

The table below gives some information about the halogens:

Element	Atomic number	Molecular formula	Bond length/nm	Bond energy/ kJ per mole
Chlorine	17	Cl ₂	0.20	240
Bromine	35	Br ₂	0.23	195
Iodine	53	I ₂	0.26	150
Astatine	85	At ₂	0.29	

Note: Bond length = distance between atoms in a molecule
 nm = nanometres (10⁻⁹ metres)
 Bond energy = energy needed to break the bond in the molecule

(a) As the atomic number in the halogens increases, what happens to the

(i) bond length?

..... [1]

(ii) bond energy?

..... [1]

(b) What do you think is the bond energy in astatine?

..... [1]

(c) Describe the relationship between bond length and bond energy as the halogen series is descended.

.....

 [2]

The solubility of the halogens in water may be summarised as follows:

chlorine	dissolves fairly readily
bromine	dissolves slightly
iodine	almost insoluble

Chemical reactions occur when the halogens dissolve in water.

(d) What is likely to be the reaction of astatine with water?

.....
 [2]

(Continued...)

QUESTIONSHEET 1 CONTINUED

(e) List the four elements in order of reactivity, placing the most reactive first.

.....
.....
.....
..... [2]

(f) Does your order of reactivity seem to fit with the bond energies?

..... [1]

Give a reason for your answer.

.....
.....
..... [2]

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High Demand Questions

QUESTIONSHEET 2

When sulphur is heated in air, a colourless, poisonous gas with an unpleasant, choking smell is formed. If this gas is collected, dried, then cooled to below -10°C , it forms a colourless liquid. Dry pH paper dipped into this liquid does not change colour, but damp pH paper dipped into the liquid shows a pH of less than 7.

- (a) What is the name of the colourless gas?

..... [1]

- (b) What is the boiling point of the colourless liquid?

..... [1]

- (c) Why does the colourless liquid not affect the dry pH paper?

..... [2]

- (d) When damp pH paper is used, the colourless liquid becomes acidic. How do you know this?

..... [1]

If the colourless gas from above is reacted with oxygen at 450°C and in the presence of vanadium pentoxide, sulphur trioxide forms as a colourless gas, which then cools to colourless crystals. If water is added to the crystals, a fiercely exothermic reaction takes place and sulphuric acid forms.

- (e) Write a balanced chemical equation for the reaction between the colourless gas named in part (a) with oxygen.

..... [2]

- (f) The vanadium pentoxide is recovered after the above reaction. What is its purpose in the reaction?

..... [1]

- (g) What is meant by an 'exothermic reaction'?

..... [1]

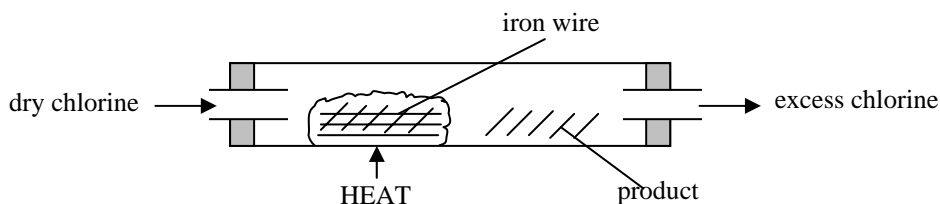
- (h) Write a balanced chemical equation for the reaction of sulphur trioxide with water.

..... [2]

- (i) In fact, this reaction is much too exothermic to carry out safely. It would spray sulphuric acid all around the room. In practice, the sulphur trioxide is added to 98% sulphuric acid, where it reacts with the 2% water present to form more sulphuric acid. Why is the reaction much safer when carried out like this?

..... [2]

The diagram below shows an apparatus that can be used to react chlorine with iron.



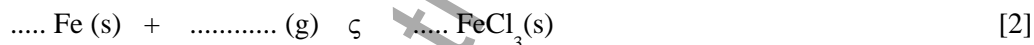
- (a) (i) Describe the **appearance** of the Group VII element chlorine.

..... [1]

- (ii) What compound is formed during the reaction that takes place?

..... [1]

- (iii) Complete and balance the following symbol equation for the chemical change that takes place.



- (iv) Give **one** reason why this reaction *must* be carried out in a fume cupboard.

