All questions are for both separate science and combined science students

Q1.

This question is about elements, compounds and mixtures.

(a) Substance A contains only one type of atom.

Substance A does not conduct electricity.

Which type of substance is A?

Tick (✓) one box.

Compound	☐
Metallic element	☐
Mixture	☐
Non-metallic element	☐

(1)

(b) Substance B contains two types of atoms.

The atoms are chemically combined together in fixed proportions.

Which type of substance is B?

Tick (✓) one box.

Compound	☐
Metallic element	☐
Mixture	☐
Non-metallic element	☐

(1)

(c) What is the name of the elements in Group 0 of the periodic table?

Tick (✓) one box.

Alkali metals ☐

Halogens ☐

Noble gases ☐

Transition metals ☐

(1)

(d) Which statement about the elements in Group 0 is correct?

Tick (✓) one box.

All elements in the group are very reactive. ☐

All elements in the group form negative ions. ☐

The boiling points increase down the group. ☐

The relative atomic masses (*Ar*) decrease down the group. ☐

(1)

(e) Neon is in Group 0.

What type of particles are in a sample of neon?

Tick (✓) one box.

Atoms ☐

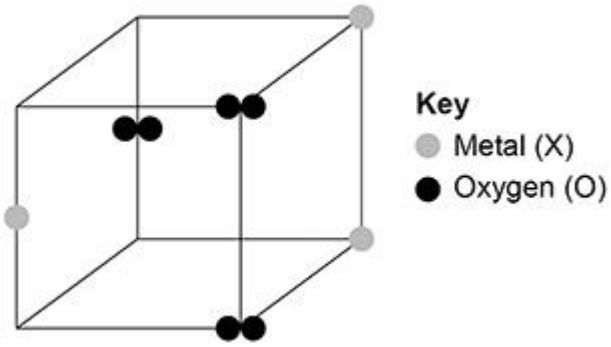
Ions ☐

Molecules ☐

(1)

(f) Figure 1 represents part of the structure of an oxide of a metal.

Figure 1



Determine the empirical formula of this oxide.

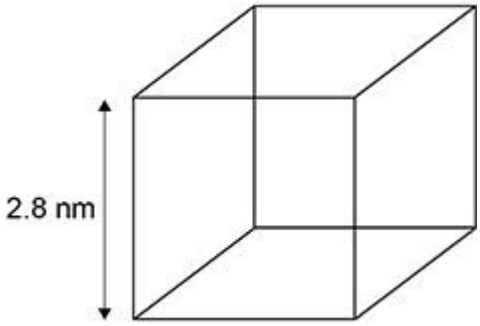
Empirical formula XO

(1)

A nanoparticle of a metallic element is a cube.

Figure 2 shows a diagram of the nanoparticle.

Figure 2



(g) The surface area of a cube is given by the equation:

surface area = (length of side)2 × 6

Calculate the surface area of the cube in Figure 2. Give your answer to 2 significant figures.

Surface area (2 significant figures) = _____ nm2

(3)

(h) Fine and coarse particles of the metallic element are also cubes.

The length of a fine particle cube is 10 times smaller than the length of a coarse particle cube.
How does the surface area to volume ratio of the fine particle cube compare with that of the coarse particle cube?
Tick (✓) one box.

Both surface area to volume ratios are the same. ☐

The surface area to volume ratio of the fine particle is 10 times greater. ☐

The surface area to volume ratio of the fine particle is 10 times smaller. ☐

(1)

(Total 10 marks)

Q2.

This question is about Group 1 elements.

(a) Complete Table 1 to show the electronic structure of a potassium atom.

Table 1

Atom	Number of electrons	Electronic structure
Sodium	11	2,8,1
Potassium	19	

(1)

(b) Why do Group 1 elements have similar chemical properties?

Tick (✓) one box.

They have the same number of electron shells. ☐

They have the same number of outer shell electrons. ☐

They have two electrons in the first shell. ☐

(1)

(c) What is the type of bonding in sodium?

Tick (✓) one box.

Covalent ☐

Ionic ☐

Metallic ☐

(1)

Table 2 shows observations made when lithium, potassium and rubidium react with water.

Table 2

Element	Observations
Lithium	Bubbles slowly Floats Moves slowly
Sodium	1 _____ 2 _____
Potassium	Bubbles very quickly Melts into a ball Floats Moves very quickly Flame
Rubidium	Sinks Melts into a ball Explodes with a flame

(d) Give two observations you could make when sodium reacts with water.

