APPLIED SCIENCE AAQ

BRIDGING PROJECT – CHEMISTRY

The topics in this booklet are covered in the AQA Combined Science Foundation Level specification and also form part of the Unit 2 assessment for this qualification, so it is vitally important you recap these in preparation for the course.

Please complete the tasks within and bring the completed booklet to your first lesson in September.

Name: _____

Electronic Structure

Fill in the table below with the names and properties of the subatomic particles

Particle name	Location in atom	Relative charge	Relative mass

Fill in the table below with the names and properties of the first 20 elements in the Periodic Table

Element name & symbol	Atomic number	Atomic mass number	Period number	Group number	Electron configuration
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

Calculate the number of each subatomic particle in the following atoms *(Hint: P-E-N are the initial letters of each subatomic particle)*

1 H 1	4 He 2	7 Li 3	9 Be 4	11 B 5
P: E: N:	P: E: N:	P: E: N:	P: E: N:	P: E: N:

12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10
P: E: N:	P: E: N:	P: E: N:	P: E: N:	P: E: N:

35 Cl 17	37 Cl 17	40 Ca 20	51 V 23	60 Co 27
P: E: N:	P: E: N:	P: E: N:	P: E: N:	P: E: N:

90 Sr 38	99 Tc 43	131 Cs 55	211 Po 84	238 U 92
P: E: N:	P: E: N:	P: E: N:	P: E: N:	P: E: N:

Define the term "isotope"

_____

_____

Identify the 2 atoms which are isotopes of the same element and describe their similarities and differences *(Hint: Refer to the number of subatomic particles each atom has in your answer)*

_____

_____

Define relative atomic mass

_____

_____

Calculate the relative atomic mass (2 d.p.) of the following elements from their isotopic abundances

1. Boron: ^{10}B = 19.9%, ^{11}B = 80.1%

2. Nitrogen: ^{14}N = 99.6%, ^{15}N = 0.4%

3. Silicon: ^{28}Si = 92.2%, ^{29}Si = 4.7%, ^{30}Si = 3.1%

4. Titanium: ^{46}Ti = 8.3%, ^{47}Ti = 7.4%, ^{48}Ti = 73.7%, ^{49}Ti, 5.4%, ^{50}Ti = 5.2%

5. Germanium: ^{70}Ge = 20.8%, ^{72}Ge = 27.6%, ^{73}Ge = 7.7%, ^{74}Ge = 36.3%, ^{76}Ge = 7.6%

Calculate the relative atomic mass of the third isotope of element *X* based on the data below

Relative atomic mass of isotope	24	25
Percentage abundance	79.0	10.0

Relative atomic mass of element of ***X*** = 24.32

Relative atomic mass of third isotope = _____

Bonding

Draw a diagram of metallic bonding including the following labels: positive metal ions, delocalised electrons. Describe the arrangement of atoms in metallic bonding and how they are held together

_____

_____

_____

_____

_____

_____

Explain how the following properties of substances with metallic bonding arise based on how this type of binding works

High melting points:

_____

_____

Good thermal and electrical conductivity as solids:

_____

_____

Malleability and ductility:

_____

_____

Draw a diagram of an alloy and describe how its structure and properties are different from a pure metal

_____

_____

_____

_____

_____

Complete the table by filling each box with the missing formula for each ionic compound

	Chloride **Cl^-**	Oxide **O^{2-}**	Bromide **Br^-**	Sulfide **S^{2-}**	Iodide **I^-**	Hydroxide **OH^-**	Nitrate **NO_3^-**	Sulfate **SO_4^{2-}**	Carbonate **CO_3^{2-}**	Phosphate **PO_4^{3-}**
Hydrogen **H^+**										
Lithium **Li^+**										
Sodium **Na^+**										
Potassium **K^+**										
Magnesium **Mg^{2+}**										
Calcium **Ca^{2+}**										
Barium **Ba^{2+}**										
Silver (I) **Ag^+**										
Copper (II) **Cu^{2+}**										
Iron (III) **Fe^{3+}**										
Titanium (IV) **Ti^{4+}**										
Ammonium **NH_4^+**										

For each of the elements below:

- Identify its group number and if it is a metallic or non-metallic element
- Deduce how many electrons are lost or gained when an ion is formed
- Write the symbol for the ion which is formed

