14.5 Alkenes

01. 0620_w20_qp_41 Q: 6

(a) Ethane, propane and butane are members of the same homologous series.

(i) Name this homologous series.

..... [1]

(ii) State **two** ways members of the same homologous series are similar.

1 .....

2 .....

[2]

(b) One mole of ethane, C_2H_6, contains 6.02×10^{23} molecules.

Calculate how many molecules are in 15 g of ethane.

number of ethane molecules = ... [1]

(c) Propane reacts with chlorine.

(i) Write the formula of the product which does not contain carbon.

..... [1]

(ii) Draw the structure of an organic product formed. Show all of the atoms and all of the bonds.

[1]

(iii) State the name of this type of reaction.

..... [1]

(d) (i) Aqueous bromine was added to a sample of ethene.

Give the colour change seen.

from ..... to ..... [2]

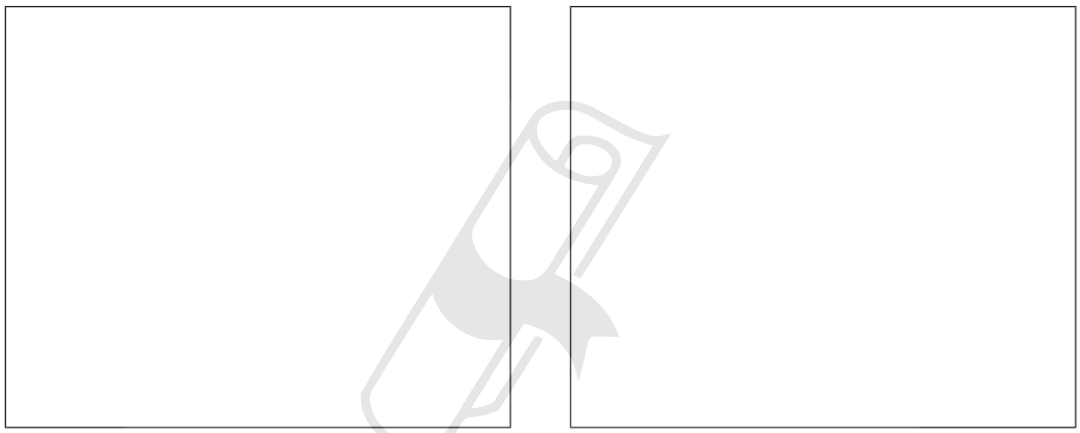
(ii) Explain, in terms of bonding, why there is no colour change when aqueous bromine is added to ethane.

.....

..... [1]

(e) There are two structural isomers with the formula C_4H_{10}.

(i) Draw the structures of both of these isomers, showing all of the atoms and all of the bonds.



[2]

(ii) Butane is formed when longer chain hydrocarbons are cracked.

Complete the chemical equation to show the other product when butane is formed by cracking.

$C_6H_{14} \rightarrow C_4H_{10}$ + ... [1]

(f) A compound contains 85.7% carbon and 14.3% hydrogen by mass.

(i) Calculate the empirical formula of this compound.

Show your working.

..... [2]

(ii) The molecular mass of the compound is 112.

Calculate the molecular formula of this compound.

..... [1]

[Total: 16]

02. 0620_w20_qp_42 Q: 4

Alkenes and alkanes are homologous series of compounds containing carbon and hydrogen atoms.

(a) State the name of the type of compound made from carbon and hydrogen atoms only.

..... [1]

(b) Alkenes take part in addition reactions.

(i) Describe what is meant by the term *addition reaction*.

..... [1]

(ii) Draw the structure of the product made in the addition reaction between propene and bromine. Show all of the atoms and all of the bonds.

[2]

(iii) Describe the colour change seen when propene is added to aqueous bromine.

from ..... to ..... [2]

(iv) Draw the structures of molecules of **two** different alkenes which both undergo an addition reaction with steam to form butan-2-ol. Show all of the atoms and all of the bonds.

[2]

(c) Propane undergoes a substitution reaction with chlorine.

Write the chemical equation for the reaction between one molecule of propane and one molecule of chlorine.

..... [2]

[Total: 10]

03. 0620_m19_qp_42 Q: 3

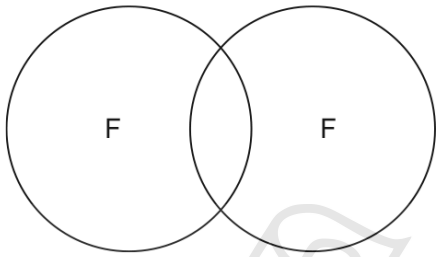
Fluorine is a Group VII element. Fluorine forms compounds with metals and non-metals.

(a) Predict the physical state of fluorine at room temperature and pressure.

..... [1]

(b) Fluorine exists as diatomic molecules.

Complete the dot-and-cross diagram to show the electron arrangement in a molecule of fluorine. Show outer shell electrons only.



[2]

(c) Write a chemical equation for the reaction between sodium and fluorine.

..... [2]

(d) Explain why chlorine does **not** react with aqueous sodium fluoride.

.....

..... [1]

(e) Tetrafluoromethane and lead(II) fluoride are fluorides of Group IV elements. Some properties of tetrafluoromethane and lead(II) fluoride are shown in the table.

property	tetrafluoromethane	lead(II) fluoride
formula	CF_4	
melting point / °C	–184	855
boiling point / °C	–127	1290
conduction of electricity when solid	non-conductor	non-conductor
conduction of electricity when molten	non-conductor	good conductor

(i) What is the formula of lead(II) fluoride?