Write your answers in Table 2.

(2)

(e) How does the reactivity of the elements change going down Group 1?

_____

_____

(1)

(f) Give two ways in which the observations in Table 2 show the change in reactivity going down Group 1.

1 _____

_____

2 _____

_____

(2)

(g) Which gas is produced when Group 1 elements react with water?

Tick (✓) one box.

Carbon dioxide ☐

Hydrogen ☐

Nitrogen ☐

Oxygen ☐

(1)

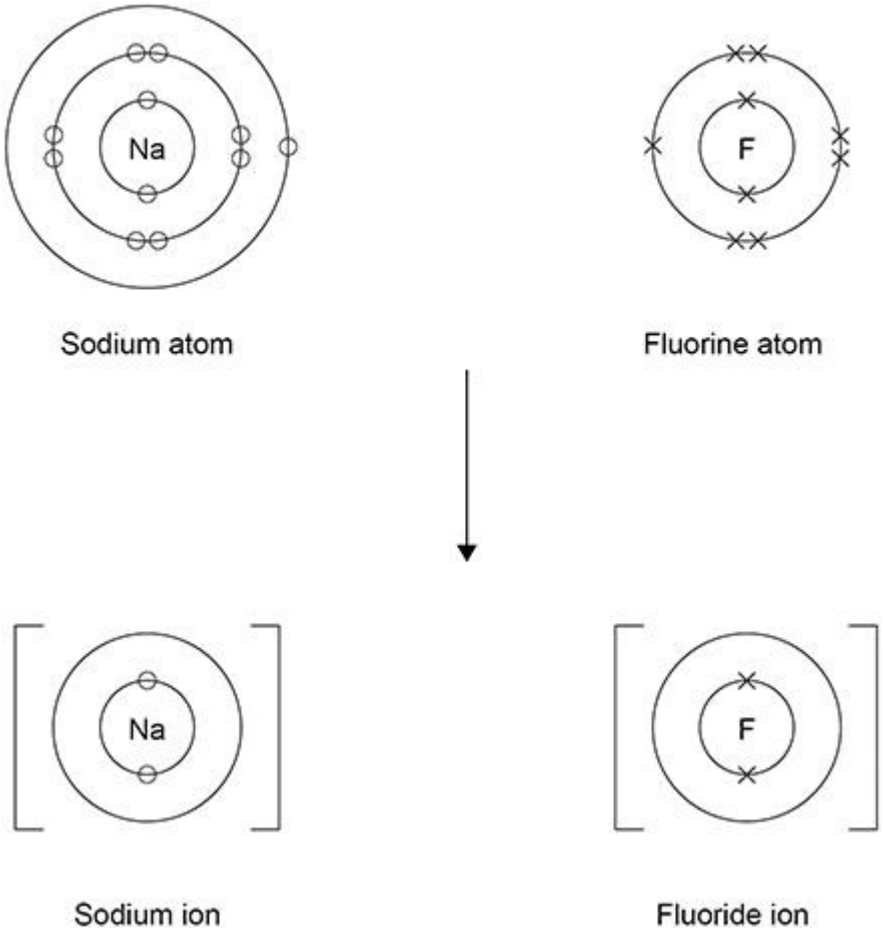
(h) Sodium fluoride is an ionic compound.

The diagram below shows dot and cross diagrams for a sodium atom and a fluorine atom.

Complete the diagram below to show what happens when a sodium atom and a fluorine atom react to produce sodium fluoride.

You should:

- complete the electronic structures of the sodium ion and the fluoride ion
- give the charges on the sodium ion and the fluoride ion.



(3)
(Total 12 marks)

Q3.

This question is about atomic structure and the periodic table.

Gallium (Ga) is an element that has two isotopes.

(a) Give the meaning of 'isotopes'. You should answer in terms of subatomic particles.

_____

_____

_____

_____

(2)

(b) The table below shows the mass numbers and percentage abundances of the isotopes of gallium.

Mass	Percentage abundance

number	(%)
69	60
71	40

Calculate the relative atomic mass (*A*r) of gallium.

Give your answer to 1 decimal place.

_____

_____

_____

_____

Relative atomic mass (1 decimal place) = _____

(2)

Gallium (Ga) is in Group 3 of the modern periodic table.

