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 (*A*r) 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 ☐

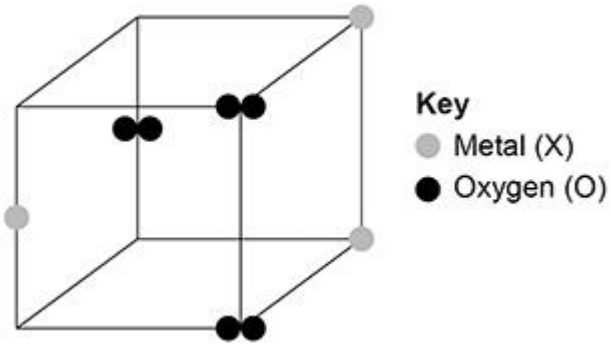
Ions ☐

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.

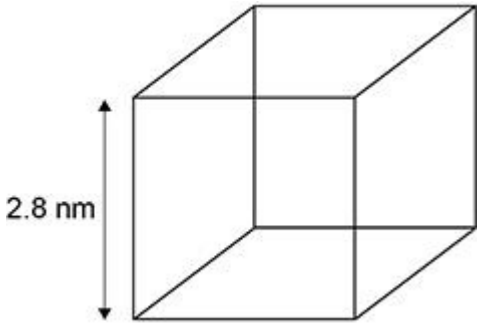
Empirical formula = XO___

(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 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 number	Percentage abundance (%)
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 $^{69}_{31}Ga$

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)

Q3.

This question is about models of the atom.

(a) Atoms were first thought to be tiny spheres that could not be divided.

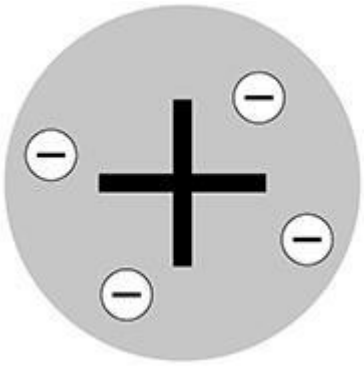
Which particle was discovered to change this model of the atom?

Tick (✓) one box.

Electron	☐
Neutron	☐
Proton	☐

(1)

(b) The diagram below shows another model of the atom.



What is the name of this model of the atom?

_____

(1)

(c) A scientist fired particles at gold atoms.

Some of these particles were scattered.

The results led to a different model of the atom.

Which type of particle was fired at the gold atoms?

Tick (✓) one box.

Alpha ☐

Electron ☐

Neutron ☐

Proton ☐

(1)

(d) Which scientist first suggested that electrons orbit the nucleus at specific distances?

Tick (✓) one box.

Bohr ☐

Chadwick ☐

Mendeleev ☐

(1)

(e) The model of the atom used today has three subatomic particles:

- electrons
- neutrons
- protons.

Complete the sentences.

Atoms of the same element have the same atomic number because they have the
same number of _____.

Atoms of the same element can have different mass numbers because they have
different numbers of _____.

Atoms have no overall charge because they have the same number of

_____ and _____.

(3)

(f) The radius of a nucleus is approximately 1×10^{-14} m

The radius of an atom is approximately 1 × 10–10 m

A teacher uses a ball of radius 1 cm to represent the nucleus.

What could represent the atom on the same scale?

Tick (✓) one box.

A ball of radius 10 cm	☐
A sports arena of radius 100 m	☐
An island of radius 10 km	☐
A planet of radius 1000 km	☐

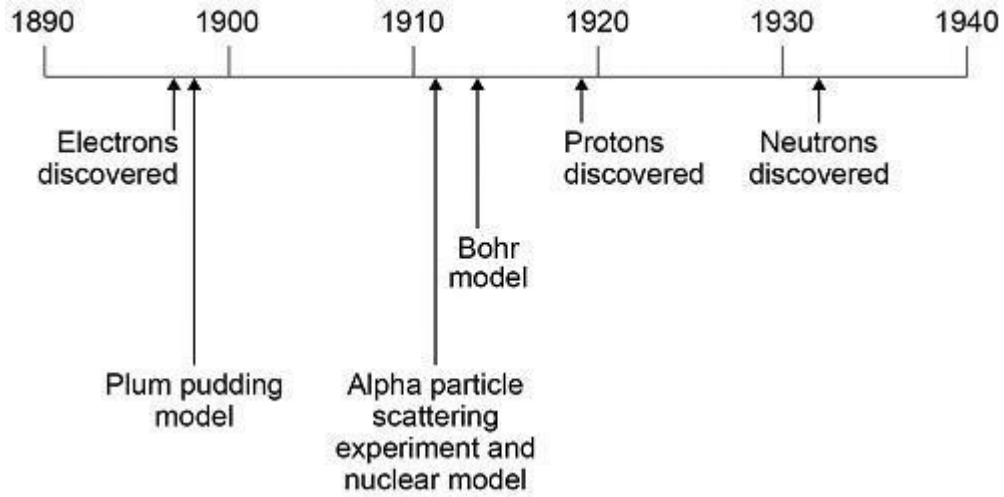
(1)

