

國立清華大學 命題紙

96 學年度 生醫工程與環境科學 系(所) 乙(環境分子科學) 組碩士班入學考試

科目 有機化學及物理化學 科目代碼 2604 共 8 頁第 1 頁 *請在【答案卷卡】內作答

一、有機化學

單一選擇題 (50%；每題二分；務必以答案卡作答；答錯不倒扣)

- 1) In the UV-visible spectrum of (*E*)-1,3,5-hexatriene, the lowest energy absorption corresponds to:
A) a σ to π transition.
B) a σ to π^* transition.
C) a π to σ^* transition.
D) a σ to σ^* transition.
E) a π to π^* transition.
- 2) Which of the following molecules is chiral?
A) 1,2-pentadiene
B) 2,3-pentadiene
C) 2-methyl-2,3-pentadiene
D) 2-chloro-4-methyl-2,3-pentadiene
E) none of the above molecules is chiral
- 3) When trans-hex-3-ene is treated with PhCO_3H , the major organic product is:
A) a meso epoxide
B) a 1:1 mixture of enantiomeric epoxides
C) a meso diol
D) a 1:1 mixture of enantiomeric diols
E) hexan-3-ol
- 4) Which of the following compounds is the most reactive dienophile in a Diels-Alder reaction with 1,3-butadiene?
A) $\text{CH}_2=\text{CHOCH}_3$
B) $\text{CH}_2=\text{CHCHO}$
C) $\text{CH}_3\text{CH}=\text{CHCH}_3$
D) $(\text{CH}_3)_2\text{C}=\text{CH}_2$
E) $\text{CH}_2=\text{CH}_2$
- 5) Absorption of what type of electromagnetic radiation results in transitions among allowed rotational motions?
A) X-rays
B) radio waves
C) microwaves
D) ultraviolet light
E) infrared light

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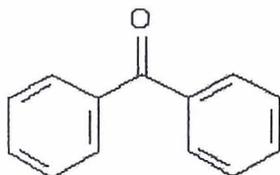
科目 有機化學及物理化學 科目代碼 2604 共 8 頁第 2 頁 *請在【答案卷卡】內作答

- 6) Which of the following reagents can be used to convert cyclopentanol to cyclopentane?
- A) TsCl, pyridine followed by LiAlH_4
 - B) $\text{Na}_2\text{Cr}_2\text{O}_7$, H_2SO_4
 - C) NaBH_4 followed by H_3O^+
 - D) H_2SO_4 , heat followed by H_2 , Pt
 - E) both A and D
- 7) Which of the following reagents should be used to convert an internal alkyne to an α -diketone?
- A) KMnO_4 , H_2O , neutral
 - B) O_3 then H_2O
 - C) Si_2BH then H_2O_2
 - D) Na, NH_3
 - E) HgSO_4 , H_2SO_4
- 8) Both (*E*)- and (*Z*)-hex-3-ene can be subjected to a hydroboration-oxidation sequence. How are the products from these two reactions related to each other?
- A) The (*E*)- and (*Z*)-isomers generate the same products but in differing amounts.
 - B) The (*E*)- and (*Z*)-isomers generate the same products in exactly the same amounts.
 - C) The products of the two isomers are related as constitutional isomers.
 - D) The products of the two isomers are related as diastereomers.
 - E) The products of the two isomers are not structurally related.
- 9) Consider the constitutional isomers 2-methylbut-1-ene, 2-methylbut-2-ene, and 3-methylbut-1-ene. When each of these alkenes is subjected to catalytic hydrogenation (H_2 , Pt), a single product results. Which of the following best describes the structural relationship among these products?
- A) The products are cis-trans isomers.
 - B) The products are identical.
 - C) The products are constitutional isomers.
 - D) The products are enantiomers.
 - E) The products are diastereomers.
- 10) Which of the following is classified as a vinyl halide?
- A) $\text{CH}_3\text{CH}=\text{CHOH}$
 - B) $\text{CH}_3\text{CH}=\text{CHCl}$
 - C) $\text{CH}_3\text{CH}=\text{CHCH}_2\text{Cl}$
 - D) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$
 - E) $\text{BrCH}_2\text{CH}=\text{CH}_2$

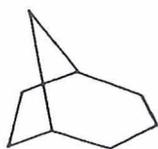
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11) What is the IUPAC name of the following compound:



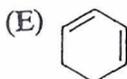
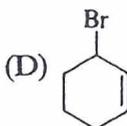
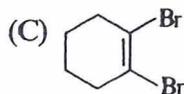
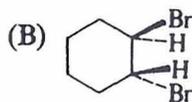
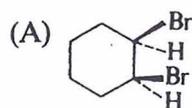
- A) Diphenyl Ketone
- B) Benzophenone
- C) Dibenzyl Ketone
- D) 1,1-Diphenylmethanone
- E) Benzalphenone



12) The hydrocarbon shown above is

- (A) bicyclo[1.1.0]butane
- (B) benzyne
- (C) bicyclo[3.2.1]octane
- (D) bicyclo[2.2.2]octane
- (E) tricyclo[3.3.1.1^{3,7}]decane

13) Which of the following is the major organic product of the rapid reaction of cyclohexene with bromine in the dark at 10° C ?



