

Question	1	2	3	4	5	Total
Mark	/8	/10	/16	/7	/9	/50

CHEM 121 TEST B

Tuesday, 1 February 2005

Name (Print clearly):

Signature:

Instructions:

Attempt **all** questions. Enter answers in the spaces provided (continue on the back of the **opposite** sheet if necessary).

Total marks: 50

Time allowed: 60 minutes

Note:

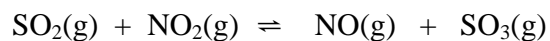
At the end of this paper are:

1. A Periodic Table
2. A sheet containing physical chemistry formulae

[Please check that both of these pages are attached before starting to answer the test paper!]

1. [8 marks]

a) Write an expression for K for the following reaction:



b) Given that at 450°C, $K = 86.4$ for the above reaction, **explain** whether the reaction would proceed forwards or backwards if the gases were mixed at the following initial concentrations.

$$p(\text{SO}_2) = 1.2 \text{ atm.}$$

$$p(\text{NO}) = 3.0 \text{ atm.}$$

$$p(\text{NO}_2) = 0.5 \text{ atm.}$$

$$P(\text{SO}_3) = 7.2 \text{ atm.}$$

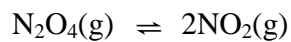
c) After the reaction has reached equilibrium, what would result from carrying out the following operations? **Give** your reasoning.

i) Introduction of more NO

ii) Increasing the volume of the container by a factor of 4.

2. [10 marks]

Brown nitrogen dioxide, NO_2 , and colourless dinitrogen tetroxide, N_2O_4 , exist in equilibrium according to the equation:



a) NO_2 is placed in an evacuated flask at 120°C .

i) What change would be **observed** as the reaction proceeds towards equilibrium?

ii) How could you tell when equilibrium had been reached?

b) Pure NO_2 was placed in an evacuated flask at 120°C . The partial pressure of the NO_2 was 2.00 atm. At equilibrium, the partial pressure of NO_2 was 1.82 atm.

i) What is the partial pressure of N_2O_4 at equilibrium?

- ii) Calculate the equilibrium constant, K , for this reaction at 120°C .
- iii) Will the total pressure increase or decrease as the system comes to equilibrium?
- c) At 150°C the value of K is 132.9. Is the reaction endothermic or exothermic? **Explain** your answer

3. [16 marks]

(a) Compound X is dissolved in pure water to give a solution of $\text{pH} = 8.3$.

(i) Is X an acid or a base?

(ii) Calculate the concentration of hydrogen ions in the solution.

(iii) Calculate the pOH of the solution.

(iv) In its reaction with X, explain whether water acts as an acid or a base.

(b) Write the chemical equation for the process that occurs when ammonia is dissolved in water.

(c) Given $K_a(\text{NH}_4^+) = 5.6 \times 10^{-10}$, calculate $K_b(\text{NH}_3)$

(d) Calculate the pH of $0.05 \text{ mol L}^{-1} \text{ NH}_4\text{Cl}$

(e) Calculate the pH of the solution formed when 10 mL of $0.05 \text{ mol L}^{-1} \text{ NH}_4\text{Cl}$ and 10 mL of $0.10 \text{ mol L}^{-1} \text{ NH}_3$ are mixed.

(f) What special properties does the solution formed in (e) have? Briefly explain how these arise.

4. [7 marks]

Silver chromate dissolves slightly in water as follows:



- (a) Write an expression for the solubility product K_{sp} of silver chromate.
- (b) If $K_{sp} = 1.9 \times 10^{-12}$, calculate the concentration of silver ions in a saturated solution of silver chromate.
- (c) Silver nitrate solution, $8.00 \times 10^{-4} \text{ mol L}^{-1}$, is mixed with an equal volume of potassium chromate solution $6.00 \times 10^{-3} \text{ mol L}^{-1}$. Determine whether or not you would expect to see a precipitate form.

5. [9 marks]

Water has many unique properties. Write a brief explanation of each of the following. You may illustrate your answers with diagrams if you wish.

a) Ice is less dense than water

b) Considering its molecular weight the boiling point of water is exceptionally high?

c) On a very hot day you would walk bare feet through a puddle but not over a sheet of roofing iron.

END OF PAPER

Periodic Table

1 H 1.008																	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.8	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.0	10 Ne 20.2
11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.9	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc (99)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57-71 see below	72 Hf 178.5	73 Ta 181.0	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89-103 see below	104 Rf (257)	105 Db (260)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110	111	112						

57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (147)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
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89 Ac (227)	90 Th 232.0	91 Pa (231)	92 U 238.1	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (245)	98 Cf (251)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (254)	103 Lr (257)
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