Miscellaneous Calculations

(1) Mole and Mass

-2006 I(7)

3.000g of pure rubidium metal is oxidised to 3.280g of rubidium (I) oxide Rb_2O with the number of moles remaining unchanged. What is the mass number of rubidium?

1) 85.7 2) 93.7 3) 171

4) 187 5) 343 6) 375

-2009 III(1)

Ⅲ The solubility of sodium sulfite (Na_2SO_3) is 27 (g/100 g-water) at 20℃. Answer the following questions (1) and (2). (Atomic weights : H : 1.0, O : 16.0, Na : 23.0, and S : 32.0)

(1) What is the mass percent concentration of the saturated solution of Na_2SO_3 at 20℃?

-2007 III

Ⅲ Exactly 4.32g of oxygen gas was required to completely burn a 2.16g sample of a mixture of methanol and ethanol. Answer the following questions (1) and (2). (Atomic weights; H=1.0, C=12.0, and O=16.0)

(1) How many moles of ethanol are contained in the sample?

(2) What is the percentage by weight of methanol in the sample? Write the percentage to two significant figures.

(1)	mol
(2)	%

-2010 Q3

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

-2010 Q5

Q5 By heating 0.322 g of sodium sulfate hydrate ($Na_2SO_4 \cdot nH_2O$), 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

(2) Deduction of Formula

-2008 VI

Ⅵ When 12.0mg of an ether compound X consisting of only carbon, hydrogen, and oxygen atoms was completely combusted, 26.4mg of CO_2 and 14.4mg of H_2O were formed. After 12.0g of X was heated in a 1.00l-reaction vessel and completely vaporized, the compound showed 6.56 atm at 127℃. Answer the questions (1) to (4). Use the following values for atomic weights; H : 1.00, C : 12.0, O : 16.0 and the gas constant $R = 0.082l \cdot \text{atm/K} \cdot \text{mol}$.

Question (1) What is the empirical equation of the compoud X?

Question (2) Calculate the molecular weight.

Question (3) What is the molecular equation of the compound X?

Question (4) Select the structure of the compound X from (1) to (6).

(1) CH_3CH_2OH (2) $CH_3CH_2OCH_3$ (3) $CH_3CH_2CH_2OH$

(4) CH_3COOH (5) CH_3COOCH_3 (6) CH_3CHO

-2009 IX

Ⅸ A certain organic compound 8.96 g contains C 1.14 g, H 0.19 g, Br 7.63 g. What is the empirical equation of the compound? Use the following values for atomic weights : H : 1.00, C : 12.0, Br : 79.9.

-2012 VII

VII When an organic compound **X** 124 mg, which consists of only carbon, hydrogen, and oxygen atoms was completely combusted, 176 mg of CO_2 and 108 mg of H_2O were formed. Answer the questions (1) and (2). Use the following values for atomic weights: H: 1.0, C: 12.0, O: 16.0.

(1) What is the empirical formula of the compound **X**?
(2) A vapor density of the organic compound at the same temperature under the same pressure is approximately twice that of oxygen. What is the molecular equation of the compound **X**?

-2013 VI(1)

(The molecular weight of X is 88)

VI Elementary analysis of the organic compound **X**, which is a liquid at room temperature and consists of carbon, hydrogen, and oxygen, shows C: 68.18%, H: 13.64 %, O: 18.18%. The molecular weight of **X** is 60. Answer questions (1)-(4). Use the following values for atomic weights: C: 12.0, H: 1.00, O: 16.0.

(1) Select the molecular formula of the compound **X**.
(a) C_2H_6O (b) $C_4H_{10}O$ (c) $C_5H_{12}O$ (d) $C_6H_{14}O$ (f) C_3H_8O (g) C_3H_7Cl

-2017 V(1)-(2)

V There is a compound **A**, which is made up of carbon, hydrogen, and oxygen atoms. The reaction of the compound **A** with acetic acid gave an ester **B**. When 3.48 mg of the ester **B** was combusted completely, 7.92 mg of carbon dioxide and 3.24 mg of H_2O were obtained. A molecular weight of the ester **B** is between 110 and 118. Here, H=1, C=12, O=16.

(1) Select the compositional formula of the ester **B** from 1)-5).
1) C_3H_6O 2) C_3H_7O 3) $C_2H_5O_2$ 4) C_2H_5O 5) $C_6H_{13}O_2$

(2) Select the molecular formula of the ester **B** from 1)-5).
1) $C_6H_6O_2$ 2) $C_6H_8O_2$ 3) $C_6H_{14}O_2$ 4) $C_6H_{12}O_2$ 5) $C_6H_{10}O_2$

-2020 V(1)

V Answer the following questions about organic compounds. Use the following values if necessary; the atomic weights of C, O, and H are 12.0, 16.0, and 1.00, respectively.

