Combined Science
Past Paper Practice

5.2 Structure, Bonding and the Properties of Matter

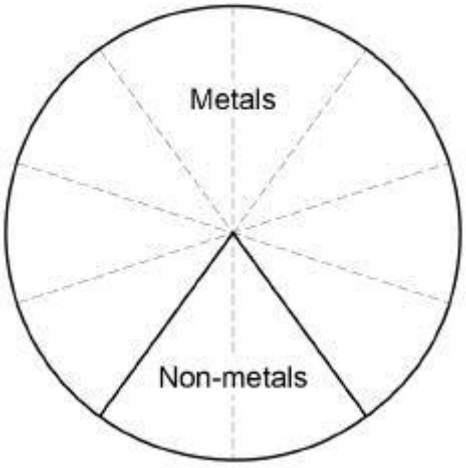
5.2.2 How Bonding is Related to the Properties of Substances							
Demand	**Question**	**Page Number**	**Mark Scheme**	**Demand**	**Question**	**Page Number**	**Mark Scheme**
Low	**1**	2	66	High	**14**	37	81
	2	4	67		**15**	39	82
	3	8	68		**16**	41	84
	4	11	69		**17**	43	86
	6	17	72		**18**	45	88
	7	20	73		**20**	50	90
	8	23	74		**21**	51	91
	9	26	75		**22**	53	93
Standard	**11**	31	77		**23**	55	94
	12	33	79		**24**	57	95
	13	35	80				

5.2.3 Structure and Bonding of Carbon							
Demand	**Question**	**Page Number**	**Mark Scheme**	**Demand**	**Question**	**Page Number**	**Mark Scheme**
Low	**5**	14	71	Standard	**28**	64	99
	25	58	96	High	**19**	47	89
	26	59	97				
Standard	**10**	29	76				
	27	62	98				

Q1.

This question is about elements and compounds.

(a) The chart below shows the proportion of elements in the periodic table that are metals and non-metals.



Determine the percentage of the elements in the chart above that are metals.

_____

_____

Percentage = _____ %

(2)

(b) Give **two** physical properties of metals.

1. _____

_____

2. _____

_____

(2)

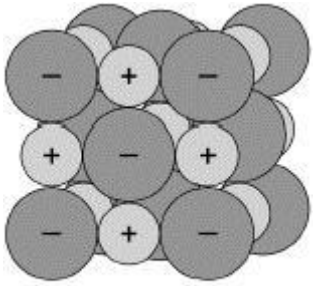
(c) Sodium reacts with chlorine to produce sodium chloride.

Balance the equation for the reaction.

_____ $Na + Cl_2 \rightarrow$ _____ $NaCl$

(1)

The diagram below shows part of the structure of sodium chloride (NaCl).



Sodium chloride

(d) What holds the particles together in sodium chloride?

Use the diagram above.

Tick (✓) **one** box.

Electrostatic attractions	☐
Intermolecular forces	☐
Metallic bonds	☐

(1)

(e) Solid sodium chloride does not conduct electricity.

Give **two** ways in which sodium chloride can be made to conduct electricity.

1. _____

_____

2. _____

_____

(2)

(Total 8 marks)

Q2.

This question is about elements in the periodic table.

(a) What property was used to arrange elements in early periodic tables?

Tick (✓) **one** box.

Atomic number ☐

Atomic weight ☐

Mass number ☐

(1)

(b) In early periodic tables, iodine (I) was placed before tellurium (Te).

Mendeleev placed iodine after tellurium.

Figure 1 shows part of Mendeleev's periodic table.

Figure 1

16 **O**	19 **F**
32 **S**	35.5 **Cl**
79 **Se**	80 **Br**
128 **Te**	127 **I**

Suggest **one** reason why Mendeleev placed iodine in the column shown in **Figure 1**.

_____

_____

(1)

The table below shows the melting points of three Group 1 metals.

