

2013 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 2013

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 below. Use the following values for atomic weights: H=1.0, C=12.0, O=16.0, Na=23.0, Mg=24.3, S=32.0, Cl=35.5.

(1) Which of the atoms 1) to 4) has the smallest first ionization energy?

- 1) Li 2) Be 3) Na 4) Mg

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

- 1) gold 2) diamond 3) iron 4) magnesium

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

- 1) carbon dioxide 2) ethane
3) ethylene (ethene) 4) propylene

(4) Which of the substances 1) to 4) has the lowest boiling point?

- 1) H₂O 2) H₂S 3) H₂Se 4) H₂Te

(5) Which of the descriptions 1) to 4) is not correct for the properties of sodium chloride?

- 1) Sodium ions and chloride ions are bonded by electrostatic attractive forces.
2) Aqueous solution exhibits neutral pH.
3) The number of sodium ions in the closest neighbor of a chloride ion is 6.
4) Refractive indices differ according to the crystallographic directions in single crystal.

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

- 1) $\underline{\text{Cl}}_2 + \text{SO}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{H}\underline{\text{Cl}} + \text{H}_2\text{SO}_4$
- 2) $\underline{\text{S}}\text{O}_2 + 2\text{H}_2\text{S} \rightarrow 2\text{H}_2\text{O} + 3\underline{\text{S}}$
- 3) $\text{CuSO}_4 + \text{H}_2\underline{\text{S}} \rightarrow \text{CuS} + \text{H}_2\underline{\text{S}}\text{O}_4$
- 4) $10\text{KCl} + 2\underline{\text{KMn}}\text{O}_4 + 8\text{H}_2\text{SO}_4 \rightarrow 5\text{Cl}_2 + 2\underline{\text{Mn}}\text{SO}_4 + 6\text{K}_2\text{SO}_4 + 8\text{H}_2\text{O}$

(7) 10 g of substances 1) to 4) were dissolved in each 1.0 L of water. Which solution will have the highest boiling point?

- 1) glucose
- 2) sodium chloride
- 3) sodium sulfate
- 4) magnesium chloride

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

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

Complete oxidation of 1 mol of methane requires (a) L of oxygen at 0 °C, under 1 atm. The heat of formation of methane is calculated to be (b) kJ mol⁻¹ using following values; bonding energy of a hydrogen molecule : 432 kJ mol⁻¹, bonding energy of a C-H bond in methane : 414 kJ mol⁻¹, sublimation energy of carbon (graphite) : 717 kJ mol⁻¹.

(a)		(b)	
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III Give the appropriate name of compounds that contain calcium for (a) to (d) by the chemical formulas.

(i) The reaction of metallic calcium with water produces (a). (b) is obtained by the reaction of (a) with carbon dioxide

(ii) Oxidation of metallic calcium produces (c). The reaction of (c) with water produces (a).

(iii) Both (a) and (b) produces (d) by their reactions with hydrogen chloride. Metallic calcium is obtained by the electrolysis of (d).

