注意：本試題包含單選題及問答題兩部份

Part I. 單選題 （30 題，60 分）

1. The IUPAC name for $CH_3CH_2CHBrC(CH_3)_3$ is:
(A) 3-bromoheptane (B) 2-bromo-1,1,1-trimethylbutane (C) *t*-butylpropyl bromide
(D) 3-bromo-2,2-dimethylpentane (E) 3-bromo-1-dimethylpentane

2. What statement does NOT apply to the boiling points of alkanes?
(A) The boiling point increases as the length of the carbon chain increases.
(B) Straight chain alkanes have a higher boiling point than their branched isomers.
(C) The boiling points are influenced by hydrogen bonding.
(D) Because they are nonpolar, alkanes have lower boiling points than other organic compounds of similar molar mass.
(E) The boiling points are affected by Van der Waals attractions.

3. For the most stable conformation of *trans*-1,2-dimethylcyclohexane:
(A) both methyls will occupy the axial position.
(B) one methyl will occupy the axial position and the other an equatorial position.
(C) both methyls will occupy the equatorial position.
(D) more than one answer is correct.
(E) none of the above.

4. In the chlorination of methane, the propagation steps involve forming:
(A) H radicals (B) methyl radicals (C) chlorine radicals (D) A, B, and C (E) B and C

5. The double bond in ethane is made up of
(A) a pi bond and a sigma bond formed by lateral overlap of two *p* orbitals.
(B) a sigma bond formed by overlap of two s orbitals and a pi bond formed by lateral overlap of two p orbitals.
(C) a sigma bond formed by end-on overlap of two sp^2 orbitals and a pi bond formed by lateral overlap of two *p* orbitals.
(D) a pi bond formed by end-on overlap of two sp^2 orbitals and a sigma bond formed by overlap of two *s* orbitals.
(E) a pi bond formed by lateral overlap of two sp^2 orbitals and a sigma bond formed by end-on overlap of two sp^2 orbitals.

6. Addition of H_2 to 2-butyne in the presence of the Lindlar's catalyst will produce:
(A) butane (B) isobutylene (C) *trans*-2-butene (D) 1-butene (E) *cis*-2-butene

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7. What type of compound is formed when a secondary alcohol is treated with Jones' reagent?
(A) an alkene (B) an alkyne (C) an aldehyde (D) an ketone (E) an acid

8. Upon ozonolysis which alkene will give only acetone?
(A) 3-hexene (B) 2-methyl-3-hexene (C) 2,3-dimethyl-2-butene
(D) 2-methyl-2-pentene (E) 2,2-dimethyl-2-butene

9. Markovnikov addition of HCl to propene involves:
(A) initial attack by the chloride ion (B) formation of a propyl cation
(C) initial attach by the chlorine atom (D) formation of an isopropyl cation
(E) isomerization of 1-chloropropane

10. In the mechanism for the nitration of benzene, what is the function of H_2SO_4?
(A) to act solely as a solvent (B) to accept a proton from HNO_3 (C) to generate heat for reaction to occur
(D) to donate a proton to HNO_3 (E) to protonate the benzene ring

11. If *p*-nitrophenol is treated with chlorine in the presence of $AlCl_3$, the only trisubstituted product observed is:
(A) 3-chloro-4-nitrophenol (B) 2-chloro-4-nitrophenol (C) 4-chloro-3-nitrophenol
(D) 4-chloro-2-nitrophenol (E) 3-chloro-5-nitrophenol

12. The observed rotation for 100 mL of an aqueous solution containing 1 g of sucrose, placed in a 2-decimeter sample tube, is +1.33° at 25 °C. What is the specific rotation of sucrose?
(A) +66.5° (B) +266° (C) +133° (D) +41.5° (E) none of the above

13. The reaction of a Grignard reagent with acetaldehyde followed by acid hydrolysis will produce what type of product?
(A) a primary alcohol (B) a secondary alcohol (C) a tertiary alcohol
(D) an acid (E) a ketone

14. What alkene reacts with methanol in an acid catalyzed reaction to produce *tert*-butyl methyl ether?
(A) ethylene (B) 2-methylpropene (C) 2-butene (D) propene (E) 1-butene

15. Which statement is true for S_N2 reactions?
(A) The rate of the reaction is dependent on the stability of a carbocation.
(B) The rate of the reaction is dependent on just the substrate.
(C) Displacement occurs with inversion of configuration.
(D) The fastest reaction will occur with tertiary halide.
(E) The mechanism is a two step process.

接次頁

16. Which statement is FALSE? *tert*-Butyl alcohol reacts
(A) with HCl to give 2-methylpropene by an E1 mechanism.
(B) with HCl to give 2-chloro-2-methylpropane by an S_N1 mechanism.
(C) with HCl and HBr at very different rates.
(D) with HCl or HBr to give a carbocation intermediate.
(E) with HCl to give both 2-methylpropene and 2-chloro-2-methylpropane.

