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 110 學年度碩士班考試入學試題

系所班組別：生命科學院
丙組(計算生物與人工智慧組)

科目代碼：0603

考試科目：物理化學

－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. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，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。

國立清華大學 110 學年度碩士班考試入學試題

系所班組別：生命科學院丙組

考試科目（代碼）：物理化學(0603)

1. The following kinetic data were determined for an enzyme. We should be able to determine the enzyme activity by analyzing the data. In addition, in the presence of two different inhibitors at 1 mM concentration, we observed the kinetic data changed. Assume the enzyme concentration of 10 μM is used in the experiments.

[S] (mM)	ν (mM s^{-1})	ν (mM s^{-1}) + inhibitor 1	ν (mM s^{-1}) + inhibitor 2
1	12	4.3	5.5
2	20	8	9
4	29	14	13
8	35	21	16
12	40	26	18

(a) Please write down Michaelis–Menten equation. (6%)

(b) Please explain the physical meaning of K_{cat}, K_M and K_{cat}/K_M for an enzyme. (6%)

(c) Please estimate V_{max}, K_{cat} and K_M for the enzyme by Lineweaver-Burk plot. (6%)

(d) Please explain how to determine the type of inhibition and K_I for the two inhibitors. (6%)

2. If we consider a 850 MHz NMR spectrometer, the resonance of ^1H nuclear is 850MHz. Please calculate the energy that is required to make the transition from the lower energy state to the higher state. Meanwhile, please explain how to calculate the population ratio of molecules in the higher and lower states? (8%)

3. Please explain the mechanism to form a hydrogen bond and compare it with covalent bond. Explain why hydrogen bond is so important in maintaining a protein structure. (8%)

國立清華大學 110 學年度碩士班考試入學試題

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4. Electrons have been explained to have different distributions outside of nuclei. Please explain what s orbital and *p* orbital are? Meanwhile, what is sp^3 hybridization? Give an example. (10%)

5. Lightning and thunder are natural phenomena. Please briefly explain the underlying mechanism of lightning. (10%)

6. What is the bond order for O_2^+, and O_2? Which molecule is more stable? (20%)

7. A solution has formic acid at 5 mM, and formic ion at 6 mM, to which 5 mM HCl is added. What is the pH of this solution? (pKa of formic acid is 3.7) (10%)

8. Suppose that the enthalpy change of the dissociation of double-stranded DNA base pairs is ~10 kJ mol^{-1} of base pairs and the corresponding entropy change is 30 J K^{-1} mol^{-1}. At what temperature (°C) can you expect a double-stranded DNA to dissociate spontaneously? (10%)