

## Mark schemes

Q1.

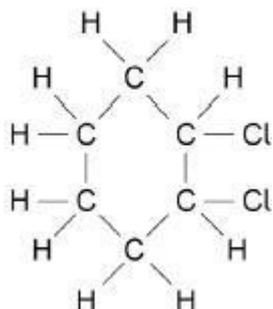
- (a) fuel 1
- (b) propene 1
- (c) (percentage yield =)  
 $\frac{380}{400} \times 100$  1  
 = 95 (%) 1
- (d) some ethanol changes back into ethene and steam 1  
 some ethanol escapes from the apparatus 1
- (e)  $C_2H_5OH + 3 O_2 \rightarrow$   
 $3 H_2O + 2 CO_2$   
*allow multiples* 1
- (f) (advantages)  
 (fermentation) low energy usage 1  
 (fermentation) uses renewable raw materials 1  
 (disadvantages)  
 (fermentation) produces impure ethanol 1  
 (fermentation) slow rate of reaction 1
- [11]

Q2.

- (a) (test)  
 (add) bromine (water) 1
- (result)  
 (changes from) brown / orange to colourless  
*ignore clear* 1

(b)  $C_nH_{2n-2}$  1

(c)



*allow 1 mark for the structure of  
1, 1-dichlorocyclohexane or 1, 3-  
dichlorocyclohexane or 1, 4-  
dichlorocyclohexane*

2

(d) ( $M_r(C_6H_{10}Cl_2) = 153$ ) 1

$$(\% \text{ chlorine}) = \frac{71}{153} \times 100$$

*allow correct use of an incorrectly  
calculated value of  $M_r$*

1

$$= 46.4 (\%)$$

*allow 46.405228758 (%) correctly  
rounded to at least 2 significant figures*

1

[8]

Q3.

(a) (steam / catalytic) cracking  
*allow thermal decomposition* 1

(b) high temperature 1

steam / catalyst

*allow a temperature in the range 300 –  
900 °C*

1

(c) Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account. 5–6

Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1-2
No relevant content	0
Indicative content	
Rate	
<ul style="list-style-type: none"> <li>• higher temperature gives higher rate</li> <li>• because more frequent collisions higher</li> <li>• pressure gives higher rate because more</li> <li>• frequent collisions a catalyst can be used to</li> <li>• give a higher rate because the activation</li> <li>• energy is reduced</li> </ul>	
Yield	
<ul style="list-style-type: none"> <li>• higher temperature gives lower yield</li> <li>• because the reaction is exothermic</li> <li>• higher pressure gives higher yield</li> <li>• because there are more molecules on left hand side</li> </ul>	
Other factors	
<ul style="list-style-type: none"> <li>• higher temperatures use more energy so costs increase</li> <li>• higher pressures use more energy so costs increase</li> <li>• higher pressures require stronger reaction vessels so costs increase</li> </ul>	
Compromise	
<ul style="list-style-type: none"> <li>• chosen temperature is a compromise between rate and yield</li> <li>• chosen temperature is a compromise between rate and cost (of energy used)</li> <li>• chosen pressure is a compromise between rate and cost (of energy used)</li> <li>• chosen pressure is a compromise between yield and cost (of energy used)</li> </ul>	
(d) fermentation	
<i>allow ferment(ing)</i>	1
(e) warm	
<i>allow a value in the range 25 °C to 45 °C</i>	1
anaerobic (conditions)	
<i>allow without oxygen / air</i>	1
(f) (conversion)	
200 km = 200,000 m	1

$$(\text{moles} =) \quad (\text{moles} =) \quad \frac{200000 \times 1.95 (\text{mol})}{1300}$$

*allow correct use of incorrect / no conversion for distance*

1

$$= 300 (\text{mol})$$

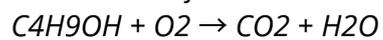
1



*allow CH<sub>10</sub>O for C<sub>4</sub>H<sub>9</sub>OH*

*allow multiples*

*allow 1 mark for*



*with incorrect / no multipliers*

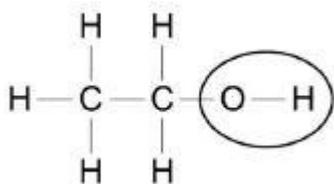
*ignore state symbols*

2

[17]

Q4.