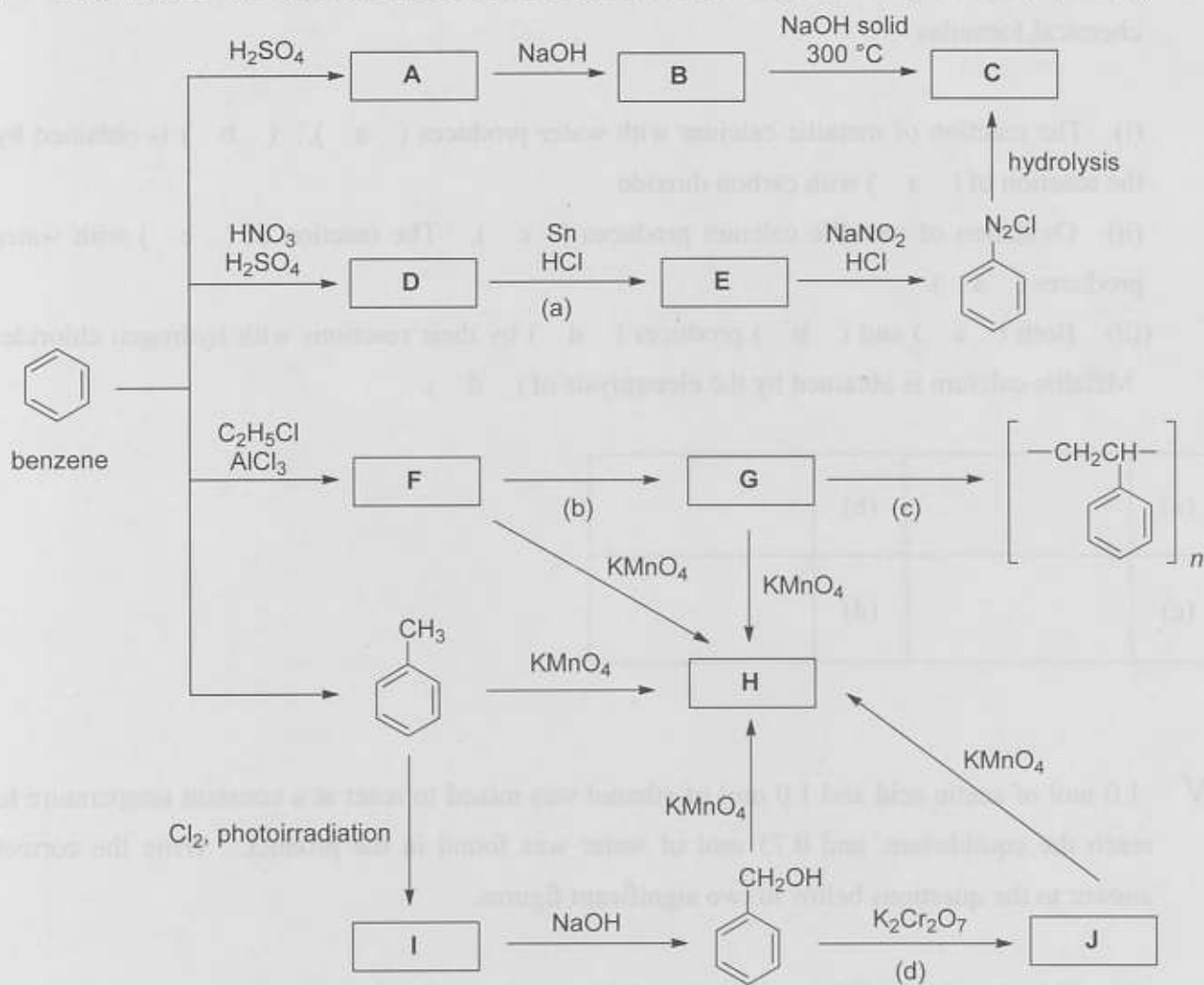
(a)		(b)	
(c)		(d)	

IV 1.0 mol of acetic acid and 1.0 mol of ethanol was mixed to react at a constant temperature to reach the equilibrium, and 0.75 mol of water was found in the product. Write the correct answer to the questions below to two significant figures.

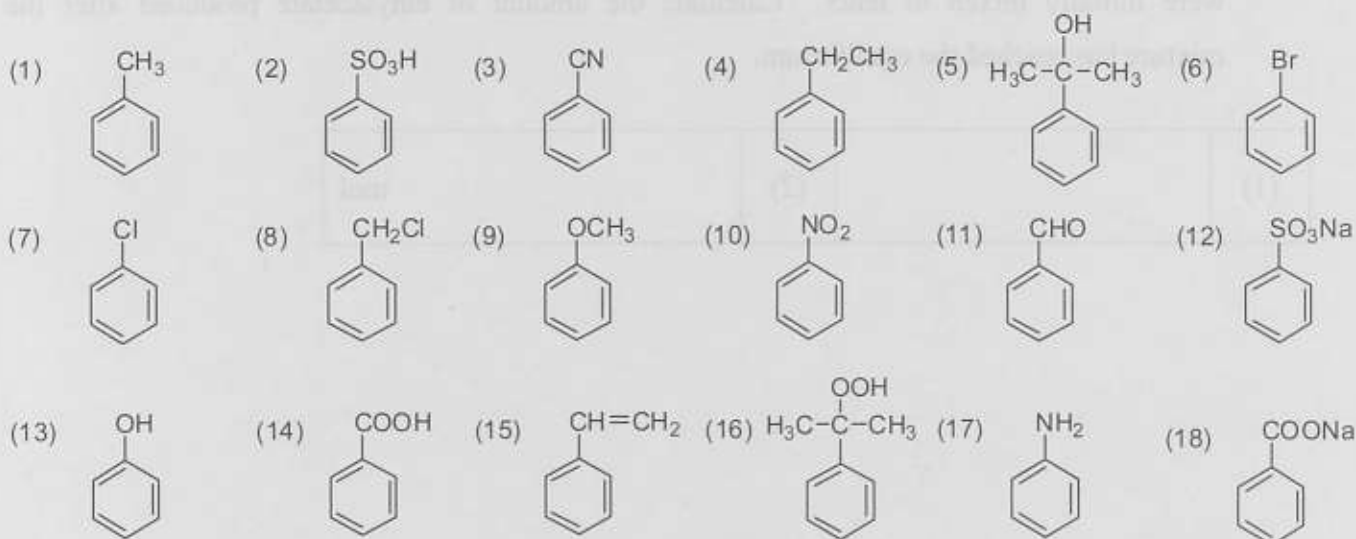
- Calculate the equilibrium constant of this reaction at the above temperature.
- At the same temperature, 1.0 mol of acetic acid, 1.0 mol of ethanol and 4.0 mol of water were initially mixed to react. Calculate the amount of ethylacetate produced after the mixture has reached the equilibrium.

