國立暨南國際大學 104 學年度轉學生入學考試試題　　第 3 節

科目：普通化學　　適用：應化系二

編號：341

考生注意：
1.依次序作答，只要標明題號，不必抄題。
2.答案必須寫在答案卷上，否則不予計分。
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本 試 題
共 5 頁
第 1 頁

一、單選題 (54%，每題 3 分)

1. The formula of water is H_2O. Which of the following statements is true?

   [A] There are two hydrogen atoms and one oxygen atom per water molecule.

   [B] The mass of hydrogen is twice that of oxygen in each water molecule.

   [C] There are two oxygen atoms and one hydrogen atom per water molecule.

   [D] The mass of oxygen is twice that of hydrogen in each water molecule.

   [E] Two of these are true.

2. How many protons, neutrons, and electrons are in an atom of $^{59}_{27}Co$?

   [A] 59, 27, 32　　　[B] 59, 32, 27　　　[C] 27, 32, 27　　　[D] 27, 59, 27　　　[E] 32, 27, 32

3. Which of the following is not correct?

   [A] $Fe(NO_3)_3$—iron(III) nitrate　　　[B] $CaCl_2$—calcium chloride　　　[C] N_2O_3—dinitrogen trioxide

   [D] Al_2O_3—dialuminum trioxide　　　[E] KH_2PO_4—potassium dihydrogen phosphate

4. Which of the following statements is false?

   [A] Every atom has three subatomic particles: the electron, proton, and neutron.

   [B] By knowing the number of protons in a neutral element, you are able to determine mass number.

   [C] The number of protons in the nucleus of an atom of any particular element is called that element's atomic number.

   [D] Every atom has an equal number of electrons and protons, so atoms have no net electrical charge.

   [E] An ion is formed by either adding or subtracting electrons from the atom.

5. Which of the following sets of quantum numbers are not allowed?

   [A] $n = 4$, $l = 3$, $m_l = -3$, $m_s = -\frac{1}{2}$　　　　[B] $n = 1$, $l = 0$, $m_l = 0$, $m_s = +\frac{1}{2}$

   [C] $n = 2$, $l = 1$, $m_l = 1$, $m_s = -\frac{1}{2}$　　　　[D] $n = 3$, $l = 2$, $m_l = -1$, $m_s = +\frac{1}{2}$

   [E] $n = 0$, $l = 0$, $m_l = 0$, $m_s = +\frac{1}{2}$

6. The rate law for the decomposition of phosphine (PH_3) is

   $$\text{Rate} = -d[PH_3] / dt = k[PH_3]$$

   It takes 180. s for the concentration of 0.80 M PH_3 to decrease to 0.10 M. How much time is required for 2.00 M PH_3 to decrease to a concentration of 0.25 M?

   [A] 180 s　　　[B] 120 s　　　[C] 150 s　　　[D] 240 s　　　[E] 60 s

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本 試 題
共 5 頁
第 2 頁

7. Which of the following ways of describing solution composition is temperature-dependent?

   [A] molality　　　　[B] mole fraction　　　　[C] molarity　　　　[D] mass percent

   [E] none of these.

8. A 51.24 g sample of $Ba(OH)_2$ is dissolved in enough water to make 1.20 L of solution. How many mL of this solution must be diluted with water in order to make 1.00 L of 0.200 M $Ba(OH)_2$? Molecular weight of $Ba(OH)_2$ is 171.342.

   [A] 666 mL　　　[B] 1200 mL　　　[C] 400 mL　　　[D] 800 mL　　　[E] 333 mL

9. Which of the following statements is false?

   [A] Boyle's law—the volume of a given sample of gas at constant temperature varies inversely with the pressure.

   [B] Charles's law—the pressure of a given sample of gas at constant volume is directly proportional to the temperature in kelvins.

   [C] Avogadro's law—equal volumes of gases at the same temperature and pressure contain the same number of particle.

   [D] Le Châtelier's principle—if a change is imposed on a system at equilibrium, the position of the equilibrium will shift in a direction that tends to reduce the effect of that change.