..... [1]

(ii) What type of bonding is present between the atoms in tetrafluoromethane?

..... [1]

(iii) What type of structure does solid lead(II) fluoride have?

..... [1]

(iv) Explain, in terms of attractive forces between particles, why lead(II) fluoride has a much higher melting point than tetrafluoromethane.

In your answer refer to the types of attractive forces between particles and their relative strengths.

.....

.....

.....

..... [3]

(f) Tetrafluoroethene is an unsaturated compound with the formula C_2F_4.
Tetrafluoroethene is the monomer used to make the polymer poly(tetrafluoroethene).

(i) What is meant by the term *unsaturated*?

.....

..... [1]

(ii) Describe a test to show that tetrafluoroethene is unsaturated.

test.....

observations .....
[2]

(iii) Draw the structure of a molecule of tetrafluoroethene. Show all of the atoms and all of the bonds.

[1]

(iv) Tetrafluoroethene can be polymerised to form poly(tetrafluoroethene).

Draw **one** repeat unit of poly(tetrafluoroethene). Show all of the atoms and all of the bonds.

[2]

(v) Deduce the empirical formula of:

tetrafluoroethene .....

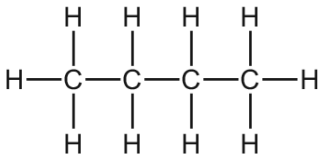
poly(tetrafluoroethene). .....
[2]

[Total: 20]

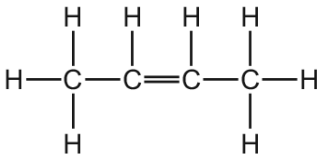
04. 0620_m17_qp_42 Q: 1

(a) Five organic compounds have the following structures.

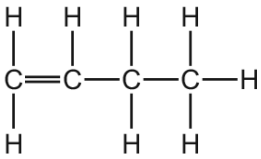
A



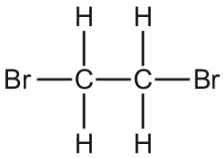
B



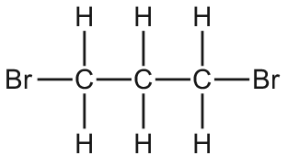
C



D



E



(i) Which compound is butane?

..... [1]

(ii) Which **two** compounds are structural isomers of each other?

..... [1]

(iii) Which compound can be made by reacting an alkene with bromine?

..... [1]

(iv) Which compound is a saturated hydrocarbon?

..... [1]

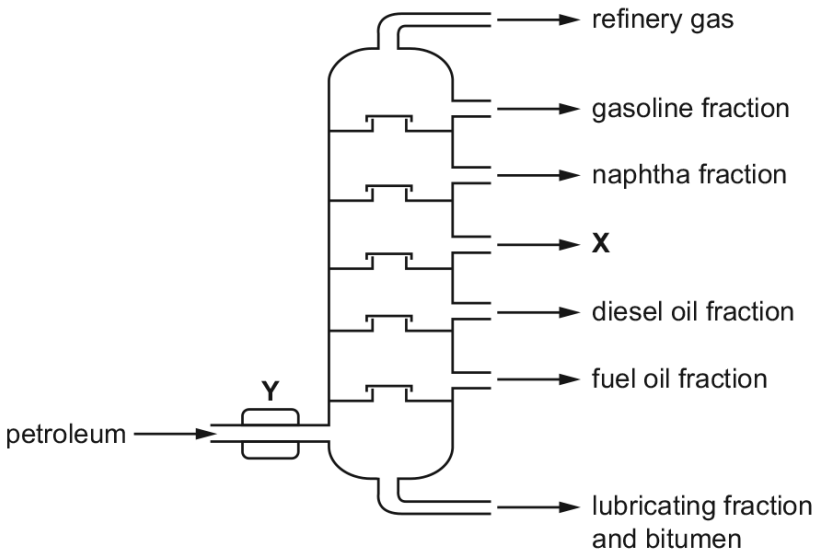
(v) Which compound has the empirical formula C_2H_5?

..... [1]

(vi) Name the **two** products made during the complete combustion of compound **C**.

..... [1]

(b) Petroleum can be separated into useful substances using the apparatus shown.



(i) Name the fraction which is the most viscous.

..... [1]

(ii) Name the fraction with the smallest molecules.

..... [1]

(iii) Name the fraction which has the weakest attractive forces between molecules.

..... [1]

(iv) Fraction **X** is used as jet fuel.

Name fraction **X**.

..... [1]

(v) What happens at point **Y** on the diagram?

..... [1]

[Total: 11]

05. 0620_s17_qp_43 Q: 4

Gasoline is used as a fuel for cars. It is a mixture of hydrocarbons.

(a) Name the raw material from which gasoline is obtained.

..... [1]

(b) One of the compounds in gasoline is heptane, C_7H_{16}. Heptane is a saturated hydrocarbon.

(i) What is meant by the term *saturated hydrocarbon*?

saturated .....

.....

hydrocarbon .....

.....

[3]

(ii) To which homologous series does heptane belong?

..... [1]

(iii) Give **two** characteristics of an homologous series.

1 .....

2 .....

[2]

(iv) Complete the chemical equation for the complete combustion of heptane.

C_7H_{16} + ...O_2 → ..... + ...

[2]

(c) Car engines produce carbon monoxide and oxides of nitrogen.

