

成功大學材料系 93 學年度碩士班研究生入學考試試題

B 卷：普通化學、熱力學、有機化學。共 90 題，滿分 90 分。倒扣至零分為止。

科目名稱：普通化學

每題為 4 選 1，每一題答對得 1 分，答錯倒扣 0.25 分。

- To accelerate a chemical reaction, which one is NOT the means to be taken?
 - to increase pressure or to decrease volume for a reaction
 - to add much more reactants
 - to increase heat for the endothermic reaction
 - to approach the lowest Gibbs free energy.
- Proton has the charge of
 - 1
 - +1
 - none
 - +2.
- $(A)FeCr_2O_4(s) + (B)K_2CO_3(s) + (C)O_2(g) \rightarrow (D)K_2CrO_4(s) + (E)Fe_2O_3(s) + (F)CO_2(g)$.
When the equation is balanced,
 - $A + E > B + D$
 - $A + C > D + F$
 - $B = D$
 - $C = F$.
- For the following species, which one has the highest acid strength:
 - F
 - CN⁻
 - H₂O
 - NO₂⁻.
- Infrared Spectroscopy is capable to determine the wavelengths of
 - atomic absorption
 - photoelectron emission
 - molecular rotation and vibration
 - molecular binding energy.
- The following description: "neutral species with a carbon that has only three bonds and seven outer-shell electrons, one of which is unpaired" is correlated with:
 - carbocation
 - free radical
 - carbanion
 - electron attachment.
- For the following descriptions of buffered solutions, which one is NOT correct?
 - an application of acid-base solution
 - resistance to a pH change when either hydroxide ions or protons are added
 - like human blood, to absorb the acids and bases
 - a strong acid and its salt or a strong base and its salt.

(背面仍有題目,請繼續作答)

8. For the enthalpy change ΔH and the entropy change ΔS of a process, a spontaneous result for all temperatures will occur when
① $\Delta S > 0, \Delta H < 0$ ② $\Delta S > 0, \Delta H > 0$ ③ $\Delta S < 0, \Delta H < 0$ ④ $\Delta S < 0, \Delta H > 0$
9. Combined the First Law with the Second Law of Thermodynamics, $dU + PdV =$
① SdT ② TdS ③ $-SdT$ ④ $-TdS$.
10. The alkaline dry cell lasts longer than the acidic cell mainly because the zinc anode corrodes less rapidly under basic conditions than under acidic conditions. Here the verb "corrodes" means
① energy loses ② heat transfer ③ cathode reaction ④ anode reaction.
11. The largest radius of the following ions is ① Be^{2+} ② Mg^{2+} ③ Ca^{2+} ④ Sr^{2+} .
12. Diamond is the hardest naturally occurring substance because the structure is stabilized by
① covalent bonds ② metallic bonds ③ ionic bonds ④ van der Waal force.
13. Which factor will NOT affect solubility?
① structure ② pressure ③ temperature ④ total volume.
14. Which description of Titanium is incorrect?
① high fretting wear resistance ② high strength
③ in white color ④ TiO_2 as the oxide form.
15. Which one is NOT a spontaneous process?
① corrosion ② metal melting with the increase of heat absorption
③ purification of sea water ④ air pollution in a city.
16. Which of the following pair of elements should combine to give covalent compound?
① $\text{N}_2 + \text{O}_2$, ② $\text{Cl}_2 + \text{Cr}$, ③ $\text{S}_8 + \text{Na}_2$, ④ $\text{Cu} + \text{Sn}$

17. What is the empirical formula of the compound that contains 0.483 grams of nitrogen and 1.104 grams of oxygen? (A) N_2O , (B) NO , (C) NO_2 , (D) N_2O_3
18. Which of the following graphs does not give a straight line for an ideal gas?
(A) V versus T, (B) T versus P, (C) P versus $1/V$, (D) n versus $1/P$
19. Which of the following reaction could do work of expansion on its surroundings?
(A) $CH_4(g) + 2 O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$
(B) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
(C) $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$
(D) $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$
20. Which of the following sets of orbitals is arranged in order of increasing energy?
(A) $3d < 4s < 4p < 5s < 4d$, (B) $3d < 4s < 4p < 4d < 5s$,
(C) $4s < 3d < 4p < 5s < 4d$, (D) $4s < 3d < 4p < 4d < 5s$
21. Which of the following species does not have an electron configuration of $1s^2 2s^2 2p^6$?
(A) O^{2-} , (B) F^- , (C) Al^{3+} , (D) Ca^{2+}
22. Which of the following elements of the most electronegative?
(A) S, (B) Cl, (C) P, (D) Br
23. Which of the following does not contain a double bond?
(A) N_2 , (B) CO_2 , (C) C_2H_4 , (D) NO_2
24. Identify the reducing agent in the following reaction:
$$Cu(s) + Ag^+(aq) \rightarrow Cu^{2+}(aq) + Ag(s)$$