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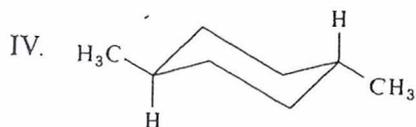
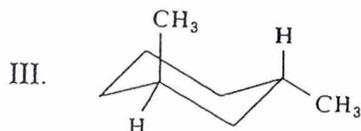
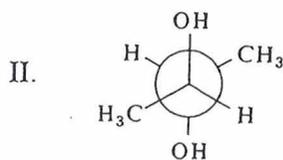
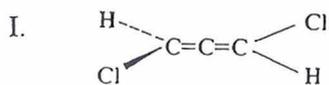
14) An unknown compound was found to react with sodium hydride with the evolution of hydrogen. The compound could not be acetylated under the normal conditions for acetylation. The compound resisted oxidation under mild conditions and under vigorous conditions yielded only products of molecular weight much smaller than the unknown. On the basis of these facts the compound is

- (A) a primary alcohol
- (B) an aldehyde
- (C) a secondary alcohol
- (D) a tertiary alcohol
- (E) a secondary amine

15) The most acidic of the following compounds is

- (A) phenol
- (B) *p*-aminophenol
- (C) *p*-nitrophenol
- (D) *m*-nitrophenol
- (E) 2, 6-di-*t*-butylphenol

16) Compounds that are incapable of optical activity include which of the following?



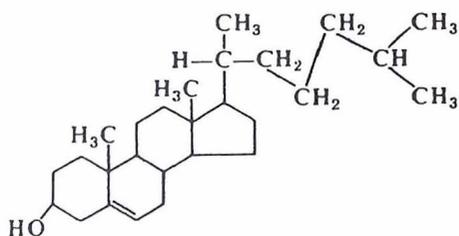
- (A) I only
- (B) III only
- (C) I and II
- (D) II and IV
- (E) III and IV

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- 17) Which of the following ketones will give a positive iodoform test?
- 4-heptanone
 - 3-hexanone
 - 2-hexanone
 - cyclohexanone
 - 2-methyl-3-pentanone
- 18) A correct order of reactivity of acid derivatives towards nucleophilic attack is:
- esters > acid anhydrides > amides.
 - anhydrides > amides > esters.
 - carboxylates > esters > amides.
 - anhydrides > acids > acid chlorides.
 - anhydrides > amides > carboxylates.
- 19) Carboxylic acids boil at considerably higher temperatures than do alcohols, ketones, or aldehydes of similar molecular weights. This is because they:
- have a greater oxygen content.
 - are more acidic.
 - form stable hydrogen-bonded dimers.
 - are hydrophobic.
 - none of the above.
- 20) Secondary amines react with the nitrosonium ion to generate:
- diazonium salts
 - oximes
 - N-nitrosoamines
 - imines
 - anilines



- 21) The formula above represents a member of the class of compounds known as
- terpenes
 - alkaloids
 - carbohydrates
 - steroids
 - vitamins

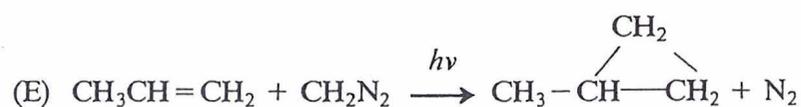
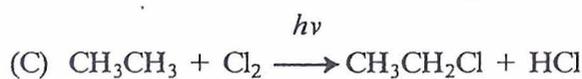
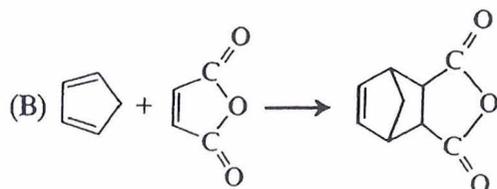
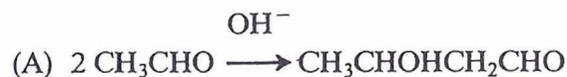
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科目 有機化學及物理化學 科目代碼 2604 共 8 頁第 6 頁 *請在【答案卷卡】內作答

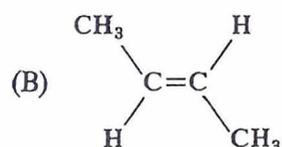
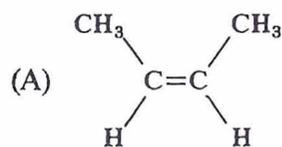
22) If one assumes that substitution could occur at any unsubstituted position, which of the following compounds could form two and only two mononitration products?

- (A) Chlorobenzene
- (B) 1, 3, 5-Trichlorobenzene
- (C) *p*-Dichlorobenzene
- (D) 1, 2, 3, 4-Tetrachlorobenzene
- (E) *o*-Dichlorobenzene

23) Which of the following reactions involves a carbocation intermediate?



