注意：考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。

國立清華大學 108 學年度碩士班考試入學試題

系所班組別：**分析與環境科學研究所**

考試科目(代碼)：**環境化學(2902)**

－作答注意事項－

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。
2. 作答中如有發現試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「**國立清華大學試場規則及違規處理辦法**」，無法因本試題封面作答注意事項中未列明而稱未知悉。

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(1) Please define or explain the following terms: (20%, 5% for each)

(a) Electron activity

(b) Galvanic cell

(c) Reverse osmosis

(d) Soil texture

(2) A water contains the following water parameters.

Parameter	Concentration/Value
pH	8.0
Total alkalinity	300 mg/L as $CaCO_3$
Ca^{2+}	145 mg/L
Mg^{2+}	18.3 mg/L
SO_4^{2-}	192 mg/L
Cl^-	71 mg/L
NH_3-N	3.5 mg-N/L

(a) Please calculate the concentrations of bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) ions in water. (10%)

(b) Please determine the concentration of non-carbonate hardness. (8%)

(c) Please use the Langelier index (LI = $pH_a - pH_s$, where pH_a is the actual pH in water, and pH_s is the theoretical pH value saturated with $CaCO_3$ in water) to determine the stability of water with $CaCO_3$? (7%)

(d) Lime-soda process is used to remove hardness. Please determine the amounts of lime (calcium oxide) and soda required per liter. (10%)

(e) Chlorination is used to remove NH_3-N and the product of ammonia oxidation is N_2. Please determine the final pH value after chlorination. (10%)

$H_2CO_3 \rightarrow H^+ + HCO_3^-$ $\quad pK_{a1} = 6.3$

$HCO_3^- \rightarrow H^+ + CO_3^{2-}$ $\quad pK_{a2} = 10.3$

$Ca^{2+} + CO_3^{2-} \rightarrow CaCO_{3(s)}$ $\quad pK_{sp} = 8.34$

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(3) Please define photochemical oxidants and show the possible reactions of the production of peroxylacetyl nitrate (PAN) in photochemical smog. (10%)

(4) The following table is the enthalpy of chemicals.

Chemical	**Enthalpy (ΔH_f^0) (Kcal/mol)**	**Chemical**	**Enthalpy (ΔH_f^0) (Kcal/mol)**
Octane	-59.71	$CO_{2(g)}$	-94.05
Methanol	-57.04	$CO_{2(aq)}$	-98.69
Methane	-17.89	$H_2O_{(g)}$	-57.80
$O_{2(aq)}$	-3.9	$H_2O_{(l)}$	-68.32

(a) Write out the balanced chemical equations for the complete combustion of octane and methanol. Which fuel generates more heat per mole of carbon dioxide produced? (7%)

(b) Gasohol (10% methane in gasoline) is regarded as an alternative fuel for automobiles. Which impact on greenhouse effect might you predict for engine emissions in a car running on gasohol instead of gasoline (Assume gasoline is essentially octane) ? (8%)

(5) Ozone in the stratosphere is formed when O_2 molecules absorb solar radiation.

(a) Please write down the formation mechanism of O_3 from O_2 in stratosphere. (5%)

(b) The maximum concentration of O_3 occurs at around 30 km altitude. Please determine the maximum ozone (O_3) concentration at the steady state by assuming the standard Gibbs free energy of O_3 is +163.4 kJ/mol at 25°C and 1 atm. (5%)

Note: The atomic masses of elements are as follows:

H = 1.0	C = 12.0	N = 14.0	O = 16.0	Ca = 40.0	Na = 23.0
Mg = 24.3	Al = 27.0	Si = 28.1	S = 32.1	Cl = 35.5	K = 39.1
Fe = 56.0					