Metal	**Melting point in °C**
Lithium	180
Sodium	98
Potassium	63

(c) What state is lithium at 100 °C?

Use table above.

Tick (✓) **one** box.

Gas ☐ Liquid ☐ Solid ☐

(1)

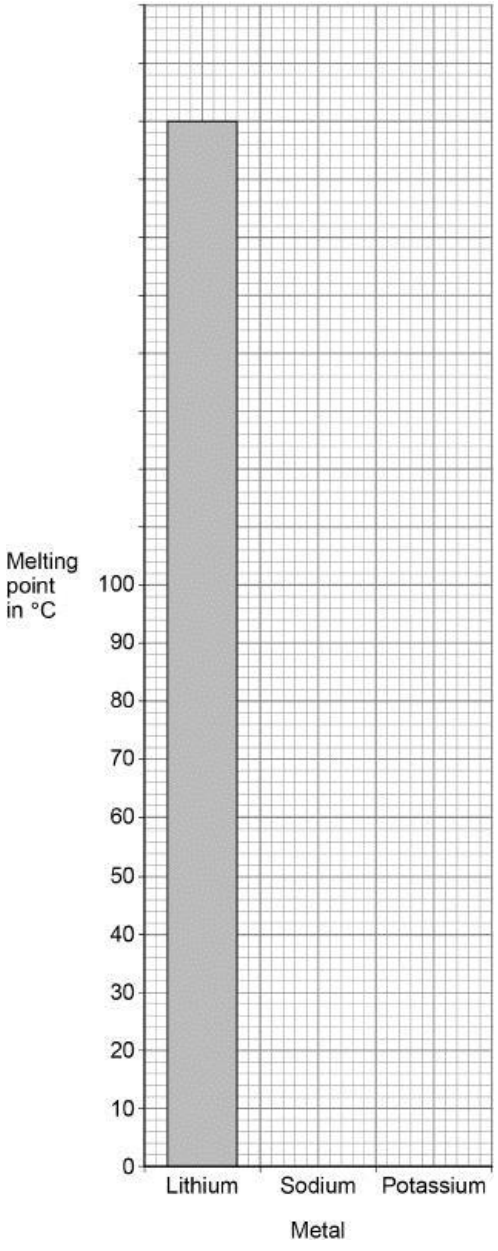
(d) Complete the graph below.

Use the table above.

You should:

- complete the scale on the y-axis
- draw bars to show the melting points of sodium and potassium.

(3)

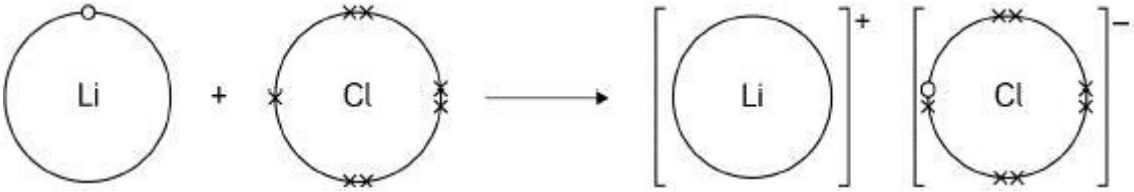


(e) Lithium reacts with chlorine to produce lithium chloride.

Figure 2 shows what happens to the electrons in the outer shells when a lithium atom reacts with a chlorine atom.

The dots (o) and crosses (x) represent electrons.

Figure 2



Describe what happens to a lithium atom and to a chlorine atom when they react.

Use **Figure 2** to answer in terms of electrons.

