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 ) = 8.31×10³ ( Pa・L ) / ( K・mol )
Avogadro constant: N_A = 6.02×10²³ / mol
Pressure: 1 atm = 1.01×10⁵ Pa = 760 mmHg
Faraday's constant: F = 9.65×10⁴ 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?

\[ \begin{align*}
\text{① } & \text{H}_2 \\
\text{② } & \text{Cl}_2 \\
\text{③ } & \text{CO}_2 \\
\text{④ } & \text{H}_2\text{O} \\
\text{⑤ } & \text{CH}_4
\end{align*} \]

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

\[ _{8}^{16}\text{O}^{2-} \]

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

\[ \begin{align*}
\text{① } & 5 \\
\text{② } & 6 \\
\text{③ } & 7 \\
\text{④ } & 8 \\
\text{⑤ } & 9
\end{align*} \]

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

\[ \begin{align*}
\text{① } & \text{F}^- \\
\text{② } & \text{Ne} \\
\text{③ } & \text{Al}^{3+} \\
\text{④ } & \text{Mg}^{2+} \\
\text{⑤ } & \text{Cl}^-
\end{align*} \]

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

\[ \begin{align*}
\text{① } & \text{Al}_2\text{O}_3 \\
\text{② } & \text{MnO}_2 \\
\text{③ } & \text{HClO}_4 \\
\text{④ } & \text{K}_2\text{Cr}_2\text{O}_7 \\
\text{⑤ } & \text{N}_2\text{O}_5
\end{align*} \]
Q5  Answer the following questions about the thermochemical equation of combustion of propane $\text{C}_3\text{H}_8 (g)$.

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

$$\text{C}_3\text{H}_8 (g) + a \text{ O}_2 (g) = b \text{ CO}_2 (g) + c \text{ H}_2\text{O (l)} + 2219 \text{ kJ}$$

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 $\text{CH}_2\text{ClCH}_2\text{Cl}$?

1. $\text{CH}_2=\text{CH}_2$  
2. $\text{CH}=\text{CH}$  
3. $\text{CCl}=\text{CCl}$  
4. $\text{CHCl}=\text{CHCl}$  
5. $\text{CH}_2=\text{CHCl}$
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.

\[ \log_{10} 2 = 0.30, \quad \log_{10} 5 = 0.70 \]

① 0.3  ② 7.3  ③ 11.3  ④ 13.3  ⑤ 14.3

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

① 10  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.

**CH₃COOH**

(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 (CuSO₄) 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 CH₃COOH and 2.0 mol ethanol C₂H₅OH was made to react at constant temperature. Calculate the amount of substance (mol) of the ethyl acetate CH₃COOC₂H₅ 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