題號： 65
科目：普通化學
節次： 8

國立臺灣大學 108 學年度碩士班招生考試試題

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＊請在答案卷上標明題號並依序作答，計算題需要計算過程及正確單位
- Gas constant: $R = 8.314$ J/mol-K $= 0.0821$ L-atm/mol-K
- $H = 1.01$ g/mol; $C = 12.0$ g/mol; $P = 31.0$ g/mol; $O = 16.0$ g/mol; $Na = 23.0$ g/mol; $N = 14.0$ g/mol
- $C = 3.00 \times 10^8$ m/s; $h = 6.63 \times 10^{-34}$ J-s; $R_H = 1.096776 \times 10^7$ m^{-1}; $F = 96500$ C/mol

1. A typical commercial-grade phosphoric acid is 75%H_3PO_4 by mass and density 1.57 g/mL. Calculate the molarity (mol/L) of the acid. **(5%)**

2. A student weighs out 0.5681 g of potassium hydrogen phthalate (KHP, molar mass = 204.0 g/mol) and titrates to the equivalence point with 21.54 mL of a stock NaOH solution. What is the concentration of the stock NaOH solution? **(5%)**

3. A 0.5865 g sample of lactic acid ($C_3H_6O_3$) is burned in a calorimeter whose heat capacity is 4.812 kJ/°C. The temperature increases from 23.10°C to 24.95°C. Calculate the molar heat of combustion of lactic acid. **(5%)**

4. Calculate the pH values of the following solutions: **(15%)**
   (A) 0.10 M HCl(aq)
   (B) 0.10 M CH_3COOH(aq)
   (C) A solution containing 0.10 M CH_3COOH and 0.10 M CH_3COONa
   For acetic acid, CH_3COOH, $K_a = 1.0 \times 10^{-5}$.

5. The safety air bags in automobiles are inflated by nitrogen gas generated by the rapid decomposition of sodium azide, NaN_3: $NaN_3(s) \rightarrow Na(s) + N_2(g)$. If an air bag has a volume of 36.0 L and is to be filled with nitrogen gas at a pressure of 1.15 atm and a temperature of 27.0 °C, how many grams of NaN_3 must be decomposed? Write down the balanced chemical equation first. **(10%)**

6. **Identify** and **name the functional groups** (in English) of the compound. **(10%)**

serine
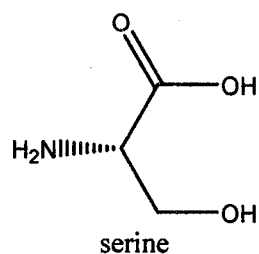
7. Consider the following reaction: $NO_2(g) + CO(g) \rightarrow NO(g) + CO_2(g)$
   The initial rate of the reaction is measured at several different concentrations of the reactants with the following results.
   (A) Determine the rate law of the reaction.
   (B) If the initial concentrations of NO_2 and CO are 0.30 M and 0.60 M respectively, what is the value of the initial rate of the reaction? **(10%)**

$[NO_2]_0$ (M)	$[CO]_0$ (M)	Initial rate (M/s)
0.10	0.10	0.0021
0.20	0.10	0.0082
0.20	0.20	0.0083
0.40	0.10	0.033

見背面

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8. Consider the decomposition of calcium carbonate under standard states and 298 K:

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g).$$

(A) Use the data in the following table to calculate the values of ΔH°, ΔS°, and ΔG° at 298 K.

(B) Is this an endothermic or exothermic reaction?

(C) How is the entropy change of the system, increase or decrease?

(D) Is the process spontaneous or not at 298 K?

(E) What is the value of the ΔG when the reaction is at equilibrium?　　　　　　　**(10%)**

	$CaCO_3(s)$	$CaO(s)$	$CO_2(g)$
ΔH_f° (kJ/mol)	-1207	-636	-394
S° (J/mol.K)	93	40.	214
ΔG_f° (kJ/mol)	-1129	-604	-394

9. For the galvanic cell　$Mg(s)\,|\,Mg^{2+}(aq)\,|\,|\,Al^{3+}(aq)\,|\,Al(s)$,

(A) Indicate the anode, cathode, and the direction of electrons flow.

(B) Give the balanced net equation for the cell reaction.

(C) Calculate the standard cell voltage at 298 K.

(D) Calculate the standard free-energy change, ΔG°, of the reaction at 25°C.

(E) What is the value of cell voltage when the reaction reaches equilibrium?　　　　　**(10%)**

$$Al^{3+} + 3e^- \rightarrow Al \qquad E^\circ = -1.66 \text{ V}$$
$$Mg^{2+} + 2e^- \rightarrow Mg \qquad E^\circ = -2.37 \text{ V}$$
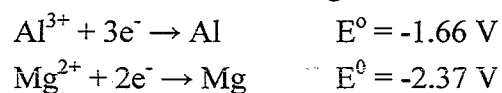
10. For the complex ion $[CoF_6]^{3-}$, F^- is a weak field ligand.

(A) Give the oxidation state and coordination number of central metal ion.

(B) Write the electron configurations of the central metal ion.

(C) What's the geometry of the complex ion?

(D) Draw the crystal-field energy-level diagrams and show the placement of electrons for the complex.

(E) Is the complex ion diamagnetic or paramagnetic?　　　　　　　**(10%)**

11. Consider the O_2 molecule:

(A) Draw the molecular orbitals energy-level diagram.

(B) Determine the bond order.

(C) Indicate the magnetic property (diamagnetic or paramagnetic) of the molecule.　　　**(10%)**

試題隨卷繳回