一、選擇題（皆為單選題）：30 題，每題 2 分，共 60 分

※注意：請於試卷上「選擇題作答區」依序作答。

1. Which is the strongest base?　(A) $CH_4$　(B) $CH_3NH^-$　(C) $CH_3O^-$　(D) $Cl^-$

2. The following compounds have similar molecular weights. Which has the highest boiling point?
(A) $CH_3CH{=}O$　(B) $CH_3CH_2CH_3$　(C) $C_2H_5OH$　(D) $CH_3OCH_3$

3. In order for a reagent to behave as a nucleophile, it must have
(A) a nitrogen or sulfur atom.　(B) an overall negative charge.
(C) a non-bonding electron pair.　(D) an overall positive charge.

4. Which of the following compounds does NOT have isomers?
(A) $CH_3CH_2CH_2Cl$　(B) $CH_3CHO$　(C) $CH_2{=}CHCl$　(D) $ClCH_2CH_2Cl$

5. Which of the following molecules is most likely to exist primarily in a planar conformation?
(A)  　(B)  　(C)  　(D) 

6. Which of the molecules below can hydrogen-bond to water but NOT to itself?
(A) $CH_3CH_2OCH_2CH_3$　(B) $CH_3CH_2COOH$　(C) $(CH_3CH_2)_2CHOH$　(D) $CH_3CH_2NHCH_2CH_3$

7. Which of the following $C_6H_{12}$ isomers has the largest heat of combustion?
(A) Cyclohexane　(B) Methylcyclopentane　(C) Ethylcyclobutane　(D) Propylcyclopropane

8. Reactions that release a large amount of heat are often very favorable reactions. What reactions are such reactions often referred to?
(A) Entropy driven　(B) Enthalpy driven　(C) Free energy driven　(D) Activation energy driven

9. Chemists determine the activation energy for a reaction by
(A) measuring product amounts.　(B) calculating from bond dissociation energies.
(C) measuring reaction rates.　(D) calculating from $\Delta H$ values.

10. Catalysts alter the kinetics of a reaction by
(A) lowering the energy of activation for the reaction.
(B) making the products more stable.
(C) making the reaction more exothermic.
(D) providing a source of free radicals to initiate a reaction.

11. Which of the following olefins would react most rapidly with concentrated sulphuric acid?
(A) $H_2C{=}CH_2$　(B) $(CH_3)_2C{=}CH_2$　(C) $Cl_2C{=}CCl_2$　(D) $CF_3CH{=}CH_2$

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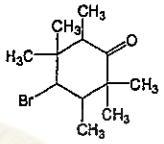
12. Which of the following must be true for an optically active compound?
(A) The molecular configuration must have two or more stereogenic centers.
(B) The molecular configuration is chiral.
(C) The compound is a racemic mixture of enantiomers.
(D) The molecular configuration is achiral.

13. Pure (S)-2-butanol has a specific rotation of +13.52 degrees. A sample of 2-butanol purified by distillation has a calculated specific rotation of +6.76 degrees. What can you conclude about the composition?
(A) 75% of the sample has racemized.　(B) 50% the sample has rearranged into a meso isomer.
(C) 50% of the sample has racemized.　(D) The sample has completely racemized.

14. How many stereoisomers are possible for this molecule?
(A) 8　(B) 6　(C) 3　(D) 2

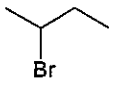



15. Chloroethane, $C_2H_5Cl$, does not react with methanol under mild conditions. What reagent could be added to the reaction mixture to increase the rate of substitution?
(A) HCl　(B) $AgNO_3$　(C) NaOH　(D) $NH_4OH$

16. Which of the following alkyl halides will react more quickly in the E1 reaction?
(A) 

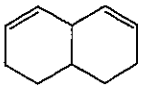
(B) 

(C) 

(D) 


17. A polar aprotic solvent like acetone or THF is a good solvent to use for which of the following type of reaction?
(A) E1 reaction　(B) E2 reaction　(C) $S_N1$ reaction　(D) $S_N2$ reaction

18. Indicate which spectral technique would best be used to distinguish between the following compounds:
(A) UV Spectroscopy　(B) IR Spectroscopy
(C) Mass Spectrometry　(D) $^1H$ NMR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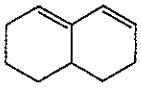

19. Which C=O function has the lowest stretching frequency in the infrared spectrum?
(A) Acyl chloride　(B) Amide　(C) Aldehyde　(D) Ester

20. Which of the following alcohols will dehydrate under the mildest conditions of acid concentration and temperature?　(A) $CH_3OH$　(B) $(CH_3)_2CHOH$　(C) $CH_2CH_2OH$　(D) $(CH_3)_3COH$

21. The methyl and ethyl esters of many amino acids are sold commercially as their hydrochloride salts. Why are these derivatives not sold in the form of the neutral amino esters?
(A) An extra step in their preparation would be required.
(B) Rearrangement to the N-alkylamino acid takes place.
(C) Polymerization takes place by acylation of amine groups by an ester.
(D) The salts are solids, whereas many amino esters are liquids and are difficult to package.

