NAME:

STUDENT ID Nº

CHEM 114: Mid-course TEST
THURSDAY 3rd MAY 2007 7.00-9.00pm
Answer ALL QUESTIONS

TIME MANAGEMENT:
This examination is marked out of 120. An approximate marking scheme is provided to help you allocate your time effectively. You are encouraged to spend approximately 1 minute per mark allocated.

ANSWERS:
*Fill in your answers in the spaces provided. If you need more space (*e.g. *for calculation workings) please use the blank paper on the back of the preceding page*

PERIODIC TABLE*:*
A Periodic Table is included on a separate sheet. You are encouraged to use it.

QUESTION 1 ***[26 marks total]***

Potassium (K) reacts with fluorine (F_2) to produce potassium fluoride.

(a) Write out the electronic configurations for these two elements. *[4 marks]*

F

K

(b) Write out a balanced equation for the formation of potassium fluoride from the elements. *[3 marks]*

(c) If 5 g of fluorine reacts completely with potassium, how many grams of potassium fluoride are produced? Include details of your calculation. *[5 marks]*

(d) Potassium is a solid which melts at 63.5^{o}C whereas fluorine is a gas which boils at -188^{o}C. Explain the reasons for these different material properties in terms of the bonding properties of elemental potassium and fluorine. *[8 marks]*

(e) Predict the nature of **bonding** in a sample of potassium fluoride. Explain your reasoning. Use this information to predict some of the **material** properties (physical properties) of potassium fluoride, explaining your reasoning. *[6 marks]*

QUESTION 2 ***[20 marks total]***

The following table lists some enthalpy changes for processes associated with the formation of potassium fluoride from potassium and fluorine.

TABLE

(**A**) Enthalpy change for atomisation of potassium $K(s) \rightarrow K(g)$, $\Delta H = +89$ kJ mol^{-1}

(**B**) Enthalpy change for atomisation of fluorine $\frac{1}{2} F_2(g) \rightarrow F(g)$, $\Delta H = +79$ kJ mol^{-1}

(**C**) First ionization energy of potassium $K(g) \rightarrow K^+(g) + e^-$, $\Delta H = +419$ kJ mol^{-1}

(**D**) First electron affinity of fluorine $F(g) + e^- \rightarrow F^-(g)$, $\Delta H = -328$ kJ mol^{-1}

(**E**) Lattice enthalpy of potassium fluoride $K^+(g) + F^-(g) \rightarrow KF(s)$ $\Delta H = -829$ kJ mol^{-1}

(a) For each of the five processes (**A**-**E**) listed in the **TABLE** identify whether the processes are endothermic or exothermic and briefly explain the reasons for the value (the sign and the magnitude) of each enthalpy change. *[15 marks]*

(b) Use the values given in the **TABLE** to calculate the enthalpy change for the formation of potassium fluoride. Include the details of your calculation and briefly explain your reasoning. *[5 marks]*

QUESTION 3 ***[24 marks total]***

The following table gives the boiling points of five fluorine-containing organic molecules. Answer parts **(a)-(d)** using these data.

TABLE: Boiling points of some organofluorocompounds

	Compound	*Formula*	*Molecular mass*	*Boiling point (^oC)*
(i)	Fluoromethane	CH_3F	34	-78
(ii)	Difluoromethane	CH_2F_2	52	-52
(iii)	Tetrafluoromethane	CF_4	88	-128
(iv)	1-Fluorobutane	$CH_3CH_2CH_2CH_2F$	76	33
(v)	2-Fluorobutane	$CH_3CH_2CHFCH_3$	76	25

(a) What is the orientation of the four bonds around the carbon in tetrafluoromethane? (circle the correct answer) *[1 mark]*

Square Linear Bent Tetrahedral

(b) Briefly explain why tetrafluoromethane adopts this shape. *[3 marks]*

(c) Identify all the molecules in the **TABLE** that possess a permanent dipole. Briefly explain your reasoning for each molecule in the table. *[10 marks]*

(d) Using specific information from the table, explain how dipoles, molecular size and shape affect the magnitude of intermolecular forces in low polarity molecular compounds. *[10 marks]*

QUESTION 4 ***[25 marks total]***

The conversion of hydrogen peroxide into water and oxygen is catalysed by iron salts according to the following equation (you do not need to understand the details of this chemistry).

$$H_2O_2 + 2\ Fe^{2+} + 2\ H^+ \rightarrow 2\ H_2O + 2\ Fe^{3+}$$

(a) For the kinetic studies, a solution of hydrogen peroxide is made up to a concentration of 10×10^{-6} mol L^{-1}. Calculate the number of grams of hydrogen peroxide in 500 mL of this solution. Include the details of your calculation.

