

I. Please choose the fittest answer to complete the sentence in each question. (60%)

1. ( ) Do you think \_\_\_\_ is easier than to act?  
(A) talking (B) about to talk (C) of taking (D) to talk
2. ( ) I am not sure of \_\_\_\_ the table.  
(A) where putting (B) where being put (C) where to put (D) where to be put
3. ( ) Here almost everyone has a lap-top, \_\_\_\_ a mobile.  
(A) to say nothing of (B) not to speak (C) to speak nothing of (D) no more to say
4. ( ) Maria studies harder than \_\_\_\_ at that corner.  
(A) the boy who seated (B) the boy is seated (C) is the boy seated (D) does the boy seat
5. ( ) They seemed \_\_\_\_ for hours when we met them yesterday.  
(A) that they had walked (B) that they walked (C) to have walked (D) as if had walked
6. ( ) He is \_\_\_\_ young \_\_\_\_ school.  
(A) too, for go to (B) so, to go to (C) too, to go to (D) too, to going to
7. ( ) He is given to pleasure = He does nothing but \_\_\_\_ pleasure.  
(A) pursue (B) to pursue (C) deny (D) denying
8. ( ) All the spectators desired nothing but \_\_\_\_ an exciting game.  
(A) there being (B) there be (C) there is (D) there to be
9. ( ) Flattery cannot help \_\_\_\_ your end.  
(A) to gaining (B) gain (C) gaining (D) for gaining
10. ( ) This plan is sure \_\_\_\_.  
(A) to fail (B) of failing (C) of failure (D) to be failed
11. ( ) Any \_\_\_\_ person may apply for this position.  
(A) interest (B) interesting (C) interested (D) interests
12. ( ) I am tired of eating \_\_\_\_.  
(A) freezing meat (B) boiling egg (C) can fish (D) fried potatoes
13. ( ) The watch \_\_\_\_ to May is very expensive.  
(A) which is belonged (B) belonging (C) belonged (D) belongs
14. ( ) There stood a lime tree \_\_\_\_ with apples fresh and wet with dew.  
(A) to load (B) loading (C) being loaded (D) loaded
15. ( ) They returned \_\_\_\_.  
(A) to defeat (B) to defeating (C) defeating (D) defeated
16. ( ) The accused \_\_\_\_ of trespassing on privacy.  
(A) stood accused (B) to stand accused (C) stood accusing (D) of standing accusing
17. ( ) She seemed \_\_\_\_ at my question.  
(A) annoy (B) annoying (C) to annoy (D) annoyed
18. ( ) I saw the key \_\_\_\_ here this morning.  
(A) laying (B) laid (C) lain (D) having laid
19. ( ) As he entered the room, he found many books \_\_\_\_ scattered on the floor.  
(A) laying (B) to lay (C) lying (D) lie
20. ( ) A thief slipped in \_\_\_\_ and caught on the very spot.  
(A) observing (B) observed (C) unobserving (D) unobserved
21. ( ) \_\_\_\_ being a fine day last Sunday, we went mountain climbing.  
(A) For (B) It (C) As (D) The weather

22. ( ) Everyone \_\_\_\_, the dinner began.  
(A) was seated (B) seated (C) were seated (D) sat
23. ( ) Ginna plays tennis so well that, \_\_\_\_ the proper training, she may well become a creditable professional.  
(A) give (B) she is given (C) giving (D) given
24. ( ) My shoes \_\_\_\_ worn out, I had to buy a new pair.  
(A) was (B) has been (C) having (D) being
25. ( ) As a desert is like a sea, \_\_\_\_ a camel like a ship.  
(a) and the same as (B) so does (C) so that (D) so is
26. ( ) I know a better doctor than does Sam.  
(A) The doctor I know is better than Sam  
(B) Sam knows a doctor who is better than I am  
(C) Sam knows a doctor who is better than himself  
(D) The doctor I know is better than the doctor Sam knows
27. ( ) We could hardly help our tears.  
(A) If we could help it, we would not burst out laughing  
(B) We were not in a position to shed tears  
(C) We shed tears in spite of ourselves  
(D) We helped ourselves to tears
28. ( ) He cannot speak English, not to mention German.  
(A) He can speak either English or German  
(B) He can speak neither English nor German  
(C) He can speak both English and German  
(D) He can speak not English but German
29. ( ) She is a graduate student, but her scholarship is not good enough, not to speak of practical experience.  
(A) For all her scanty scholarship, she is a good mixer  
(B) She is fresh from school  
(C) Her practical experience is nothing to speak of  
(D) We do not have the slightest idea of her practical experience
30. ( ) Our business is too great a success not to excite envy in the rivals.  
(A) The rivals will be pleased to hear our exciting success  
(B) Our successful business will leave the rivals cold  
(C) The rivals will think lightly of our success in business  
(D) The rivals are sure to be jealous of our success

