

VCE Chemistry Units 3&4

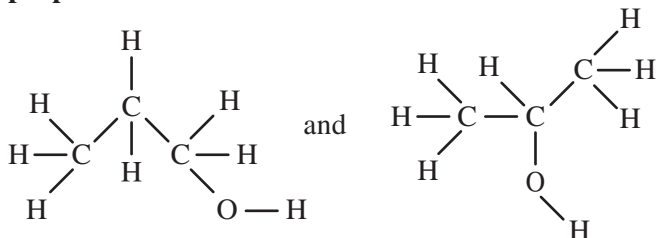
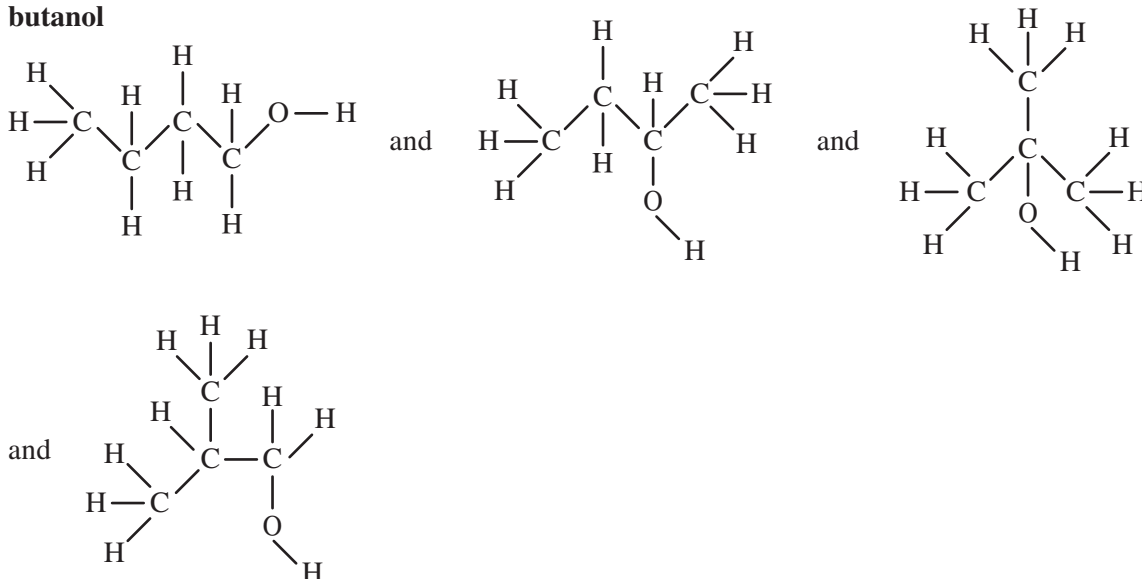
Suggested Solutions

Test 5: How are organic compounds categorised and synthesised?

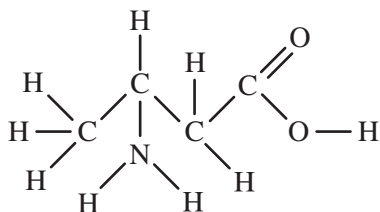
- Structure, nomenclature and properties of organic compounds
- Reactions of organic compounds

SECTION A – MULTIPLE-CHOICE QUESTIONS**Question 1 C**

The relevant structures are shown below.

propanol**butanol****Question 2 C**

The relevant structure is shown below. There are nine H atoms per molecule.

**Question 3 D**

D is correct. 'Counting' the carbon atoms, dimeth = $2 \times 1 + \text{prop} = 3$, gives a total of 5. (If you cannot 'see' the solution in this way, draw the relevant structures.)

A is incorrect. It does contain six carbon atoms. Counting the carbon atoms, hex = 6.

B is incorrect. It does contain six carbon atoms. Counting the carbon atoms, meth = $1 + \text{pent} = 5$.

C is incorrect. It does contain six carbon atoms. Counting the carbon atoms, eth = $2 + \text{but} = 4$.

Question 4 A

$\text{CH}_3\text{CH}_2\text{CH}_2\text{COOCH}_2\text{CH}_3$ is the ester ethyl butanoate. It is prepared using ethanol, butanoic acid and an acid catalyst.

Question 5 C

C is an incorrect statement and so is the required response. CH_3COOH is a weak acid, while $\text{CH}_3\text{CH}_2\text{NH}_2$ is a weak base.

A is a correct statement and so is not the required response. The presence of the polar C–Cl bond in chloroalkanes makes them more reactive than alkanes.

B is a correct statement and so is not the required response. Non-cyclic C_6H_{12} contains one double carbon–carbon bond, while non-cyclic C_5H_8 contains two.