..... [1]

- (b) The element iodine is below chlorine in Group VII of the Periodic Table. If iodine was allowed to react with iron wire, state whether you would expect this reaction to be **more vigorous, less vigorous** or **about the same** as the reaction between chlorine and iron wire.

..... [1]

- (c) Group I elements also react with Group VII elements.

- (i) Complete and balance the symbol equation for the reaction between sodium and bromine.



- (ii) If the following pairs of elements were allowed to react together, choose the pair that would be **most** reactive and give an explanation for your choice.

lithium and fluorine

sodium and chlorine

potassium and chlorine

potassium and fluorine

(Continued...)

QUESTIONSHEET 3 CONTINUED

The **most** reactive pair is: [1]

Give an explanation for your choice.

.....

..... [2]

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High Demand Questions

QUESTIONSHEET 4

For each of the following pairs of substances describe how you would distinguish between them by giving **one chemical** test in each case.

Describe your **observation** on **both** substances.

- (i) Nitrogen and oxygen.

.....
.....
..... [2]

- (ii) Hydrogen and chlorine.

.....
.....
..... [2]

- (iii) Carbon dioxide and sulphur dioxide.

.....
.....
..... [3]

- (iv) Water and ammonia solution.

.....
.....
..... [3]

High Demand Questions

QUESTIONSHEET 5

Sulphuric acid is manufactured industrially by the contact process. During the early part of the process, sulphur is reacted with oxygen to give an oxide **A**. This substance is then converted into sulphur trioxide by reacting **A** with the element **B**.

- (a) (i) Calculate the **simplest formula** of the oxide of sulphur **A** from the following information.
3.2 g of sulphur gave 6.4 g of the oxide **A**.

Please show how you worked out your answer.

$A_r(\text{S}) = 32$; $A_r(\text{O}) = 16$.

.....
.....
.....
..... [3]

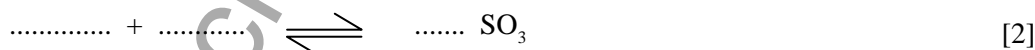
- (ii) Name the element **B**. [1]

- (b) The reaction between **A** and **B** to give the gas sulphur trioxide is **reversible**. Explain the term 'reversible' and **complete** and **balance** the chemical equation.

- (i) A reversible reaction is

.....
..... [1]

- (ii) Complete and balance the equation;



- (c) Both oxygen and sulphur are in the same group of the Periodic Table. One method for both to react is to become an ion X^{2-} . Explain in terms of their **electronic structures** why oxygen is **more reactive** towards this change than sulphur.

.....
.....
..... [2]

High Demand Questions

QUESTIONSHEET 6

Plants need many substances for healthy growth and for the chemical reactions which occur within them. Most of these substances are absorbed in solution in water through the roots. The three main essential elements which plants need are nitrogen, phosphorus and potassium. These elements may be supplied naturally by the soil, but often we need to add one or more of them in the form of fertilisers. A fertiliser is sold in a bag labelled with its name followed by three numbers which indicate, respectively, the percentages of nitrogen, phosphorus and potassium present. e.g. Regular 20 – 10 – 12 means that the fertiliser is called regular and contains 20% nitrogen, 10% phosphorus and 12% potassium. Such fertilisers are known as NPK fertilisers. Here is a list of some common fertilisers.

Universal 15 – 15 – 15

Extra grass 29 – 5 – 5

Double season PK for fertile soils 0 – 20 – 20

Maincrop potato 10 – 10 – 15 + 4.5 Mg

Concentrated maincrop potato 15 – 15 – 19

Granphos 2 – 40 – 0

Barley for high potash clay soils 29 – 13 – 0

Winter wheat 9 – 23 – 18

(a) Why are these fertilisers known as NPK fertilisers?

.....
..... [2]

(b) Name the essential element which:

(i) is already present in fertile soil and so does not need adding.

..... [1]

(ii) favours green growth (e.g. grass).

..... [1]

(iii) potatoes need in extra high concentration.

..... [1]

(c) Name an element, other than nitrogen, phosphorus or potassium, which potatoes need.

..... [1]

(d) What percentage of nitrogen would be supplied by a fertiliser of pure ammonium nitrate NH_4NO_3 ?
(Relative atomic masses: H = 1, N = 14, O = 16).

.....
.....
..... [3]

(Continued...)