[5 marks]

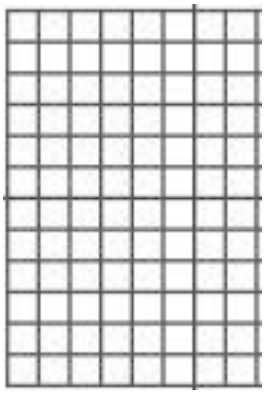
(b) How many grams of Fe^{2+} ions are required to react with 100 mL of the 10×10^{-6} M solution of hydrogen peroxide? Include the details of your calculation. *[5 marks]*

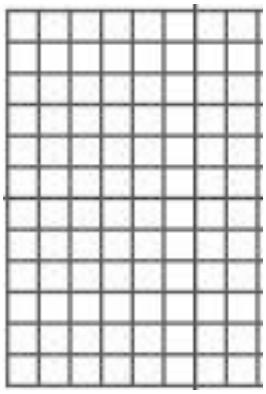
The dependence on the rate of the reaction was evaluated by measuring the concentration of hydrogen peroxide as a function of time. Some rate data for this reaction are presented in the following **TABLE**. Use this data to answer parts **(c)** – **(e)**.

TABLE

Time (s)	$[H_2O_2]$ ($\times 10^{-6}$M)	ln $[H_2O_2]$
0	10.00	2.30
2	7.05	1.95
4	5.00	1.61
6	3.53	1.26
8	2.50	0.92
10	1.77	0.57
12	1.25	0.22

(c) Plot graphs of $[H_2O_2]$ vs time and $\ln[H_2O_2]$ vs time on the grids below. *[8 marks]*





(d) Is this reaction zero order, first order or second order with respect to H_2O_2? Briefly explain your reasoning. *[4 marks]*

(e) Write out a rate equation for this reaction (*i.e.* an expression linking the rate of reaction with the concentrations of hydrogen peroxide and the rate constant, *k*, for the reaction). *[3 marks]*

QUESTION 5 ***[4 marks total]***

Potassium is a mixture of two major isotopes: potassium-39 (mass = 38.96) and potassium-41 (mass = 40.96). Naturally occurring potassium is 93.26% potassium-39 and 6.73% potassium-41. Calculate the atomic weight of bulk samples of potassium. *[4 marks]*

QUESTION 6 ***[21 marks total]***

Trichloromethane, $CHCl_3$, is a liquid at room temperature and pressure. The enthalpy (ΔH_{vap}) and entropy (ΔS_{vap}) changes for the vaporization of trichloromethane have been determined:

Enthalpy change for $CHCl_3(l) \rightarrow CHCl_3(g)$, $\Delta H_{vap} = +31290 \text{ J mol}^{-1}$

Entropy change for $CHCl_3(l) \rightarrow CHCl_3(g)$, $\Delta S_{vap} = +83.9 \text{ J K}^{-1} \text{ mol}^{-1}$

(a) Is the vaporization of trichloromethane an exothermic or an endothermic reaction? Circle the correct answer. *[1 mark]*

EXOTHERMIC ENDOTHERMIC

(b) Discuss the value of ΔH_{vap} in terms of the changes in bonding associated with vaporization. *[5 marks]*

(c) Discuss the value of ΔS_{vap} in terms of the changes in order associated with vaporization. *[4 marks]*

(d) At the boiling point of trichloromethane, T, the value of $T\Delta S_{vap} = \Delta H_{vap}$. Calculate the boiling point of trichloromethane in degrees centigrade (^{o}C). *[5 marks]*

(e) Calculate the amount of energy that it would take to boil 10g of trichloromethane (at its boiling point). *[6 marks]*

END OF TEST