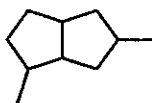


注意：本有機試題包含單選題及問答題兩部份

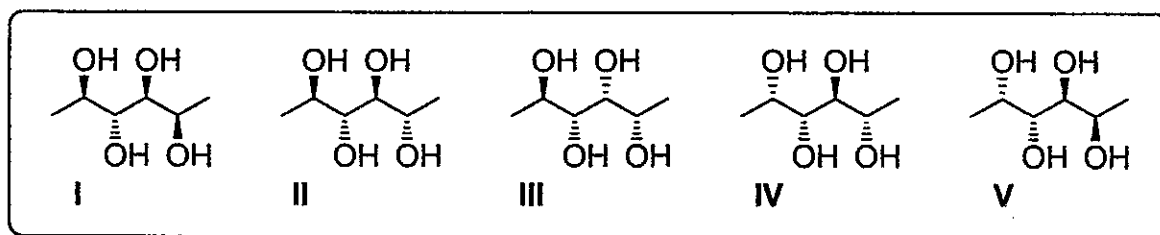
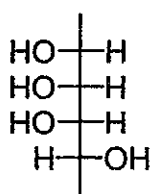
Part I. 單選題 (15 題, 共 30 分) 請用 2B 鉛筆作答於答案卡, 並先詳閱答案卡上之「畫記說明」。

1. What is the IUPAC name of the following compound?



- (A) 1,4-dimethylbicyclo[3.3.0]octane      (B) 2,5-dimethylbicyclo[3.3.0]octane  
 (C) 2,7-dimethylbicyclo[3.3.0]octane      (D) 1,6-dimethylbicyclo[3.3.0]octane  
 (E) 3,8-dimethylbicyclo[3.3.0]octane

2. Which of the following choices represents the wedge/dash drawing of the Fischer projection shown on the left?

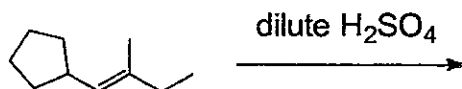


- (A) I      (B) II      (C) III      (D) IV      (E) V

3. Which of the following describes the difference between protic and aprotic solvents?

- (A) protic solvents stabilize anions only.  
 (B) aprotic solvents stabilize anions only.  
 (C) protic solvents stabilize cations only.  
 (D) aprotic solvents stabilize both cations and anions.  
 (E) protic solvents stabilize both cations and anions.

4. Describe the major product(s) of the reaction below.



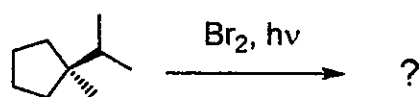
- (A) only one stereoisomer.  
 (B) an equal mixture of enantiomers.  
 (C) a mixture of diastereomers and their enantiomers.  
 (D) a mixture of constitutional isomers.  
 (E) a mixture of constitutional isomers and their enantiomers.

5. What functional group would be expected to be present in the final product of the reaction between 1-hexyne and a mixture of mercuric sulfate and aqueous sulfuric acid??

- (A) aldehyde  
 (B) ketone  
 (C) diol  
 (D) alkene  
 (E) carboxylic acid

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6. Explain whether the major product(s) of the following reaction is optically active and why this is the case.



- (A) The product is optically active because a chiral center is created at the right side vertex of the ring.  
 (B) The product is optically active because it has a chiral center at a terminal carbon.  
 (C) The product is not optically active because it has a chiral center that is part of the ring.  
 (D) The product is not optically active because its chiral center is not part of the ring.  
 (E) The product is not optically active because it has no chiral centers.

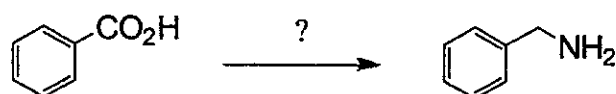
7. Select the best reagent to convert 4,5-dimethylhex-2-yne to *trans*-4,5-dimethylhex-2-ene.

