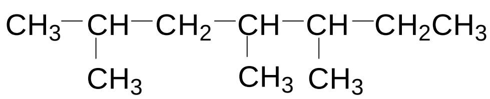
Raffles Institution
Year 5 H2 Chemistry 2024

Tutorial 10: Hydrocarbons – Alkanes (Suggested Answers)

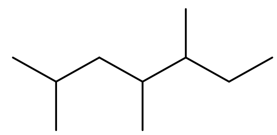
Self-Check Questions – Suggested Answers

1 **(a)** **(i)** 3,3-diethyl-4-methylheptane
(ii) 4-ethyl-2,2,3,6-tetramethyloctane
(iii) 3-ethyl-2,7-dimethyloctane
(iv) 2,2,5-trimethylheptane
(v) 3,3,4-triethylhexane

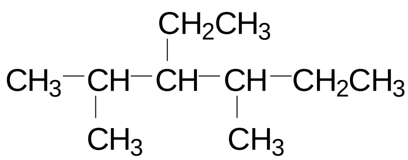
(b) **(i)** 2,4,5-trimethylheptane



or



(ii) 3-ethyl-2,4-dimethylhexane



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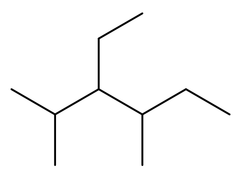


2 The given compounds have **simple molecular structures** and can be arranged in the following order of increasing boiling point:

2-methylpentane < hexane < 3,3-dimethylpentane < 2-methylhexane < heptane

i.e. (e) < (d) < (c) < (a) < (b)

Comparing (c), (a) and (b) vs (e) and (d)

- (c), (a) and (b) are seven-carbon alkanes while (e) and (d) are six-carbon alkanes. (c), (a) and (b) have more electrons per molecule and hence, larger and more polarisable electron clouds than (e) and (d). Hence, the instantaneous dipole-induced dipole interactions in (c), (a) and (b) are stronger and more heat is required for boiling these alkanes, resulting in them having a higher boiling point than (e) and (d).

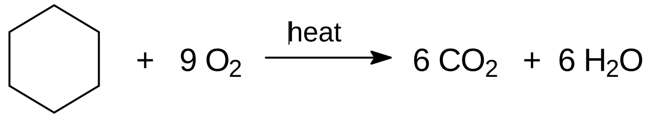
Comparing (c), (a) and (b)

- the degree of branching decreases from (c) to (a) to (b)
- there is increasing surface area of contact between molecules from (c) to (a) to (b)
- strength of instantaneous dipole-induced dipole interactions increases from (c) to (a) to (b)
- higher boiling point from (c) to (a) to (b)

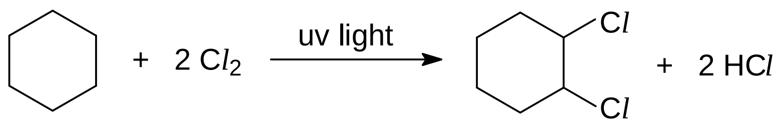
Comparing (e) and (d)

- the degree of branching decreases from (e) to (d),
- there is greater surface area of contact between molecules of (d),
- hence stronger instantaneous dipole-induced dipole interactions in (d)
- higher boiling point for (d)

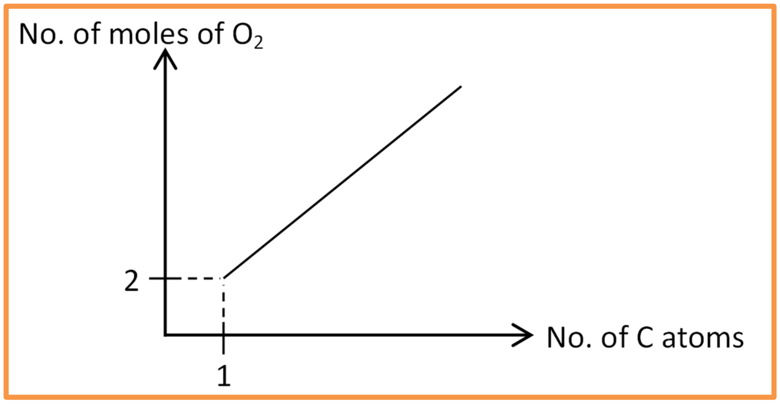
3 Reaction (1): **Combustion**



Reaction (2): **Free-radical substitution**



4 $C_nH_{2n+2} + \frac{3n+1}{2} O_2(g) \longrightarrow n\ CO_2(g) + (n+1)\ H_2O(l)$



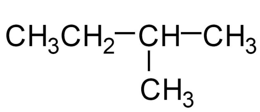
5(a) Volume of unreacted O_2 and CO_2 = 250 cm^3
Volume of unreacted O_2 = volume of residual gas (after shaking with NaOH) = 100 cm^3
Volume of CO_2 produced = 250 – 100 = 150 cm^3

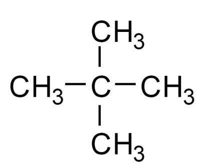
	C_xH_y		$+ (x + y/4)O_2(g)$	$\rightarrow$	$xCO_2(g)$	$+ y/2\ H_2O\ (l)$
volume used/cm^3	30		340		-	-
volume reacted/cm^3	30		(340 -100) =240		(250 -100) =150	
volume ratio	1	:	8	:	5	
molar ratio	1	:	8	:	5	
molar ratio	1	:	(x + y/4)	:	x	

From the table, **x = 5**
And (x + y/4) = 8 ⇒ **y = 12**
Hence, the molecular formula of the hydrocarbon is **C_5H_{12}**.