D is a correct statement and so is not the required response. The boiling point of alkanes increases with increasing size due to an increased strength of dispersion forces.

Question 6 B

B is correct and **A** is incorrect. The atom economy is close to 60%. The relevant calculation is as follows.

mass of desired product: $(2 \times 12) + (4 \times 1) + (2 \times 35.5) = 99$

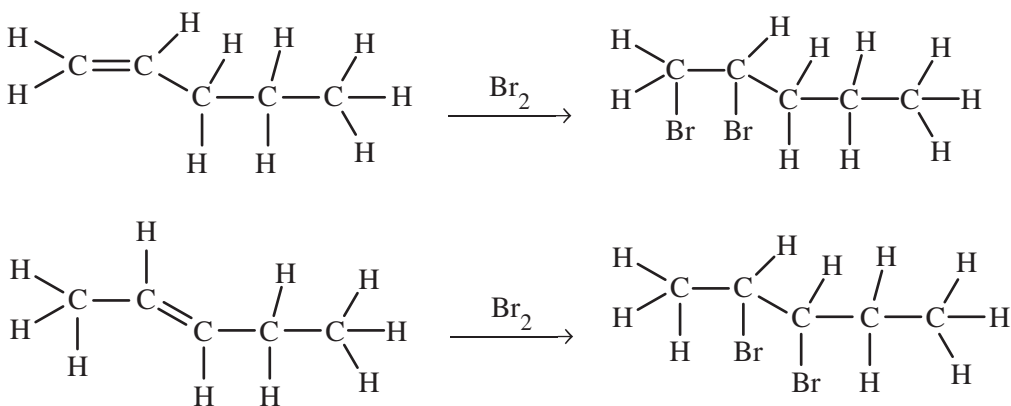
mass of reactants: $(2 \times 12) + (6 \times 1) + (4 \times 35.5) = 172$

$$\% \text{ atom economy} = \frac{99}{172} \times \frac{100}{1} = 58\%$$

C and **D** are incorrect. The reaction of alkanes is substitution.

Question 7 D

D is correct and **A** is incorrect. The relevant addition reactions are shown below.



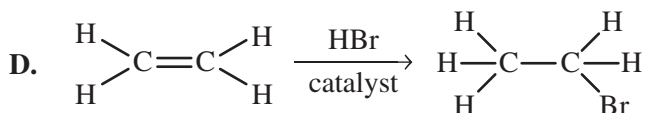
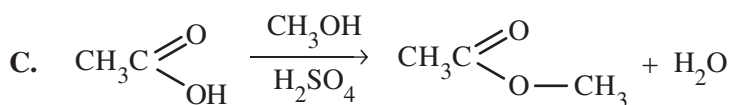
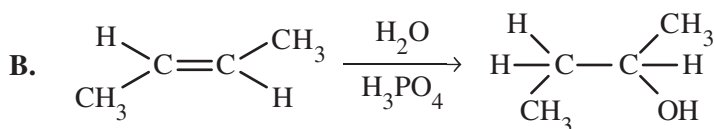
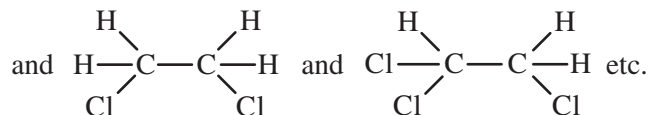
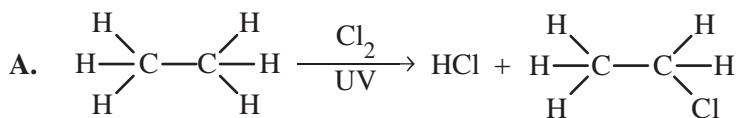
The products are 1,2-dibromopentane and 2,3-dibromopentane. These have the same molecular formula but different structural formulas. They are isomers, not the same compound.

B is incorrect. The products are saturated.

C is incorrect. The products have a higher molar mass than the organic reactants.

Question 8 A

The relevant reactions are shown below.

**Question 9 D**

D is correct. This link is the ester that forms when the carboxyl group of the triglyceride fatty acid reacts with the hydroxyl group of the alcohol used to generate the biodiesel ester group.

A is incorrect. This shows the peptide (amide) group in proteins.

B is incorrect. This shows the glycosidic (ether) link in carbohydrates such as starch and cellulose.

C is incorrect. This shows a disulfide (covalent) link found in the tertiary structure of proteins.

Question 10 B

B is correct. Catalysts increase the rate of reactions, allowing reactions to occur at a lower temperature than might otherwise be required. This reduces energy use.