1. Sodium, Na
2. Fluorine, F
3. Oxygen, O
4. Magnesium, Mg
5. Aluminium, Al
6. Potassium, K
7. Chlorine, Cl
8. Calcium, Ca
9. Sulfur, S
10. Phosphorus, P

Draw diagrams of the electron configuration of the ions formed for questions 1-5, then 6-10. Identify the 2 elements which also share this electron configuration

1-5:

6-10:

Element: _____

Element: _____

Draw a diagram of what happens magnesium chloride is formed from its elements. Include labels and references to electron movement and ionic charge in your answer

Draw a diagram of the lattice arrangement in ionic substances and describe how it is held together

_____

_____

_____

_____

Explain how the following properties of substances with ionic bonding arise based on how this type of binding works

High melting points:

_____

_____

Good thermal and electrical conductivity but only as liquids and solutions in water:

_____

_____

Draw dot-and-cross bonding diagrams for the following molecules

1. Hydrogen, H_2
2. Chlorine, Cl_2
3. Oxygen, O_2
4. Nitrogen, N_2
5. Methane, CH_4
6. Ammonia, NH_3
7. Water, H_2O
8. Hydrogen chloride, HCl
9. Carbon dioxide, CO_2
10. Hydrogen cyanide, HCN

Explain how the following properties of substances with covalent bonding arise based on how this type of binding works

Low melting points:

_____

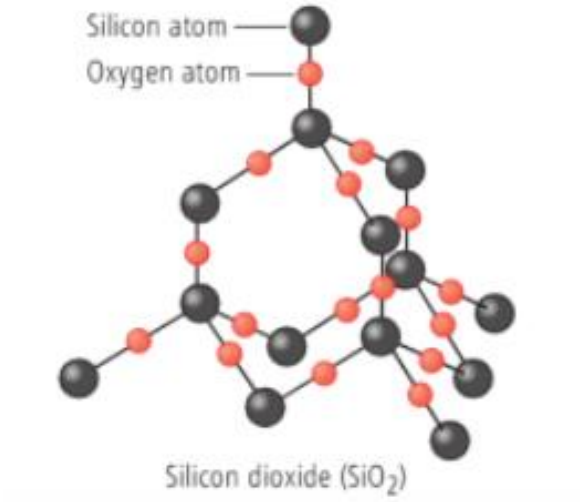
_____

Very poor or no thermal and electrical conductivity in any state:

_____

_____

Silicon oxide, SiO_2, or "silica" is a macromolecular compound (a.k.a. giant covalent structure). Describe as fully as possible the structure of silica (See diagram below)



_____

_____

_____

_____

_____

_____

Complete the table below on properties of macromolecular structures made of carbon

Carbon allotrope	No. of C atoms bonded from each C atom	Hard or soft?	Melting point: high/low? Explain (same for both)	Conductivity: poor/good? Explain
Diamond				
Graphite				

Quantitative Chemistry

Calculate the relative formula mass of the following compounds, then the percentage of each relative formula mass contributed by the specified element

Compound	Relative formula mass	Element	%Element in compound
H_2O		O	
CO_2		C	
SiO_2		Si	
SF_6		F	
CaF_2		F	
$FeSO_4$		Fe	
Na_2CO_3		Na	
$Ca(OH)_2$		Ca	
$Al_2(SO_4)_3$		Al	
$(NH_4)_3PO_4$		N	

Balance the following equations

1. __ H_2 + __ Cl_2 → __ HCl

2. __ Zn + __ O_2 → __ ZnO

3. __ Al + __ Cl_2 → __ $AlCl_3$

4. __ Fe + __ O_2 → __ Fe_2O_3

5. __ NaOH + __ H_2SO_4 → __ Na_2SO_4 + __ H_2O

6. __ KOH + __ H_3PO_4 → __ K_3PO_4 + __ H_2O

7. __ $CaCl_2$ + __ KOH → __ $Ca(OH)_2$ + __ KCl

8. __ K + __ H_2O → __ KOH + __ H_2

9. __ K_2SO_3 + __ HCl → __ KCl + __ SO_2 + __ H_2O

10. __ $Pb(NO_3)_2$ → __ PbO + __ NO_2 + __ O_2

Recall the formula and units linking solution concentration, mass and solution volume

Answer the following questions on concentration calculations

1. What volume is required to make a 1.9 g/cm^3 solution using 0.95 g of salt?

2. How many kg of salt would you need to add to make 3 dm^3 of a 600 g/dm^3 salt solution?

3. Ernest needs to make as much 500 g/dm^3 of NaOH solution as possible. He has 1.5 kg of NaOH pellets. How much solution can he make? Give your answer in dm^3.