- (A) Na, NH<sub>3</sub>                      (B) HBr, ROOR                      (C) Lindlar reagent  
 (D) H<sub>2</sub>, Pd                      (E) i) OsO<sub>4</sub>; ii) NaHSO<sub>3</sub>, H<sub>2</sub>O

8. Which of these alkyl halides cannot be used to prepare amines using Gabriel synthesis?

- (A) 1-bromo-3-methylbutane    (B) 1-bromopentane                      (C) 1-bromo-2,3-dimethylbutane  
 (D) 2-bromo-3-methylpentane    (E) 2-bromo-2,3-dimethylbutane

9. What reagents are needed to carry out the conversion shown?



- (A) i) SOCl<sub>2</sub>/pyridine; ii) LiAlH<sub>4</sub>; iii) H<sub>2</sub>O.  
 (B) i) NaCN; ii) LiAlH<sub>4</sub>; iii) H<sub>2</sub>O.  
 (C) i) NaN<sub>3</sub>; ii) LiAlH<sub>4</sub>; iii) H<sub>2</sub>O.  
 (D) i) SOCl<sub>2</sub>; ii) excess NH<sub>3</sub>; iii) excess LiAlH<sub>4</sub>; iv) H<sub>2</sub>O.  
 (E) i) HNO<sub>3</sub>/H<sub>2</sub>SO<sub>4</sub>; ii) H<sub>2</sub>/Pt.

10. Which of the given ketones will give a positive haloform test?

- (A) 3-heptanone                      (B) cyclohexanone                      (C) 2-pentanone  
 (D) 3-hexanone                      (E) 2-methyl-3-hexanone

11. Molecular orbitals of equal energy are referred to as \_\_\_\_\_ orbitals.

- (A) nonbonding                      (B) hybridized                      (C) antibonding  
 (D) degenerate                      (E) bonding

12. Which of the choices is the electrophile for the Friedel-Crafts acylation of benzene?

- (A) aluminum chloride                      (B) carbanion                      (C) carbocation  
 (D) acylium ion                      (E) aluminum tetrachloride anion

13. A kinetically-controlled process describes a reaction that

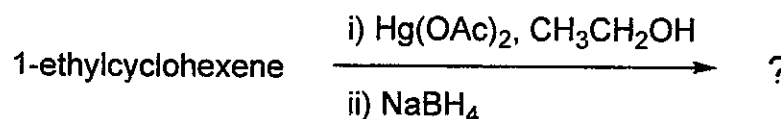
- (A) generates the most stable product.  
 (B) generates the product whose formation requires the smallest energy of activation.  
 (C) generates the product requiring the fewest steps.  
 (D) generates the product formed at the slowest rate.  
 (E) generates the product favored at high temperatures.

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14. Which of the statements given is true about the location of signals in a  $^1\text{H}$  NMR spectrum?

- (A) It indicates the number of neighboring protons.
- (B) It indicates the electronic environment of neighboring protons.
- (C) It indicates the electronic environment of absorbing protons.
- (D) It indicates the number of different protons.
- (E) It indicates the number of protons in the signal.

15. Predict the major product for the reaction shown.

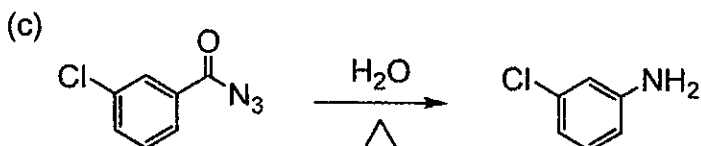
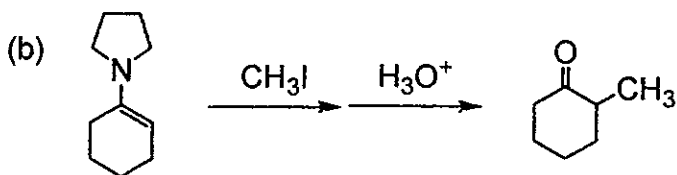
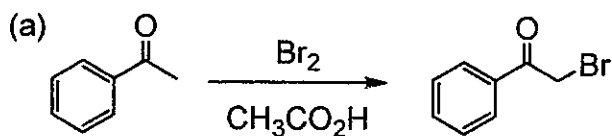


- (A) 1-ethylcyclohexanol
- (B) 2-ethoxy-1-ethylcyclohexane
- (C) 1-ethoxy-2-ethylcyclohexane
- (D) 2-ethylcyclohexanol
- (E) 1-ethoxy-1-ethylcyclohexane