(A) $Cu(s)$, (B) $Ag^+(aq)$, (C) $Cu^{2+}(aq)$, (D) $Ag(s)$
25. Which of the following metal elements is the most abundant in earth crust?
(A) Au, (B) Al, (C) Ag, (D) Cu

(背面仍有題目,請繼續作答)

26. Which of the following species in the atmosphere is mainly responsible for producing acid rain? (A) SO_2 , (B) O_2 , (C) N_2 , (D) H_2
27. Most transition metals have more than one oxidation state. Which of the following elements has the most number of different oxidation states?
(A) Ti, (B) Fe, (C) Mn, (D) Ni
28. Increasing the temperature of a liquid will do which of the following?
(A) Increase its boiling point, (B) Increase its melting point,
(C) Increase its vapor pressure, (D) Increase the amount of heat required to boil a mole of the liquid
29. For the following reaction:
$$\text{ClNO}_2(\text{g}) + \text{NO}(\text{g}) \rightleftharpoons \text{NO}_2(\text{g}) + \text{ClNO}(\text{g})$$

The forward reaction rate constant k_f is $7300 \text{ L/mol}\cdot\text{s}$, while the reverse reaction rate constant k_r is $0.55 \text{ L/mol}\cdot\text{s}$. What is the equilibrium constant K_{eq} for the above reaction?
(A) 4.0×10^3 , (B) 1.3×10^4 , (C) 7.5×10^{-5} , (D) 2.5×10^{-5}
30. Which of the following reactions occurs at the anode during electrolysis of a molten NaCl?
(A) $\text{Na}(\text{s}) \rightarrow \text{Na}^+(\text{aq}) + \text{e}^-$, (B) $2\text{Cl}^- \rightarrow \text{Cl}_2(\text{g}) + 2\text{e}^-$,
(C) $\text{H}_2(\text{g}) \rightarrow 2\text{H}^+(\text{aq}) + 2\text{e}^-$, (D) none of the above.

科目名稱：熱力學

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31. Which property is not a thermodynamic property?
① heat capacity; ② heat conductivity; ③ activity; ④ chemical potential.
32. Enthalpy is equivalent to heat when
① pressure is constant; ② volume is constant;
③ temperature is constant; ④ entropy is constant.
33. The infinitesimal variation of Gibbs free energy with temperature at constant pressure defines ① volume; ② entropy; ③ enthalpy; ④ internal energy.
34. Which is necessary for a phase transition to occur?
① decrease in enthalpy; ② decrease in free energy;
③ decrease in entropy; ④ decrease in internal energy.
35. A process of a system in contact with a pressure reservoir may be considered as an
① isobaric process; ② isothermal process;
③ isometric process; ④ isentropic process.
36. Which property has an inexact differential?
① entropy; ② enthalpy; ③ internal energy; ④ work.
37. Activity may be obtained directly from the measurement of
① heat; ② temperature; ③ thermal conductivity; ④ partial pressure.
38. Which is a condition of a regular solution?
① enthalpy of mixing = 0;
② entropy of mixing = 0;
③ Gibbs free energy of mixing = 0;
④ entropy of mixing = entropy of mixing of an ideal solution.
39. At what temperature can C_p and C_v of pure water be equal?
① 0°C ; ② 4°C ; ③ 25°C ; ④ 100°C

(背面仍有題目,請繼續作答)