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



(1) Select the structural formulas for the compounds A to J from (1)-(18).



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 (11). If necessary, the same number can be used twice.

- (1) oxidation (2) reduction (3) dehydrogenation (4) addition (5) substitution
 (6) dehydration (7) decomposition (8) neutralization (9) addition polymerization
 (10) condensation polymerization (11) hydrolysis

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

VI Answer the following questions about a systematic separation. Give the compound name as a neutral molecule, although it is ionic.

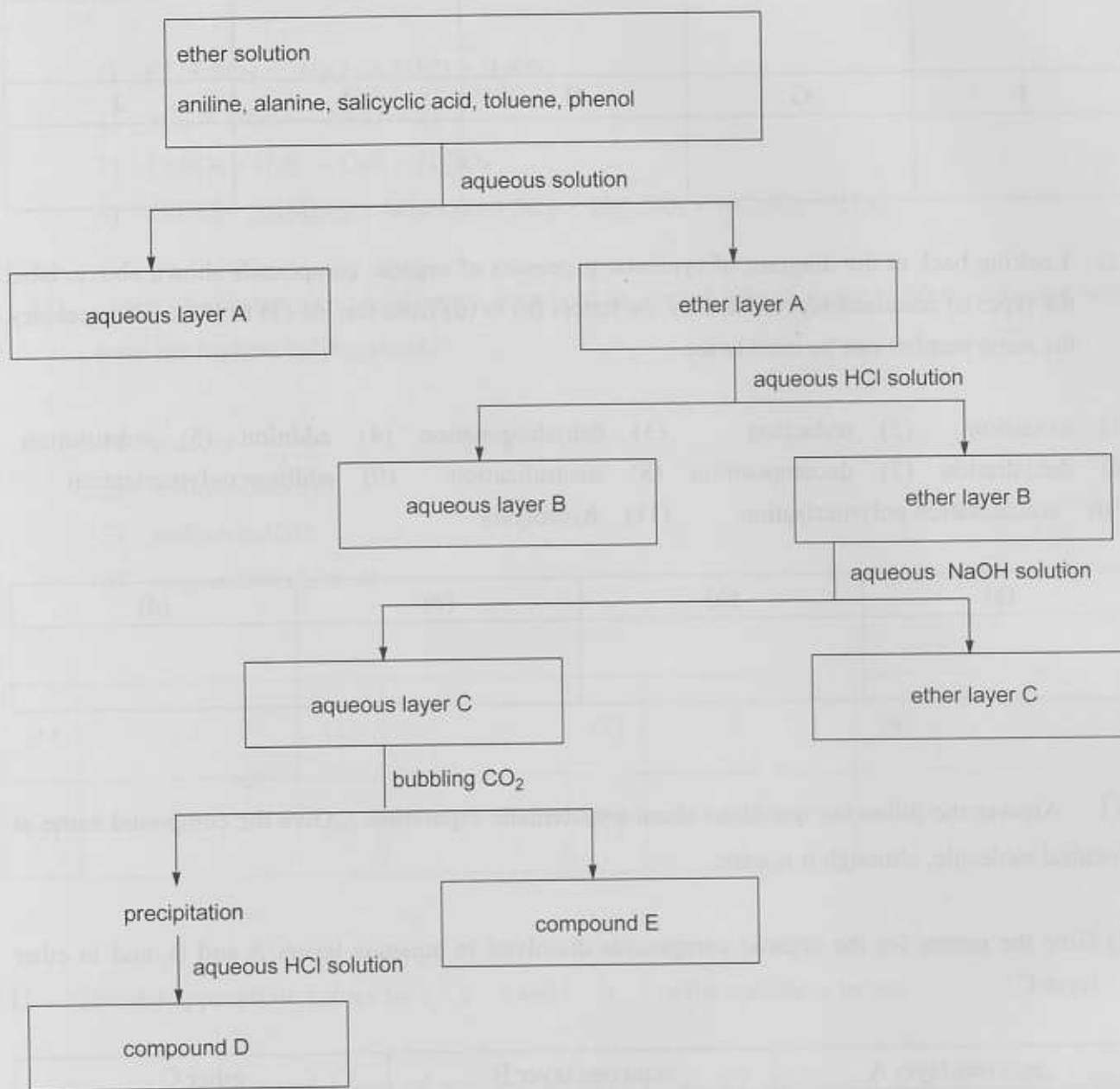
(1) Give the names for the organic compounds dissolved in aqueous layers A and B, and in ether layer C.

aqueous layer A	aqueous layer B	ether C

(2) Give the name for the compound D.

(3) Give the name for the compound E.

Compound D	Compound E



VII Write the name of organic compounds obtained from the following reactions.

- (1) reaction of sodium acetate with sodium hydroxide
- (2) reaction of calcium carbide with water
- (3) heat ethanol at 160 °C

(1)	(2)	(3)