_____

_____

_____

_____

_____

_____

_____

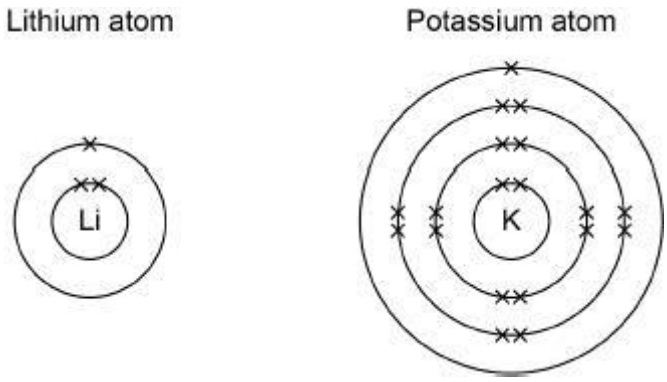
_____

(3)

(f) Lithium and potassium are in the same group of the periodic table.

Figure 3 represents the electronic structures of a lithium atom and of a potassium atom.

Figure 3



Give **two** reasons why potassium is more reactive than lithium.

1. _____

_____

2. _____

_____

(2)

(Total 11 marks)

Q3.

This question is about oxygen and compounds of oxygen.

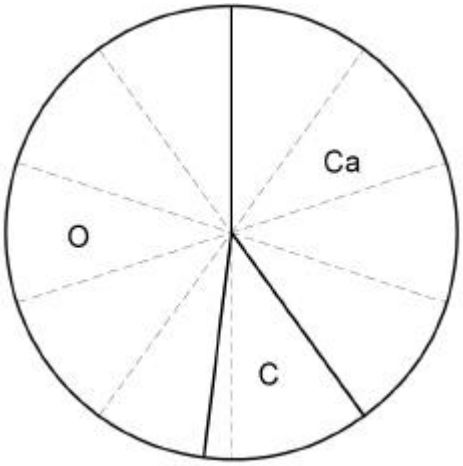
(a) What is the state symbol of oxygen at room temperature?

_____

(1)

(b) **Figure 1** shows the percentage by mass of the elements calcium, carbon and oxygen in calcium carbonate.

Figure 1



What is the percentage by mass of calcium in calcium carbonate?

_____

Percentage = _____ %

(1)

(c) At high temperature, sodium nitrate decomposes into sodium nitrite and oxygen.

A student heats three samples of sodium nitrate.

The mass of each sample was 4.50 g

The mass of solid after heating was recorded.

Table 1 shows the mass of solid after heating in each experiment.

Table 1

Experiment	Mass of solid after heating in g
1	3.76
2	3.98
3	4.09

Calculate the mean mass of solid after heating.

Give your answer to 3 significant figures.

_____

_____

_____

_____

_____

_____

Mean mass of solid after heating = _____ g

(3)

(d) **Table 2** shows the electronic structure of hydrogen and oxygen.

Table 2

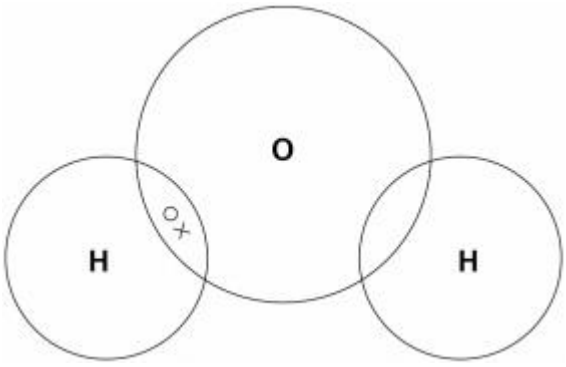
Element	Electronic structure
Hydrogen	1
Oxygen	2,6

Figure 2 shows part of a dot and cross diagram of a molecule of water (H_2O).

Complete the dot and cross diagram.

You should show only the electrons in the outer energy levels.

Figure 2



(2)

Oxygen and sulfur are examples of simple molecules.

(e) Complete the sentence.

Choose the answer from the box.

