THE OPEN UNIVERSITY OF SRI LANKA
B.Sc. DEGREE PROGRAMME /STAND ALONE COURSES - LEVEL 4

CHU 2125/CHE 4125 – ANALYTICAL CHEMISTRY II
ASSIGNMENT TEST II – NO BOOK TEST (2006/2007)
TIME : ONE AND HALF HOURS

Date: 08th September 2006 Time. 4.00 p.m. 5.30 p.m.

Registration Number : ....

Question No.	Marks
1	
2	
Percentage	

Instructions to candidates:

This question paper contains six pages and two questions.
Answer all questions. Please use a pen (not a pencil) in answering. Write down the answers in the spaces provided. Attached sheets will not be graded.

01. Consider the following half reaction.

$$MnO_4^- + 8\,H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4\,H_2O$$

i. Do you consider this as a balanced equation? Yes or No. Give reasons for your answer. (15 marks)

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ii. Apply Nernst equation to the above half reaction in its original form including R,T and F. Write down "n" for the number of moles of electrons. (5 marks)

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iii. Do you include concentration of water when applying the Nernst equation to the above half reaction? Yes or No. Give reasons for your answer (20 marks)

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iv. Starting from the equation you wrote as the answer to part (ii), derive the following equation.

$$pH + \frac{nF(E - E^{o})}{8x2.303RT} = \frac{1}{8}\log\frac{[MnO_4^-]}{[Mn^{2+}]}$$

(30 marks)

Clearly write down every step of your derivation.

2. A mixture (x and y) consisting of two organic solvents was separated using a distillation apparatus. Boiling point of solvent x is 45^0 C and the boiling point of solvent Y is 90^0C. Total volume of the solvent mixture was 200 cm^3 . During distillation about 80 cm^3 of <u>pure solvent X</u> and about 100 cm^3 of <u>pure solvent Y</u> was collected into two separate containers.

i. Draw a graph of temperature versus volume of distillate collected for this separation.

- Lable the two axes. Vol. Of Distillate collected in cm^3 and temperature in ^{0}C.
- Indicate boiling point of solvent X and boiling point of solvent Y.

(14 marks)

ii. Also draw a temperature versus composition diagram for this separation.

- Indicate the liquid phase and vapor phase in your diagram.
- Consider a solution which has 80% of Y and 20% of X. Indicate (in your diagram) the point at which you can obtain the composition of vapor of this solution.
- What can you say about the composition of vapor above this solution?

(16 marks)

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B.Sc. Degree Programme / Stand alone course – Level 4

CHU 2125/CHE 4125 – Analytical Chemistry I - 2006/2007
Answer guide to Assignment Test I I

An advice to students.

Our experience in marking has proved the fact that most of the students haven't looked at the answer guides supplied for assignments I and II before they come for the final exam. **Time you spend to read the answer guide will not be wasted!**

1. (i)

Yes. It is a balanced equation. It has equal number of atoms (atomically balanced) and charges (electrically balanced)on either side (left and right).

LHS : Mn = 1, O = 4, H = 8 RHS : Mn = 1, O = 4, H = 8

Charge of LHS = -1 + 8 + (-5) = +2 Charge of RHS = +2

(ii)

$$E = E^{\circ} - \frac{RT}{nF} \ln \frac{[Mn^{2+}]}{[MnO_4^-][H^+]^8}$$

(iii)

No. We don't include the concentration of water since it is assumed to be a constant. These reactions are carried out in dilute solutions. Hence we assume the activities of ions are equal to their concentrations. Since we carry out the reaction in very dilute solution, the concentration of water does not change much as a result of this reduction reaction. Hence the concentration (or activity) of water is taken as a constant.

(iv)

$$E = E^\circ - \frac{RT}{nF} \ln\left(\frac{[Mn^{2+}]}{[MnO_4^-]} x \frac{1}{[H^+]^8}\right)$$

$$E = E^\circ - \frac{2.303\ RT}{nF} \log\left(\frac{[Mn^{2+}]}{[MnO_4^-]} x \frac{1}{[H^+]^8}\right)$$ *Since* $\log(a\,x\,b) = \log\ a + \log\ b$

$$E = E^\circ - \frac{2.303\ RT}{nF}\left(\log\frac{[Mn^{2+}]}{[MnO_4^-]} + \log\frac{1}{[H^+]^8}\right)$$

$$E = E^\circ - \frac{2.303\ RT}{nF}\log\frac{[Mn^{2+}]}{[MnO_4^-]} - \frac{2.303\ RT}{nF}\log\frac{1}{[H^+]^8}$$

$$E = E^\circ - \frac{2.303\ RT}{nF}\log\frac{[Mn^{2+}]}{[MnO_4^-]} - \frac{2.303\ RT}{nF}\log[H^+]^{-8}$$ *Since* $\log\ (a)^{-x} = -x\log\ a$

$$E = E^\circ - \frac{2.303\ RT}{nF}\log\frac{[Mn^{2+}]}{[MnO_4^-]} - \frac{(-8)\ 2.303\ RT}{nF}\log\ [H^+]$$

$$E = E^\circ - \frac{2.303\ RT}{nF}\log\frac{[Mn^{2+}]}{[MnO_4^-]} + \frac{(8)\ 2.303\ RT}{nF}\log\ [H^+]$$ *By taking* $\log[H]^+$ *term to LHS*

$$\frac{(-8)\ 2.303\ RT}{nF}\log\ [H^+] + E = E^\circ - \frac{2.303\ RT}{nF}\log\frac{[Mn^{2+}]}{[MnO_4^-]}$$