(i) Name an environmental problem that is caused by the release of oxides of nitrogen into the air.

..... [1]

(ii) Explain how carbon monoxide and oxides of nitrogen are formed in car engines.

carbon monoxide .....

.....

oxides of nitrogen .....

.....
[3]

(iii) State **one** adverse effect of carbon monoxide on human health.

..... [1]

(iv) Describe and explain how catalytic converters remove oxides of nitrogen from car engine exhaust fumes. You are advised to include a chemical equation in your answer.

.....

.....

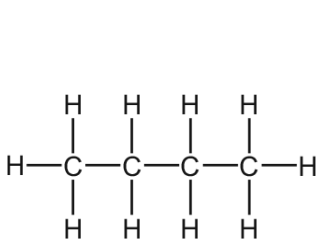
.....

.....

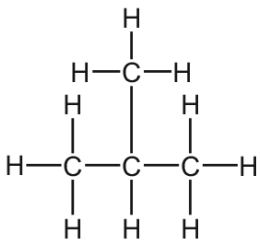
.....

..... [3]

(d) The formula C_4H_{10} represents two structural isomers, **A** and **B**.



A



B

(i) Name isomer **A**.

..... [1]

(ii) What is meant by the term *structural isomers*?

.....

.....

..... [2]

(iii) Isomer **B** reacts with chlorine in a substitution reaction.

Give the conditions required for the reaction to occur and draw the structures of **two** possible products, **one** of which is organic and **one** of which is **not** organic.

conditions .....

structures of products

[3]

[Total: 23]

06. 0620_w17_qp_43 Q: 6

(a) Alkanes and alkenes are two homologous series of hydrocarbons.

(i) What is meant by the term *hydrocarbon*?

..... [1]

(ii) What is the general formula of the homologous series of

alkanes, ...

alkenes? .....

[2]

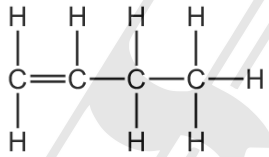
(iii) Other than having a general formula, state **two** characteristics of a homologous series.

1 .....

2 .....

[2]

(iv) The structure of an alkene molecule with the molecular formula C_4H_8 is shown.



Draw the structure of a different alkene molecule with the molecular formula C_4H_8. Show all of the atoms and all of the bonds.

[1]

(v) What term describes molecules with the same molecular formula but different structural formulae?

..... [1]

(b) 25 cm^3 of a gaseous hydrocarbon, C_xH_y, were burnt in 150 cm^3 of oxygen. This was an excess of oxygen.

After cooling, the volume of the gases remaining was 100 cm^3. This consisted of 75 cm^3 of carbon dioxide and 25 cm^3 of unreacted oxygen. The water that was produced in the reaction was liquid.

All volumes were measured at the same temperature and pressure.

(i) What is meant by an *excess* of oxygen?

..... [1]

(ii) What was the volume of oxygen that reacted with the hydrocarbon?

..... cm^3 [1]

(iii) Complete the table to show the smallest whole number ratio of volumes.

	volume of hydrocarbon reacted	:	volume of oxygen reacted	:	volume of carbon dioxide produced
smallest whole number ratio of volumes		:		:	

[1]

(iv) Use your answer to **(b)(iii)** to balance the chemical equation. Deduce the formula of the hydrocarbon.

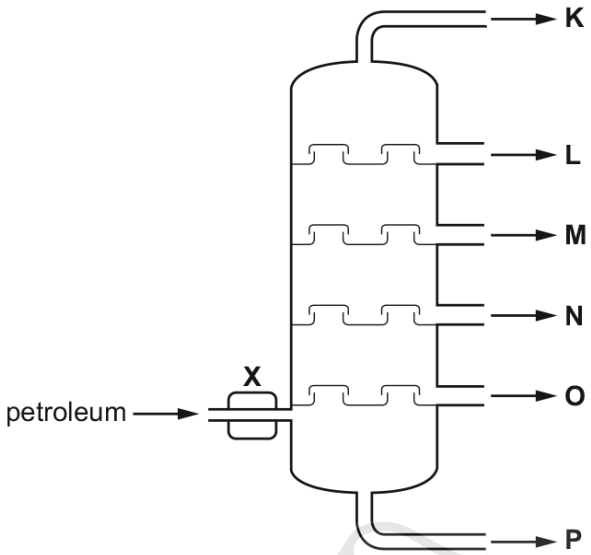
$$C_xH_y(g) + ...O_2(g) \rightarrow .....CO_2(g) + ...H_2O(l)$$

formula of the hydrocarbon = ... [2]

[Total: 12]

07. 0620_w16_qp_41 Q: 3

(a) Petroleum is a mixture of hydrocarbons. It is separated into useful fractions by fractional distillation. This can be done using the fractionating column shown.



(i) What happens to the petroleum at point **X**, before it enters the fractionating column?

.....

..... [1]

(ii) State **two** ways in which fraction **O** differs from fraction **L**.

.....

.....

..... [2]

(b) Most of the hydrocarbons obtained from petroleum are alkanes. The alkanes are an homologous series of saturated hydrocarbons with the general formula C_nH_{2n+2}.

Give **two** characteristics, other than having the same general formula, of members of an homologous series.

.....

.....

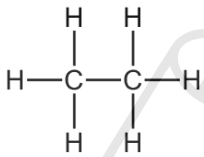
..... [2]

(c) The alkane with the molecular formula C_5H_{12} can exist as a number of structural isomers.

