

2007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 2007

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.

(2007)

CHEMISTRY

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

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

Atomic weight : H=1.0, C=12.0, N=14.0, O=16.0, Na=23.0, Al=27.0, S=32.1, Cl=35.5

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

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

1 Answer the following questions. Write the number of the correct answer in each answer box.

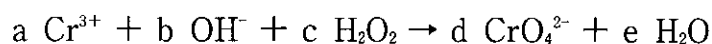
(A) Which is the chemical species where the oxidation number of the underlined element is the same as that of chlorine in NaClO_2 ?

- ① $\underline{\text{N}}\text{H}_3$ ② $\underline{\text{A}}\text{l}_2\text{O}_3$ ③ $\underline{\text{F}}\text{eO}$ ④ $\text{K}\underline{\text{Mn}}\text{O}_4$ ⑤ $\underline{\text{N}}\text{O}_3^-$

(B) Which of the following, aliphatic, chain-like hydrocarbons has a double bond in itself?

- ① C_4H_{10} ② C_2H_2 ③ C_3H_4 ④ C_2H_6 ⑤ C_3H_6

(C) Which is the correct combination of the coefficients a~e for the following reaction?



- ① a=1, b=8, c=2, d=3, e=5 ② a=3, b=8, c=2, d=4, e=5
③ a=5, b=6, c=3, d=2, e=10 ④ a=2, b=10, c=3, d=2, e=8
⑤ a=3, b=7, c=2, d=5, e=4 ⑥ a=9, b=8, c=10, d=3, e=5

(D) Which is the gas with density of 1.63g/ℓ in the standard state?

- ① Cl₂ ② H₂S ③ NH₃ ④ CO₂ ⑤ HCl

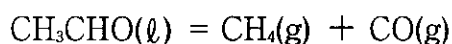
(E) A cell is covered with a semipermeable membrane. The erythrocyte may explode, when blood is diluted in water. Which is the correct reason for the explosion?

- ① Boiling point elevation ② Osmotic pressure
③ Freezing point depression ④ Vapor pressure depression
⑤ Coagulation

(F) What is the degree of polymerization for the polyethylene with molecular weight 1.50×10^5 ?

- ① 3.45×10^2 ② 8.28×10^2 ③ 2.47×10^3
④ 5.36×10^3 ⑤ 1.39×10^4

- 2 Evaluate the heat of reaction of the following reaction from the heat of formation data of each material. Write the number of the correct answer in the answer box.



Here, ℓ is liquid, and g is gas. The data of heat of formation for each material are as follows.

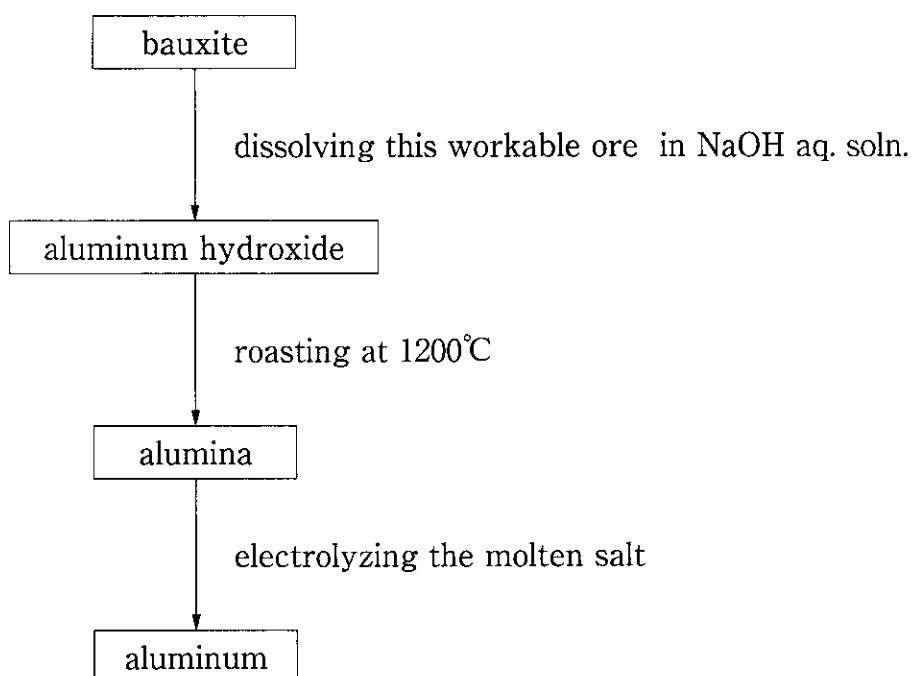
$\text{CH}_3\text{CHO}(\ell)$: 192.0 kJ/mol

