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一. 選擇題：(45 %；每題三分，答錯不倒扣)

1. What is the correct formula for chromium(VI) oxide?

   A)CrO_6; B) Cr_2O_3 ; C)CrO_2 ; D) CrO_3; E) Cr_6O_6.

2. Iron is produced from its ore by the reactions:

   $2C(s) + O_2(g) \rightarrow 2CO(g)$;　$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$

   How many moles of $O_2(g)$ are required to produce 1 mole of Fe(s)?

   A) 0.5 mole; B) 0.75 mole ; C) 1.5 mole; D) 1.0 mole; E) none of these.

3. Which of the following statements is(are) true? Oxidation and reduction:

   A) accompany all chemical changes; B) describe the loss and gain of electron(s), respectively; C) cannot occur inappropriately of each other; D) All are true; E) B and C are true.

4. The following unbalanced reaction occurs in basic media:

   $Fe^{2+} + CrO_7^{2-} \rightarrow Fe^{3+} + Cr^{3+}$

   The coefficient for water in the balanced equation is ____ and water appears on the ____ side of the reaction.

   A) 7, left; B) 7, right; C) 14, left; D) 14, right; E) None of these.

5. For identical 1.0-L flasks contain the gases He, Cl_2, CH_4 and NH_3, each at 0 ^{o}C and 1 atm. Which gas has the highest dnsity?

   A) He; B) Cl_2; C) CH_4; D) NH_3; E) all gases the same.

6. Following the question 5, for which gas do the molecules have the highest average velocity?

   A) He; B) Cl_2; C) CH_4; D) NH_3; E) all gases the same.

7. If, at a given temperature, the equilibrium constant for the reaction

   $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$　is K_p, then the equilibrium constant for the reaction $HCl(g) \rightleftharpoons 1/2\ H_2(g) + 1/2\ Cl_2(g)$ can be represented as:

   A) $1/K_p^2$; B) K_p^2 ; C) $1/\sqrt{K_p}$; D) $\sqrt{K_p}$; E) None of the above.

8. The pH of a HCl solution at 25 ^{o}C in which [HCl] = 1.0×10^{-8} M is:

   A) 8.0 ; B) 7.5 ; C) 7.0; D) 6.5 E) none of these.

（背面仍有題目，請繼續作答）

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9. Calculate the pH value of a solution that contains 3.25 M HCN ($K_a = 6.2 \times 10^{-10}$), 1.0 M NaOH and 1.50 M NaCN.

A) 9.25 ; B) 8.86 ; C) 8.28; D) 9.8; E) none of these.

10. Calculate the solubility of $Cu(OH)_2$ in a solution buffered at pH = 8.50. (K_{sp} of $Cu(OH)_2 = 1.6 \times 10^{-19}$)

A) 1.6×10^{-2} M ; B) 1.6×10^{-6} M ; C) 5.7×10^{-10} M ; D) 1.6×10^{-8} M ; E) 1.8×10^{-9} M

11. A certain solid substance that is very hard, has a high melting point, and is nonconducting unless melted is most likely to be?

A) Graphite ; B) NaCl ; C) Cu ; D) SiO_2; E) none of these.

12. A salt solution sits in an open beaker. Assuming constant temperature and pressure, the vapor pressure of the solution.

A) increases over time; B) decreases over time; C) stays the same over time; D) Need to know the temperature and pressure to answer this. E) not enough information given.

13. Choose the element that is the strongest reducing agent in aqueous solution?

A) Li ; B) Na ; C) K; D) Rb; E) not enough information given.

14. Choose the species with the smallest radius?

A) F; B) F^-; C) Cl ; d) Cl^- ; E) All are the same.

15. Which of the following is paramagnetic?

A) $Zn(H_2O)_6^+$; B) $Co(NH_3)_6^{3+}$ (strong field); C) $Cu(CN)_3^{2-}$;

D) $Mn(CN)_6^{2-}$ (strong field) ; (E) none of these.

二. 問答題與計算題: (55 %)

1. Write down the following equations or chemical reactions: (9 %)

(a). Schrödinger equation for particle (mass = m) motion in one dimension with potential energy (V) = 0. (b). The radical polymerization of ethylene molecules to polyethylene. (c). Arrhenius equation.

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2. (a) Write down the Nernst equation.

(b) At 25 °C, the RT/F = 0.0257 V, please calculate the electrical potential of the following concentration cell. $Zn(s)| Zn^{2+}(0.1 \ M) || Zn^{2+}(1.0 \ M)| Zn(s)$. (9 %)

3. The overall reaction for the corrosion (rusting) of iron by oxygen is

$$4 \ Fe(s) + 3 \ O_2(g) \rightleftharpoons 2 \ Fe_2O_3(s)$$
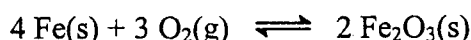
Use the following data, calculate the ΔH^0, ΔS^0, ΔS_{surr}, ΔG^0 and the equilibrium constant for this reaction at 25 °C. (12 %)

Substance	ΔH_f^0 (kJ/mol)	$S^0 (JK^{-1}mol^{-1})$
$Fe_2O_3(s)$	– 800	100
Fe(s)	0	30
$O_2(g)$	0	200

4. Draw the molecular orbital energy-level diagram for B_2 molecule and predict its bond order and magnetism? (8 %)

5. (a). The right-hand figure is a plot of ln[reactant] vs. reaction time. What is the reaction order of that reaction? Verify the rate law.
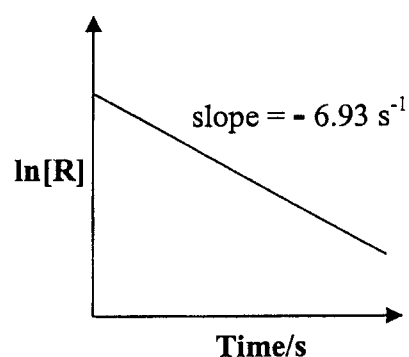
(b). Calculate the values of the reaction constant and half-life ($t_{1/2}$). (9 %)

slope = - 6.93 s⁻¹

ln[R]

Time/s

6. Finish the following table by writing the functional group for each organics. (8 %)

Class	Functional group
Alcohols	–OH
Esters	(a)
Ketones	(b)
Carboxylic acid	(c)
Halohydrocarbons	(d)