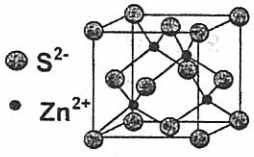
※注意：第 I、II 題選擇題請於試卷上「選擇題作答區」內依序作答，惟第 III 題請務必作答於「非選擇題作答區」第一頁，並應註明題號。

- **Gas constant: R = 8.314 J/mol-K = 0.0821 L-atm/mol-K**
- **H = 1.01 g/mol, C = 12.01 g/mol, F = 19.00 g/mol, Cl = 35.45 g/mol, Br = 79.9 g/mol**
- **C = 3.00 × 10^8 m/s; h = 6.63 × 10^{-34} J-s; R_H = 1.096776 × 10^7 m^{-1}; F = 96500 C/mol**

I. 單選題 （**30%**, 每題 **3** 分）

1. A typical commercial-grade hydrochloric acid is 38% HCl by mass and density 1.18 g/mL. Calculate the molarity (mol/L) of the acid.
   (A) 10 M (B) 12 M (C) 18 M (D) 32 M
2. What volume of 0.0112 M HBr(aq) is required to neutralize 25.0 mL of 0.0138 M $Ba(OH)_2$?
   (A) 15.4 mL (B) 25.0 mL (C) 30.8 mL (D) 61.6 mL
3. A sample of natural gas contains 8.00 mol of CH_4, 0.400 mol of C_2H_6, and 0.200 mol of C_3H_8. If the total pressure of the gases is 2.00 atm, the partial pressure of CH_4 in atm is
   (A) 0.930 (B) 1.86 (C) 2.00 (D) 8.60
4. A 0.309 g sample of coal is burned in a bomb calorimeter with a heat capacity of 4.62 kJ/°C. The temperature in the calorimeter rises from 20.45 to 22.28°C. Calculate the heat of combustion of the coal, in kJ/g.
   (A) –27.4 (B) –8.45 (C) +8.45 (D) +27.4
5. For the following types of electromagnetic radiation which one shows the highest energy?
   (A) microwave (B) infrared, IR (C) visible (D) ultraviolet, UV
6. What is the valence shell electron configuration of the halogens?
   (A) ns^2 (B) ns^2np^3 (C) ns^2np^5 (D) ns^2np^6
7. Which chemical species undergoes reduction according to the following cell diagram
   $Sn(s) \mid Sn^{2+} \parallel NO_3^-$(acidic soln), $NO(g) \mid Pt(s)$
   (A) Sn (B) Sn^{2+} (C) NO_3^- (D) NO
8. If the human eye has an osmotic pressure of 8.00 atm at 25°C, what concentration of solute particles in water will provide an isotonic eyedrop solution?
   (A) 0.00323 M (B) 0.0385 M (C) 0.327 M (D) 3.90 M
9. The structure of crystalline zinc sulfide is shown below. How many S^{2-} ions are in each ZnS unit cell?
   (A) 1 (B) 2 (C) 3 (D) 4



10. How many moles of $NaCH_3COO$ must be added to 2.0 L of 0.10 M CH_3COOH to form a buffer whose pH is 5.00? $K_a(CH_3COOH) = 1.8 \times 10^{-5}$.
    (A) 0.055 mol (B) 0.11 mol (C) 0.18 mol (D) 0.36 mol

II. 複選題（**60%**, 每題答案可能 **1** 至多個，全部選對始得題分 **3** 分）

11. Choose the one that has four significant figures.
    (A) 22.01 (B) 2.3×10^3 (C) 76.10 (D) 0.111
12. Choose the correct conversion in the followings:
    (A) 5 nm = 5×10^{-9} m (B) 6 mg = 6×10^{-3} g (C) 7 μL = 7×10^{-6} L (D) 25 °C = 298 K

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13. For the $^{59}_{27}Co^{2+}$ ion, it contains
(A) 29 protons (B) 27 neutrons (C) 27 electrons (D) 59 nucleons.

14. Choose the one that is weak acid.
(A) $NH_3(aq)$ (B) $HNO_3(aq)$ (C) HF(aq) (D) $CH_3COOH(aq)$

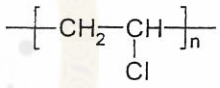
15. The temperature of a 5.0 L container of N_2 gas is increased from 20°C to 250°C at constant volume.
(A) The average kinetic energy of the molecules increases.
(B) The average speed of the molecules increases.
(C) The number of N_2 molecules increases.
(D) The pressure of the N_2 gas increases.

