Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- C_nH_{2n}
- propene

2.2

- refinery gases: bottled gas for heating and cooking
- bitumen: surfacing roads and roofs

2.3

- add bromine water and shake
- hexene turns it from orange to colourless; with hexane it stays orange

2.4

- $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

3.1

- crude oil is heated until most of it turns to vapour
- the column is hot at the bottom and cooler at the top
- each fraction condenses at a different height, depending on its boiling point

3.2

- $C_{10}H_{22} \rightarrow C_8H_{18} + C_2H_4$
- there is more demand for short-chain fractions such as petrol than there is supply
- the alkenes made are used to make polymers

3.3

(a) $2CH_4 + 3O_2 \rightarrow 2CO + 4H_2O$; carbon monoxide joins to haemoglobin, so the blood carries less oxygen

(b) sulfur impurities in the fuel react with oxygen to form sulfur dioxide; at the high temperature of burning, nitrogen and oxygen from the air react to form nitrogen oxides; these gases dissolve in rain water to form acids (sulfuric and nitric acid) that fall as acid rain

(c) moles octane $= 57 \div 114 = 0.50$; moles $CO_2 = 0.50 \times 8 = 4.0$; $4.0 \times 44 =$ **176** g

(d) points to include:

- both release carbon dioxide, a greenhouse gas linked to climate change (K)
- coal contains more carbon per unit of energy, so it releases more carbon dioxide (An)
- coal contains sulfur, so it releases sulfur dioxide and causes acid rain; natural gas has almost none (An)
- coal releases soot (particulates), which harm lungs; methane burns cleanly with enough air (An)
- both make nitrogen oxides at high temperature (K)
- conclusion: natural gas pollutes less, but both are non-renewable (An)

Levels: **5–6** a full, logical answer with correct chemistry and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.