

※注意：請於答案卷上依序作答，並應註明作答之大題及小題題號。

1. Write the molecular formulas for the following compounds.

- (a) silicon tetrachloride (b) nitrous acid (c) zinc sulfide
(d) gallium arsenide (e) dinitrogen pentoxide (10%)

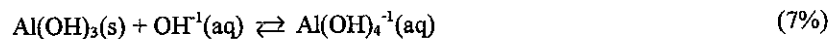
2. A 1.000 g sample of XI_2 is dissolved in water, and excess silver nitrate is added to precipitate all of the iodide as AgI. The mass of the dry AgI is found to be 1.375 g. Calculate the atomic weight (mass) of X. The atomic weights of Ag and I are 108 and 127, respectively. (8%)

3. We usually state that the ideal gas law tends to hold best at low pressures and high temperatures. Show how the van der Waals equation could be simplified to the ideal gas law under these conditions. (Hint: The van der Waals equation is $[P + a(\frac{n}{V})^2](V - nb) = nRT$. One could express the van der Waals equation in the form of PV/nRT). (6%)

4. Show that the solubility of $Al(OH)_3$, as a function of $[H^+]$, obeys the equation:

$$S = [H^+]^3 K_{sp}/K_w^3 + K \cdot K_w/[H^+]$$

where $S = \text{solubility} = [Al^{3+}] + [Al(OH)_4^{-1}]$ and K is the equilibrium constant for



5. Citric acid ($H_3C_6H_5O_7$) is a tri-protic acid with $K_{a1} = 8.4 \times 10^{-4}$, $K_{a2} = 1.8 \times 10^{-5}$, and $K_{a3} = 4.0 \times 10^{-6}$. Calculate the pH and the concentration of $C_6H_5O_7^{-3}$ ion of citric acid aqueous solution with 0.15 M initial citric acid concentration. (6%)

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6. For the reaction



at 600 K, the equilibrium constant is 11.5 atm. Suppose that 3.0 g of PCl_5 is placed in an evacuated 500 mL bulb, which is then heated to 600 K.

- What would the pressure of PCl_5 be if it did not dissociate?
- What is the partial pressure of PCl_5 at equilibrium?
- What is the degree of dissociation of PCl_5 at equilibrium?
- What is the total pressure in the bulb at equilibrium?

(Note: $R = 1.987 \text{ cal/mol-deg} = 8.314 \text{ J/mol-deg}$. The atomic weights of P and Cl are 31.0 and 35.5, respectively) (12%)

7. In describing the spatial motion of the electron of a hydrogen atom, we need three quantum number, n , l , and m . Each quantum number has its unique physical implication. What are they?

(6%)

8. (a) What is the English full name for VSEPR model?

(b) In VSEPR model, how do you arrange the relative geometric positions among the lone electron pairs and bonding electron pairs? Give your reasoning.

(c) Predict the molecular structure and the bond angles for each of the following.

(i) XeCl_2 (ii) ICl_3 (iii) ICl_5 (iv) TeF_4 (v) PCl_5 (16%)

9. For the molecular species O_2 , O_2^+ , and O_2^- , use the molecular orbital model to obtain their electron configurations and also the bond orders. Which has the strongest bond? (Note that the σ_{2p} is lower than π_{2p} orbital for these cases) (6%)

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10. What is the Arrhenius equation for the rate constant of an elementary reaction? Explain the physical meaning for each of the experimental parameters and variables in this equation. (8%)

11. What are the units for each of the following if concentrations are expressed in moles per liter and time in seconds?

(a) rate of a chemical reaction

(b) rate constant for a zero-order reaction

(c) rate constant for a second-order reaction

(6%)

12. Explain the following three kinds of interactions between molecules:

(a) Electric dipole-dipole interaction

(b) Hydrogen bonding

(c) London dispersion force

(9%)

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