4. Calculate the concentration of a salt solution with 9.7 g of salt in 500 cm^3? Give your answer in g/dm^3.

5. How many kg of salt would you need to add to make 6 dm^3 of a 500 g/dm^3 salt solution?

Rates of reaction

State the three things needed for a reaction to occur

1. _____

2. _____

3. _____

Explain using your answer to the question above why the following factors affect the rate of reaction (*Hint: all of the answers either relate to the frequency of these events)*

Concentration/gas pressure

_____

_____

_____

_____

Temperature

_____

_____

_____

_____

Surface area to volume ratio

_____

_____

_____

_____

Catalyst

_____

_____

_____

_____

Define the terms exothermic and endothermic and give an example of each type of reaction

Exothermic: _____

Example: _____

Endothermic: _____

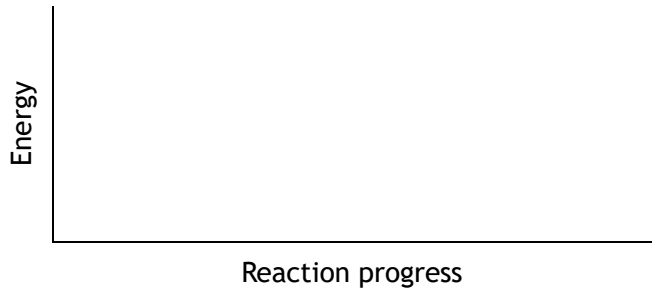
Example: _____

Complete the energy level diagrams and reaction profile diagrams for an exothermic and an exothermic reaction including the following labels

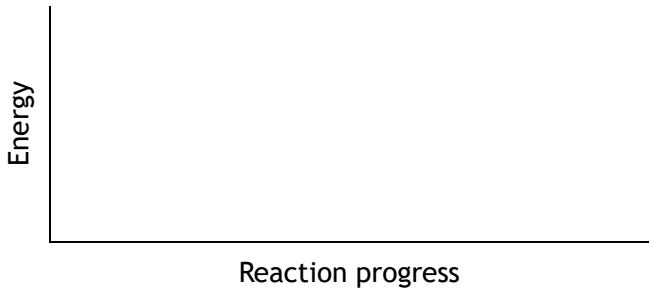
- Both axes labels
- Reactants and products
- Total energy change
- Activation energy (Reaction profiles diagrams only)