$\text{CH}_4(\text{g})$: 74.9 kJ/mol

$\text{CO}(\text{g})$: 110.5 kJ/mol

- ① - 2.6 kJ/mol ② - 4.6 kJ/mol ③ - 5.6 kJ/mol
④ - 6.6 kJ/mol ⑤ - 8.6 kJ/mol

- 3 The procedure shown in the flow chart below is well known in the technical production of aluminum. Answer the following questions concerning this procedure. Write the number of the correct answer in each answer box.



(A) Before the molten salt electrolysis, alumina is dissolved into previously fused cryolite, Na_3AlF_6 . The molten mixture is then electrolyzed. What will the cryolite do for the electrolysis mainly? Choose the proper description from among the following.

- ① raise the yield of aluminum.
- ② bring the melting point of the mixture down.
- ③ raise the purity of aluminum deposited.
- ④ remove the impurities present in the molten mixture.
- ⑤ prevent the oxidation of aluminum obtained.

C

(B) What is the quantity of electricity needed in order to obtain 20.0g of aluminum?

- ① $1.75F$
- ② $2.04F$
- ③ $2.22F$
- ④ $2.63F$
- ⑤ $2.85F$

(C) How much energy is needed to obtain 20.0g of aluminum, when this molten mixture is electrolyzed with 5.00V as a bath voltage?

- ① $2.53 \times 10^6 \text{ J}$
- ② $2.16 \times 10^6 \text{ J}$
- ③ $1.76 \times 10^6 \text{ J}$
- ④ $1.44 \times 10^6 \text{ J}$
- ⑤ $1.07 \times 10^6 \text{ J}$

C

(D) Through the X-ray investigation of the aluminum thus obtained, it has been found that its crystal structure is f.c.c. and that its lattice constant is $4.05 \times 10^{-1} \text{ nm}$. What can be estimated as the atomic radius of aluminum, given that $\sqrt{2} = 1.41$?

- ① $1.25 \times 10^{-1} \text{ nm}$ ② $1.43 \times 10^{-1} \text{ nm}$ ③ $1.76 \times 10^{-1} \text{ nm}$
④ $1.93 \times 10^{-1} \text{ nm}$ ⑤ $2.06 \times 10^{-1} \text{ nm}$

4 The density of the aqueous solution in which 13.0g of sodium hydroxide is dissolved in 87.0g of water is $1.142 \times 10^3 \text{ kg/m}^3$. Answer the following questions. Write the number of the correct answer in each answer box.

(A) Calculate the mole fraction of the water.

- ① 0.063 ② 0.937 ③ 0.036 ④ 0.964 ⑤ 0.056

(B) Calculate the concentration of the sodium hydroxide solution.

- ① 1.17 mol/l ② 2.78 mol/l ③ 3.71 mol/l
④ 4.67 mol/l ⑤ 5.89 mol/l

5 A sodium hydroxide aq. soln. was electrolyzed with a current of 0.500A using carbon rod electrodes. Answer the following questions concerning this electrolysis. Write the number of the correct answer in each answer box.

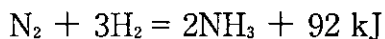
(A) What kind of gas arose from the cathode?

