

國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：有機化學及無機化學【化學系碩士班】

題號：422001

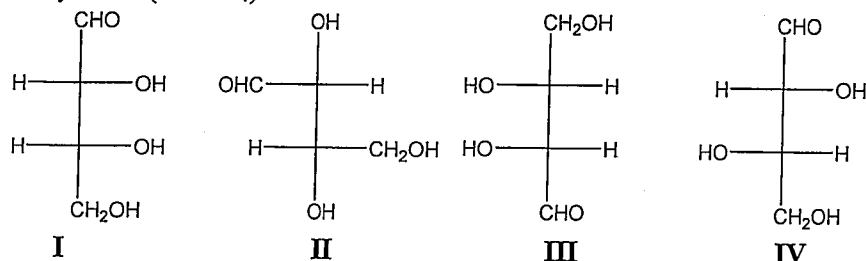
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(一) 選擇題 (64%)

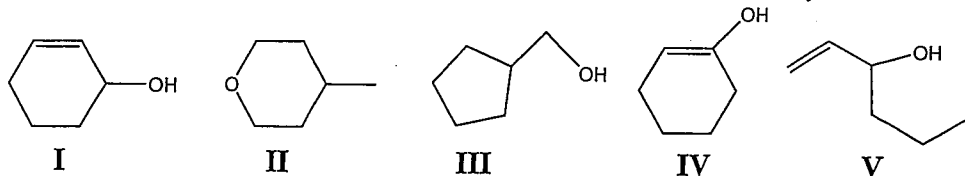
There is only one correct answer for each question. (2%×32 = 64%)

1. Which of the following sugars structure below give meso-product when treated with excess sodium borohydride (NaBH<sub>4</sub>)



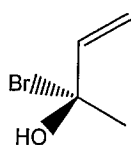
(A) I, II (B) I (C) I, III (D) II, IV (E) IV

2. Which of the following structure is **NOT** a structural isomer of cyclohexanol



(A) I, II (B) II, III (C) III, V (D) I, IV (E) None of the above

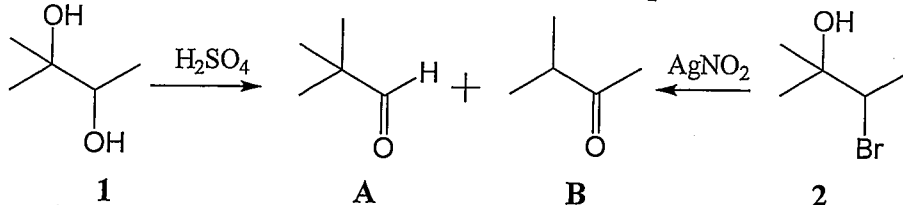
3. What is the name of the following compound?



(A) (S)-1-bromo-1-methyl-2-butenol (B) (S)-2-bromo-3-butene-2-ol  
 (C) (S)-3-bromo-1-butene-3-ol (D) (R)-2-bromo-3-butene-2-ol  
 (E) (R)-3-bromo-1-butene-3-ol

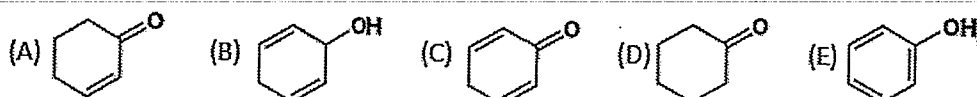
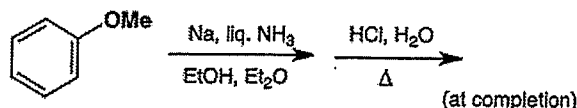
4. Which carbon of (E) hex-3-en-2-one has most downfield chemical shift in the <sup>1</sup>H NMR spectrum?  
 (A) C-1 (B) C-2 (C) C-3 (D) C-4 (E) C-5 and C-6

5. Which statement below is correct for the reaction compound 1 and 2 below



(A) Both 1 and 2 give A (B) Both 1 and 2 give B (C) 1 gives A and 2 gives B  
 (D) 1 gives B and 2 gives A (E) None of the product shown

