I. Picking the most suitable answer (each question 4 points)

1. Which molecule would you expect to have no dipole moment (i.e., $\mu = 0$)?
   - (A) CHF₃
   - (B) \( \text{C} = \text{C} \) \text{F}
   - (C) NF₃
   - (D) \( \text{F} = \text{F} \) \text{C}
   - (E) CH₂F₂

2. The compound shown below is a synthetic estrogen. It is marketed as an oral contraceptive under the name Enovid.

   ![Chemical Structure](image_url)

   In addition to an alkane (actually cycloalkane) skeleton, the Enovid molecule also contains the following functional groups:
   - (A) Ether, alcohol, alkyn
   - (B) Aldehyde, alkene, alkyn, alcohol
   - (C) Ketone, alkane, alcohol, alkyn
   - (D) Alcohol, carboxylic acid, alkene, alkyn
   - (E) Amine, alkene, ether, alkyn

3. The strongest of attractive forces is which type?
   - (A) van der Waals
   - (B) Ion-dipole
   - (C) Dipole-dipole
   - (D) Cation-anion
   - (E) Hydrogen bond

4. Which is the weakest nucleophile in polar aprotic solvents?
   - (A) I⁻
   - (B) Br⁻
   - (C) Cl⁻
   - (D) F⁻

5. Based on the position of the central atom in the periodic chart, we predict that the strongest acid of the following is:
   - (A) H₂O
   - (B) H₂S
   - (C) H₂Se
   - (D) H₂Te

6. Which carbocation would be most stable?
   - (A) I
   - (B) II
   - (C) III
   - (D) IV
   - (E) V

7. cis-1,3-Dibromocyclohexane is represented by structure(s):

   ![Chemical Structures](image_url)

   - (A) I
   - (B) II
   - (C) III
   - (D) II and III
   - (E) I and II
8. Which cycloalkane has the largest heat of combustion per CH₂ group?

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

9. Which of the following is bicyclo[3.2.2] nonane?

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

10. Pairs of enantiomers are:

   \[
   \begin{align*}
   &\text{I} \quad \begin{array}{c}
   \text{CH₃} \\
   \text{CH₂CH₂CH₃}
   \end{array} \\
   &\text{II} \quad \begin{array}{c}
   \text{Cl} \\
   \text{CH₂CH₂CH₃}
   \end{array} \\
   &\text{III} \quad \begin{array}{c}
   \text{H} \\
   \text{CH₂CH₂CH₃}
   \end{array} \\
   &\text{IV} \quad \begin{array}{c}
   \text{CH₂CH₂CH₃} \\
   \text{H}
   \end{array} \\
   &\text{V} \quad \begin{array}{c}
   \text{Cl} \\
   \text{CH₂CH₂CH₃}
   \end{array}
   \end{align*}
   \]

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

11. Which of the following is a meso compound?

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

12. Which of the following statements is (are) true of S₉₁ reaction of alkyl halides in general?
(A) The rate of an S₉₁ reaction depends on the concentration of the alkyl halide.
(B) The rate of an S₉₁ reaction depends on the concentration of the nucleophile.
(C) S₉₁ reaction of alkyl halides are favored by polar solvents.
(D) Answers (A) and (C) are true.
(E) Answers (A), (B), and (C) are true.

13. Which molecule would have the lowest heat of hydrogenation?

(A) I  (B) II  (C) III  (D) IV  (E) V
14. The addition of bromine to cyclohexene would produce the compound(s) represented by structure(s):

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

15. Which reaction would you expect to have the smallest energy of activation?

\[
\begin{align*}
(A) \quad CH_3^* + CH_3^* & \rightarrow CH_3CH_3 & \Delta H^* \ (\text{Kcal mol}^{-1}) \\
(B) \quad CH_3^* + F^- & \rightarrow CH_3^* + HF & -88 \\
(C) \quad CH_3^* + I^- & \rightarrow CH_3^* + HI & -32 \\
(D) \quad CH_3^* + Br^- & \rightarrow CH_3^* + HBr & +16.5 \\
(E) \quad CH_3^* + Cl^- & \rightarrow CH_3^* + HCl & +1
\end{align*}
\]

II. 請填寫正確產物（每題 5 分）

16. 

\[
\begin{align*}
\text{CH}_3 & \quad \text{Hg(OAc)}_2 & \quad \text{NaBH}_4 & \quad \text{OH}^- \\
\text{THF, } \text{H}_2\text{O} & \quad & & \\
\end{align*}
\]

17. 

\[
\begin{align*}
\text{OH}^- & \quad \text{CH}_3\text{SO}_2\text{Cl} & \quad \text{NaI} & \quad \text{ethanol} \\
\text{base} & \quad & & \\
\end{align*}
\]

18. (i) CH₃MgBr  

(ii) H₃O⁺

19. 

\[
\begin{align*}
\text{Cl} & \quad \text{Cl} & \quad \text{Cl} & \quad \text{Cl} & \quad \text{CH}_2\text{Cl}_2 & \quad \text{C}_5\text{H}_4\text{C}_6\text{H}_4 \\
\end{align*}
\]

20. 

\[
\begin{align*}
\text{Br}_2 & \quad \text{FeBr}_3 \\
\text{catalyst} & \quad \\
\end{align*}
\]

21. 

\[
\begin{align*}
\text{NBS} & \quad \text{light} \\
\end{align*}
\]

22. (i) KMnO₄, OH⁻  

(ii) H₃O⁺

23. tert-butyl methyl ketone + RCOOH 

\[
\begin{align*}
\end{align*}
\]
第二部分：分析化學共 100 分

1. How can systematic errors be detected?  (20 分)

2. Name the main classifications of quantitative analysis in analytical chemistry.  (20 分)

3. What is "standard addition method"?  What is its main application?  (20 分)

4. Define "buffer capacity".  (20 分)

5. Define the following terms (A) precision (B) accuracy (C) median (D) mean  (20 分)