- ① N₂ ② O₂ ③ H₂ ④ Cl₂ ⑤ CO₂

(B) What was the time for the electrolysis when 56.0ml(standard state) of gas arose from the cathode?

- ① 695 sec ② 965 sec ③ 895 sec ④ 1056 sec ⑤ 1156 sec

6 2.00 mole of N₂ and 5.00 mole of H₂ were mixed in the presence of a proper catalyst and maintained at a certain temperature. The following reaction occurred in the gas mixture and then arrived at equilibrium where the total pressure was 1.01×10^6 Pa. The mole fraction of NH₃ formed was found to be 2.50×10^{-1} .



Answer the following questions concerning this reversible reaction. Write the number of the correct answer in each answer box.

(A) How much heat was evolved through this reaction ?

- ① 29.7 kJ ② 37.8 kJ ③ 42.9 kJ ④ 51.6 kJ ⑤ 64.4 kJ

(B) What was the partial pressure of N_2 at equilibrium?

① 7.23×10^4 Pa

② 9.18×10^4 Pa

③ 1.86×10^5 Pa

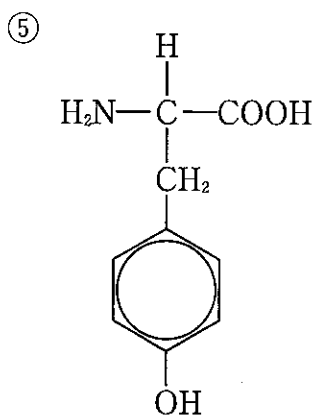
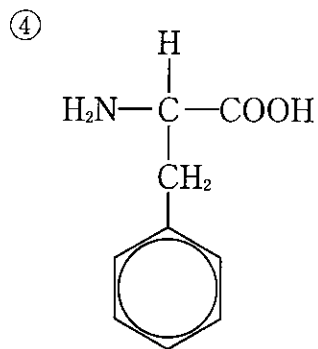
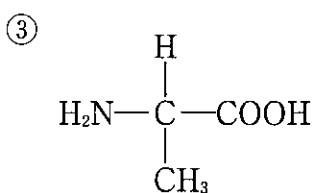
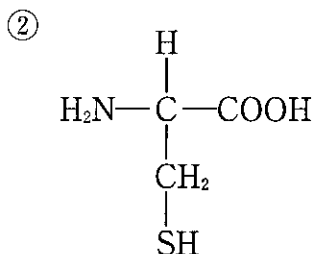
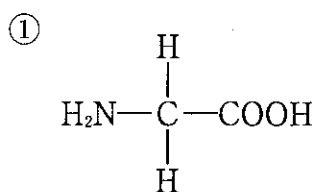
④ 2.34×10^5 Pa

⑤ 5.23×10^5 Pa



- 7 Enkephalin(one of the pentapeptides), well known as one kind of opioid peptide, was hydrolyzed by protease into four kinds of α -amino acids. An α -amino acid whose molecular weight is the smallest among them was well isolated and subjected to elementary analysis, so that the content for each constituent was found as follows; carbon, 32.0%; hydrogen, 6.67%; oxygen, 42.7%; nitrogen, 18.7%. Answer the following questions concerning this amino acid. Write the number of the correct answer in each answer box.

(A) What is the structural formula for this amino acid?



(B) What is the name of this amino acid?

- ① alanine ② tyrosine ③ glycine ④ cysteine ⑤ phenylalanine

8 An ester was synthesized by the reaction of the primary alcohol with acetic acid. After synthesizing, the molecular weight of the ester was 1.7 times that of the original alcohol. Which alcohol was used? Write the number of the correct answer in the answer box.

- ① CH_3OH ② $\text{C}_2\text{H}_5\text{OH}$ ③ $\text{C}_3\text{H}_7\text{OH}$ ④ $\text{C}_4\text{H}_9\text{OH}$ ⑤ $\text{C}_5\text{H}_{11}\text{OH}$