Hydrocarbons – 2016

1. 9701/21/O/N/16/No.4

In each section of this question an organic compound is shown. For each compound give its name and answer the questions about it.

(a) $CH_3CH_2CH(CH_3)CH=CHCH_3$

(i) name ..... [1]

(ii) This compound shows stereoisomerism.

Define *stereoisomerism.*

.....

.....

..... [1]

(iii) State and explain how many stereoisomers of this structure there are.

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.....

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.....

.....

..... [4]

(b) $(CH_3)_2C=C(CH_3)_2$

(i) name ..... [1]

(ii) Draw the **skeletal** formula of the organic product of the reaction of this compound with cold, dilute, acidified manganate(VII) ions.

[1]

(iii) Name the organic product of the reaction of this compound with hot, concentrated, acidified manganate(VII) ions.

..... [1]

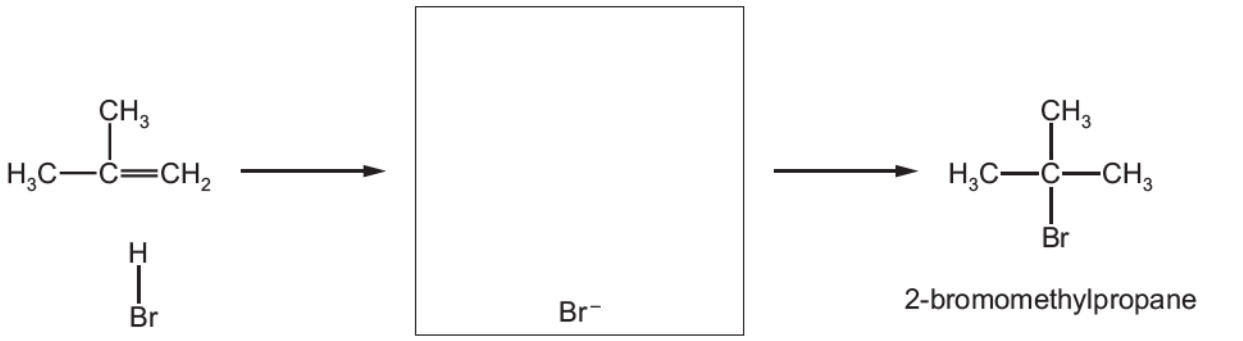
(iv) Draw the structure of part of a molecule of the addition polymer formed from this compound, showing exactly **three** repeat units.

[1]

(c) $(CH_3)_2C=CH_2$

(i) name ..... [1]

(ii) Complete the mechanism for the reaction of this compound with hydrogen bromide. Include all necessary curly arrows, lone pairs, charges and partial charges.



2-bromomethylpropane

[4]

(iii) Explain fully why 2-bromomethylpropane is the major product of this reaction while only relatively small amounts of 1-bromomethylpropane are produced.

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.....

.....

..... [3]

[Total: 18]

2. 9701/22/O/N/16/No.4

In each section of this question the structural formula of an organic compound is shown. For each compound answer the questions about it.

(a) $CH_3CH_2CHBrCH_3$

(i) Name this compound.

..... [1]

(ii) This compound shows stereoisomerism.

Draw the **two** stereoisomers in the conventional way.

[2]

(iii) Give the structures of **three** other structural isomers of C_4H_9Br.

[3]

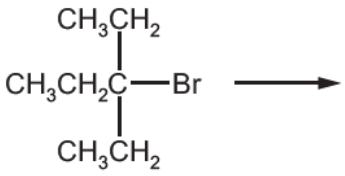
(b) $(C_2H_5)_3CBr$

(i) Name this compound.

..... [1]

(ii) $(C_2H_5)_3CBr$ reacts with aqueous OH^-.

Complete the mechanism for this reaction including all necessary curly arrows, charges, partial charges and lone pairs.



[3]

(iii) What *type of mechanism* occurs in **(ii)**?

..... [1]

(c) $CH_3CH_2CH_2CHBrCH_3$

(i) Give the reagents and conditions necessary for the conversion of this compound into a mixture of alkenes.

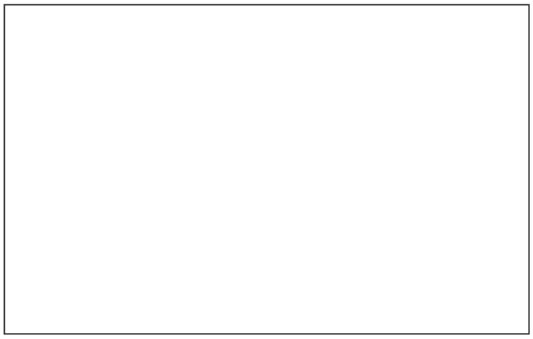
.....

..... [2]

(ii) Give the name of the mechanism for the conversion in **(i)**.

..... [1]

(iii) Draw the skeletal formulae of the three alkenes produced by the conversion in **(i)**.



[3]

[Total: 17]

3. 9701/21/M/J/16/No.4

This question is about molecules with molecular formula C_4H_8.

(a) Give the structures of a pair of **positional** isomers with the formula C_4H_8.

[1]

(b) Give the structures of a pair of **chain** isomers with the formula C_4H_8, that do **not** exhibit stereoisomerism.