(Total 8 marks)

Q4.

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.

_____

_____

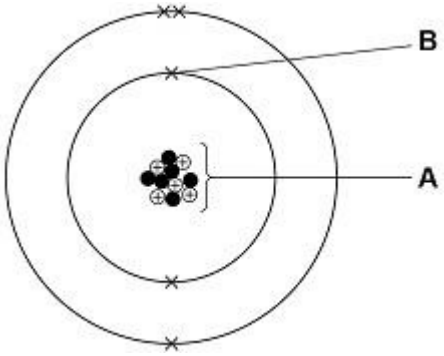
(1)
(Total 8 marks)

Q5.

This question is about atomic structure.

Figure 1 represents an atom of element Z.

Figure 1



(a) Name the parts of the atom labelled A and B.

Choose answers from the box.

electron	neutron	nucleus	proton

A _____

B _____

(2)

(b) Which particle has the lowest mass?

Choose the answer from the box.

electron	neutron	nucleus	proton

_____

(1)

(c) Which group of the periodic table contains element Z?

Use Figure 1.

Group _____

(1)

(d) Give the atomic number and the mass number of element Z .

Use Figure 1.

Choose answers from the box.

1	5	6	11	16

Atomic number _____

Mass number _____

(2)

Bromine has two different types of atom.

The atoms have a different number of neutrons but the same number of protons.

(e) What is the name for this type of atom?

Tick (✓) one box.

Compound ☐

Ion ☐

Isotope ☐

Molecule ☐

(1)

(f) The different types of bromine atom can be represented as $^{79}_{35}Br$ and $^{81}_{35}Br$

The relative atomic mass (*Ar*) of bromine is 80

Which statement is true about the number of each type of atom in bromine?

Tick (✓) one box.

There are fewer $^{79}_{35}Br$ atoms than $^{81}_{35}Br$ atoms. ☐

There are more $^{79}_{35}Br$ atoms than $^{81}_{35}Br$ atoms. ☐

There are the same number of $^{79}_{35}Br$ atoms and $^{81}_{35}Br$ atoms. ☐

(1)

(Total 8 marks)

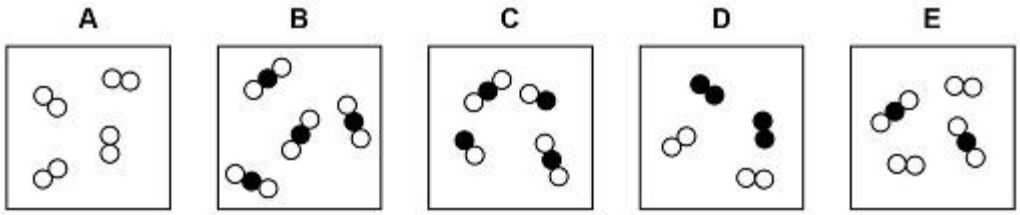
Q6.

This question is about elements, compounds and mixtures.

Figure 1 shows five different substances, A, B, C, D and E.

○ and ● represent atoms of different elements.

Figure 1



Use Figure 1 to answer parts (a) to (c)

(a) Which substance is only one compound?

Tick (✓) one box.

A ☐ B ☐ C ☐ D ☐ E ☐

(1)

(b) Which substance is a mixture of elements?

Tick (✓) one box.

A ☐ B ☐ C ☐ D ☐ E ☐

(1)

(c) Which substance is a mixture of an element and a compound?

Tick (✓) one box.

A ☐ B ☐ C ☐ D ☐ E ☐

(1)

Substances are separated from a mixture using different methods.

(d) Draw one line from each method of separation to the substance and mixture it would separate.

