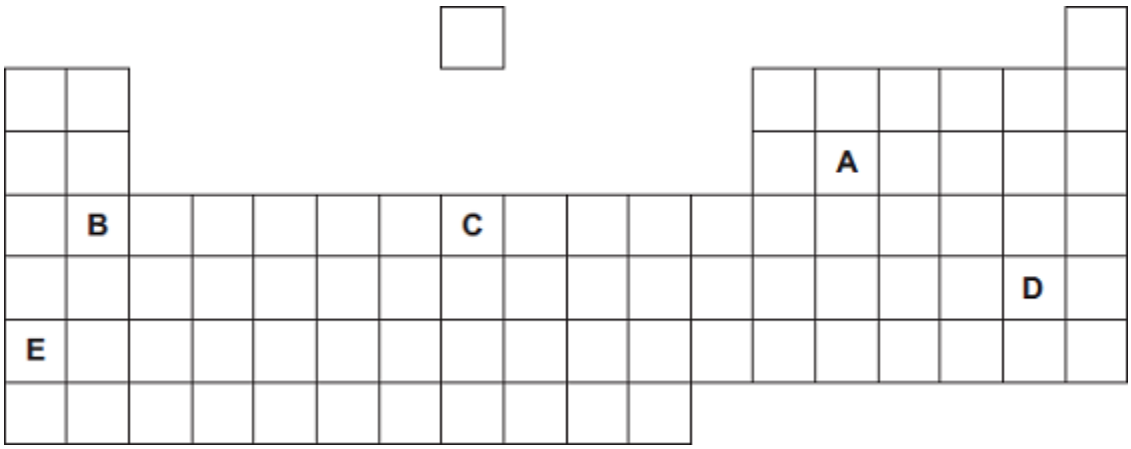
1. The periodic table on the Data Sheet may help you to answer these questions.

Part of the periodic table is shown below.



The letters are **not** the symbols of these elements.

Choose your answers **only** from the letters shown in the periodic table above.

Which letter, **A**, **B**, **C**, **D** or **E**, represents:

(a) (i) an alkali metal Letter ☐

(1)

(ii) a transition element Letter ☐

(1)

(iii) a Group 4 element ? Letter ☐

(1)

(b) A chemistry teacher demonstrated the reaction between sodium and water to a class of students. One of the students wrote the following notes:

The reaction between sodium and water

A piece of sodium was cut easily into smaller pieces with a knife.

The sodium was added to some water in a trough.

The sodium:

- floated
- melted quickly to give a silvery ball
- moved on the surface of the water
- fizzed.

Use the information in the box to help you answer these questions.

What evidence is there that:

(i) sodium has a low melting point

_____

_____

(1)

(ii) sodium is soft

_____

_____

(1)

(iii) a gas was produced?

_____

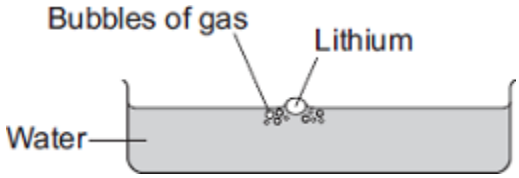
_____

(1)

(Total 6 marks)

2. Lithium is in Group 1 of the periodic table.

Lithium reacts with water to produce a gas and an alkaline solution.



(a) (i) Name the gas produced.

_____

(1)

(ii) Which ion causes the solution to be alkaline?

_____

(1)

(b) Potassium is also in Group 1 of the periodic table.
Potassium reacts with water in a similar way to lithium.

Write down **two** differences you would see between the reactions of potassium and lithium with water.

1. _____

_____

2. _____

_____

(2)

(Total 4 marks)

3. Group 7 is an important family of elements in the periodic table.

(a) (i) What name is given to the Group 7 elements?

Draw a ring around your answer.

Halogens **Noble gases** **Transition elements**

(1)

(ii) The grid shows some statements about Group 7 elements.

Tick (✓) the **two** correct statements.

Statement	(✓)
They are metals	
They consist of molecules	
They have coloured vapours	
They have high melting points	

(2)

(b) The table gives information about some of the Group 7 elements.

Name of element	Melting point in °C	Boiling point in °C	Electronic structure
Fluorine	–220	–188	2, 7
Chlorine	–101	–35	2, 8, 7
Bromine	–7	58	2, 8, 18, 7
Iodine	114	183	2, 8, 18, 18, 7

Use information from the table to help you to answer these questions.

Write the correct number in the box to complete the sentence.

(i) All these elements are in Group 7 because they have ☐ electrons in their outer shell.

(1)

(ii) Draw a ring around the correct word in the box to complete the sentence.

At 20 °C bromine is a

gas.
liquid.
solid.

(1)

(iii) Use the periodic table on the **Data Sheet** to name the Group 7 element that is **not** shown in the table.

_____

(1)

(c) A student investigated the reactivity of three Group 7 elements.

The student added:

- aqueous chlorine to potassium bromide and potassium iodide solutions
- aqueous bromine to potassium chloride and potassium iodide solutions
- aqueous iodine to potassium chloride and potassium bromide solutions.

The student's results are shown in the table.

Solutions of	**Potassium chloride**	**Potassium bromide**	**Potassium iodide**
Chlorine		Solution turned orange-brown	Solution turned brown
Bromine	No change		Solution turned brown
Iodine	No change	No change	

Explain how these results show that chlorine is more reactive than bromine and iodine.

