一、 選擇題（每題 1 分）

1. Determine the average oxidation number of carbon in $C_6H_{12}O_6$ (glucose).
   a). –2 b). +4 c). +2 d). 0

2. For a certain reaction, Q = 2.33, while K = 3.54. What do you expect to happen?
   a). The reaction will proceed forward. b). The reaction will proceed backward.
   c). The reaction will proceed away from equilibrium. d). The direction cannot be determined.

3. When zinc reacts with HCl, H_2 is released. In this system the release of the H_2 is counteracted by outside force, which results in a smaller volume by the end of the reaction. The work done by the outside force:
   a). Is negative on the system b). Is positive on the system
   c). Is positive on the surroundings d). Is zero

4. The CO_2 and H_2O in the atmosphere have all of the following effects, except:
   a). Increase the temperature of the earth b). Absorbing infrared radiation
   c). Allowing UV light to escape the earth d). Absorbing visible light

5. A state of higher entropy means:
   a). A lower number of possible arrangement b). A higher number of possible arrangements
   c). Lower probabilities to be reached d). Lower probabilities to reach a possible state

6. Heat is released during a particular process. This means that:
   a). The process is spontaneous under all conditions b). $\Delta S_{surr} > 0$
   b). The process tends to be spontaneous d). $\Delta S_{sys} > 0$

7. Which of the following elements would you expect to corrode most easily?
   a). Ag b). Au c). Al d). Fe

8. How many distinct magnetic quantum numbers are possible if the angular momentum quantum number is 6?
   a). 13 b). 7 c). 12 d). 11

9. Place the following atoms, Cl, F, Na, C, in order of decreasing electron affinity values.
   a). C > Cl > F > Na b). F > Na > Cl > C
   c). Cl > F > C > Na d). F > Cl > C > Na

10. Place the following species in order of increasing size: Ne, B^{3+}, O^{2-}, and Be^{2+}
    a). $B^{3+} < Be^{2+} < Ne < O^{2-}$ b). $O^{2-} < Ne < Be^{2+} < B^{3+}$
    c). $Ne < B^{3+} < Be^{2+} < O^{2-}$ d). $Ne < O^{2-} < B^{3+} < Be^{2+}$

11. Which of the following molecules contains a central atom that violates the octet rule?
    a). SF_4 b). COF_2 c). $Si(OH)_4$ d). PBr_3

12. According to the molecular orbital model, a bonding orbital:
    a). Is unstable b). Is more stable than antibonding orbital
    c). Is as stable as an antibonding orbital d). Is less stable than a non-bonding orbital

13. The rate of decomposition of ammonia to hydrogen gas and nitrogen gas
    $2NH_3(g) \rightarrow N_2(g)) + H_2(g)$
    is expressed as $-\Delta [NH_3]/\Delta t$. Express the rate of this reaction in terms of $\Delta [H_2]/\Delta t$.
    a). Rate = 2/3 x $\Delta [H_2]/\Delta t$ b). Rate = $\Delta [H_2]/\Delta t$
    c). Rate = 3 x $\Delta [H_2]/\Delta t$ d). Rate = 2 x $\Delta [H_2]/\Delta t$

(背面仍有題目,請繼續作答)

14. Which of the following species is paramagnetic?
a). O_2 b). C_2 c). B_2 d). N_2

15. Which of the following molecules interact primarily through London-dispersion forces?
a). SO_2 b). CCl_4 c). CH_2Cl_2 d). H_2S

16. Four distinct solvents, A, B, C, and D have the following K_b values = 0.51, 4.59, 5.07, and 40.0 °C/m. Their respective molar masses are = 60, 88, 98, and 152 g/mol. 3.0 g of a solute with molar mass of 138.0 g/mol is dissolved in 200.0 g of one of the solvents. The boiling point is changed by 4.34 °C. Which solvent is it?
a). A b). B c). C d). D

17. The ligands in a complex ion act as:
a). Lewis acids b). Lewis bases c). Arrhenius base d). oxidizing agent

18. Positron production results in:
a). Higher proton/neutron ratio b). Smaller proton/neutron ratio
c). Same proton/neutron ratio d). Smaller neutron/proton ratio

19. What is the number of possible isomers of C_4H_8?
a). 6 b). 4 c). 5 d).7

20. Which one of the following alcohols would you expect to have the highest boiling point?
a). methanol b). propanol c). decanol d). hexanol

二、計算與問答題

1. A 0.0483 M $KMnO_4$ solution was used to titrate a solution containing 0.8329 g of impure CaC_2O_4. If 30.25 ml of the $KMnO_4$ solution was required to reach the titration endpoint, calculate the percent purity of the CaC_2O_4. (7 分)

$$MnO_4^-(aq) + C_2O_4^{2-}(aq) \rightarrow Mn^{2+}(aq) + CO_2(g) \quad \text{(unbalanced)}$$

2. a). What is Bond Order? b). Use MO (molecular orbital) theory to describe the bonding and stability of H_2^{2-} and H_2^+. (8 分)

3. The balanced equation for the reaction of the gases nitrogen dioxide and fluorine is

$$2NO_2(g) + F_2(g) \rightarrow 2NO_2F(g)$$

The experimentally determined rate law is

$$\text{rate} = k[NO_2][F_2].$$

A suggested mechanism for this reaction is

$$NO_2 + F_2 \rightarrow NO_2F + F \quad \text{(slow reaction)}$$
$$F + NO_2 \rightarrow NO_2F \quad \text{(fast reaction)}$$

Is this an acceptable mechanism? Explain. (8 分)

4. A sample of bone taken from an archeological dig was determined by radiocarbon dating to be 12,000 years old. If we assume that a constant atmospheric $^{14}C/^{12}C$ ratio has 13.6 disintegrations per minute pre gram of carbon, how many disintegrations per minute per gram did this sample give off ($t_{1/2}$ for ^{14}C is 5730 years). (7 分)