Method of separation	Substance and mixture
	blue food colour from a mixture of food colours
chromatography	
	copper from an alloy of copper and zinc
	copper sulfate from copper sulfate solution
crystallisation	
	ethanol from a mixture of ethanol and water

(2)

(e) Sand does not dissolve in water. A student separates a mixture of sand and water by filtration.

Draw a diagram of the apparatus the student could use.

You should label:

- where the sand is collected
- where the water is collected.

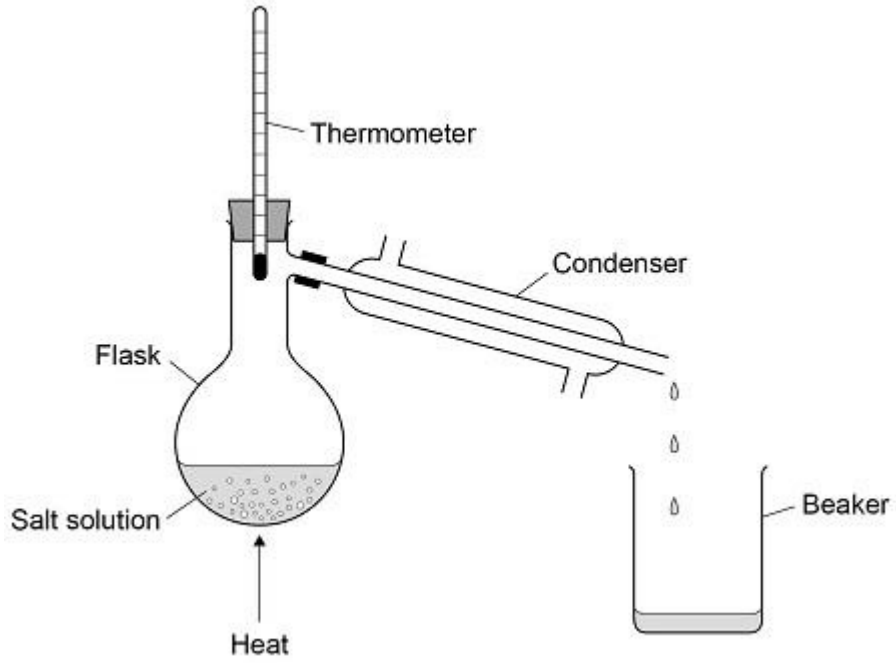
Diagram

(3)

(f) A student distils a sample of salt solution to produce pure water.

Figure 2 shows the apparatus.

Figure 2



What temperature would you expect the thermometer to show?

Tick (✓) one box.

0 °C ☐

10 °C ☐

50 °C ☐

100 °C ☐

(1)

(g) Describe how the process of distillation shown in Figure 2 produces pure water from salt solution.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 13 marks)

Q7.

This question is about atomic structure.

(a) Atoms contain subatomic particles.

The table below shows properties of two subatomic particles.

Complete the table.

Name of particle	Relative mass	Relative charge
neutron		
		+1

(2)

An element X has two isotopes.

The isotopes have different mass numbers.

(b) Define mass number.

_____

_____

(1)

(c) Why is the mass number different in the two isotopes?

_____

_____

(1)

(d) The model of the atom changed as new evidence was discovered.

The plum pudding model suggested that the atom was a ball of positive charge with electrons embedded in it.
Evidence from the alpha particle scattering experiment led to a change in the model of the atom from the plum pudding model.

Explain how.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 8 marks)

Q8.

This question is about mixtures.

(a) Substances are separated from a mixture using different methods.

Draw one line from each substance and mixture to the best method of separation.

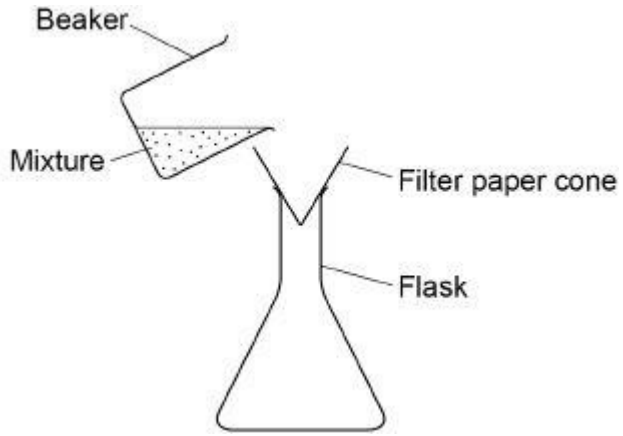
Substance and mixture	Method of separation
	Chromatography
Ethanol from ethanol and water	Crystallisation
Salt from sea water	Electrolysis
The different colours in black ink	Filtration
	Fractional distillation

(3)

(b) A student filters a mixture.

