School	*Candidate's Name (PLEASE PRINT)*

WINCHESTER
COLLEGE

Election

2021

Science

CHEMISTRY

THEORY SECTION

Time allowed: 25 minutes

Write all your answers in the spaces on this question paper

1 At room temperature and pressure (r.t.p.), the effective volume of a single gaseous molecule of any type is $3.99 \times 10^{-20}\,cm^3$ (3 sig. fig.) REGARDLESS of the identity of the molecule. If the temperature changes, the factor change in volume is also identical for all types of gaseous molecule.

(a) Compare the number of molecules in $10\,cm^3$ of gaseous methane, CH_4, at r.t.p. with the number of molecules in $10\,cm^3$ of gaseous oxygen, at the same temperature and pressure.

……..……..……

……..……..…… [1]

(b) Give the chemical formula of oxygen gas.

……..……..…… [1]

(c) Name the two products formed when methane is combusted in an excess of oxygen.

1 ……..……..……..…...……

2 ……..……..……..…… [1]

Methane is the first and simplest member of a 'family' of hydrocarbon molecules known as the alkanes. The third and fifth members of the series are propane, C_3H_8, and pentane, C_5H_{12}. As a 'family' the alkanes all combust in excess oxygen to give the same two products as methane does.

(d) Suggest a chemical formula for the nth member of the family, i.e. given an alkane with formula C_nH_w; state the value of w in terms of n.

……..……..……

……..……..…… [1]

(e) The relative atomic masses of carbon and hydrogen are 12 and 1 respectively. What is the formula of the fourth member of the alkane family, C_4H_z i.e. what is the value of z? What percentage of the total relative mass of this alkane is due to just carbon? Give your answer to 1 decimal place.

……

…… [2]

(f) A different alkane, C_xH_y, was found to be 84.21% carbon by mass. Showing your working, determine the formula of the alkane.

……

……

……

…… [2]

(g) A fundamental principle of chemical reactions is that matter is conserved. Write balanced symbol equations for the combustion of propane and pentane in excess oxygen; that is equations which have equal numbers of each type of atom on both sides of the equation.

example: sodium hydroxide + sulfuric acid → sodium sulfate + water
is **$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$** as a balanced symbol equation
with 2Na, 6O, 4H and 1S on each side of the equation.

propane + oxygen: ……

pentane + oxygen: …… [4]

(h) Why is incomplete combustion of pentane more likely to occur than incomplete combustion of propane?

……

…… [1]

10 cm^3 of propane is completely combusted in oxygen:

(i) (i) What is the minimum volume of oxygen required to combust 10 cm^3 of propane completely?

……..…..……...…… [1]

(ii) The reaction needed cooling to return to r.t.p., i.e. the chemical reaction had given out heat energy. What word is used to describe chemical reactions that give out heat energy?

……...…….…..……...… [1]

(iii) After cooling the reaction back to r.t.p. what is the total change in gas volume, $V_{products} - V_{reactants}$?

……...…..…….……..…

……....……...…… [2]

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2 A molecule of methane is formed by 'bonding' one carbon atom to four hydrogen atoms. The bonds can be represented by lines as in Fig. 1 below. When carbon atoms bond to other atoms there are ALWAYS four bonds around each carbon atom. When hydrogen atoms bond to other atoms there is ALWAYS only one bond per hydrogen atom.

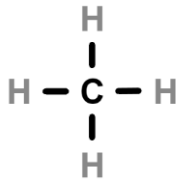

Fig. 1

(a) Draw the atoms and bonds in a molecule of propane.

[1]

(b) The overall formula C_5H_{12} can be achieved by more than one arrangement of atoms and bonds. Draw all the possible structures.

[3]

3 Zamak 2 is an alloy (mixture of) zinc, aluminium, and copper. It has formula $ZnAl_4Cu_3$.

(a) Which of the three metals in Zamak 2 is most reactive?

……...……...…… [1]

(b) **Excess** samples of these three metals are placed in separate test tubes of dilute sulfuric acid. Which will **not** react?

……...……...…… [1]

(c) The three metals are added to the two test tubes that showed sign of reaction in (b). Give the **word** equation for the **one** reaction that occurs in one of these two tubes.

……...……...…… [2]

End of this paper