**II. Please choose the most appropriate answer from the word bank for each blank in the essay.**  
(20%)

[Word Bank . ]

(1) a very unequal business (2) brain drain (3) ethical recruitment policies (4) global health budget (5) key (6) lack (7) shortages (8) stark (9) struggling to cope (10) train more staff

The statistics in the World Health report are (31). The continents of North and South America have just ten per cent of the world's burden of disease but thirty-seven per cent of the world's health workers, and spend over fifty per cent of the total (32). The continent of Africa has twenty-four per cent of the world's disease, just three per cent of the world's health workers and less than one per cent of the budget.

Access to health care is (33). Of the fifty-seven countries which (34) health workers, thirty-six of them are in sub-Saharan Africa, the very same countries which are (35) with the AIDS epidemic.

The World Health Organization says the (36) are undermining not just the battle against deadly diseases like AIDS, tuberculosis and malaria; they're affecting childhood vaccination campaigns and basic care for pregnant women.

The reasons for the shortages are many, but money is (37). Rich countries need more doctors and nurses too, and salaries are higher than in Africa. The WHO says developing countries are suffering a (38) of health professionals.

The report calls for (39) for migrant health workers and international investment to help poor countries (40) because at the moment the world is short of four-million health workers and one-point-three-billion people lack even the most basic health care.

**III. Composition: write about the work of the world, the people who do it, and things that are worth doing well (20%).**

一、下列方法或儀器可以研究蛋白質之何種構造或性質？(9%)

- a) Mass Spectrometry
- b) Edman degradation
- c) Analytic ultracentrifugation

二、就下列各方面比較原核細胞與真核細胞之差異(9%)

- a) mRNA 之構造特徵
- b) ribosome 之組成
- c) RNA polymerase 之種類及催化產物

三、下列 enzyme 之作用如何？(9%)

- a) AP endonuclease
- b) telomerase
- c) DNA gyrase

四、簡述下列分子如何影響細胞訊息傳遞？(6%)

- a) retinoic acid
- b) cGMP

五、寫出 glutathion 之組成(或構造)(3%)

六、CO 對人體有害，CO 結合於 free heme 之  $K_d$  或  $P_{50}$  比  $O_2$  低約 20000，但當 heme 為 heme-myoglobin 之狀態時，上述值減至 200，解釋此 affinity 何以不同(6%)

七、氨由 amino acids 代謝產生並輸送至肝臟去合成 urea，敘述由 amino acids 產生之氨如何由 muscle 輸送至 liver？如何由 tissue 輸送至 liver？(6%)

八、寫出真核細胞 RNA polymerase II 參與基因轉錄作用(transcription)如何被活化？(6%)

九、E.coli 之 Rec A 和 Rec BCD 如何參與 DNA recombination，簡述之(6%)

十、敘述 ubiquitin 如何參與 protein degradation 之過程？(6%)

十一、寫出由微量檢體進行親子鑑定過程中需用到那些生物技術，簡述之(6%)

十二、說明 apoB 100 和 LCAT(lecithin:cholesterol acyltransferase)在膽固醇代謝的角色。(6%)

十三、血液透析(hemodialysis)的病人易出現 carnitine 流失，若不給予適當補充會造成病人的何種代謝作用無法正常進行？(6%)

十四、說明血糖在肝臟 VLDL 形成及 fatty acid 合成分解過程中所扮演的角色。(6%)

十五、說明 calmodulin 在肝醣代謝的角色。(5%)

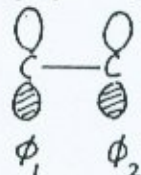
十六、說明 thermogenin (uncoupling protein) 對於 oxidative phosphorylation 的影響？(5%)

(1) 基本上,用 LCAO 及 Huckel 方法來處理具有共軛  $\pi$  - 電子有機化合物的分子軌域時,是以線性組合各個單一原子上擁有的 " $p\pi$  - 原子軌域" 而形式. 以乙烯為例說明如下:

(一) 乙烯的 LCAO  $p\pi$  - 分子軌域是  $\psi = c_1\phi_1 + c_2\phi_2$  .

