Basic Concepts

Total mark – 21

Question: 1

1. Some of the hydrocarbons in kerosene have the formula $C_{10}H_{22}$.

(i) What is the name of the straight chain hydrocarbon with the formula $C_{10}H_{22}$?

.....

[1]

(ii) Draw the skeletal formula of one branched chain isomer with the formula $C_{10}H_{22}$.

[1]

(iii) Explain why the straight chain isomer of $C_{10}H_{22}$ has a higher boiling point than any of its branched chain structural isomers.

.....

.....

.....

.....

.....

[2]

(iv) Explain why the straight chain isomer of $C_{10}H_{22}$ is converted by the petroleum industry into its branched chain isomers.

.....

.....

[1]

[Total 5 marks]

1. (i) Decane ✓

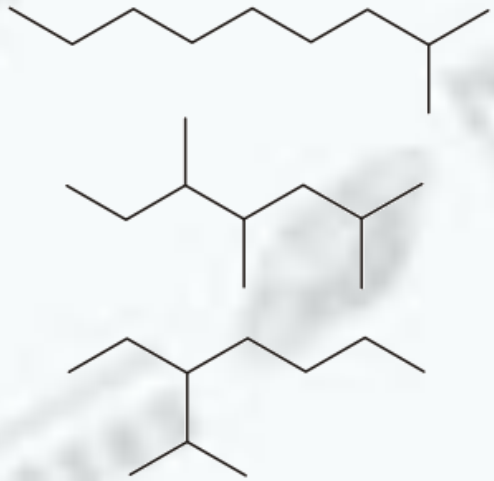
DO NOT ALLOW *deceane*

1

(ii) Skeletal formula of branched $C_{10}H_{22}$ ✓

Formula ***must*** *be skeletal*
AND *must not include any symbol, e.g.* CH_3

Any possible skeletal formulae e.g.



1

(iii) Decane has more surface contact
OR branched chains have less surface contact ✓

Both answers need to be comparisons
Assume 'it' refers to decane
IGNORE *surface area*
ALLOW *straight chains can get closer together*
OR *branched chains cannot get as close to one another*
IGNORE *branched chain are more compact*

Decane has more van der Waals' forces
OR branched chains have fewer van der Waals' forces ✓

ALLOW *Decane has stronger van der Waals' forces*
OR *branched chains have weaker van der Waals' forces*

More intermolecular forces is ***not*** *sufficient*

2

(iv) Branched chains have more efficient combustion
OR decane has less efficient combustion ✓

ALLOW *branched chains are easier to burn*
OR *easier to combust*
OR *burn better*
OR *more efficient fuel*
OR *less likely to produce pre-ignition or knocking*
OR *increases octane rating*

ALLOW *ORA for decane*

Better fuel is ***NOT*** *sufficient*
Burns more cleanly is ***NOT*** *sufficient*

1

[5]

Question: 2

3. The 'curly arrows' model is used in reaction mechanisms to show the movement of electron pairs during chemical reactions.

Choose a reaction mechanism that you have studied involving the curly arrow model.

Name and describe your chosen reaction mechanism.

In your answer, include:

- an example of the reaction with the chosen mechanism,
- the type of bond fission that occurs,
- relevant dipoles.

.....

.....

.....

.....

.....

.....

[Total 6 marks]

3. **EITHER**

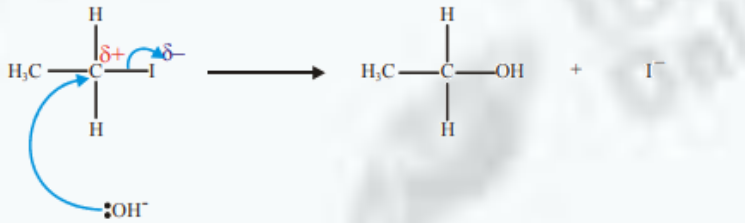
Nucleophilic substitution ✓
Example of nucleophilic substitution ✓
Heterolytic fission ✓
C–I curly arrow ✓
Correct dipole on C— I bond ✓
OH^- curly arrow from one lone pair on O of OH^- ion
OR from minus sign on OH^- ion ✓

OR

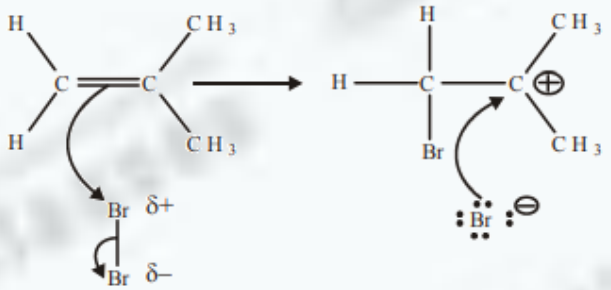
Electrophilic addition ✓
Example of electrophilic addition ✓
Heterolytic fission ✓
Curly arrow from C=C bond to Br—Br bond and
Dipole and curly arrow associated with Br_2 ✓
Correct carbocation ion ✓
Curly arrow from one lone pair on Br^- ion
OR from minus sign on Br^- ion ✓

The example mark can be awarded as an example of the name of the mechanism given or if the name is wrong can be given as an example of a reasonably correct drawn mechanism

*If **curly half arrows** drawn do not give a mark the first time used and then apply ECF*