[1]

(c) Give the structures and full names of a pair of **stereoisomers** with the formula C_4H_8.

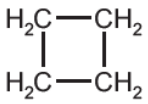
.....

.....

[2]

(d) The structure of a molecule, **A**, of formula C_4H_8 is shown.

Draw a functional group isomer of molecule **A** in box **B**. Explain how molecules **A** and **B** could be distinguished by a chemical test.



A

B

.....

.....

..... [3]

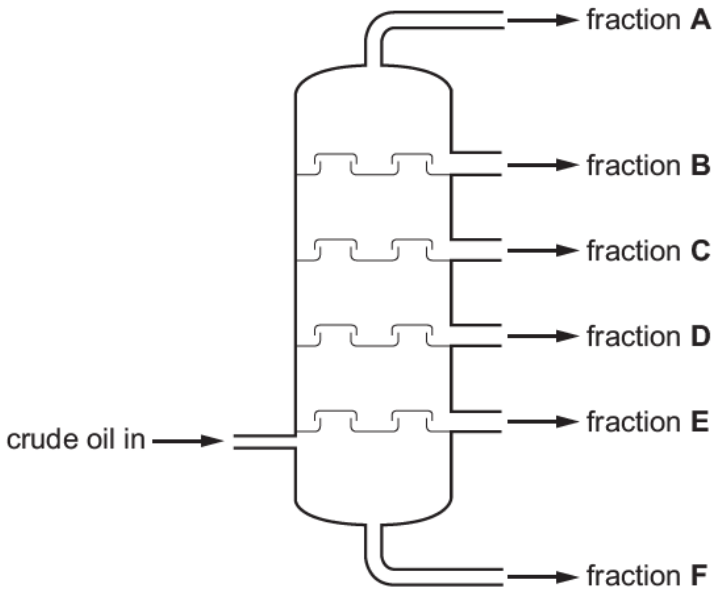
[Total: 7]

4. 9701/23/M/J/16/No.3

Crude oil is a mixture of hydrocarbons and provides many useful chemicals when processed.

Two of the stages involved in the processing of crude oil are fractional distillation and cracking.

(a) The diagram is a simplified representation of a fractional distillation column.



(i) What has to be done to the crude oil before it enters the column?

..... [1]

(ii) What trend in **structure** is there from fraction **A** to fraction **F**?

.....

..... [1]

(iii) State the trends in **two** properties of the fractions from **A** to **F**.

.....

.....

..... [2]

(b) The naphtha fraction from fractional distillation of crude oil is used as a starting material for cracking.

(i) Write an equation for the cracking of $C_{12}H_{26}$ to form the products ethene and one other hydrocarbon in a 2 : 1 mole ratio.

..... [1]

(ii) Suggest a use for each of the products from your equation in **(i)**. Explain what makes each product from **(i)** suitable for the use you suggest.

use of ethene .....

.....

explanation .....

.....

use of other product .....

.....

explanation .....

.....

[4]

(c) Burning hydrocarbons can cause a number of environmental problems.

The products of internal combustion engines can include oxides of nitrogen and oxides of carbon.

Sulfur dioxide is a by-product of burning coal in power stations.

(i) Explain how and why oxides of nitrogen are produced in internal combustion engines.

.....

.....

..... [2]

(ii) Write an equation for the reaction between nitrogen monoxide and carbon monoxide in a catalytic converter.

..... [1]

(iii) Write equations to show the involvement of nitrogen monoxide in the formation of acid rain from atmospheric sulfur dioxide.

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.....

..... [3]

(iv) Describe two of the problems associated with acid rain.

.....

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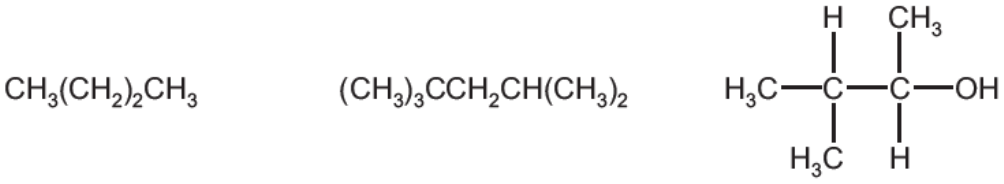
..... [2]

[Total: 17]

5. 9701/22/F/M/16/No.4

The following compounds were all found to be components of a sample of petrol.



G **H** **J**

(a) (i) Give the **molecular** formula of compound **G**.

..... [1]

(ii) Give the **empirical** formula of compound **H**.

..... [1]

(iii) Draw the **skeletal** formula of compound **J**.

[1]

(b) Write an equation to represent the complete combustion of compound **H**.

..... [1]

(c) Fossil fuels are often contaminated with sulfur.

State and explain why supplies of fossil fuels that contain sulfur pose a problem to the environment.

.....

.....

..... [2]

(d) The boiling points of compounds **G**, **H** and **J** are shown below.

compound	**G**	**H**	**J**
boiling point / °C	0	99	112

Explain the differences in the boiling points of the three compounds.

.....

.....

.....

.....

.....

.....

..... [4]

(e) Compound **J** can be produced from 2-chloro-3-methylbutane, $C_5H_{11}Cl$.

Give the reagent(s) and conditions for this reaction.

..... [1]

[Total: 11]