QUESTIONSHEET 6 CONTINUED

- (e) A farmer was offered a choice of potassium nitrate or urea as a fertiliser. Although much more expensive per gram of nitrogen, he chose potassium nitrate. Give **one** reason which may have influenced his choice.

.....
..... [1]

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High Demand Questions

QUESTIONSHEET 7

Phosphorus (P) is directly below nitrogen in the periodic table.

- (a) Write down the electronic configuration of phosphorus.

..... [1]

- (b) Write down the formula of the compound you would expect phosphorus to form with hydrogen, and use a dot and cross diagram to show how it is formed.

Formula [3]

- (c) (i) Would you expect this compound to be a solid, a liquid or a gas at room temperature?

..... [1]

- (ii) Explain your reasons.

.....
..... [2]

- (d) Give one use for phosphorus-containing compounds

..... [1]

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High Demand Questions

QUESTIONSHEET 8

- (a) Solid sulphur consists of rings of eight atoms.
Fill in the gaps in the table below to show the changes in appearance and structure of sulphur when it is heated.

appearance	structure
Yellow solid	Rings of 8 atoms
Melts to form a _____ liquid	
Boils	Separated sulphur atoms and groups of atoms

[4]

- (b) Sulphur exists in two crystalline forms.
What are different crystalline forms of the same element known as?

..... [1]

- (c) When molten sulphur is cooled slowly, needle-like crystals form under the surface.
Why do some rocks contain crystals when they are split open?

..... [2]

- (d) These crystals change slowly to another form with rhombic-shaped crystals as they cool.

- (i) What changes are seen as the needle-like crystals cool?

..... [1]

- (ii) What changes would be seen in the rhombic crystals as they cool?

..... [1]

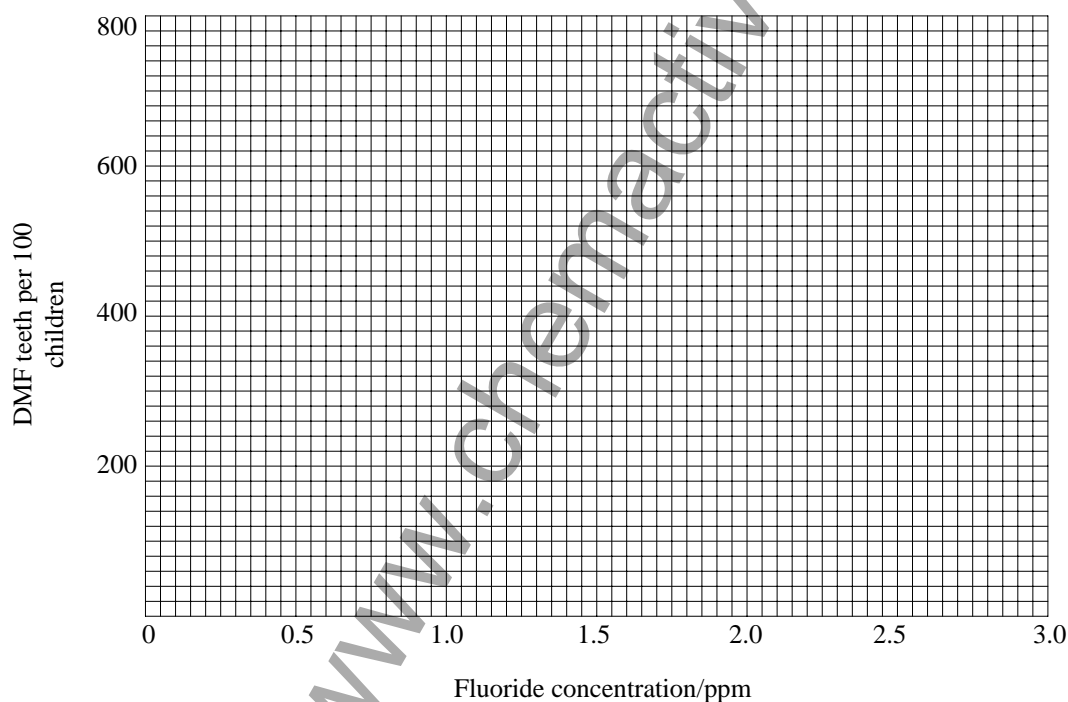
Tooth decay in the UK is a serious problem. About 7000 sets of dentures are supplied each year to school children alone. This is a waste of healthy teeth and money.

