

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

(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.

(1) The oxidation number of the nitrogen atom in  $\text{NH}_4\text{Cl}$  is

- 1) -5                      2) -4                      3) -3                      4) -2  
 5) 2                        6) 3                        7) 4                        8) 5

(2) Select two suitable chemical reagents to form sulfur dioxide in a laboratory.

- 1) sodium chloride      2) sodium hydroxide      3) sodium sulfite  
 4) iron sulfide            5) formic acid              6) sulfuric acid

(3) Arrange the following substances A, B, and C in order of decreasing melting point.

- A : graphite              B : naphthalene              C : sodium chloride  
 1)  $A > B > C$               2)  $A > C > B$               3)  $B > A > C$   
 4)  $B > C > A$               5)  $C > A > B$               6)  $C > B > A$

(4) Which of the following molecules and ions cannot form a coordinate bond with the  $\text{Fe}^{2+}$  ion?

- 1)  $\text{CH}_4$                       2)  $\text{H}_2\text{O}$                       3)  $\text{NH}_3$   
 4)  $\text{CN}^-$                       5)  $\text{Cl}^-$                       6)  $\text{OH}^-$

(5) Arrange the following mixed solutions A, B, and C in order of decreasing value of pH.

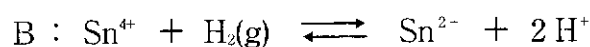
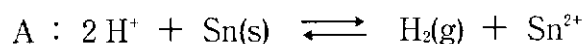
A : 15ml of 0.1mol/l  $\text{H}_2\text{SO}_4$  and 10ml of 0.1mol/l NaOH

B : 15ml of 0.1mol/l HCl and 10ml of 0.1mol/l  $\text{Na}_2\text{CO}_3$

C : 15ml of 0.1mol/l HCl and 10ml of 0.1mol/l NaOH

- 1)  $A > B > C$       2)  $A > C > B$       3)  $A > B = C$       4)  $B = C > A$   
 5)  $B > A > C$       6)  $B > C > A$       7)  $B > A = C$       8)  $A = C > B$   
 9)  $C > A > B$       10)  $C > B > A$       11)  $C > A = B$       12)  $A = B > C$

(6) As written, the following reactions A and B proceed to the right :



The order of oxidizing strength is

- 1)  $\text{H}^+ > \text{Sn}^{2+} > \text{Sn}^{4+}$       2)  $\text{H}^+ > \text{Sn}^{4+} > \text{Sn}^{2+}$       3)  $\text{Sn}^{2+} > \text{H}^+ > \text{Sn}^{4+}$   
 4)  $\text{Sn}^{2+} > \text{Sn}^{4+} > \text{H}^+$       5)  $\text{Sn}^{4+} > \text{H}^+ > \text{Sn}^{2+}$       6)  $\text{Sn}^{4+} > \text{Sn}^{2+} > \text{H}^+$

(7) The solubility of oxygen in 1.0l water is 28ml at  $25^\circ\text{C}$  and 1.0 atm. How much oxygen can be dissolved in 1.0l of water at  $25^\circ\text{C}$  and 4.0 atm?

- 1) 7ml      2) 14ml      3) 28ml      4) 84ml      5) 112ml

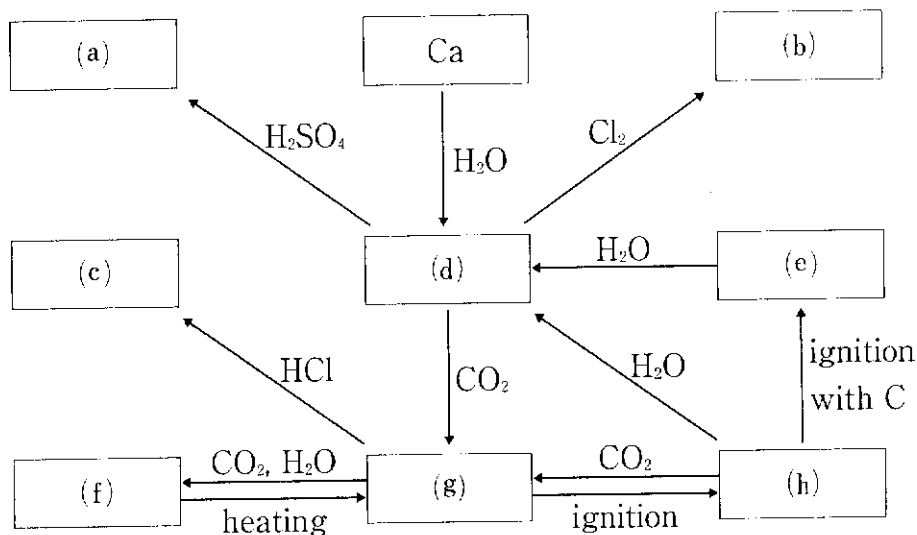
(8) The stopcock between a 2-liter bulb containing nitrogen gas at  $25^\circ\text{C}$  and 5 atm and a 3-liter bulb containing argon gas at  $25^\circ\text{C}$  and 10 atm is opened.