40. Which statement can best describe the second law of thermodynamics?
- (A) total energy of the universe remains constant;
 (B) total entropy of the universe remains constant;
 (C) total entropy of the universe keeps increasing;
 (D) total entropy of the universe keeps decreasing.
41. Which of the follows is NOT a unit of pressure?
- (A) kg/m^2 ; (B) $\text{N}\cdot\text{s/m}^2$; (C) bar; (D) Pa.
42. At $T=300\text{K}$ and $P=50000\text{Pa}$, the volume of one mole ideal gas is
- (A) 49.8 liters; (B) 22.4 liters (C) 4.92 cm^3 ; (D) 1 liter.
43. The initial state of one more gas is $P_1=1\text{ atm}$, $V_1=10\text{ liters}$ and the final state of the gas is $P_2=10\text{ atm}$, $V_2=2\text{ liters}$. What is the work done by the gas during the process?
- (A) 10 liter-atm; (B) -10 liter-atm;
 (C) -1000 joules; (D) cannot be determined.
44. The internal energy (U) and the enthalpy (H) of a system are related by:
- (A) $dH=dU+PdV$; (B) $dH=dU+VdP$;
 (C) $H=U+PV$; (D) $dH=dU+\delta q_p+PdV$ (δq_p is heat absorbed at constant pressure).
45. When a gas expands adiabatically and reversibly, which of the following statements is NOT correct?
- (A) no change of entropy for the gas;
 (B) the gas does no work;
 (C) the gas pressure decreases;
 (D) the temperature decreases.
46. Consider one mole of ideal gas undergoing a reversible adiabatic process, then
- (A) $c_v dT=-PdV$; (B) $c_p dT=PdV$;
 (C) $(P_1 V_1)^\gamma=(P_2 V_2)^\gamma$, where $\gamma=c_p/c_v$; (D) $c_v \ln(T_1/T_2)=R \ln(V_1/V_2)$.
47. Which one of the following statements is correct?
- (A) The entropy of a system will remain unchanged during a reversible process.
 (B) It is impossible that the entropy of a system decreases during any process.
 (C) The entropy of a closed system increases when the system undergoes an irreversible process.
 (D) None of above is correct.

48. In a steam engine, steam enters at $800\text{ }^{\circ}\text{C}$ and is exhausted at $120\text{ }^{\circ}\text{C}$. What is the maximum efficiency of this engine?
 (A) 0.63; (B) 0.52.; (C) 0.85; (D) 0.72.
49. What is the correct process for a Carnot engine?
 (A) Two constant-pressure steps and two-constant volume steps;
 (B) two isothermal steps and two constant-entropy steps;
 (C) two isothermal steps and two constant-volume steps;
 (D) two adiabatic steps and two constant-pressure steps.
50. The change of entropy for one mole of an ideal gas during a constant-volume process (from state 1 to state 2) is
 (A) $c_p \ln(P_2/P_1)$; (B) $R \ln(P_2/P_1)$; (C) $c_v \ln(T_2/T_1)$; (D) $c_p \ln(T_2/T_1)$.
51. In a diagram showing the variation of the change in the Gibbs free energy for a reaction with temperature, the positive slope indicates that
 (A) the entropy for the reaction will increase when the temperature increases
 (B) the enthalpy for the reaction will increase when the temperature increases
 (C) the entropy for the reaction will decrease when the temperature increases
 (D) the enthalpy for the reaction will decrease when the temperature increases
52. In a diagram showing the variation of the change in the Gibbs free energy for a reaction with temperature, when the temperature approaches absolute zero, the fact that the value of intercept is negative indicates that
 (A) the reaction will absorb heat (B) the reaction will release heat
 (C) the entropy will be negative at 0K (D) the entropy will be positive at 0K
53. In the diagram showing the variation of the enthalpies of $(\text{Pb}+1/\text{O}_2)$ with temperature, there is a sudden increase at 600K, this change corresponds to
 (A) boiling of Pb (B) volume change of O_2
 (C) releasing of heat (D) heat capacity change of Pb
54. In a real gas system, when the van der Waals equation, $PV^3 - (Pb + RT) V^2 + aV - ab = 0$, is applicable, the pressure at the critical temperature will be
 (A) $3b$ (B) $a/(27b^2)$ (C) $8a/(27bR)$ (D) a/V^2

(背面仍有題目,請繼續作答)