(二) 運動方程式是  $H\psi = E\psi$

(三) 乙烯的 Eigen value 計算方法如下:



$$H(c_1\phi_1 + c_2\phi_2) = E(c_1\phi_1 + c_2\phi_2)$$

上式左右各乘以  $(c_1\phi_1 + c_2\phi_2)^*$  ,然後再積分:

$$E = \frac{\langle (c_1\phi_1 + c_2\phi_2) | H | (c_1\phi_1 + c_2\phi_2) \rangle}{\langle (c_1\phi_1 + c_2\phi_2) | (c_1\phi_1 + c_2\phi_2) \rangle}$$

$$\text{令 } H_{11} = \langle \phi_1 | H | \phi_1 \rangle, \quad H_{22} = \langle \phi_2 | H | \phi_2 \rangle,$$

$$H_{12} = \langle \phi_1 | H | \phi_2 \rangle, \quad H_{21} = \langle \phi_2 | H | \phi_1 \rangle, \quad H_{12} = H_{21}$$

$$S_{11} = \langle \phi_1 | \phi_1 \rangle, \quad S_{12} = \langle \phi_1 | \phi_2 \rangle, \quad S_{22} = \langle \phi_2 | \phi_2 \rangle$$

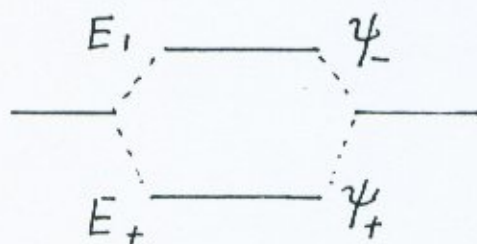
$$\therefore E = \frac{c_1^2 H_{11} + 2c_1 c_2 H_{12} + c_2^2 H_{22}}{c_1^2 S_{11} + 2c_1 c_2 S_{12} + c_2^2 S_{22}}$$

(1) 請利用乙烯的分子軌域說明上列  $H_{11}$ ,  $H_{12}$ ,  $S_{11}$ ,  $S_{12}$  的基本定義

(2) 請利用 Variation 方法計算  $E = ?$ , (令  $H_{ii} = \alpha$   $H_{ij} (i = j+1) = \beta$ )

(3) 請利用 Variation 方法計算  $c_1 = ?$ ,  $c_2 = ?$

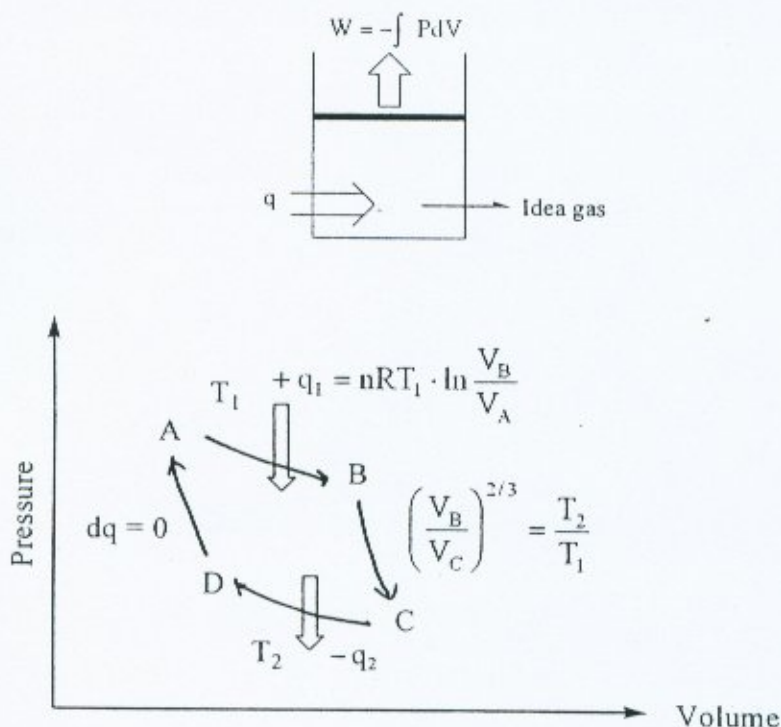
(4) 請依照下圖所示寫出  $\psi_+$  = ?  $\psi_-$  = ?  $E_+$  = ?  $E_-$  = ?



