

說明： 答案一律寫在試卷上，否則不予計分。

Please answer the following in depth: (每類 4 分)

1. When 0.952 g of an organic compound containing C, H, and O is burned completely in oxygen, 1.35 g of  $\text{CO}_2$  and 0.826 g of  $\text{H}_2\text{O}$  are produced. What is the empirical formula of the compound?

Please answer the following briefly:

2. Identify each of the following compounds as a strong electrolyte, weak electrolyte, or nonelectrolyte.
  - a.  $\text{CH}_3\text{OH}$  (methanol)
  - b.  $\text{CH}_3\text{COOH}$
  - c.  $\text{KNO}_3$
  - d.  $\text{NH}_3$
  - e.  $\text{NH}_4\text{Cl}$
3. How many mL of  $\text{H}_2\text{O}$  are required to dilute 500 mL of 2.0 M HCl to exactly 0.50 M HCl?
4. What is the molecular mass of a gas that effuses at a rate 2.0 times faster than  $\text{N}_2\text{O}$ ?
5. The heat of solution of  $\text{NH}_4\text{NO}_3$  is +26.2 kJ/mol. Is heat evolved or released when a solution of  $\text{NH}_4\text{NO}_3$  is diluted by addition of more water?
6. Write the ground state electron configuration for the phosphorus atom.
7. The radius of an atom of sodium is 190 picometers. How many nanometers is this?

(背面仍有題目,請繼續作答)

8. Use the Born-Haber cycle to calculate the lattice energy of NaBr(s). Given the following data:

$$\begin{aligned}\Delta H(\text{sub}) \text{ Na} &= 109 \text{ kJ} \\ \text{IE} (\text{Na}) &= 496 \text{ kJ} \\ 1/2D (\text{Br-Br}) &= 96 \text{ kJ} \\ \text{EA} (\text{Br}) &= -324 \text{ kJ} \\ \Delta H_f^\circ (\text{NaBr}) &= -361 \text{ kJ}\end{aligned}$$

9. Ozone ( $\text{O}_3$ ) is an allotropic form of oxygen. Use VSEPR theory to predict the shape of the ozone molecule.
10. Write the molecular orbital, electron configuration for  $\text{O}_2$ .
11. Iron crystallizes in a body-centered cubic unit. The edge of this cell is 287 pm. Calculate the density of iron?
12. In the course of research a chemist isolates a new compound with an empirical formula  $\text{C}_3\text{H}_3\text{O}_2$ . 2.51 g of the compound when dissolved in 100 g of water produces a solution with a freezing point of  $-0.325^\circ\text{C}$ . What is the molecular formula of the compound?
13. Nitrogen pentoxide decomposes by a first-order reaction yielding  $\text{N}_2\text{O}_4$  and oxygen.
- $$2\text{N}_2\text{O}_5 \rightarrow 2\text{N}_2\text{O}_4 + \text{O}_2$$
- At a given temperature, the half-life of  $\text{N}_2\text{O}_5$  is 0.90 hours. What is the first-order rate constant for  $\text{N}_2\text{O}_5$  decomposition?
14. The activation energy for a certain reaction is 113 kJ/mol. By what factor (how many times) will the rate constant increase when the temperature is raised from 310 K to 325 K?
15. 4.2 mol of oxygen and 4.0 mol of NO are introduced to an evacuated 0.50 L reaction vessel. At the temperature of the system, the equilibrium:
- $$2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$$
- is reached when  $[\text{NO}] = 1.6 \text{ M}$ . Calculate  $K_c$  for the reaction.
16. What is the pH of  $1 \times 10^{-9} \text{ M HCl}$ ?

(背面仍有題目,請繼續作答)

17. Bromothymol blue is a common acid-base indicator. It has a  $K_a$  equal to  $1.6 \times 10^{-7}$ . Its undissociated form is yellow and its conjugate base is blue. What color would a solution have at  $\text{pH} = 5.8$ ?
18. The concentration of  $\text{Mg}^{2+}$  in seawater is  $5.0 \times 10^{-2}$  M. What is the  $[\text{OH}^-]$  necessary to remove 90% of the  $\text{Mg}^{2+}$ ?  
 $K_{sp}$  for  $\text{Mg}(\text{OH})_2 = 1.2 \times 10^{-11}$ .
19. Write out the steps that show how sulfur in coal is converted to sulfuric acid in acid rain.
20. The heat of vaporization of water is 2.27 kJ/g. What is the  $\Delta S_{v,p}$  per mol at the normal boiling point?
21. When a solution of a certain gadolinium salt is electrolyzed with a current of 1.0 A for 2.0 h, 0.025 mol of Gd metal form. Calculate the charge on the gadolinium ion.
22. Write equations describing one way of preparing silicon.
23. What is the oxidation number of Fe in  $[\text{Fe}(\text{CN})_6]^{4-}$ ?
24. On a neutron number versus proton number plot, a nucleus of aluminum-28 lies above the belt of stability. Write an equation for radioactive decay of aluminum-28.
25. Sketch structural formulas for all the isomers of  $\text{C}_6\text{H}_{14}$ .