※ 考生請注意：本試題不可使用計算機

1. Describe concisely why activities of aqueous species often are not the same as their concentrations and the primary principles and assumptions that are often used to account for this discrepancy. (15pt.)

2. Below is the logC-pH plot for 1.0×10^{-3} M of diprotic acid H_2A. Utilize this diagram to obtain answers for the following questions.

(a) The pK_{a1} and pK_{a2} of this H_2A acid. (5pt.)
(b) The equilibrium pH of a solution that contains 5.0×10^{-4} M H_2A and 5.0×10^{-4} M NaHA. (5pt.)
(c) The equilibrium pH of a solution that contains 5.0×10^{-4} M H_2A and 5.0×10^{-4} M Na_2A. (5pt.)
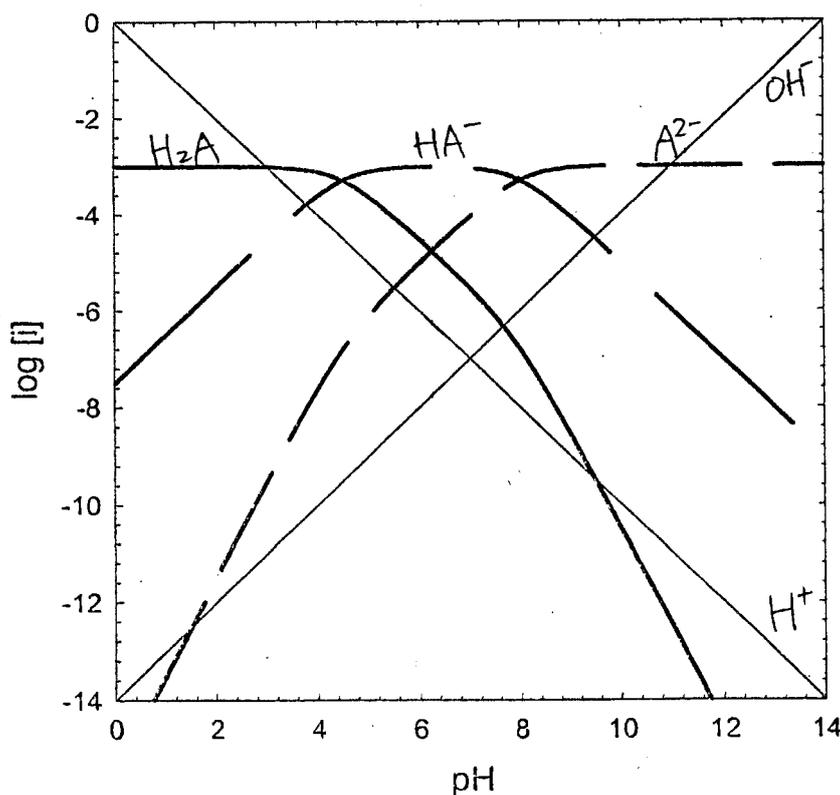
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3. For a gas described by the van der Waals equation of state, $P = \dfrac{RT}{(V_m - b)} - \dfrac{a}{V_m^2}$

Use this equation to complete these tasks:

(a) Calculate $(\partial U / \partial V)_T$ using $(\partial U / \partial V)_T = T(\partial P / \partial T)_V - P$　　(10pt.)

(b) Derive an expression for the change in internal energy, $\Delta U_T = \int_{V_{m,i}}^{V_{m,f}} \left(\dfrac{\partial U}{\partial V}\right)_T \, dV_m$, in compressing a van der Waals gas from an initial molar volume $V_{m,i}$ to a final molar volume $V_{m,f}$ at constant temperature. (10pt.)

4. Suppose that in a waste water treatment plant a toxic pollutant A produces a more toxic intermediate B which goes to decay to a nontoxic product C, each stage of the reaction being first-order. The process can be expressed as following

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$
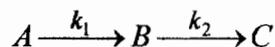
Assume no back reaction occurs and $k_1 > k_2$.
(a) Plot a diagram to illustrate the concentration change of A, B and C over time. (15pt.)
(b) At what time will intermediate B be present in greatest concentration? (15pt.)

5. (a) Please define stereoisomers. (10pt.)

(b) Which of the following alkenes can exist cis-trans isomers? Write their structures. (10pt.)

　　　　(1) $CH_2=CHCH_2CH_3$

　　　　(2) $CH_2=C(CH_3)_2$

　　　　(3) $CH_3CH=CHCH_3$

　　　　(4) $CH_3CH_2CH=CHCl$