※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

一 **Acid-Base Chemistry.** Please find the pH value of a solution containing 0.01M acetic acid and 0.02M sodium acetate. If sufficient amount of NaOH (achieve 0.001M) is added to the above acetic acid/sodium acetate solution, what the final pH value will be for this new solution? (acetic acid pKa=4.74) (20 pts)

二 **Solubility.** Polychlorinated biphenyls (PCBs) are a mixture of over 200 individual compounds and these pollutants have been spread widely throughout the environment. If the concentration of PCB-105 (one of the individual compounds) was 300 pmole/m^3 in the air above a large lake and the concentration in the surface water of the lake was 100 pmole/m^3, would this compound tend to move from the water into the air or from the air into the water? Please clearly explain your answer using the following information: The Henry's law constant for this compound is 10 mole/L-atm and assume the air/water temperature is 25°C. (20 pts).

三、 **Chemical Reaction Kinetics.** Nitrogen oxide (NO_2) concentrations are measured in an air-quality study and decreased from 5 ppm to 2 ppm in 4 minutes with a particular light intensity. (a) what is the first-order rate constant for this reaction? (b) what is the half-life of NO2 during this study? (c) what would the rate constant need to be changed to in order to decrease the time required to lower the NO2 concentration from 5 ppm to 2 ppm in 1.5 minutes? (25 pts).

四、 **Chemical Reaction Stoichiometry** Yeasts are used to convert glucose to produce biomass, glycerol, and ethanol by the following overall reaction under anaerobic conditions.

$$C_6H_{12}O_6 + 0.118\ NH_3 \rightarrow 0.6\ CH_{1.75}N_{0.2}O_{0.45}\ (\text{biomass}) + 0.4\ C_3H_8O_3 + 1.2\ CO_2 + 1.5\ C_2H_5OH + 0.03\ H_2O$$

Calculate (1) the theoretical biomass yield in g of biomass per g of glucose, (2) the ethanol yield in g of ethanol per g of glucose. Please comment on how to maximize the ethanol yield through this biochemical reaction (10 pts)

五 **Chemical Reaction Thermodynamics** Answer the following questions regarding the biodegradation of phenol:

(a) Construct a half reaction for the oxidation of phenol (C_6H_6O) to $CO_2(g)$ (7 pt)

(b) Determine $\Delta G^{0'}$ for the reaction (8 pt)

(c) For anaerobic conditions and pH =7, is the conversion of phenol to methane gas ($CH_4(g)$) thermodynamically favorable? (10 pt)

	$C_6H_6O(aq)$	H^+(pH=7)	$CO_2(g)$	$H_2O(l)$	$CH_4(g)$
G_f^0(KJ/mol)	-47.5	-39.87	-394.38	-237.18	-50