Part II. 問答題 (2 題, 共 20 分) 請於試卷內之「非選擇題作答區」依序作答, 並應註明作答之大題及小題題號。

1. Provide structural features for the following groups or compounds; (a) *gem*-dichloride, (b) formyl, (c) trifluoromethanesulfonyl, and (d) azo compound. (8 points, 2 points/each)

2. Provide a step-by-step mechanism to account for the conversions. (12 points, 4 points/each)



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無機化學 (50 分) ※注意：第 16 至第 30 題選擇題考生應作答於 答案卡。

16. What is the total valence electron count in  $\text{Ru}(\text{NO})(\text{PPh}_3)_2\text{Cl}_3$ ? [2 pts]

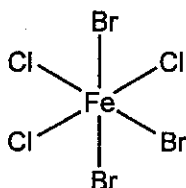
- A. 14
- B. 15
- C. 16
- D. 17
- E. 18

17. The oxidation state of the metal in the complex  $[\text{CpMo}(\text{CO})_3(\text{H}_2\text{O})]^+$  is: [2 pts]

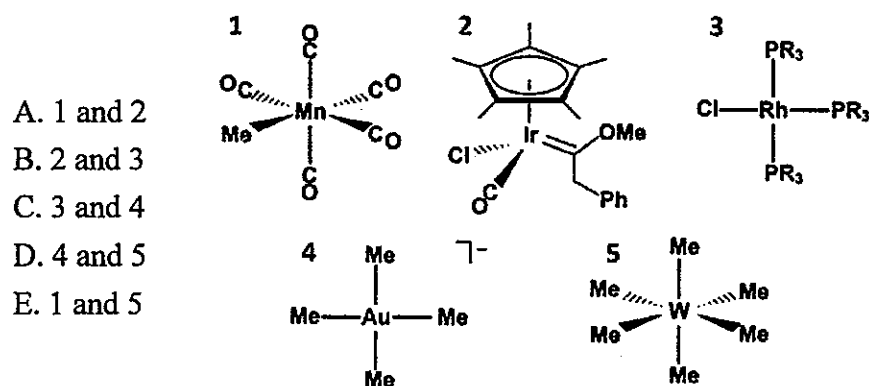
- A. -2
- B. -1
- C. 0
- D. +1
- E. +2

18. What is the point group of the below complex shown? [2 pts]

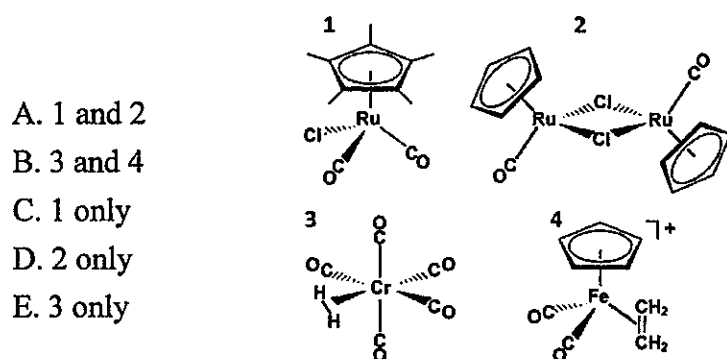
- A.  $C_2$
- B.  $C_{2v}$
- C.  $C_{3v}$
- D.  $D_{2h}$
- E.  $O_h$



19. Organometallic complexes of the late transition metals tend not to obey the 18-electron rule; many of them follow a 16-electron rule. Which of the complexes below is a 16-electron species? [2 pts]



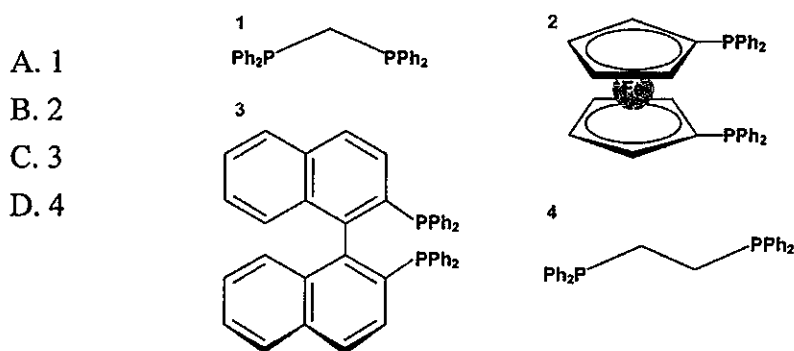
20. In which of the following complexes is there a 1-electron donor ligand? [2 pts]