Figure 1 shows the apparatus.

Figure 1



Suggest one improvement to the apparatus.

_____

_____

(1)

(c) Complete the sentences.

Choose answers from the box.

condense	evaporate	freeze	melt	solidify

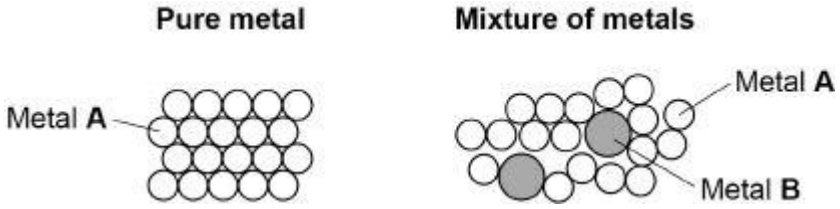
In simple distillation, the mixture is heated to make the liquid _____ .

The vapour is then cooled to make it _____ .

(2)

Figure 2 shows the arrangement of atoms in a pure metal and in a mixture of metals.

Figure 2



(d) Calculate the percentage of metal B atoms in the mixture of metals shown in Figure 2.

_____

_____

_____

Percentage of metal B atoms = _____ %

(2)

(e) What is a mixture of metals called?

Tick one box.

An alloy ☐

A compound ☐

A molecule ☐

A polymer ☐

(1)

(f) Why is the mixture of metals in Figure 2 harder than the pure metal?

Tick one box.

The atoms in the mixture are different shapes. ☐

The layers in the mixture are distorted. ☐

The layers in the mixture slide more easily. ☐

The mixture has a giant structure. ☐

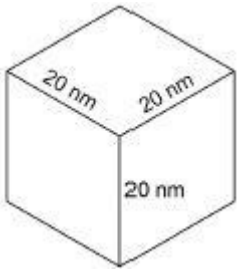
(1)

(g) A nanoparticle of pure metal A is a cube.

Each side of the cube has a length of 20 nm.

Figure 3 shows the cube.

Figure 3



What is the volume of the nanoparticle?

Tick one box.

20 nm3 ☐

60 nm3 ☐

400 nm3 ☐

8000 nm3 ☐

(1)

(Total 11 marks)

Q9.

This question is about the structure of the atom.

(a) Complete the sentences.

Choose answers from the box.

Each word may be used once, more than once, or not at all.

electron	ion	neutron
nucleus	proton	

The centre of the atom is the _____ .

The two types of particle in the centre of the atom are the proton

and the _____ .

James Chadwick proved the existence of the _____

.

Niels Bohr suggested particles orbit the centre of the atom. This type of particle

is the _____ .

The two types of particle with the same mass are the neutron

and the _____ .

(5)

The table below shows information about two isotopes of element X.

	Mass number	Percentage (%) abundance
Isotope 1	63	70
Isotope 2	65	30

(b) Calculate the relative atomic mass (*A*r) of element X using the equation:

$$A_r = \frac{\text{(mass number} \times \text{percentage) of isotope 1} + \text{(mass number} \times \text{percentage) of isotope 2}}{100}$$

Use the table above. Give your answer to 1 decimal place.

_____

_____

_____

_____

*A*r = _____

(2)

(c) Suggest the identity of element X.

Use the periodic table.

Element X is

_____

(1)

(d) The radius of an atom of element X is 1.2×10^{-10} m

The radius of the centre of the atom is $\frac{1}{10000}$ the radius of the atom.

Calculate the radius of the centre of an atom of element X.

Give your answer in standard form.