(a)



1

(b)

Name of element	Symbol for element	Number of atoms in one molecule of ethanol
carbon	C	2
hydrogen	H	6
oxygen	O	1

*ignore O<sub>2</sub>*

1

1

1

(c) a solvent

1

(d) sugar

*allow named sugar*

*allow saccharide*

1

(e) yeast 1

(f) ethyl ethanoate 1

(g) water 1  
*ignore H2O*

(h)  $400 \text{ cm}^3 = 0.40 \text{ dm}^3$  1

$$\frac{1.00}{0.40} \times 20$$

*allow correct use of incorrectly converted or unconverted volume*

= 50 (g) 1

alternative approach:

$$1.0 \text{ dm}^3 = 1000 \text{ cm}^3 \text{ (1)}$$

$$\frac{1000}{400} \times 20 \text{ (1)}$$

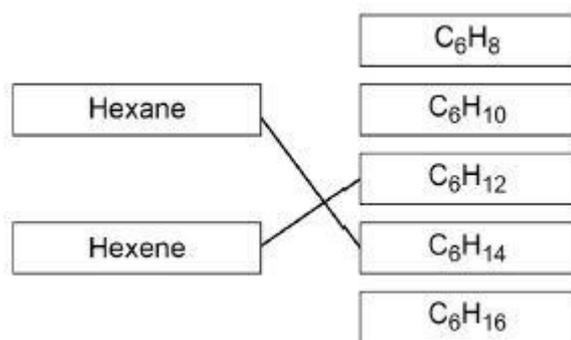
*allow correct use of incorrectly converted or unconverted volume*

= 50 (g) (1)

[12]

Q5.

(a)



additional line from a box on the left negates the mark for that box

(b) (remains) orange 1  
*must be in this order*

	<i>allow no (colour) change</i>	1
	(becomes) colourless	
	<i>ignore initial colour ignore clear</i>	1
(c)	Level 2: Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	4-6
	Level 1: Relevant features are identified and differences noted.	1-3
	No relevant content	0
	Indicative content	
	Structure and bonding	
	<ul style="list-style-type: none"> <li>• both are hydrocarbons</li> <li>• both contain two carbon atoms (per molecule) ethane</li> <li>• contains six hydrogen atoms (per molecule) (but) ethene</li> <li>• contains four hydrogen atoms (per molecule)</li> <li>• both have covalent bonds</li> <li>• ethane contains a single C—C bond</li> <li>• (but) ethene contains a double bond</li> <li>• both contain C—H bonds</li> <li>• both small molecules</li> </ul>	
	Reactions	
	<ul style="list-style-type: none"> <li>• both react with oxygen in complete combustion reactions</li> <li>• to produce water and carbon dioxide</li> <li>• both react with oxygen in incomplete combustion reactions</li> <li>• to produce water, carbon monoxide and carbon</li> <li>• incomplete combustion is more likely with ethene</li> <li>• ethene decolourises bromine water</li> <li>• (but) ethane does not decolourise bromine water</li> <li>• ethene is more reactive (than ethane)</li> <li>• ethene can react with hydrogen (to produce ethane)</li> <li>• ethene can react with water (to produce ethanol)</li> <li>• ethene can react with halogens (to produce halogenoalkanes)</li> <li>• ethene can undergo addition reactions</li> <li>• ethene can polymerise (to produce poly(ethene))</li> </ul> <p>ignore physical properties ignore references to flammability</p>	

[10]

Q6.

