

Hydrocarbons and Naming Alkanes

Answer key with worked solutions

A. Understanding

1. Definitions.

(a) A compound of **carbon and hydrogen only**. (b) Containing **only single C-C bonds**, so each carbon holds the maximum number of hydrogen atoms (alkanes). (c) A family of compounds with the **same general formula** and similar chemistry, each member differing from the next by CH_2 .

B. Formulas

2. Molecular formulas.

(a) C_6H_{14} (b) $\text{C}_{10}\text{H}_{22}$ (c) C_4H_8 (d) C_3H_4 (e) $2n + 2 = 20$, so $n = 9$: C_9H_{20}

C. Naming

3. Names.

(a) **butane** (b) **2-methylpropane** (c) **2-methylpentane** (d) **2,2-dimethylbutane** (e) **2,3-dimethylbutane** (f) **3-ethylpentane**

4. Condensed formulas.

(a) $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{CH}_3$ (b) $(\text{CH}_3)_3\text{CCH}_2\text{CH}(\text{CH}_3)_2$ (c) $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}(\text{C}_2\text{H}_5)\text{CH}_2\text{CH}_3$ (d) $\text{CH}_3\text{CH}=\text{CHCH}_3$

5. Corrected names.

(a) **pentane**: a methyl on carbon 1 just extends the chain (longest chain missed). (b) **2-methylbutane**: the ethyl group is part of a longer chain (longest chain missed). (c) **2-methylbutane**: numbered from the wrong end (lowest locants). (d) **2,2-dimethylbutane**: numbered from the wrong end.

D. Isomers and alkenes

6. Isomers of C_6H_{14} .

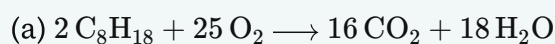
hexane $CH_3CH_2CH_2CH_2CH_2CH_3$; **2-methylpentane** $CH_3CH(CH_3)CH_2CH_2CH_3$; **3-methylpentane** $CH_3CH_2CH(CH_3)CH_2CH_3$; **2,2-dimethylbutane** $CH_3C(CH_3)_2CH_2CH_3$; **2,3-dimethylbutane** $CH_3CH(CH_3)CH(CH_3)CH_3$

7. Alkenes.

(a) **but-1-ene**, **but-2-ene**, **pent-1-ene**. (b) The chain must be numbered so the double bond gets the lowest locant; numbered from the other end, “but-3-ene” is **but-1-ene**.

E. Combustion

8. Burning octane.



(b) $n(C_8H_{18}) = \frac{100.0 \text{ g}}{114.22 \text{ g/mol}} = 0.8755 \text{ mol}$

$$n(CO_2) = 0.8755 \text{ mol } C_8H_{18} \times \frac{16 \text{ mol } CO_2}{2 \text{ mol } C_8H_{18}} = 7.004 \text{ mol}$$

$$m(CO_2) = 7.004 \text{ mol} \times 44.01 \text{ g/mol} = \mathbf{308.2 \text{ g}}$$

F. Challenge

9. Formula from combustion data.

(a) All the C ends up in CO_2 and all the H in H_2O :

$$n(C) = n(CO_2) = \frac{2.641 \text{ g}}{44.01 \text{ g/mol}} = 0.06001 \text{ mol}$$

$$n(H_2O) = \frac{1.351 \text{ g}}{18.02 \text{ g/mol}} = 0.07497 \text{ mol, so } n(H) = 2 \times 0.07497 \text{ mol} = 0.1499 \text{ mol}$$

Ratio H : C = 0.1499 mol : 0.06001 mol = 2.498 : 1 $\approx$ 2.5 : 1 = 5 : 2, so the empirical formula is C_2H_5 (29.06 g/mol).

$$\frac{58.1 \text{ g/mol}}{29.06 \text{ g/mol}} = 2.00, \text{ so the molecular formula is } C_4H_{10}.$$

(b) **butane** and **2-methylpropane**.