Mark schemes

1 (a) Propanol

(b) Butanol has the highest boiling point

(c)

\[
\begin{array}{c}
\text{H} \\
\text{H} \quad \text{C} \quad \text{O} \quad \text{H} \\
\text{H}
\end{array}
\]

(d) Ethene + water \( \rightarrow \) ethanol

\text{allow answers in either order}

\text{allow steam for water}

(e) Goes back to reactor

\text{allow is recycled}

(f) Air contains oxygen

\text{which oxidises ethanol}

\text{allow ethanol reacted with oxygen}

\text{to produce ethanoic acid}

2 (a) \( \text{C}_3\text{H}_{12} \)

(b) Alkanes

(c) (3) \( \text{CO}_2 \)

(4) \( \text{H}_2\text{O} \)

\text{allow for 1 mark}

\( 4 \text{ CO}_2 + 3 \text{ H}_2\text{O} \)

(d) Contains hydrogen and carbon

\text{(hydrogen and carbon) only}
(e) (diesel) produces more oxides of nitrogen

*allow converse answers in terms of petrol*

produces (more) particulate matter

produces less carbon dioxide

(f)

```
<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage (%) of bottles made from other materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>5</td>
</tr>
<tr>
<td>1980</td>
<td>10</td>
</tr>
<tr>
<td>1985</td>
<td>22</td>
</tr>
<tr>
<td>1990</td>
<td>42</td>
</tr>
<tr>
<td>1995</td>
<td>70</td>
</tr>
<tr>
<td>2000</td>
<td>72</td>
</tr>
<tr>
<td>2005</td>
<td>90</td>
</tr>
<tr>
<td>2010</td>
<td>95</td>
</tr>
</tbody>
</table>
```

3 

(a) all points correct

±1 small square

*allow 1 mark for 6 or 7 plots*
(b) **Level 3 (5–6 marks):**
A detailed and coherent argument is provided which considers a range of issues and comes to a conclusion consistent with the reasoning.

**Level 2 (3–4 marks):**
An attempt to describe the advantages and disadvantages of the production and uses is made, which comes to a conclusion. The logic may be inconsistent at times but builds towards a coherent argument.

**Level 1 (1–2 marks):**
Simple statements made. The logic may be unclear and the conclusion, if present, may not be consistent with the reasoning.

**0 marks:**
No relevant content.

**Indicative content**

- glass – 2 stages in production of soda-lime glass
- glass – second stage, heating sand, limestone and sodium carbonate
- HDPE – 3 stages in production
- HDPE – second stage, cracking of naphtha to obtain ethene
- HDPE – third stage, polymerisation of ethene
- fewer stages in glass production, may be quicker
- higher temperature in glass manufacture, therefore maybe higher energy requirement
- glass bottle can be reused
- consideration of collection / cleaning costs to reuse glass bottles
- other glass products can be made from recycled glass
- plastic has greater range of sizes
- both produced from limited raw materials
- higher percentage recycled materials in glass conserves raw materials

This indicative content is not exhaustive, other creditworthy responses should be awarded marks as appropriate.

(a) \( \text{C}_6\text{H}_{14} \)

(b) A

(c) B

(d) C

(e) Propanol
(a) (ethene)

\[
\begin{array}{c}
\text{H} \\
\vdots \\
\text{C} = \text{C} \\
\text{H} \\
\end{array}
\]

\begin{array}{c}
\text{n} \\
\end{array}

(polyethene)

\[
\begin{array}{c}
\text{H} \\
\vdots \\
\text{C} = \text{C} \\
\text{H} \\
\end{array}
\]

\begin{array}{c}
\text{n} \\
\end{array}

1

(b) any four from:

- poly(ethene) produced by addition polymerisation whereas polyester by condensation polymerisation
- poly(ethene) produced from one monomer whereas polyester produced from two different monomers
- poly(ethene) produced from ethene / alkene whereas polyester from a (di)carboxylic acid and a diol / alcohol
- poly(ethene) is the only product formed whereas polyester water also produced
- poly(ethene) repeating unit is a hydrocarbon whereas polyester has an ester linkage

4

[6]

(a) water level above the start line

and

start line drawn in ink

allow water level too high

1

water level

food colours would dissolve into water

or

start line

the ink would ‘run’ on the paper

1

(b) (distance moved by A) 2.8cm and 8.2 cm (distance moved by solvent)

allow values in range 2.7 – 2.9 cm and 8.1 – 8.3 cm

1

2.8

8.2
allow 0.33 or 0.35
allow ecf from incorrect measurement to final answer for 2 marks if given to 2 significant figures
accept 0.34 without working shown for 3 marks

(c) 6.6 cm
allow values between 6.48 and 6.64 cm

(d) solvent moves through paper
different dyes have different solubilities in solvent
and different attractions for the paper
and so are carried different distances

(e) calcium ions
allow \( Ca^{2+} \)
sodium ions
allow \( Na^+ \)

