2017 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 2017

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**.

(2017)

CHEMISTRY

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

Marks	

I Write the reference number of the correct answer in the Answer Sheet.

(1) Which of the atoms 1) to 4) has the largest electronegativity?

1) H 2) F 3) I 4) Cs

(2) Which of the substances 1) to 4) is an amphoteric oxide?

1) MgO 2) Al_2O_3 3) SiO_2 4) SO_3

(3) Which of the molecules 1) to 4) is nonpolar?

1) HCl 2) H_2O 3) CO_2 4) NH_3

(4) Which of the simple substances 1) to 4) is liquid under atmospheric pressure at 25 ºC?

1) He 2) S 3) Hg 4) Pb

(5) Which of the descriptions 1) to 4) is not correct for the properties of fluorine and chlorine?

1) The atomic radii of chlorine is larger than that of fluorine.
2) Both elements form the diatomic molecules.
3) A simple substance of fluorine is a stronger oxidizing agent than that of chlorine.
4) Neither fluorine nor chlorine form oxides.

(6) Which of reactions described in 1) to 4) is not accompanied by generation of gas?

1) Excess aqueous ammonia is added to silver chloride.
2) Concentrated sulfuric acid is added to sodium chloride and the mixture is heated.
3) Hydrochloric acid is added to iron(II) sulfide.
4) Aqueous solution of hydrogen peroxide is added to manganese dioxide.

(7) Which of the descriptions 1) to 4) is correct for ionic crystals?

1) The van der Waals interaction is predominant in the bonding force of ionic crystals.
2) Most of the ionic crystals are volatile.
3) When an ionic crystal is dissolved in water, the resultant aqueous solution conducts electricity.
4) Ionic crystals are ductile and malleable.

(1)		(2)		(3)		(4)	
(5)		(6)		(7)			

II Aqueous solution of sodium hydroxide was electrochemically decomposed by using platinum electrodes. Answer the following questions.

(1) Write the chemical formula of the substance formed at the cathode during the electrolysis.

(2) An electric current of 9.65 A flowed for 2 hours during the electrolysis. Calculate the total amount of substance formed at the anode after the electrolysis to two significant figures. The Faraday constant is 96500 C mol^{-1}.

(1)		(2)	mol

III In a sealed vessel, 1.0 mol of dinitrogen tetroxide in a gaseous state was initially prepared. After a long enough time at a constant temperature, the reaction below reached equilibrium. At the equilibrium, 1.2 mol of nitrogen dioxide was found, and the total pressure was 1.0×10^5 Pa in the vessel.

$$N_2O_4\,(g) \rightleftarrows 2NO_2\,(g)$$

(1) Calculate the partial pressure of dinitrogen tetroxide in the vessel at the equilibrium to two significant figures.

(2) Calculate the pressure equilibrium constant to two significant figures, and show it with the unit.

(1)	Pa	(2)	

IV Fill (a) ~ (d) in the sentences below with the most appropriate chemical formulae or values. Enter these on the answer sheet.

(1) Aqueous solutions of sodium hydroxide and hydrogen peroxide were successively added into an aqueous solution containing Cr^{3+} and Fe^{3+}, so that the resultant solution was basic. Heating of the solution led to the precipitation of (a). After the precipitation was removed, the supernatant solution became weak acid by adding acetic acid. Further addition of lead acetate into the solution led to the precipitation of (b).

(2) A crystalline silicon adopts a diamond-type structure. The number of Si atom covalently bonded to one Si atom in the crystalline silicon is (c) . The energy required for breaking the bonds in crystalline silicon to convert the crystal into Si atoms is 439 kJ mol^{-1}, and the bond energies for Si–H and H–H bonds are 318 and 436 kJ mol^{-1}, respectively. Hence, the heat of formation for SiH_4 (g) is evaluated to be (d) kJ mol^{-1}.

(a)		(b)	
(c)		(d)	kJ mol^{-1}

V There is a compound **A**, which is made up of carbon, hydrogen, and oxygen atoms. The reaction of the compound **A** with acetic acid gave an ester **B**. When 3.48 mg of the ester **B** was combusted completely, 7.92 mg of carbon dioxide and 3.24 mg of H_2O were obtained. A molecular weight of the ester **B** is between 110 and 118. Here, H=1, C=12, O=16.

(1) Select the compositional formula of the ester **B** from 1)-5).

1) C_3H_6O 2) C_3H_7O 3) $C_2H_5O_2$ 4) C_2H_5O 5) $C_6H_{13}O_2$

(2) Select the molecular formula of the ester **B** from 1)-5).

1) $C_6H_6O_2$ 2) $C_6H_8O_2$ 3) $C_6H_{14}O_2$ 4) $C_6H_{12}O_2$ 5) $C_6H_{10}O_2$

(3) Select the functional group which is involved in the compound **A** from 1)-5).

