

**1(a).** The first member of the alkane homologous series is methane,  $\text{CH}_4$ .

State the formula of the alkane with 10 carbon atoms.

.....**[1]**

**(b).** Write the **balanced symbol** equation for the **complete** combustion of methane.

.....**[2]**

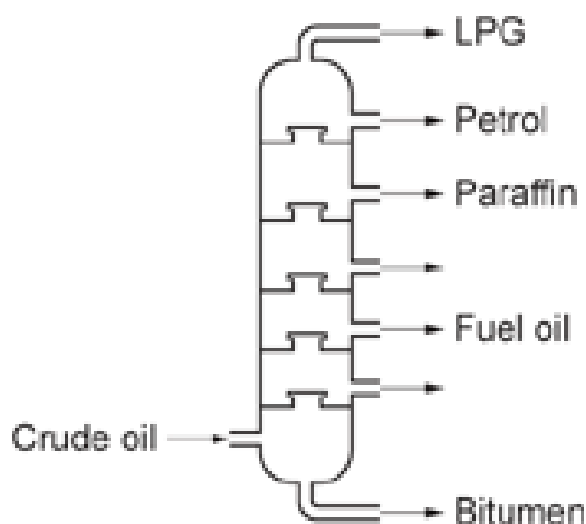
**(c).** Methane can undergo **incomplete** combustion.

Carbon monoxide and water are made in incomplete combustion.

State **one** other possible product of the incomplete combustion of methane.

.....**[1]**

**(d).** Alkanes are obtained from the fractional distillation of crude oil.



The LPG fraction contains propane and butane.

Explain why the LPG fraction leaves at the **top** of the fractionating column.  
Use ideas about intermolecular forces.

.....**[4]**

(e). Which industry is crude oil a feedstock for?

[1]

(f). Draw lines to connect each **description** with its correct **structural formula**.

Description	Structural Formula
Made by an addition reaction between an alkene and hydrogen, $H_2$	
Made when propanol is oxidised	
Made when propene reacts with bromine water	
Made in a condensation polymerisation reaction	

[4]

2. Which equation shows the reaction at the **anode** in a hydrogen/oxygen fuel cell?

- A**  $H_2(g) \rightarrow 2H^+(aq) + 2e^-$   
**B**  $4H^+(aq) + O_2(g) + 4e^- \rightarrow 2H_2O(g)$   
**C**  $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$   
**D**  $O_2(g) + 4e^- \rightarrow 2O^{2-}(g)$

Your answer

[1]

3. The polymer nylon can be made from hexanedioyl dichloride,  $\text{ClOC}(\text{CH}_2)_4\text{COC}\text{Cl}$ , and hexane-1,6-diamine,  $\text{NH}_2(\text{CH}_2)_6\text{NH}_2$ .

Which small molecule is made as well as nylon?

- A  $\text{HCl}$
- B  $\text{H}_2$
- C  $\text{H}_2\text{O}$
- D  $\text{NH}_3$

Your answer

☐

[1]

4. Which of these is one of the four nucleotides in the polymer DNA?

- A Cytosine
- B Deoxyribose
- C Fructose
- D Phosphate

Your answer

☐

[1]

5. Polyesters are condensation polymers.

Which monomers are polyesters made from?

- A A carboxylic acid and an ester
- B An alcohol and a carboxylic acid
- C An alcohol and an amine
- D An amine and a carboxylic acid

Your answer

☐

[1]

**6(a).** Methanoic acid is a carboxylic acid.

Carboxylic acids react with alcohols to form an ester and one other product.

- i. What type of reaction is this?

Tick (✓) **one** box.

Addition

☐

Condensation

☐

Decomposition

☐

Neutralisation

☐

[1]

- ii. State the name of the other product in this type of reaction.

..... [1]

**(b).**

- i. Draw the structural formula of methanol,  $\text{CH}_3\text{OH}$ .

[2]

- ii. State the **functional group** in methanol.

..... [1]

**(c).** Methanol can be oxidised to methanoic acid.

State the **oxidising agent** used in this reaction.

..... [1]

### Table 20.1

Alkane	Energy given out (kJ)
butane	49.2
ethane	52.6
methane	55.6
propane	50.4

[1]

**Table 20.2** shows some information about four other molecules that are found in four different fractions.

### Table 20.2

Molecule	Formula	Boiling point (°C)
heptadecane	C <sub>17</sub> H <sub>36</sub>	302
eicosane	C <sub>20</sub> H <sub>42</sub>	342
tetracosane	C <sub>24</sub> H <sub>50</sub>	
octacosane	C <sub>28</sub> H <sub>58</sub>	436

- i. Predict the boiling point of tetracosane.