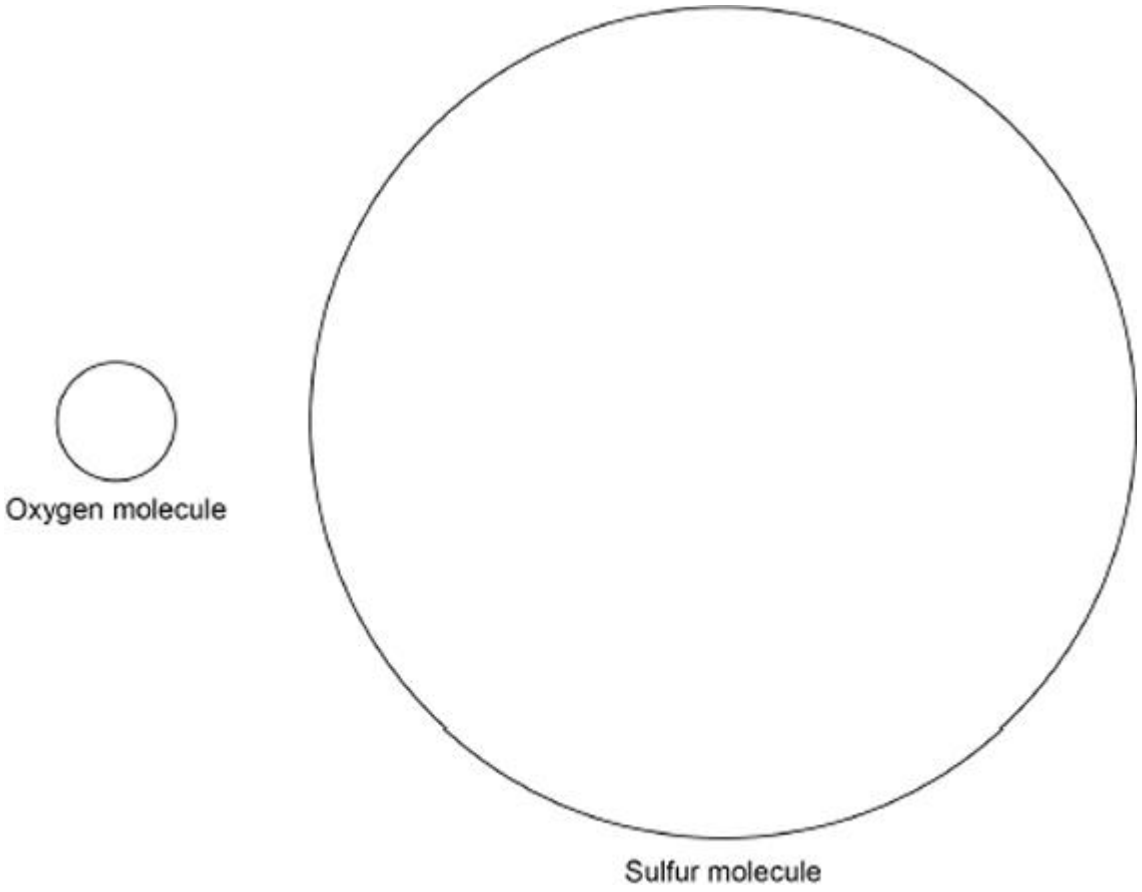
covalent	ionic	metallic

There are _____ bonds between the atoms of oxygen in an oxygen molecule.

(1)

(f) **Figure 3** shows the relative sizes of an oxygen molecule and a sulfur molecule.

Figure 3



How does the boiling point of sulfur compare with the boiling point of oxygen?

Complete the sentences.

The boiling point of sulfur is _____ the boiling point of oxygen.

This is because in sulfur the intermolecular forces are _____ than the intermolecular forces in oxygen.

(2)

(Total 10 marks)

Q4.

This question is about the halogens.

(a) Which group in the periodic table is known as the halogens?

Tick **one** box.