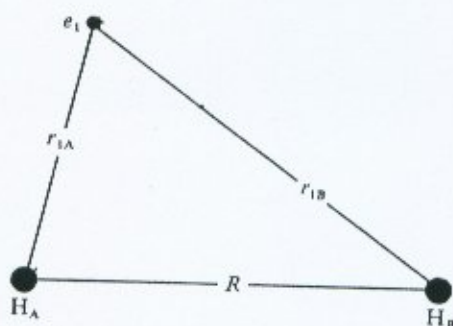
(2) 依照 Pauli 原理,請寫出有關氦原子的函數:

- (a) 氦原子在基態 ( $1s^1 1s^1$ ) 時的空間函數(space wave function),
- (b) 氦原子在基態時的自旋函數(spin wave function),
- (c) 氦原子在激態 ( $1s^1 2s^1$ ) 時的空間函數以及自旋函數,
- (d) 代表氦原子在基態時的完整波函數(必須是反對稱).

(3)請利用下圖理想氣體膨脹模式以及 Carnot Cycle 說明



- (a) 熱力學第一定律 (The first law of thermodynamics),
- (b) 恆溫及可逆反應所產生的功 (Isothermal and reversible work)
- (c) 熱機效應 (The efficiency of a heat engine),
- (d) 熱力學第二定律 (The second law of thermodynamics).



(4)

(a) 依上圖氫分子  $H_2^+$  的構造寫出其完整的運算符號(Hamiltonian operator)  $\hat{H}=?$

(b) 根據 Schrödinger equation  $\hat{H}\psi = E\psi$  寫出  $H_2^+$  分子的  $\psi = ?$

(c) 根據 Born-Oppenheimer 近似法, 請概要的說明如何簡化上列

$\hat{H}\psi = E\psi$  的結果來計算  $H_2^+$  中電子的能量  $E_{\text{electronic}} = ?$

可使用電子計算機

**Part A. Multiple choices (only one correct answer for each question) (50%)**

1. The term "proof" is defined as twice the percent by volume of pure ethanol in solution. Thus, a solution that is 75% (by volume) ethanol is 150 proof. What is the molarity of ethanol in a 92 proof ethanol/water solution?

