

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°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}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

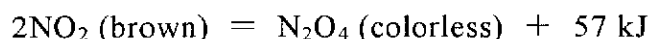
Q4 From ①–⑤ choose the best pair of methods to purify iodine (I₂) and potassium nitrate (KNO₃). **4**

	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 (Na₂SO₄·*n*H₂O), 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

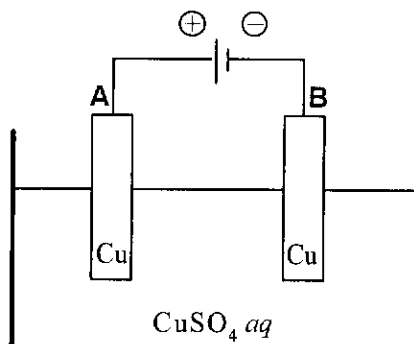
- ① CH_4 ② C_3H_8 ③ HF ④ N_2 ⑤ NH_3

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**



	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

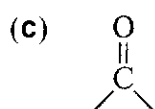
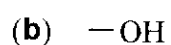
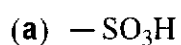
Q14 From ①–④ below choose the metal that does not deposit silver (Ag) on the surface when immersed in aqueous silver nitrate ($\text{AgNO}_3 \text{ aq}$). **14**

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 (HCl *aq*).
- ② The metal dissolves in aqueous sodium hydroxide (NaOH *aq*).
- ③ A precipitate is formed when aqueous ammonia (NH₃ *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	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.

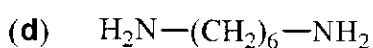
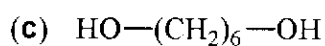
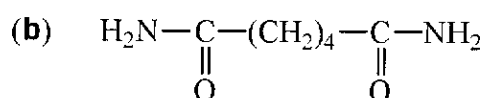
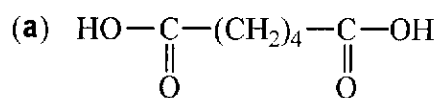
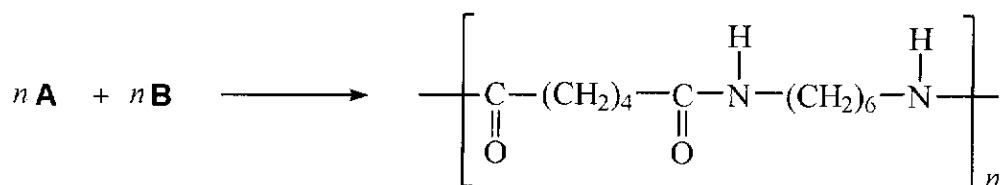
	a	b
①	1-butene (but-1-ene)	1-butene (but-1-ene)
②	1-butene (but-1-ene)	2-butene (but-2-ene)
③	1-butene (but-1-ene)	methylpropene
④	methylpropene	1-butene (but-1-ene)
⑤	methylpropene	2-butene (but-2-ene)
⑥	methylpropene	methylpropene

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**



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