

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

(高等専門学校留学生)

COLLEGE OF TECHNOLOGY 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 :**  $R = 8.31 \times 10^3 \text{ Pa} \cdot \text{L}/(\text{K} \cdot \text{mol}) = 8.31 \text{ J}/(\text{K} \cdot \text{mol})$   
 $= 0.082 \text{ atm} \cdot \text{L}/(\text{K} \cdot \text{mol})$

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

**Standard state :**  $0^\circ\text{C}$ ,  $1.0 \times 10^5 \text{ Pa}$  (= 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  $^{53}\text{Cr}$       ②  $^{55}\text{Mn}$       ③  $^{57}\text{Fe}$       ④  $^{59}\text{Co}$       ⑤  $^{66}\text{Zn}$

**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  $\text{Cl}_2$       ③ CO      ④  $\text{O}_3$       ⑤  $\text{SO}_2$

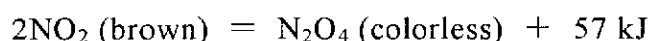
**Q4** From ①–⑤ choose the best pair of methods to purify iodine (I<sub>2</sub>) and potassium nitrate (KNO<sub>3</sub>). **4**

	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<sub>2</sub>SO<sub>4</sub>·*n*H<sub>2</sub>O), 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.



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**

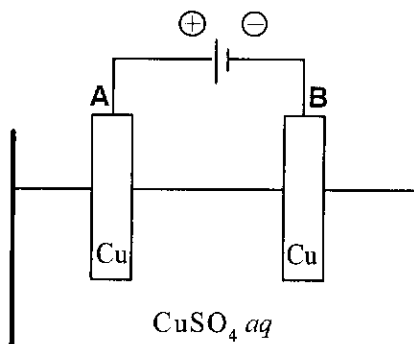
- ①  $CH_4$       ②  $C_3H_8$       ③  $HF$       ④  $N_2$       ⑤  $NH_3$

**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 ( $\text{CuSO}_4 \text{ aq}$ ) 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**



	<b>A</b>	<b>B</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 ( $\text{Na}$ ) is added to water.
- (b) Hydrochloric acid ( $\text{HCl aq}$ ) is added to copper ( $\text{Cu}$ ).
- (c) Water is electrolyzed.
- (d) Hydrochloric acid is added to manganese(IV) oxide ( $\text{MnO}_2$ ) 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 ( $\text{Cl}_2$ ) and hydrogen ( $\text{H}_2$ ) are obtained.

	<b>a</b>	<b>b</b>	<b>c</b>
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  $\text{XH}_4$  (where X stands for an element) .

	<b>a</b>	<b>b</b>	<b>c</b>
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 ( $\text{AgNO}_3 \text{ aq}$ ). **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**

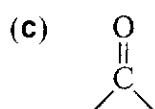
- ① The metal dissolves in hydrochloric acid ( $\text{HCl } aq$ ).
- ② The metal dissolves in aqueous sodium hydroxide ( $\text{NaOH } aq$ ).
- ③ A precipitate is formed when aqueous ammonia ( $\text{NH}_3$ *aq*) is added to the aqueous solution of each ion. This precipitate dissolves if excess aqueous 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)  $-\text{SO}_3\text{H}$

(b)  $-\text{OH}$



	<b>a</b>	<b>b</b>	<b>c</b>
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.

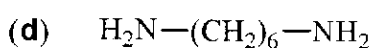
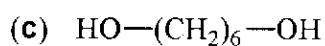
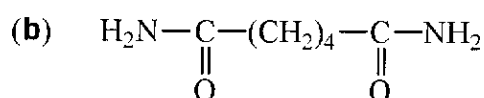
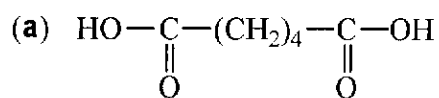
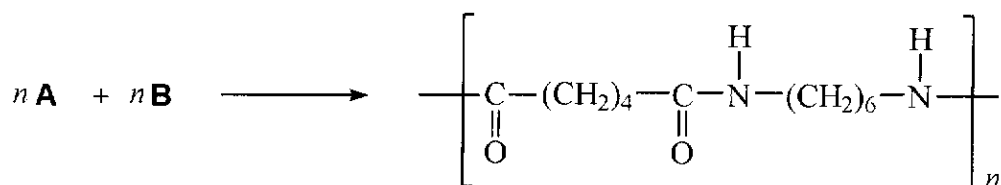
	<b>a</b>	<b>b</b>
①	1-butene (but-1-ene)	1-butene (but-1-ene)
②	1-butene (but-1-ene)	2-butene (but-2-ene)
③	1-butene (but-1-ene)	methylpropene
④	methylpropene	1-butene (but-1-ene)
⑤	methylpropene	2-butene (but-2-ene)
⑥	methylpropene	methylpropene

**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**



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