$$\text{density of ethanol} = 0.80 \text{ g/cm}^3$$

$$\text{density of water} = 1.0 \text{ g/cm}^3$$

$$\text{mol. wt. of ethanol} = 46$$

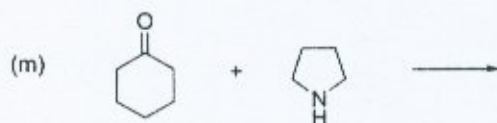
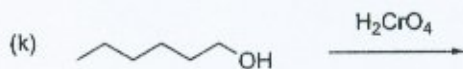
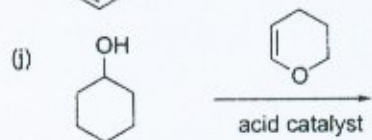
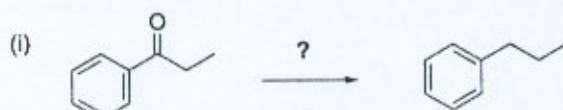
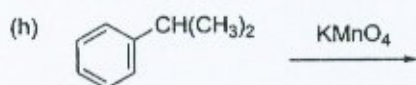
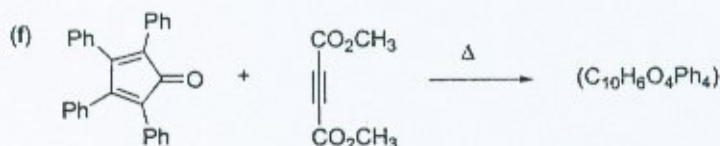
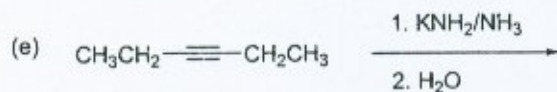
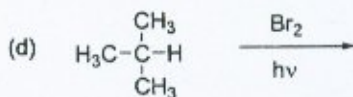
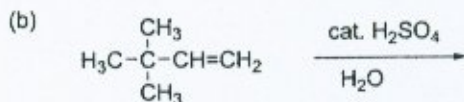
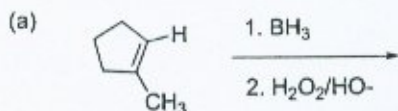
- [A] 0.46 M    [B] 0.80 M    [C] 0.92 M    [D] 17 M    [E] 8.0 M
2. What is the energy of a photon of blue light that has a wavelength of 450 nm? ( $h = 6.626 \times 10^{-34}$  J·s,  $c = 2.9979 \times 10^8$  m/s)
- [A]  $4.4 \times 10^{-19}$  J    [B]  $1.5 \times 10^5$  J    [C]  $6.7 \times 10^{14}$  J    [D]  $5.8 \times 10^{-19}$  J    [E]  $1.01 \times 10^{48}$  J
3. Calculate the pH of a 0.005 M solution of potassium oxide,  $K_2O$ .
- [A] 11.7    [B] 7.0    [C] 2.3    [D] 12.0    [E] 2.0
4. Which of the following solid salts should be more soluble in 1.0 M  $NH_3$  than in water?
- [A] KCl    [B]  $Na_2CO_3$     [C] AgBr    [D]  $KNO_3$     [E] none of these
5. When  $AlCl_3$  dissolves in pure water, the solution will be
- [A] basic    [B] neutral    [C] acidic    [D] basic, acidic, or neutral, depending on the amount of  $AlCl_3$   
[E] There is not enough information to determine it.
6. Carry out the mathematical operation,  $4.184 \times 100.62 \times (25.27 - 24.16)$ , and give the result with the correct number of *significant figures*.
- [A] 467    [B] 467.3    [C] 467.30    [D] 467.303    [E] none of these
7. Calculate the pH of a 0.30 M NaF solution at 25°C. The  $K_a$  value for HF is  $7.2 \times 10^{-4}$ .
- [A] 1.83    [B] 5.71    [C] 6.81    [D] 8.31    [E] 10.7
8. Calculate the electrode potential (at 25°C) of a silver electrode immersed in a 0.0500 M solution of NaCl using
- $$E_{Ag^+/Ag}^0 = 0.799 \text{ V} \quad (2.303RT/nF = 0.0592 \text{ when } T = 25^\circ\text{C}, n = 1, K_{sp}(AgCl) = 1.82 \times 10^{-10})$$
- [A] 0.199 V    [B] 0.299 V    [C] 0.399 V    [D] 0.499 V    [E] 0.599 V
9. Consider the galvanic cell based on the following half-reactions:
- $$Au^{3+} + 3e^- \rightarrow Au \quad E^0 = 1.50 \text{ V}$$
- $$Tl^+ + e^- \rightarrow Tl \quad E^0 = -0.34 \text{ V}$$
- Calculate  $K$  (equilibrium constant) for the cell reaction at 25°C. ( $F = 96485 \text{ C/mol } e^-$ ;  $T(K) = T(^{\circ}\text{C}) + 273$ ;  $R = 8.314 \text{ J/mol}\cdot\text{K}$ )
- [A]  $1.81 \times 10^{23}$     [B]  $3.37 \times 10^{-5}$     [C]  $8.71 \times 10^{57}$     [D]  $6.55 \times 10^{-32}$     [E]  $2.29 \times 10^{99}$
10. A solution contains  $Ag^+$ ,  $Pb^{2+}$ , and  $Ni^{2+}$ . We can use three solutions, NaCl,  $Na_2SO_4$ , and  $Na_2S$ , to separate the positive ions. The three solutions should be added in which order?
- [A]  $Na_2SO_4$ ,  $Na_2S$ , NaCl    [B]  $Na_2S$ , NaCl,  $Na_2SO_4$     [C] NaCl,  $Na_2SO_4$ ,  $Na_2S$     [D] NaCl,  $Na_2S$ ,  $Na_2SO_4$   
[E]  $Na_2SO_4$ , NaCl,  $Na_2S$