_____

_____

_____

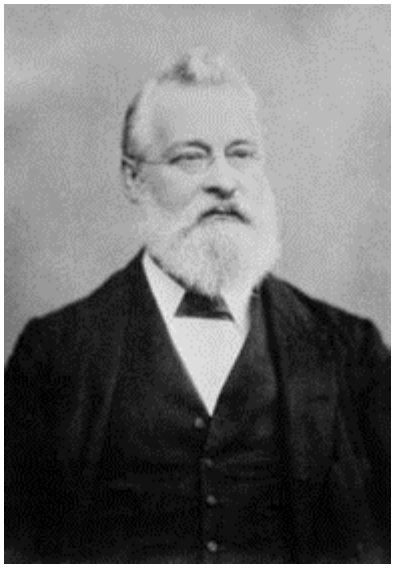
_____

(2)

(Total 8 marks)

4. The periodic table on the Data Sheet may help you answer these questions.

(a) Many chemists have contributed to the development of the periodic table.



John Newlands was one of the first chemists who attempted to classify elements in a systematic way based on atomic weight. In 1866 he suggested that there was a repeating pattern of elements with similar properties every eighth element.
Part of Newlands' periodic table is shown below.

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co, Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce, La	Zr	Di, Mo	Ro, Ru

Many chemists in 1866 did not accept Newland's; periodic table.

By Conget at nl.wikipedia [Public domain], from Wikimedia Commons

(i) Give **one** piece of evidence which supports Newlands' ideas.

_____

_____

(1)

(ii) Suggest **two** reasons why many chemists in 1866 did not accept Newlands' ideas.

1. _____

_____

_____

2. _____

_____

_____

(2)

(b) Chlorine, bromine and iodine are Group 7 elements.

A student investigated the reactivity of these elements.
The student added:

- aqueous chlorine to potassium bromide and potassium iodide solutions
- aqueous bromine to potassium chloride and potassium iodide solutions
- aqueous iodine to potassium chloride and potassium bromide solutions.

The student's results are shown below.

Solution	**Potassium chloride**	**Potassium bromide**	**Potassium iodide**
Chlorine		Solution turned orange-brown	Solution turned brown
Bromine	No reaction		Solution turned brown
Iodine	No reaction	No reaction	

(i) Use these results to state **and** explain the trend in reactivity of these Group 7 elements.

_____

_____

_____

_____

(2)

(ii) Complete the equation below, which represents the reaction between chlorine and potassium bromide.

$$Cl_2 \quad + \quad 2KBr \quad \longrightarrow \quad \_\_\_\_ \quad + \quad 2KCl$$

(1)

(iii) In terms of electronic structure, state why chlorine, bromine and iodine are in Group 7.

_____

_____

(1)

(c) Lithium, sodium and potassium are Group 1 elements.

Group 1 elements become **more** reactive down the group.

Explain why in terms of electronic structure.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

5. The halogens are in Group 7 of the periodic table.

(a) Why, in terms of electrons, are the halogens in Group 7?

_____

_____

(1)

(b) Sea water contains bromide ions (Br^-).
The bromide ions can be changed to bromine by bubbling chlorine gas into sea water.
Chlorine is able to displace bromine from sea water because chlorine is more reactive than bromine.

$$2Br^-(aq) + Cl_2(g) \rightarrow Br_2(g) + 2Cl^-(aq)$$

Explain, in terms of electrons, why chlorine is more reactive than bromine.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 4 marks)

6. The halogens are elements in Group 7.

(a) Bromine is in Group 7.

Give the number of electrons in the outer shell of a bromine atom.

_____

(1)

(b) Bromine reacts with hydrogen. The gas hydrogen bromide is produced.

What is the structure of hydrogen bromide?

Tick **one** box.

- Giant covalent ☐
- Ionic lattice ☐
- Metallic structure ☐
- Small molecule ☐

(1)

(c) What is the formula for fluorine gas?

Tick **one** box.

- F ☐
- F_2 ☐
- F^2 ☐
- 2F ☐

(1)

A student mixes solutions of halogens with solutions of their salts.

The table below shows the student's observations.

	Potassium chloride (colourless)	**Potassium bromide (colourless)**	**Potassium iodide (colourless)**
Chlorine (colourless)		Solution turns orange	Solution turns brown
Bromine (orange)	No change		Solution turns brown
Iodine (brown)	No change	No change	

(d) Explain how the reactivity of the halogens changes going down Group 7.

Use the results in the table above.

(3)

A company uses chlorine to produce titanium chloride from titanium dioxide.

(e) What is the relative formula mass (M_r) of titanium dioxide, TiO_2?

Relative atomic masses (A_r): O = 16 Ti = 48

Tick **one** box.

64 ☐

80 ☐

128 ☐

768 ☐

(1)

(f) The company calculates that 500 g of titanium dioxide should produce 1.2 kg of titanium chloride.

However, the company finds that 500 g of titanium dioxide only produces 900 g of titanium chloride.

Calculate the percentage yield.

_____

_____

_____

_____

Percentage yield = _____ %

(2)

(Total 9 marks)

7. By 1869, about 60 elements had been discovered.
Mendeleev arranged these elements in a table, in order of their atomic weight.
He also put elements with similar chemical properties in the same columns.

Mendeleev and part of his table are shown below.

