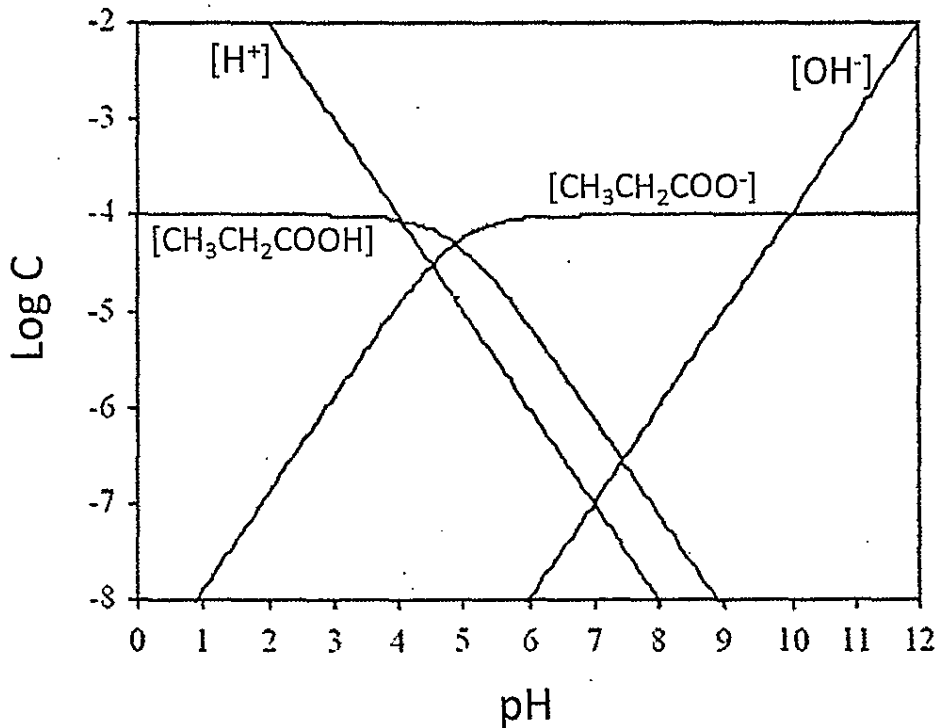


※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. In industry, propionic acid is mainly produced by the hydrocarboxylation of ethylene using nickel carbonyl. Most propionic acid produced is consumed as a preservative for both animal feed and food for human consumption. Propionic acid is also useful as an intermediate in the production of other chemicals, especially polymers. As a result, propionic acid often exists in wastewater. The following is the logarithmic concentration diagram for a  $10^{-4}$  M solution of propionic acid.

- (1) If the wastewater only contains  $10^{-4}$  M propionic acid and no other substances, please estimate the pH of this wastewater. (6 pt)
- (2) If the wastewater contains  $10^{-4}$  M propionic acid and  $5 \times 10^{-5}$  M NaOH, please estimate the pH of this wastewater. (6 pt)
- (3) If the wastewater contains  $10^{-4}$  M propionic acid and  $5 \times 10^{-5}$  M  $H_2SO_4$ , please estimate the pH of this wastewater. (6 pt)
- (4) If the wastewater contains  $10^{-4}$  M propionic acid,  $5 \times 10^{-5}$  M NaOH and  $5 \times 10^{-5}$  M KOH, please estimate the pH of this wastewater. (7 pt)

Please state your reason for full credits.



2. A groundwater plume contains several persistent organic contaminants including chloroform, trichloroethene, benzene, toluene, phenol, benzoapyrene, acrolein and DDT. An air stripping device with activated carbon filter and/or a permeable reactive barrier (PRB) containing zero valent iron and organic carbon are proposed to intercept and treat the contaminated groundwater.

Values of  $K_{ow}$  and  $K_H$  for the above compounds are listed as following:

Compound	$\log K_{ow}$	$K_H$ (atm/M)
chloroform	1.97	4.1
trichloroethene	2.42	11.6
benzene	2.13	5.6
toluene	2.73	6.4
phenol	1.46	0.00076
benzoapyrene	6.06	0.00049
acrolein	0.01	0.0038
DDT	6.91	0.038

- (1) Please rank above compounds based on its water solubility in ascending order. (6 pt)
- (2) Please list the compounds which can be treated by air stripping. (6 pt)
- (3) Assume all compounds are treated by PRB. Since the PRB contains organic carbon, these pollutants will be retarded as them pass through the PRB as well as reduced by the zero valent iron. Assume these pollutants cannot be completely degraded by zero valent iron. Please rank the above compounds on the basis of the slowest to the fastest when coming out from the PRB. (6 pt)
- (4) Which of the above compounds may exhibit the lowest bioavailability? Why? (7 pt)

3. 含氯有機溶劑（例如三氯乙烯）是毒性汙染物。台灣的工程界經常以厭氧生物復育技術整治三氯乙烯汙染的地層，其作法通常是將有機物（藥劑）注入地層中，刺激地層中的微生物活性。請以乳化油藥劑為例，說明三氯乙烯如何被去毒化，以及此現地厭氧生物刺激(Biostimulation)復育技術的微生物學理論依據。（25分）

4. 甲烷菌在分類學上是屬於古菌域(Domain Archaea)，全球約有 80% 甲烷是由甲烷菌產生。請舉出甲烷菌可利用的基質種類，並就該基質種類列舉一種甲烷菌屬名(15分)；並說明甲烷菌的細胞膜結構與大腸桿菌有何不同(10分)。