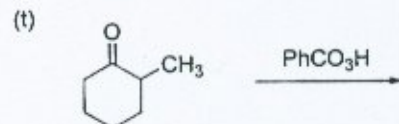
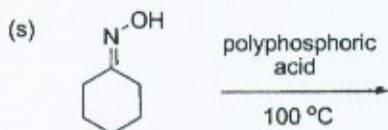
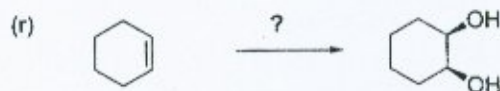
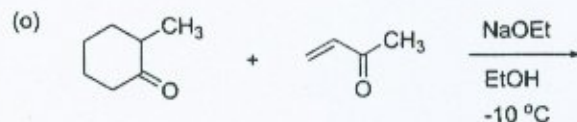
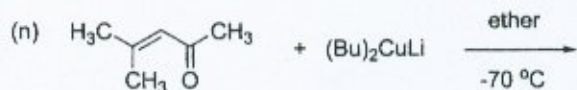


**Part B. Answer the following questions as completely as you can. (50%)**

1. (a) Comparing with the single-beam spectrophotometers, what is(are) the advantage(s) to use double-beam instruments? (8%)  
(b) What are the advantages to use multichannel instruments, such as diode array instruments? (8%)
2. Explain why the inductively coupled plasma-atomic emission spectrometer (ICP-AES) has higher sensitivity, higher precision, and wider linearity of concentration than the Flame-AES has. (8%)
3. (a) The columns used for gas chromatography (GC) can be classified into two types, the packed columns and the open tubular (capillary) columns. Please explain the differences between these two types. (6%)  
(b) Explain what the "temperature programming" is. Why do we need to use this technique for GC experiments? (6%)
4. (a) Explain why the pH meter can sense the concentration (actually, activity) of  $H^+$  in the solutions. (7%)  
(b) Define the cyclic voltammetry (CV). What is the technique used for? (7%)

(40%) 1. Give the major products or the missing reagents for each of the following reactions.





- (10%) 2. (a) Draw the structure of (2*S*,3*R*)-2,3-dibromobutane. (2%)  
 (b) Describe how this compound could be synthesized from acetylene. (6%)  
 (c) Is this compound optically active? (2%)

- (8%) 3. Compound **A** was isolated from the bark of the sweet birch (*Betula lenta*). Compound **A** is soluble in 5% aqueous NaOH solution but not in 5% aqueous NaHCO<sub>3</sub> solution. The spectral data for compound **A** are summarized below. Deduce the structure of compound **A**.

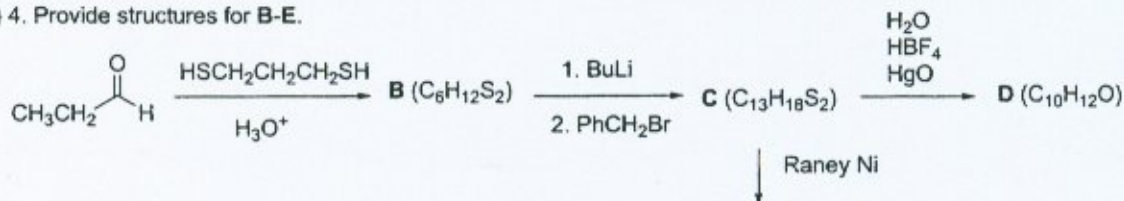
MS:  $m/z = 152$  ( $M^+$ , 49%), 121 (20%), 120 (100%), 92 (54%).

IR (neat): 3205 (br), 1675 (s), 1307 (s), 1253 (s), 1220 (s) and 757 (s)  $\text{cm}^{-1}$ .