Draw the structures of **two** isomers with the formula C_5H_{12}.

[2]

(d) The alkane ethane has the structure shown.



When a mixture of ethane and chlorine is exposed to ultraviolet light a substitution reaction takes place.

Draw the structure of **one** organic product from this substitution reaction.

[1]

(e) Isoprene is a naturally occurring hydrocarbon.

(i) Explain how the name of isoprene suggests that it contains a C=C double bond.

..... [1]

(ii) A sample of isoprene had the following composition by mass: C, 88.24%; H, 11.76%.

Calculate the empirical formula of isoprene. Show all your working.

empirical formula = ... [3]

(iii) What additional information would be required to calculate the molecular formula of isoprene?

..... [1]

[Total: 13]

08. 0620_w16_qp_42 Q: 5

Chlorine, bromine and iodine are halogens.

(a) Chlorine can be made in the laboratory by heating manganese(IV) oxide with concentrated hydrochloric acid.

$$MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + 2H_2O(l) + Cl_2(g)$$

Calculate the volume of 8.00 mol / dm^3 $HCl(aq)$ needed to react with 3.48 g of MnO_2.

- moles of MnO_2 used

..... mol

- moles of HCl needed

..... mol

- volume of HCl needed

..... cm^3

[4]

(b) A student bubbled chlorine gas into a test-tube containing aqueous potassium bromide.

(i) Describe the colour change seen in the test-tube.

from ..... to .....

[2]

(ii) Complete the **ionic** equation for this reaction.

Include state symbols.

$$Cl_2(g) + ...Br^-(aq) \rightarrow ..... + ...$$

[3]

(c) When one mole of bromine, Br_2, reacts with one mole of propene, one organic product is formed.

(i) Which part of the propene molecule reacts with bromine?

..... [1]

(ii) What is the name of the type of reaction which takes place between bromine and propene?

..... [1]

(d) When one mole of chlorine, Cl_2, reacts with one mole of propane, a mixture of two structural isomers is formed.

(i) What is the name of the type of reaction which takes place between chlorine and propane?

..... [1]

(ii) Explain what is meant by the term *structural isomers*.

.....

..... [2]

(iii) Draw the structure of **two** structural isomers formed when **one** mole of chlorine reacts with **one** mole of propane.

(e) Iodine forms an oxide which has the composition by mass: I, 76.0%; O, 24.0%.

(i) Use this information to determine the empirical formula of this oxide of iodine.

empirical formula ..... [3]

(ii) The oxide of iodine in **(e)(i)** dissolves in water.

Predict and explain the effect of adding Universal Indicator to an aqueous solution of this oxide of iodine.

effect on Universal Indicator .....

explanation .....

[2]

[Total: 21]

---

09. 0620_w15_qp_33 Q: 2

Choose from the following list of gases. A gas may be chosen once, more than once or not at all.

sulfur dioxide **hydrogen** **methane** **carbon monoxide**

argon **ethene** **butane**

(a) It is used to bleach wood pulp. ..... [1]

(b) When burned in oxygen, the only product is water. ..... [1]

(c) It can polymerise. ..... [1]

(d) It is used to provide an inert atmosphere for welding. ..... [1]

(e) When reacted with oxygen, the only product is carbon dioxide. ..... [1]

(f) It is produced by the decay of vegetation in the absence of oxygen. ..... [1]

[Total: 6]

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10. 0620_w15_qp_33 Q: 4

Two homologous series of hydrocarbons are the alkanes and the alkenes.

(a) (i) One general characteristic of a homologous series is that the physical properties vary in a predictable way.

State **three** other general characteristics of a homologous series.

.....

.....

..... [3]

(ii) How can the molecular formula of a hydrocarbon show whether it is an alkane or an alkene?

.....

..... [2]

(iii) How do alkanes and alkenes differ in their molecular structures?

.....

..... [2]

(b) Cracking is the thermal decomposition of alkanes into smaller hydrocarbons and possibly hydrogen.

(i) State **two** conditions required for the cracking of an alkane.

..... [2]

(ii) One type of cracking produces an alkane and an alkene.

Complete an equation for the cracking of heptane into an alkane and an alkene.

$C_7H_{16} \rightarrow$ ..... + ... [1]

(iii) Complete an equation for the cracking of heptane into hydrogen and two other products.

$C_7H_{16} \rightarrow$ ..... + ... + H_2 [1]

(iv) Suggest **one** reason why cracking is important.

..... [1]

(c) Hydrocarbons burn in excess oxygen to form carbon dioxide and water. 20 cm^3 of a gaseous hydrocarbon burned in an excess of oxygen, 200 cm^3. After cooling, the volume of the residual gas at r.t.p. was 150 cm^3, 50 cm^3 of which was oxygen.

(i) Determine the volume of the oxygen used.

..... [1]

(ii) Determine the volume of the carbon dioxide formed.

..... [1]

(iii) The hydrocarbon was an alkane.

Determine the formula of the hydrocarbon.

