Atoms, molecules and stoichiometry – 2022 June AS Chemistry 9701

1. June/2022/Paper_11/No.3

   In separate experiments, 5.0 g samples of each of four s-block metals are added to an excess of water. The gas evolved is collected and its volume measured under the same conditions of temperature and pressure for each sample.

   Which metal produces the largest volume of gas?

   A   calcium

   B   potassium

   C   rubidium

   D   strontium

2. June/2022/Paper_11/No.4

   A student reacts 1 mol of copper with concentrated nitric acid to produce 1 mol of copper(II) nitrate, 2 mol of water and substance X. No other product is formed.
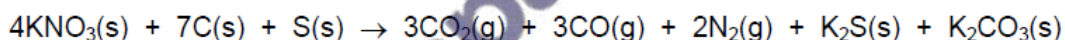
   Substance X does not contain copper or hydrogen.

   What could be substance X?

   A N_2 B N_2O C NO D NO_2

3. June/2022/Paper_11/No.7

   'Black powder' is a mixture of potassium nitrate, carbon and sulfur. The mixture reacts as shown.

   $$4KNO_3(s) + 7C(s) + S(s) \rightarrow 3CO_2(g) + 3CO(g) + 2N_2(g) + K_2S(s) + K_2CO_3(s)$$

   A sealed tube containing black powder has a volume of $10.0\,cm^3$. When all of the black powder reacts, the reaction causes a pressure of $2 \times 10^6\,Pa$ and a temperature of 2500 K.

   The volume of the K_2CO_3 and K_2S produced can be ignored.

   How many moles of KNO_3 are contained in the sealed tube?

   A 4.81×10^{-4} B 9.63×10^{-4} C 1.93×10^{-3} D 9.63×10^{-1}
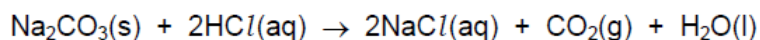
4. June/2022/Paper_11/No.11

   A student reacts 4 mol of ammonia with oxygen to produce an oxide of nitrogen and water only. Each nitrogen atom increases its oxidation state by 5 in the reaction.

   How many moles of oxygen gas react with 4 mol of ammonia in this reaction?

   A   4 mol   B   5 mol   C   7 mol   D   10 mol

5.

A 3.0 g sample of Na_2CO_3 powder is stirred into $50 \, cm^3$ of $1.0 \, mol \, dm^{-3}$ HCl. The volume of CO_2 produced is $600 \, cm^3$.

$$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

[M_r: Na_2CO_3, 106.0]

Which volume of CO_2 is produced if 1.0 g of Na_2CO_3 powder is stirred into $50 \, cm^3$ of $1.0 \, mol \, dm^{-3}$ HCl under the same conditions?

A $600 \, cm^3$ **B** $452 \, cm^3$ **C** $226 \, cm^3$ **D** $200 \, cm^3$

6.

Which sample contains the most iodine?

A 1 g of CaI_2 **B** 1 g of KI **C** 1 g of NaI **D** 1 g of NH_4I

7.

When a small sample of hydrocarbon Q is completely combusted, it produces 3.52 g of carbon dioxide and 1.44 g of water.

What could be the structure of hydrocarbon Q?

A   **B**   **C**   **D**

H—C≡C—C≡C—H

8.
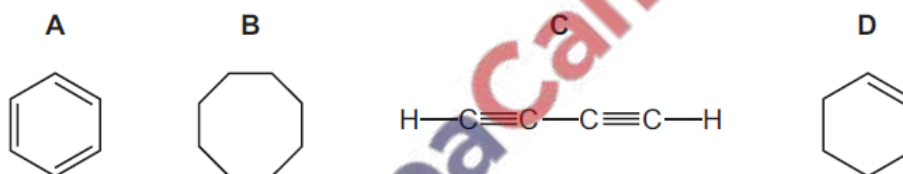
Analysis of the hormone thyroxine gives the results shown.

Heating 0.500 g of thyroxine with aqueous silver nitrate produces 0.604 g of silver iodide. All of the iodine in the thyroxine sample is converted to silver iodide.

Complete combustion of 0.500 g of thyroxine produces $232 \, cm^3$ of carbon dioxide and $7.72 \, cm^3$ of nitrogen, measured under room conditions.

Which molecular formula of thyroxine agrees with these values?

A $C_{15}H_{11}NO_4I_4$ $M_r = 776.6$

B $C_{15}H_7NO_4I_8$ $M_r = 1280.2$

C $C_{30}H_{25}NO_6I_4$ $M_r = 1002.6$

D $C_{30}H_{21}NO_6I_8$ $M_r = 1506.2$

9. June/2022/Paper_13/No.4

How many moles of oxygen, O_2, are needed to burn 1 mol of ethane if the products of the reaction are water and carbon only?

A 1.5 **B** 3 **C** 3.5 **D** 5

10. June/2022/Paper_13/No.8

A student reacts 1 mol of magnesium powder in a sealed $0.030 \, m^3$ container of oxygen at a pressure of $2.0 \times 10^5 \, Pa$ and a temperature of 600 K. The magnesium reacts completely to form MgO.

Which percentage of the oxygen will be used up?

A 5.0% **B** 10% **C** 42% **D** 83%

11. June/2022/Paper_21/No.4(a)

Compound **V** is a liquid.

V contains 77.2% carbon, 11.4% hydrogen and 11.4% oxygen by mass.

V has a relative molecular mass of 280.

(a) Calculate the molecular formula of **V**. Show your working.

molecular formula of **V** = ... [3]

3

(e) An isotope of copper has a relative isotopic mass of 65.

Complete Table 1.2 for an atom of copper-65.

Table 1.2

	atomic number	nucleon number	number of neutrons	electronic arrangement
copper-65				

[3]

(f) (i) The element copper has a relative atomic mass of 63.5.

Calculate how many atoms are present in 1.05 g of copper.

atoms of copper present = ... [1]

(ii) Copper has a melting point of 1085 °C and a high electrical conductivity.

Explain these properties of copper by referring to its structure and bonding.

....

....

.... [2]