# 2009年度日本政府(文部科学省)奨学金留学生選考試験

## QUALIFYING EXAMINATION FOR APPLICANTS FOR JAPANESE GOVERNMENT (MONBUKAGAKUSHO) SCHOLARSHIPS 2009

### 学科試験　　問題

### EXAMINATION QUESTIONS

### (高等専門学校留学生)

### COLLEGE OF TECHNOLOGY STUDENTS

# 化　　学

## CHEMISTRY

注意　☆試験時間は60分。

PLEASE NOTE : THE TEST PERIOD IS 60 MINUTES.

| CHEMISTRY | Nationality | | No. | | Marks | |
|---|---|---|---|---|---|---|
| | Name | (Please print full name, underlining family name) | | | | |

If necessary, use the following data to answer the questions below.

Atomic weights : H = 1.0 , C = 12.0 , N = 14.0 , O = 16.0 , Cl = 35.5 , Ca = 40.0

Quantity of electricity : $1.00 F = 9.65 \times 10^4$ C

Gas constant $R$ : 0.082 ℓ atm/(mol K)

Molar volume of gas at the standard state : 22.4 ℓ/mol

log 2 = 0.3

1. Answer the following questions (A) ～ (E). Write the number of the correct answer in each answer box.

(A) An isotope of oxygen in which there are 10 neutrons is _____ .

①  $^{10}O$     ②  $^{12}O$     ③  $^{14}O$     ④  $^{16}O$     ⑤  $^{18}O$

(B) The oxidation number of S in $SO_4^{2-}$ is _____ .

①  $-\text{II} \, (-2)$        ②  $+\text{II} \, (+2)$        ③  $+\text{IV} \, (+4)$

④  $+\text{VI} \, (+6)$        ⑤  $+\text{VIII} \, (+8)$

(C) The ion with the same number of electrons as argon is _____.

　　① Ne　　② Na⁺　　③ Cl⁻　　④ F⁻　　⑤ Mg²⁺

(D) The sugar which does not reduce Fehling's solution is _____.

　　① glucose　　　　② fructose　　　　③ galactose

　　④ sucrose　　　　⑤ maltose

(E) The polymer which has an ester bond in the molecule is _____.

　　① polyethylene　　　　　　② polypropylene

　　③ polyethylene terephthalate　　④ 6,6-nylon

　　⑤ protein

2. When a flask of constant capacity holds 1.2 mole each of acetic acid and ethanol with a catalyst and the temperature is kept at 25°C, 0.80 mole of ethylacetate is produced at equilibrium. Answer the following questions (A) and (B). Write the number of the correct answer in each answer box.

(A) Calculate the equilibrium constant of the following reaction.

$$CH_3COOH + C_2H_5OH \rightleftarrows CH_3COOC_2H_5 + H_2O$$
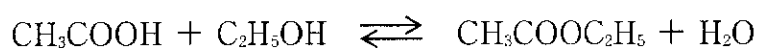
　　① 0.25　　② 0.64　　③ 2.0　　④ 4.0　　⑤ 6.0

（B） Ethanol is added in the above equilibrium situation, and 1.0 mole of ethylacetate in total is produced. How many moles of ethanol are added?

① 0. 25 mol      ② 0. 80 mol      ③ 1. 05 mol

④ 1. 25 mol      ⑤ 2. 25 mol

3. A 500 ㎖ solution is produced by dissolving 0. 37 g of calcium hydroxide in sufficient water. Answer the following questions （A） ～ （C）. Write the number of the correct answer in each answer box.

（A） Determine the molarity of this solution.

① 0. 0050 mol／ℓ      ② 0. 010 mol／ℓ      ③ 0. 020 mol／ℓ

④ 0. 10 mol／ℓ      ⑤ 0. 74 mol／ℓ

（B） What is the pH of this solution?

① 1. 7      ② 2. 0      ③ 12. 0      ④ 12. 3      ⑤ 13. 0

（C） How much of a 0.010 mol／ℓ HCl solution is required to neutralize 100 ㎖ of this calcium hydroxide solution?