It has been suggested that the presence of fluoride ions, F^- , in drinking water helps to prevent tooth decay. The data in the following table come from six different areas of the country, where fluoride ions occur naturally in the water supply.

DMF teeth per 100 children	fluoride concentration/ppm
430	0.5
350	0.9
240	2.6
720	0.1
250	1.9
300	1.2

Note: DMF = decayed, missing or filled
ppm = parts per millionS

- (a) On the chart below plot a graph of DMF against ppm of fluoride concentration. [2]



- (b) Does your graph support or contradict the suggestion that fluoride ions in drinking water help to prevent tooth decay?

..... [1]

(Continued...)

QUESTIONSHEET 9 CONTINUED

It has been found in a much wider study from many more areas in the UK that similar results are obtained. Also, the presence of small amounts of fluoride in the water does not appear to be at all harmful. As a result, it has been suggested that in areas where there is no natural fluoride in the water, drinking water should undergo fluoridation i.e. should have fluoride added.

- (c) Give a reason why fluoridation might be a good idea in areas with no natural fluoride in the drinking water.

..... [1]

- (d) Give **one** argument which might be used against fluoridation of water supplies.

.....

..... [1]

- (e) Suggest **two** other ways, other than fluoridation of water, in which people could take small amounts of fluoride ions

.....

..... [2]

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The table below gives some information about six different gases.

Formula of molecule	Mass of one mole of molecules/g	Volume occupied by 1g at rtp/dm ³
CH ₄	16	1.50
NH ₃	17	1.40
N ₂	28	0.86
O ₂	32	0.76
CO ₂	44	0.54
SO ₂	64	0.38

rtp = room temperature and pressure

relative atomic masses: H=1, C=12, N=14, O=16, F=19, Ar=40

- (a) Give the name of the molecules listed in the first column.

CH₄ = [1]

NH₃ = [1]

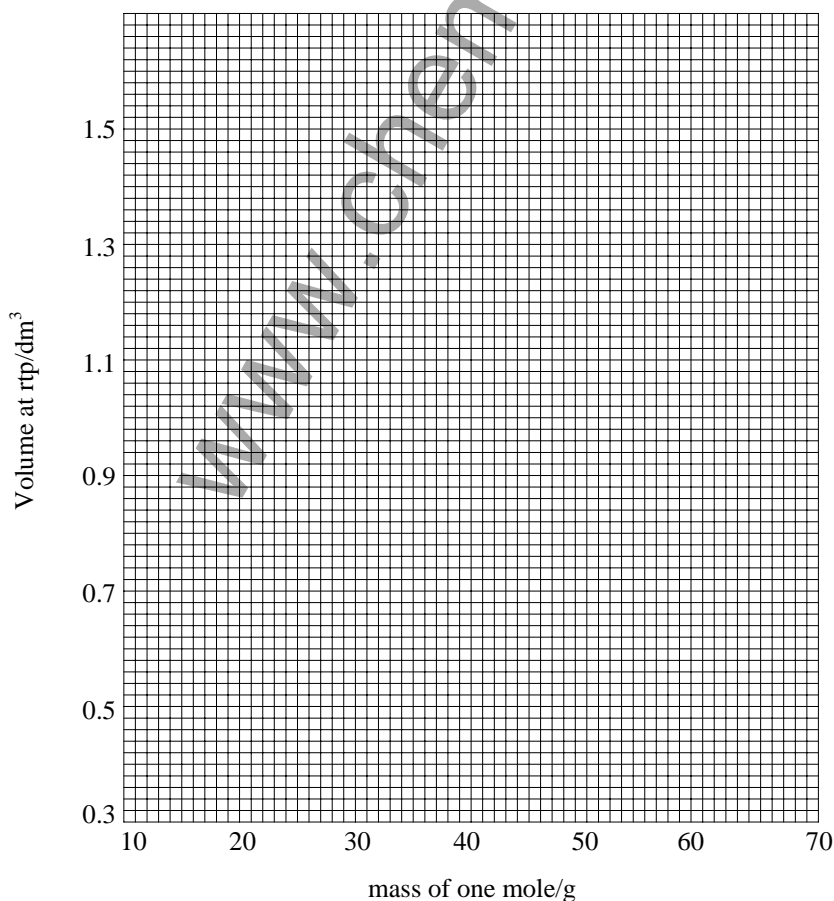
N₂ = [1]

O₂ = [1]

CO₂ = [1]

SO₂ = [1]

- (b) On the chart below plot a graph of volume against mass of one mole. [2]



(Continued...)

