編號：H 208 　系所：奈米科技暨微系統工程研究所 　　科目：普通化學

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普 通 化 學

一. 選擇題 (45 %，每題 3 分):

1. In the reaction: $2A + B \rightarrow 3C + D$
   3.0 mol **A** and 2.0 mol **B** recat to form 4.0 mol **C**. What is the percent yield of this reaction?   (A). 50 % (B). 67 % (C). 75 % (D). 89 % (e). 100 %.

2. Which pair of ions would *not* be expected to form a precipitate when dilute solutions of each are mixed?
   (A). Al^{3+}, S^{2-} (B). Pb^{2+}, Cl^- (C). Ba^{2+}, PO_4^{3-} (D). Pb^{2+}, OH^-, (E). Mg^{2+}, SO_4^{2-}.

3. Body temperature is about 36 °C. On a cold day, what volume of air at 2 °C must a person with a lung (肺) capacity of 2.00 L breathe in to fill the lung?
   (A). 2.26 L (B). 1.78 L (C). 1.13 L (D). 3.54 L (E). 0.25 L.

4. The equilibrium constant for $A + 2B \rightleftharpoons 3C$ is 2.1 x 10^{-6}. Determine the equilibrium constant for $2A + 4B \rightleftharpoons 6C$.
   (A). 4.2 x 10^{-6} (B). 2.1 x 10^{-6} (C). 4.4 x 10^{-12} (D). 1.8 x 10^{-11} (E). none of these.

5.   The equilibrium constant for the reaction $A^- + H^+ \rightleftharpoons HA$ is called:
   (A). K_a (B). K_b (C). $1/K_a$ (D). K_w/K_b (D). K_wK_a.

6.   As water is heated, its pH decreases. This means that
   (A). the water is no longer neutral (B). $[H^+] > [OH^-]$ (C). $[OH^-] > [H^+]$
   (D). A and B are correct (E). none of these.

7. Calculate the pH of a 2.0 x 10^{-5} M HOC_6H_5 (酚); $K_a = 1.6 \times 10^{-10}$.
   (A). 7.25 (B). 6.94 (C). 6.50 (D). 7.06 (E). none of these.

8. An element's most stable ion forms an ionic compound with chloride have the formula XCl_2. If the mass number of the ion is 89 and it has 36 electrons, what is the element and how many neutrons does it have?.
   (A). Kr, 53 neutrons (B). Kr, 55 neutrons (C). Rb, 52 neutrons (D). Sr, 51 neutrons.

9. Which of the compounds below is an example of a network solid?
   (A). $S_8(s)$ (B). $SiO_2(s)$ (C). $MgO(s)$ (D). $NaCl(s)$ (E). $C_{25}H_{52}(s)$
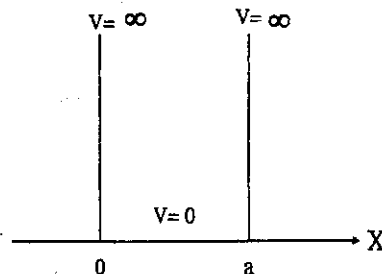
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10. Choose the metal with the largest first ionization energy:

(A). Na (B). Mg (C). Al (D). K (E) Ca.

11. Which of the following statements is true about *p*-type silicon?

(A). It is produced by doping Si with P or As. (B). Electrons are the mobile charge carrier. (C). It does not conduct electricity as well as silicon. (D). All are true. (E). None is true.

12. Choose the species with the smallest hydration (水合) energy (absolute value).

(A). F^- (B). Cl^- (C). Br^- (D). I^- (E). All the same.

13. A radioactive isotope of vanadium, $^{53}_{23}V$, decays by a producing β particles and gamma rays. The nuclide formed has the atomic number:

(A). 22 (B). 21 (C). 23 (D). 24 (E). none of these.

14. A radioactive element has a half-life of 25 min. How many minutes will it take for the number of atoms present to decay to $1/8^{th}$ of the initial value?

(A). 75 min (B). 50 min (C). 25 min (D). 100 min (E). None of these.

15. A concentration cell is constructed using two Ni electrodes with Ni^{2+} concentrations of 1.0 M and 1.0×10^{-4} M in the two half cells. The reduction potential of Ni^{2+} is -0.23 V. Calculate the cell potential of the cell at 25 °C.

(A). 0.0 V (B). $+1.32$ V (C). -1.32 V (D). $+0.118$ V (E). $+0.0592$ V

(Hint: $\varepsilon = \varepsilon^0 - (0.05916/n) \log C$)

二. 問答題與計算題 (55 %):

1. (a). Write down the First, Second and Third Law of Thermodynamics.

   (b). Calculate the ΔS(surrounding), ΔG and K for the following reaction at 25 °C and 1 atm. (12 %)

   $Sb_4O_6(s) + 6C(s) \rightarrow 4 Sb(s) + 6 CO(g)$ $\Delta H = 778$ kJ; $\Delta S = 380$ J/K

2. (a). Write down the de Broglie equation.

   (b). Write down the Schrödinger equation for the particle in a box (Right figure).

   (c). How many unpaired electrons present each of the following atoms or ions in the ground sate: O, O^+, F?   (9 %)

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3. (a). Draw a Molecular Orbital energy-level diagram for the O_2 molecule.
   (b). Why the O_2 is paramagnetic?
   (c). Calculate the bond orders of O_2^+ and O_2^-. (8 %)

4. (a) Write the integrated (積分型) rate laws for zero-order, first-order and second-order reactions.
   (b). For a first-order reaction, the rate constant is 20 s. What is the half-life of the reaction?
   (c) Write down the Arrhenius equation. (10 %)

5. (a). Draw the possible electron arrangements in the split $3d$ orbitals of an octahedral complex of Co^{3+} ($3d^6$). (Hint: In a strong field and in a weak field).
   (b). The F^- is a weak field ligand; predict the CoF_6^{3-} complex ion is paramagnetic or diamagnetic, Why? (8 %)

6. (a). Illustrate simple examples to explain the following types of polymerization:
      (1). Addition polymerization;　　(2). Condensation polymerization
   (b). What is the product of the following reaction?　　(8 %)

$$CH_2=CH_2 \ + \ H_2O \ \xrightarrow[\text{catalyst}]{\text{Acid}} \ Product$$