

2024 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 2024

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

(2024)

Nationality		No.	
Name	(Please print full name, underlining family name)		

Marks	
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If necessary, use the following data to answer the questions below.

Atomic weight : H=1.0, C=12.0, N=14.0, O=16.0, Na=23.0, S=32.0, Cl=35.5

Molar volume of gas at the standard state (STP) : 22.4 L/mol

Gas constant : $R = 8.31 \times 10^3 \text{ Pa} \cdot \text{L}/(\text{K} \cdot \text{mol}) = 0.082 \text{ atm} \cdot \text{L}/(\text{K} \cdot \text{mol})$

Avogadro constant : $N_A = 6.02 \times 10^{23} / \text{mol}$

Pressure : 1 atm = $1.01 \times 10^5 \text{ Pa} = 760 \text{ mmHg}$

Ion product of water : $K_w = [\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-14} (\text{mol/L})^2$

$\sqrt{2} = 1.4$

Choose the correct answer from the choices ① to ⑤ below. Select the closest one, when your calculated result does not exactly match any of the values of the alternatives in each group.

Q1 Which of the following elements dose not place in the alkaline earth metals on the periodic table ?

- ① Ba ② Ca ③ Rn ④ Sr ⑤ Ra

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Q2 Which of the following atoms has a same number of neutrons as atomic number ?

- ① ^3He ② ^{17}O ③ ^{23}Na ④ ^{32}S ⑤ ^{40}Ar

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Q3 Which of the following molecules has the most electrons ?

- ① CH_3OH ② C_3H_8 ③ NH_3 ④ CO_2 ⑤ Cl_2

Q4 Which of the following ions has the smallest ionic radius ?

- ① O^{2-} ② F^- ③ Na^+ ④ Mg^{2+} ⑤ Al^{3+}

Q5 Which of the following compounds is a electrolyte ?

- ① $\text{C}_2\text{H}_5\text{OH}$ ② $\text{Ca}(\text{OH})_2$ ③ $\text{C}_6\text{H}_{12}\text{O}_6$ ④ O_2 ⑤ $\text{C}_{12}\text{H}_{22}\text{O}_{11}$

Q6 Which of the following salts is the acid salt that shows basic when dissolved in water ?

- ① KCl ② $\text{MgCl}(\text{OH})$ ③ NaHCO_3 ④ NH_4Cl ⑤ NaHSO_4

Q7 Calculate the degree of ionization, α , of 0.10 mol/L acetic acid, CH_3COOH . Assume that the ionization constant, K_a , of acetic acid is 2.0×10^{-5} mol/L.

- ① 2.0×10^{-4} ② 1.4×10^{-3} ③ 2.0×10^{-3}
④ 1.4×10^{-2} ⑤ 2.0×10^{-2}

Q8 A 20 mL solution is prepared by dissolving 0.8 mg of sodium hydroxide, NaOH, in water. What is the pH of this solution ?

- ① 1 ② 2 ③ 11 ④ 12 ⑤ 13

Q9 Which of the following compounds has the largest oxidation number in the underlined nitrogen atoms ?

- ① NO ② NH₃ ③ NO₂ ④ N₂ ⑤ NH₄NO₃

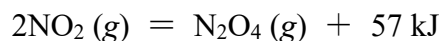
Q10 Which option is correct for mass changes of electrodes when lead storage battery, (−)Pb | H₂SO₄ aq | PbO₂(+) , discharges ?

- ① Cathode increased and anode decreased.
② Cathode decreased and anode increased.
③ Both electrodes decreased.
④ Both electrodes increased.
⑤ Both electrodes neither increased nor decreased.

Q11 The heats of combustion of hydrogen (g), carbon (graphite), methane (g), propane (g) and methanol (l) are 286 kJ/mol, 394 kJ/mol, 891 kJ/mol, 2219 kJ/mol and 726 kJ/mol respectively. Which of these fuels is the most efficient to combust ? Compare the thermal energy (kJ/g) released when 1 g of substance burns.

