**1** This question is about fuels.

Octane ($C_8H_{18}$) is a hydrocarbon in petrol.

(a) Cracking breaks down large hydrocarbon molecules into smaller hydrocarbon molecules.

Which hydrocarbon molecule can be cracked to produce octane, $C_8H_{18}$?

Tick **one** box.

$C_4H_8$ ☐

$C_4H_{10}$ ☐

$C_8H_{16}$ ☐

$C_{12}H_{26}$ ☐

**(1)**

(b) What type of carbon compound is octane, $C_8H_{18}$?

Tick **one** box.

Alcohol ☐

Alkane ☐

Carboxylic acid ☐

Ester ☐

**(1)**

(c) Oxygen is needed to burn fuels.

Name the source of the oxygen needed to burn fuels.

_____

_____

**(1)**

(d) Particulates and sulfur dioxide are pollutants produced when some fuels burn.

Draw **one** line from each pollutant to the polluting effect.

| **Pollutant** | **Polluting effect** |
|---|---|
| | Acid rain |
| Particulates | Global dimming |
| | Global warming |
| Sulfur dioxide | Landfill |
| | Sewage sludge |

**(2)**

(e) Which **two** gases are produced when fuels burn in car engines?

Tick **two** boxes.

- Ammonia ☐
- Carbon dioxide ☐
- Carbon monoxide ☐
- Nitrogen ☐
- Oxygen ☐

**(2)**

(f) Vehicles produce most of the atmospheric pollution in cities.

How could the atmospheric pollution in cities be reduced?

Tick **two** boxes.

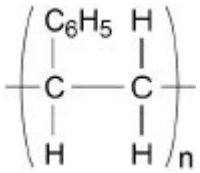
| | |
|---|---|
| Build more roads in cities | ☐ |
| Build new car factories | ☐ |
| Develop fuel efficient engines | ☐ |
| Make car tax cheaper | ☐ |
| Use electric cars | ☐ |

**(2)**

**(Total 9 marks)**

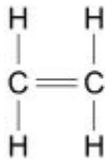
**2** Disposable cups are made from coated paper or poly(styrene).

The diagram below represents the structure of poly(styrene).



(a) Which small molecule is used to produce poly(styrene)?

Tick **one** box.



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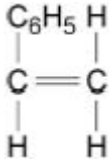

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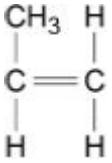

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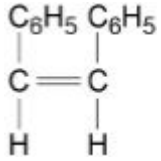


☐

**(1)**

(b) Which process is used to make poly(styrene) from small molecules?

Tick **one** box.

Cracking ☐

Distillation ☐

Fermentation ☐

Polymerisation ☐

**(1)**

(c) Complete the sentences.

Choose answers from the box.

| | | | |
|---|---|---|---|
| **ceramics** | **composites** | **four** | **many** |
| **monomers** | **polymers** | **two** | |

Poly(styrene) is produced from small molecules called _____

When poly(styrene) is made, _____styrene molecules join to form large molecules.

These large molecules are called _____ .

**(3)**

(d) The table below gives some information about disposable cups.

| | **Coated paper cups** | **Polystyrene cups** |
|---|---|---|
| Source of raw materials | Wood | Crude oil |
| Energy to make 1 cup in arbitrary units | 550 | 200 |
| Biodegradable | Yes | No |
| Recyclable | No | Yes |

Compare the advantages and disadvantages of using coated paper and poly(styrene) to make disposable cups.

Use the table above and your knowledge and understanding of life cycle assessments (LCAs).

**(4)**

**(Total 9 marks)**

**3** Methylated spirit is a useful product made from a mixture of substances.

The table below shows the mass of the substances in a sample of methylated spirit.

| **Substance** | **Mass in grams** |
|---|---|
| Ethanol | 265.5 |
| Methanol | 23.3 |
| Pyridine | 3.0 |
| Methyl violet | 1.5 |

(a) What name is given to a useful product such as methylated spirit?

**(1)**

(b) Calculate the percentage by mass of methanol in methylated spirit.

Use the table above.

Percentage = _____ %

**(2)**

Methylated spirit contains ethanol and is available cheaply.

Methylated spirit also contains:

- pyridine which has a very unpleasant smell
- methyl violet which makes the mixture purple.

(c) Suggest why pyridine and methyl violet are added to ethanol to make methylated spirit.

**(1)**

(d) Suggest **one** use of methylated spirit.

**(1)**

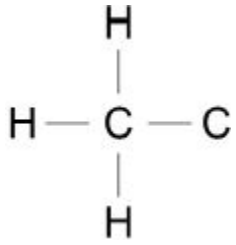
(e) Describe how ethanol is produced from sugar solution.

Give the name of this process.

**(3)**

(f) The diagram below shows part of the displayed formula for ethanol.

Complete the diagram.



**(1)**

(g) Name the gas produced when sodium is added to ethanol.

_____

**(1)**

(h) Methanol is used to produce methanoic acid.

What type of substance reacts with methanol to produce methanoic acid?

_____

**(1)**

**(Total 11 marks)**

**4** This question is about polymers.

(a) Polyesters are produced when monomers join together and lose a small molecule.

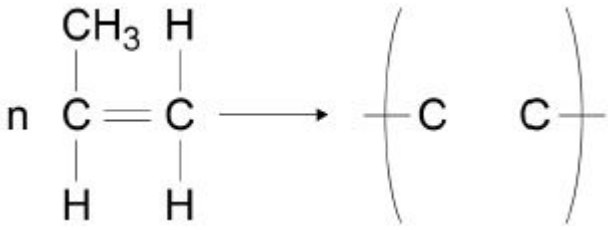
Name the small molecule lost.

_____

**(1)**

(b) Poly(propene) is produced from propene.

Complete the structure of poly(propene) in the equation.



**(3)**

(c) Carpets are made from:

- poly(propene)
- wool
- a mixture of poly(propene) and wool.

Poly(propene) wears out more slowly than wool.

A mixture of poly(propene) and wool to make carpets is more sustainable than using just poly(propene) or just wool.

Suggest why.

_____

_____

_____

_____

**(2)**

Polymer fibres are used to make firefighter uniforms.

The table below shows some properties of two polymer fibres.

| | **Polymer fibres** | |
|---|---|---|
| **Property** | **Poly(propene)** | **Polyester** |
| Density in g/cm$^3$ | 0.90 | 1.38 |
| Melting point in °C | 165 | 260 |
| Flame resistance | Poor | Good |
| Water absorption | Low | High |

(d) Evaluate the suitability of poly(propene) and polyester for firefighter uniforms.

**(4)**

**(Total 10 marks)**