17. Enantiomers may differ in the following property:
(A) boiling point (B) melting point (C) solubility in water
(D) the rate at which they react with a chiral reagent (E) number of degree they rotate plane polarized light

18. When cyclohexene is treated with peroxyacetic acid, the product that forms is:
(A) dicyclohexyl ether (B) 1,2-cyclohexanediol (C) hexanol
(D) cyclohexene oxide (E) none of the above

19. The equilibrium that exists between the keto and enol forms of aldehydes and ketones is known as:
(A) stereoisomerism (B) positional isomerism (C) tautomerism
(D) geometric isomerism (E) configurational isomerism

20. When (*S*)-3-bromo-1-butene is treated with HBr, two stereoisomeric products form. What is the relationship of these two products?
(A) enantiomers (B) diastereomers (C) meso compounds (D) racemic mixture (E) cis/trans

21. What is the stereochemical relationship of the products formed by reacting racemic lactic acid with (*S*)-1-phenylethylamine?
(A) enantiomers (B) meso compounds (C) racemic mixture
(D) diastereomers (E) none of the above

22. The mechanism by which acylation of an amine with an acid chloride takes place is:
(A) nucleophilic acyl substitution (B) electrophilic aromatic substitution (C) nucleophilic addition
(D) electrophilic addition (E) nucleophilic aromatic substitution

23. In a carbonyl group
(A) the oxygen acts as Lewis acid.
(B) the carbon is sp^3 hybridized.
(C) the C=O bond length is shortened due to resonance.
(D) the carbon is nucleophilic and the oxygen is electrophilic.
(E) the carbon is electrophilic and the oxygen is nucleophilic.

24. Vulcanization is a process to strengthen natural rubber by crosslinking polymer chains with what element?
(A) sodium (B) titanium (C) sulfur (D) phosphorus (E) aluminum

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25. Which of the following molecules would be classified as a synthetic detergent?
(A) $CH_3(CH_2)_{11}OSO_3^-Na^+$　(B) $CH_3(CH_2)_{10}CO_2^-Na^+$　(C) $CH_3(CH_2)_{10}CH_2OH$
(D) $CH_3(CH_2)_{14}CO_2H$　(E) $CH_3(CH_2)_{10}CH_2O^-Na^+$

26. What two families of compounds react to give a polyurethane?
(A) alcohol/isocyanate　(B) acid/ester　(C) amine/amide　(D) amine/ester　(E) isocyanate/amine

27. The rate determining step in the following reaction is:

$$CH_3CH_2CH_2OH + HBr \xrightarrow{\text{heat}} CH_3CH_2CH_2Br + H_2O$$

(A) protonation of the alcohol.
(B) ionization of the alcohol to give a carbocation.
(C) loss of water from the protonated alcohol to give a carbocation.
(D) capture of a carbocation by bromide ion.
(E) displacement of water from the protonated alcohol by bromide ion.

28. The boiling point of propanoic acid is higher than that of 1-butanol because:
(A) propanoic acid has a higher molecular weight than 1-butanol.
(B) propanoic acid is more soluble in water than 1-butanol.
(C) propanoic acid forms hydrogen bonded dimers and 1-butanol does not.
(D) 1-butanol forms hydrogen bonded dimers and propanoic acid does not.
(E) none of the above.

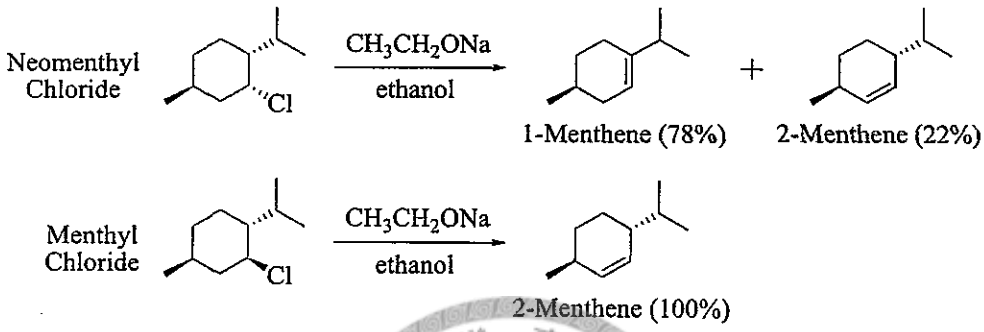
29. The difference between the pyranose and furanose forms of a given aldohexose is:
(A) ring size　(B) the configuration of the anomeric carbon　(C) the type of functional groups
(D) the number of functional groups　(E) none of the above

30. What structural feature is common to all steroids?
(A) all have unsaturation　(B) all contain ketone functionality　(C) all are aromatic
(D) all have three six membered rings and on five membered ring fused together　(E) none of the above

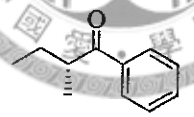
接次頁

Part II. 問答題 （3 題，40 分）

1. Treatment of neomenthyl chloride with NaOEt gives mainly 1-menthene, whereas menthyl chloride gives 2-menthene as the only product and at a much slower rate. Please explain these experimental results. (15 points)



2. When a solution of (+)-2-methyl-1-phenylbutan-1-one (shown below) in aqueous ethanol is treated with either acids of bases, the solution gradually loses its optical activity. Please account for this observation. (10 points)



3. Please give structural formula for the intermediates **A** and **B**, and propose a mechanism for the formation of product from the intermediate **B**. (15 points)