(c) Give the numbers of electrons and neutrons in an atom of the isotope ^{69}Ga

Number of electrons _____

Number of neutrons _____

(2)

(d) What is the most likely formula of a gallium ion?

Tick (✓) one box.

Ga+ ☐

Ga– ☐

Ga^{3+} ☐

Ga^{3-} ☐

(1)

(e) Gallium was discovered six years after Mendeleev published his periodic table.

Give two reasons why the discovery of gallium helped Mendeleev's periodic table to become accepted.

1 _____

_____

2 _____

_____

(2)

(Total 9 marks)

Q4.

This question is about Group 1 elements.

(a) Give two observations you could make when a small piece of potassium is added to water.

1 _____

_____

2 _____

_____

(2)

(b) Complete the equation for the reaction of potassium with water.

You should balance the equation.

$$K + \quad H_2O \rightarrow \quad +$$

(2)

(c) Explain why the reactivity of elements changes going down Group 1.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

Sodium reacts with oxygen to produce the ionic compound sodium oxide.

Oxygen is a Group 6 element.

(d) Draw a dot and cross diagram to show what happens when atoms of sodium and oxygen react to produce sodium oxide.

Diagram

(4)

(e) Why is oxygen described as being reduced in the reaction between sodium and oxygen?

_____

_____

(1)

(f) Explain why sodium oxide has a high melting point.

_____

_____

_____

_____

_____

_____

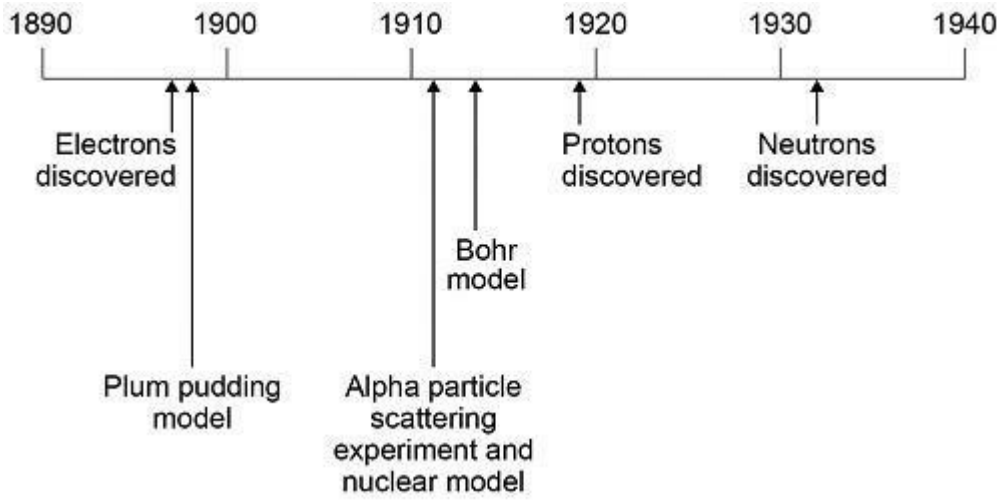
(3)

(Total 16 marks)

Q5.

This question is about the development of scientific theories.

The diagram below shows a timeline of some important steps in the development of the model of the atom.



(a) The plum pudding model did not have a nucleus. Describe three other differences between the nuclear model of the atom and the plum pudding model.

1 _____

_____

_____

2 _____

_____

_____

3 _____

_____

_____

(3)

(b) Niels Bohr adapted the nuclear model.

Describe the change that Bohr made to the nuclear model.

_____

_____

_____

_____

(2)

(c) Mendeleev published his periodic table in 1869.

Mendeleev arranged the elements in order of atomic weight. Mendeleev then reversed the order of some pairs of elements. A student suggested Mendeleev's reason for reversing the order was to
arrange the elements in order of atomic number.
Explain why the student's suggestion cannot be correct.

Use the diagram above.

_____

_____

_____

_____ (2)

(d) Give the correct reason why Mendeleev reversed the order of some pairs of elements.

_____

_____

(1)
(Total 8 marks)

Q6.

This question is about the elements in Group 7 of the periodic table.

Table 1 shows the melting points and boiling points of some of the elements.

Table 1

Element	Melting point in °C	Boiling point in °C
Fluorin	–220	–188
e	–101	–35
Chlorin	–7	59
e		

(a) What is the state of bromine at 100 °C?
Bromin
Use Table 1.
e

Tick (✓) one box.