(f) two different colours
or
\( Ca^{2+} \) / one is orange-red and \( Na^+ \) / the other is yellow
allow brick red for \( Ca^{2+} \) and / or orange for \( Na^+ \)
allow incorrect colours if consistent with answer to 7.5

(so) colours mix
or
(so) one colour masks the other

(g) (Student A was incorrect)
because sodium compounds are white not green
or
because sodium carbonate is soluble
so can’t contain sodium ions
(Student B was incorrect) because adding acid to carbonate produces carbon dioxide

so must contain carbonate not chloride ions

(a) both water vapour and ethanol will condense
   - allow steam for water vapour
   - allow they both become liquids
   - allow ethane condenses at a lower temperature
   - allow some of the steam hasn’t reacted
   - allow it is a reversible reaction / equilibrium

(b) amount will decrease

   because the equilibrium will move to the left

(c) more ethanol will be produced

   because system moves to least / fewer molecules

(a) fermentation

(b) (i) turns cloudy / milky / white
   - ignore bubbles

   because carbon dioxide is produced
   - allow CO₂ produced

(ii) filter paper

(a) (i) high temperature
   - allow heating / hot / 250-900 °C

   catalyst or steam
   - allow named catalyst eg zeolite, Al₂O₃, silica, ceramic
   - allow in the absence of air / oxygen

   ignore any references to pressure
(ii) colourless
   
   allow decolourised

   ignore clear / discoloured

(iii)

\[
\begin{array}{cccccc}
  & H & H & H & H & \\
H & C & C & C & C & H \\
  & H & H & H & H & \\
\end{array}
\]

(b) (i) 20.3(0) (kJ)
   
   if answer incorrect allow 1 mark for 24.36/1.2

(ii) use a lid
   
   allow insulate beaker or use draught shield

   reduce energy / heat loss

   ignore references to thermometer or repeats or distance of flame or loss of water vapour

   allow stir (1) to distribute energy / heat (1)

   allow use a metal can (1) as it's a better conductor (1)

(iii) carbon/soot
   
   ignore tar, smoke

   (produced by) incomplete combustion

   allow from a limited supply of oxygen/air

(iv) hexane gives out the greatest energy (per 1.0 g)
   
   ignore more energy

   hexane produces the least smoke / carbon / soot

   allow has the cleanest flame

   ignore less smoke / carbon / soot
Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a ‘best-fit’ approach to the marking.

**Level 3 (5 – 6 marks):**

Descriptions of advantages **and** disadvantages that are linked to their own knowledge.

**Level 2 (3 – 4 marks):**

Descriptions of an advantage **and** a disadvantage with some use of their knowledge to add value.

**Level 1 (1 – 2 marks):**

Statements made from the information that indicate whether at least one statement is an advantage **or** a disadvantage **or** a linked advantage or disadvantage

**0 marks:**

No relevant content

**Examples of the added value statements and links made in the response could include:**

Note that link words are in bold; links can be either way round. Accept reverse arguments and ignore cost throughout.

**Advantages of using hydrogen:**

- Combustion only produces water **so** causes no pollution
- Combustion does not produce carbon dioxide **so** this does not contribute to global warming or climate change
- Combustion does not produce sulfur dioxide **so** this does not contribute to acid rain
- Incomplete combustion of petrol produces carbon monoxide **that is** toxic
- Incomplete combustion of petrol produces particulates **that** contribute to global dimming
- Petrol comes from a non-renewable resource **but** there are renewable/other methods of producing hydrogen
- Hydrogen releases more energy **so** less fuel needed or more efficient

**Disadvantages of using hydrogen:**

- Hydrogen is a gas **so** is difficult to store or transfer to vehicles
- Hydrogen gas is very flammable **so** leaks cause a greater risk of explosion
- Most hydrogen is produced from fossil fuels **which** are running out
- Cannot be used in existing car engines **so** modification / development or replacement is needed
- Lack of filling stations **so** difficult to refuel your vehicle

(a) add yeast and ferment **or** by fermentation

*allow in a warm place **or** temperatures within the range 20-45°C **or** with an airlock / absence of air*
(b) heat (the mixture)

ethanol has a lower boiling point than water or more ethanol than water vaporises or ethanol evaporates first or when the temperature reaches 78°C

allow ethanol and water boil at different temperatures

condense (the vapour)

allow condense at different temperatures for the last two marking points

if no other mark is awarded, allow repeat distillation or use fractional distillation apparatus for 1 mark

(a) water / H₂O

allow steam or hydrogen oxide

(b) (i) A

(ii) exothermic

products (energy) lower than reactants (energy)

(iii) 1860 (kJ)

(c) (i) 22.5

38.7

16.2

allow ecf for correct subtraction

(ii) 50 (g)

(iii) 20.1 (kJ)

allow propanol

ignore 3

(iv) as the number of carbon atoms (in one molecule of alcohol) increases the heat energy given out increases (when the alcohol is burned)
(v) any two from:
• no lid
• no insulation
• no draught shield

*Allow heat / energy loss to surroundings for any one of these marks*

• incomplete combustion
• inaccurate measurement
• no repeats (to calculate a mean)