	Group							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Period 1	H							
Period 2	Li	Be	B	C	N	O	F	
Period 3	Na	Mg	Al	Si	P	S	Cl	
Period 4	K Cu	Ca Zn	– –	Ti –	V As	Cr Se	Mn Br	Fe Co Ni

(a) (i) Name **one** element in Group 1 of Mendeleev's table that is not in Group 1 of the periodic table on the Data Sheet.
Give a reason why this element should not be in Group 1.

Name of element _____

Reason _____

_____

(2)

(ii) Which group of the periodic table on the Data Sheet is missing from Mendeleev's table?

_____

(1)

(b) The gaps (–) in Mendeleev's table were for elements that had not been discovered.

(i) Compare Mendeleev's table with the periodic table on the Data Sheet.

Name **one** of the elements in Period 4 that had not been discovered by 1869.

_____

(1)

(ii) Mendeleev was able to make predictions about the undiscovered elements. This eventually led most scientists to accept his table.

Suggest what predictions Mendeleev was able to make about these undiscovered elements.

(2)

(c) In terms of their electronic structure:

(i) state why lithium and sodium are both in Group 1

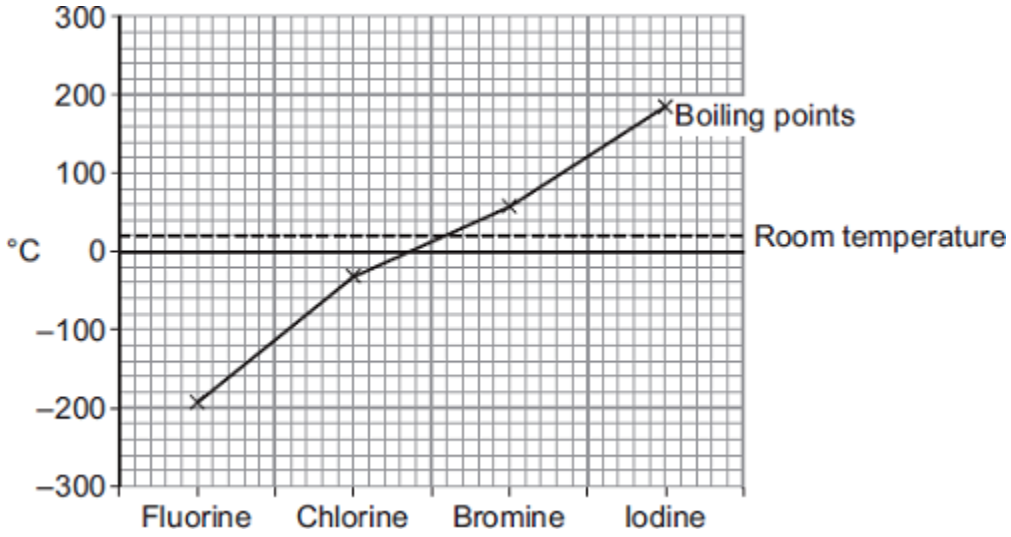
(1)

(ii) explain why sodium is more reactive than lithium.

(3)

(Total 10 marks)

8. The graph shows the boiling points of the halogens.



(a) Use the graph to help you answer these questions.

(i) Use the correct answer from the box to complete the sentence.

gas	liquid	solid

At room temperature chlorine is a _____ .

(1)

(ii) Describe the trend in boiling point from fluorine to iodine.

_____

_____

(1)

(b) Chlorine reacts with metals to produce metal chlorides.

(i) When a chlorine atom forms a chloride ion it gains one electron.

What is the charge on a chloride ion?

_____

(1)

(ii) Write a word equation for the reaction between sodium and chlorine.

_____

(1)

(c) In the UK water companies add chlorine to tap water.

Why is chlorine added to tap water?

_____

(1)

(d) Water companies add fluoride to tap water in some parts of the UK.

Fluoride is added to improve dental health.

Suggest **one** reason why some people are against adding fluoride to tap water.

_____

_____

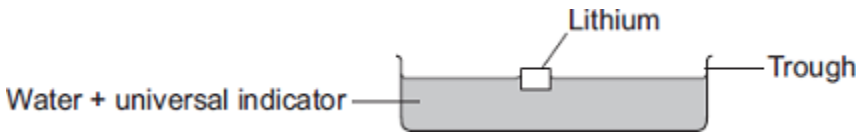
_____

(1)

(Total 6 marks)

9. A student was investigating the reaction of lithium and water.

She added a few drops of universal indicator to water in a trough and added a piece of lithium.



The word equation for the reaction is:

lithium + water ⟶ lithium hydroxide + hydrogen

(a) (i) The lithium floated on the water.

State **two** other observations that the student would **see** during the reaction.

1. _____

2. _____

(2)

(ii) Balance the symbol equation for the reaction of lithium and water.

2 Li(s) + _____ $H_2O(l)$ ⟶ _____ LiOH(aq) + $H_2(g)$

(2)

(iii) Describe a simple test and the result that would show the gas was hydrogen.

_____

_____

(1)

(iv) All Group 1 metals have similar reactions with water.

State why, in terms of electronic structure.

_____

_____

(1)

(b) Lithium and other Group 1 metals have different properties from the transition metals.

Tick (✓) **two** properties that are properties of Group 1 metals.

They react with oxygen. ☐

They form coloured compounds. ☐

They are strong and hard. ☐

They have low melting points. ☐

(2)

(c) The electronic structure of a potassium atom is 2, 8, 8, 1

(i) Draw a diagram to show the electronic structure of a potassium ion.

Show the charge on the potassium ion.