<u>Energy level diagrams:</u>

EXOTHERMIC REACTION

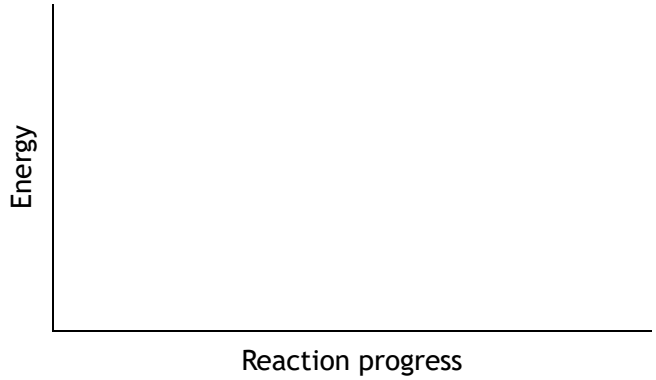


ENDOTHERMIC REACTION

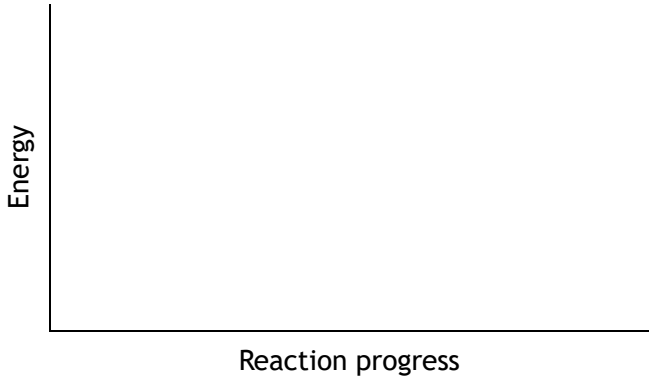


<u>Reaction profile diagrams:</u>

EXOTHERMIC REACTION



ENDOTHERMIC REACTION



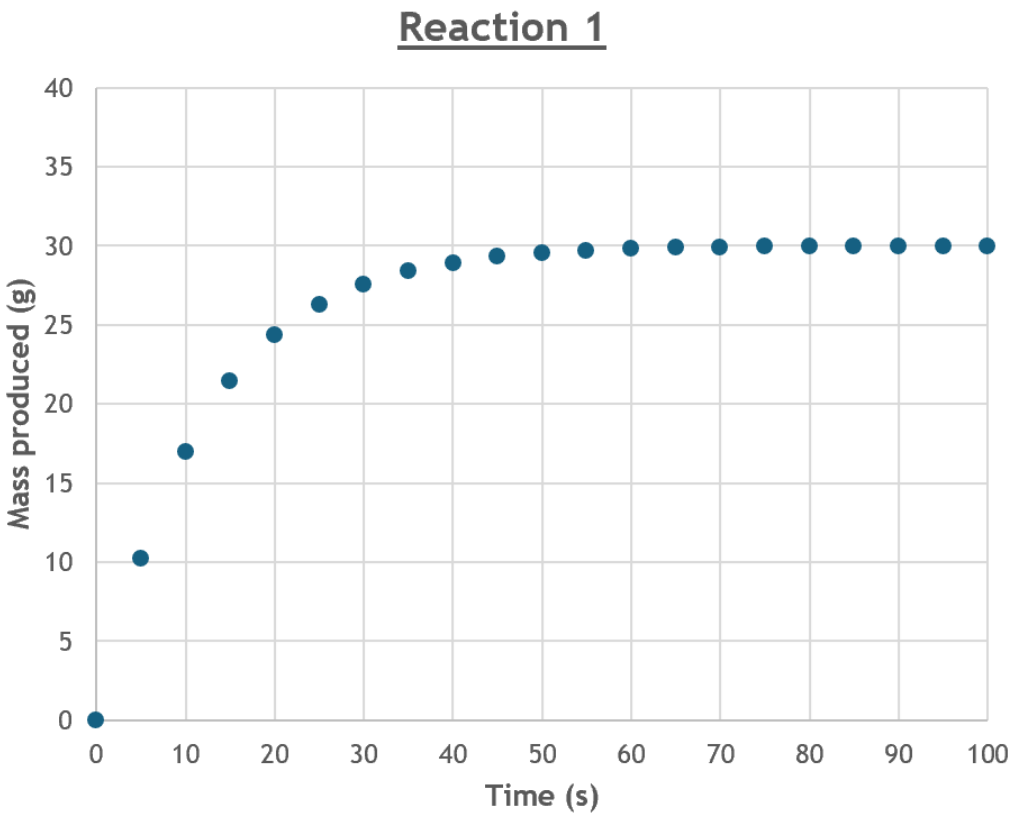
Define activation energy

_____

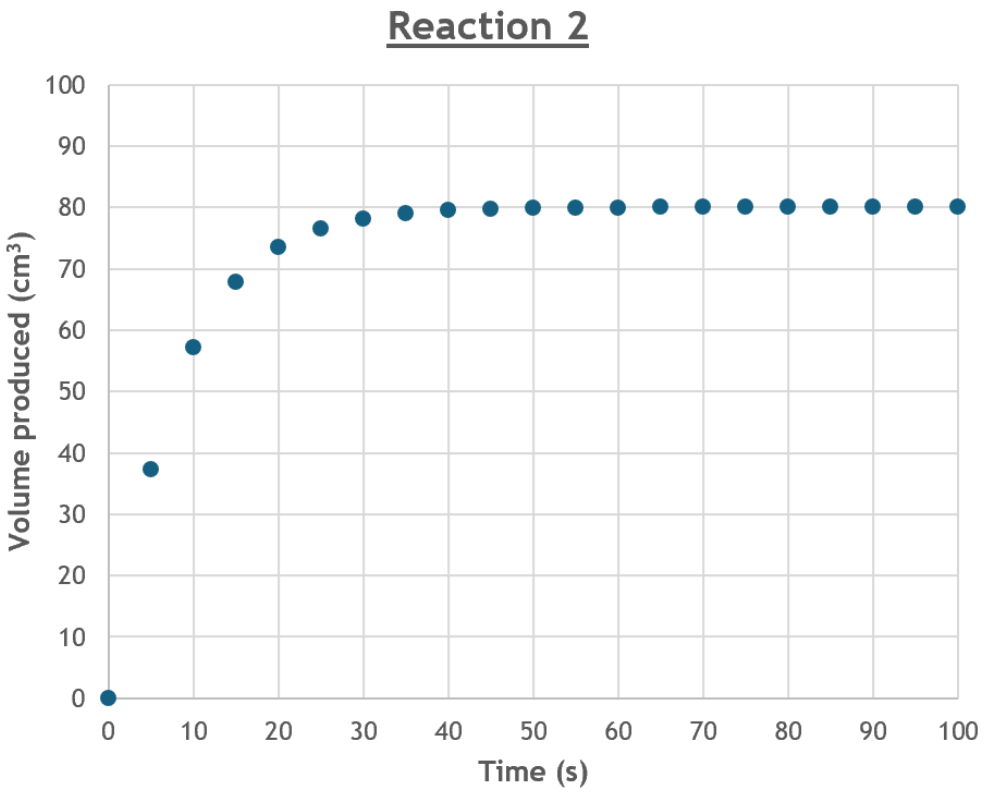
_____

Deduce the following properties of the reactions shown in the graphs below

- Total reaction time
- Overall rate of reaction

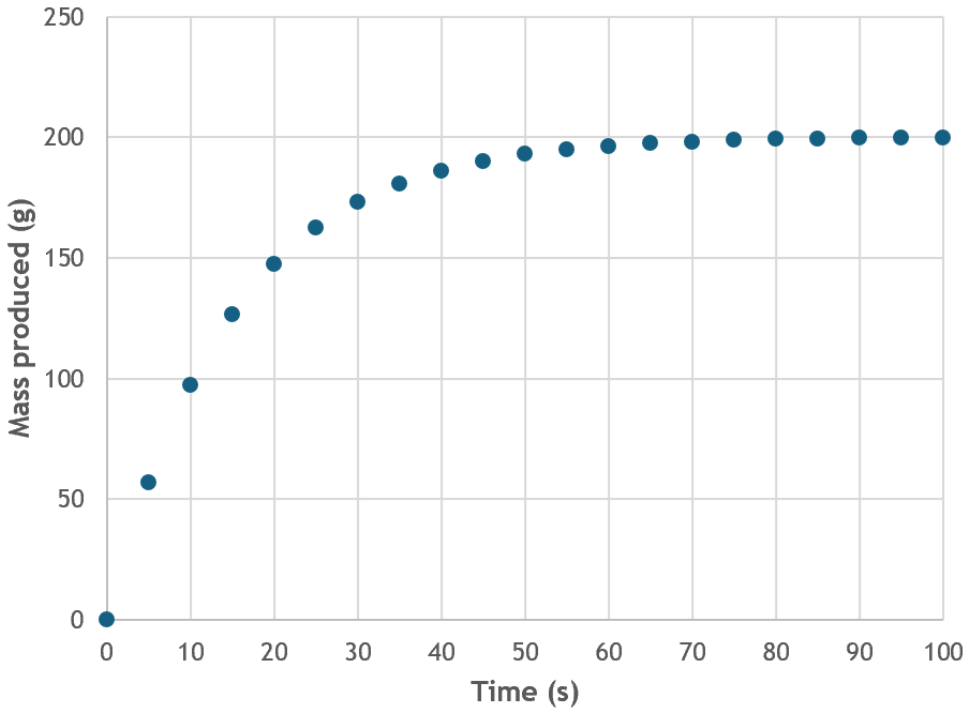


Total reaction time: _____ Overall rate of reaction: _____



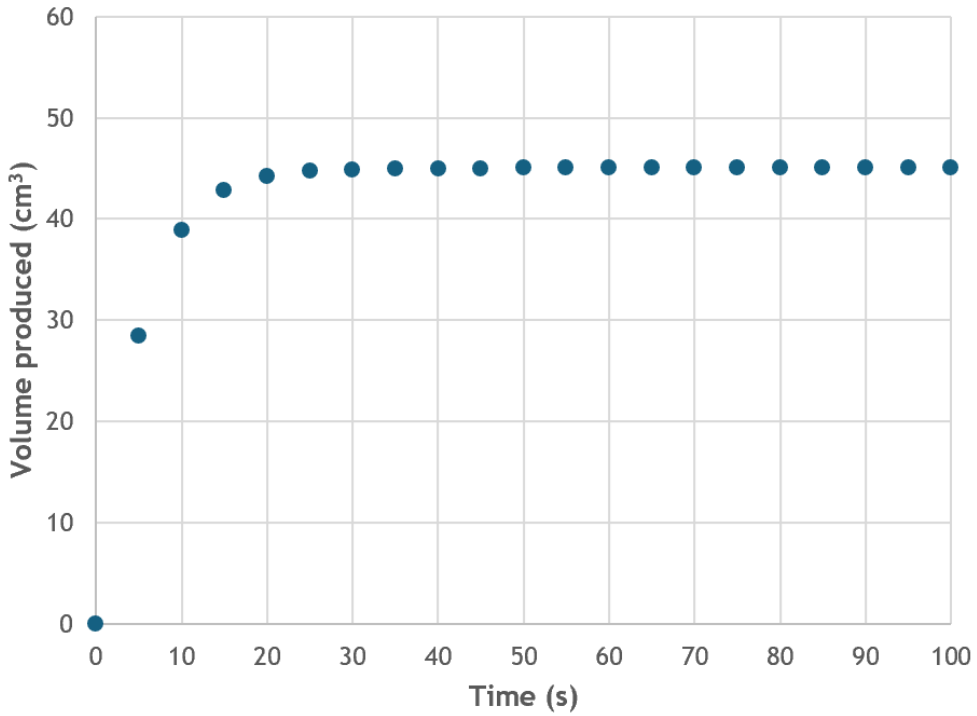
Total reaction time: _____ Overall rate of reaction: _____

Reaction 3



Total reaction time: _____ Overall rate of reaction: _____

Reaction 4



Total reaction time: _____ Overall rate of reaction: _____

Organic Chemistry

Describe the differences between the conditions in which complete and incomplete combustion happen

_____

_____

Identify the 2 products which are always formed during complete combustion of hydrocarbons