***ALLOW** mechanisms for other halogenoalkaes*



***ALLOW** mechanisms for other halogens and hydrogen halides*

ALLOW
Electrophilic substitution ✓
Example of electrophilic substitution ✓
Heterolytic fission ✓
Curly arrow from benzene ring to the electrophile (i.e. NO_2^+ OR Br^+) ✓
Correct intermediate ✓
Curly arrow to show loss of hydrogen ion ✓

ALLOW
Nucleophilic addition ✓
Example of nucleophilic addition ✓
Heterolytic fission ✓
Correct dipole on carbonyl group ✓
Curly arrow from lone pair on H^- ion
OR from minus sign on H^- to C=O carbon and breaking of C=O bond ✓
Curly arrow from carbonyl oxygen to either H^+ or H_2O ✓

[6]

Question: 3

4. Draw the skeletal formula for 2-methylpentan-3-ol.

[Total 1 mark]

5. Butan-2-ol and 2-methylpropan-2-ol are structural isomers.

(i) What is meant by the term *structural isomer*?

.....

.....

.....

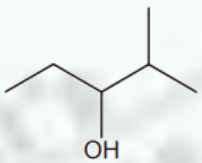
[1]

(ii) Draw another structural isomer of these two alcohols.

[1]

[Total 2 marks]

4.



✓

*Formula **must** be skeletal **AND** not include any symbol except for OH*

[1]

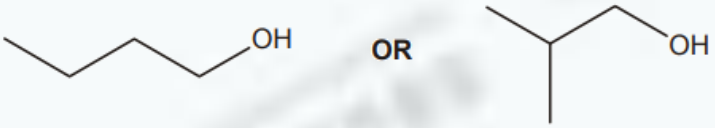
5. (i) Same **molecular** formula but different structural formulae ✓

***ALLOW** Same molecular formula but different arrangement of atoms*
***OR** Same molecular formula but different structures*
***OR** Same molecular formula but different displayed formulae*
***DO NOT ALLOW** Same molecular formula but different spatial arrangement of atoms*

1

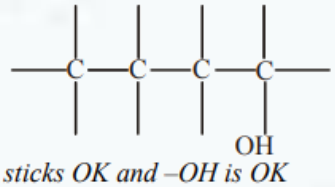
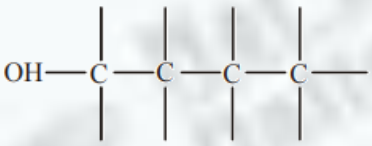
(ii) $CH_3CH_2CH_2CH_2OH$ **OR** $(CH_3)_2CHCH_2OH$ ✓

ALLOW



ALLOW *displayed formula*

ALLOW *sticks (i.e. no H shown bonded to C)*

ALLOW	**DO NOT ALLOW** OH shown as below
 *sticks OK and –OH is OK*	 *sticks OK and OH– is not OK*

ALLOW *correct ethers*

1

[2]

Question: 4

6. Crude oil is a source of hydrocarbons which can be used as fuels or for processing into petrochemicals.

Octane, C_8H_{18}, is one of the alkanes present in petrol.

Carbon dioxide is formed during the complete combustion of octane.

$$C_8H_{18} + 12½O_2 \rightarrow 8CO_2 + 9H_2O$$

What is the general formula for an alkane?

.....

[Total 1 mark]

7. Oil companies process hydrocarbons, such as octane, into branched and cyclic hydrocarbons that promote efficient combustion in petrol.

Draw the skeletal formulae of a branched hydrocarbon and a cyclic hydrocarbon, each containing eight carbon atoms.

[Total 2 marks]

6. C_nH_{2n+2} ✓

ALLOW $C_nH_{2(n+1)}$ ✓

IGNORE *size of subscripts*

[1]

7. skeletal formula of a branched isomer of C_8H_{18} ✓

skeletal formula of a cyclic hydrocarbon **OR** skeletal formula of substituted arene of C_8H_{10}✓

ALLOW *any ring between* C_3 *and* C_8 *with 8 carbon atoms per molecule*

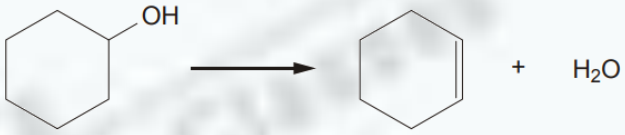
IGNORE *wrong names*

If two correct structural or displayed formulae drawn award one mark

[2]

Question: 5

8. Alkenes can be prepared by the dehydration of alcohols with an acid catalyst. Cyclohexene can be prepared by the dehydration of cyclohexanol, shown below.



A student reacted 7.65 g of cyclohexanol, $C_6H_{12}O$, and obtained 0.0268 mol of cyclohexene.

(i) What is the molecular formula of cyclohexene?

.....

[1]

(ii) Calculate the percentage yield of cyclohexene.

answer = ... %

[3]

[Total 4 marks]

8. (i) C_6H_{10} ✓

1

(ii) M_r(cyclohexanol) = 100 ✓

amount of cyclohexanol = 0.0765 mol ✓

percentage yield = 35.0% ✓

ALLOW *full marks for correct answer with no or limited working out*

ALLOW *ecf from wrong molar mass i.e. 7.65 ÷ molar mass*

ALLOW *ecf from wrong amount in moles i.e. [0.0268 ÷ moles] × 100*

ALLOW *35%*

ALLOW *two marks for 0.35%*

If M_r of 82 is used then % yield will be 28.7 or 29 and this is worth two marks

3

[4]