[1]

[Total: 15]

11. 0620_s14_qp_33 Q: 1

Choose a gas from the following list to answer the questions below. Each gas may be used once, more than once or not at all.

ammonia **carbon dioxide** **carbon monoxide** **fluorine**

hydrogen **krypton** **nitrogen** **propene** **sulfur dioxide**

(a) It is a product of respiration. ..... [1]

(b) It polymerises to form a poly(alkene). ..... [1]

(c) It is a noble gas. ..... [1]

(d) It is the main component of air. ..... [1]

(e) It is a very reactive non-metal. ..... [1]

(f) It is used to kill micro-organisms in fruit juice. ..... [1]

(g) It burns to form water as the only product. ..... [1]

[Total: 7]

12. 0620_s14_qp_33 Q: 6

The alkanes are a family of saturated hydrocarbons. Their reactions include combustion, cracking and substitution.

(a) (i) What is meant by the term *hydrocarbon*?

..... [1]

(ii) What is meant by the term *saturated*?

..... [1]

(b) (i) What is the general formula for the homologous series of alkanes?

..... [1]

(ii) Calculate the mass of one mole of an alkane with 14 carbon atoms.

.....

..... [2]

(c) The complete combustion of hydrocarbons produces carbon dioxide and water only.

(i) Write the equation for the complete combustion of nonane, C_9H_{20}.

..... [2]

(ii) 20 cm^3 of a gaseous hydrocarbon was mixed with an excess of oxygen, 200 cm^3. The mixture was ignited. After cooling, 40 cm^3 of oxygen and 100 cm^3 of carbon dioxide remained. Deduce the formula of the hydrocarbon and the equation for its combustion. All volumes were measured at r.t.p..

.....

.....

.....

.....

..... [3]

(d) Cracking is used to obtain short-chain alkanes, alkenes and hydrogen from long-chain alkanes.

(i) Give a use for each of the three products listed above.

short-chain alkanes .....

alkenes .....

hydrogen ..... [3]

(ii) Write an equation for the cracking of decane, $C_{10}H_{22}$, which produces two different alkenes and hydrogen as the only products.

..... [1]

(e) Chlorine reacts with propane in a substitution reaction to form 1-chloropropane.

$$CH_3-CH_2-CH_3 + Cl_2 \rightarrow CH_3-CH_2-CH_2-Cl + HCl$$

(i) What is the essential condition for the above reaction?

..... [1]

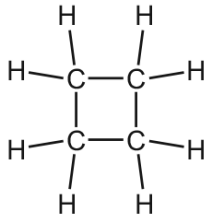
(ii) There is more than one possible substitution reaction between chlorine and propane. Suggest the structural formula of a different product.

..... [1]

[Total: 16]

13. 0620_w14_qp_32 Q: 3

(a) A hydrocarbon has the following structural formula.



(i) State the molecular formula and the empirical formula of this hydrocarbon.

molecular formula .....

empirical formula .....

[2]

(ii) Draw the structural formula of an isomer of the above hydrocarbon.

[1]

(iii) Explain why these two hydrocarbons are isomers.

.....

..... [2]

(iv) Are these two hydrocarbons members of the same homologous series?
Give a reason for your choice.

.....

..... [1]

(b) Alkenes can be made from alkanes by cracking.

(i) Explain the term *cracking*.

.....

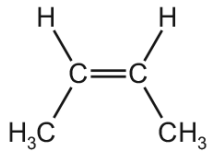
..... [2]

(ii) One mole of an alkane, when cracked, produced one mole of hexane, C_6H_{14}, and two moles of ethene.
What is the molecular formula of the original alkane?

..... [1]

(c) Alkenes are used in polymerisation reactions and addition reactions.

(i) Draw the structural formula of the product formed by the addition polymerisation of but-2-ene. Its formula is given below.



[3]

(ii) Give the name and structural formula of the addition product formed from ethene and bromine.

name .....

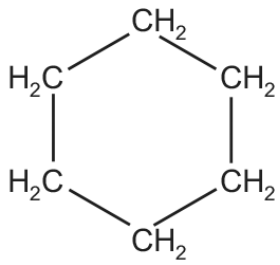
structural formula

[2]

[Total: 14]

14. 0620_s13_qp_31 Q: 4

The structural formula of cyclohexane is drawn below.



(a) The name gives information about the structure of the compound.
Hex because there are six carbon atoms and **cyclo** because they are joined in a ring.
What information about the structure of this compound is given by the ending **ane**?

.....

..... [2]

(b) What are the molecular and empirical formulae of cyclohexane?

molecular formula .....

empirical formula ..... [2]

(c) Draw the structural formula of cyclobutane.

[1]

(d) **(i)** Deduce the molecular formula of hexene.

..... [1]

(ii) Explain why cyclohexane and the alkene, hexene, are isomers.

.....

.....

..... [2]

(e) Describe a test which would distinguish between cyclohexane and the unsaturated hydrocarbon hexene.

test .....

result of test with cyclohexane .....

.....

result of test with hexene .....

..... [3]

[Total: 11]

15. 0620_w12_qp_33 Q: 2

(a) State a use for each of the following gases.

(i) chlorine ..... [1]

(ii) argon ..... [1]

(iii) ethene ..... [1]

(iv) oxygen ..... [1]

(b) Describe how oxygen is obtained from air.

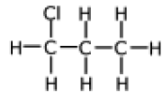
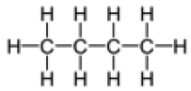
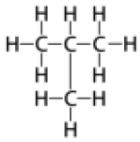
.....

