Chapter 14 – Answers to end of chapter questions

1  a  Hexane
   b  4-Ethyl-2-methylhexane
   c  Cycloheptane
   d  Hexane
   e  Methylcyclopropane
   f  Ethylcyclopentane

2  a  A  diesel oil
     B  gasoline
     C  gasoline
     D  gasoline
     E  refinery gas
   b  C and D
   c  C and E
   d  E B D C A
   e  A
   f  B

3  i

![Image of compound i with structure C_{8}H_{16}]

ii

![Image of compound ii with structure C_{7}H_{14}]

iii

![Image of compound iii with structure C_{13}H_{28}]

iv

![Image of compound iv with structure C_{13}H_{28}]
4  

b  Yes

c  661 kJ mol⁻¹

d  —CH₂—

e  Molecules contain the same numbers of C and H atoms – therefore the same numbers of bonds are broken and made.

f  butane: \(-\frac{2877}{58} = -49.6\) kJ g⁻¹
pentane: \(-\frac{3509}{72} = -48.7\) kJ g⁻¹
hexane: \(-\frac{4195}{86} = -48.8\) kJ g⁻¹

The values are very similar.

5  

a  There are no polar bonds in nonane, so there are no centres of electrical charge to act as electrophiles or nucleophiles and attract species that are normally reactive such as OH⁻ and H⁺.

b  \(\text{C}_9\text{H}_{20} + 14 \text{O}_2 \rightarrow 9 \text{CO}_2 + 10 \text{H}_2\text{O}\)

c  Formula mass of nonane:
\((9 \times 12) + (20 \times 1) = 128\)

Formula mass of carbon dioxide:
\((1 \times 12) + (2 \times 16) = 44\)

d  Burning 1 mol of nonane releases 9 moles of CO₂

Burning 128 g of nonane releases \((9 \times 44) = 396\) g of CO₂

Burning 1 kg of nonane releases \(396 \times (1000 \text{ g ÷ 128 g}) = 3094\) g = 3.094 kg

e  44 g of carbon dioxide occupies 24 dm³

3094 g of carbon dioxide occupies \(24 \text{ dm}^3 \times (3094 \text{ g ÷ 44 g}) = 1688\) dm³
6  a  CH₃.CH.CH₃.CH₂.CH₂.CH₂.CH₃.

b  

c  

7  a  HBr

b  C₆H₁₄ + Br₂ → C₆H₁₃Br + HBr

c  Sunlight is required to initiate the reaction by breaking the Br—Br bond.

d  Br₂ → Br⁺ + Br⁺  

    C₆H₁₄ + Br⁺ → C₆H₁₃⁺ + HBr  

    C₆H₁₃⁺ + Br₂ → C₆H₁₂Br + Br⁺  

    C₆H₁₃⁺ + C₆H₁₃⁺ → C₁₂H₂₆  

    Br⁺ + Br⁺ → Br₂  

    C₁₂H₂₆⁺ + Br⁻ → C₁₂H₁₃Br  

8  

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9  a  Cl₂ + C₆H₁₄ → C₆H₁₃Cl + HCl
   b  No reaction
   c  No reaction
   d  No reaction
   e  No reaction
   f  Cracking, e.g. C₆H₁₄ → C₂H₄ + C₄H₁₀

10  a  C₁₀H₂₂
   b  Any three formulae showing C and H atoms joined by single bonds, with or without branching.
   c  Cracking is carried out to provide extra gasoline and to provide alkenes. Alkenes are used by the petrochemical industry as starting materials to synthesise larger organic molecules.
   d  The reactions occur at lower temperatures in the presence of a catalyst, so reducing the energy required and the costs incurred.

11  Modifications: larger, pressurised storage tank; modified system for mixing fuel with air
   Advantages: burns more efficiently – less C produced in the engine, less CO in the exhaust.

12  a  Reaction with an alkali – sodium hydroxide, or calcium hydroxide
   b  Cooling the mixture – ethane liquefies at –100°C
   c  Fuel
   d  Nitrogen is unreactive.
   e  C₂H₆ → C₂H₄ + H₂
      High temperature, catalyst
   f  Naphtha is more available than natural gas in Europe.