55. In a van der Waals equation, $(P + \frac{a}{V^2})(V - b) = RT$, b is used as the correction term for
- Ⓐ the interaction occurring between particles Ⓑ the weight of the particles
Ⓒ the finite volume of the particles Ⓓ the temperature of the gas
56. Which is a condition of an ideal solution?
- Ⓐ enthalpy of mixing = 0; Ⓑ entropy of mixing = 0;
Ⓒ Gibbs free energy of mixing = 0; Ⓓ Helmholtz free energy of mixing = 0.
57. Which activity coefficient is an indication of an "ordered" type solid solution?
- Ⓐ < 1; Ⓑ > 1; Ⓒ = 1; Ⓓ < 1 or = 1.
58. Which function is a path function?
- Ⓐ Gibbs free energy; Ⓑ entropy; Ⓒ work; Ⓓ enthalpy.
59. Which energy is not a thermodynamic potential?
- Ⓐ internal energy; Ⓑ Gibbs free energy;
Ⓒ activation energy; Ⓓ Helmholtz free energy.
60. Which property is an intensive property?
- Ⓐ enthalpy; Ⓑ temperature; Ⓒ Gibbs free energy; Ⓓ entropy.

科目名稱：有機化學。

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



- (a) 3-methylhexane (b) 2-ethylpentane
(c) 3-ethyl-2-methylhexane (d) 2-ethylhexane

62. Which is (are) the major product(s) of the following reaction?



- (a) 2-bromo-2-methylhexane
(b) 3-bromo-2-methylhexane
(c) 4-bromo-2-methylhexane
(d) 4-bromo-2-methylhexane and 3-bromo-2-methylhexane

63. Which of the following are most likely to behave as electrophiles?

- (a) Cl^- (b) CH_3^+ (c) $\text{N}(\text{CH}_3)_3$ (d) none of them

64. Which is the product of the following reaction?



- (a) (b) (c)
(d)

(背面仍有題目,請繼續作答)

65. Rank the compounds according to their reactivity toward electrophilic substitution.

- (a) chlorobenzene > benzene > o-dichlorobenzene
- (b) o-dichlorobenzene > benzene > chlorobenzene
- (c) o-dichlorobenzene > chlorobenzene > benzene
- (d) benzene > chlorobenzene > o-dichlorobenzene

66. Which ion is a better leaving group?

- (a) NH_2^- (b) Br^- (c) F^- (d) OH^-

67. The monomer used to make polypropylene is

- (a) $\text{CH}_2=\text{CH}_2$
- (b) $\text{CH}_2=\text{CHCl}$
- (c) $\text{CH}_2=\text{CHCH}_3$
- (d) $\text{CH}_2=\text{CHC}_6\text{H}_5$

68. What are the characteristic absorption frequencies of carbonyl group ($\text{C}=\text{O}$) in the IR spectrum?

- (a) 1690~1780 cm^{-1}
- (b) 3500-3800 cm^{-1}
- (c) 2500~3000 cm^{-1}
- (d) 2000~2300 cm^{-1}

69. Which instrument can be used to analyze polymer molecular weight?

- (a) GPC (Gel Permeation Chromatography)
- (b) ESCA (Electron Spectroscopy for Chemical Analysis)
- (c) IR spectroscopy
- (d) Raman spectroscopy

70. Give IUPAC name for the following compound:

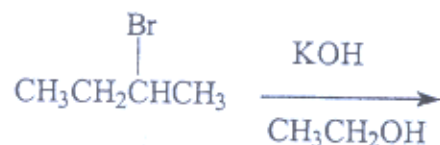


- (a) 2-Ethylpentanoic acid (b) 3-Ethylpentanoic acid
- (c) 2-ethylbutanoic acid (d) 3-ethylbutanoic acid

71. What is the reaction product from a diacid and a diamine?

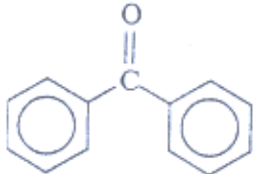
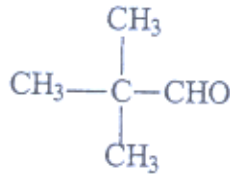
- (a) polyester (b) polyimide (c) polyamide (d) polyether

72. What is the major product of the following reaction?



- (a) $\text{CH}_3\text{CH}=\text{CHCH}_3$ (b) $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ (c) $\text{CH}_3\text{CH}_2\overset{\text{OH}}{\text{C}}\text{HCH}_3$
(d) no reaction