Gas ☐

Liquid ☐

Solid ☐

(1)

(b) What temperature does chlorine gas condense at to form a liquid?

Use Table 1.

Temperature = _____ °C

(1)

(c) Complete the sentences.

Going down Group 7 the melting points _____ .

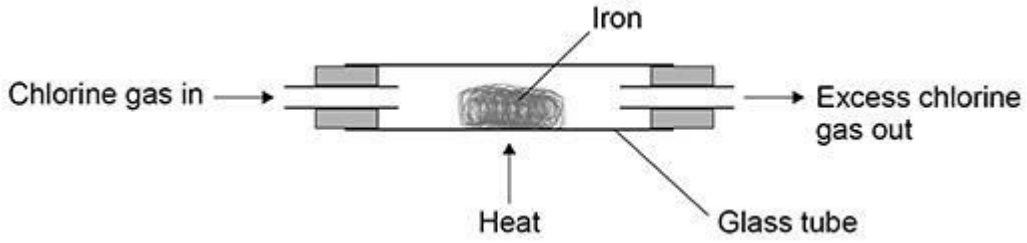
This is because the size of the molecules increases so the intermolecular forces

_____ .

(2)

A teacher investigated the reaction of iron with chlorine.

The diagram below shows the apparatus used.



(d) Why did the teacher do the investigation in a fume cupboard?

Tick (✓) one box.

Chlorine gas is coloured. ☐

Chlorine gas is flammable. ☐

Chlorine gas is toxic. ☐

(1)

(e) The word equation for the reaction is:

iron + chlorine → iron chloride

Iron chloride is a solid.

The teacher weighed the glass tube and contents:

- before the reaction
- after the reaction.

What happened to the mass of the glass tube and contents during the reaction?
Give one reason for your answer.

The mass of the glass tube and contents _____

Reason _____

_____

(2)

The teacher repeated the investigation with bromine gas and with iodine gas.

Table 2 shows the results.

Table 2

Element	Observation
Chlorine	Iron burns vigorously with an orange glow
Bromine	Iron burns with an orange glow
Iodine	Iron slowly turns darker

(f) Fluorine is above chlorine in Group 7.

Predict what you would observe when fluorine gas reacts with iron.

Use Table 2.

_____

_____

(1)

(g) Balance the equation for the reaction between iron and bromine.

$$2Fe + \_\_\_\_\_ Br_2 \rightarrow 2 FeBr_3$$

(1)

(h) Calculate the relative formula mass (*M*r) of $FeBr_3$

Relative atomic masses (*A*r): Fe = 56 Br = 80

_____

_____

Relative formula mass (*Mr*) = _____

(2)

(Total 11 marks)

Q7.

This question is about the halogens.

Table 1 shows the melting points and boiling points of some halogens.

Table 1

Element	Melting point in °C	Boiling point in °C
Fluorin e	–220	–188
Chlorin e	–101	–35
Bromin e	–7	59

(a) What is the state of bromine at 0 °C and at 100 °C?

Tick (✓) one box.

State at 0 °C	State at 100 °C	
Gas	Gas	☐
Gas	Liquid	☐
Liquid	Gas	☐
Liquid	Liquid	☐
Solid	Gas	☐
Solid	Liquid	☐

(1)

(b) Explain the trend in boiling points of the halogens shown in Table 1.

_____

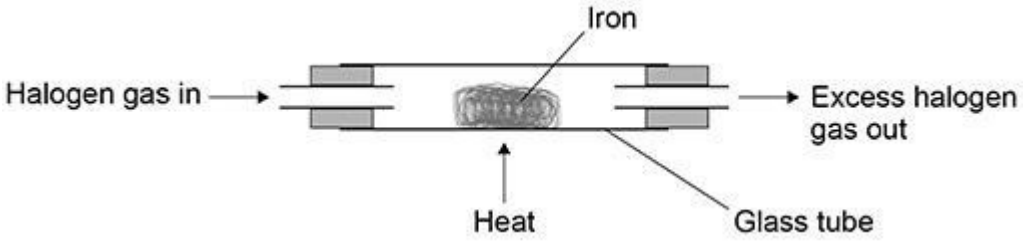
(4)

(c) Why is it not correct to say that the boiling point of a single bromine molecule is 59 °C?

(1)

Iron reacts with each of the halogens in their gaseous form.

The diagram below shows the apparatus used.