   [E] Ideal gas law—an equation of state for a gas, where the state of the gas is its condition at a given time; expressed by $PV = nRT$, where P = pressure, V = volume, n = moles of the gas, R = the universal gas constant, and T = absolute temperature.

10. Which of the following statements is true?

   [A] In terms of the Brønsted-Lowry definition, an acid is a proton (H^+) donor, and a base is a hydroxide (OH^-) donor.

   [B] The number of electrons lost in the reduction half-reaction must equal the number of electron gain in the oxidation half-reaction.

   [C] Oxidation is a decrease in oxidation number; reduction is an increase in oxidation state.

   [D] An oxidizing agent is oxidized and a reducing agent is reduced in a redox reaction.

   [E] The equivalent point is the point in the titration at which enough titrant has been added to react exactly with the substance being determined.

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本試題
共 5 頁
第 3 頁

11. A chemist dissolves 2.00 mmol of weak acid, HA, in 100.0 mL of water and titrates the resulting solution with 0.0500 M NaOH. After 20.0 mL of NaOH has been added, the pH is 6.00. What is the K_a value for the acid?

[A] 1.0×10^{-6} 　　[B] 2.0×10^{-6} 　　[C] 8.3×10^{-3} 　　[D] 1.0×10^{-3} 　　[E] 2.0×10^{-3}

12. List the following ions and atoms in order of increasing radius: S^{2-}, Cl^-, Ar, K^+, Ca^{2+}.

[A] $Ca^{2+} < K^+ < Ar < S^{2-} < Cl^-$ 　　　　[B] $S^{2-} < Cl^- < Ar < K^+ < Ca^{2+}$

[C] $Ca^{2+} < K^+ < Ar < Cl^- < S^{2-}$ 　　　　[D] $K^+ < Ca^{2+} < Ar < Cl^- < S^{2-}$

[E] $S^{2-} < Cl^- < Ar < Ca^{2+} < K^+$

13. A solution of hydrogen peroxide is 30.0% H_2O_2 by mass and has a density of 1.11 g/cm^3. The molarity of the solution is:

[A] 7.94 M 　　[B] 0.98 M 　　[C] 8.82 M 　　[D] 9.79 M 　　[E] 12.61 M

14. 30.0 mL of pure water at 280 K is mixed with 50.0 mL of pure water at 360 K. What is the final temperature of the mixture?
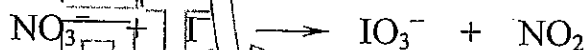
[A] 340 K 　　[B] 330 K 　　[C] 310 K 　　[D] 320 K 　　[E] 300 K

15. The following reaction occurs in aqueous acid solution:

$$NO_3^- + I^- \longrightarrow IO_3^- + NO_2$$

The change in oxidation state for iodine is:

[A] −5 　　[B] −1 　　[C] 0 　　[D] +5 　　[E] +6

16. Arrange the following bonds according to increasing polarity: H–H, O–H, F–H, and S–H.

[A] H–H < O–H < F–H < S–H 　　　　[B] S–H < O–H < F–H < H–H

[C] H–H < S–H < O–H < F–H 　　　　[D] H–H < S–H < F–H < O–H

[E] F–H < O–H < S–H < H–H

17. For each of the following atoms and ions, which one has incorrect electron configuration?

[A] N: $1s^2 2s^2 2p^3$ 　　　　　　　　[B] F^-: $1s^2 2s^2 2p^6$

[C] Ti: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$ 　　　　[D] Cr: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$

[E] Cu^+: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$

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本 試 題
共 5 頁
第 4 頁

18. The average mass of a boron atom is 10.81. If you were able to isolate a single boron atom, what is the chance that you would randomly get atom with mass 10.81?
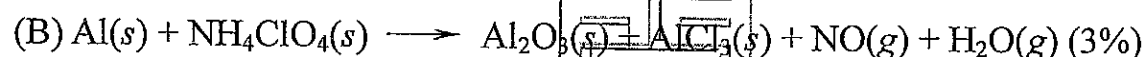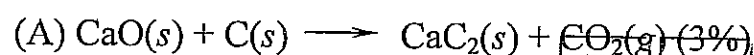
[A] >50%　　　　[B] 0%　　　　[C] ~11%　　　　[D] 100%　　　　[E] 0.81%

二、簡答與計算題，請列出關鍵公式與計算過程。(46%)

1. (5%) Derive the relationship between two equilibruim constants: K and K_p.