6. Which is the most likely product for this reaction sequence below:



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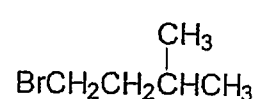
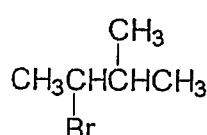
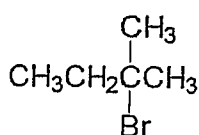
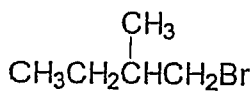
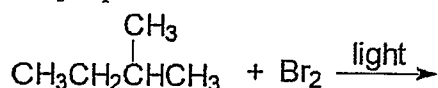
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7. Which is the major product for the reaction



below

I

II

III

IV

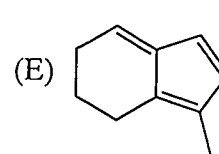
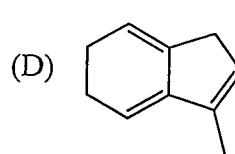
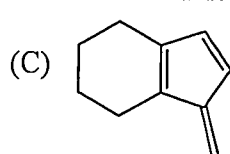
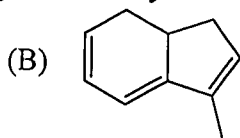
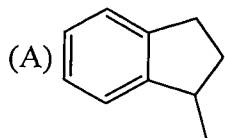
(A) I (B) II (C) III (D) IV (E) I and IV

8. Device a series of reaction to convert benzene into 3-chlorobromobenzene by selective the reagents given in an appropriate order:

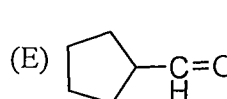
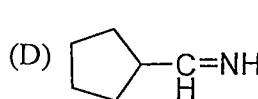
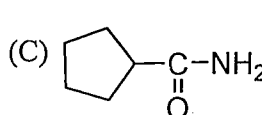
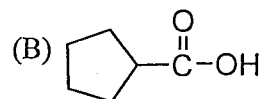
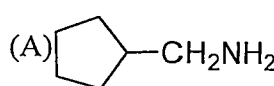
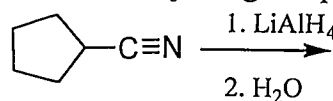
1 sulfuric acid (conc.) heat	2 $\text{Cl}_2 + \text{FeCl}_3$ & heat	3 $\text{NaNO}_2 + \text{H}_3\text{O}^{(+)}$ 0 °C	4 $\text{H}_2$ Pd/C	5 Mg in ether
6 $\text{PBr}_3$	7 $\text{H}_3\text{PO}_2$	8 $\text{HNO}_3$ (conc.) + $\text{H}_2\text{SO}_4$ (conc.) & heat	9 $\text{Cu}_2\text{Br}_2 + \text{HBr}$	10 $(\text{CH}_3\text{CO})_2\text{O}$ + pyridine

(A) 1 then 2 then 6 (B) 2 then 8 then 4 then 3 then 9 (C) 8 then 2 then 4 then 3 then 9  
(D) 8 then 4 then 10 then 2 then 3 then 9 (E) 3 then 9 then 8 then 5 then 6

9. Which of the following isomeric hydrocarbons is most acidic?



10. Which \ What is the major organic product obtained from the following reaction?



11. Choose the best conditions to achieve the following stereospecific transformation.



(A) 1. Mg 2.  $\text{CO}_2$  3.  $\text{H}^+$  (B) 1.  $\text{KO}^t\text{Bu}$  2.  $\text{HBR}_2$  3.  $\text{H}_2\text{O}_2, \text{NaOH}$   
(C) 1.  $\text{NaOAc}$  2.  $\text{H}_2\text{O}, \text{H}^+$  (D) 1.  $\text{KOH}$  2.  $\text{PCC}, \text{H}_2\text{O}$   
(E) 1.  $\text{NaCN}$  2.  $\text{KOH}, \text{H}_2\text{O}$  3.  $\text{H}^+, \text{H}_2\text{O}$