_____

_____

_____

_____

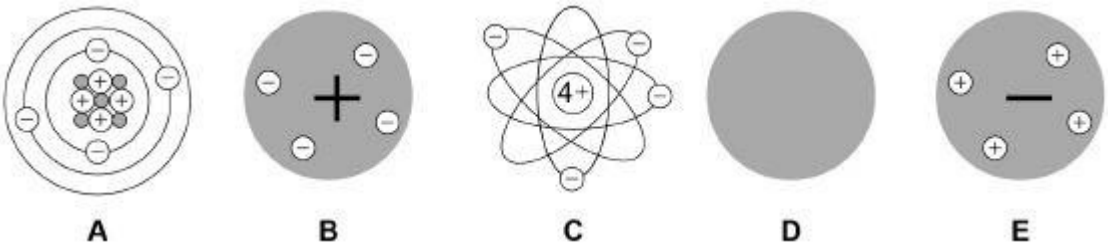
Radius = _____ m

(2)

(Total 10 marks)

Q10.

The diagram below represents different models of the atom.



(a) Which diagram shows the plum pudding model of the atom?

Tick one box.

A		B		C		D		E	

(1)

(b) Which diagram shows the model of the atom developed from the alpha particle scattering experiment?

Tick one box.

A		B		C		D		E	

(1)

(c) Which diagram shows the model of the atom resulting from Bohr's work?

Tick one box.

A		B		C		D		E	

(1)

(d) Define the mass number of an atom.

_____

_____

(1)

(e) Element X has two isotopes. Their mass numbers are 69 and 71

The percentage abundance of each isotope is:

- 60% of 69X
- 40% of 71X

Estimate the relative atomic mass of element X.

Tick one box.

< 69.5 ☐

Between 69.5 and 70.0 ☐

Between 70.0 and 70.5 ☐

> 70.5 ☐

(1)

(f) Chadwick's experimental work on the atom led to a better understanding of isotopes.

Explain how his work led to this understanding.

_____

_____

_____

_____

_____

_____

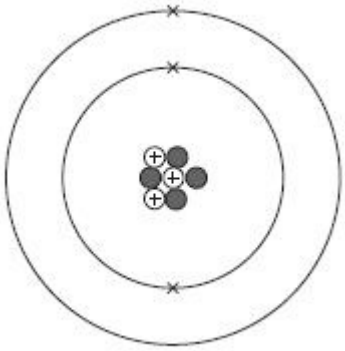
(3)

(Total 8 marks)

Q11.

This question is about atomic structure.

The figure below represents the structure of a lithium atom.



(a) Name the particle in the atom that has a positive charge.

_____

(1)

(b) Name the particle in the atom that has the smallest mass.

_____

(1)

(c) Complete the sentences.

Choose the answers from the box.

3	4	7	10

The mass number of the lithium atom is _____.

The number of neutrons in the lithium atom is _____.

(2)

(d) What are lithium atoms with different numbers of neutrons called?

Tick (✓) one box.

Compounds ☐

Ions ☐

Isotopes ☐

Molecules ☐

(1)

(e) Name the particle in the atom discovered by James Chadwick.

_____ .

(1)

(f) An element has two isotopes.

The table shows information about the isotopes.

	Mass number	Percentage (%) abundance
Isotope 1	10	20
Isotope 2	11	80

Calculate the relative atomic mass (*Ar*) of the element.

Use the equation:

$$A_r = \frac{(\text{mass number} \times \text{percentage}) \text{ of isotope 1} + (\text{mass number} \times \text{percentage}) \text{ of isotope 2}}{100}$$

Give your answer to 1 decimal place.

_____

_____

_____

_____

Relative atomic mass (*Ar*) = _____

(2)

(g) The radius of an atom is 0.2 nm

The radius of the nucleus is $\frac{1}{10000}$ the radius of the atom.

Calculate the radius of the nucleus.

Give your answer in standard form.

_____

_____

_____

_____

Radius = _____ nm

(2)

(Total 10 marks)

Q12.

This question is about atoms.

(a) What does the number 19 represent in $^{19}_{9}F$?

_____

(1)

(b) How many atoms are present in one mole of fluorine atoms?

Tick (✓) one box.

2.03×10^{26} ☐

2.06×10^{23} ☐

6.02×10^{23} ☐

6.02×10^{26} ☐

(1)

(c) The plum pudding model of the atom was replaced by the nuclear model.

The nuclear model was developed after the alpha particle scattering experiment.
Compare the plum pudding model with the nuclear model of the atom.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(d) An element has three isotopes.

The table shows the mass numbers and percentage of each isotope.

	Isotope 1	Isotope 2	Isotope 3
Mass number	24	25	26
Percentage (%)	78.6	10.1	11.3

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

Give your answer to 3 significant figures.

