

- 注意事項： 1. 答案一律寫在試卷上，否則不予計分。
2. 請標明題號依序作答，不必抄題。
3. 試題應隨同試卷繳回，不得攜出試場。

題 1 至 題 20 每題 3 分，題 21 至 題 25 每題 8 分。

1. 原子之電子分佈可以用四種量子數, n, l, m_l, s 來描述，下列那一組 n, l, m_l, s 是錯誤的？
a. 1 0 0 1/2 b. 1 0 0 -1/2 c. 4 3 3 1/2 d. 6 2 0 -1/2 e. 4 2 3 1/2
2. 某一鉻離子之電子組態為 $\text{Ar } 3d^4$ ，則該鉻離子之電荷為
a. 2- b. 3+ c. 4+ d. 2+ e. 3-
3. 下列那一組分子間有氫鍵存在？
a. H_2 and HI b. CH_3OH and NH_3 c. CH_4 and CH_3CH_3
d. SO_2 and CH_2O e. H_2 and F_2
4. A 10.0 g sample of gas, with a specific heat of 0.50 J/g-K, is heated from 10 to 60°C. During the heating of this sample, the gas expands against a constant pressure equal to 1 atm from an initial volume 1.0 L to a final volume of 25.75 L. Calculate the change in internal energy (E), in kJ.
a. 2.52 b. -2.52 c. 2.26 d. -5.00 e. -2.26
5. Select a molecule from the following, $\text{S}_2, \text{SO}, \text{SO}_3, \text{S}_2\text{Cl}_2, \text{SCl}_2$, that has the highest entropy value at room temperature.
a. SO b. SO_3 c. S_2Cl_2 d. SCl_2 e. S_2
6. Calculate the entropy change, in J/mol-K, for the following reaction
 $\text{GeF}_2(\text{g}) \rightarrow \text{GeF}_2(\text{s})$ $\Delta H_{\text{sub}} = 27.0 \text{ kCal/mol at } 25^\circ\text{C}$.
a. 413 b. -413 c. 90.6 d. -90.6 e. -379
7. Calculate the ΔG° for the reaction at 25 °C
 $\text{C}(\text{diamond}) \rightarrow \text{C}(\text{graphite})$
given that $\Delta H^\circ = 1.895 \text{ kJ/mol}(\text{diamond}), S^\circ = 2.377 \text{ J/mol-K}(\text{diamond}),$
 $S^\circ = 5.740 \text{ J/mol-K}(\text{graphite})$
a. 2.90 b. -1.90 c. -2.90 d. 1.90 e. 0.89
8. Calculate ΔG° of formation for $\text{H}_3\text{PO}_4(\text{l})$, if
 $4\text{P}(\text{s}) + 5\text{O}_2(\text{g}) \rightarrow \text{P}_4\text{O}_{10}(\text{s})$ $\Delta G^\circ = -269.8 \text{ kJ/mol}$
 $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2(\text{g}) + 1/2\text{O}_2(\text{g})$ $\Delta G^\circ = 237.2 \text{ kJ/mol}$
 $\text{P}_4\text{O}_{10}(\text{s}) + 6\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{H}_3\text{PO}_4(\text{l})$ $\Delta G^\circ = 630.2 \text{ kJ/mol}$
 $3/2\text{H}_2(\text{g}) + \text{P}(\text{s}) + 2\text{O}_2(\text{g}) \rightarrow \text{H}_3\text{PO}_4(\text{l})$ $\Delta G^\circ = ?$
a. -1063 b. -265.7 c. 1063 d. 265.7 e. -123.0
9. For a second order rate expression, which plot of the following will be a straight line? note: [A] is the concentration, t is time.
a. [A] vs. 1/t b. 1/[A] vs. t c. 1/[A] vs. t^2 d. $[\text{A}]^2$ vs. t e. $\ln[\text{A}]$ vs. t

(背面仍有題目,請繼續作答)