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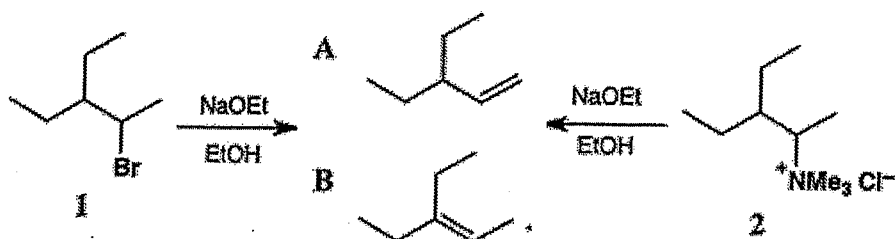
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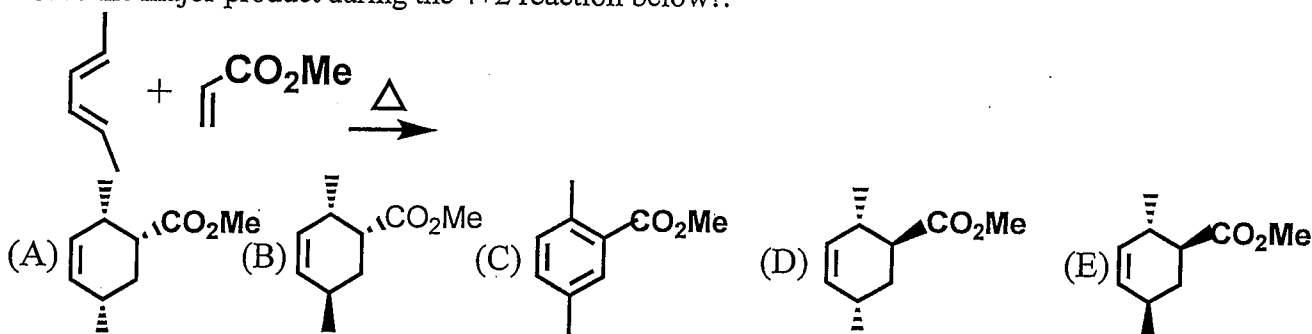
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12. Which of the following statement is CORRECT for the reaction of compound 1 and 2 shown below:

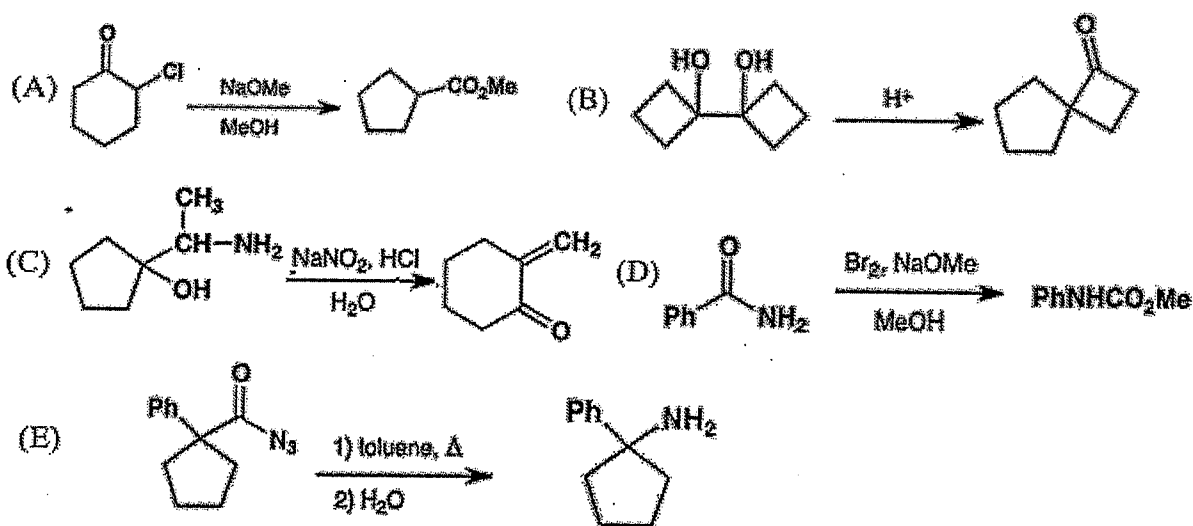


- (A) Compound 1 and 2 can both give A (B). Compound 1 and 2 can both give B  
 (C). Compound 1 give A and 2 give B (D). Compound 1 give B and 2 give A  
 (E). Compound 1 give B and 2 do not react