_____

_____

_____

_____

Relative atomic mass = _____

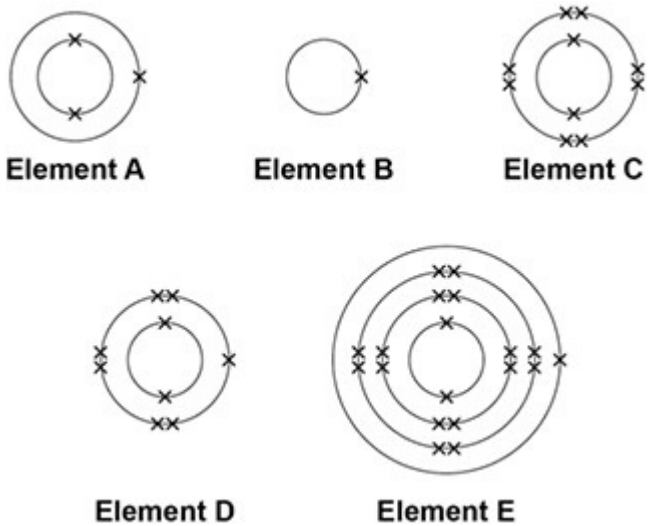
(2)

(Total 8 marks)

Q13.

The electronic structure of the atoms of five elements are shown in the figure below.

The letters are not the symbols of the elements.



Choose the element to answer the question. Each element can be used once, more than once or not at all.
Use the periodic table to help you.

(a) Which element is hydrogen?

Tick one box.

A ☐ B ☐ C ☐ D ☐ E ☐

(1)

(b) Which element is a halogen?

Tick one box.

A ☐ B ☐ C ☐ D ☐ E ☐

(1)

(c) Which element is a metal in the same group of the periodic table as element A?

Tick one box.

A ☐ B ☐ C ☐ D ☐ E ☐

(1)

(d) Which element exists as single atoms?

Tick one box.

A ☐ B ☐ C ☐ D ☐ E ☐

(1)

(e) There are two isotopes of element A. Information about the two isotopes is shown in the table below.

Mass number of the isotope	6	7
Percentage abundance	92.5	7.5

Use the information in the table above above to calculate the relative atomic mass of element A.
Give your answer to 2 decimal places.

_____

_____

_____

_____

_____

_____

_____

Relative atomic mass = _____

(4)

(Total 8 marks)

Q14.

An atom of aluminium has the symbol $^{27}_{13}Al$

(a) Give the number of protons, neutrons and electrons in this atom of aluminium.

Number of protons _____

Number of neutrons _____

Number of electrons _____

(3)

(b) Why is aluminium positioned in Group 3 of the periodic table?

_____

_____

(1)

(c) In the periodic table, the transition elements and Group 1 elements are metals.

Some of the properties of two transition elements and two Group 1 elements are shown in the table below.

	Transition elements		Group 1 elements	
	Chromium	Iron	Sodium	Caesium
Melting point in °C	1857	1535	98	29
Formula of oxides	CrO Cr2O3 CrO2 CrO3	FeO Fe2O3 Fe3O4	Na2O	Cs2O

Use your own knowledge and the data in the table above to compare the chemical and physical properties of transition elements and Group 1 elements.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 10 marks)

Q15.

This question is about mixtures and analysis.

(a) Which two substances are mixtures?

Tick two boxes.

Air	☐
Carbon dioxide	☐
Graphite	☐
Sodium Chloride	☐
Steel	☐

(2)

(b) Draw one line from each context to the correct meaning.

Context	Meaning
	A substance that has had nothing added to it
Pure substance in chemistry	A single element or a single compound

	A substance containing only atoms which have different numbers of protons
Pure substance in everyday life	A substance that can be separated by filtration
	A useful product made by mixing substances

(2)

(c) What is the test for chlorine gas?

Tick one box.

- A glowing splint relights ☐
- A lighted splint gives a pop ☐
- Damp litmus paper turns white ☐
- Limewater turns milky ☐

(1)

(d) A student tested a metal chloride solution with sodium hydroxide solution.

A brown precipitate formed.

What was the metal ion in the metal chloride solution?

Tick one box.

