

臺灣綜合大學系統 109 學年度學士班轉學生聯合招生考試試題

科目名稱	普通化學 B	類組代碼	共同考科
		科目碼	E0018

※本項考試依簡章規定各考科均「不可以」使用計算機

本科試題共計 2 頁

說明：答案一律寫在答案卷上；請依序作答，並標明題號。

計算題務必列出計算過程，只寫答案不計分

( $R = 0.082 \text{ atm L/mol K} = 8.314 \text{ J/mol K}$ )

- (a) How many of the following species ( $\text{ICl}_3$ ,  $\text{F}_3\text{ClO}$ ,  $\text{IO}_2\text{F}_2^-$ ,  $\text{I}_3^-$ ,  $\text{SOF}_4$ ) have seesaw (翹翹板) structures? (4%)

(b) How many species listed in (a) have a hybridization of  $dsp^3$  on the central atom? (4%)

(c) How many of the following species ( $\text{SO}_4^{2-}$ ,  $\text{XeF}_4$ ,  $\text{ClF}_3$ ,  $\text{CO}_3^{2-}$ ,  $\text{N}_2\text{H}_4$ ,  $\text{PH}_3$ ,  $\text{XeO}_3$ ) have all of their atoms on the same plane? (4%)

(d) How many of the following ( $\text{O}_2^{2+}$ ,  $\text{B}_2$ ,  $\text{C}_2^{2-}$ ,  $\text{NO}^-$ ,  $\text{F}_2^{2+}$ ,  $\text{CN}^+$ ,  $\text{OF}^+$ ,  $\text{HF}^-$ ) are paramagnetic? (4%)

(e) Which of the followings ( $\text{N}_2^{2+}$ ,  $\text{N}$ ,  $\text{N}_2^-$ ,  $\text{N}_2$ ,  $\text{N}_2^{2-}$ ) has the largest first ionization energy? (4%)
- The vapor pressure ( $p$ ) of water, ethanol, and diethyl ether are measured as a function of Kelvin temperature ( $T$ ). The plot of  $\ln(p)$  vs.  $1/T$  yields straight line with slope  $b$ , and intercept  $c$ .

(a) Order the above species in order of the largest to the smallest  $b$ . (4%)

(b) How to obtain the entropy change of vaporization? (4%)
- (a) What's the total number of structural and geometric (cis-trans) isomers of  $\text{C}_3\text{H}_5\text{Cl}$ ? (5%)

(b) Which of the followings (dimethylamine, amine, aniline, diphenylamine, methylamine) is the weakest base? (5%)

(c) Describe how to make 2-methyl-2-propanol from an alkene. (5%)

(d) Plot the ideal H-NMR spectra for  $\text{C}_2\text{H}_5\text{COOH}$ . (5%)
- (a) If the standard reduction potential ( $E^\circ$ ) for the half reaction  $\text{Cr}^{2+} + 2 e^- \rightarrow \text{Cr}$ , and  $\text{Cr}^{3+} + e^- \rightarrow \text{Cr}^{2+}$  is  $\epsilon_1$  and  $\epsilon_2$ , respectively, calculate  $E^\circ$  for the half reaction  $\text{Cr}^{3+} + 3 e^- \rightarrow \text{Cr}$ ? (5%)

(b) Use a d-orbital splitting diagram to rationalize the stability of  $\text{Co}^{2+}$  tetrahedral complex ions. (5%)
- (a) 2 mole of  $\text{CO}_2(\text{g})$  at 300 K and 2.0 atm expands isothermally against a constant external pressure of 1.0 atm. Calculate  $q$  in the surroundings and  $\Delta S$  of the universe. (10%)

(b) The heat of vaporization of water at the normal boiling point, 373 K, is 40.7 kJ/mol. The specific heat capacity of liquid water is  $4.2 \text{ J K}^{-1} \text{ g}^{-1}$  and of gaseous water is  $2.0 \text{ J K}^{-1} \text{ g}^{-1}$ . Assume that these values are independent of temperature. Calculate the molar heat of vaporization of water at 298 K? (5%)
- For the reaction  $\text{C}_2\text{H}_4 + \text{H}_2 \rightarrow \text{C}_2\text{H}_6$  in the presence of mercury vapor a possible mechanism is

$$\text{Hg} + \text{H}_2 \rightarrow \text{Hg} + 2\text{H} \quad (\text{rate constant } k_1)$$

$$\text{H} + \text{C}_2\text{H}_4 \rightarrow \text{C}_2\text{H}_5 \quad (\text{rate constant } k_2)$$

$$\text{C}_2\text{H}_5 + \text{H}_2 \rightarrow \text{C}_2\text{H}_6 + \text{H} \quad (\text{rate constant } k_3)$$

$$\text{H} + \text{H} \rightarrow \text{H}_2 \quad (\text{rate constant } k_4)$$

Determine the rate law for the production of  $\text{C}_2\text{H}_6$  using the steady-state approximation. (12%)

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7. Consider the model for a particle of mass  $m$  in a one-dimensional box of size  $L$ . The potential is zero inside the box, and infinite outside the box.

(a) Solve the Schrodinger equation by using  $A \sin(kx)$  as a trial solution to determine  $k$  and total energy  $E$  in terms of quantum number  $n$ . (10 %)

(b) Calculate the probability of finding the particle between  $L/6$  to  $L/2$  if  $n = 3$ . (5 %)