10. Which one of the following mathematical expressions enables us to calculate the first-order rate constant? note: k is rate constant, $[A]_0$ initial concentration, $t_{1/2}$ half-life time.
 a. $k = 1/t_{1/2}$ b. $k = t_{1/2}$ c. $k = [A]_0 t_{1/2}$ d. $k = 0.693/t_{1/2}$
 e. $k = 2.30 t_{1/2}$
11. Which oxide, when dissolved in water, produces a basic solution?
 a. oxide of carbon b. oxide of nitrogen c. oxide of sulfur
 d. oxide of arsenic e. oxide of radium
12. Which substance is inconsistent with the Arrhenius definition of an acid?
 a. SO_2 b. HNO_3 c. CaO d. NO_2 e. HI
13. Calculate the pH of a solution prepared by mixing 20.0 mL of 0.01 M HCl with 100.0 mL of 0.10 M HCN solution. $K_a = 1.0 \times 10^{-10}$. Assume volumes to be additive
 a. 2.0 b. 2.8 c. 10 d. 1.0 e. 5.5
14. Which one of the following has a metal ion that is likely to undergo the most extensive hydrolysis?
 a. $CaBr_2$ b. $AlCl_3$ c. KF d. RaS e. MgO
15. Which of the following act as a buffer?
 a. KH_2PO_4 b. HCl and $NaCl$ c. HNO_2 and HNO_3 d. KF and HF
 e. KI and HI
16. If $Zn(CN)_2 \rightarrow Zn^{2+} + 2CN^-$ $K_{sp} = 8 \times 10^{-12}$
 $AgI \rightarrow Ag^+ + I^-$ $K_{sp} = 1.5 \times 10^{-16}$
 $Ag^+ + 2CN^- \rightarrow [Ag(CN)_2]^-$ $K_f = 5.6 \times 10^{18}$
 Calculate K_{eq} for the reaction
 $AgI + [Zn(CN)_2] \rightarrow [Ag(CN)_2]^- + Zn^{2+} + I^-$
 Will AgI dissolve in a solution containing $[Zn(CN)_2]$?
 a. 1.2×10^{-28} insoluble b. 4.5×10^6 soluble c. 9.0×10^2 soluble
 d. 6.7×10^{-9} insoluble e. 2.0×10^{-44} insoluble
17. If $Hg^{2+} + 2e^- \rightarrow Hg$ $E^\circ = +0.854 V$
 $(Hg_2)^{2+} + 2e^- \rightarrow 2Hg$ $E^\circ = +0.792 V$
 Calculate the potential for the reduction of mercury(II) to Mercury(I).
 $2Hg^{2+} + 2e^- \rightarrow (Hg_2)^{2+}$ $E^\circ = ?$
 a. +0.062 V b. +0.916 V c. +0.458 V d. -0.062 V e. -0.916 V

(背面仍有題目,請繼續作答)

18. If $\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$ $E^\circ = +0.77 \text{ V}$
 $\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$ $E^\circ = -0.41 \text{ V}$
 Calculate the equilibrium constant for the following reaction at 298°K
 $\text{Fe}(\text{s}) + 2\text{Fe}^{3+}(\text{aq}) \rightarrow 3\text{Fe}^{2+}$ $K_{\text{eq}} = ?$
 a. 1.37×10^{-40} b. 5.20×10^{53} c. 1.92×10^{-54} d. 1.45×10^{-12}
 e. 7.33×10^{39}
19. which complex ion should exhibit the largest crystal field splitting energy?
 a. $[\text{FeCl}_4]^-$ b. $[\text{Fe}(\text{CN})_6]^{3-}$ c. $[\text{CoCl}_4]^{2-}$ d. $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$
 e. $[\text{Zn}(\text{NH}_3)_4]^{2+}$
20. Using your knowledge of the electromagnetic spectrum and the relative energies of visible light, specify which ligand will cause a Co^{2+} complex ion to be rose colored.
 a. F^- b. OH_2 c. Cl^- d. NH_3 e. Br^-
21. Draw the resonance Lewis structures for hydrazoic acid, HN_3 , and diazomethane, CH_2N_2 . The skeletal structures of the molecules are
- H N N N

$\begin{array}{c} \text{H} \\ | \\ \text{C N N} \\ | \\ \text{H} \end{array}$
22. Compare the acidity strength of H_2SO_4 , HClO_4 , HNO_3 , H_2CO_3 from high to low, explain the reason.
23. Here is a set of experimental rate constants for a particular first order decomposition:
- | Temperature($^\circ\text{C}$) | 20 | 40 |
|---------------------------------|------|-----|
| $k \times 10^5 / \text{sec}$ | 47.5 | 576 |
- Determine the activation energy for the reaction in this temperature range and calculate the half-life for the reaction at 30°C .
24. Use molecular orbital theory to compare the relative stability of the following species and indicate their magnetic properties (diamagnetic or paramagnetic)
 O_2 , O_2^+ , O_2^- , O_2^{2-} .
25. EDTA (ethylenediaminetetraacetate) is used for lead and other metal poison treatment. Write the structure of EDTA and describe how does it work for the poison treatment.