

- 說明: 1. 請標明題號, 依序作答, 答案一律以橫式寫在答案卷上。
2. 11 題選擇題請用橫式一行寫在答案卷最前面。
3. 參考數據如下:

(1) Atomic mass (weight): H 1.008, C 12.011, O 15.9994, P 30.9738,
Cl 35.4257, Ni 58.69, ${}^7_3\text{Li}$ 7.0160, ${}^7_4\text{Be}$ 7.0169, e^- 5.486x10⁻⁴

(2) Acidity:	pKa	Acidity:	pKa
HNO ₂	3.34	HOCl	7.46
HOAc	4.74	NH ₄ ⁺	9.24
H ₂ CO ₃	6.36	HCO ₃ ⁻	10.33

(3) Thermodynamic data:

	ΔH_f° (KJ/mol)	S° (J/Kmol)
CaCO ₃ -1207		93
CaO -634		40
CO ₂ -394		214

(4) log2=0.30, log3=0.48, log4=0.60, log5=0.70,
log6=0.78, log7=0.85, log8=0.90, log9=0.95

1. Select the best answer (22%)

(1) Which contains the greatest mass of oxygen in one molecule of (a) ethanol (C₂H₅OH) (b) glucose (c) water (d) carbon dioxide (e) tetraphosphorus hexoxide.

(2) Which force makes the most important contribution to the lattice energy of solid argon? (a) van de Waal's force (b) ionic bonding (c) covalent bonding (d) metallic bonding (e) hydrogen bonding.

(3) Which of the following is the strongest reducing agent? (a) HCl (b) H₂ (c) H₂O₂ (d) NaH (e) Na⁺

(4) Which of the following compounds is an amine? (a) C₂H₅CONH₂ (b) CH₃COOCH₃ (c) C₇H₁₅NH₂ (d) CHCl (e) CH₃COCH₃

(5) Arrange the following ions and molecules in increasing order of their carbon-oxygen bond order: 1. CO₃²⁻ 2. HCOO⁻ 3. HCHO 4. CH₃OH (a) 1=2=3>4 (b) 3>1=2>4 (c) 2>3>1>4 (d) 3>1>4>2 (e) 3>2>1>4

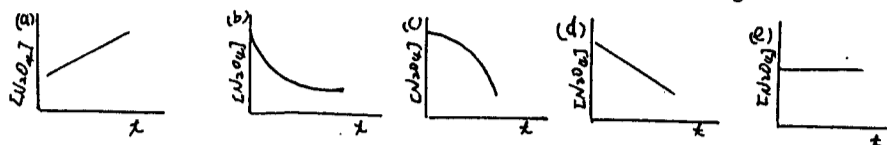
(6) What hybrid orbital is found on the central atom in TeCl₄ (a) SP³ (b) P² (c) dsp³ (d) d²sp³ (e) dsp²

(7) Which of the following represent resonance forms of the same species

(a) $\text{:N}\equiv\text{C}-\ddot{\text{O}}:$ and $\text{:}\ddot{\text{N}}=\text{C}=\ddot{\text{O}}:$ (b) $\text{H}-\overset{\text{H}}{\underset{\text{H}}{\text{C}}}-\overset{\text{O}}{\text{C}}-\text{H}$ and $\text{H}-\overset{\text{O}}{\text{C}}-\overset{\text{H}}{\text{C}}-\text{H}$ (c) $\text{:}\ddot{\text{N}}=\text{N}=\ddot{\text{O}}:$ and $\text{:}\ddot{\text{N}}=\ddot{\text{O}}-\text{N}:$
 (d) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{C} \\ / \quad \backslash \\ \text{CH}_3 \quad \text{H} \\ \text{B}_1 \quad \text{B}_2 \end{array}$ and $\begin{array}{c} \text{CH}_3 \\ | \\ \text{C} \\ / \quad \backslash \\ \text{H} \quad \text{CH}_3 \\ \text{B}_1 \quad \text{B}_2 \end{array}$ (e) $(\text{:}\ddot{\text{N}}=\text{C}=\ddot{\text{S}}:)^-$ and $(\text{:}\ddot{\text{S}}=\text{C}=\ddot{\text{N}}:)^-$

(8) Which of the following is nonpolar, but contains polar bonds? (a) hydrogen chloride (b) water (c) sulfur trioxide (d) nitrogen dioxide (e) sulfur dioxide

(9) Which of the following graphs best describes the rate at which dinitrogen tetroxide decomposes to nitrogen dioxide, if this reaction is first order in dinitrogen tetroxide?



(10) For the reaction: $2\text{NO}(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{NOCl}(\text{g})$, the following initial rates of reaction have been observed for certain reactant concentrations

[NO]	[Cl ₂]	rate, -d[Cl ₂]/dt
0.50 M	0.50 M	1.14 M/min
1.00 M	0.50 M	4.56 M/min
1.00 M	1.00 M	9.12 M/min

then the rate equation, $d[\text{NOCl}]/dt =$ (a) $k[\text{NO}][\text{Cl}_2]$ (b) $k[\text{NO}]^2[\text{Cl}_2]$ (c) $k[\text{NO}][\text{Cl}_2]^2$ (d) $k[\text{NO}]^3[\text{Cl}_2]$ (e) $k[\text{NO}][\text{Cl}_2]^3$

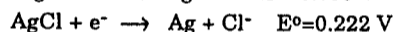
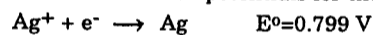
(11) To prepare a buffer with pH close to 3.4, you could use a mixture of (a) NH_4NO_3 and NH_3 (b) HOCl and NaOCl (c) HOAc and NaOAc (d) HNO_2 and KNO_2 (e) NaHCO_3 and Na_2CO_3

2. Explain the difference in the color of aqueous solutions of the following ions: 4%

$[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]^{2+}$, $[\text{Co}(\text{NH}_3)_5(\text{H}_2\text{O})]^{3+}$, $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$
 yellow red violet

3. Ether, $(\text{C}_2\text{H}_5)_2\text{O}$, is prepared by the reaction of ethanol with sulfuric acid. What is the percent yield of the reaction that produces 12.5 g of ether from 36.0 g of ethanol. 4%

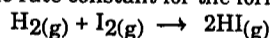
4. The standard reduction potentials for the reactions are:



Calculate the solubility product for AgCl . 4%

5. Trimethylphosphine, $(\text{P}(\text{CH}_3)_3)$, can act as a ligand. If trimethylphosphine is added to a solution of nickel(II) chloride in acetone, a blue compound that has a molecular mass of approximately 270 and contains 21.5% Ni, 26.0% Cl, and 52.5% $\text{P}(\text{CH}_3)_3$ can be isolated. This blue compound does not have any isomeric forms. What is the molecular formula and geometry of this blue compound. 4%

6. The rate constant for the formation of HI from the elements:



is $2.7 \times 10^{-4} \text{ L/mol}\cdot\text{s}$ at 600 K and $3.5 \times 10^{-3} \text{ L/mol}\cdot\text{s}$ at 650 K. Find the activation energy of this reaction. 4%

7. For a reaction: $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$

When 1.00 mol of CaCO_3 (volume=34.2 mL) decomposes at 25 °C and 1 atm to give solid CaO (volume=16.9 mL) and $\text{CO}_2(\text{g})$. What are w and ΔG° for this reaction? 4%

8. Write a balanced equation that can describe each of the following reactions. 4%

(a) hot water vapor and hot carbon react to form water gas.

(b) ${}^6\text{C}^{14}$ undergoes β^- decay.