- Calcium ☐
- Copper(II) ☐
- Iron(II) ☐
- Iron(III) ☐

(1)

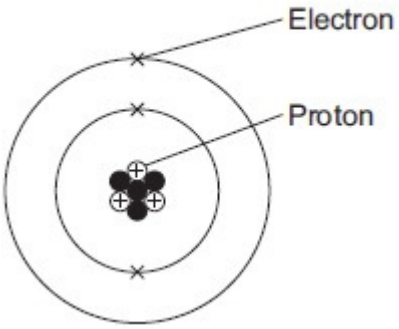
(Total 6 marks)

Q16.

There are eight elements in the second row (lithium to neon) of the periodic table.

(a) Figure 1 shows a lithium atom.

Figure 1



(i) What is the mass number of the lithium atom in Figure 1?

Tick (✓) one box.

3 ☐

4 ☐

7 ☐

(1)

(ii) What is the charge of an electron?

Tick (✓) one box.

–1 ☐

0 ☐

+1 ☐

(1)

(iii) Protons are in the nucleus.

Which other sub-atomic particles are in the nucleus?

Tick (✓) one box.

ions ☐

molecules ☐

neutrons ☐

(1)

(b) What is always different for atoms of different elements?

Tick (✓) one box.

number of neutrons ☐

number of protons ☐

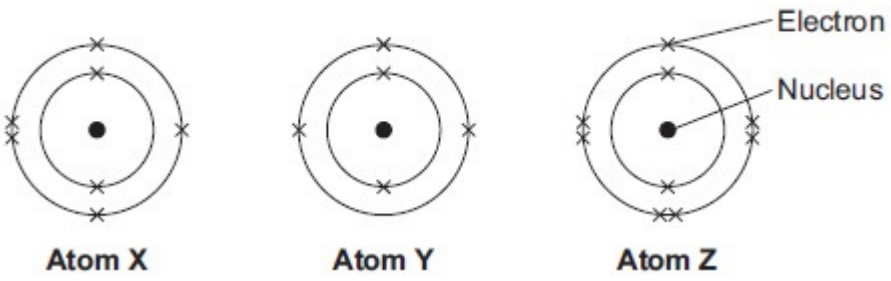
number of shells ☐

(1)

(c) Figure 2 shows the electron arrangements of three different atoms, X, Y and Z.

These atoms are from elements in the second row (lithium to neon) of the periodic table.

Figure 2



Which atom is from an element in Group 3 of the periodic table?

Tick (✓) one box.

Atom X ☐

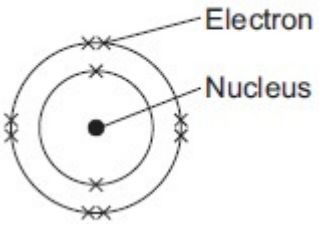
Atom Y ☐

Atom Z ☐

(1)

(d) Figure 3 shows the electron arrangement of a different atom from an element in the second row of the periodic table.

Figure 3



(i) Give the chemical symbol of this element.

_____

(1)

(ii) Why is this element unreactive?

_____

_____

(1)

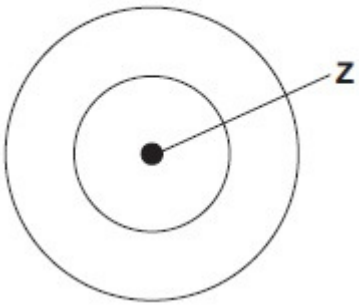
(Total 7 marks)

Q17.

There are eight elements in the second row (lithium to neon) of the periodic table.

(a) Figure 1 shows an atom with two energy levels (shells).

Figure 1



(i) Complete Figure 1 to show the electronic structure of a boron atom.

(1)

(ii) What does the central part labelled Z represent in Figure 1?

_____

(1)

(iii) Name the sub-atomic particles in part Z of a boron atom.

Give the relative charges of these sub-atomic particles.

_____

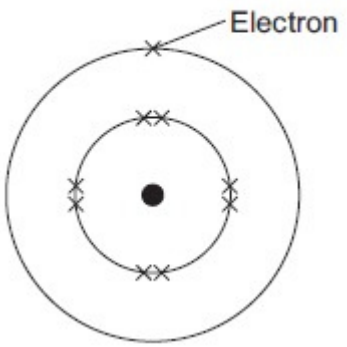
_____

_____

(3)

(b) The electronic structure of a neon atom shown in Figure 2 is not correct.

Figure 2



Explain what is wrong with the electronic structure shown in Figure 2.

