



1. 在純金屬的凝固(solidification)的變態(transformation)中，請問會涉及哪兩種能量？請寫出涉及液體藉由均勻成核(homogeneous nucleation)，生成一個無應變固體核(strain-free solid nucleus)變態之總自由能變化的公式。此外請畫圖說明凝固過程中，形成固體核的能量變化。(10%)
2. 直徑為 0.250 cm、長 20 cm 之長圓棒，承受 5000 N 重量。在此負載時，長圓棒的直徑變為 0.210 cm，請算出 (a) 工程應力和工程應變，(b) 真實應力和真實應變。(10%)
3. 當已被冷加工之金屬加熱到發生回復(recovery)溫度範圍時，(a) 內部的殘餘應力，(b) 強度，(c) 延展性和 (d) 硬度，會受到如何的影響？(10%)
4. (a) 在某些部分結晶之熱塑性塑膠中會發現球狀晶結構，請描述球狀晶之結構。(b) 熱塑性塑膠的結晶度會如何影響其密度和其拉伸強度？請說明解釋之。(10%)
5. 寫出共晶(eutectic)，共析(eutectoid)，包晶(peritectic)，包析(peritectoid)等反應之反應方程。在二元相圖中這些不變的反應點會有多少的自由度？(10%)
6. 敘述「陶瓷材料」電、熱、化學、機械之特性，並說明原因。(10%)
7. NaCl 的熔點為 801°C，但為何 NaCl 可輕易被水溶解？溶解後是什麼狀態？(10%)
8. 一般來說當溫度上升時金屬的電阻上升，但半導體的電阻卻下降，解釋之。(10%)
9. 鐵在室溫下是什麼結構？晶格常數為 0.287 nm，原子量為 55.847 克/莫耳，計算鐵的理論密度。(10%)
10. 當溫度逐漸下降時，畫出在圖 1 中 a、b、c、d 四點所產生的金相組織示意圖，並標出相之名稱。(10%)

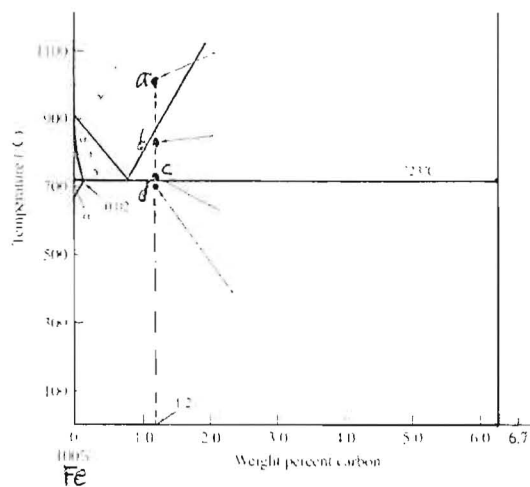


圖 1



## 一、選擇題 (共 15 題，每題 2 分)

1. ( ) 在一個容器內，當氣體之體積膨脹時，代表容器(可視之為一個系統)對周圍環境做功，由於容器作功會導致系統內能量會降低，所以此時的「功」值應為：①零；②正值；③負值；④無法計算。
2. ( ) 對於共價鍵(covalent bond)的描述，何者錯誤？①是一種由二個原子共用一個或多個電子的化學鍵；②形成共價鍵的原子對外仍然顯示電荷；③共價鍵的強度比氫鍵要強；④一般以共價鍵結合的產物是分子。
3. ( ) 是誰提出“電子( $e^-$ )具有粒子性質和波動性質”：①拉塞福(Rutherford)；②波爾(Bohr)；③愛因斯坦(Einstein)；④德布洛依(De Broglie)。
4. ( ) 以下對於價電子(valence electron)的描述，何者錯誤？①位於原子最外層電子層的電子；②原子價電子愈少，原子就愈不穩定；③原子價電子愈少，原子就愈不容易發生反應；④支配原子的鍵結作用。
5. ( ) 對於路易斯結構(Lewis structures)的規則，以下哪一項不正確？①陰電性最大之元素放在中央；②每對形成鍵結的原子之間至少必須使用一對電子形成一個鍵；③除了氫以外，所有原子皆須完全填滿 8 個電子；④若整個結構包含太多電子，則有必要在中心原子處形成雙鍵或參鍵。
6. ( ) Which of the following statements is **not** a postulate of Dalton's atomic theory? ?
  - ① Each element is characterized by the mass of its atoms ;
  - ② Atoms are composed of protons, neutrons, and electrons ;
  - ③ Chemical reactions only rearrange atomic combinations ;
  - ④ Elements are composed of atoms .
7. ( ) At the equilibrium bond length ?
  - ① the attractive forces holding the atoms together are less than the repulsive forces ;
  - ② the potential energy is a maximum ;
  - ③ the potential energy is a minimum ;
  - ④ the repulsive forces are greater than the attractive forces holding the atoms together .
8. ( ) Water has an unusually high ?
  - ① electrical conductivity ;
  - ② heat of combustion ;
  - ③ heat of formation ;