When equilibrium between the bulbs has been reached at  $25^\circ\text{C}$ , the gas pressure in the two bulbs is

- 1) 3 atm      2) 4 atm      3) 6 atm      4) 8 atm  
 5) 15 atm      6) 20 atm      7) 30 atm      8) 40 atm

(1)	(2)	(3)	(4)
(5)	(6)	(7)	(8)

II Give names for the substances (a) to (h). Write the reference number of the correct answer in the answer box.



- 1) calcium oxide                      2) calcium hydroxide                      3) calcium sulfate  
 4) calcium carbide                      5) calcium carbonate                      6) calcium chloride  
 7) calcium hydrogencarbonate                      8) bleaching powder

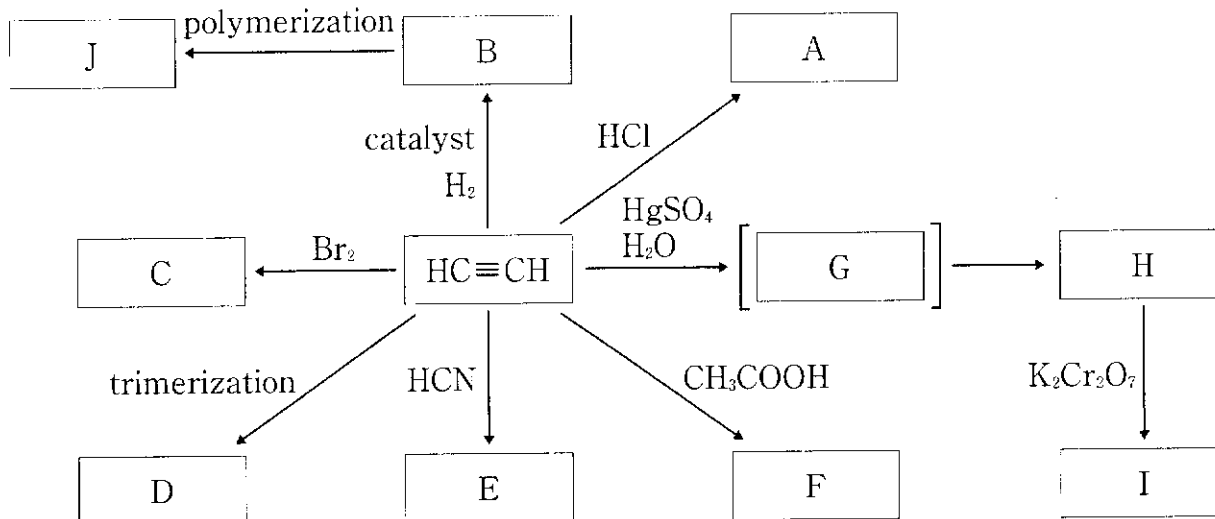
(a)	(b)	(c)	(d)
(e)	(f)	(g)	(h)

III In the electrolysis of 200ml of 0.15mol/l  $\text{CuSO}_4$  solution using platinum electrodes, 0.16g of oxygen gas evolved at the anode. Answer the following questions (1) and (2). (Atomic weights ; H : 1.0, O : 16.0, S : 32.0, and Cu : 63.5)

- (1) How many faradays of charge was passed through the solution?  
 (2) What should be the molarity of the  $\text{CuSO}_4$  solution after the electrolysis?