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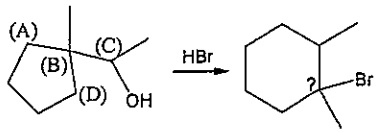
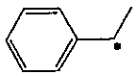
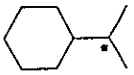
22. Which of the following statements about benzene is INCORRECT?
(A) It undergoes electrophilic substitution reactions rather than electrophilic addition reactions.
(B) It is less reactive than hexatriene ($CH_2$=CH-CH=CH-CH=$CH_2$).
(C) The carbon-carbon bond lengths are longer than ethane.
(D) The carbon-carbon bond lengths are all the same.

23. In the reaction shown below, the carbon bonded to Br was originally which carbon?




24. Which of the following is the most stable free radical?

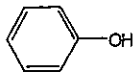
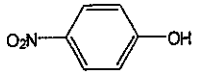
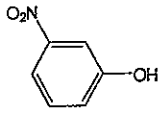
(A)  　(B) $\bullet CF_3$　(C)  　(D) 

25. Which is NOT characteristic of a free radical chain reaction?
(A) It gives the product derived from the most stable free radical.
(B) It produces a mole of product for a mole of free radical initiated.
(C) It may be initiated by peroxides.
(D) It may be initiated by ultraviolet light.

26. Which of the following statements is NOT true?
(A)C=O is stronger than an equivalent C=C.
(B)The nitrogen hybridization of an amine oxide is $sp^3$.
(C)Fischer esterification of acids with alcohols requires a strong base catalyst.
(D)Amide hydrolysis may be carried out with either strong acid or base catalysis.

27. Which of the following reagents would be best for converting phenylacetamide ($C_6H_5CH_2CONH_2$) to phenethylamine ($C_6H_5CH_2CH_2NH_2$)?
(A) $H_2$ and Pt catalyst　(B) Aqueous NaOBr　(C) $LiAlH_4$ in ether　(D) $NaBH_3CN$

28. Rank the following molecules in order of acidity:

(I)  　(II)  　(III) 

(A)II > III > I　(B) II > I > III　(C) I > II > III　(D) I > III > II　(E) III > II > I

29. Which of the following aldehydes used alone will undergo an aldol reaction?
(A) $CH_2O$　(B) $CH_3(CH_2)_2CHO$　(C) $C_6H_5CHO$　(D) $CH_2$=CHCHO

30. The reaction between carbon dioxide and a Grignard reagent will yield
(A) an alcohol.　(B) an alkylmagnesium halide.　(C) magnesium carbonate.　(D) a carboxylic acid.

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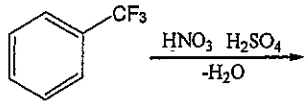
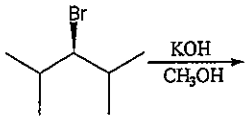
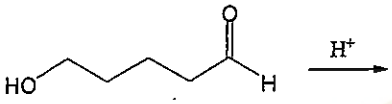
二、問答題：共 40 分

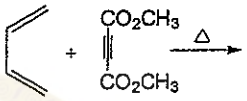
※注意：請於試卷上「非選擇題作答區」依序作答，並註明作答之題號。

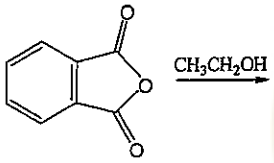
1. Draw the structure of the MAJOR product of the following reactions. (21%)

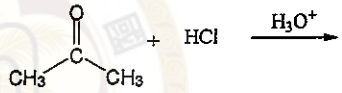
(a) 

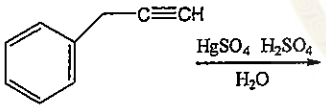

(b) 


(c) 

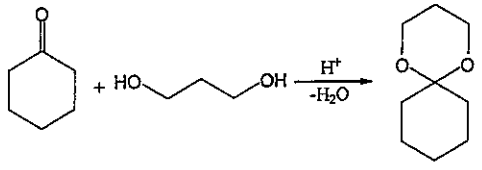

(d) 

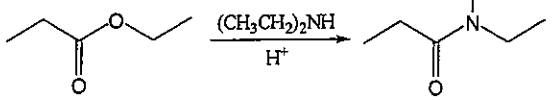

(e) 


(f) 


(g) 


2. Write the complete stepwise mechanism for the following reactions. Show all electron flow with arrows and include all intermediate structures. (10%)

(a) 


(b) 


3. Below are shown three $^1$H NMR data of $C_4H_8Cl_2$ isomers. Draw the corresponding structures. (9%)
(a) δ=1.5 (d, 6H) and 4.1 (quin, 2H) ppm
(b) δ=1.6 (d, 3H), 2.1 (q, 2H), 3.6 (t, 2H), and 4.2 (sex, 1) ppm
(c) δ=1.0 (t, 3H), 1.9 (quin, 2H), 3.6 (d, 2H), and 3.9 (quin, 1) ppm

**試題隨卷繳回**