(2)

(ii) Potassium is more reactive than sodium.

Explain why, in terms of electronic structure.

(3)

(Total 13 marks)

10. (a) Dmitri Mendeleev was one of the first chemists to classify the elements by arranging them in order of their atomic weights. His periodic table was published in 1869.

How did Mendeleev know that there must be undiscovered elements **and** how did he take this into account when he designed his periodic table?

(2)

(b) By the early 20th century protons and electrons had been discovered.

Describe how knowledge of the numbers of protons and electrons in atoms allow chemists to place elements in their correct order and correct group.

_____

_____

_____

_____

_____

_____

(3)

(c) The transition elements are a block of elements between Groups 2 and 3 of the periodic table.

(i) Transition elements have similar properties.

Explain why, in terms of electronic structure.

_____

_____

_____

_____

(2)

(ii) There are **no** transition elements between the Group 2 element magnesium and the Group 3 element aluminium.

Give a reason why, in terms of electronic structure.

_____

_____

_____

(1)

(Total 8 marks)

11. This question is about Group 7 elements.

Chlorine is more reactive than iodine.

(a) Name the products formed when chlorine solution reacts with potassium iodide solution.

_____

_____

(1)

(b) Explain why chlorine is more reactive than iodine.

_____

_____

_____

_____

_____

_____

(3)

(c) Chlorine reacts with hydrogen to form hydrogen chloride.

Explain why hydrogen chloride is a gas at room temperature.

Answer in terms of structure and bonding.

_____

_____

_____

_____

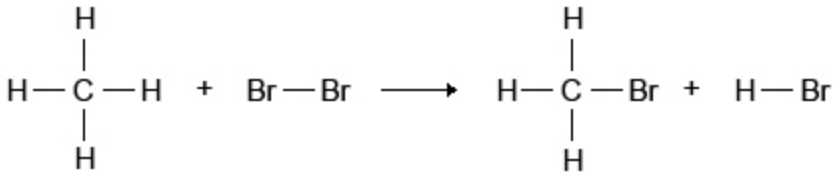
_____

_____

(3)

(d) Bromine reacts with methane in sunlight.

The diagram below shows the displayed formulae for the reaction of bromine with methane.



The table below shows the bond energies and the overall energy change in the reaction.

	C — H	**Br — Br**	**C — Br**	**H — Br**	**Overall energy change**
Energy in kJ/mol	412	193	**X**	366	−51

Calculate the bond energy **X** for the C—Br bond.

Use the diagram and the table above.

Bond energy **X** = _____ kJ/mol

(4)

(Total 11 marks)

12. This question is about the halogens (Group 7).

(a) How do the boiling points of the halogens change down the group from fluorine to iodine?

(1)

(b) Sodium bromide is produced by reacting sodium with bromine.

Sodium bromide is an ionic compound.

(i) Write down the symbols of the **two** ions in sodium bromide.

(1)

(ii) Chlorine reacts with sodium bromide solution to produce bromine and one other product.

Complete the word equation for the reaction.

chlorine + sodium bromide ⟶ bromine + _____

(1)

(iii) Why does chlorine displace bromine from sodium bromide?

_____

_____

(1)

(iv) Use the Chemistry Data Sheet to help you to answer this question.

Suggest which halogen could react with sodium chloride solution to produce chlorine.

_____

(1)

(Total 5 marks)

13. This question is about the periodic table of elements.

Use the Chemistry Data Sheet to help you to answer these questions.

In 1869 Dmitri Mendeleev produced an early version of the periodic table.

(a) Draw a ring around the correct answer to complete each sentence.

(i) Mendeleev first arranged the elements in order of

their

atomic weight.
date of discovery.
electron number.

(1)

(ii) Mendeleev then placed elements with similar properties in columns

called

groups.
periods.
shells.

(1)

(iii) When the next element did not fit the pattern,

Mendeleev

- ignored the element.
- left a gap.
- put the element at the end of the row.

(1)

(iv) Mendeleev was not able to include the noble gases (Group 0) in his periodic table because the noble gases

- are not elements.
- are not reactive.
- had not been discovered by 1869.

(1)

(b) Use the correct word from the box to complete each sentence.

electrons	**molecules**	**neutrons**	**protons**

In the modern periodic table elements are arranged in order of the number of _____ in their nucleus. Elements in the same group have the same number of _____ in their highest energy level (outer shell).

(2)

(c) Sodium (Na) is in Group 1 of the periodic table.

Nickel (Ni) is a transition element.

Tick (✓) **two** correct statements about sodium and nickel.

Statement	**Tick (✓)**
Sodium and nickel are both metals.	
Sodium has a higher melting point than nickel.	
Sodium is more reactive than nickel.	
Sodium is harder than nickel.	

(2)

(d) Chlorine, bromine and iodine are in Group 7 of the periodic table.

Chlorine is more reactive than bromine.

(i) Complete the word equation for the reaction between chlorine and sodium bromide.

chlorine + sodium bromide ⟶ _____ + sodium chloride

(1)

(ii) Why does iodine **not** react with sodium bromide solution?

_____

_____

(1)

(Total 10 marks)

14. Use the periodic table and the information in the table below to help you to answer the questions.

The table shows part of an early version of the periodic table.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
H						
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl

(a) Hydrogen was placed at the top of Group 1 in the early version of the periodic table.

The modern periodic table does **not** show hydrogen in Group 1.