24) Which of the following compounds has only a single sharp peak in its ^1H nuclear magnetic resonance spectrum?



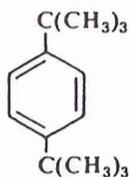
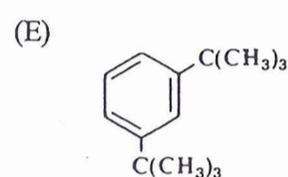
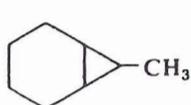
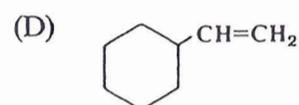
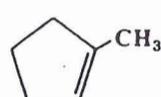
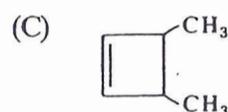
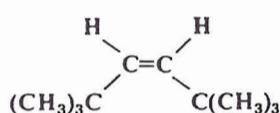
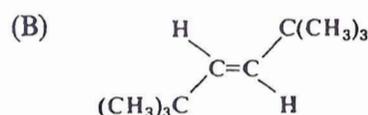
- (C) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
- (D) $\text{FCH}_2\text{CH}_2\text{F}$
- (E) $\text{ClCH}_2\text{CH}_2\text{Cl}$

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25) Isomers in which of the following pairs would probably be most nearly equal in stability?



二、物理化學

計算問答題 (50%; 每題十分; 務必作答於答案卷內)

1. (a) Carry out the mathematics to show that a reversible engine **cannot have a smaller efficiency** than a Carnot engine if it uses the same heat reservoirs.

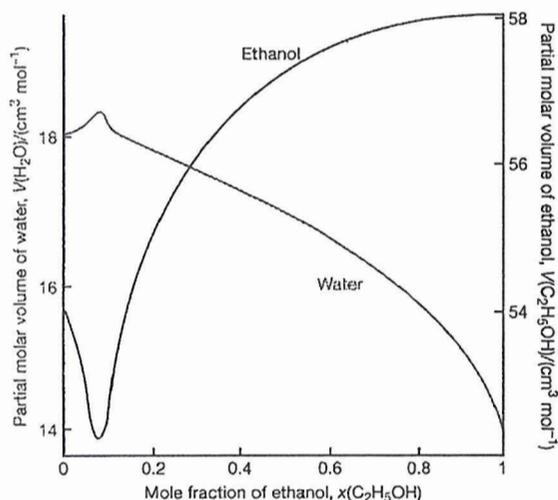
(b) Consider an ideal refrigerator operating between 0°C and 25°C . The refrigerator is to produce 1.0 g of ice each second from water at 0°C . How much work must be done per second? The molar heat of fusion of water is 6.0095 kJ/mol. (10%)

2. Consider 2 mole of an ideal monatomic gas at an initial pressure of 1.00 atm and initial temperature of 273.15 K. Assume it expands adiabatically against a constant pressure of 0.395 atm until equilibrium is reached. (a) What is the final temperature? (b) What is the final volume? (c) How much work is done on the gas in this process? (d) What is the change in the internal energy of the gas in this process? (e) What is the change in the enthalpy of the gas in this process? (10%)

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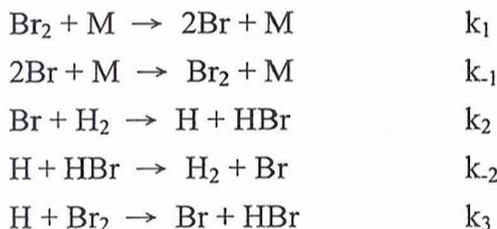
3. A corrupt barman attempts to prepare 100.0 cm^3 of a drink by mixing 30.0 cm^3 of ethanol with 70.0 cm^3 of water at 25°C . What volumes should have been mixed in order to arrive at a mixture of the same strength but of the required volume (100.0 cm^3)? The densities of pure water and ethanol are 0.997 and 0.789 g/cm^3 at 25°C , respectively. (10%)



4. Cyclobutadiene, C_4H_4 , is a four-carbon atom ring. Write the secular determinantal equation for the π molecular orbitals of this planar molecule. Find the Hückel molecular orbital energies and show the HOMO and LUMO. Predict the total π electronic energy of this compound. Is there extra π electron stabilization (as in butadiene or benzene) in this molecule? (10%)

5. (a) What are the three types of reaction common to all chain mechanisms?

(b) The $\text{H}_2 + \text{Br}_2$ reaction mechanism involves free radical carriers, molecules, or atoms with one or more unpaired electrons. Given the following possible elementary processes:



Show that the overall reaction rate is

$$\frac{d[\text{HBr}]}{dt} = \frac{A[\text{H}_2][\text{Br}_2]^{1/2}}{1 + B \frac{[\text{HBr}]}{[\text{Br}_2]}}$$

and in the process evaluate A and B in terms of k_1, k_{-1}, k_2, \dots (10%)