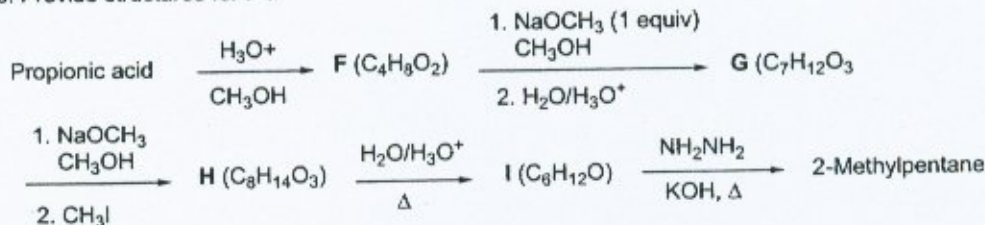
<sup>1</sup>H NMR (CDCl<sub>3</sub>, 300 MHz):  $\delta$  3.92 (s, 3H), 6.85 (t,  $J = 8$  Hz, 1H), 7.00 (d,  $J = 8$  Hz, 1H), 7.44 (t,  $J = 8$  Hz, 1H), 7.83 (d,  $J = 8$  Hz, 1H), 10.8 (s, 1H).

<sup>13</sup>C NMR (CDCl<sub>3</sub>):  $\delta$  52.1 (q), 112.7 (s), 117.7 (d), 119.2 (d), 130.1 (d), 135.7 (d), 162.0 (s), 170.7 (s).

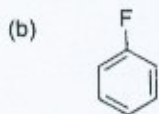
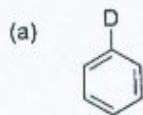
- (8%) 4. Provide structures for **B-E**.



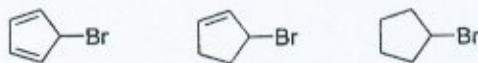
(8%) 5. Provide structures for F-I.



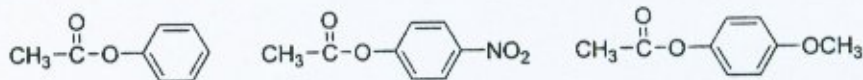
(8%) 6. How the following two compounds could be prepared from benzene?



(9%) 7. (a) Rank the following compounds by the ease with which they ionize under acidic conditions.



(b) Rank the following esters by the rate of hydrolysis.



(c) Rank of the following compounds by the rate of electrophilic aromatic substitution.



(9%) 8. Give an example for each of the following name reactions.

(a) Hofmann rearrangement (b) Fischer Indole synthesis (c) Claisen rearrangement

1. Figure 1 shows the  $^{13}\text{C}$  NMR spectrum of  $(\text{cot})\text{Fe}(\text{CO})_3$  at several temperatures. The signals at 214 and 212 ppm are attributed to CO, and the others are attributed to cot (cyclooctatetraene;  $\text{C}_8\text{H}_8$ ). (15%)
- (a) According to EAN rule, please draw the solid state structure for  $(\text{cot})\text{Fe}(\text{CO})_3$ .
- (b) Explain the appearance of the spectrum at  $-134^\circ\text{C}$ , and its change with T.