5(b)
- Possible isomers of the alkane:

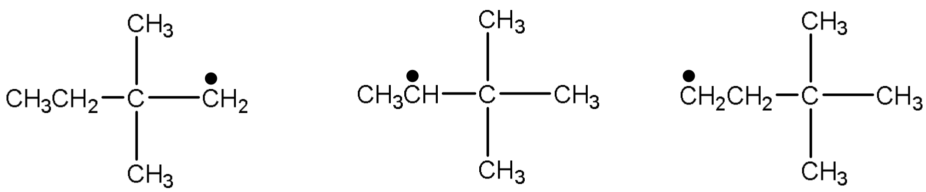
$CH_3CH_2CH_2CH_2CH_3$
pentane


2-methylbutane

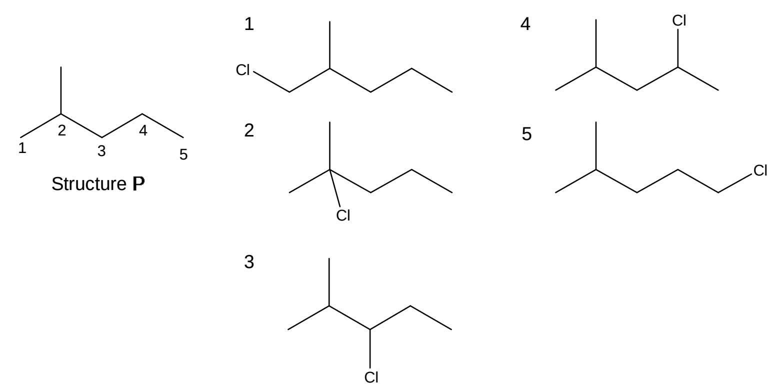

2,2-dimethylpropane

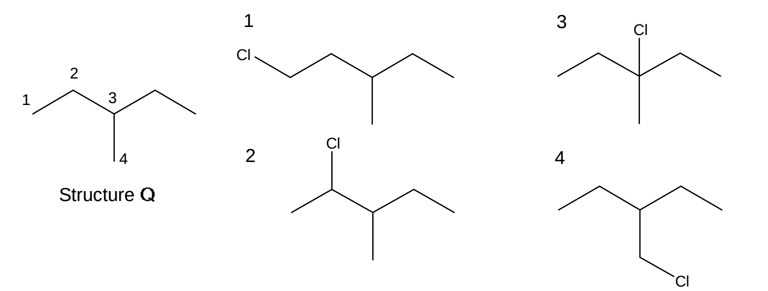
6 Answer : C

Possible answers:



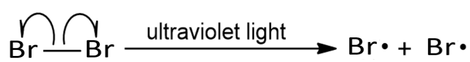
7 Answer : B





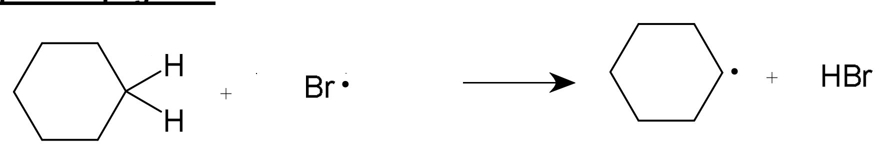
8 The mechanism is **free-radical substitution** which consists of the following steps:

Step 1: Initiation

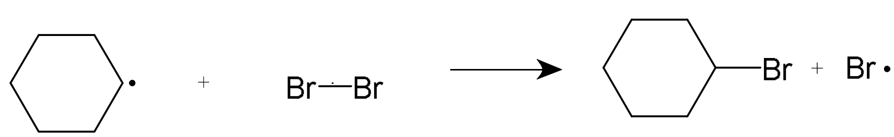


Step 2: Propagation

(a)

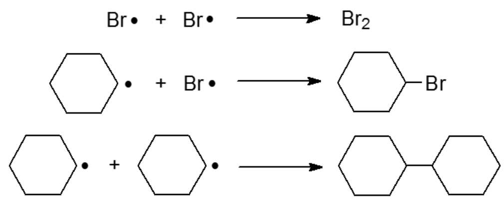


(b)



Then **(a), (b), (a), (b), ……**

Step 3: Termination



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