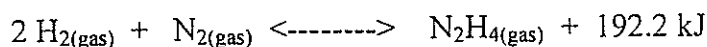
Question 13: Which of the following solutions has the highest boiling point temperature?

- (a) a 0.10 molal NaCl solution
- (b) a 0.10 molal NaNO₃ solution
- (c) a 0.10 molal sugar solution
- (d) a 0.10 molal Ca(NO₃)₂ solution
- (e) All of the above solutions have the same boiling point temperature

Question 14: How many mls of 18 Molar H₂SO₄ would be needed to prepare 250 mls of 0.300 Molar H₂SO₄ solution?

- (a) 3.00 mls
- (b) 0.00209 liters
- (c) 8.34 mls
- (d) 4.17 mls
- (e) Cannot be calculated from the information given

Question 15: The following chemical reaction occurs in a closed container



Which of the following changes would not cause the chemical equilibrium to shift to the left-hand side

- (a) removal of H₂ gas
- (b) addition of N₂H₄ gas

- (c) addition of a catalyst
- (d) increasing the volume of the container
- (e) increasing the temperature of the gas mixture

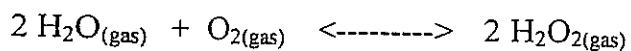
Question 16: Which of the following is not a colligative property

- (a) basicity
- (b) boiling point elevation
- (c) freezing point depression
- (d) osmotic pressure
- (e) vapor pressure lowering

Question 17: How many grams of copper are in 150 grams of a copper alloy that has a composition of 80.0 % copper by mass, 12.5 % zinc by mass and 7.5 % iron by mass.

- (a) 53.33 grams
- (b) 80 grams
- (c) 120 grams
- (d) 100 grams
- (e) Cannot be determined from the information given. One would need to the molecular formula of the alloy to calculate the number of grams of copper.

Question 18: The partial pressure-based equilibrium constant for the reaction of water vapor and oxygen gas to form hydrogen peroxide

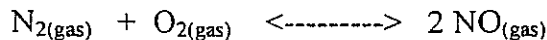


Is equal to $K_c = 0.175$ at 75°C . What is the numerical value of the equilibrium constant expressed in terms of pressure, K_p ?

- (a) $K_p = 0.175$
- (b) $K_p = 5.000$

- (c) $K_p = 143.8$
- (d) $K_p = 6.125 \times 10^{-3}$
- (e) $K_p = 2.144 \times 10^{-4}$

Question 19: The partial pressure-based equilibrium constant for the reaction of nitrogen gas and oxygen gas to form nitric oxide



Is equal to $K_p = 0.175$ at 75°C . What is the numerical value of the equilibrium constant expressed in terms of pressure, K_c ?

- (a) $K_c = 0.175$
- (b) $K_c = 5.000$
- (c) $K_c = 143.8$
- (d) $K_c = 6.125 \times 10^{-3}$
- (e) $K_c = 2.144 \times 10^{-4}$

Question 20: Osmosis involves the

- (a) Movement of solvent through a semipermeable membrane from a region of lower solute concentration (higher solvent concentrations) to a region of higher solute concentration (lower solvent concentrations)
- (b) The attraction between solute and solvent molecules that causes an increase in the viscosity of the solution as one decreases the solution temperature.
- (c) Statement that if a system is at equilibrium and the conditions are changed so that there is no longer an equilibrium, the system will react to reach a new equilibrium in a way that partially counteracts the change.
- (d) complex manner in which a catalyst affects the rate of a reaction, but not the equilibrium concentrations
- (e) None of the above statements are true

NUMERICAL (NON-MULTIPLE CHOICE) QUESTIONS: Each numerical question is worth 10 points. Remember partial credit is based on the work shown, and to receive partial credit the work must be consistent with the answer shown.

Question 21 (10 points)

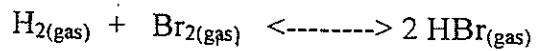
Calculate the boiling point temperature of a solution of 4.00 grams of urea, $\text{CO}(\text{NH}_2)_2$, dissolved in 95.0 grams of water. The freezing point depression constant for water is $k_{\text{fp}} = 0.52 \text{ }^\circ\text{C/molal}$. Note: Urea does not ionize.

Question 22 (10 points)

The osmotic pressure of a solution prepared by adding 0.184 grams of a protein to 1.5 liters of distilled water is 3.14 mm of Hg at 25 °C. What is the molar mass of the protein?

Question 23 (10 Points)

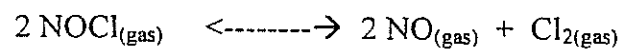
The equilibrium constant for the reaction



is $K_c = 100.0$ at 745 K. When 2 mole of Br_2 and 2 mole of H_2 are allowed to equilibrate at 745 K in a flask of volume 5.00 liters, what amount (in moles) of HBr will be produced?

Question 24 (10 Points)

Nitrosyl chloride, NOCl, decomposes to NO and Cl₂ at high temperature



Suppose that 2.00 moles of NOCl is placed in a 2.00 liter flask and the temperature is raised to 450 °C. When equilibrium has been established 0.96 moles of NO is present. Calculate the molarity-based equilibrium constant, K_c, for the decomposition reaction from the data given.

VIIIA

2 He 4.00	10 Ne 20.18	18 Ar 39.95	36 Kr 83.80	54 Xe 131.29	86 Rn (222)
5 B 10.81	13 Al 26.98	31 Ga 69.72	49 In 114.82	81 Tl 204.38	
6 C 12.01	14 Si 28.09	32 Ge 72.59	50 Sn 118.69	82 Pb 207.20	
7 N 14.01	15 P 30.97	33 As 74.92	51 Sb 121.75	83 Bi 208.98	
8 O 16.00	16 S 32.06	34 Se 78.96	52 Te 127.60	84 Po (209)	
9 F 19.00	17 Cl 35.45	35 Br 79.90	53 I 126.90	85 At (210)	

IA

1 H 1.01	3 Li 6.94	11 Na 23.00	19 K 39.10	37 Rb 85.47	55 Cs 132.91	87 Fr (223)
4 Be 9.01	12 Mg 24.31	20 Ca 40.08	38 Sr 87.62	56 Ba 137.33	88 Ra 226.03	
21 Sc 44.96	39 Y 88.91	57 La 138.91	89 Ac 227.03			
22 Ti 47.88	40 Zr 91.22	72 Hf 178.49	104 Uaq8 (261)			
23 V 50.94	41 Nb 92.91	73 Ta 180.94	105 Uap8 (262)			
24 Cr 51.97	42 Mo 95.94	74 W 183.85	106 Umb8 (263)			
25 Mn 54.94	43 Tc (98)	75 Re 186.21				
26 Fe 55.85	44 Ru 101.07	76 Os 190.20				
27 Co 58.93	45 Rh 102.91	77 Ir 192.22				
28 Ni 58.69	46 Pd 106.42	78 Pt 195.08				
29 Cu 63.55	47 Ag 107.87	79 Au 196.97				
30 Zn 65.38	48 Cd 112.41	80 Hg 200.59				

VIIIB

26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38
44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41
76 Os 190.20	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59

IB

IIIB

Lanthanides

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 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
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Actinides

90 Th	91 Pa	92 U	93 Np 237.05	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 (260)
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