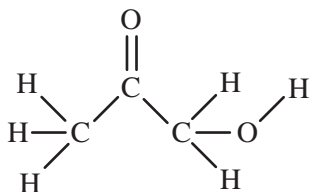
A and **C** are incorrect. Catalysts do not alter the reactants or products of a reaction, and so do not alter the atom economy.

D is incorrect. Catalytic action does not necessarily allow for a change of solvent.

SECTION B

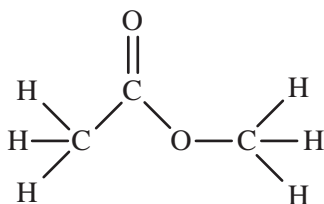
Question 1 (6 marks)

a. i.

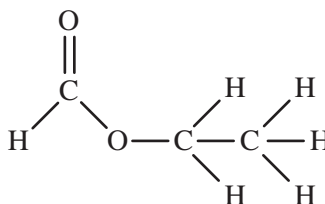


1 mark

ii.



OR



1 mark

iii. 1-hydroxypropan-2-one

1 mark

iv. methyl ethanoate (or ethyl methanoate)

1 mark

b. i. Both have a hexagonal ring structure.

1 mark

ii. Any one of:

- Cyclohexane has 12 hydrogen atoms compared with 6 for benzene.
- Cyclohexane has only single carbon–carbon bonds compared with some unsaturation in the benzene molecule.

1 mark

Question 2 (7 marks)

a. $\text{CH}_3\text{CH}_2\text{OH(l)} \rightarrow \text{CH}_3\text{CHO(l)} + 2\text{H}^+(\text{aq}) + 2\text{e}^-$

1 mark

b. $n(\text{CH}_3\text{CH}_2\text{OH}) = \frac{m}{M} = \frac{4.25}{46.0} \text{ mol}$

1 mark

$$n(\text{CH}_3\text{CHO}) = n(\text{CH}_3\text{CH}_2\text{OH})$$

$$m(\text{CH}_3\text{CHO}) = n \times M = \frac{4.25}{46.0} \times 44.0 = 4.07 \text{ g}$$

1 mark

$$\% \text{ yield} = \frac{3.56}{4.07} \times \frac{100}{1} = 87.5\%$$

1 mark

c. Any one of:

- Ethanol and ethanal may evaporate from the reaction vessel.
- The reaction does not go to completion; it is an equilibrium reaction.
- Some ethanal is lost in the collection process.
- Some ethanal was oxidised further to produce ethanoic acid.

1 mark

d. ethanol

1 mark

The hydroxyl group in ethanol can form hydrogen bonds with water, increasing solubility.
Ethanal is not able to hydrogen bond with water.

1 mark

Question 3 (12 marks)

a. Hydrocarbons are non-polar molecules, so the only intermolecular bonding is by dispersion forces.

1 mark

Dispersion forces increase in strength as molecular mass increases, leading to the increasing boiling points.

1 mark

b. The production of biodiesel from fats and oils, and bioethanol produced by fermentation, rather than using petrodiesel obtained from fossil fuels illustrates the use of renewable feedstocks.

1 mark

The fats and oils used in biodiesel production, and the plant material used in bioethanol production, can be grown and replaced at a rate at least as fast as their use.

1 mark

The fossil fuel source for petrodiesel, crude oil, cannot be replaced at a sustainable rate.

1 mark

c. i. hydroxyl

1 mark

ii. $M(\text{starch polymer}) = 2000 \times M(\text{glucose}) - 1999 \times M(\text{water})$

$$= (2000 \times 180) - (1999 \times 18)$$

1 mark

$$= 324018 = 3.24 \times 10^5 \text{ g mol}^{-1}$$

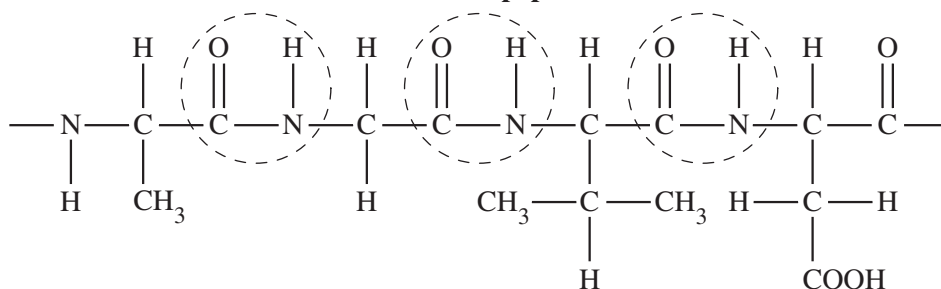
1 mark

d. i. four

1 mark

ii.

amide OR peptide



1 mark

Note: Award mark for any one link circled and named correctly.

iii. water

1 mark

a suitable catalyst (enzyme or concentrated hydrochloric acid)

1 mark