

2012 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 2012

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

I Write the reference number of the correct answer in the answer box. Use the following values for atomic weights: H=1.0, C=12.0, O=16.0.

(1) Which of the ions or atom 1) to 4) has the smallest radius?

- 1) F^- 2) Ne 3) Na^+ 4) Mg^{2+}

(2) In the solid state which of the substances 1) to 4) has the highest electrical conductivity?

- 1) copper 2) silver iodide 3) silicon 4) graphite

(3) Which of the substances 1) to 4) has a linear molecular shape?

- 1) methane 2) carbon dioxide
3) nitrogen dioxide 4) ozone

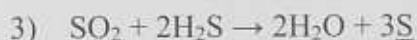
(4) Which of the metals 1) to 4) is insoluble in hydrochloric acid?

- 1) copper 2) magnesium 3) tin 4) zinc

(5) Which of the solutions 1) to 4) exhibits a pH value of 2?

- 1) 0.01 mol/L aqueous solution of acetic acid
2) 0.05 mol/L sulfuric acid
3) 0.01 mol/L hydrochloric acid
4) 1×10^{-12} mol/L aqueous solution of sodium hydroxide

(6) In which of the reactions 1) to 4) the underlined element is oxidized?



(7) A gaseous mixture of NO_2 and N_2O_4 is sealed in 4 identical vessels with movable pistons. When the conditions are modified as described in 1) to 4), in which condition does the molar ratio of NO_2 to N_2O_4 remain unchanged after a long time enough to reach equilibrium?

1) Total pressure is increased by moving the piston at a constant temperature.

2) Temperature is increased while keeping the total pressure constant by moving the piston.

3) Additional NO_2 is introduced from outside while keeping the total pressure constant by moving the piston at a constant temperature.

4) Additional N_2 is introduced from outside while keeping the total pressure constant by moving the piston at a constant temperature.

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

II Give the appropriate values for (a) and (b) in the sentences below.

1 mol of graphite is completely oxidized to carbon dioxide while evolving 394 kJ of heat, and 1 mol of carbon monoxide is completely oxidized to carbon dioxide while evolving 283 kJ of heat. At 0°C , under 1 atm, (a) L of oxygen is required to oxidize 1 mol of graphite to carbon monoxide with the heat evolution of (b) kJ.

(a)		(b)	
-----	--	-----	--

III Procedures (i) to (iii) describe experiments to separate individual metal ions from a neutral aqueous solution which contains Ag^+ , Cu^{2+} and Zn^{2+} . Write the appropriate colors for (a) and (b), and appropriate chemical formula for (1) and (2).

(i) Upon addition of hydrochloric acid to the solution, (a) precipitates formed. The chemical formula of the precipitates is (1).

(ii) To the supernatant obtained from experiment (i), (2) was bubbled in to form (b) precipitates.

(iii) To the supernatant obtained from experiment (ii), base was added and (2) was bubbled in to form white precipitates.

(a)		(b)	
(1)		(2)	

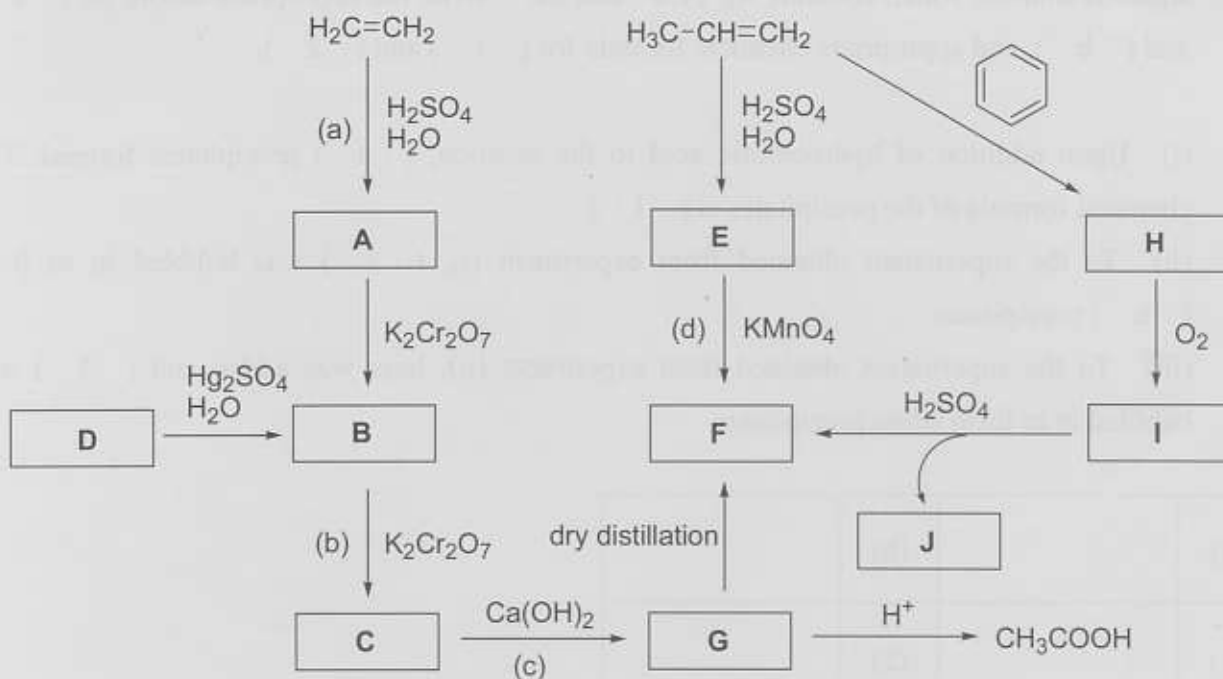
IV Write the correct answer to the questions below to two significant figures.