(d) Give one reason why this experiment should be done in a fume cupboard.

(1)

(e) Explain why the reactivity of the halogens decreases going down the group.

_____

(3)

(f) A teacher investigated the reaction of iron with chlorine using the apparatus in the above diagram.

The word equation for the reaction is:

iron + chlorine → iron chloride

The teacher weighed:

- the glass tube
- the glass tube and iron before the reaction
- the glass tube and iron chloride after the reaction.

Table 2 shows the teacher's results.

Table 2

	Mass in g
Glass tube	51.56
Glass tube and iron	56.04
Glass tube and iron chloride	64.56

Calculate the simplest whole number ratio of:

moles of iron atoms : moles of chlorine atoms

Determine the balanced equation for the reaction.

Relative atomic masses (*A*r): Cl = 35.5 Fe = 56

_____

_____

_____

_____

_____

_____ Moles of

iron atoms : moles of chlorine atoms = _____ : _____

Equation for the reaction _____

(6)

(Total 16 marks)

Q8.

This question is about the periodic table.

In the 19th century, some scientists tried to classify the elements by arranging them in order of their atomic weights.

The figure below shows the periodic table Mendeleev produced in 1869.

His periodic table was more widely accepted than previous versions.

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
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
Period 5	Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	* I

(a) The atomic weight of tellurium (Te) is 128 and that of iodine (I) is 127

Why did Mendeleev reverse the order of these two elements?

_____

_____

(1)

(b) Mendeleev left spaces marked with an asterisk *

He left these spaces because he thought missing elements belonged there.

Why did Mendeleev's periodic table become more widely accepted than previous versions?

_____

_____

_____

_____

_____

_____

(3)

(c) Mendeleev arranged the elements in order of their atomic weight.

What is the modern name for atomic weight?

Tick (✓) one box.

Atomic number ☐

Mass number ☐

Relative atomic mass ☐

Relative formula mass ☐

(1)

(d) Complete the sentence.

In the modern periodic table, the elements are arranged in order of

_____

(1)

Chlorine, iodine and astatine are in Group 7 of the modern periodic table.

(e) Astatine (At) is below iodine in Group 7.

Predict:

- the formula of an astatine molecule
- the state of astatine at room temperature.

Formula of astatine molecule _____

State at room temperature _____

(2)

(f) Sodium is in Group 1 of the modern periodic table.

Describe what you would see when sodium reacts with chlorine.

_____

_____

_____

_____

(2)

(Total 10 marks)

Q9.

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)

Q10.

This question is about elements in Group 1.

A teacher burns sodium in oxygen.

(a) Complete the word equation for the reaction.

sodium + oxygen → _____

(1)

(b) What is the name of this type of reaction?

Tick one box.

Decomposition	☐
Electrolysis	☐
Oxidation	☐
Precipitation	☐

(1)

(c) The teacher dissolves the product of the reaction in water and adds universal indicator.

The universal indicator turns purple.

What is the pH value of the solution?

Tick one box.

1		4		7		13	

(1)

(d) The solution contains a substance with the formula NaOH

Give the name of the substance.

_____

(1)

(e) All alkalis contain the same ion.

What is the formula of this ion?

Tick one box.

H^+ ☐

Na+ ☐

OH− ☐

O^{2-} ☐

(1)

(f) A solution of NaOH had a concentration of 40 g/dm3

What mass of NaOH would there be in 250 cm3 of the solution?

_____

_____

_____

_____

Mass = _____ g

(2)