1) aldehyde 2) ketone 3) alkene 4) alcohol 5) phenol

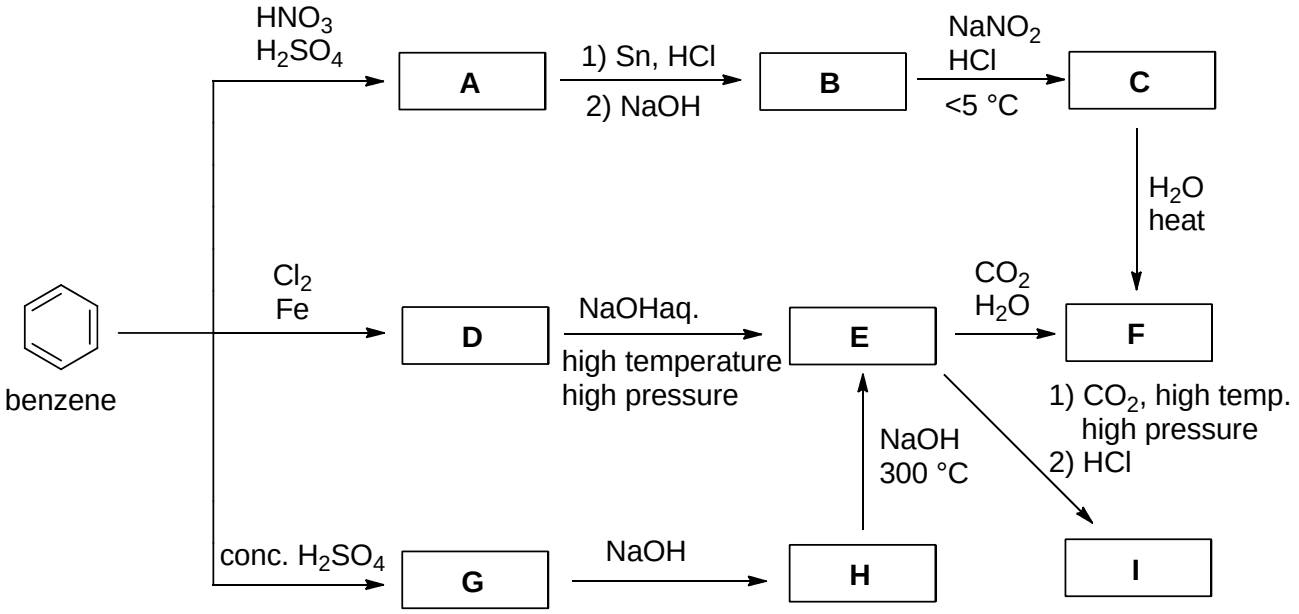
(4) Select the molecular formula of the compound **A** from 1)-5).

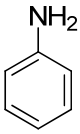
1) C_4H_7O 2) C_5H_9O 3) C_4H_8O 4) $C_4H_{10}O$ 5) $C_5H_{11}O$

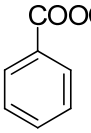
(5) How many structural isomers exist for the ester **B**?

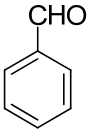
(1)		(2)		(3)		(4)		(5)	

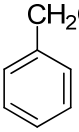
VI Outlined here are the synthetic processes of aromatic compounds. Select the appropriate structural formulas for the compounds **A** to **I** from (1)-(15).

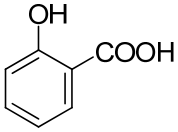


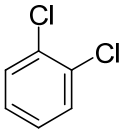
(1) 

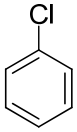
(2) 

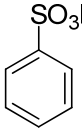
(3) 

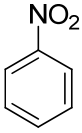
(4) 

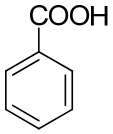
(5) 

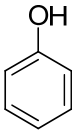
(6) 

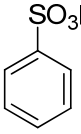
(7) 

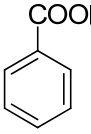
(8) 

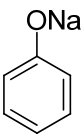
(9) 

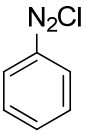
(10) 

(11) 

(12) 

(13) 

(14) 

(15) 

A	B	C	D	E

F	G	H	I

VII Answer the following questions.

(1) Which of the descriptions 1) to 6) is correct for acetylene? Select two.

1) It is a linear molecule.

2) Cis and trans isomers exist.

3) It is obtained by the reaction of calcium carbonate with H_2O.

4) It has a regular tetrahedron structure.

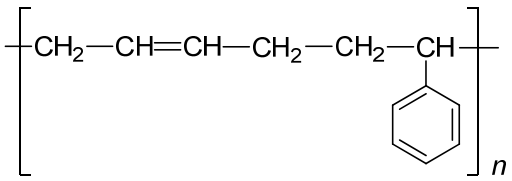
5) It reacts with H_2O to give acetaldehyde.

6) It does not react with bromine.

(2) Which compound has only single bonds?

1) acetone 2) aniline 3) formic acid 4) cyclohexene 5) cyclohexane

(3) Which of compounds 1) to 6) reacts with styrene to give the copolymer shown below?



1) formaldehyde 2) isoprene 3) propylene 4) 2-butene 5) 1,3-butadiene 6) ethylene

(1)		(2)		(3)	