11.2 Alkanes

Set A **Answer key**

A From the lesson

13 MARKS

1

2,3-dimethylbutane [1]

2

$x = 30 \div 10 = 3$ [1]

$x + \frac{y}{4} = 50 \div 10 = 5$, so $y = 8$ [1]

$\mathbf{C_3H_8}$, propane [1]

3 **(a)**

6 primary : 2 secondary H = **3 : 1** [1]

(b)

9 primary : 1 tertiary H = **9 : 1** [1]

4

Pentane has a larger surface area of contact, so stronger instantaneous dipole–induced dipole interactions [1]

more energy is needed to overcome them. [1]

5

$Br\bullet + CH_4 \rightarrow \bullet CH_3 + HBr$ [1]

$\bullet CH_3 + Br_2 \rightarrow CH_3Br + Br\bullet$ [1]

6

Limited halogen (excess alkane). [1]

7

Energy released forming permanent dipole–induced dipole interactions is insufficient to overcome the instantaneous dipole–induced dipole interactions between alkane molecules [1]

and the hydrogen bonds between water molecules. [1]

B Practice

18 MARKS

8

D 3 : 2 : 1 [1]

By probability, there are 6 possible (1°) hydrogen atoms for substitution that lead to 1-bromopentane, 4 possible (2°) hydrogen atoms that lead to 2-bromopentane, and 2 possible (2°) hydrogen atoms that lead to 3-bromopentane.

9 **B** 1 < 3 < 4 < 2 [1]

The intermolecular forces between alkane molecules are instantaneous dipole–induced dipole interactions. The weaker or less extensive the intermolecular forces between the alkane molecules, the lower the boiling point.

Alkane 1 has the smallest electron cloud (34 electrons, against 42 for the rest), so the weakest instantaneous dipole–induced dipole interactions. Alkane 1 has the lowest boiling point.

Among alkanes 2 to 4, alkane 2 is the only straight-chained molecule and so has the most extensive instantaneous dipole–induced dipole interactions. Alkane 3 is more branched than alkane 4, so it has the least extensive instantaneous dipole–induced dipole interactions of the three. The boiling points increase as 3 < 4 < 2.

10 **(a)** 2,2-dimethylbutane [1]

(b) 2,3-dimethylpentane [1]

11 Boiling point: (e) < (d) < (c) < (a) < (b), i.e. 2-methylpentane (60 °C) < hexane (69 °C) < 3,3-dimethylpentane (86 °C) < 2-methylhexane (91 °C) < heptane (98 °C) [1]

(c), (a) and (b) have higher boiling points than (e) and (d) because of their larger molecular size (7 C against 6 C). Their electron clouds are larger and more easily polarised, so the intermolecular instantaneous dipole–induced dipole interactions (instantaneous dipole–induced dipole interactions) are more extensive. Since boiling involves overcoming intermolecular forces, the boiling points of (c), (a) and (b) are higher. [1]

For (c), (a) and (b) (same number of C atoms), the degree of branching decreases from (c) to (a) to (b), so there is a greater surface area of contact between molecules, more extensive instantaneous dipole–induced dipole interactions and hence a higher boiling point from (c) to (a) to (b). [1]

Likewise, the degree of branching decreases from (e) to (d), so there is a greater surface area of contact between molecules of (d), more extensive instantaneous dipole–induced dipole interactions and hence a higher boiling point for (d) than (e). [1]

12 $C_xH_y + (x + \frac{y}{4})O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O(l)$. Volumes / cm^3: C_xH_y 30, O_2 (340 − 100) = 240, CO_2 (250 − 100) = 150. Mole ratio 1 : 8 : 5

1 mol of C_xH_y produces x mol of CO_2, hence x = 5. Also, $(x + \frac{y}{4}) = 8$, so y = 12. [1]

The alkane is C_5H_{12}. M_r = **72.0** [1]

There are 3 isomers: $CH_3CH_2CH_2CH_2CH_3$ pentane, $CH_3CH(CH_3)CH_2CH_3$ 2-methylbutane, $C(CH_3)_4$ 2,2-dimethylpropane [1]

13 **(a)**

Name of mechanism: free radical substitution.

Initiation: 

[1]

Propagation: 



[1]

Termination: 



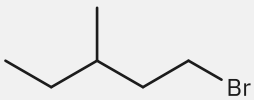
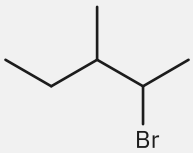
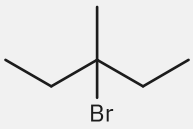
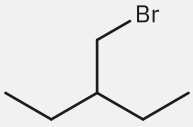


[1]

(b)

In free radical substitution, the first step (initiation) involves the homolytic fission of the X–X bond. The Br–Br bond is longer and weaker than Cl–Cl, and hence its bond energy is lower. Thus, light of a lower energy is sufficient to break the bond to form the free radicals. [1]

(c)

structure	relative proportion
 compound X	6
	4
	1
	3

Three structures with their proportions [3]