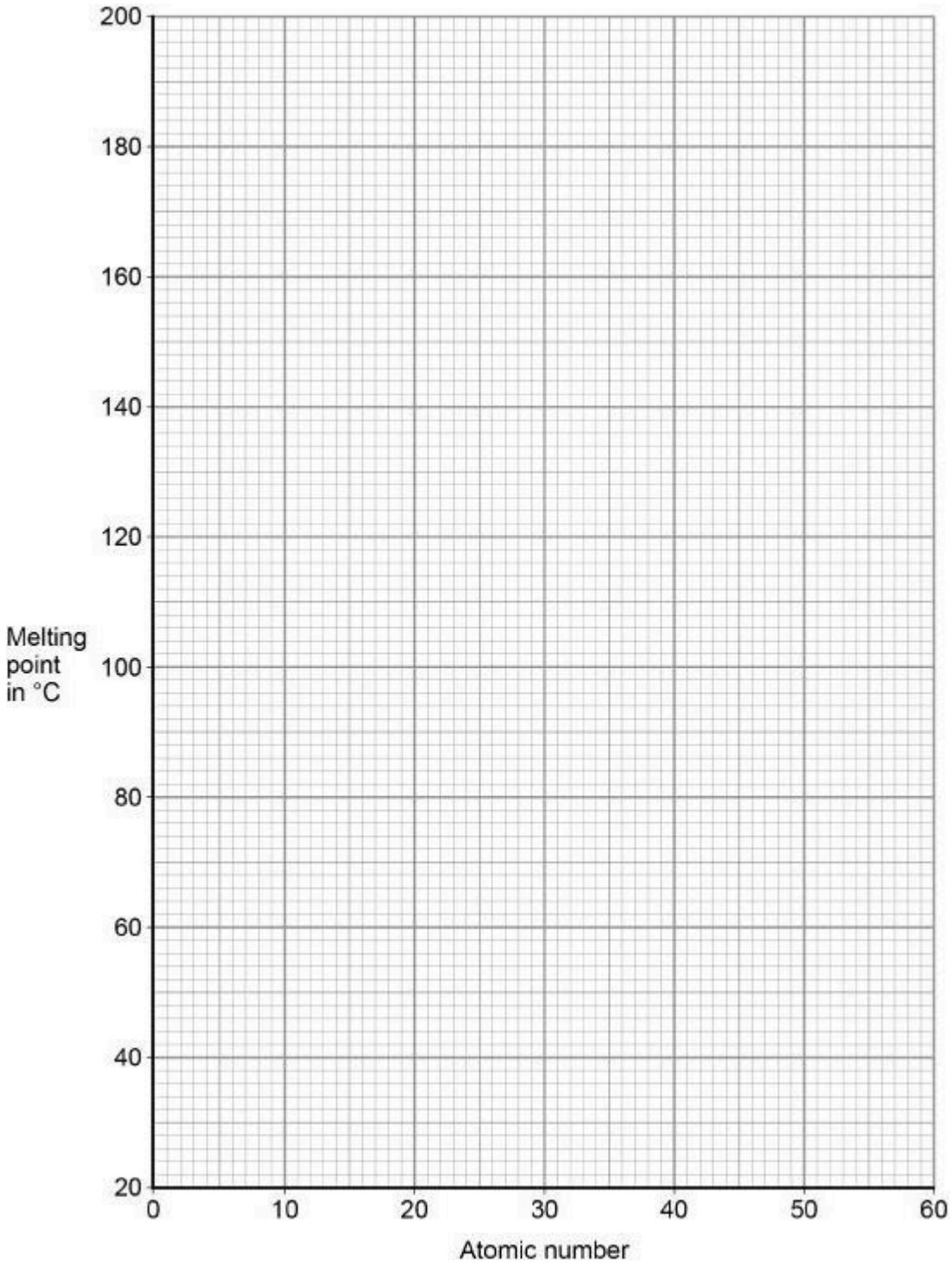
(g) The melting points of the elements in Group 1 show a trend.

The table below shows the atomic numbers and melting points of the Group 1 elements.

Element	Atomic number	Melting point in °C

Lithium	3	181
Sodium	11	98
Potassium	19	63
Rubidium	37	X
Caesium	55	29

Plot the data from the table on the graph below.



(2)

(h) Predict the melting point, in °C, of rubidium, atomic number 37

Use the graph above.

Melting point = _____ °C

(1)

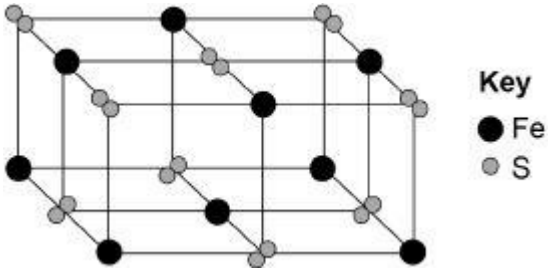
(Total 10 marks)

Q11.

This question is about metals and metal compounds.

(a) Iron pyrites is an ionic compound.

The diagram below shows a structure for iron pyrites.



Determine the formula of iron pyrites.

Use the diagram above.

_____

(1)

(b) An atom of iron is represented as $^{56}_{26}Fe$

Give the number of protons, neutrons and electrons in this atom of iron.