73. Which of the following compound would you expect to undergo aldol condensation?

- (a) HCHO (b)  (c) 
(d) $\text{CH}_3(\text{CH}_2)_8\text{CHO}$

74. Which compound is most reactive toward Friedel-Crafts reaction?

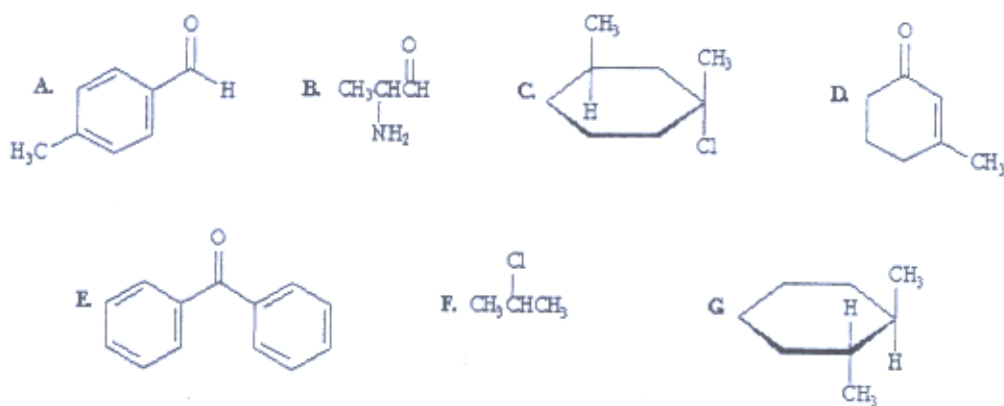
- (a) bromobenzene (b) anisole (c) toluene (d) p-bromotoluene

75. Which compound reacting with a carboxylic acid will give an ester?

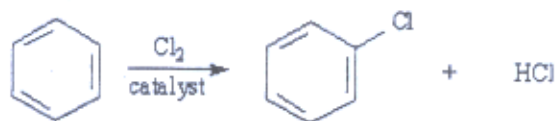
- (a) Amine
(b) Alcohol
(c) ketone
(d) aldehyde

76. Refer to following, which is a correct statement? Ⓐ A is an aromatic ketone. Ⓑ B is an aromatic ketone. Ⓒ D is an aromatic ketone. Ⓓ E is an aromatic ketone.

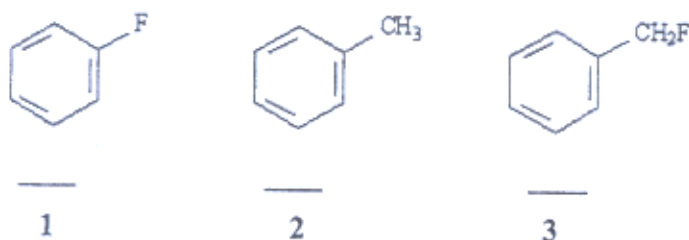
(背面仍有題目,請繼續作答)



77. The reaction type of the following reaction is: (A) addition (B) elimination (C) substitution (D) rearrangement



78. Rank the compounds in the group below according to their reactivity toward electrophilic aromatic substitution (most reactive = 1; least reactive = 3). (A) 1>2>3 (B) 2>3>1 (C) 1>3>2 (D) 3>2>1



79. Which of the followings describes organic molecules which rotate plane-polarized light (A) chirality (B) enantiomers (C) meso compounds (D) optically active