2. What are concentration cells? (3%) Explain how a concentration cell works. (4%)
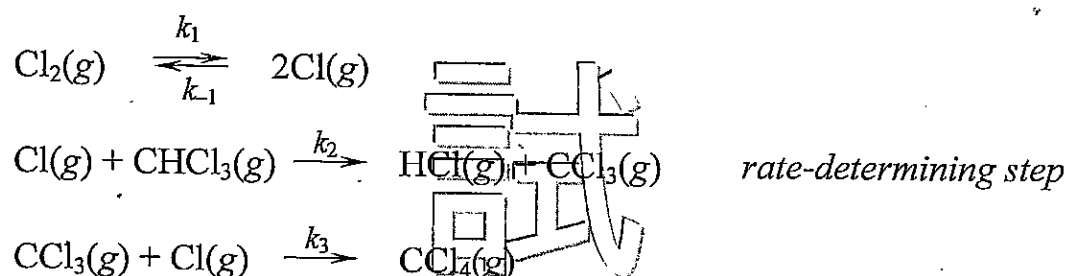
3. Balance the following equations:

    (A) $CaO(s) + C(s) \longrightarrow CaC_2(s) + CO_2(g)$ (3%)

    (B) $Al(s) + NH_4ClO_4(s) \longrightarrow Al_2O_3(s) + AlCl_3(s) + NO(g) + H_2O(g)$ (3%)

4. (6%) The gas-phase reaction of chlorine with chloroform is described by the equation

$$Cl_2(g) + CHCl_3(g) \longrightarrow HCl(g) + CCl_4(g)$$
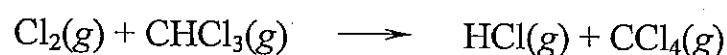
A proposed mechanism for this reaction follows:

$$Cl_2(g) \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} 2Cl(g)$$

$$Cl(g) + CHCl_3(g) \overset{k_2}{\longrightarrow} HCl(g) + CCl_3(g) \quad \textit{rate-determining step}$$

$$CCl_3(g) + Cl(g) \overset{k_3}{\longrightarrow} CCl_4(g)$$

Derive the rate law for the reaction.

5. (6%) Methanol is a high-octane fuel used in high-performance racing engines. Calculate $\Delta G°$ for the reaction

$$2CH_3OH(g) + 3O_2(g) \longrightarrow 2CO_2(g) + 4H_2O(g)$$
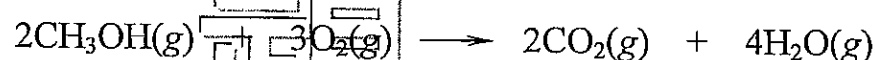
Substance	$\Delta G°_f$ (kJ/mol)
$CH_3OH(g)$	−163
$O_2(g)$	0
$CO_2(g)$	−394
$H_2O(g)$	−229

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本試題
共 5 頁
第 5 頁

6. Values of K_w as a function of temperature are as follows:

Temperature (°C)	K_w
0	1.14×10^{-15}
25	1.00×10^{-14}
35	2.09×10^{-14}
40	2.92×10^{-14}
50	5.47×10^{-14}

(A) Is the autoionization of water exothermic or endothermic? (2%)

(B) Calculate the $[H^+]$ in pure water at 40 °C. (3%)

(C) Is the pH of pure water at 40 °C larger or smaller than 7? (2%)

7. Explain the following descriptions:

(A) $O_2(g)$ is paramagnetic. (3%)

(B) In the unit cell for ZnS, the S^{2-} ions are closest packed with the Zn^{2+} ions filling alternate tetrahedral holes. (3%)

(C) The process of gas diffusion enrichment is used to increase the amount of ^{235}U to ^{238}U in $UF_6(g)$. (3%)