Number of protons ___ Number of neutrons

_____ Number of electrons

_____

(3)

(c) Iron is a transition metal.

Sodium is a Group 1 metal.

Give two differences between the properties of iron and sodium.

1. _____

_____ 2.

_____

_____

(2)

Nickel is extracted from nickel oxide by reduction with carbon.

(d) Explain why carbon can be used to extract nickel from nickel oxide.

_____

_____

_____

_____

(2)

(e) An equation for the reaction is:

$$NiO + C \rightarrow Ni + CO$$

Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses (*Ar*): C = 12 Relative formula mass (*Mr*): NiO = 75 Give your answer to 3 significant figures.

_____

_____

_____

_____

_____

_____

Percentage atom economy = _____ %

(3)

(Total 11 marks)

Q12.

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.

_____

_____

_____

_____

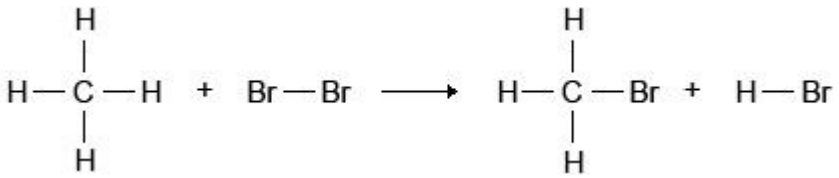
_____

_____

(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

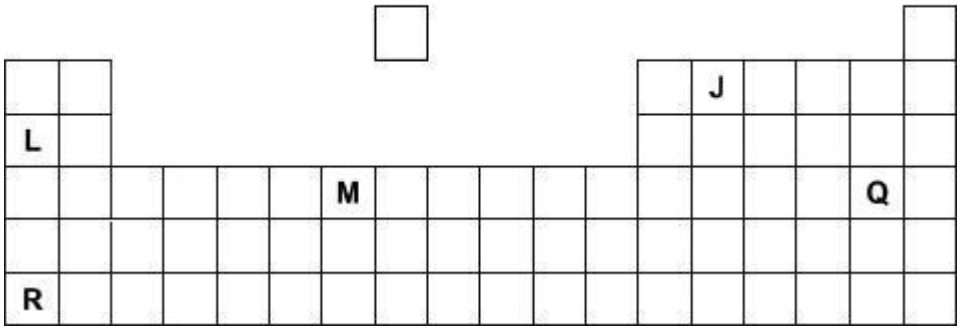
(4)

(Total 11 marks)

Q13.

Figure 1 shows an outline of the modern periodic table.

Figure 1



J, L, M, Q and R represent elements in the periodic table.

(a) Which element has four electrons in its outer shell?

Tick (✓) one box.

J ☐ L ☐ M ☐ Q ☐ R ☐

(1)

(b) Which two elements in Figure 1 are in the same period?

_____ and _____

(1)

(c) Which element reacts with potassium to form an ionic compound?

Tick (✓) one box.

J ☐ L ☐ M ☐ Q ☐ R ☐

(1)

(d) Which element forms ions with different charges?

Tick (✓) one box.

J ☐ L ☐ M ☐ Q ☐ R ☐

(1)

(e) Which element has three electron shells?

Tick (✓) one box.

J ☐ L ☐ M ☐ Q ☐ R ☐

(1)

(f) In the 1860s scientists were trying to organise elements.

Figure 2 shows the table published by John Newlands in 1865.
The elements are arranged in order of their atomic weights.

Figure 2

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
Pd	Ag	Cd	U	Sn	Sb	Te

Figure 3 shows the periodic table published by Dmitri Mendeleev in 1869.

Figure 3

H							
Li	Be	B	C	N	O	F	
Na	Mg	Al	Si	P	S	Cl	
K Cu	Ca Zn	? ?	Ti ?	V As	Cr Se	Mn Br	Fe Co Ni
Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	? I	Ru Rh Pd

Mendeleev's table became accepted by other scientists whereas Newlands' table was not.

Evaluate Newlands' and Mendeleev's tables.

You should include:

- a comparison of the tables
- reasons why Mendeleev's table was more acceptable.

Use Figure 2 and Figure 3 and your own knowledge.

(6)

(Total 11 marks)

Q14.

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
Fluorin	−188	colourless
e	−35	pale green
Chlorin	X	orange
e	184	brown
Bromin		
e Iodine		

(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:

$$Cl2(aq) + 2KI(aq) \rightarrow I2\ (aq) + 2KCl(aq)$$

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.