(1) 9.0 g of glucose, $\text{C}_6\text{H}_{12}\text{O}_6$, was dissolved in 100 g of water. The freezing point of the glucose solution was determined to be $-0.94\text{ }^\circ\text{C}$. Determine the molar freezing-point depression of water in the unit of (K kg / mol).

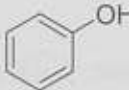
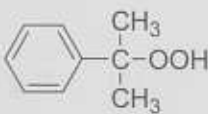
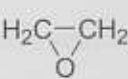
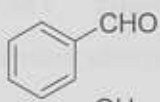
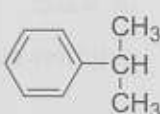
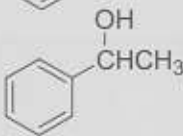
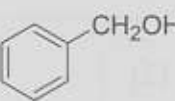
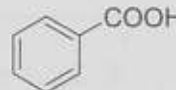
(2) A salt is composed of cation M^+ and anion X^- , and perfectly dissociates when dissolved in water. 2.0 g of this salt was dissolved in 100 g of water. The freezing point of the salt solution was determined to be $-1.3\text{ }^\circ\text{C}$. Determine the formula mass of the salt.

(1)	K kg / mol	(2)	
-----	------------	-----	--

V Outlined here are synthetic processes of organic compounds. Answer the questions (1) and (2).



(1) Select the structural formulas for the compounds A to J from (1)-(25). If necessary, the same number can be used twice.

- (1) CH_3CHO (2) CH_3CH_3 (3) $\text{CH}_3\text{CH}_2\text{OH}$ (4)  (5) 
(6) CH_3COOH (7) $(\text{CH}_3\text{COO})_2\text{Ca}$ (8) $\text{CH}_3\text{CH}_2\text{Br}$ (9) $\text{HOCH}_2\text{CH}_2\text{OH}$ (10) $\text{CH}_3\text{COOCH}_3$
(11)  (12) $(\text{CH}_3\text{CH}_2\text{O})_2\text{Ca}$ (13) CaC_2 (14) CH_3OH (15) $\text{H}_3\text{C}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$
(16) $\text{HC}\equiv\text{CH}$ (17)  (18) HCHO (19) $\text{CH}_3\overset{\text{OH}}{\text{CH}}\text{CH}_3$ (20) 
(21) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ (22)  (23)  (24)  (25) $\text{H}_2\text{C}=\text{CHOCOCCH}_3$

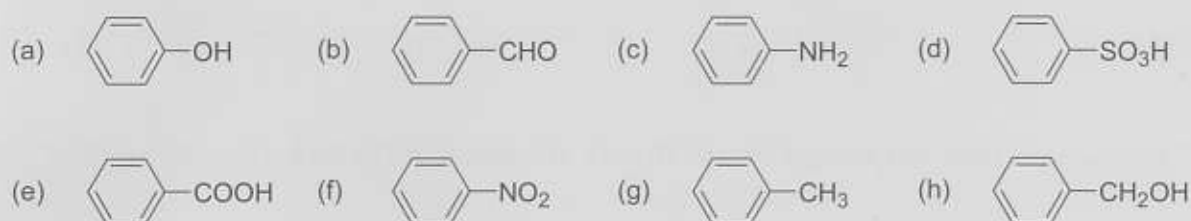
A	B	C	D	E
F	G	H	I	J

(2) Looking back at the diagram of synthetic processes of organic compounds shown above, label the types of reactions represented by the letters (a) to (d) from the list (1) to (8). If necessary, the same number can be used twice.

- (1) oxidation (2) hydrogenation (3) dehydration (4) addition
 (5) addition polymerization (6) substitution (7) decomposition (8) neutralization

(a)	(b)	(c)	(d)

VI Select the appropriate nature for the aromatic compounds (a)-(h) from (1)-(8).



- (1) It is a neutral liquid and gives a negative result on the silver mirror test. It reacts with carboxylic acids to give esters.
- (2) It is soluble in water and its aqueous solution is strongly acidic.
- (3) It is slightly soluble in water and its aqueous solution is slightly acidic. It undergoes color reaction to blue purple with aqueous iron (III) chloride.
- (4) It is neutral liquid, and it gives a positive silver mirror test result and a negative Fehling's test result.
- (5) It is insoluble in water, but soluble in dilute hydrochloric acid. It undergoes a color reaction to reddish purple with aqueous calcium hypochlorite.
- (6) It is insoluble in cold water, but soluble in hot water. It reacts with alcohol to give esters.
- (7) It is insoluble in water and it gives a negative result on the silver mirror test. It is generally used as a solvent.
- (8) It is insoluble in water and yellow. One of the derivatives is used as explosives.

(a)	(b)	(c)	(d)
(e)	(f)	(g)	(h)

VII When an organic compound **X** 124 mg, which consists of only carbon, hydrogen, and oxygen atoms was completely combusted, 176 mg of CO_2 and 108 mg of H_2O were formed. Answer the questions (1) and (2). Use the following values for atomic weights: H: 1.0, C: 12.0, O: 16.0.

- (1) What is the empirical formula of the compound **X**?
- (2) A vapor density of the organic compound at the same temperature under the same pressure is approximately twice that of oxygen. What is the molecular equation of the compound **X**?

(1)	(2)