Group 1 ☐

Group 2 ☐

Group 7 ☐

Group 0 ☐

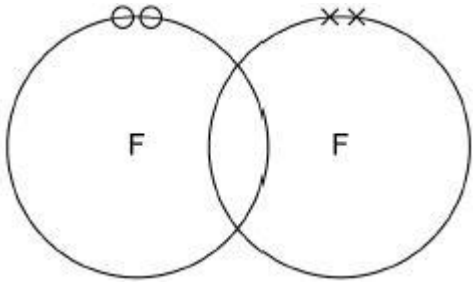
(1)

(b) A fluorine atom has 7 electrons in the outer shell.

The diagram below shows part of a dot and cross diagram to represent a molecule of fluorine (F_2).

Complete the dot and cross diagram.

You should show only the electrons in the outer shells.



(2)

(c) Chlorine reacts with potassium bromide solution.

Complete the word equation.

chlorine + potassium bromide → _____ + _____

_____

(2)

(d) What type of reaction happens when chlorine reacts with potassium bromide solution?

Tick **one** box.

decomposition ☐

displacement ☐

neutralisation ☐

precipitation ☐

(1)

(e) Complete the sentence.

Choose the answer from the box.

an atom	**an electron**	**a neutron**	**a proton**

Chlorine is more reactive than bromine.

This is because chlorine gains _____ more easily.

(1)

(f) How does the size of a chlorine atom compare with the size of a bromine atom?

Complete the sentence.

Choose the answer from the box.

bigger than	**the same size as**	**smaller than**

A chlorine atom is _____ a bromine atom.

(1)

(g) Give a reason for your answer to part **(f)**

Reason _____

_____

(1)

(h) Fluorine reacts with chlorine to produce ClF_3

Balance the chemical equation for the reaction.

$$Cl_2 + \_\_\_\_\_F_2 \longrightarrow 2\ ClF_3$$

(1)

(i) Explain why fluorine is a gas at room temperature.

Use the following words in your answer:

energy **forces** **molecules** **weak**

(3)

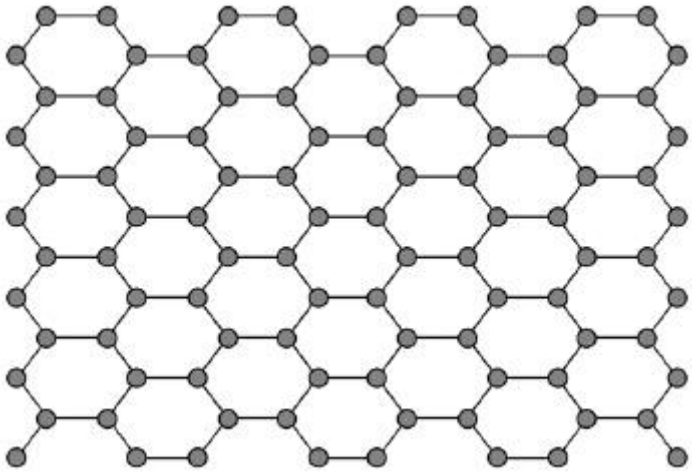
(Total 13 marks)

Q5.

This question is about structure and bonding.

(a) **Figure 1** shows part of one layer of graphene.

Figure 1



Which element is graphene made from?

Tick **one** box.

Carbon ☐

Copper ☐

Hydrogen ☐

Sodium ☐

(1)

(b) Each atom in graphene has one delocalised electron.

Complete the sentence.

Choose the answer from the box.

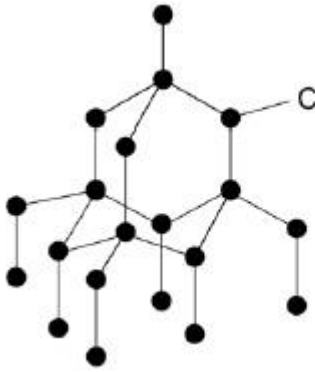
act as a lubricant	**be used as a fuel**
conduct electricity	**dissolve in water**

Delocalised electrons allow graphene to _____ .

(1)

(c) Which structure is a fullerene?