Now we can multiply the whole equation by $\frac{nF}{8\,x\,2.303\,RT}$

and obtain the following equation.

$$-\log[H]^+ + \frac{nFE}{8x2.303\ RT} = \frac{nFE^\circ}{8x2.303\ RT} - \frac{1}{8}\log\frac{[Mn^{2+}]}{[MnO_4^-]}$$

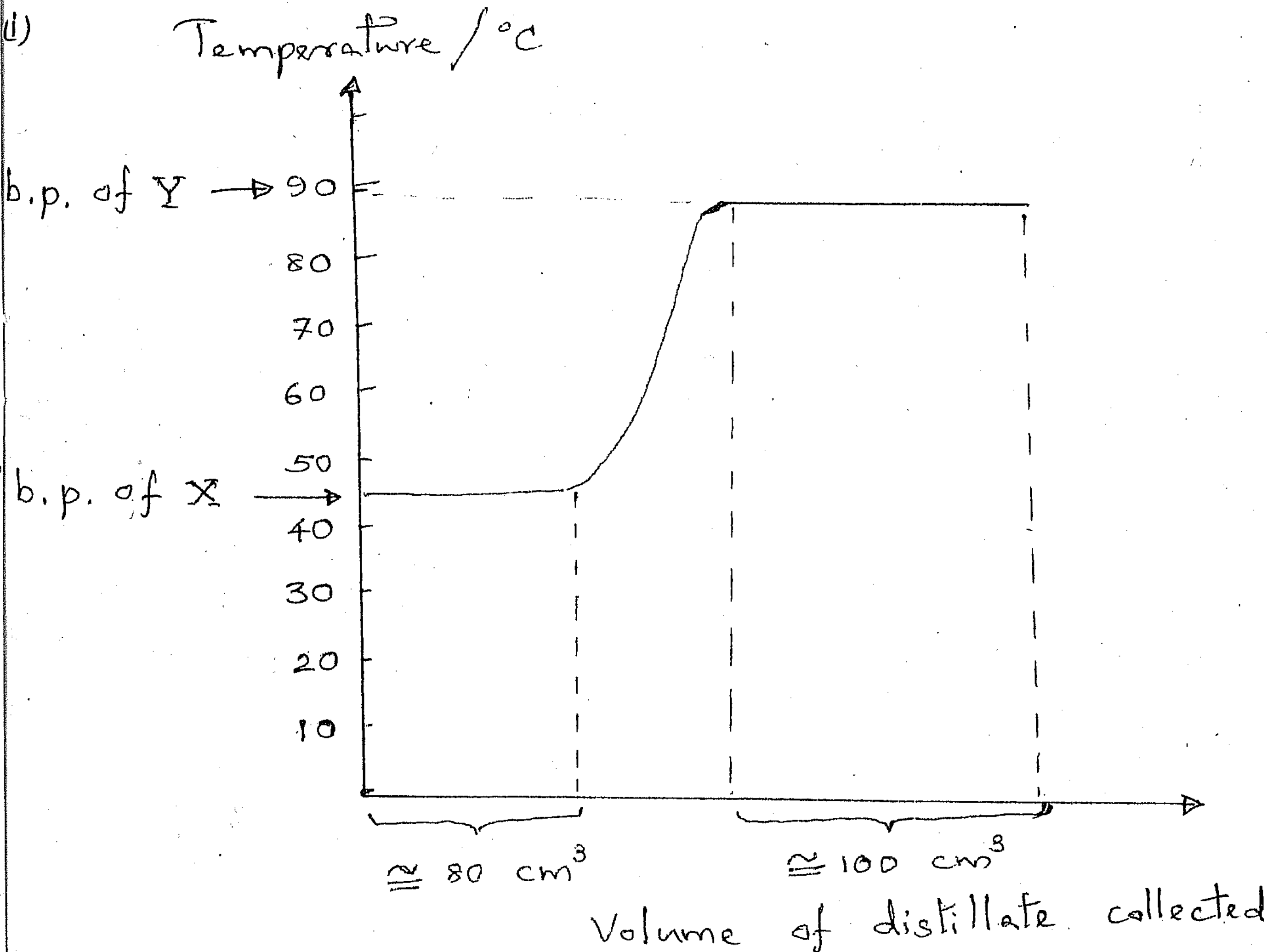
$$pH + \frac{nF(E - E^\circ)}{8 x 2.303\ RT} = -\frac{1}{8} \log \frac{[Mn^{2+}]}{[MnO_4^-]}$$

Since $-x \log a = \log (a)^{-x}$

$$pH + \frac{nF(E - E^\circ)}{8 x 2.303\ RT} = \frac{1}{8} \log \left[\frac{[Mn^{2+}]}{[MnO_4^-]}\right]^{-1}$$

$$pH + \frac{nF(E - E^\circ)}{8 x 2.303\ RT} = \frac{1}{8} \log \frac{[MnO_4^-]}{[Mn^{2+}]}$$

(i)



As you can see from this diagram, when a pure solvent is boiling, the temperature remains constant.