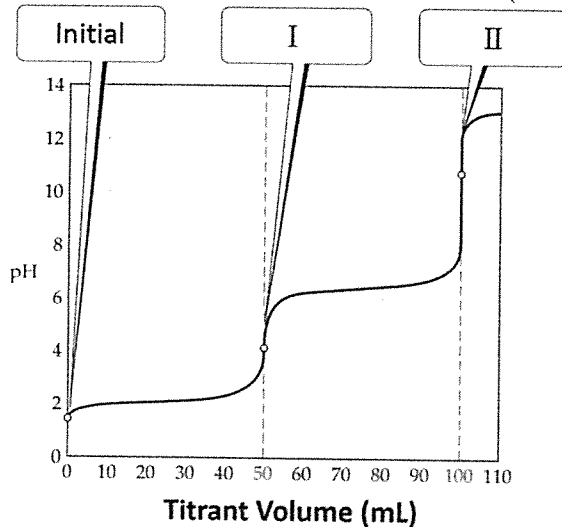


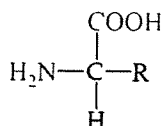
Section A. Multiple Choice Questions 本大題請於試卷內之「選擇題作答區」依序作答。
(Each question may contain single or multiple answers)

1. An acid-base titration curve is shown as below. (10%)



- Which of the following description for the figure is correct:
- (A) The titrant should be a strong base
 - (B) I is called the equivalence point and II is called the end point.
 - (C) The analyte is a monoprotic acid
 - (D) This curve contains one buffer zone
 - (E) None of the above
2. Which of the following statement is correct? (10%)
- (A) Gibbs free energy change can be utilized to decide if a chemical reaction is spontaneous
 - (B) Entropy is the definition of disorder in quantum mechanics
 - (C) Nernst equation is given as : $\Delta G = \Delta G^0 + RT \ln Q$
 - (D) Enthalpy is defined as the internal energy minus the product of pressure and volume: $H = E - PV$
 - (E) Arrhenius equation states that the reaction rate constant (k) is linearly proportional to the difference in internal energy (ΔE^0)
3. According to the molecular orbital theory, which of the follow molecule is diamagnetic? (10%)
- (A) C_2
 - (B) O_2
 - (C) B_2
 - (D) NO
 - (E) HF
4. Which kind of intermolecular interaction present in this solution: 1.0 M $CH_3CH_2CH_2OH$ in water (10%)
- (A) Dipole-dipole force
 - (B) Dispersion force
 - (C) Ionic bonding
 - (D) Hydrogen bonding
 - (E) Ion-dipole force
5. 25.0 mL of a phosphorous acid (H_3PO_3) solution (pH = 1.59) titrated with 0.102 M NaOH requires 23.3 mL of NaOH to neutralize all the acidic protons. Which of the following description for the solution is correct: (10%)
- (A) The molarity of the H_3PO_3 solution should be 0.048 M
 - (B) The percent ionization of the H_3PO_3 should be 35 % (assume $K_{a1} \gg K_{a2}$)
 - (C) H_3PO_3 is not an organic acid
 - (D) The K_{a1} of the H_3PO_3 should be 0.031 (assume $K_{a1} \gg K_{a2}$)
 - (E) H_3PO_3 is a triprotic acid

6. A family of molecules looks like this: (10%)

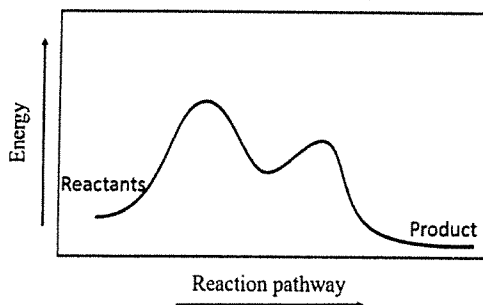


Which of the following description is correct?

- (A) This kind of molecule contains no carbonyl group
(B) This kind of molecule is an alcohol
(C) This kind of molecule can act as a strong acid
(D) This kind of molecule can function as a Lewis base
(E) This kind of molecule is not found in nature
7. A cell is illustrated as this: (10%)
 $\text{Cu}(s) / \text{Cu}^{2+}(aq) 0.01 \text{ M} // \text{Cu}^{2+}(aq) 0.10 \text{ M} / \text{Cu}(s)$
Which of the following description is correct?
(A) The half-reaction happening at the cathode is: $\text{Cu}(s) \rightarrow \text{Cu}^{2+}(aq, 0.01 \text{ M}) + 2e^-$
(B) There is no electron flow in this cell circuit
(C) When the reaction reaches equilibrium, the cell is discharged
(D) The anions in the salt bridge would migrate to the left hand side of the cell
(E) The cell potential is 0.06 V

Section B. Calculation and Concepts 本大題請於試卷內之「非選擇題作答區」標明題號依序作答。
(Please write down your calculation and explanation in detail)

8. A sample of 44.0 g of $\text{CO}_2(\text{g})$ is confined to a 6.00 L container at 25.0 °C. (10%)
Van der Waals constants for $\text{CO}_2(\text{g})$: $a (\text{L}^2\text{-atm/mol}^2) = 3.59$; $b (\text{L/mol}) = 0.0427$
 $\text{H}_2\text{O}(\text{g})$: $a (\text{L}^2\text{-atm/mol}^2) = 5.46$; $b (\text{L/mol}) = 0.0305$
- (a) What is the pressure of the gas if it can be treated as an ideal gas?
(b) What is the pressure of the gas if it is treated as a real gas?
(c) Draw the Lewis structure of this gas molecule.
(d) Label all the bond dipoles and point out the overall dipole moment direction of this gas molecule.
(e) Predict the molecular shape and describe the bonding hybrid orbitals in the molecule.
9. Consider the following energy profile of an unknown chemical reaction: (10%)



- (a) Is this chemical reaction a three-step reaction? Why or why not?
(b) Label the activated complex and the intermediate in the profile.
(c) Label the overall reaction enthalpy change in the profile.
(d) Point out the reaction rate determining step position in the profile and label its activation energy.
(e) Use Le Châtelier's principle to estimate the equilibrium movement if the reaction temperature is raised.
10. Calculate the pH of these solutions: (10%)
- (a) A solution is formed by adding 10.0 mL of 0.0510 M NaOH to 40.0 mL of 0.0250 M benzoic acid ($K_a = 6.3 \times 10^{-5}$).
(b) A solution is formed by adding 10.0 mL of 0.100 M HCl to 20.0 mL of 0.100 M NH_3 ($K_b = 1.8 \times 10^{-5}$).
(c) A solution is formed by adding 50.0 mL of 0.100 M NaOH to 50.0 mL of 0.100 M acetic acid ($K_a = 1.8 \times 10^{-5}$).