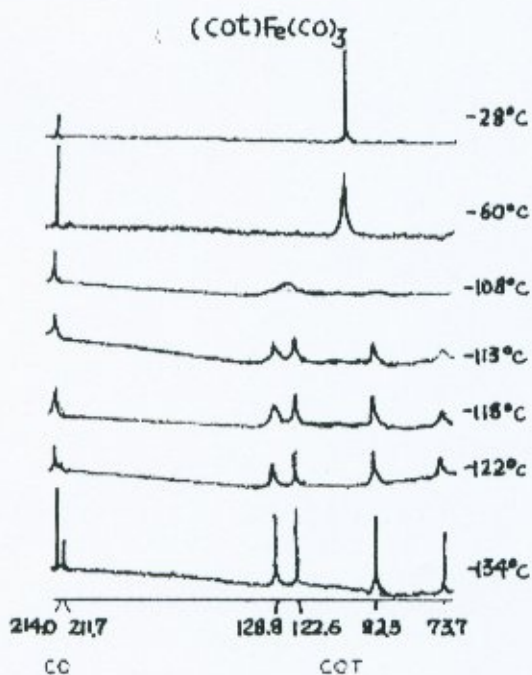
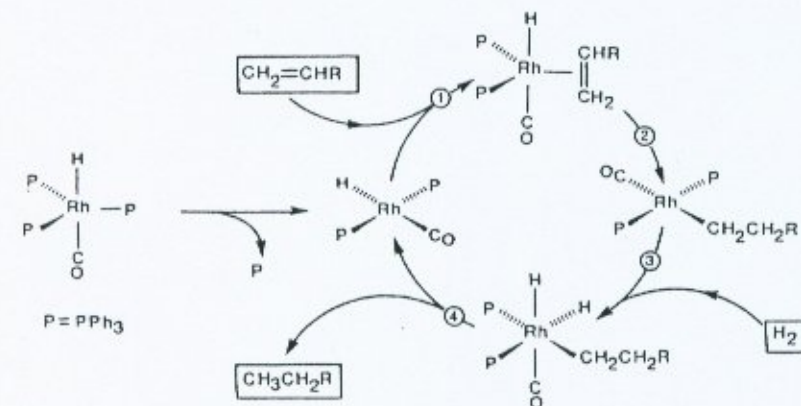


Figure 1. The carbon-13 NMR spectra of  $(\text{C}_8\text{H}_8)\text{Fe}(\text{CO})_3$  at various temperatures. Chemical shifts are downfield from tetramethylsilane, ring protons are decoupled, and solvent signals have been omitted for clarity.

2. Calculate *styx* numbers and draw valences structures for the  $\text{B}_4\text{H}_{10}$ . (5%)
3. Describe and sketch the *pπd* bonding in hexachlorotriphosphazene and in cyclic  $(\text{PCl}_2\text{N})_4$ , assuming it to be planar. (10%)
4. Write down the molecular orbital (MO) electron configuration for the  $\text{NO}^+$  ion: (10%)
- (a) What is the bond order?
- (b) Will the bond length be shorter or longer than NO?
- (c) How many unpaired electron(s) in  $\text{NO}^+$  ion?
- (d) Will the unpaired electron(s) be concentrated more on the N or the O? Explain.

5. Describe the geometry of the following compounds and indicated their point group: (10%)  
 (a)  $\text{ClF}_3$  (b)  $[\text{Re}_2\text{Cl}_8]^{2+}$  (c)  $\text{Fe}(\text{C}_5\text{H}_5)_2$  (d)  $\text{trans-Co}(\text{NH}_3)_4\text{Cl}_2$  (e)  $\text{Mn}_2(\text{CO})_{10}$
6. Explain the term "Inner sphere mechanism" and "outer sphere mechanism". Give one example for each case. (10%)
7.  $[\text{W}(\text{CO})_5\text{Cl}]^-$  has the lower energy CO stretching frequency than  $[\text{Re}(\text{CO})_5\text{Cl}]$  in IR spectrum. Why? (5%)
8. Give the  $\Delta H=80 \text{ KJ/mol}$  and  $\Delta S=-13 \text{ e.u.}$ , can you suggest a plausible mechanism for following CO-substitution reaction: (5%)  
 $\text{Mn}(\text{CO})_4(\text{NO}) + \text{L} \longrightarrow \text{Mn}(\text{CO})_3(\text{NO})\text{L} + \text{CO}$
9. Why is  $[(\text{C}_5\text{H}_5)_2\text{Fe}]^+(\text{PF}_6)^-$  a good oxidizing reagent while  $(\text{C}_5\text{H}_5)_2\text{Co}$  is a good reducing reagent? (5%)
10. Suggest at least two experiments or techniques not involving X-ray different to distinguish *cis*- and *trans*- $\text{W}(\text{CO})_4(\text{PMe}_3)_2$ . (5%)
11. Please describe the reaction mechanism 1 to 4 in Wilkinson's catalyst alkene hydrogenations. (10%)



12. Please distinguish the transition metal hydride complexes and dihydrogen complexes in bonding model, structural, spectroscopic features. (10%)