21.  $N_2$  can act as a ligand in a similar way as CO. In comparison to CO, which of the following is true? [2 pts]

- A. It is a better  $\sigma$  donor and  $\pi$  acceptor.
- B. It is a better  $\sigma$  donor but poorer  $\pi$  acceptor.
- C. It is a poorer  $\sigma$  donor but a better  $\pi$  acceptor.
- D. It is a poorer  $\sigma$  donor and  $\pi$  acceptor.
- E. None of above is correct

22. Which of the following diphosphine is BINAP? (BINAP = 2,2-bis(diphenylphosphino)-1,1'-binaphthyl) [2 pts]



23. One of the following complexes does not contain a dihydrogen ligand. Which is likely?

(note: dppe = 1,2-bis(diphenylphosphino)ethane; Ph = phenyl; <sup>i</sup>Pr = isopropyl) [2 pts]

- A.  $MoH_2(CO)(dppe)_2$
- B.  $WH_2(CO)(dppe)_2$
- C.  $RuH_4(PPh_3)_3$
- D.  $[ReH_2(P^iPr_3)_3(CO)_3]^+$

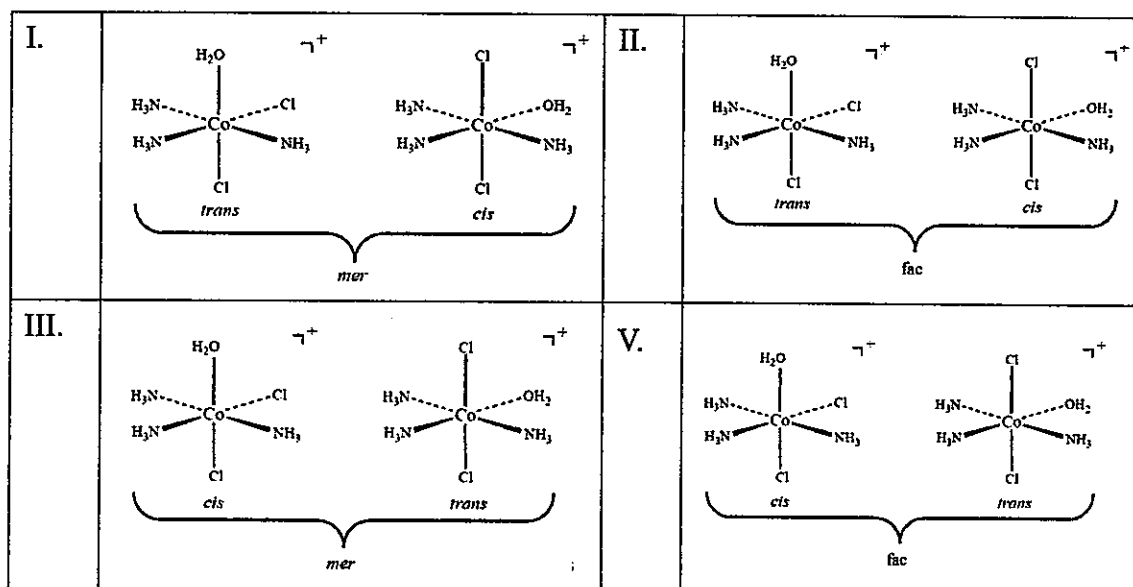
24. The primary decomposition pathway for transition metal alkyls is: [2 pts]

- A.  $\alpha$ -Hydrogen elimination
- B.  $\beta$ -Hydrogen elimination
- C.  $\gamma$ -Hydrogen elimination
- D. Reductive elimination
- E. Oxidation addition

25. In  $\beta$ -Hydrogen elimination, the following are true except: [2 pts]

- A. The metal center must have 18 valence electrons
- B. The metal center must have a vacant site
- C. There must be a hydrogen atom at the  $\beta$  position
- D. The M-C-C-H unit must be able to achieve coplanarity
- E. None of above is correct

26. Which of the following geometry isomers is correct? [2 pts]



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

27. What are the ALL possible magnetic moments of Co(II) in tetrahedral, octahedral, and square-planar complexes? [2 pts]

