2008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 2008

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.	
Name	(Please print full name, underlining family name)		

Marks	

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

Atomic weights : H=1.0, C=12.0, N=14.0, O=16.0, Cl=35.5, Ca=40.0, Cu=63.5, S=32.0, Ag=108.0

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

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

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

(A) The element which has two valence electrons in the M shell is _____.

① Be ② O ③ Mg ④ Ca ⑤ S

(B) The nitrogen compound which has the same oxidation number as the N in HNO_3 is _____.

① NH_3 ② N_2 ③ NO ④ N_2O_4 ⑤ N_2O_5

(C) C_3H_8O has _____ isomers.

① two ② three ③ four ④ five ⑤ six

(D) Which is the linear molecule with a double bond?

① CO_2 ② H_2O ③ NH_3 ④ C_2H_2 ⑤ CH_3OH

(E) Which is the compound which consists only of a single bond?

① Cyclohexene ② Aniline ③ Glycerin
④ Formic acid ⑤ Acetone

(F) Which is the compound with one carboxyl group?

① Maleic acid ② Lactic acid ③ Phthalic acid
④ Oxalic acid ⑤ Sulfuric acid

(G) Which is the correct formula weight of the copper sulfate pentahydrate (Ⅱ) $CuSO_4 \cdot 5H_2O$?

① 219.5 ② 229.5 ③ 249.5 ④ 269.5 ⑤ 289.5

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

CONDITION : When a 10 ℓ flask holds 1 mole each of CO_2 and H_2, and the temperature is kept low, 0.5 mole each of CO and H_2O are produced at equilibrium.

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

$$CO_2 + H_2 \rightleftharpoons CO + H_2O \text{ (gas)}$$

① 0.25 ② 0.5 ③ 1.0 ④ 2.0 ⑤ 4.0

(B) How many moles of CO in total are produced if 0.5 mol of CO_2 is added in the above equilibrium situation?

① 0.55 mol ② 0.60 mol ③ 0.75 mol
④ 0.80 mol ⑤ 0.90 mol

3. We have a U-tube which is partitioned by a semipermeable membrane. When we put pure water in the A side, and the same amount of aqueous solution of protein in the B side, what kind of phenomenon happens? Write the number of the correct answer in the answer box.

① No change of the solution level.
② Solution level also rises A and B.
③ Solution level also drops A and B.
④ Solution level of A drops, and the level of B rises.
⑤ Solution level of A rises, and the level of B drops.

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

CONDITION : 24.0g of graphite is burned incompletely, and 14.0g of CO and 66.0g of CO_2 are produced.

If necessary, you can use the heat of combustion values given in the following reactions.

$C\ (graphite) + O_2 = CO_2 + 394\ kJ/mol$

$CO + 1/2O_2 = CO_2 + 283\ kJ/mol$

(A) Calculate the heat of formation of CO.

① −111 kJ/mol ② 111 kJ/mol ③ 240 kJ/mol

④ 480 kJ/mol ⑤ 677 kJ/mol

(B) How much heat energy (in kilojoules) is generated by this reaction?

① 505 kJ ② 646.5 kJ ③ 702 kJ ④ 788 kJ ⑤ 843.5 kJ

5. The electrolysis of a silver nitrate solution is carried out by a current of 12A flowing through it for one hour. Answer the following questions. Write the number of the correct answer in each answer box.

(A) What is the quantity of electricity which has flowed by this time?

① 3.42×10^4C ② 3.24×10^4C ③ 4.32×10^4C
④ 4.68×10^4C ⑤ 4.02×10^4C

(B) What is the quantity of silver deposited at the cathode?

① 84.3 g ② 48.3 g ③ 38.4 g ④ 54.4 g ⑤ 68.3 g

6. In the addition reaction of hydrogen, 0.850 mol of ethane is produced from acetylene. Answer the following questions. Write the number of the correct answer in each answer box.

(A) Calculate the quantity (mol) of hydrogen for the reaction.

① 1.2 mol ② 1.5 mol ③ 1.7 mol ④ 1.9 mol ⑤ 2.1 mol

(B) Calculate the volume (ℓ) of the hydrogen gas at the standard state.

① 38.1 ℓ ② 28.2 ℓ ③ 48.3 ℓ ④ 18.4 ℓ ⑤ 58.5 ℓ

7. The combustion of 14.8mg of an organic compound, which contains only carbon, hydrogen, and oxygen, gave 21.5mg CO_2 and 8.7mg H_2O. Answer the following questions. Write the number of the correct answer in each answer box.

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

① C_2H_5O ② CH_2O ③ $C_2H_4O_2$ ④ CH_4O_2 ⑤ C_2H_6O

(B) Which is the molecular formula of the compound whose molecular weight is 60?

① CH_4O_2 ② C_2H_6O ③ $C_2H_4O_2$ ④ C_2H_5O ⑤ CH_2O

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

(A) Three molecules of the same amino acid are condensed to synthesize a tripeptide. The molecular mass of the tripeptide is 2.52 times that of the amino acid. What is the molecular mass of the amino acid?

① 75 ② 89 ③ 117 ④ 131 ⑤ 146

(B) How many isomeric tripeptides are possible if they are synthesized from three different kinds of amino acid?

① 3 ② 6 ③ 9 ④ 18 ⑤ 27