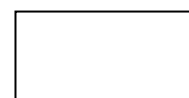
- ① H₂ ② C ③ CH₄ ④ C₃H₈ ⑤ CH₃OH

Q12 In the following reaction, which is the correct combination that procedures are for the shift equilibrium to the right ?



- (A) Raising the temperature
- (B) Increasing the pressure
- (C) Adding the catalyst
- (D) Reducing the amount of $\text{NO}_2(g)$
- (E) Reducing the amount of $\text{N}_2\text{O}_4(g)$

- ① (A) and (B) ② (A) and (C) ③ (B) and (D)
④ (B) and (E) ⑤ (C) and (E)



Q13 Which is the most appropriate graph to show the relationship between the pressure (P) and volume (V) of an ideal gas when the amount of substance and temperature are constant ?

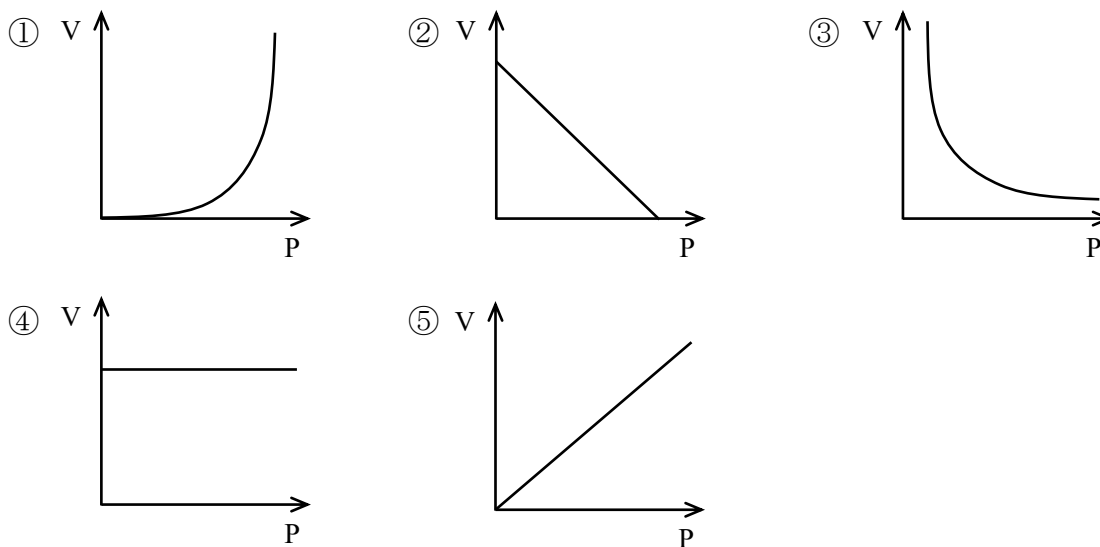
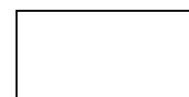


Figure 1



Q14 The density of a gas is 1.2 g/L at 303 K and 1.01×10^5 Pa. Which is the molecular formula of this gas ?

- ① C_2H_2 ② HCN ③ C_2H_6 ④ H_2S ⑤ HCl

Q15 Which of the following oxides is an acidic oxide ?

- ① Na_2O ② ZnO ③ SO_3 ④ Al_2O_3 ⑤ MgO

Q16 By the procedures shown in the following figure, each ion is separated from an aqueous solution containing metallic ions Ag^+ , Cu^{2+} and Fe^{3+} . Which is the most appropriate combination of metallic ions contained in the precipitates A and B ?