(i) State one **similarity** between hydrogen and the elements in Group 1.

_____

_____

(1)

(ii) State one **difference** between hydrogen and the elements in Group 1.

_____

_____

(1)

(b) Fluorine, chlorine, bromine and iodine are in Group 7, the halogens.

The reactivity of the halogens decreases down the group.

Bromine reacts with a solution of potassium iodide to produce iodine.

$$Br_2 + 2KI \longrightarrow 2KBr + I_2$$

(i) In the reaction between bromine and potassium iodide, there is a reduction of bromine to bromide ions.

In terms of electrons, what is meant by reduction?

_____

_____

(1)

(ii) Complete the half equation for the oxidation of iodide ions to iodine molecules.

$$2I^- \longrightarrow$$

(2)

(iii) Explain, in terms of electronic structure, why fluorine is the most reactive element in Group 7.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

15. This question is about halogens and their compounds.

The table below shows the boiling points and properties of some of the elements in Group 7 of the periodic table.

Element	**Boiling point in °C**	**Colour in aqueous solution**
Fluorine	−188	colourless
Chlorine	−35	pale green
Bromine	X	orange
Iodine	184	brown

(a) Why does iodine have a higher boiling point than chlorine?

Tick **one** box.

Iodine is ionic and chlorine is covalent ☐

Iodine is less reactive than chlorine ☐

The covalent bonds between iodine atoms are stronger ☐

The forces between iodine molecules are stronger ☐

(1)

(b) Predict the boiling point of bromine.

_____

(1)

(c) A redox reaction takes place when aqueous chlorine is added to potassium iodide solution.

The equation for this reaction is:

$$Cl_2(aq) + 2KI(aq) \rightarrow I_2(aq) + 2KCl(aq)$$

Look at table above.

What is the colour of the final solution in this reaction?

Tick **one** box.

Brown ☐

Orange ☐

Pale green ☐

Colourless ☐

(1)

(d) What is the ionic equation for the reaction of chlorine with potassium iodide?

Tick **one** box.

$Cl_2 + 2K \rightarrow 2KCl$ ☐

$2I^- + Cl_2 \rightarrow I_2 + 2Cl^-$ ☐

$I^- + Cl \rightarrow I + Cl^-$ ☐

$I^- + K^+ \rightarrow KI$ ☐

(1)

(e) Why does potassium iodide solution conduct electricity?

Tick **one** box.

It contains a metal ☐

It contains electrons which can move ☐

It contains ions which can move ☐

It contains water ☐

(1)

(f) What are the products of electrolysing potassium iodide solution?

Tick **one** box.

Product at cathode	**Product at anode**	
hydrogen	iodine	☐
hydrogen	oxygen	☐
potassium	iodine	☐
potassium	oxygen	☐

(1)

(Total 6 marks)

16. This question is about atoms.

Atoms contain electrons, neutrons and protons.

(a) (i) Which of these particles has a positive charge?

Tick (✓) **one** box.

Electron ☐

Neutron ☐

Proton ☐

(1)

(ii) Which of these particles does **not** have an electrical charge?

Tick (✓) **one** box.

Electron ☐

Neutron ☐

Proton ☐

(1)

(b) How are the elements in the periodic table arranged?

Tick (✓) **one** box.

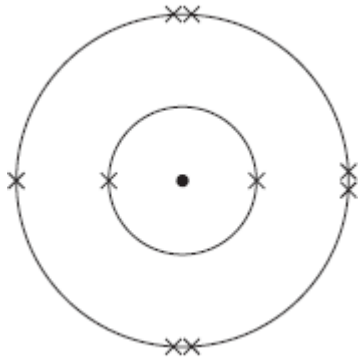
In order of increasing atomic number ☐

In order of increasing mass number ☐

In order of increasing reactivity ☐

(1)

(c) The diagram shows the arrangement of the electrons in an atom of fluorine.



(i) How many protons are in an atom of fluorine?

Tick (✓) **one** box.

2 ☐

7 ☐

9 ☐

(1)

(ii) The boiling point of fluorine is −188 °C.

What is the state of fluorine at room temperature?

Tick (✓) **one** box.

Solid ☐

Liquid ☐

Gas ☐

(1)

(d) Fluorine reacts with copper to form an ionic compound.

(i) Explain, in terms of electrons and electronic structure, what happens to a fluorine atom when it reacts with copper.

Use the figure above to help you to answer this question.

_____

_____

_____

_____

_____

(2)

(ii) Describe a chemical test which would show that a solution contains copper(II) ions.

_____

_____

_____

_____

_____

(2)

(Total 9 marks)

17. This question is about elements and the periodic table.

(a) Use the correct answers from the box to complete the sentences.

atoms	**atomic weights**	**electrons**	**proton numbers**

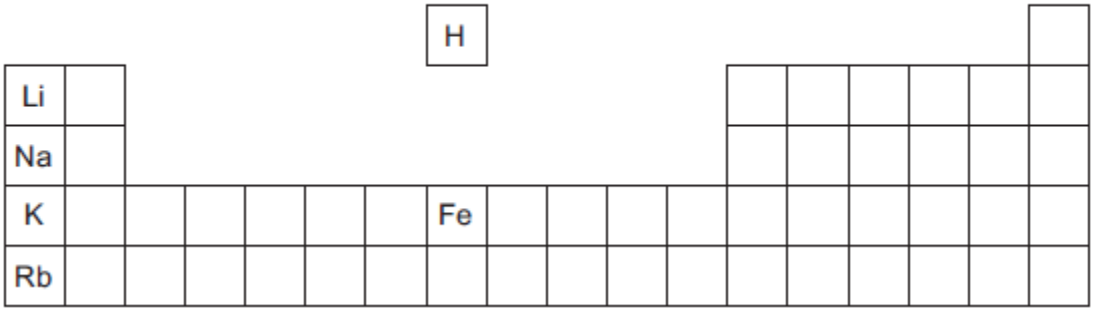
Newlands' and Mendeleev's periodic tables show the elements in order of their _____ .

