

Answers to Unit 5 Review: Hydrocarbons

Acetylene: the common name for ethyne (C_2H_2).

Acyclic: an organic molecule that does not contain a cyclic structure.

Addition Reaction: A reaction in which a multiple bond is broken and new atoms are added to the carbons on either side of the multiple bond.

Aliphatic: a hydrocarbon that does not contain benzene.

Alkane: a hydrocarbon with only single bonds.

Alkene: a hydrocarbon that has a double bond.

Alkyne: a hydrocarbon that contains a triple bond.

Aromatic: a molecule that contains benzene.

Bond energy: the energy needed to break a bond (or the energy released when a bond forms).

Calorimeter: a device used to measure energy changes. A bomb calorimeter is a common type of calorimeter (consisting of a chamber, water, ignition wires, thermometer, stirrer, etc.).

Cyclic: where atoms are bonded together in a circular or ring shape.

Endothermic: a reaction in which energy is absorbed (thus, cooling the surroundings).

Exothermic: a reaction in which energy is released (thus, heating the surroundings).

Fractionation: (a.k.a. fractional distillation) where petroleum is refined. The petroleum is heated and molecules of similar sizes are extracted by cooling the vapour at a range of temperatures.

Monomer: the smallest repeating unit of a polymer.

Organic chemistry: The study of carbon containing compounds with the exception of CO , CO_2 , and ionic compounds that contain carbon.

Petroleum: a mixture of organic molecules (mainly hydrocarbons) that is obtained via drilling.

Polymer: a long molecule made up of many small, identical, repeating units.

Saturated hydrocarbon: a hydrocarbon that does not have any double or triple bonds.

Unsaturated hydrocarbon: a hydrocarbon that has double and/or triple bonds.

Wöhler: he was the first person to synthesize an organic compound, showing that organic compounds are independent of life.

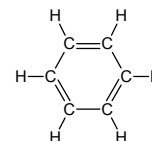
2. a) Alkanes: C_nH_{2n+2}

b) Alkenes: C_nH_{2n}

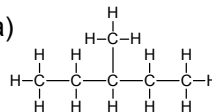
c) Alkynes: C_nH_{2n-2}

d) Cycloalkanes: C_nH_{2n}

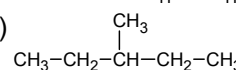
3.



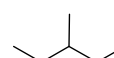
4. a)



b)



c)



5. a) $2C_6H_{14} + 19O_2 \rightarrow 14H_2O + 12CO_2$
(5a has only 1 solution - a ratio of 2:19:14:12)

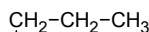
b) $C_6H_{14} + 8O_2 \rightarrow 7H_2O + 3CO_2 + 3CO$

$C_6H_{14} + 5O_2 \rightarrow 7H_2O + 3CO + 3C$

(there are many other possibilities for 5b)

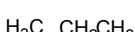
6. a) $CH_3-CH(CH_3)-CH_2-CH_3$

b)

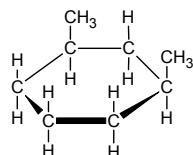


$CH_3-CH_2-CH=C-CH_2-CH_2-CH_3$

c)



d)



e) 2,5,5-trimethylheptane

f) 3-methylcyclohexene

7. a) not isomers - cyclopentane is C_5H_{10} , pentane is C_5H_{12}

b) structural isomers – same chemical formula, different IUPAC names

c) geometric isomers – same formula and same name (except for cis/trans)

7. d) structural isomers – same formula but different IUPAC names (1,2... vs 1,3...)

e) geometric isomers –

cis-1-bromo-2-chloroethene versus

trans-1-bromo-2-chloroethene

f) not isomers – they are the same molecule

8. Add Br_2 to each. Ethane will not react, ethene will discolour Br_2 (orange to colourless), a mole of ethyne will discolour twice as much Br_2 as a mole of ethene.

9. a) $H_2C=CH_2 + Br-Br \rightarrow H_2C(Br)-CH_2(Br)$

b) $H-C\equiv C-H + Br-Br + Br-Br \rightarrow H-C(Br)(Br)-C(Br)(Br)-H$

| 9. a) | Bond | kJ/mol | # | required | # | released |
|-------|------------------------|--------|---|----------|---|----------|
| | C-H | 413 | 4 | 1652 | 4 | 1652 |
| | C=C | 614 | 1 | 614 | | |
| | Br-Br | 193 | 1 | 193 | | |
| | C-Br | 288 | | | 2 | 576 |
| | C-C | 348 | | | 1 | 348 |
| | 117 kJ released | | | 2459 | | 2576 |

| 9. b) | Bond | kJ/mol | # | required | # | released |
|-------|------------------------|--------|---|----------|---|----------|
| | C-H | 413 | 2 | 826 | 2 | 826 |
| | $C\equiv C$ | 839 | 1 | 839 | | |
| | Br-Br | 193 | 2 | 386 | | |
| | C-Br | 288 | | | 4 | 1152 |
| | C-C | 348 | | | 1 | 348 |
| | 275 kJ released | | | 2051 | | 2326 |

10. See "energy from hydrocarbons" handout

11. $q = cm\Delta T$ $c = q/m\Delta T = \frac{3.0 J}{0.16 g \times 78^\circ C} = 0.24 J/(g^\circ C)$

The metal is silver. Silver is $0.24 J/(g^\circ C)$ -pg. 568

12. a) $q = cm\Delta T = 4.18 J/(g^\circ C) \times 350 g \times 1.5^\circ C = 2.19 kJ$

b) butane = $C_4H_{10} = 58.14 g/mol$

mol = $50.0 g \times (1 mol)/(58.14 g) = 0.86 mol$

Molar heat of reaction has units of kJ/mol,
= $2.19 kJ/0.86 mol = 2.55 kJ/mol$

13. a) should be 2-methyl-3-hexyne

b) too many bonds on carbon #3

c) should include either cis or trans in name

d) no # for ene (e.g. 3-methyl-1-octene?)

e) should be 3,3-dimethylheptane

f) should be 4-ethyl-2,3-dimethylnonane