QUESTIONSHEET 10 CONTINUED

- (c) Use your graph to find the volume at rtp occupied by:
- (i) 1g of ethene, C_2H_4 [1]
- (ii) 1g of argon [1]
- (d)(i) What is the mass of one mole of molecules of a gas for which 1g at rtp occupies 0.52 dm^3 ?
..... [1]
- (ii) If the molecule is made up of nitrogen and oxygen only, what is its formula?
Show your working.
.....
.....
..... [3]
- (e) Determine the volume at rtp occupied by 1g of hydrogen fluoride, HF.
Show your working.
.....
.....
..... [5]

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The following table contains some information about Group VII of the Periodic Table.

Element	Formula	Atomic number	Melting point (°C)	Colour
fluorine	F ₂	9	-223	pale yellow
chlorine	Cl ₂	17	-103	yellow-green
bromine	Br ₂	35	-7	red-brown
iodine	I ₂	53	114	purple-black

(a)(i) Name the element with the **lowest** melting point.

..... [1]

(ii) Chlorine is a **diatomic** gas. Explain the meaning of 'diatomic'.

.....
 [1]

(iii) Give the electronic structure of chlorine.

..... [1]

(iv) Explain how **chloride ions** are formed from **chlorine atoms**.

.....
 [2]

(b) Astatine, At, is another member of Group VII with an atomic number of 85.

(i) Give the formula for astatine.

..... [1]

(ii) Describe the **appearance** of astatine.

..... [1]

(iii) Give the number of electrons in the outer shell of astatine.

..... [1]

(iv) Astatine is expected to form a compound with hydrogen in a similar way to chlorine and hydrogen. By means of a labelled diagram, show how the atoms are bonded together. Name this type of bonding.
 Diagram

[2]

Type of bonding. [1]

Medium Demand Questions

QUESTIONSHEET 12

The table below shows some properties of elements **A**, **B**, **C**, **D** and **E**.

(The letters are **not** chemical symbols.)

Element	Melting point (°C)	Boiling point (°C)	Conducts heat	Brittle	Reaction with water	Shiny
A	119	444	no	yes	insoluble	no
B	-7	59	no	no	slightly soluble	no
C	98	883	yes	no	reacts	yes
D	1083	2336	yes	no	insoluble	yes
E	-259	-253	no	no	slightly soluble	no

(a) Give the letter of the element which is a **liquid** under room conditions.[1]

(b) Give the letters of **all** the elements that are **non-metals** giving **two** reasons for your answer.

(i) The elements that are non-metals are[3]

(ii) Reasons.

.....
 [1]

(c) Elements **A** and **E** when heated can react together to give a gas. Name the type of bonding you would expect this compound to have. Give a reason for your answer.

Type of bonding[1]

Reason.

.....
 [2]

(d) Gas **E** has no colour or smell. It burns in oxygen giving a vapour which condenses on a cold surface as a colourless neutral liquid. The gas **E** has a number of important uses including the industrial manufacture of ammonia. Name the gas **E**.

Gas **E** is[1]

Diamond and graphite are two **allotropes** of the element carbon.

- (a) Explain the meaning of allotropy

.....
..... [1]

- (b) Draw the structure of both diamond and graphite.

(i) Diamond

(ii) Graphite.

[4]

- (c) Use the above **structures** to explain the following.

- (i) Diamond is a very **hard** substance often used to cut and engrave glass.

.....
.....
.....
..... [2]

- (ii) Graphite **conducts electricity** and is used as electrodes in industry and as positive terminals in batteries.

.....
.....
.....
..... [2]

The following box contains non-metals and their atomic numbers.

hydrogen 1,	helium 2,	carbon 6,
nitrogen 7,	oxygen 8,	fluorine 9,
sulphur 16,	chlorine 17,	bromine 35.