80. The specific rotation of a compound is denoted by the symbol:

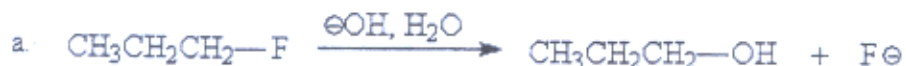
- (A) R (B) S (C) T (D) $[\alpha]_D$

81. The pair of stereoisomers below is

- (A) enantiomers (B) diastereomers (C) identical (D) none of the above



82. The mechanism of the following reactions is (A) S_N1 (B) S_N2 (C) E1 (D) E2

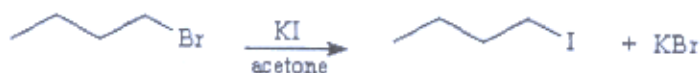


or

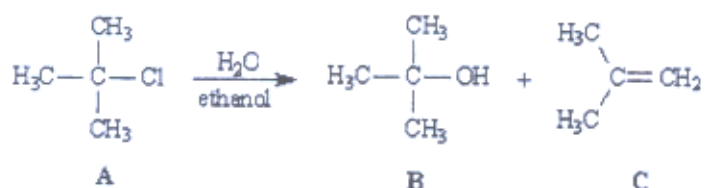


83. The nucleophile in the following reaction is:

- (A) K⁺ (B) alkyl group (C) Br⁻ (D) I⁻

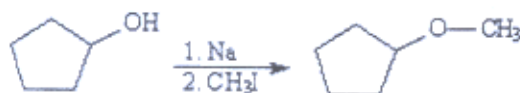


84. The substrate in the reaction is: (A) A (B) B (C) C (D) ethanol



85. Mechanistically, the Williamson ether synthesis of the following is:

- (A) an E1 process (B) an S_N1 process (C) an E2 process (D) an S_N2 process



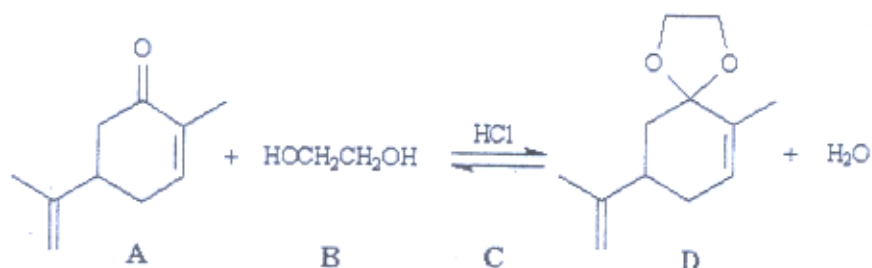
86. Choose the *best* reagent for carrying out the following conversions

- (A) CrO₃, H₂SO₄, H₂O (B) 1. NaBH₄, ethanol, 2. H₃O⁺
(C) 1. LiAlH₄, ether, 2. H₃O⁺ (D) 1. PCC, CH₂Cl₂, 2. H₃O⁺



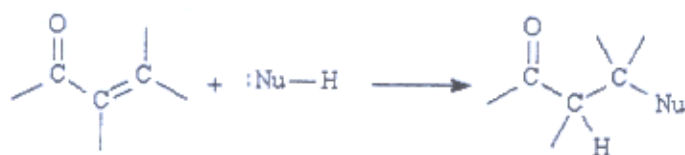
(背面仍有題目,請繼續作答)

87. The nucleophile in the following reaction is: (A) A (B) B (C) C (D) D



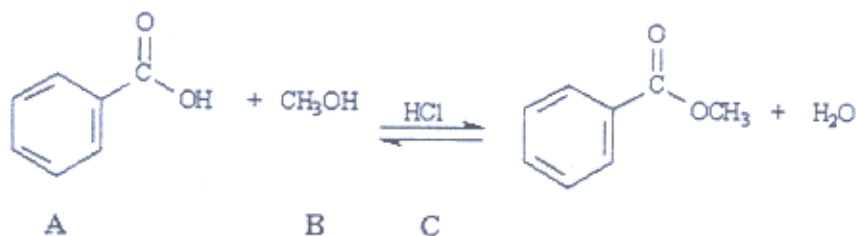
88. Unsaturated aldehydes and ketones can undergo reaction with nucleophiles at the carbon, as shown below. This reaction is called a(n) _____ reaction.

(A) conjugate addition. (B) electrophilic addition. (C) direct addition (D) 1,2-addition.

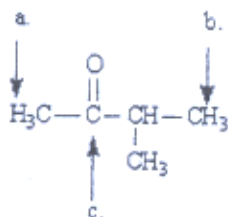


89. The reaction of a carboxylic acid with an alcohol in the presence of acid is termed *Fischer esterification*. The nucleophile in the following reaction is

(A) A (B) B (C) C (D) none of the above



90. Refer to the structure of 3-methyl-2-butanone below. What is the splitting pattern for the hydrogens in 3-methyl-2-butanone labeled b.?



(A) septet (B) quartet (C) doublet (D) singlet