① 25 ㎖      ② 50 ㎖      ③ 100 ㎖      ④ 150 ㎖      ⑤ 200 ㎖

4. The heat of combustion of ethanol is represented by the following thermo-chemical equation.

$C_2H_5OH$ (liquid) $+ 3O_2$ (gas) $= 2CO_2$ (gas) $+ 3H_2O$ (liquid) $+ 1369$ kJ

Answer the following questions (A) and (B). Write the number of the correct answer in each answer box.

(A) How much heat energy (in kilojoules) will be needed to completely burn 23.0 g of ethanol (liquid) ?

① 274 kJ   ② 548 kJ   ③ 685 kJ   ④ 1369 kJ   ⑤ 2738 kJ

(B) The heats of formation of carbon dioxide (gas) and water (liquid) are respectively 394 kJ/mol, 286 kJ/mol. Find the heat of formation of ethanol (liquid).

① 108 kJ/mol          ② 277 kJ/mol          ③ 680 kJ/mol

④ 1646 kJ/mol         ⑤ 3015 kJ/mol

5. When a solution of $CuCl_2$ was electrolyzed with a platinum electrode which uses a current of 2. 5 amperes, 112 ㎖ of gas was generated. Answer the following questions (A) ~ (C). Write the number of the correct answer in each answer box.

(A) Choose from ①~⑥ the appropriate description of the correct combination of electrode and gas generated.

① $Cl_2$ at cathode      ② $Cl_2$ at anode      ③ $O_2$ at cathode

④ $O_2$ at anode      ⑤ $H_2$ at cathode      ⑥ $H_2$ at anode

(B) What is the quantity of electricity which had flowed in this electrolysis?

① 241. 25 C      ② 482. 5 C      ③ 965 C

④ 1930 C      ⑤ 3860 C

(C) How many seconds did this electrolysis take?

① 96. 5 sec      ② 193 sec      ③ 386 sec

④ 772 sec      ⑤ 1544 sec

6. An unknown compound has the following percentage composition by weight: $C = 61.0\%$, $H = 15.3\%$ and $N = 23.7\%$. Its molecular mass is 59. Answer the following questions (A) and (B). Write the number of the correct answer in each answer box.

(A) Which is the molecular formula of the compound?

① $CH_5N_3$    ② $C_2H_7N_2$    ③ $C_3H_9N$

(B) How many structural isomers of this compound are expected?

① 1        ② 2        ③ 3        ④ 4        ⑤ 5

7. Compounds A and B have the same molecular formula $C_4H_{10}O$. Both compounds react with sodium generating $H_2$ gas. Compound A is readily oxidized by $K_2Cr_2O_7$ but compound B is not. Compound A has a stereogenic carbon atom. Answer the following question. Write the number of the correct answer in the answer box.

Choose the description of the correct combination of compounds A and B.

① A : $CH_3CH_2CH_2CH_2OH$         B : $(CH_3)_3COH$

② A : $CH_3CH_2CH_2CH_2OH$         B : $CH_3CH_2OCH_2CH_3$

③ A : $(CH_3)_2CHCH_2OH$            B : $(CH_3)_3COH$

④ A : $(CH_3)_3COH$                     B : $CH_3CH_2CH(OH)CH_3$

⑤ A : $CH_3CH_2CH(OH)CH_3$       B : $(CH_3)_3COH$

⑥ A : $(CH_3)_3COH$                     B : $(CH_3)_2CHCH_2OH$

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8. Answer the following questions (A) and (B). Write the number of the correct answer in each answer box.

(A) If the density of a gas consisting of one element is 0. 90 g/ℓ under the standard state, what is its molar mass?

①  4. 0 g/mol          ②  20 g/mol          ③  32 g/mol

④  38 g/mol            ⑤  71 g/mol

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(B) What is the mass of 6.0 ℓ of nitrogen gas at 8.2 atm pressure and 27℃?

　　① 14 g 　② 28 g 　③ 42 g 　④ 56 g 　⑤ 112 g