Use **only** elements from these given non-metals to answer the following questions. **Each element may be used once, more than once or not at all.**

- (a) Name **one** element which is
- (i) a liquid at room temperature,[1]
- (ii) has **four** electrons in its outer shell,[1]
- (iii) has the electronic structure 2, 8, 7[1]
- (iv) forms an ion with the formula X^{2-}[1]
- (b) Nitrogen reacts with hydrogen to give the gas ammonia.
- Give the **formula** and the **type** of bonding in ammonia.
- Formula.[1]
- Type of bonding.[1]
- (c) Name the element which readily burns in air with a pale blue flame giving off an unpleasant smelling gas which is one of the main causes of acid rain.
- The element is[1]
- (d) Two elements X and Y form compounds with hydrogen with the formulae H_2X and YH_4 .
- Name the elements X and Y.
- Element X is[1]
- Element Y is[1]

Medium Demand Questions

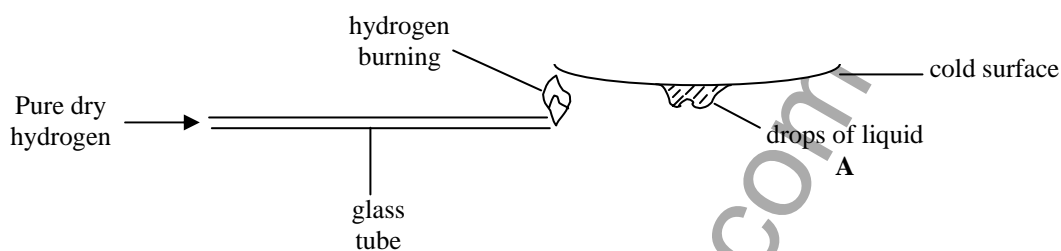
QUESTIONSHEET 15

(a) Give two **physical** properties of hydrogen.

(i) [1]

(ii) [1]

(b) Some pure hydrogen was carefully burnt on a cold surface as shown in the diagram.



(i) Name **two** chemicals that could be used to make hydrogen in the laboratory.

..... and [2]

(ii) Give the **precaution** that must be taken before hydrogen is ignited.

.....
 [1]

(iii) Name the liquid A. [1]

(iv) Give a simple chemical **test** and **observation** to confirm the identity of the liquid.

Test..... [1]

Observation..... [1]

..... [1]

(c) One of the first uses of hydrogen was in airships since it is the lightest of all gases.

Unfortunately it reacts violently with the oxygen in the air which has led to a number of disasters.

Name the **safer** gas which is used in present day airships.

..... [1]

Medium Demand Questions

QUESTIONSHEET 16

The table below contains some information about four different substances **A**, **B**, **C** and **D**.

(The letters are **not** chemical symbols.)

Study the table carefully and answer the given questions.

Substance	Boiling point ($^{\circ}\text{C}$)	Conducts electricity when solid	Conducts electricity when melted
A	above 500	yes	yes
B	below 500	no	no
C	above 500	no	no
D	above 500	no	yes

(a) State which substance is most likely to be:-

(i) diamond, [1]

(ii) iodine, [1]

(iii) copper [1]

(b) The four substances are diamond, copper, iodine and sodium chloride. Which of these substances best fits the following descriptions?

(i) Atoms bonded by sharing electrons to form small molecules.

..... [1]

(ii) Atoms bonded by sharing electrons to form giant covalent structures.

..... [1]

(iii) Atoms bonded by electron transfer to form giant ionic structures.

..... [1]

(c) During the **electrolysis** of molten sodium chloride the chloride ion, Cl^- , is attracted towards the positive electrode and releases chlorine gas, Cl_2 .

(i) Explain the meaning of the term electrolysis.

.....

..... [1]

(ii) Complete the equation that takes place at the positive electrode.



The following table gives some information about gases which are found in the air.

Gas	Boiling point/ $^{\circ}\text{C}$	Soluble in water?
nitrogen	-196	no
oxygen	-183	slightly
argon	-186	no
carbon dioxide	-40 (sublimes)	fairly
neon	-246	no
helium	-269	no
krypton	-153	no
xenon	-108	no

- (a) As well as the above, which other gas is normally found in the air?
 [1]
- (b) Which of the above gases becomes liquid at the lowest temperature?
 [1]
- (c) Carbon dioxide sublimes at -40°C . What would you observe if carbon dioxide gas was cooled to this temperature?
 [1]
- (d) If a mixture of liquid nitrogen and liquid oxygen was allowed to warm up, which one would boil first?
 [1]
- (e) What is the name of the process which allows nitrogen and oxygen to be separated from liquid air by warming?
 [1]
- (f) State the approximate percentages by volume of nitrogen and oxygen in the air. [2]
- Nitrogen%
- Oxygen%
- (g) The percentages of nitrogen and oxygen in the air which has been boiled out of water are different to those given in part (f). Why is this?