..... [2]

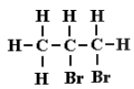
[Total: 6]

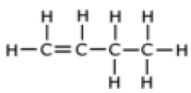
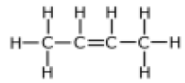
01. 0620_w20_ms_41 Q: 6

Question	Answer	Marks
(a)(i)	alkanes	1
(a)(ii)	one mark each for any two of: • same chemical properties • same functional group • same general formula • (consecutive members) differ by CH_2 • common (allow similar) methods of preparation • physical properties vary in predictable manner / show trends / gradually change OR example of a physical property variation i.e. melting point / boiling point / volatility (1)	2
(b)	3.01×10^{23} (molecules)	1

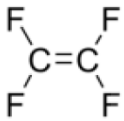
Question	Answer	Marks
(c)(i)	HCl	1
(c)(ii)		1
(c)(ii)	substitution	1
(d)(i)	from: orange (1) to: colourless (1)	2
(d)(ii)	contains no double bonds/ethane **only** contains single bonds	1
(e)(i)	 (1)  (1)	2
(e)(ii)	C_2H_4	1
(f)(i)	(C = 85.7, H = 14.3, M_r 112) C = $\frac{85.7}{12}$ = 7.14 H = $\frac{14.3}{1}$ = 14.3 (1) (ratio = 7.13 : 14.3 = 1 : 2) CH_2 (2)	2
(f)(ii)	C_8H_{16}	1

02. 0620_w20_ms_42 Q: 4

Question	Answer	Marks
(a)	hydrocarbon	1
(b)(i)	(only) one product is formed	1
(b)(ii)	 3 single bonded C atoms entire molecule correct	2
(b)(iii)	orange (1) to colourless (1)	2

Question	Answer	Marks
(b)(iv	structure of but-1-ene  structure of but-2-ene 	2
(c)	$C_3H_8 + Cl_2 \rightarrow C_3H_7Cl + HCl$ HCl as product rest of equation	2

03. 0620_m19_ms_42 Q: 3

(a)	gas / gaseous	1
(b)	**M1** 1 shared pair of electrons(1) **M2** 6 non-bonding electrons on each atom to complete an octet(1)	2
(c)	$2Na + F_2 \rightarrow 2NaF$ **M1** NaF anywhere(1) **M2** equation fully correct(1)	2
(d)	chlor**ine** less reactive than fluor**ine ORA**	1
(e)(i)	PbF_2	1
(e)(ii)	covalent	1
(e)(iii)	giant ionic lattice	1
(e)(iv)	**M1**(It or lead(II) fluoride) forces of attraction between ions / ionic bonds(1) **M2**(tetrafluoromethane) forces of attraction between molecules(1) **M3** ionic bonds stronger than attractive forces between molecules / ionic bonds need more energy to break than attractive forces between molecules(1)	3
(f)(i)	not all the bonds are single bonds	1
(f)(ii)	**M1** bromine / bromine water(1) **M2** turns colourless / decolourises(1)	2
(f)(iii)		1

(f)(iv)	 **M1** C-C(1) **M2** each C bonded to 2 F and no other atoms + extension bonds(1)	2
(f)(v)	**M1** CF_2(1) **M2** CF_2(1)	2

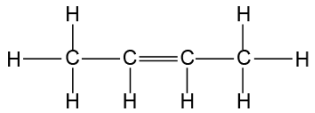
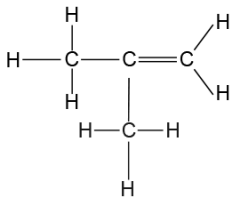
04. 0620_m17_ms_42 Q: 1

(a)(i)	**A**	1
(a)(ii)	**B and C**	1
(a)(iii)	**D**	1
(a)(iv)	**A**	1
(a)(v)	**A**	1
(a)(vi)	carbon dioxide **and** water	1
(b)(i)	bitumen	1
(b)(ii)	refinery gas	1
(b)(iii)	refinery gas	1
(b)(iv)	kerosene	1
(b)(v)	heated / boiled / evaporated / vaporised	1

05. 0620_s17_ms_43 Q: 4

(a)	petroleum	1
(b)(i)	*saturated:* only single bonds **OR** no double / multiple bonds (between carbon atoms)	1
	hydrocarbon: (compound that) contains carbon and hydrogen	1
	hydrocarbon: and no other elements / only	1
(b)(ii)	alkane(s)	1
(b)(iii)	any 2 from: □ same / similar chemical properties □ (same) general formula □ (consecutive members) differ by CH_2 □ same functional group □ common (allow similar) methods of preparation □ physical properties vary in predictable manner / show trends / gradually change / example of a physical property variation	2
(b)(iv)	CO_2 and H_2O on right-hand side and no other products / reagents	1
	11 (O_2), 7 (CO_2), 8 (H_2O)	1
(c)(i)	acid rain	1
(c)(ii)	*carbon monoxide*: from incomplete combustion (of fuel)	1
	oxides of nitrogen: nitrogen (from the air) reacts with oxygen (from the air)	1
	oxides of nitrogen: at high temperatures (in engine) **OR** (electrical) spark (in the engine)	1
(c)(iii)	poisonous / toxic / death	1
(c)(iv)	any 3 from: □ oxides of nitrogen are reduced / lose oxygen (to form nitrogen) □ oxides of nitrogen form nitrogen □ (oxides of nitrogen) react with carbon monoxide □ gases (adsorb / stick) on the catalyst's surface	3
(d)(i)	butane	1
(d)(ii)	(molecules with) the same molecular formula	1
	different structural formula / different displayed formula	1
(d)(iii)	**UV** light / **sun**light	1
	H–C*l*	1
	any mono to deca chloro-substituted derivative of methyl propane	1