Boiling point of tetracosane = ..... °C [1]

- ii. Octacosane is separated lower down the fractionating column than the other three molecules in **Table 20.2**.

\_\_\_\_\_

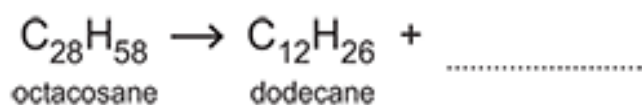
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\_\_\_\_\_

(c). Cracking breaks down large molecules produced in fractional distillation into more useful molecules.

The equation shows the cracking of octacosane to make dodecane and **one** other product.

Complete and balance the equation.



[2]

(d). **Table 20.3** shows the percentage supply and demand for some of the different fractions obtained from crude oil.

**Table 20.3**

Fraction	Percentage supply (%)	Percentage demand (%)
LPG	2	4
petrol	5	23
naphtha	8	5
kerosene	12	7
diesel oil	17	23
fuel oil	56	38

More petrol can be obtained by cracking another fraction.

Suggest and explain which fraction is cracked to obtain petrol.

Fraction

.....

Reason

.....

[2]

(e). Butane,  $\text{C}_4\text{H}_{10}$ , is an alkane.

Butane undergoes complete combustion in oxygen.

Write the **balanced symbol** equation for the complete combustion of butane.

[2]

8. What is the half equation for the reaction at the **anode** in a hydrogen/oxygen fuel cell?

- A**  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$   
**B**  $2\text{H}_2 \rightarrow 4\text{H}^+ + 4\text{e}^-$   
**C**  $4\text{H}^+ + 4\text{e}^- \rightarrow 2\text{H}_2$   
**D**  $4\text{H}^+ + \text{O}_2 + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}$

Your answer

☐

[1]

9. Ethane is a very small hydrocarbon molecule.

Which row about ethane is correct?

	Easy to ignite?	Boiling point
<b>A</b>	✓	high
<b>B</b>	X	high
<b>C</b>	✓	low
<b>D</b>	X	low

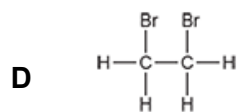
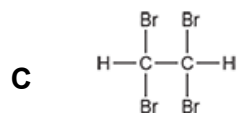
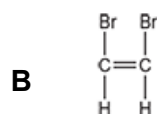
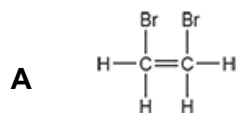
Your answer

☐

[1]

10. Ethene,  $\text{C}_2\text{H}_4$ , reacts with bromine in an addition reaction.

What is the structural formula of the product?



Your answer

☐

[1]

11. Which statement about chemical cells is correct?

- A They produce a voltage indefinitely.
- B They produce a voltage once all of the reactants are used up.
- C They produce a voltage until one of the reactants is completely used up.
- D They produce a voltage until the reactants are partly used up.

Your answer

[1]

12. Which of these homologous series can form addition polymers?

- A Alcohols and carboxylic acids
- B Alkenes and alkanes
- C Alkenes only
- D Carboxylic acids only

Your answer

[1]

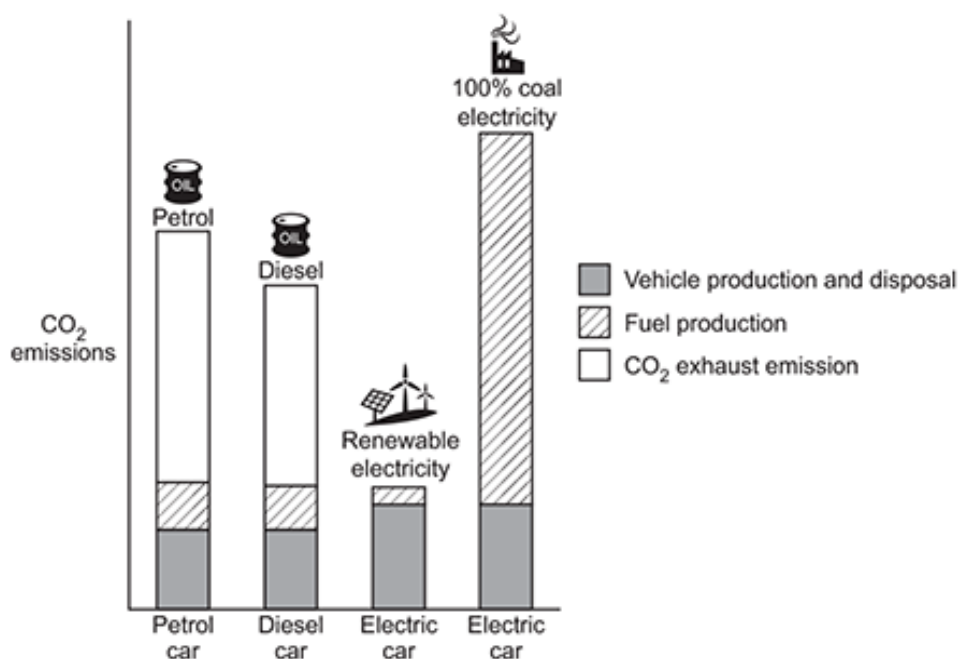
13(a). A car manufacturer is concerned about the carbon dioxide, CO<sub>2</sub>, emissions of different cars during their lifetime.