(1)	F	(2)	mol/l
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
IV Outlined here are synthetic processes of organic compounds. Answer the questions (1) to (4)



Question (1) : Select the structural formulas for the compounds A to J from (1)–

(20). Compound G is an unstable intermediate.

- |                                       |  |   |
|---------------------------------------|--|---|
| (1) $\text{CH}_3\text{CH}_2\text{Cl}$ | (2) $\text{CH}_3\text{CH}_3$                   | (3) $\text{CH}_3\text{CH}_2\text{CN}$   |
| (4) $\text{BrHC}=\text{CHBr}$         | (5) $\left[ \text{CH}_2-\text{CH}_2 \right]_n$ | (6) $\text{CH}_3\text{CHO}$             |
| (7) $\text{CH}_3\text{COOH}$          | (8) $\text{CH}_3\text{CH}_2\text{Br}$          | (9) $\text{BrCH}_2\text{CH}_2\text{Br}$ |

- |  |  |   |
|--|--|---|
| (10) $\text{H}_2\text{C}=\overset{\text{O}}{\parallel}\text{CHCOCH}_3$ | (11) $\text{H}_2\text{C}=\text{CHOH}$  | (12) $\text{H}_2\text{C}=\text{CH}_2$                                       |
| (13) $\text{H}_2\text{C}=\text{CHCN}$                                  | (14) $\text{CH}_3\text{OH}$  | (15) $\text{H}_3\text{C}-\overset{\text{O}}{\parallel}\text{C}-\text{CH}_3$ |
| (16) $\text{CH}_3\text{CH}_2\text{CH}_3$                               | (17)  | (18) $\text{HCHO}$  |
| (19) $\text{H}_2\text{C}=\text{CHCl}$                                  | (20) $\text{H}_2\text{C}=\overset{\text{O}}{\parallel}\text{CHOCCH}_3$                   |   |

Question (2) : Among the compounds (1)–(20) shown above, two undergo the silver mirror reaction. Select the two compounds from (1) to (20).

Question (3) : What color precipitate is formed by the passage of acetylene gas into an aqueous solution of ammoniac silver nitrate? Choose from (1) to (5) shown below and write the number in the answer box.

Question (4) : What color precipitate is formed by the passage of acetylene gas into an aqueous solution of ammoniac copper (I) chloride? Choose from (1) to (5) shown below and write the number in the answer box.

- (1) white                      (2) black                      (3) red  
 (4) blue                      (5) yellow

(1)				
A	B	C	D	E
F	G	H	I	J
(2)		(3)		(4)

V What is the state of compounds (1) to (5) when these are exposed at 0 °C under 1 atm? Choose from (a) to (c) and write the letter in the answer box.

- (1) methanol                      (2) acetic acid                      (3) acetaldehyde  
 (4) acetone                      (5) ethylene  
 (a) gas                      (b) liquid                      (c) solid

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

VI When 12.0mg of an ether compound X consisting of only carbon, hydrogen, and oxygen atoms was completely combusted, 26.4mg of  $\text{CO}_2$  and 14.4mg of  $\text{H}_2\text{O}$  were formed. After 12.0g of X was heated in a 1.00l-reaction vessel and completely vaporized, the compound showed 6.56 atm at  $127^\circ\text{C}$ . Answer the questions (1) to (4). Use the following values for atomic weights; H : 1.00, C : 12.0, O : 16.0 and the gas constant  $R = 0.0821 \cdot \text{atm/K} \cdot \text{mol}$ .

Question (1) What is the empirical equation of the compound X?

Question (2) Calculate the molecular weight.

Question (3) What is the molecular equation of the compound X?

Question (4) Select the structure of the compound X from (1) to (6).

- (1)  $\text{CH}_3\text{CH}_2\text{OH}$                       (2)  $\text{CH}_3\text{CH}_2\text{OCH}_3$                       (3)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$   
 (4)  $\text{CH}_3\text{COOH}$                       (5)  $\text{CH}_3\text{COOCH}_3$                       (6)  $\text{CH}_3\text{CHO}$

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