2010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 2010

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

Use the following values. "L" indicates liters.

Gas constant : $R = 8.31 \times 10^3$ Pa·L/(K·mol) = 8.31 J/(K·mol)

= 0.082 atm·L/(K·mol)

Avogadro constant : $N_A = 6.0 \times 10^{23}$ /mol

Standard state : 0℃, 1.0×10^5 Pa (= 1.0 atm)

Atomic weight : H : 1.0 C : 12 N : 14 O : 16 F : 19 Na : 23

S : 32 Cl : 36 Ar : 40

Q1 From ①–⑤ below choose the atom that has the largest number of outermost shell electrons. **1**

① B ② Cl ③ He ④ Na ⑤ S

Q2 An atom has 32 neutrons and its trivalent cation has 24 electrons. From ①–⑤ below choose the atom. **2**

① ^{53}Cr ② ^{55}Mn ③ ^{57}Fe ④ ^{59}Co ⑤ ^{66}Zn

Q3 Given that the following gases ①–⑤ have the same mass, choose the one that has the smallest number of molecules. **3**

① Ar ② Cl_2 ③ CO ④ O_3 ⑤ SO_2

Q4 From ①-⑤ choose the best pair of methods to purify iodine (I_2) and potassium nitrate (KNO_3) . **4**

	Iodine	Potassium nitrate
①	recrystallization	sublimation
②	recrystallization	distillation
③	sublimation	distillation
④	sublimation	recrystallization
⑤	distillation	recrystallization

Q5 By heating 0.322 g of sodium sulfate hydrate ($Na_2SO_4 \cdot nH_2O$), 0.142 g of its anhydride is obtained. From ①-⑤ below choose the most appropriate value for n. **5**

① 4 ② 6 ③ 8 ④ 10 ⑤ 12

Q6 The following reaction is in an equilibrium state.

$$2NO_2 \text{ (brown)} = N_2O_4 \text{ (colorless)} + 57 \text{ kJ}$$

From ①-④ below choose two correct ones out of statements (**a**)-(**d**). **6**

(**a**) As the temperature is increased, the color darkens.

(**b**) As the temperature is increased, the color lightens.

(**c**) As the pressure is increased, the brown color first darkens, and then, after a few seconds, lightens.

(**d**) As the pressure is increased, the brown color first lightens, and then, after a few seconds, darkens.

① **a**, **c** ② **a**, **d** ③ **b**, **c** ④ **b**, **d**

Q7 From ①–⑤ below choose the molecule that is linear and has the double bond. **7**

① acetylene ② carbon dioxide

③ hydrogen peroxide ④ methane

⑤ propene (propylene)

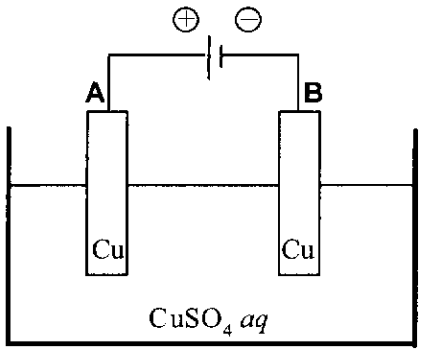
Q8 Given that air is a mixture of N_2 and O_2 with a volume ratio of 4:1, from ①–⑤ below choose the one that identifies a gas that has a larger density than air at the same temperature and pressure. **8**

① CH_4 ② C_3H_8 ③ HF ④ N_2 ⑤ NH_3

Q9 Sulfur dioxide (SO_2) is formed when copper (Cu) is dissolved in a hot, concentrated sulfuric acid (conc. H_2SO_4). From ①–⑤ below, choose the one that is the correct value for the change in the oxidation number of sulfur in this reaction. **9**

① 2 ② 3 ③ 4 ④ 5 ⑤ 6

Q10 An electric current is made to flow through an aqueous copper sulfate ($CuSO_4$ *aq*) as shown below. From ①-⑥ below choose the pair that includes correct statements describing the change that takes place at the electrodes **A** and **B**, respectively. **10**



	A	B
①	The mass increases.	The mass decreases.
②	The mass increases.	A gas is generated.
③	The mass decreases.	The mass increases.
④	The mass decreases.	A gas is generated.
⑤	A gas is generated.	The mass increases.
⑥	A gas is generated.	The mass decreases.

Q11 From ①-⑥ below choose the one that contains two methods to generate hydrogen. **11**

(**a**) Metallic sodium (Na) is added to water.

(**b**) Hydrochloric acid (HCl *aq*) is added to copper (Cu).

(**c**) Water is electrolyzed.

(**d**) Hydrochloric acid is added to manganese(IV) oxide (MnO_2) and the mixture is heated.

① **a, b** ② **a, c** ③ **a, d** ④ **b, c** ⑤ **b, d** ⑥ **c, d**

Q12 The following statements (**a**)-(**c**) on sodium chloride (NaCl) are either true or false. From ①-⑥ below choose the correct combination of "true (T)" and "false (F)". **12**

(**a**) Its crystal does not conduct electricity.

