

所別：化學學系碩士班 科目：綜合化學

考生請注意：

- (1) 第[1][3][6][7][9]題為計算題，答題時務必列出清楚的計算式並標明各項單位。
- (2) 各計算題於計算及答題時之要求精確位數如下：  
第[1][3][6]題 四捨五入至小數點後第3位  
第[7]題 四捨五入至小數點後第4位  
第[9]題 四捨五入至小數點後第2位
- (3) 參考常數如下：

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1. Planck's constant:  $6.626 \times 10^{-34}$  Js
2. Atomic masses H: 1.008; He: 4.003
3. Gas constant  $R = 8.3145 \text{ J K}^{-1} \text{ mol}^{-1}$
4. Some useful values:  $\ln 0.25 = -1.3863$   
 $\ln 0.175 = -1.7430$

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1. Please calculate the wavelength (in the unit of nm) for an electron (mass =  $9.11 \times 10^{-31}$  kg) traveling at a speed of  $1.0 \times 10^7$  m/s. (3 pts)
2. Please indicate acid-base properties of the following aqueous solutions (use the terms of "acidic" or "basic" or "neutral" for each case):  
(a)  $\text{KNO}_3$ ; (b)  $\text{NaC}_2\text{H}_3\text{O}_2$ ; (c)  $\text{FeCl}_3$ ; (d)  $\text{KF}$ . (2 pts each; total 8 pts)
3. A mixture of 1g  $\text{He}_{(g)}$  and 1g  $\text{H}_{2(g)}$  exerts a pressure of 0.48 atm. Calculate the partial pressure of each gas presented in the mixture. (4 pts)
4. Balance the following redox reactions, which occur in basic solution: (2 pts each, 6 pts)  
(i)  $\text{Al}_{(s)} + \text{MnO}_{4(aq)}^- \rightarrow \text{MnO}_{2(s)} + \text{Al}(\text{OH})_{4(aq)}^-$   
(ii)  $\text{Cl}_{2(g)} \rightarrow \text{Cl}_{(aq)}^- + \text{ClO}_{(aq)}^-$   
(iii)  $\text{CN}_{(aq)}^- + \text{MnO}_{4(aq)}^- \rightarrow \text{CNO}_{(aq)}^- + \text{MnO}_{2(s)}$
5. Assign oxidation states to all the atoms in the following:  
(1)  $\text{Fe}_3\text{O}_4$ ; (2)  $\text{Na}_2\text{S}_2\text{O}_3$ ; (3)  $\text{NO}$ ; (4)  $\text{Mg}_2\text{P}_2\text{O}_7$ ; (5)  $\text{As}_4$ ; (6)  $\text{NaBiO}_3$ . (0.5 pts each atom; total 7 pts)
6. When 2.00 mol of  $\text{SO}_{2(g)}$  reacts completely with 1.00 mol of  $\text{O}_{2(g)}$  to form 2.00 mol of  $\text{SO}_{3(g)}$  at  $25^\circ\text{C}$  and a constant pressure of 1.00 atm, 198 kJ of energy is released as heat. Calculate  $\Delta H$  and  $\Delta E$  for this process. (4 pts)
7. The rate law for the decomposition of phosphine ( $\text{PH}_3$ ) is

$$\text{Rate} = -\frac{d[\text{PH}_3]}{dt} = k[\text{PH}_3]$$

It takes 120s for the concentration of 1.00M  $\text{PH}_3$  to decrease to 0.250M. How much time is required for 2.00M  $\text{PH}_3$  to decrease to a concentration of 0.350M? (4 pts)

注意：背面有試題

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8. Sketch the complete titration curve of a weak acid (HA) with a strong base (3 pts). On your curve, please *clearly* indicate the points that correspond to the following: (1 pt for each)  
a. the equivalence point; b. the maximum buffering region; c.  $\text{pH} = \text{pK}_a$ ; d. pH depends only on [HA]; e. pH depends only on  $[\text{A}^-]$ . (8 pts)
9. Calculate the pH of a 1.0M solution of  $\text{NaH}_2\text{PO}_4$ . (The  $\text{pK}_{a1}$ ,  $\text{pK}_{a2}$ , and  $\text{pK}_{a3}$  for  $\text{H}_3\text{PO}_4$  are 2.12, 7.21, and 12.32) (3 pts)
10. Predict the molecular structure for each of the following, and also indicate the lone pair of the central atom if present. (10 pts)  
(a)  $\text{XeF}_4$  (b)  $\text{I}_3^-$  (c)  $\text{SeO}_3$  (d)  $\text{TeCl}_4$  (e)  $\text{ICl}_5$
11. How can an n-type semiconductor be prepared from pure germanium? How can a p-type semiconductor be produced from a pure germanium? (4 pts)
12.  $\text{Ga}_2\text{O}_3$  is an amphoteric oxide and  $\text{In}_2\text{O}_3$  is a basic oxide. Write equations describing reaction that illustrate these properties. (3 pts)
13. Predict the bond length, bond energy and also their relative stability for NO and  $\text{NO}^+$  in terms of molecular orbitals. (4 pts)
14. What are interhalogen compounds? Give an example each for  $\text{AB}_7$  and  $\text{AB}_5$ . (3 pts)
15. Does the complex ion  $[\text{Co}(\text{NH}_3)\text{Br}(\text{en})_2]$  exhibit geometric isomerism? Does it exhibit optical isomerism? (4 pts)
16. The  $\text{Co}(\text{NH}_3)_6^{3+}$  ion is diamagnetic but  $\text{Fe}(\text{H}_2\text{O})_6^{2+}$  is paramagnetic. Explain. (4 pts)
17. The two polymers of PE and PP have been applied as practical products in our daily life. Draw their structures of monomers and polymers. (4 pts)
18. Which of the noncyclic isomers of bromochloropropene is/are optical active? (3 pts)
19. Phosphorus formed all possible halides;  $\text{PX}_3$  and  $\text{PX}_5$ . Predict the possible products once reacted with water. (3 pts)
20. Explain precisely the term definition between "electron affinity" and "electronegativity". (3 pts)
21. What is the so-called inert pair effect? Explain and also give two examples. (4 pts)
22. Describe the structural differences between DNA and RNA. (4 pts)