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

（学部留学生）

UNDERGRADUATE 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

Ⅰ Write the reference number of the correct answer in the answer box.

(Atomic weights; H=1.0, C=12.0, N=14.0, O=16.0, and Cl=35.5. Gas constant; R=0.082 l ·atm/(K·mol))

(1) Which of the following compounds 1) to 4) is insoluble in aqueous ammonia?

1) $AgCl$

2) $Al(OH)_3$

3) $Cu(OH)_2$

4) $Zn(OH)_2$

(2) Which of the following gases 1) to 5) has a density of 1.96g/l at 0℃ and 1-atm pressure?

1) oxygen

2) nitrogen

3) hydrogen chloride

4) propane

5) butane

(3) Which of the following metals 1) to 6) reacts with water to evolve hydrogen gas at room temperature?

1) Ag

2) Ca

3) Cu

4) Fe

5) Pb

6) Zn

(4) Heating a mixture of sodium chloride and concentrated sulfuric acid evolves

1) HCl

2) Cl_2

3) H_2

4) H_2S

5) SO_2

(5) Which of the following gaseous atoms 1) to 5) has the smallest first ionization potential?

   1) helium   2) neon   3) argon

   4) krypton   5) xenon

(6) Bubbling hydrogen sulfide through an acidic solution produces black precipitates. Which of the following cations 1) to 5) is contained in the solution?

   1) Al^{3+} 2) Ba^{2+} 3) Cd^{2+}
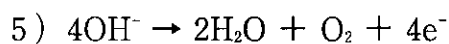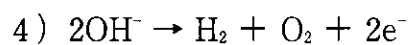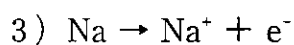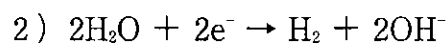
   4) Pb^{2+} 5) Zn^{2+}

(7) It is found that 0.42g of a gaseous compound containing only hydrogen and carbon occupies 410ml at a temperature of 300K and a pressure of 0.90atm. Assuming the gaseous compound is an ideal gas, what is the molecular formula of the compound?

   1) CH_4 2) C_2H_6 3) C_2H_4

   4) C_2H_2 5) C_3H_8 6) C_3H_6

(8) Which of the following descriptions 1) to 4) is correct?

   1) The pH of the solution that results when 10ml of 1.0×10^{-5}mol/l HCl is diluted to 10l with distilled water is 8.

   2) The pH of the solution that results when 10ml of 1.0×10^{-3}mol/l NaOH is diluted to 1.0l with distilled water is 9.

   3) The pH of the solution that results when 10ml of 1.0×10^{-2}mol/l CH_3COOH is diluted to 1.0l with distilled water is 4.

   4) The pH of the solution that results when 10ml of 1.0×10^{-3}mol/l H_2SO_4 is diluted to 1.0l with distilled water is 5.

(9) In the electrolysis of an aqueous solution of sodium hydroxide using platinum electrodes, the reactions that occur at the anode and the cathode are respectively

1) $Na^+ + e^- \rightarrow Na$

2) $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

3) $Na \rightarrow Na^+ + e^-$

4) $2OH^- \rightarrow H_2 + O_2 + 2e^-$

5) $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

(1)		(2)		(3)		(4)		(5)	
							anode	cathode
(6)		(7)		(8)		(9)			

II A 40.0l sample of N_2 gas containing SO_2 gas as an impurity was bubbled through a 3% solution of H_2O_2. The SO_2 was converted to H_2SO_4:

$SO_2 + H_2O_2 \rightarrow H_2SO_4$
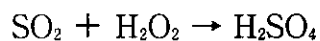
A 25.0ml portion of 0.0100mol/l NaOH was added to the solution, and the excess base was back-titrated with 13.6ml of 0.0100mol/l HCl. Calculate the parts per million of SO_2 (that is, ml SO_2/10^{6}ml sample) if the density of SO_2 is 2.85g/l. (Atomic weights; H=1.0, N=14.0, O=16.0, Na=23.0, S=32.0, and Cl=35.5)

ppm

Ⅲ Exactly 4.32g of oxygen gas was required to completely burn a 2.16g sample of a mixture of methanol and ethanol. Answer the following questions (1) and (2). (Atomic weights; H=1.0, C=12.0, and O=16.0)

(1) How many moles of ethanol are contained in the sample?

(2) What is the percentage by weight of methanol in the sample? Write the percentage to two significant figures.

(1)		mol
(2)		%

Ⅳ Answer the following questions (1) to (3).

(1) Select the functional group from [B] of each of the compounds ①-⑧ in [A], and select the name of the compound from [C].

[A]	[B]	[C]
① CH_3OH	(a) ketone	(a) acetaldehyde
② CH_3CHO	(b) carboxyl	(b) methyl acetate
③ CH_3OCH_3	(c) nitro	(c) nitromethane
④ CH_3NO_2	(d) amino	(d) toluene
⑤ CH_3Br	(e) ester	(e) methylamine
⑥ CH_3COOH	(f) ether	(f) methanol
⑦ CH_3NH_2	(g) aldehyde	(g) dimethyl ether
⑧ CH_3COCH_3	(h) propyl	(h) acetic acid
	(i) sulfonyl	(i) ethanol
	(j) phenyl	(j) bromomethane
	(k) hydroxyl	(k) acetone
	(l) halogen	(l) xylene

	[A]	[B]	[C]
①		
②		
③		
④		
⑤		
⑥		
⑦		
⑧		

(2) What is the product when ① and ⑥ in [A] are heated with a small amount of sulfuric acid? Select the product from [C].

(3) What is the product when ② in [A] is heated with ammoniacal silver nitrate solution? Select the product from [C].

(2)	
(3)	

V Answer the following questions concerning oils and fats.

Question 1. Oils and fats are esters from higher fatty acids and [A]. The specific gravities of oils and fats are [B] than water, and oils and fats are insoluble in water but soluble in organic solvents. Oils and fats that are solid at ambient temperatures are called [C] and oils and fats that are liquid at ambient temperatures are called [D].

(1) Write the reference of the correct answer to [A].

(a) carboxylic acid   (b) amine   (c) glycerol (glycerin)

(d) glycol   (e) halogen

(2) Select an appropriate word for [B].

(a) heavier   (b) bigger   (c) smaller

(d) higher   (e) harder

(3) Select an appropriate word for [C].

(a) fatty oil   (b) ether   (c) margarine

(d) soap   (e) fat

(4) Select an appropriate word for [D].

(a) fatty oil   (b) ether   (c) margarine

(d) soap   (e) fat

Question 2. A kind of fatty acid was obtained by hydrolysis of some oil and fat. For hydrolysis of 0.884g of the oil and fat, 15ml of 0.2mol/l aqueous solution of potassium hydroxide was required.

(5) What is the molecular weight of the oil and fat?

(6) What is the molecular weight of the fatty acid?

(1)	(2)	(3)	(4)	(5)	(6)