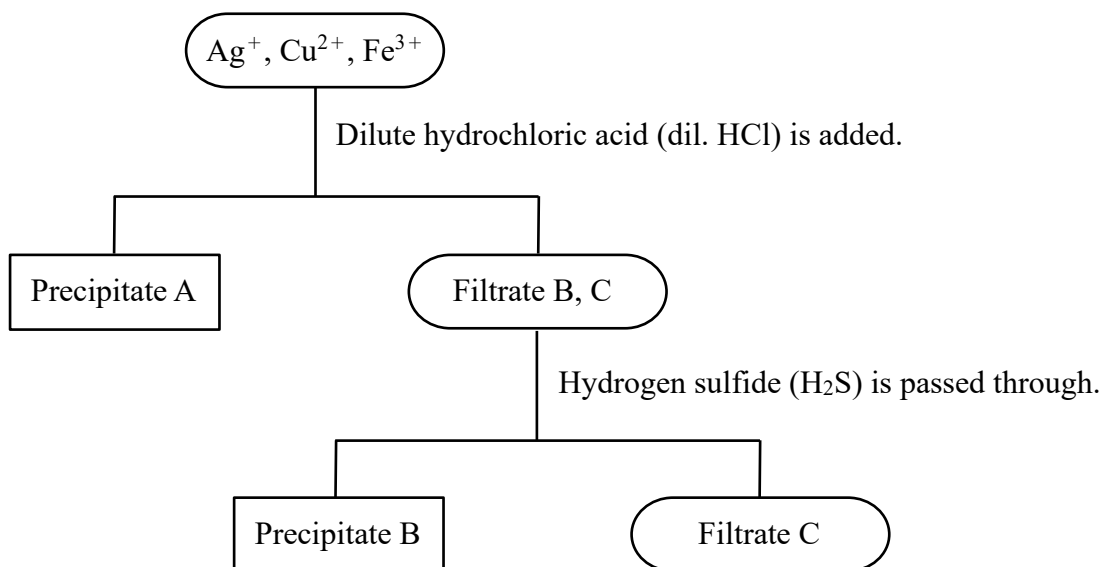


Figure 2

Table 1

	Ion contained in A	Ion contained in B
①	Ag^+	Cu^{2+}
②	Ag^+	Fe^{3+}
③	Cu^{2+}	Fe^{3+}
④	Fe^{3+}	Ag^+
⑤	Fe^{3+}	Cu^{2+}



Q17 9.2 mg of an organic compounds composed of carbon (C), hydrogen (H) and oxygen (O) having hydroxyl groups was completely combusted to yield 17.6 mg of carbon dioxide (CO₂) and 10.8 mg of water (H₂O). Which is this organic compound ?

- ① Methanol ② Ethanol ③ Acetaldehyde (Ethanal)
 ④ Dimethyl ether (Methoxymethane) ⑤ Acetone (Propan-2-one, Propanone)

Q18 How many structural isomers are there for the compound with molecular formula C₄H₁₀O ? If stereoisomers are involved, they do not need to be counted separately.

- ① 4 ② 5 ③ 6 ④ 7 ⑤ 8

Q19 Which of the following compounds show a silver mirror reaction ?

- ① C₂H₅OH ② CH₃COOH ③ C₂H₅OC₂H₅
 ④ CH₃CHO ⑤ CH₃COOC₂H₅

Q20 Which of the following compounds show a color reaction, when iron(III) chloride, FeCl₃, solution was added ?

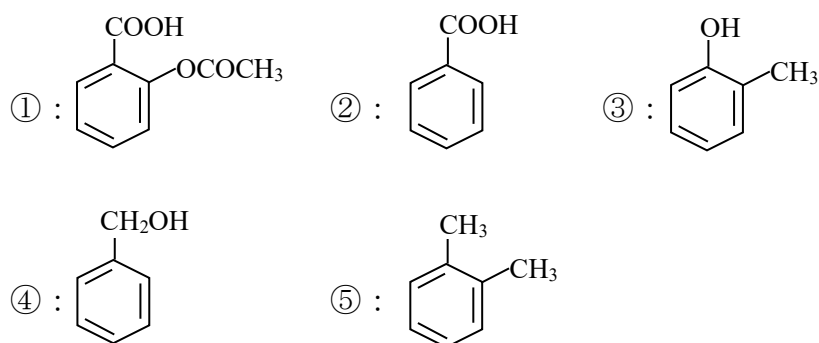


Figure 3