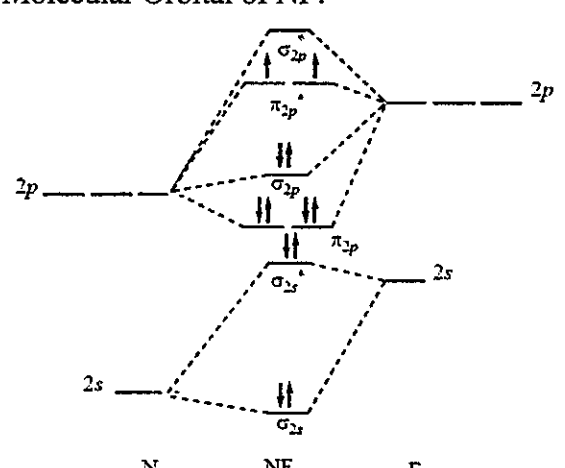
- I. Co(II) is  $d^7$ .
  - II. In tetrahedral complexes, it is generally high spin and has 3 unpaired electrons;
  - III. In octahedral complexes, it is also typically high spin and also has 3 unpaired electrons; in square planar complexes, it has 1 unpaired electron.
  - IV. The magnetic moments can be calculated as  $\mu = n(n+1) = 3.9, 3.9,$  and  $1.6$  mB, respectively.
- (A) I, II (B) I, II, III (C) I, II, III, IV (D) II, III, IV

28. Which of the following spin arrangement is NOT correct? [2 pts]

I	<p><math>[\text{Ti}(\text{H}_2\text{O})_6]^{3+}</math> with 2 unpaired electron. <math>d^1</math>:</p>
II.	<p><math>[\text{FeBr}_4]^-</math> with the maximum number of unpaired electrons (5).</p>
III.	<p><math>[\text{Co}(\text{CN})_6]^{3-}</math>.</p>
IV.	<p><math>[\text{M}(\text{H}_2\text{O})_6]^{2+}</math> having <math>\text{LFSE} = -\frac{3}{5}\Delta_o</math>. Both high spin <math>d^4</math> and <math>d^9</math> have the correct <math>\Delta_o</math>.</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>High spin <math>d^4</math>: M = Cr</p> <p><math>0.6\Delta_o</math></p> </div> <div style="text-align: center;"> <p><math>d^9</math>: M = Cu</p> <p><math>0.6\Delta_o</math></p> </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;"> <p><math>-0.4\Delta_o</math></p> </div> <div style="text-align: center;"> <p><math>-0.4\Delta_o</math></p> </div> </div>

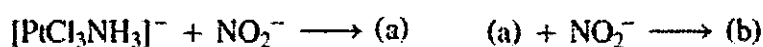
(A) II, III (B) I, III (C) I, IV (D) II, IV

29. NF is a known molecule. Which of the following description is correct? [2 pts]

I	<p>Molecular Orbital of NF:</p> 
II.	<p>NF is isoelectronic (has the same number of valence electrons) with O<sub>2</sub>. Therefore, NF is predicted to be paramagnetic with a bond order of 2. The populations of the bonding (8 electrons) and antibonding (4 electrons) molecular orbitals in the diagram suggest a double bond.</p>
III.	<p>The <math>\sigma_{2s}</math>, <math>\sigma_{2s}^*</math>, <math>\sigma_{2p}</math>, and <math>\sigma_{2p}^*</math> orbitals exhibit <math>C_{\infty v}</math> symmetry, with the NF bond axis the infinite-fold rotation axis.</p>
IV.	<p>The <math>\pi_{2p}</math> and <math>\pi_{2p}^*</math> orbitals exhibit <math>C_s</math> symmetry. The latter do not possess <math>C_2</math> rotation axes coincident to the infinite-fold rotation axis of the <math>\sigma</math> orbitals on the basis of the change in wave function sign upon crossing the nodes on the bond axis.</p>