 [2]

QUESTIONSHEET 17 CONTINUED

- (h) Nitrogen and oxygen are both obtained by allowing liquid air to warm up. Why is oxygen more expensive than nitrogen?

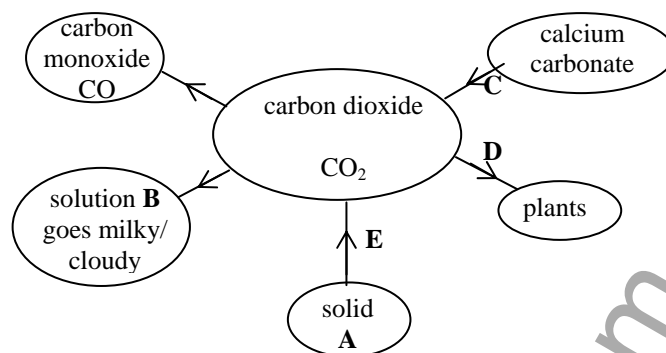
..... [1]

- (i) Green plants need carbon dioxide for photosynthesis. How can some green plants continue to live under water?

..... [1]

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The flow chart shows some of the reactions and changes involved in carbon compounds.



- (a) Name the chemical substances labelled **A** and **B**.

A is [1]

B is [1]

- (b) Name the different processes **C**, **D** and **E**.

C is [1]

D is [1]

E is [1]

- (c) How can carbon dioxide be converted into carbon monoxide?

..... [2]

- (d) Give **one** important use of carbon dioxide.

..... [1]

- (e) Carbon is often used as a reducing agent. When a mixture of carbon and copper oxide are heated the copper oxide is reduced to copper. Complete and balance the equation for the reaction.



- (f) Carbon and silicon both belong to Group 4 of the Periodic Table of elements. They form oxides with similar formulae CO₂ and SiO₂. In terms of **structures** explain why carbon dioxide is a gas at room conditions but silicon dioxide has a very high melting point.

..... [2]

Low Demand Questions

QUESTIONSHEET 19

Use The Periodic Table to answer this question.

(a) Give the **symbol** for the element

(i) oxygen

..... [1]

(ii) potassium

.....

(b) Give the **name** of the element with the symbol

[1]

(i) C

.....

(ii) Na

.....

(c) Complete the following table.

[3]

<i>Substance</i>	<i>Chemical formula</i>	<i>Elements present</i>
zinc oxide	ZnO	zinc and oxygen
iron sulphide	FeS	
sodium hydroxide	NaOH	
	KCl	potassium and chlorine

(d) The chemical formula for carbon monoxide is **CO**.

(i) How many **different** elements are represented in carbon monoxide?

..... [1]

(ii) Give the total number of atoms the formula **CO** represents.

..... [1]

(e) The chemical formula for sulphuric acid is **H₂SO₄**.

(i) How many **different** elements are present in sulphuric acid?

..... [1]

(ii) Give the **total** number of atoms present in **H₂SO₄**.

..... [1]

The table below gives some information about halogens.

Element	Atomic symbol	Atomic number	Melting point/°C	Boiling point/°C
Fluorine	F	9	-220	-188
Chlorine	Cl	17	-101	-35
Bromine	Br	35	-7	+58
Iodine	I	53	+114	+183
Astatine	At	85		

(a) As the atomic number increases what happens to the

(i) melting point?

..... [1]

(ii) boiling point?

..... [1]

(b) Are these elements solids, liquids or gases at room temperature (20°C)?

(i) fluorine is a [1]

(ii) chlorine is a [1]

(iii) bromine is a [1]

(iv) iodine is a [1]

(c) In which physical state do you think astatine exists at room temperature?

..... [1]

The behaviour of the halogens with water may be summarised as follows:

fluorine	violent reaction
chlorine	dissolves fairly readily
bromine	dissolves slightly
iodine	almost insoluble

(d) What is likely to be the behaviour of astatine with water?

..... [1]

(e) List the five elements in order of reactivity, placing the most reactive first.

.....

.....

.....

.....

..... [2]

TOTAL / 10