Product 1: _____ Product 2: _____

Identify the 2 alternative products which can be formed during incomplete combustion and the hazards associated with them

Product 1: _____ Product 2: _____

Hazard(s): _____ Hazard(s): _____

_____ _____

Balance the combustion symbol equations below

1. __ CH_4 + __ O_2 → __ CO_2 + __ H_2O

2. __ C_2H_6 + __ O_2 → __ CO_2 + __ H_2O

3. __ C_6H_{12} + __ O_2 → __ CO + __ H_2O

4. __ C_5H_{12} + __ O_2 → __ C + __ H_2O

5. __ C_7H_{16} + __ O_2 → **3** C + __ CO + __ H_2O

6. __ C_2H_5OH + __ O_2 → __ CO_2 + __ H_2O

Describe what hydrocarbon cracking is and the different conditions used in steam cracking and catalytic cracking

_____

_____

_____

_____

Fill in the missing gaps in the following hydrocarbon cracking symbol equations

1. $C_{12}H_{26} \rightarrow C__H_{14} + C_6H__$

2. $C__H_{50} \rightarrow C_{13}H_{28} + C_{11}H__$

3. $C_{50}H__ \rightarrow 2\ C__H_{40} + C_{10}H_{22}$

Write out the general formulae for both homologous series of hydrocarbons

Alkanes: _____ Alkenes: _____

Fill in the tables below with the names, symbol formulae and displayed formulae for each of the alkanes and alkenes

Alkanes:

No. of C atoms	Alkane name	Symbol formula	Displayed formula
1			
2			
3			
4			
5			
6			

Alkenes:

No. of C atoms	Alkene name	Symbol formula	Displayed formula
2			
3			
4			
5			
6			

Independent research task - Describe the benefits and problems of the following materials

- Hydrocarbons
- CFCs (chlorofluorocarbons)
- Ethanol
- Polymers

In your answers, make reference to the following features:

- How each of the materials is extracted and used
- Why these resources are useful in these circumstances
- Disadvantages of the materials when they are used
- Potential issues caused by usage of these materials including amounts of the resources or environmental impacts)
- Solutions to the issues caused by the usage of these materials (e.g. methods of reducing the impacts, laws passed to limit usage, alternative methods of extracting the resources or alternatives to the resources themselves