- ④ specific heat °
9. ( ) Which is **not** a spontaneous process ?
- ① combustion of gasoline to produce carbon dioxide and water ;
- ② diffusion of perfume in a room ;
- ③ dissolution of sodium chloride in water ;
- ④ freezing of water at 1°C °
10. ( ) Which one of the following statements does **not** describe the equilibrium state?
- ① Equilibrium is dynamic and there is no net conversion to reactants and products ;
- ② The concentration of the reactants is equal to the concentration of the products ;
- ③ The concentration of the reactants and products reach a constant level ;
- ④ The rate of the forward reaction is equal to the rate of the reverse reaction.
11. ( ) For which of the following will the entropy of the system increase ? ① condensation of steam ; ② reaction of magnesium with oxygen to form magnesium oxide ; ③ reaction of nitrogen and hydrogen to form ammonia ; ④ sublimation of dry ice.
12. ( ) Which cell involves a nonspontaneous redox reaction ? ① concentration cell ; ② electrolytic cell ; ③ fuel cell ; ④ galvanic cell.
13. ( ) What are the three major chemicals that are commercially obtained from sea water ?
- ① sodium chloride, magnesium, and bromine ;
- ② sodium chloride, calcium carbonate, sodium sulfate ;
- ③ sodium chloride, sodium bromide, sodium carbonate ;
- ④ sodium chloride, calcium chloride, calcium carbonate °
14. ( ) As one traverses the periodic table from left to right, the effective nuclear charge  $Z_{\text{eff}}$  increases. As a result of this the periodic properties of \_\_\_\_\_.
- ① atomic size increases, IE increases, EA increases and electronegativity increases ;
- ② atomic size decreases, IE increases, EA increases and electronegativity increases ;
- ③ atomic size decreases, IE decreases, EA increases and electronegativity increases ;
- ④ atomic size decreases, IE decreases, EA increases and electronegativity increases.



15. ( ) Which of the following statements about properties of organic compounds is **not** correct ?
- ① Most organic compounds are not soluble in water ;
  - ② Most organic compounds do not conduct electricity ;
  - ③ Organic compounds have higher melting and boiling points than ionic compounds ;
  - ④ Organic compounds have weak intermolecular forces .

二、計算問答題 (共 7 題，每題 10 分)

1. 六氟化硫是一種無色、無味的氣體，由於它缺少化學活性(反應性)，故常被當作電子產品的絕緣體來使用。請問：在 69.5°C、體積 5.43 L 之鋼瓶中，1.82 莫耳(mole)的此一氣體之壓力為何？
2. 何謂狀態函數(State function)？請列舉四種狀態函數。
3. 請依據以下兩個條件，分別計算它們的能量(以焦耳為單位)，並說明他們分別屬於哪一種光譜：
  - (1) 一個具有波長  $5.00 \times 10^4$  nm 的光子(photon)。
  - (2) 一個具有波長  $5.00 \times 10^{-2}$  nm 的光子(photon)。
4. 將 100°C、19.0 克的水蒸氣壓縮並冷卻至 0°C，此一過程所釋放出的能量可以使多少克的冰融化？
5. (a) At the normal body temperature of 37°C,  $K_w = 2.42 \times 10^{-14}$ . The  $H_3O^+$  concentration of normal blood ranges from  $3.5 \times 10^{-8}$  to  $4.5 \times 10^{-8}$ . The  $OH^-$  concentration of normal blood ranges from \_\_\_\_\_ to \_\_\_\_\_, and blood is \_\_\_\_\_ (acidic, basic, neutral). ?
 

(b) A  $1.25 \times 10^{-4}$  M solution of the anti-inflammatory drug naproxen has a pH = 4.2. The  $K_a$  and  $pK_a$  of naproxen are \_\_\_\_\_ and \_\_\_\_\_.
6. (a) Reduction half-reactions with corresponding standard half-cell potentials are shown below.
 
$$Ag^+(aq) + 1 e^- \rightarrow Ag(s) \quad E^\circ = +0.80 V$$

$$Zn^{2+}(aq) + 2 e^- \rightarrow Zn(s) \quad E^\circ = -0.76 V$$

$$Al^{3+}(aq) + 3 e^- \rightarrow Al(s) \quad E^\circ = -1.66 V$$



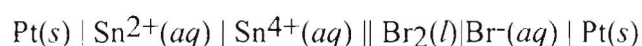
Of the species above, the strongest oxidizing agent is \_\_\_\_\_, and the strongest reducing agent is \_\_\_\_\_.

(b) The standard cell potential for the following galvanic cell is 1.21 V.



When  $[\text{Al}^{3+}] = 0.10 \text{ M}$  and  $[\text{Fe}^{2+}] = 0.10 \text{ M}$ , will the cell potential at  $25^\circ\text{C}$  be less than, the same as, or greater than 1.21 V?

(c) In the galvanic cell represented by the shorthand notation below, electrons are lost by \_\_\_\_\_ and gained by \_\_\_\_\_.



7. (a) Ni has a face-centered unit cell. The number of Ni atoms in the unit cell is \_\_\_\_\_.
- (b) A compound having A ions on each corner and B ions on each face of a cubic unit cell has the empirical formula \_\_\_\_\_.
- (c) The boiling point of a solution containing a nonvolatile solute will be \_\_\_\_\_ than the boiling point of the pure solvent, whereas the boiling point of a solution of two volatile liquids will be \_\_\_\_\_ than the boiling point of the more volatile liquid and \_\_\_\_\_ than the boiling point of the less volatile liquid.