※單選題請作答於答案卷首頁之「選擇題作答區」。

I. 單選題，每題 3 分，答錯倒扣 1 分；共 72 分。

1. Which of the following gas has the highest molecular speed?
(a) N_2 at 500 K (b) CH_4 at 400 K (c) H_2 at 100 K (d) O_2 at 600 K

2. What is the pH of a solution formed by mixing 28 mL, 0.1 M CH_3COOH with 18 mL, 0.1 M NaOH. ($K_a = 1.8 \times 10^{-5}$ for CH_3COOH)
(a) 2 (b) 3 (c) 4 (d) 5

3. What is the number of unpaired electrons in $[Fe(CN)_6]^{2-}$?
(a) 0 (b) 2 (c) 4 (d) 5　　(Z = 26 for Fe; CN^- is a strong-field ligand)

4. β-emission transforms $^{25}_{12}Mg$ into what nuclide?
(a) $^{24}_{11}Na$ (b) $^{25}_{13}Al$ (c) $^{24}_{12}Mg$ (d) $^{26}_{13}Al$

5. Which of the following aqueous solution (0.01 M each) has the highest vapor pressure?
(a) sucrose (b) NaOH (c) CH3COOH (d) H_2SO_4

6. Upon recharging of the lead-storage battery, what is the reducing agent?
(a) PbO_2 (b) Pb (c) $PbSO_4$ (d) H_2SO_4

7. Which of the following pairs illustrate the Law of Multiple Proportions?
(a) O_2, O_3 (b) H_2O, D_2O (c) PCl_3, PCl_5 (d) CO_2, SiO_2

8. Which of the following gas has a density of 1.34 $g \cdot L^{-1}$ at STP?
(a) H_2 (b) CO_2 (c) CH_4 (d) C_2H_6

9. Which metal form a nitride with nitrogen gas?
(a) Li (b) Na (c) Fe (d) Cu

10. Which of the following property does not vary with temperature?
(a) density (b) molality (c) osmotic pressure (d) molar volume of a gas

11. Which of the following is an example of a conjugated molecule?
(a) 1,3-butadiene (b) trans-2-butene (c) cis-2-butene (d) 1,2-butadiene

12. What is the solubility (in M) of $Mg(OH)_2$ ($K_{sp} = 1.8 \times 10^{-11}$) at pH 10?
(a) 1.6×10^{-4} (b) 4.2×10^{-4} (c) 1.8×10^{-3} (d) 4.2×10^{-3}

13. Which aqueous solution (0.01 M each) has the highest boiling point?
(a) NaCl (b) $CaCl_2$ (c) Na_3PO_4 (d) $(NH_4)_2SO_4$

14. For a first order reaction, 6.25% of the reactant remains after 24 min. What is the half-life (in min) of the reaction?
(a) 4 (b) 6 (c) 8 (d) 12

15. If $K_p = 16$ for $NH_4Cl_{(s)} \leftrightarrows NH_{3(g)} + HCl_{(g)}$, what is the total pressure (in atm) of the system when $NH_4Cl_{(s)}$ is placed in a close container and reaches equilibrium?
(a) 4 (b) 8 (c) 16 (d) 32

16. Which of the following species is NOT amphiprotic?
(a) $H_2PO_4^-$ (b) HPO_4^{2-} (c) PO_4^{3-} (d) H_2O

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17. Which process is accompanied by a decrease in entropy for the system?
(a) wax melts (b) dry ice sublimes (c) water evaporates (d) water vapor condenses

18. Which is necessarily true for a spontaneous process?
(a) $q < 0$ (b) $\Delta S > 0$ (c) $\Delta H < 0$ (d) $\Delta S_{universe} > 0$

19. For a certain phase transition, $\Delta H = 25$ kJ·mol^{-1} and $\Delta S = 100$ J·mol^{-1}·K^{-1}. At what temperature (in K) does this phase transition occur?
(a) 200 (b) 250 (c) 300 (d) 400

20. What mass (in g) of Cu will be deposited from a solution of Cu^{2+} by a current of 1.5 A for 2 h? (Cu = 63.5, F = 96500 coulombs)
(a) 1.8 (b) 3.6 (c) 5.4 (d) 7.2

21. Which alkaline earth metal does not react with water or steam?
(a) Be (b) Mg (c) Ca (d) Sr

22. Which substance protects the Earth's surface from UV radiation?
(a) O_2 (b) O_3 (c) H_2O (d) CO_2

23. A fat is an example of which functional group?
(a) ether (b) ketone (c) amide (d) ester

24. The aqueous solution of which following ion would be colorless?
(a) Sc^{3+} (b) Fe^{3+} (c) Co^{2+} (d) Ni^{2+}

II. Answer the following questions for the ion SF_5^-. 10%
(A) Draw its Lewis structure. (B) What is its electron group geometry?
(C) What is its molecular geometry? (D) What are the formal charges of S & F?
(E) Give the hybridization of S.

III. For the third period elements (Na ~ Cl), identify the element(s) with the following properties. 10%

(A) elements are molecular substances	(B) forms a basic oxide
(C) forms an amphoteric oxide	(D) the strongest oxidizing agent
(E) the atom is diamagnetic	(F) the atom has 2 unpaired electrons

IV. The edge length of the MnO unit cell is 4.47 Å and the density of MnO is 5.28 g cm^{-3}. Answer the following questions. (Mn = 55 g/mol) 8%
(A) Does MnO crystallize in the NaCl or the CsCl (body-centered cubic) structure? Explain your answer.
(B) Calculate the ionic radius of Mn^{2+} if the ionic radius of O^{2-} is 1.4 Å.

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