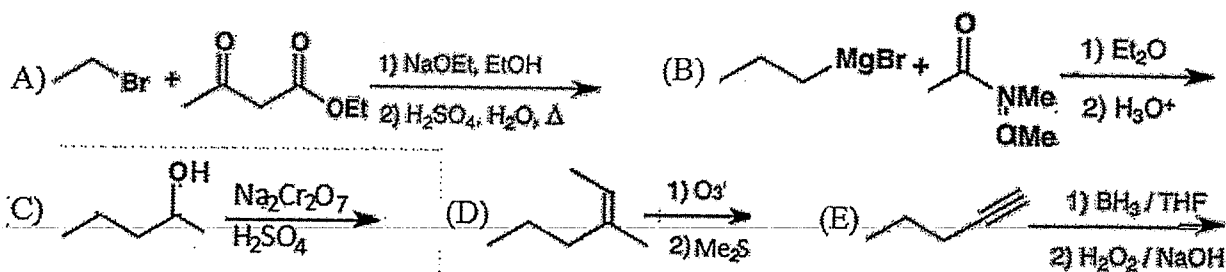
13. Give the major product during the 4+2 reaction below?.



14. Which of the following reaction shown below give the WRONG product.



15. Which reaction CANNOT be used for the synthesis of pentan-2-one?



16. Which reaction below give the INCORRECT product for the reaction.

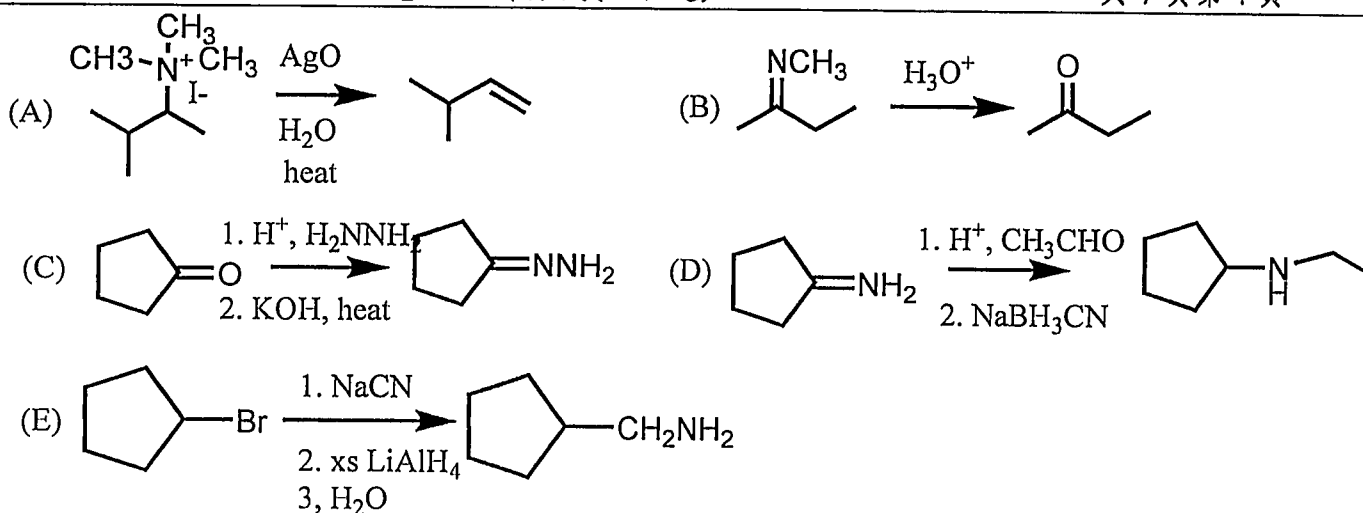
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17. Sodium chloride is a typical example of X structure. It has Y occupying octahedral holes and Z occupying tetrahedral holes.