_____

_____

_____

_____

_____

_____

(3)

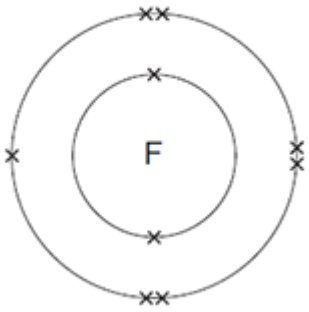
(Total 8 marks)

Q18.

This question is about fluorine.

(a) Figure 1 shows the arrangement of electrons in a fluorine atom.

Figure 1



(i) In which group of the periodic table is fluorine?

Group _____

(1)

(ii) Complete the table below to show the particles in an atom and their relative masses.

Name of particle	Relative mass
Proton	
Neutron	1
	Very small

(2)

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

alkalis	alloys	isotopes

Atoms of fluorine with different numbers of neutrons are

called _____ .

(1)

(b) Sodium reacts with fluorine to produce sodium fluoride.

(i) Complete the word equation for this reaction.

sodium + _____ → _____

(1)

(ii) Complete the sentence.

Substances in which atoms of two or more different elements are chemically
combined are called _____ .

(1)

(iii) The relative formula mass (*Mr*) of sodium fluoride is 42.

Use the correct answer from the box to complete the sentence.

ion	mole	molecule

The relative formula mass (*Mr*), in grams, of sodium fluoride is one

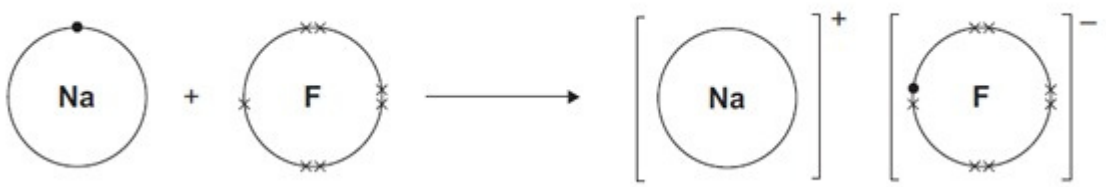
_____ of the substance.

(1)

(iv) Figure 2 shows what happens to the electrons in the outer shells when a sodium atom reacts with a fluorine atom.

The dots (•) and crosses (×) represent electrons.

Figure 2



Use Figure 2 to help you answer this question. Describe, as fully as you can, what happens when sodium reacts with fluorine to produce sodium fluoride.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(v) Sodium fluoride is an ionic substance.

What are two properties of ionic substances?

Tick (✓) two boxes.

Dissolve in water	☐
Gas at room temperature	☐
High melting point	☐
Low boiling point	☐

(2)

(Total 13 marks)

Q19.

This question is about atoms, molecules and nanoparticles.

(a) Different atoms have different numbers of sub-atomic particles.

(i) An oxygen atom can be represented as $^{16}_{8}O$

Explain why the mass number of this atom is 16.

You should refer to the numbers of sub-atomic particles in the nucleus of the atom.

_____

_____

_____

_____

_____

_____

(2)

(ii) Explain why $^{12}_{6}C$ and $^{14}_{6}C$ are isotopes of carbon.

You should refer to the numbers of sub-atomic particles in the nucleus of each isotope.

_____

_____

_____

_____

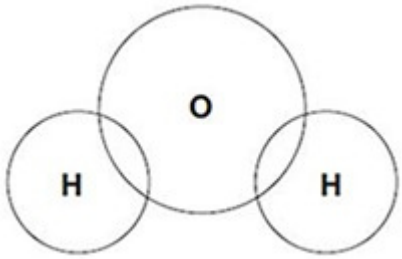
_____

_____

(3)

(b) Hydrogen atoms and oxygen atoms chemically combine to produce water molecules.

(i) Complete the figure below to show the arrangement of the outer shell electrons of the hydrogen and oxygen atoms in a molecule of water. Use dots (•) or crosses (×) to represent the electrons.



(2)

(ii) Name the type of bonding in a molecule of water.

_____

(1)

(iii) Why does pure water not conduct electricity?

_____

_____

(1)

(c) Nanoparticles of cobalt oxide can be used as catalysts in the production of hydrogen from water.

(i) How does the size of a nanoparticle compare with the size of an atom?

_____

_____

(1)

(ii) Suggest one reason why 1 g of cobalt oxide nanoparticles is a better catalyst than 1g of cobalt oxide powder.

_____

_____

(1)

(Total 11 marks)