16. Which of the following molecule is nonpolar?
(A) CO_2 (B) CCl_4 (C) H_2O (D) NH_3

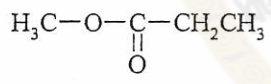
17. Which one of the following substances would have hydrogen bonding as one of its intermolecular forces?
(A) Benzene, C_6H_6 (B) CH_3F (C) CH_3OH (D) HCOOH

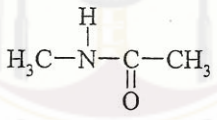
18. For the following substances: CF_4, CCl_4, and CBr_4
(A) dispersion forces: $CF_4 < CCl_4 < CBr_4$ (B) vapor pressure: $CF_4 < CCl_4 < CBr_4$
(C) normal boiling point: $CF_4 < CCl_4 < CBr_4$ (D) enthalpy of vaporization (ΔH_{vap}): $CF_4 < CCl_4 < CBr_4$

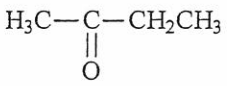
19. For the polyvinyl chloride (PVC) with the following structure
(A) CH_2CHCl is the monomer. (B) This is a condensation polymer.
(C) This is a homopolymer. (D) This is a copolymer.

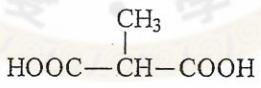


20. For the following molecules choose the one that is an ester?

(A) 

(B) 

(C) 

(D) 

21. For the reaction $2NO_2 + F_2 \rightarrow 2NO_2F$, the experimentally determined rate law is: Rate = $k[NO_2][F_2]$. A suggested mechanism for the reaction is:

step 1 $NO_2 + F_2 \xrightarrow{k_1} NO_2F + F$ slow

step 2 $F + NO_2 \xrightarrow{k_2} NO_2F$ fast

(A) Step 1 is the rate determining step.
(B) The rate law deduced from the mechanism is: Rate = $k[NO_2][F_2]$.
(C) This is an acceptable mechanism.
(D) F is the catalyst in the reaction.

22. Which of the following metals can be dissolved in 1.0 M HCl solution?
(A) Ag (B) Cu (C) Fe (D) Zn

23. Which of the followings is a representative of chlorofluorocarbon (CFC)?
(A) $CHCl_3$ (B) CCl_2F_2 (C) $CFCl_3$ (D) CHF_3

24. Which of the following is conjugated acid-base pair?
(A) HNO_3, NO_3^- (B) H_2O, OH^- (C) H_2SO_4, SO_4^{2-} (D) NH_4^+, NH_3

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25. Solubility rules predict precipitate formation for mixing 0.1 M aqueous solutions of
(A) Na_2CO_3, $Ca(NO_3)_2$ (B) NaCl, $AgNO_3$ (C) H_2SO_4, $Pb(NO_3)_2$ (D) $(NH_4)_2S$, $Cu(NO_3)_2$

26. For a **first order** reaction: A → D, the following data were obtained

time (s)	[A] (M)
0.0	2.00
5.0	1.00
10.0	0.500
15.0	0.250
20.0	0.125

(A) The average rate of the reaction between 0 and 10 s is 0.15 M/s
(B) The half life for the reaction is 5.0 seconds.
(C) A plot of 1/[A] versus time is linear.
(D) The rate constant for the reaction is 0.14 s^{-1}.

27. For the water-gas reaction: $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$ $\Delta H^\circ = 131$ kJ
Which of the following changes will affect the partial pressure of $H_2(g)$ at equilibrium?
(A) A catalyst is added to the system.
(B) An inert gas is added to the reaction vessel to increase the total pressure with no volume change.
(C) The temperature is raised to 1000 K.
(D) More coal (carbon) is added to the system.

28. Which of the following nuclide is radioactive?
(A) $^{222}_{86}Rn$ (B) $^{235}_{92}U$ (C) $^{90}_{38}Sr$ (D) $^{12}_{6}C$

29. Which of the following is chelating agent?
(A) NH_3 (B) Cl^- (C) $C_2O_4^{2-}$, oxalate ion (D) ethylenediaminetetraacetate ion, $EDTA^{4-}$

30. For the coordination compound $[Cr(NH_3)_6]Cl_3$, which of the following statement is true?
(A) The oxidation number of Cr is +3. (B) The coordination number of Cr is 3.
(C) Cl^- ion is the counter ion. (D) The geometry of the complex ion is octahedral.

III. 計算問答題 (10%)

31 Consider the decomposition of barium carbonate: $BaCO_3(s) \rightarrow BaO(s) + CO_2(g)$.
(A) Use the data in the following table to calculate the values of ΔH°, ΔS°, and ΔG° at 298 K.
(B) Is this an endothermic or exothermic reaction?
(C) How is the entropy change of the system, increase or decrease?
(D) Is the process spontaneous or not at 298 K?
(E) What is the value of the ΔG when the reaction is at equilibrium?

	$BaCO_3(s)$	$BaO(s)$	$CO_2(g)$
ΔH_f° (kJ/mol)	-1216	-554	-394
S° (J/mol.K)	112	70.4	214
ΔG_f° (kJ/mol)	-1138	-525	-394

試題隨卷繳回