- (A) X=face-centered cubic, Y=Na<sup>+</sup> and Cl<sup>-</sup>, Z=none  
 (B) X=body-centered cubic, Y=Na<sup>+</sup>, Z=Cl<sup>-</sup>  
 (C) X=face-centered cubic, Y=Na<sup>+</sup>, Z=Cl<sup>-</sup>  
 (D) X=body-centered cubic, Y=Cl<sup>-</sup>, Z=Na<sup>+</sup>  
 (E) None of the above

18. What is the symmetry of P<sub>z</sub> orbital in D<sub>3d</sub>?

D <sub>3d</sub>	E	2C <sub>3</sub>	3C <sub>2</sub>	i	2S <sub>6</sub>	3σ <sub>d</sub>
A <sub>1g</sub>	1	1	1	1	1	1
A <sub>2g</sub>	1	1	-1	1	1	-1
E <sub>g</sub>	2	-1	0	2	-1	0
A <sub>1u</sub>	1	1	1	-1	-1	-1
A <sub>2u</sub>	1	1	-1	-1	-1	1
E <sub>u</sub>	2	-1	0	-2	1	0

- (A) E<sub>u</sub>  
 (B) A<sub>1g</sub>  
 (C) A<sub>1u</sub>  
 (D) A<sub>2u</sub>  
 (E) A<sub>2g</sub>

19. The intense purple colors of KMnO<sub>4</sub> is due to:

- (A) Ligand to metal charge transfer  
 (B) Metal to ligand charge transfer  
 (C) d-d transition  
 (D) dipole-dipole interaction  
 (E) None of the above

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20. What is the most likely transition metal  $M$  in  $K_3[M(CN)_6]$  having  $LFSE = -1.2 \Delta_o$ ?
- (A) Ni  
(B) Fe  
(C) V  
(D) Cr  
(E) Co
21. What is the predicted magnetic moment for  $[FeCl_4]^-$ ?
- (A)  $4.9 \mu_B$   
(B)  $1.7 \mu_B$   
(C)  $2.8 \mu_B$   
(D)  $5.9 \mu_B$   
(E)  $0 \mu_B$
22. Which complex below is expected to show Jahn-Teller distortion?
- (A)  $[Co(CO)_6]^{3+}$   
(B)  $[Cr(CN)_6]^{3-}$   
(C)  $[Mn(H_2O)_6]^{2+}$   
(D)  $[Fe(CO)_6]^{2+}$   
(E) None of the above
23. In a cubic unit cell, what is the intersect angle between (100) and (110)?
- (A)  $180^\circ$   
(B)  $45^\circ$   
(C)  $60^\circ$   
(D)  $30^\circ$   
(E)  $90^\circ$
24. In  $CaF_2$  crystal,  $Ca^{2+}$  ions have coordination number of X while F<sup>-</sup> ions have coordination number of Y.
- (A) X=6 and Y=4  
(B) X=8 and Y=4  
(C) X=4 and Y=4  
(D) X=8 and Y=8  
(E) X=6 and Y=6
25. Among the listed characteristics below, which one does not belong to ionic bonding?
- (A) Columbic forces  
(B) Brittle  
(C) Small difference in electronegativity between bonding pairs  
(D) Low conductivity in solid state  
(E) Large bond energy
26. Which of the following statement is correct?
- (A) Back bonding concerns the electron donation coming from ligands to metal and yielding sigma bond  
(B) HOMO has higher energy levels than LUMO in molecular orbital theory.  
(C) Compared to Lewis structure, molecular orbital theory describes bonding electrons to be more delocalized.  
(D) The larger radius ratios of cation to anion ( $R_{cation}/R_{anion}$ ), the smaller coordination numbers observed in the crystal packing.  
(E) None of the above.

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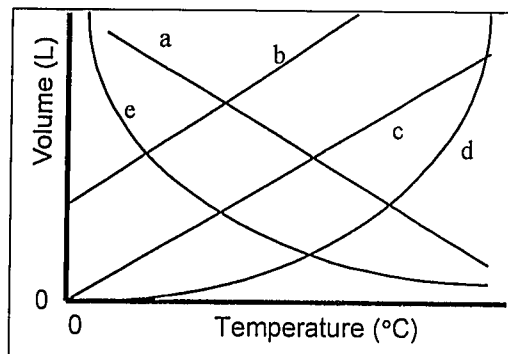
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27. Which of the lines on the figure below is the best representation of the relationship between the volume of a gas and its Celsius temperature, other factors remaining constant?



