(2016)

CHEMISTRY

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

Marks	

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

Atomic Weight: H = 1.0, C = 12.0, O = 16.0, Na = 23.0, Cu = 63.6

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

Gas constant: R = 0.082 (atm・L) / (K・mol) = 8.31×10^{3} (Pa・L) / (K・mol)

Avogadro constant: $N_A = 6.02\times10^{23}$ / mol

Pressure: 1 atm = 1.01×10^{5} Pa = 760 mmHg

Faraday's constant: F = 9.65×10^{4} C / mol

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

Q1 Answer each question about B, C, N, O, and F elements.

① B ② C ③ N ④ O ⑤ F

(A) Which is the element with the largest atomic radius ?

(B) Which is the element which becomes an anion of bivalence easily ?

(C) Which is the element with the largest electronegativity ?

Q2 Which is the polar molecule among the following molecules?

① H_2 ② Cl_2 ③ CO_2 ④ H_2O ⑤ CH_4

Q3 Answer the following questions about the oxygen ion shown below.

$^{16}_{8}O^{2-}$

(A) How many neutrons are there in this ion?

① 5 ② 6 ③ 7 ④ 8 ⑤ 9

(B) Which has the electron configuration different from the one of this oxide ion?

① F^- ② Ne ③ Al^{3+} ④ Mg^{2+} ⑤ Cl^-

Q4 Which has the largest oxidation number in the underlined atoms below?

① $\underline{Al}_2O_3$ ② $\underline{Mn}O_2$ ③ $H\underline{Cl}O_4$ ④ $K_2\underline{Cr}_2O_7$ ⑤ $\underline{N}_2O_5$

Q5 Answer the following questions about the thermochemical equation of combustion of propane C_3H_8 (*g*).

(A) What is the coefficient *a* of the following thermochemical equation?

$$C_3H_8(g) + \underline{a}\,O_2(g) = \underline{b}\,CO_2(g) + \underline{c}\,H_2O(l) + 2219\ \text{kJ}$$

① 2 ② 3 ③ 5 ④ 8 ⑤ 10

(B) Calculate the quantity of heat (kJ) when the propane of 2.24 L is burned at standard state.

① 113 ② 222 ③ 339 ④ 666 ⑤ 2220

Q6 What is the obtained compound by the thermal decomposition of the 1-2-dichloroethane CH_2ClCH_2Cl ?

① $CH_2=CH_2$ ② $CH\equiv CH$ ③ $CCl\equiv CCl$ ④ $CHCl=CHCl$

⑤ $CH_2=CHCl$

Q7　A Solution of 250 mL was prepared by adding water to sodium hydroxide NaOH 2.0 g. Answer the following questions.

(A) Calculate the molar concentration (mol / L) of this solution.

① 0. 1　② 0. 2　③ 0. 3　④ 0. 4　⑤ 0. 5

(B) Calculate the pH of this solution. Use the following value, if necessary.
$\log_{10} 2 = 0.30$,　$\log_{10} 5 = 0.70$

① 0. 3　② 7. 3　③ 11. 3　④ 13. 3　⑤14. 3

(C) Calculate the volume (mL) of HCl solution of 0.5 mol/L to neutralize 50mL of this solution.

①10　② 15　③ 20　④ 25　⑤ 30

Q8　There is oxygen gas which occupies the volume of 820 mL at 300 K and 1.5 atm. Answer the following questions.

(A) Calculate the amount of substance (mol) of this oxygen gas.

① 0.005　② 0.05　③ 0.5　④ 5.0　⑤ 50

(B) Calculate the pressure (atm) when this gas is set to 600 K and 1640 mL.

① 0.1　② 0.5　③ 1.0　④ 1.5　⑤ 2.0

Q9　Answer each question about the following compound.

$CH_3\underline{COOH}$

(A) What is the name of the underlined functional group?

① hydroxy group　② carbonyl group　③ carboxyl group

④ amino group　⑤ sulfo group

(B) What is the property of the water solution of 1 mol / L of this compound?

① strong acid　② weak acid　③ neutral　④ weak base　⑤ strong base

Q10 Electrolysis was carried out for copper sulfate ($CuSO_4$) solution for 25 minutes 44 seconds with the current of 2.5 A using the platinum electrode. Answer the following questions.

(A) Calculate the mass (g) of the metal to be deposited on the cathode.

① 0. 16　② 0. 32　③ 0. 64　④ 1. 27　⑤ 2. 54

(B) At the standard state, calculate the volume(L) of gas generated at the anode.

① 0. 08　② 0. 11　③ 0. 22　④ 0. 32　⑤ 0. 45

Q11 Mixture of 4.0 mol acetic acid CH_3COOH and 2.0 mol ethanol C_2H_5OH was made to react at constant temperature. Calculate the amount of substance (mol) of the ethyl acetate $CH_3COOC_2H_5$ generated at the equilibrium situation. The equilibrium constant K is 4.0. Use the following value, if necessary. $\sqrt{192}$ = 13. 86

① 1. 21　② 1. 69　③ 2. 13　④ 3. 86　⑤ 6. 31