Following the discovery of protons and _____, the modern periodic table shows the elements in order of their _____ .

(3)

(b) **Figure 1** shows the position of six elements in the modern periodic table.

Figure 1



(i) Which **one** of these six elements has the lowest boiling point?

_____

(1)

(ii) Complete the sentence.

In the periodic table, rubidium (Rb) is in Group _____ .

(1)

(iii) Which of these three elements is the most reactive?

Tick (✓) **one** box.

Lithium (Li) ☐

Sodium (Na) ☐

Potassium (K) ☐

(1)

(iv) Which **two** statements are correct?

Tick (✓) **two** boxes.

Iron has a higher density than potassium. ☐

Iron is softer than potassium. ☐

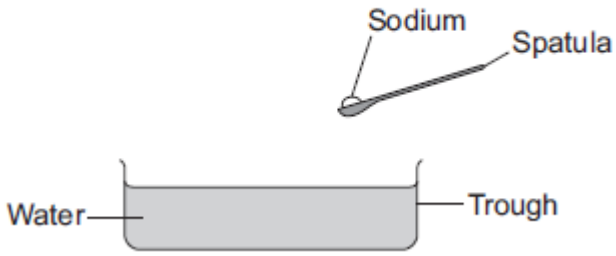
Iron reacts vigorously with water. ☐

Iron forms ions that have different charges. ☐

(2)

(c) **Figure 2** shows sodium being put into water.

Figure 2



Describe **three** observations that can be seen when sodium is put into water.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(Total 11 marks)

1. (a) (i) E

1

(ii) C

1

(iii) A

1

(b) (i) quickly melted

allow melts in contact with water,

allow bp 100 °C (of water) shows mp is low

ignore one other piece of information

1

(ii) easily cut

ignore one other piece of information

1

(iii) effervescence / fizzing / bubbling

ignore named gas

ignore one other piece of information

1

[6]

2. (a) (i) hydrogen

accept H_2

allow H

1

(ii) hydroxide

accept OH^-

allow OH

*do **not** accept lithium hydroxide*

1

(b) any **two** from:

'it' = potassium

potassium:

accept converse for lithium

- reacts / dissolves faster

  allow reacts more vigorously / quickly / violently / explodes
  ignore reacts more

- bubbles / fizzes faster

  allow fizzes more

  allow more gas

- moves faster (on the surface)

  allow moves more

- melts

  allow forms a sphere

- produces (lilac / purple) flame

  allow catches fire / ignites

  *do **not** accept other colours*

2

[4]

3. (a) (i) Halogens

1

(ii) They consist of molecules

1

They have coloured vapours

1

(b) (i) 7 / seven

1

(ii) liquid

1

(iii) astatine

allow obvious mis-spelling

ignore At

1

(c) chlorine reacts with (the) bromide [owtte]

1

chlorine reacts with (the) iodide [owtte]

allow chlorine reacts with both

or

*chlorine has more reactions for **2 marks***

or

*bromine reacts with one **and** iodine does not react at all for **2** marks*

1

4. (a) (i) a correct link between any two named elements eg same group / column same properties / number of outer electrons

allow some link between any two elements in the same group (in both Newlands and or the modern periodic table)

1

(ii) any **two** from:

ignore statements about lack of evidence / proof

- elements still being discovered

or

no gaps for undiscovered elements

- some boxes have 2 elements in them
- metals and non-metals in same column / mixed up

accept some elements in same column have different properties.

allow any sensible suggestion about misplaced elements eg copper in group 1 elements

- pattern for first 16 or so elements only

allow did not work for all elements

2

(b) (i) Cl > Br > I

accept reactivity / it decreases down the group

or

I < Br < Cl

1

Cl has 2 reactions, Br has 1 reaction, I doesn't react

owtte

allow Cl has most / more reactions and I has least / less reactions (must be clear about where Br fits in)

1

(ii) Br_2

allow multiples / fractions if correctly completed and balanced

1

(iii) (they) have 7 outer electrons

allow (they) have 7 electrons in highest occupied (energy) level / shells / rings

1

(c) *outer / last / final must be mentioned once in correct context, otherwise max **2** marks comparative required on all three points accept converse ie less reactive up group*

down group (atom / elements) bigger

or

outer electrons (level / shell /ring) further from nucleus / centre

ignore more electrons

or

more shells / level / rings

*do **not** accept more outer shells for this mark*

1

force(s) / attraction(s) are weaker

allow electron(s) attracted less easily

allow electron(s) less under influence (of nucleus)

or

more shielding

or

1

attracts less

*do **not** accept magnetic / gravitational / intermolecular forces*

electron(s) lost more easily

allow electron(s) more likely to be lost

allow easier to give away

1

[10]