28. What is the point group of  $\text{PCl}_5$ ?
- (A)  $C_{4v}$   
 (B)  $D_{5h}$   
 (C)  $C_{5v}$   
 (D)  $D_{3h}$   
 (E)  $C_{3v}$
29. Which of the following ligand decreases  $\Delta_o$  with octahedral coordination?
- (A)  $\text{F}^-$   
 (B)  $\text{CO}$   
 (C)  $\text{PR}_3$   
 (D)  $\text{CN}^-$   
 (E) None of the above
30. On the basis of 18-electron rule, please identify the first row transition metal of compound  $(\eta^3\text{-C}_5\text{H}_5)(\eta^5\text{-C}_5\text{H}_5)\text{M}(\text{CO})$ .
- (A)  $\text{M}=\text{Ni}$   
 (B)  $\text{M}=\text{Co}$   
 (C)  $\text{M}=\text{Fe}$   
 (D)  $\text{M}=\text{Mn}$  monodentate  
 (E)  $\text{M}=\text{Cr}$
31. What is the correct wavenumber order of  $\nu(\text{CO})$  in the compounds listed below?
- (A)  $[\text{Fe}(\text{CO})_6]^{2+} > [\text{Ti}(\text{CO})_6]^{2-} > \text{Cr}(\text{CO})_6$   
 (B)  $\text{Cr}(\text{CO})_6 > [\text{Fe}(\text{CO})_6]^{2+} > [\text{Ti}(\text{CO})_6]^{2-}$   
 (C)  $[\text{Fe}(\text{CO})_6]^{2+} > \text{Cr}(\text{CO})_6 > [\text{Ti}(\text{CO})_6]^{2-}$   
 (D)  $[\text{Ti}(\text{CO})_6]^{2-} > \text{Cr}(\text{CO})_6 > [\text{Fe}(\text{CO})_6]^{2+}$   
 (E) None of the above
32. How many isomers of octahedral compound of  $\text{MA}_2\text{B}_2\text{C}_2$  can be found (M is the central metal; A, B, and C are the three different monodentate ligands)?
- (A) 6  
 (B) 7  
 (C) 8  
 (D) 9  
 (E) 10

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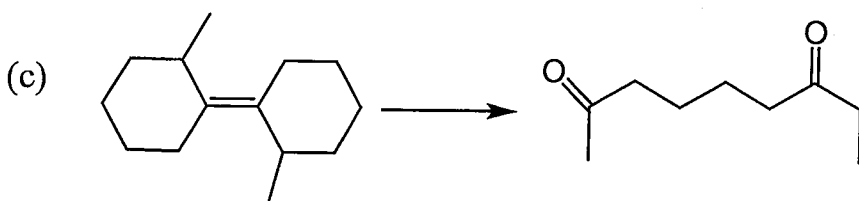
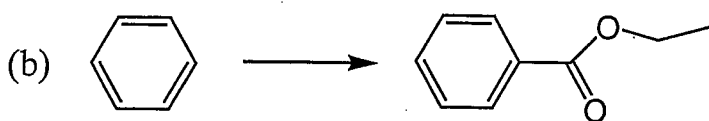
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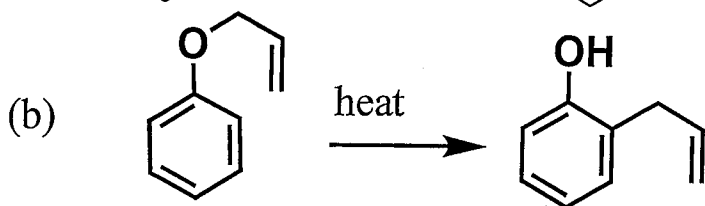
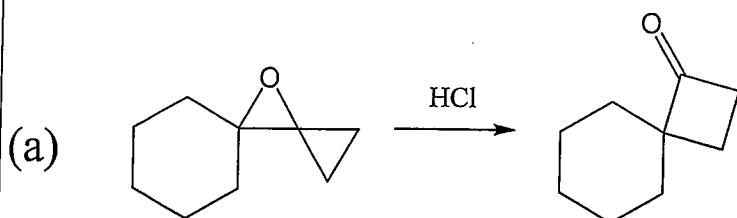
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(二) 非選擇題 (36%)

1. Give appropriate reagent(s) for the following transformation to give the desire product (More than one step are required (3x 4%= 12%))



2. Draw a reasonable mechanism for the transformation below (2 x 3%=6%)



3. Explain the major difference between hexagonal closest packing (hcp) and cubic closest packing (ccp) (6%).
4. Explain why there is no base-centered tetragonal lattice in all 14 Bravais lattices (6%)?
5. Using molecular orbital to explain how pi-acceptor ligands increase  $\Delta_o$  when they conduct octahedral coordination to transition metals. (6%)

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科目名稱：物理化學及分析化學【化學系碩士班】

題號：422002

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共 2 頁第 1 頁

Physical Chemistry (50%, 10% each)

1. For the 1s state, the probability that electron lies between  $r$  and  $r + dr$  is

$$Prob = \frac{4}{a_0^3} r^2 e^{-2r/a_0} dr$$

where  $a_0$  is the Bohr radius. Calculate the probability of an electron will be found within one Bohr radius.