(**b**) Molten sodium chloride conducts electricity.

(**c**) By electrolyzing its aqueous solution with a carbon electrode, chlorine (Cl_2) and hydrogen (H_2) are obtained.

	a	**b**	**c**
①	T	T	T
②	T	T	F
③	T	F	T
④	F	T	T
⑤	F	T	F
⑥	F	F	F

Q13 From ①–⑥ below choose the best combination of elements that are true for the following statements (**a**)-(**c**), respectively. **13**

(**a**) Its oxide is a basic oxide.

(**b**) Its hydrogen compound is soluble in water and exhibits a strong acidity.

(**c**) The composition of its hydrogen compound is XH_4 (where X stands for an element) .

	a	b	c
①	Al	Cl	C
②	Al	S	N
③	Ca	Cl	P
④	Ca	I	C
⑤	Na	I	N
⑥	Na	S	P

Q14 From ①–④ below choose the metal that **does not deposit** silver (Ag) on the surface when immersed in aqueous silver nitrate ($AgNO_3$ *aq*). **14**

① Cu ② Fe ③ Pt ④ Zn

Q15 From ①-④ below choose the statement that is **only true for aluminum (Al) or only true for zinc (Zn)**. **15**

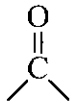
① The metal dissolves in hydrochloric acid (HCl *aq*).

② The metal dissolves in aqueous sodium hydroxide (NaOH *aq*).

③ A precipitate is formed when aqueous ammonia (NH_3 *aq*) is added to the aqueous solution of each ion. This precipitate dissolves if excess aqueous ammonia is added.

④ A precipitate is formed when aqueous sodium hydroxide is added to the aqueous solution of each ion. This precipitate dissolves if excess aqueous sodium hydroxide is added.

Q16 From ①-⑥ below choose the most appropriate combination of general names of the following functional groups (**a**)-(**c**). **16**

(**a**) $-SO_3H$ (**b**) $-OH$ (**c**) 

	a	b	c
①	carboxy group	nitro group	aldehyde group
②	carboxy group	nitro group	carbonyl group
③	carboxy group	hydroxy group	aldehyde group
④	sulfo group	nitro group	carbonyl group
⑤	sulfo group	hydroxy group	aldehyde group
⑥	sulfo group	hydroxy group	carbonyl group

Q17 From ①–⑤ below choose the pair of compounds that are both hardly soluble in water.

17

① acetic acid and acetone

② aniline and ethanol

③ ethylene glycol and phenol

④ ethyl acetate and hexane

⑤ formaldehyde and naphthalene

Q18 Of the isomers with the molecular formula C_4H_8, from ①–⑥ below choose the correct combination of them that have the following properties (**a**) and (**b**). **18**

(**a**) Optical isomers are formed when the addition reaction of chlorine (Cl_2) takes place.

(**b**) There exist *cis* and *trans* isomers.

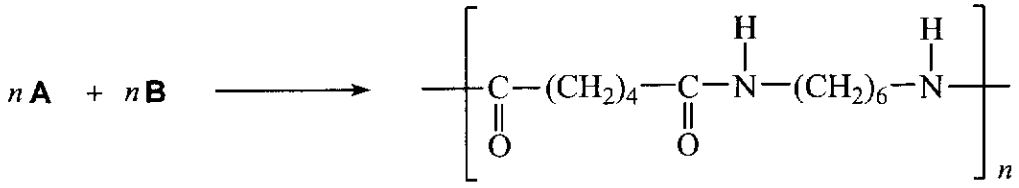
	a	**b**
①	1-butene (but-1-ene)	1-butene (but-1-ene)
②	1-butene (but-1-ene)	2-butene (but-2-ene)
③	1-butene (but-1-ene)	methylpropene
④	methylpropene	1-butene (but-1-ene)
⑤	methylpropene	2-butene (but-2-ene)
⑥	methylpropene	methylpropene

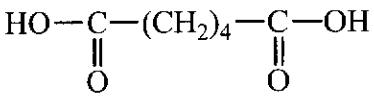
Q19 Hydrogen (H_2) is added to 0.10 mol of fat which contains only oleic acid $C_{17}H_{33}COOH$ as the fatty acid component. How much hydrogen (in L) at the standard state is necessary to saturate the fat completely. From ①–⑤ below choose the closest value.

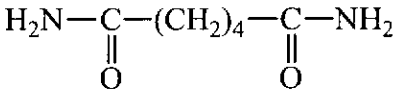
19 L

① 0.67 ② 1.12 ③ 2.24 ④ 4.48 ⑤ 6.72

Q20 From ①–⑥ below choose the correct combination of compounds (**a**)-(**d**) which are appropriate as the starting compounds for the following synthesis of nylon-6,6. **20**



(**a**) 

(**b**) 

(**c**) $HO-(CH_2)_6-OH$

(**d**) $H_2N-(CH_2)_6-NH_2$

① **a, b** ② **a, c** ③ **a, d** ④ **b, c** ⑤ **b, d** ⑥ **c, d**