5. (a) all have seven electrons in their outer shell / energy level

1

(b) *must be comparative in all points or converse*

chlorine atom is smaller than bromine atom

or
chlorine atom has fewer shells than bromine atom

1

outer shell / energy level of chlorine has stronger (electrostatic) attraction to the nucleus than bromine

or
outer shell of chlorine is less shielded from the nucleus than bromine

1

so chlorine more readily gains an extra electron

1

[4]

6. (a) 7

1

(b) small molecule

1

(c) F_2

1

(d) the reactivity decreases (going down Group 7)

allow the reactivity decreases from chlorine to iodine

1

(because) chlorine displaces bromine and iodine

allow (because) chlorine has two reactions

allow (because) neither bromine nor iodine can displace chlorine

1

(and) bromine displaces iodine **or** iodine does not react

allow (and) bromine has one reaction
or *iodine has no reactions*

allow (and) iodine cannot displace bromine

1

(e) 80

1

(f) (1.2 kg =) 1200 (g)

or (900 g =) 0.9 (kg)

1

$$(\frac{900}{1200} \times 100) = 75(\%)$$

or

$$(\frac{0.9}{1.2} \times 100) = 75(\%)$$

allow an answer correctly calculated from:

$$(\frac{900}{\text{incorrect attempt at conversion of 1.2}} \times 100)$$

or

$$(\frac{\text{conversion of 900}}{1.2} \times 100)$$

1

*an answer of 75 (%) scores **2** marks*

[9]

7. (a) (i) *incorrect or no element = **0** marks*

hydrogen

allow H / H_2

1

all the other elements are metals

allow hydrogen is a not an (alkali / group 1) metal

ignore hydrogen is a gas

OR

copper (1)

allow Cu

(copper) is not an alkali metal (1)

allow Cu is a transition element / metal

allow any valid specific chemical property eg Cu does not react with water

ignore references to electronic structure

ignore physical properties

1

(ii) Group 0 / noble gases

ignore Group 8

1

(b) (i) scandium / gallium / germanium

accept Sc / Ga / Ge

allow Krypton / Kr

1

(ii) predicted they were metals

allow atomic mass / weight

ignore atomic structure

1

predicted their (chemical/physical) properties / reactivity

accept any chemical / physical property

allow similar properties if mentioned in context of a group

1

(c) (i) (both) have <u>one</u> / <u>an</u> electron in the outer energy level / shell

ignore form single plus ions

1

(ii) *accept shell for energy level*

accept converse explanation for lithium

if 'outer' not mentioned, max 2 marks

ignore sodium reacts more easily

sodium loses one outer electron <u>more</u> easily (than lithium)

1

because outer electrons/energy level furth<u>er</u> from the nucleus in sodium **or** because sodium has <u>more</u> shells (than lithium)

*do **not** accept 'more outer shells'*

allow sodium (atom) is larger

1

because forces/attraction to hold outer electron are weak<u>er</u> in sodium (than lithium)

accept more shielding in sodium (than lithium)

1

[10]

8. (a) (i) gas

1

(ii) Increases

1

(b) (i) –1

allow Cl^-

allow –

allow negative

1

(ii) sodium + chlorine → sodium chloride

allow correct symbol equation

1

(c) reduce microbes

accept sterilise

accept prevent diseases

allow disinfect

allow kill bacteria / germs / microbes / micro-organisms

allow to make it safe to drink

ignore get rid of bacteria

1

(d) any **one** from:

- no freedom of choice

  allow unethical

- fluoride in toothpaste

- too much can cause fluorosis

  allow too much can cause damage to teeth

1

[6]

9. (a) (i) any **two** from:

- bubbles / effervescence / fizzing

  ignore hydrogen / gas produced
- lithium disappears / gets smaller

  allow dissolves

  *do **not** allow melts / burns*
- lithium moves on the surface of the water

  ignore floats
- (universal indicator) turns blue / purple

2

(ii) 2

left-hand side correct

1

2

right-hand side correct

allow multiples for full credit

1

(iii) light / burn, which will give a (squeaky) pop / explosion

1

(iv) all have 1 electron in their outer shell / energy level

allow have the same number of electrons in their outer shell / energy level

1

(b) They react with oxygen

1

They have low melting points

1

(c) (i) electronic structure [2,8,8] is drawn

*incomplete inner shells scores a maximum of **1** mark*

1

charge is +

*allow [2,8,8]$^{+}$ for **1** mark*

1

(ii) because (in potassium) the outer shell electron is further away from the nucleus **or** because potassium atoms are larger than sodium atoms

*it should be clear that the candidate is referring to the outer shell electron: if this is not clear a maximum of **2** marks can be awarded*

1

therefore the outer shell electron is less strongly attracted to the nucleus **or** is more shielded from the attraction of the nucleus and so the outer shell electron in potassium is more easily lost

1

***3** marks can be scored for answering the question in terms of sodium*

1

[13]

10. (a) if placed consecutively, then elements would be in wrong group / have wrong properties

allow some elements didn't fit pattern

1

left gaps

1

(b) (elements placed in) atomic / proton number order

1

(elements in) same group have same number of outer electrons

1

any **one** from:

- number of protons = number of electrons
- reactions/(chemical) properties depend on the (outer) electrons
- number of shells gives the period

allow number of shells increases down the group

1

(c) (i) (transition elements usually) have same / similar number of outer / 4th shell electrons

allow 2 electrons in outer shell

1

(because) inner (3rd) shell / energy level is being filled

ignore shells overlap

1

(ii) 2nd shell / energy level can (only) have maximum of 8 electrons

accept no d-orbitals

or

2nd shell / energy level cannot have 18 electrons

1

[8]