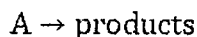
2. A simple function that is a good representation of an internuclear potential for a Morse potential is given by

$$U(r) = D_e(1 - e^{-\beta r})^2$$

Where  $r$  is  $R - R_e$ . Show that the force constant is given by

$$k = 2D_e\beta^2$$

3. Consider a chemical reaction



that obeys the rate law

$$-\frac{d[A]}{dt} = k[A]^n$$

where  $n$ , the reaction order, can be any number except  $n = 1$ . The concentration of A is  $[A]_0$  at time  $t = 0$ , and is  $[A]$  at time  $t$ . Please show that as  $n \neq 1$

$$kt = \frac{1}{n-1} \left( \frac{1}{[A]^{n-1}} - \frac{1}{[A]_0^{n-1}} \right), \quad kt_{1/2} = \frac{1}{n-1} \frac{2^{n-1} - 1}{[A]_0^{n-1}}$$

4. The compressibility is defined as the relative decrease in volume with increase of pressure under specified conditions. The most often chosen conditions lead to the isothermal compressibility

$$\kappa_T = -\frac{1}{V} \left( \frac{\partial V}{\partial P} \right)_T$$

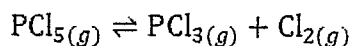
and the adiabatic compressibility.

$$\kappa_S = -\frac{1}{V} \left( \frac{\partial V}{\partial P} \right)_S$$

So, please show that

$$\frac{\kappa_T}{\kappa_S} = \frac{C_P}{C_V}$$

5. Calculate the  $\Delta G$  at 298.15 K for the reaction



if the partial pressure of  $\text{PCl}_5$  is equal to 7.5 torr, the partial pressure of  $\text{PCl}_3$  is equal to 4.5 torr, and the partial pressure of  $\text{Cl}_2$  is equal to 2.25 torr. Assume that the gases are ideal and  $\Delta G^\circ$  is  $20.661 \text{ kJmol}^{-1}$ .

背面有題

試題隨卷繳回



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## 分析化學部分（50%）

6. Define the following terms

- (a) Longitudinal diffusion and eddy diffusion. (5%)
- (b) Isocratic and gradient elution in liquid chromatography. (5%, 10% total)

7. (a) Calculate the pH of a solution that is 0.300 M in  $\text{NH}_3$  and 0.200 M in  $\text{NH}_4\text{Cl}$ .  $K_b$  for  $\text{NH}_3$  is  $1.75 \times 10^{-5}$ . (5%)

- (b) Calculate the pH change that takes place when a 100-mL portion of 0.0500 M NaOH is added to 400 mL of the buffer solution described in (a). (5%, 10% total)

8. At 580 nm, which is the wavelength of its maximum absorption, the complex  $\text{FeSCN}^{2+}$  has a molar absorptivity of  $7.00 \times 10^3 \text{ L cm}^{-1} \text{ mol}^{-1}$ . Calculate

- (a) the absorbance of  $2.50 \times 10^{-5} \text{ M}$  solution of the complex at 580 nm in a 1.00-cm cell. (3%)
- (b) the transmittance of the solutions described in (a). (4%)
- (c) the absorbance of a solution that has half the transmittance of that described in (a). (3%, 10% total)

9. (a) Why is the CaOH spectrum so much broader than the barium emission line? (5%)

- (b) Why are ionization interferences less severe in ICP than in flame emission spectroscopy? (5%, 10% total)

10. (a) How can Raman and Rayleigh scattering be identified when included in fluorescence emission spectrum? Please explain briefly. (5%)

- (b) Describe how it is possible to distinguish between XPS peaks and Auger electron peaks. (5%, 10% total)