06. 0620_w17_ms_43 Q: 6

(a)(i)	compounds containing carbon and hydrogen **only**	**1**
(a)(ii)	*alkanes:* C_nH_{2n+2}	**1**
	alkenes: C_nH_{2n}	**1**
(a)(iii)	any 2 from: □ same or similar chemical properties □ (consecutive members) differ by CH_2 □ same functional group □ common (allow similar) methods of preparation □ physical properties vary in predictable manner / show trends / gradually change **OR** example of a physical property variation	**2**
(a)(iv)	 **OR** 	**1**
(a)(v)	structural isomers	**1**

(b)(i)	**more than** enough oxygen to react with **all** of the hydrocarbon	**1**
(b)(ii)	125 (cm^3)	**1**
(b)(iii)	1:5:3	**1**
(b)(iv)	C_3H_8 If full credit is not awarded, allow 1 mark for $C_xH_y(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$	**2**

07. 0620_w16_ms_41 Q: 3

(a)(i)	heated / evaporated / boiled	**1**
(a)(ii)	any 2 from: (**O** is) more viscous / thicker (**O** is) darker (**O** has) longer / bigger molecules / more carbon atoms (**O** has a) higher boiling point **OR** melting point (**O** is) less flammable	**2**
(b)	any 2 from: similar / same chemical properties same functional group trend / pattern in physical properties (neighbouring members) differ by CH_2 common methods of preparation	**2**
(c)	any 2 structures from: pentane methylbutane dimethylpropane	**2**
(d)	correct structure with any number from 1 to 6 of the hydrogen atoms replaced by chlorine atoms	**1**
(e)(i)	(ends in) ene	**1**
(e)(ii)	**M1** 88.24 / 12 **AND** 11.76 / 1 **M2** 7.353 / 7.353 (= 1) **AND** 11.76 / 7.353 = (1.6) **M3** C_5H_8	**1** **1** **1**
(e)(iii)	relative molecular mass	**1**

08. 0620_w16_ms_42 Q: 5

(a)	$20\,cm^3$ **M1** M_r of MnO_2: 87 **M2** moles of MnO_2 used: 3.48 / 87 = 0.04 **M3** moles of HC*l* needed: 0.04 × 4 = 0.16 **M4** volume of HC*l* needed: (0.16 / 8.0) × 1000 **AND** $20\,cm^3$	**4**
(b)(i)	from colourless to yellow / orange / brown	**2**
(b)(ii)	$Cl_2(g) + 2Br^-(aq) \rightarrow Br_2(aq) + 2Cl^-(aq)$ **M1** (aq) as state symbols for the two products given **M2** correct products **M3** balancing	**3**

(c)(i)	the (C=C) double bond	**1**
(c)(ii)	addition **OR** bromination	**1**
(d)(i)	substitution	**1**
(d)(ii)	(compounds with the) same molecular formula different structural formulae or structures	**2**
(d)(iii)	structure of 1–chloropropane structure of 2–chloropropane	**2**
(e)(i)	I_2O_5 **M1** 76.0 / 127 **AND** 24.0 / 16.0 **M2** 0.59 **AND** 1.5 **OR** 1 **AND** 2.5 **M3** I_2O_5	**3**
(e)(ii)	(turns) red / pink / orange / yellow iodine is a non-metal	**2**

09. 0620_w15_ms_33 Q: 2

(a)	sulfur dioxide / SO_2;	**1**
(b)	hydrogen / H_2;	**1**
(c)	ethene / C_2H_4;	**1**
(d)	argon / Ar;	**1**
(e)	carbon monoxide / CO;	**1**
(f)	methane / CH_4;	**1**

10. 0620_w15_ms_33 Q : 4

(a)(i)	any three from: • (same) general (molecular) formula; • (consecutive members) differ by CH_2; • same functional group; • common (allow similar) methods of preparation; • same / similar chemical properties / (chemical) reactions;	**3**
(a)(ii)	C_nH_{2n} alkene; C_nH_{2n+2} alkane;	**1** **1**
(a)(iii)	alkanes <u>all</u> or <u>only</u> (C–C) single bonds / no double bonds / no multiple bonds; alkenes (at least one) C=C / double bond / multiple bond;	**1** **1**
(b)(i)	heat / high temperature / temperature between 450 °C and 800 °C; catalyst / named catalyst, e.g. zeolites or alumina or aluminium oxide or aluminosilicates or silica or oxides of chromium; **or** high pressure / pressure in range of 2–70 atm; **or** steam; absence of air / oxygen;	**2**
(b)(ii)	any correct equation producing an alkane and an alkene adding up to seven carbon atoms in the products;	**1**

(b)(iii)	any correct equation producing two alkenes and hydrogen, e.g. → C_2H_4 + C_5H_{10} + H_2 / C_3H_6 + C_4H_8 + H_2;	1
(b)(iv)	**alkenes:** more useful than alkanes / used to make polymers or plastics / used to make chemicals / petrochemicals; **or** **alkanes:** (balance the demand for different) fuels / increase petrol (fraction) or hydrogen / produce lighter fractions from heavier fractions or suitable example, e.g. naphtha to gasoline / more useful smaller molecules or more demand for smaller molecules or more demand for smaller fractions / used as fuel / used to make ammonia / used in Haber process / used in hydrogenation of vegetable oils / used to make HC*l*;	1 1
(c)(i)	150 (cm^3);	1
(c)(ii)	100 (cm^3);	1
(c)(iii)	This question was discounted.	1