11. (a) potassium chloride **and** iodine

either order

allow KCl for potassium chloride and I_2 for iodine

1

(b) (chlorine's) outer electrons / shell closer to the nucleus

allow chlorine has fewer shells

allow chlorine atom is smaller than iodine atom

ignore chlorine has fewer outer shells

1

(so) the chlorine nucleus has greater attraction for outer electrons / shell

allow chlorine has less shielding

*do **not** accept incorrect types of attraction*

1

(so) chlorine gains an electron more easily

1

***max 2** marks can be awarded if the answer refers to chloride / iodide instead of chlorine / iodine*

allow converse statements

allow energy levels for shells throughout

(c) hydrogen chloride is made of small molecules

allow hydrogen chloride is simple molecular

1

(so hydrogen chloride) has weak intermolecular forces*

1

(intermolecular forces) require little energy to overcome*

1

do **not accept reference to bonds breaking unless applied to intermolecular bonds*

(d) (bonds broken = 4(412) + 193 =)1841

1

(bonds formed = 3(412) + 366 + **X** =) 1602 + **X**

1

−51 = 1841 − (1602 + **X**)

allow use of incorrectly calculated values of bonds broken and / or bonds formed from steps 1 and 2 for steps 3 and 4

1

(**X** =) 290 (kJ/mol)

allow a correctly calculated answer from use of −51 = bonds formed − bonds broken

1

OR

alternative method ignoring the 3 unchanged C−H bonds

(412 + 193 =) 605 (1)

366 + **X** (1)

−51 = 605 − (366 + **X**) (1)

(**X** =) 290 (kJ/mol) (1)

*an answer of 290 (kJ/mol) scores **4** marks*

*an answer of 188 (kJ/mol) scores **3** marks*

*an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

[11]

12. (a) increase

1

(b) (i) Na^+ **and** Br^-

both required

1

(ii) sodium chloride

allow NaCl

*do **not** allow sodium chlorine*

1

(iii) chlorine is more reactive than bromine

allow converse argument

allow symbols Cl, Cl_2, Br and Br_2

allow chlorine / it is more reactive

*do **not** allow chloride **or** bromide*

1

(iv) fluorine

allow F / F_2.

*do **not** allow fluoride.*

1

[5]

13. (a) (i) atomic weight

1

(ii) groups

1

(iii) left a gap

1

(iv) had not been discovered by 1869

1

(b) protons

must be in correct order

1

electrons

1

(c) sodium and nickel are both metals

1

sodium is more reactive than nickel

1

(d) (i) bromine

allow Br_2 / Br

*do **not** allow bromide*

1

(ii) iodine is less reactive (than bromine)

it = iodine

allow converse

*do **not** allow bromide*

1

[10]

14. (a) (i) any **one** from:

- one electron in the outer shell / energy level
- form ions with a 1+ charge

1

(ii) any **one** from:

- hydrogen is a non-metal
- (at RTP) hydrogen is a gas
- hydrogen does not react with water
- hydrogen has only one electron shell / energy level
- hydrogen can gain an electron **or** hydrogen can form a negative / hydride / H^- ion
- hydrogen forms covalent bonds **or** shares electrons

accept answers in terms of the Group 1 elements

1

(b) (i) (bromine) gains electrons

it = bromine

*do **not** accept bromide ion gains electrons*

ignore loss of oxygen

1

(ii) I_2

must both be on the right hand side of the equation

1

$+ 2e^-$

*$2I^- - 2e^- \rightarrow I_2$ for **2** marks*

1

(iii) fluorine is the smallest atom in Group 7 **or** has the fewest energy levels in Group 7 **or** has the smallest distance between outer shell and nucleus

*the outer shell **must** be mentioned to score 3 marks*

1

fluorine has the least shielding **or** the greatest attraction between the nucleus and the outer shell

1

therefore fluorine can gain an electron (into the outer shell) more easily

1

[8]

15. (a) The forces between iodine molecules are stronger

1

(b) anything in range +30 to +120

1

(c) Brown

1

(d) $2\ I^- + Cl_2 \rightarrow I_2 + 2\ Cl^-$

1

(e) It contains ions which can move

1

(f) hydrogen iodine

1

[6]

16. (a) (i) Proton

1

(ii) Neutron

1

(b) In order of increasing atomic number

1

(c) (i) 9

1

(ii) Gas

1

(d) (i) gains (one) electron

1

(to gain a) full outer energy level **or** noble gas configuration

allow because it has seven outer electrons

1

(ii) add sodium hydroxide (solution)

*allow ammonia (solution) **or** ammonium hydroxide **or** any other soluble hydroxide **or** flame test*

1

(forms a) blue precipitate

second mark dependent on suitable reagent being added

allow blue–green / blue / green if flame test given

1

[9]

17. (a) atomic weights

must be in this order

1

electrons

1

proton numbers

1

(b) (i) H/hydrogen

allow H_2 or h

1

(ii) one / 1

allow alkali metals

1

(iii) Potassium (K)

1

(iv) Iron has a higher density than potassium

1

Iron forms ions that have different charges

1

(c) any **three** from:

- melts
- fizzes / bubbles / effervesces

  allow gas produced
- sodium floats
- size of the sodium decreases

  allow dissolves / disappears
- sodium moves

  allow two marks for moves around on the surface of the water

3

[11]