There is compound **A**, which is made up of carbon, hydrogen, and oxygen atoms. When 50.5 mg of compound **A** was combusted completely with dry oxygen, 110 mg of CO_2 and 40.5 mg of H_2O were obtained. A complete hydrolysis of compound **A** gave compounds **B** and **C** at a 2:1 molar ratio. Compound **B** reacted with sodium to give hydrogen gas. When compound **B** was oxidized, compound **D**, which gives a positive Tollens' test (silver mirror test), was formed. Further oxidation of compound **D** produced compound **E**. Each of compounds **B** and **E** produced a yellow precipitate by the treatment with I_2 and $NaOH_{aq}$. Compound **C** is the starting material for nylon 6,6.

(1) Write the appropriate values for x, y, and z in the molecular formula $C_xH_yO_z$ of compound **A**. The molecular weight of compound A does not exceed 300.

(3) Calculation With Organic Equation Involved

-2007 V Question 2

Question 2. A kind of fatty acid was obtained by hydrolysis of some oil and fat. For hydrolysis of 0.884g of the oil and fat, 15m*l* of 0.2mol/*l* aqueous solution of potassium hydroxide was required.

(5) What is the molecular weight of the oil and fat?

(6) What is the molecular weight of the fatty acid?

-2009 VIII

Ⅷ When propene C_3H_6 undergoes addition of bromine Br_2, how many mol of Br_2 can react with 1 mol of propene?

-2009 X

Ⅹ Calculate the ratio of the weight of oxygen required for the complete combustion of 1 g of propane C_3H_8 to that of 1 g of methane CH_4?

-2009 XI

Ⅺ Nitration of 50 g of benzene gave 55 g of nitrobenzene. Calculate the yield.

-2015 VI(4)

(4) The reaction of phenol with bromine molecule gives 2,4,6-tribromophenol. How many moles of bromine molecule are required in order to get 298g of 2,4,6-tribromophenol from 94g of phenol? The reaction is supposed to proceed theoretically. Here, atomic masses are H = 1, C = 12, O = 16, Br = 80.

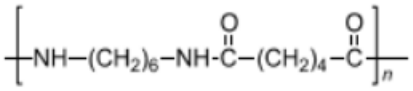
-2016 VI(4)-(5)

(4) What is the weight % of carbon in polyethylene? Calculate the weight ratio of carbon in polyethylene and answer using the unit of wt% to the first decimal place.

(5) When ethylene gas is bubbled through bromine water, which contains 1 mol of Br_2, the color of solution changes from an intense yellow to a colorless. How many moles of ethylene are needed to make the color of the bromine water to change from yellow to colorless?

-2019 VII(2)

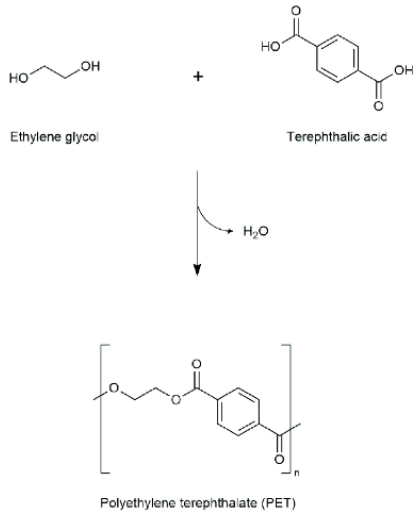
(1) The polymerization reaction of 219 g hexamethylene diamine with 219 g adipic acid gives a



(2) If the reaction described in (1) proceeds completely, how many grams of the polymer is formed? Calculate the mass to three significant figures.

-2020 VI(3)(4)

The reaction of polymerisation to form polyethylene terephthalate is



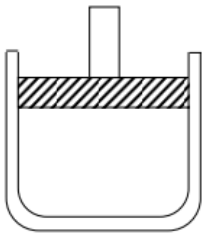
(3) For a polyethylene terephthalate with an average molecular weight of 2.00×10^4, calculate the average degrees of polymerization to three significant figures.

(4) How many molecules of glucose ($C_6H_{12}O_6$) react in a dehydration reaction to produce a molecule of amylose with a molecular weight of 2.70×10^5? Calculate the value to three significant figures.

(4) Other

-2020 IV(1)-(4) (Too many topics are involved)

IV First, 3.0 moles of N_2 and 9.0 moles of H_2 were added into a volume-variable reactor with a smooth piston as shown in the figure below. Next, the ammonia synthesis reaction ($N_2(g) + 3H_2(g) \rightleftarrows 2NH_3(g)$ $\Delta H = -92$ kJ) proceeded at constant temperature and constant pressure in the presence of a solid catalyst. After the reaction reached to an equilibrium state, the mole fraction of NH_3 was 50%. The volume of the mixed gas was 3.0 L before the reaction. All gases can be regarded as ideal gases.



(1) Calculate the number of moles for N_2, H_2 and NH_3 after the reaction to two significant figures.

(2) Calculate the amount of heat generated by the reaction.

(3) Calculate the volume of the mixed gas after the reaction to two significant figures.

(4) Calculate the equilibrium constant to two significant figures.