The car manufacturer does a life-cycle assessment for three types of car they are developing:

- a petrol car
- a diesel car
- an electric car.

The car manufacturer also looks at refuelling the electric car using electricity generated by 'renewable electricity' and '100% coal electricity'.

The graph shows the life-cycle assessment for the three types of car.



- i. Estimate the percentage of CO<sub>2</sub> emissions for a **diesel car** which come from **fuel production**.

Percentage of CO<sub>2</sub> emissions = ..... % **[1]**

- ii. The CO<sub>2</sub> emissions for an electric car are much greater when the car is refuelled using electricity generated by burning coal, rather than renewable electricity.

Suggest why.

..... **[2]**

- (b).** Petrol and diesel are both obtained from crude oil.

Petrol molecules are smaller than diesel molecules.

Petrol has a **lower boiling point** than diesel. Explain why.

..... **[1]**

- 14(a).** The table shows information about some compounds of carbon.

Compound	Formula
<b>A</b>	C <sub>2</sub> H <sub>4</sub>
<b>B</b>	C <sub>2</sub> H <sub>5</sub> OH
<b>C</b>	C <sub>3</sub> H <sub>7</sub> COOH
<b>D</b>	C <sub>4</sub> H <sub>10</sub>
<b>E</b>	C <sub>6</sub> H <sub>14</sub>

Compounds **D** and **E** belong to the homologous series called the **alkanes**.

What is the **general formula** of the alkanes?

..... **[1]**

(b). Which homologous series does compound **C** belong to?

Tick (✓) the correct answer.

Alcohols

☐

Alkenes

☐

Carboxylic acids

☐

Esters

☐

[1]

(c).  $C_2H_4$  burns in oxygen.

Write the **balanced symbol** equation for the **incomplete** combustion of  $C_2H_4$ .

..... [2]

(d). Compound **D** and compound **E** are obtained from crude oil by fractional distillation.

Explain how fractional distillation separates compound **D** and compound **E**.

Use ideas about intermolecular forces.

..... [3]

(e). Crude oil is being formed extremely slowly.

What term describes resources, like crude oil, that are being formed extremely slowly?

..... [1]

15. The table shows some of the advantages and disadvantages of using hydrogen/oxygen fuel cells to power vehicles.

	Advantage	Disadvantage
<b>A</b>	do not produce greenhouse gases	hydrogen fuel comes from hydrocarbons, which are fossil fuels
<b>B</b>	hydrogen fuel comes from the electrolysis of water, which uses electricity	no moving parts
<b>C</b>	hydrogen is a gas and stored in a large tank	hydrogen is explosive
<b>D</b>	only by-products are water and heat	fuel cells do not go 'flat'

Which row in the table is correct?

Your answer ☐

[1]

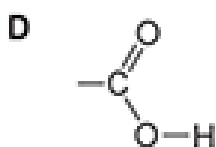
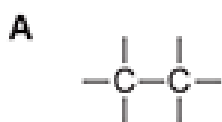
16. Which statement about polymerisation is correct?

- A Amino acid monomers make polymers called proteins by addition polymerisation.
- B DNA is a polymer made from four identical monomers called nucleotides.
- C Polyesters are condensation polymers made from monomers containing carboxylic acid and alcohol functional groups.
- D Poly(ethene) is a polymer made from ethene monomers by condensation polymerisation.

Your answer ☐

[1]

17. Which functional group does a monomer need to contain to form addition polymers?



Your answer ☐

[1]

END OF QUESTION PAPER