11. 0620_s14_ms_33 Q: 1

(a) carbon dioxide (1) [1]

(b) propene (1) [1]

(c) krypton (1) [1]

(d) nitrogen (1) [1]

(e) fluorine (1) [1]

(f) sulfur dioxide (1) [1]

(g) hydrogen (1) [1]

[Total: 7]

12. 0620_s14_ms_33 Q: 6

(a) (i) C and H only (1) [1]

(ii) only single bonds (1) [1]

(b) (i) C_nH_{2n+2} (1) [1]

(ii) $C_{14}H_{30}$ (1)
$(14 \times 12) + 30 = 198$ (g) (1) [2]

(c) (i) $C_9H_{20} + 14\ O_2 \rightarrow 9CO_2 + 10H_2O$ (2) [2]

(ii) Volume ratio

$C_xH_y(g)$	+	$O_2(g)$	→	$CO_2(g)$	+	$H_2O(l)$	
20		160		100			all in cm^3
1		8		5			mole ratio
C_5H_{12}	+	$8O_2$	→	$5CO_2$	+	$6H_2O$	

For evidence of method (1)
for equation as above (2) [3]

(d) (i) alkanes in petrol / fuel / solvent (1)
alkenes to make alcohols / plastics / polymers / solvents (1)
hydrogen to make ammonia / fuel / fuel cells, etc. (1) [3]

(ii) a correct equation for example:
$C_{10}H_{22} \rightarrow C_8H_{16} + C_2H_4 + H_2$ (1) [1]

(e) (i) light **or** lead tetraethyl / catalyst / high temperature (1) [1]

(ii) $CH_3–CHCl–CH_3$ (1) [1]

[Total: 16]

13. 0620_w14_ms_32 Q: 3

(a) (i) C_4H_8 only
CH_2 (Allow C_1H_2) [2]

(ii) Any unambiguous structural formula of methyl cyclopropane or but-1-ene or but-2-ene or methyl propene [1]

(iii) M1 same molecular formula [1]

M2 different structural formulae or different structures
or different arrangement of atoms [1]

(iv) If 'No':
one an alkane, the other an alkene
or
one is saturated / has single bonds, the other is unsaturated / has a double bond
ignore: references to the 'functional group'

If 'yes'
both alkanes **or** both saturated
ignore: references to the 'functional group' [1]

(b) (i) M1 Action of heat or catalyst or thermal decomposition (on an alkane) [1]
Ignore steam. Ignore pressure.

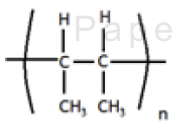
M2 Long-chained molecules or alkanes form smaller molecules (not smaller fraction) or forms smaller alkenes (or alkanes) [1]

(ii) $C_{10}H_{22}$ [1]

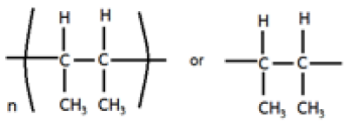
(c) (i) M1 Correct structure of one repeat unit [1]

M2 Continuation bonds **COND** on M1 [1]

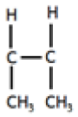
M3 use of brackets and subscript 'n' **COND** on M1 and M2 [1]



= 3 marks



= 2 marks



= 1 mark

(ii) dibromoethane or 1,2-dibromoethane [1]

14. 0620_s13_ms_31 Q: 4

(a) it is an alkane **or** hydrocarbon [1]
it is saturated **or** only C—C single bonds [1]
accept: no double bonds

(b) molecular formula C_6H_{12} [1]
empirical formula CH_2 [1]

(c) correct structural formula of cyclobutane [1]

(d) **(i)** C_6H_{12} [1]
accept: a correct structural formula

(ii) same molecular formula **not**: chemical formula [1]
different structural formulae / structures [1]

(e) add bromine (water) or (l) [1]

cond: (remains) brown **or** orange **or** red or yellow [1]

cond: changes from brown, etc. to colourless or decolourises [1]
not: clear

OR
potassium manganate(VII) [1]
note: oxidation state not essential but if given must be correct or [0]
accept: potassium permanganate

cond: remains pink / purple [1]

cond: changes from pink to colourless **(acidic)** [1]
not: clear

cond: change from pink to green / brown **(alkaline)**

[Total: 11]

15. 0620_w12_ms_33 Q: 2

(a) **(i)** manufacture of plastics / (solvents for) dry cleaning / metal degreasing / textiles / agrochemicals / pharmaceuticals / insecticides / dyestuffs / household cleaning products / bleach / water treatment / swimming pools / kill bacteria or germs or microorganisms or pathogens / sterilisation / disinfectants; [1]

(ii) electric light bulbs / fluorescent tubes / (inert gas shield for) arc welding / production of titanium / inert atmosphere / car headlights / food packaging; [1]

(iii) (manufacture of) polyethene / polyvinyl chloride (PVC) / making polymers / (to prepare) epoxyethane (which is used in the manufacture of detergents / (to make) ethylene glycol (which is used to prepare Terylene) / (to make) anti-freeze / or making ethanol (accept making alcohol) / ripening fruits; [1]

(iv) (making) steel / (oxy-acetylene) welding / cutting of metals / medical or diving or (oxygen tanks in) hospitals / astronauts / (deep sea) diving / fire fighters; [1]

(b) liquid air; [1]
fractional distillation; [1]

[Total: 6]