$Cl2 + 2K \rightarrow 2KCl$ ☐

$2I^- + Cl2 \rightarrow I2 + 2Cl^-$ ☐

$I^- + Cl \rightarrow I + Cl^-$ ☐

$I^- + K+ \rightarrow KI$ ☐

(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)

Q15.

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

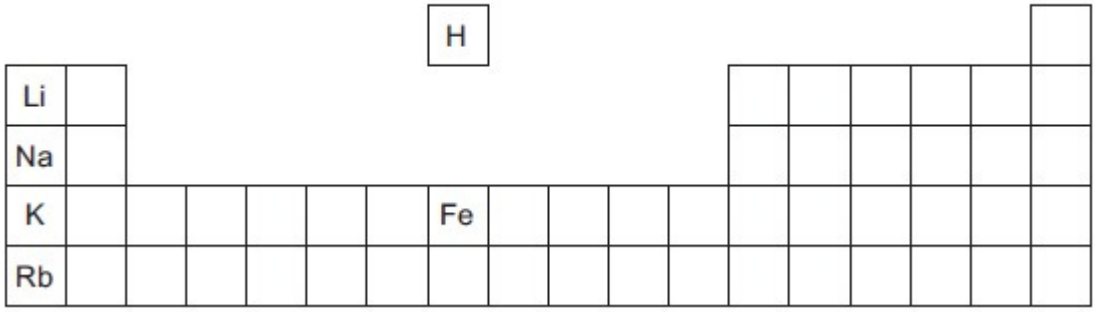
Newlands' and Mendeleev's periodic tables show the elements in order of their _____ .

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. ☐

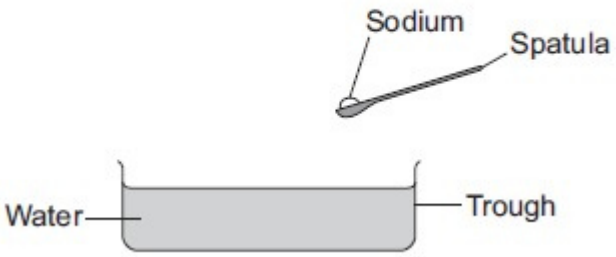
Iron reacts vigorously with water. ☐

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)

Q16.

This question is about elements and the periodic table.

(a) Newlands and Mendeleev both produced early versions of the periodic table.

(i) Complete the sentence.

In their periodic tables, Newlands and Mendeleev arranged the elements in
order of _____ .

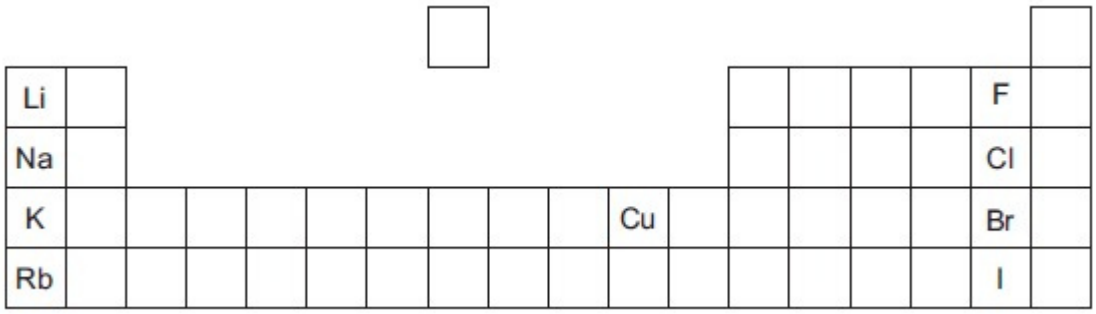
(1)

(ii) Name the particle that allowed the elements to be arranged in order of their atomic number in the modern periodic table.

_____

(1)

(b) The diagram below shows the position of nine elements in the modern periodic table.



(i) Which one of the nine elements shown in the diagram above has the lowest boiling point?

_____

(1)

(ii) Copper and potassium have different melting points and boiling points. Give one other difference between the properties of copper and potassium.

_____

_____

(1)

(iii) Explain why the reactivity of the elements increases going down Group 1 from lithium to rubidium but decreases going down Group 7 from fluorine to iodine.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 8 marks)