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

30. Predict the products of these reactions [2 pts]

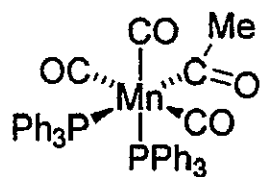


- I. (a) is *cis*-[PtCl<sub>2</sub>(NO<sub>2</sub>)(NH<sub>3</sub>)]<sup>-</sup>  
 II. (b) is *trans*-[PtCl(NO<sub>2</sub>)<sub>2</sub>(NH<sub>3</sub>)]<sup>-</sup>  
 III. Cl<sup>-</sup> has a larger *trans* effect than NH<sub>3</sub>, but smaller *trans* influence than NH<sub>3</sub>  
 IV. NO<sub>2</sub><sup>-</sup> has a larger *trans* effect than either Cl<sup>-</sup> or NH<sub>3</sub>.  
 (A) I and II    (B) I, II, III    (C) I, II, IV    (D) I, II, III, and IV

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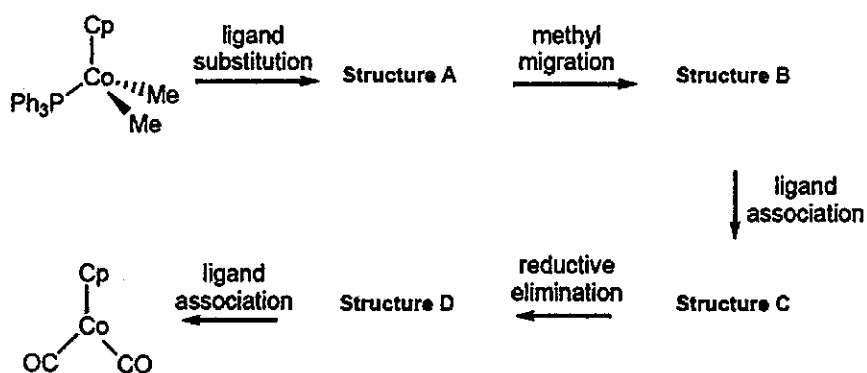
無機化學問答題請於試卷內之□非選擇題作答區□依序作答，並應註明作答之部分及題號。

1. Sketch the products of the reaction when the following complex loses (a) one PPh<sub>3</sub> or (b) one CO. It is important to note that losing one CO can result in two possible products. Draw all products.



Product by losing one PPh <sub>3</sub> : [2 pts]	First possible product by losing one CO ..[2 pts]
Second possible product by losing one CO [2 pts]	

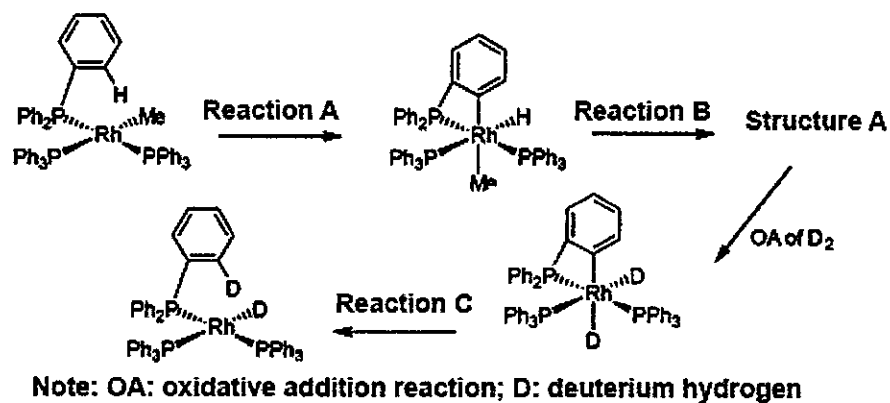
2. Suggest plausible products for the following reaction:



Structure A: ..... [2 pts]	Structure C: .....[2 pts]
Structure B: ..... [2 pts]	Structure D: .....[2 pts]



3. The complex  $\text{Rh}(\text{Me})(\text{PPh}_3)_3$  reacts with  $\text{D}_2$  to produce  $\text{Rh}(\text{D})(\text{PPh}_3)_2(\text{PPh}_2\{\text{C}_6\text{H}_4\text{D}\})$  and  $\text{CH}_4$ . Give reactions that explain by naming **Reaction A**, **Reaction B**, **Reaction C**, and drawing **Structure A** below.



Reaction A: ..... [1 pts]	Reaction C: ..... [1 pts]
Reaction B: ..... [1 pts]	Structure A: ..... [3 pts]

試題隨卷繳回