(a) HCOOH

*allow HCO<sub>2</sub>H*

1

propanoic acid

1

(b) incomplete / partial ionisation

*allow incomplete / partial dissociation*

1

(because) reaction is reversible

*allow (because) reaction is in equilibrium*

1

(c) mass (of flask and contents) decreases

1

(because) carbon dioxide is produced

1

(and) carbon dioxide escapes (from the flask)

*allow mark for the gas produced escapes (from the flask)*

1

(d) (0.01 mol/dm<sup>3</sup>) methanoic acid has a lower pH

*allow converse argument for ethanoic acid*

*allow (0.01 mol/dm<sup>3</sup>) methanoic acid is a stronger acid*

1

(so 0.01 mol/dm<sup>3</sup>) methanoic acid has a higher concentration of hydrogen ions

1

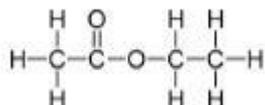
(therefore) more collisions per unit time

1

(e) ethyl ethanoate

1

(f)



1

[12]

Q7.

(a) formulation

(b) 
$$\frac{23.3}{265.5 + 23.3 + 3.0 + 1.5} (\times 100)$$
  
 allow 
$$\frac{23.3}{293.3} (\times 100)$$

= 7.9 (%)

allow 7.944084555 (%) rounded correctly

an answer of 7.9 (%) scores 2 marks

(c) to deter consumption / drinking (by people)

(d) any one from:

- fuel
- solvent
- antiseptic

allow specific uses e.g.

- fuel additive
- cleaning products
- hand-sanitisers

do not accept as an alcoholic drink

(e) ferment(ation)

ignore distillation

add yeast

anaerobic (conditions)

allow in the absence of oxygen

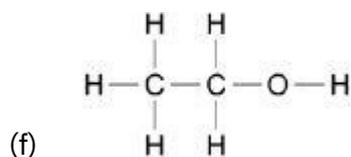
or  
warm

allow a temperature value in range 5 – 45 °C inclusive

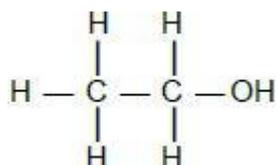
allow room temperature

ignore hot / heat

ignore high temperature



allow



(g) hydrogen

*allow H2*

(h) oxidising (agent).

*allow permanganate / dichromate ions*

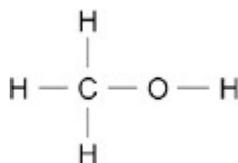
*allow [O]*

*ignore oxygen*

Q8.

(a) Propanol

(b) Butanol has the highest boiling point



(d) ethene + water ( $\rightarrow$  ethanol)

*allow answers in either order*

*allow steam for water*

(e) goes back to reactor

*allow is recycled*

(f) air contains oxygen

which oxidises ethanol

*allow ethanol reacted with oxygen*

to produce ethanoic acid

Q9.

(a) (i) fizz / effervescence / bubbles  
*allow calcium carbonate decreases in size or dissolves* 1

because carbon dioxide produced / released  
*allow because gas produced / released* 1

limewater turns cloudy / milky / white 1

because (a precipitate of or solid) calcium carbonate forms  
*allow because of carbon dioxide if not already credited* 1

(ii) 
$$\begin{array}{c} \text{H} \\ | \\ \text{H}-\text{C}-\text{C}=\text{O} \\ | \quad | \\ \text{H} \quad \text{O}-\text{H} \end{array}$$
  
*allow -OH*  
*do not allow lower case 'h'* 1

(iii) acid  
*must be in this order*  
*ignore any name of an acid* 1

ester(s) 1

(b) white (precipitate) no change  
 no change no change  
*all four correct 2 marks*  
*any two correct 1 mark* 2

(c) (i) lilac  
*allow purple* 1

red 1  
*must be in this order*

(ii) colours are masked / changed by each flame colour 1

[12]

Q10.

(a)  $C_6H_{14}$

1

(b) A

1

(c) B

1

(d) C

1

(e) Propanol

1

[5]