Tick **one** box.



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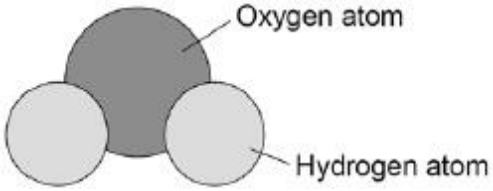

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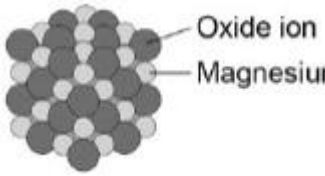

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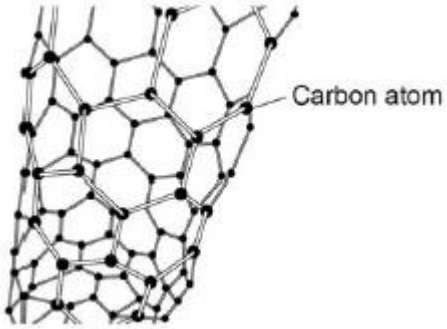
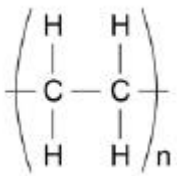


☐

(1)

Figure 2 shows part of a large hydrocarbon molecule.



(d) Which **two** elements are in all hydrocarbons?

1. _____

2. _____

(2)

(e) Complete the sentence.

Choose the answer from the box.

an atom	**a metal**	**a polymer**	**a salt**

The large molecule represented in **Figure 2** is _____ .

(1)

(f) Complete the sentence.

Choose the answer from the box.

attract	**bond**	**slide**	**vibrate**

Metals can be stretched into wires

because the layers of atoms can _____ .

(1)

(Total 7 marks)

Q6.

This question is about compounds of fluorine.

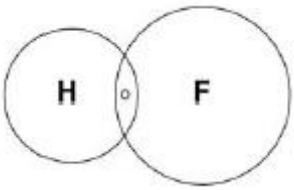
(a) A fluorine atom has 7 electrons in the outer shell.

Figure 1 shows part of a dot and cross diagram of a molecule of hydrogen fluoride (HF).

Complete the dot and cross diagram in **Figure 1**.

You should show only the electrons in the outer shells.

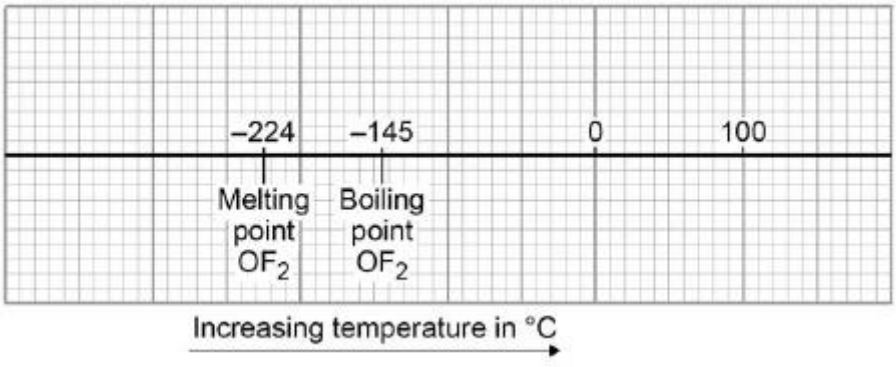
Figure 1



(1)

Figure 2 shows the boiling point and melting point of oxygen difluoride (OF_2).

Figure 2



(b) What is the state of oxygen difluoride at –200 °C?

Tick **one** box.

Aqueous (aq) ☐

Gas (g) ☐

Liquid (l) ☐

Solid (s) ☐

(1)

(c) What change of state occurs when oxygen difluoride is cooled from –220 °C to –230 °C?

Tick **one** box.

Condensing ☐

Evaporating ☐

Freezing ☐

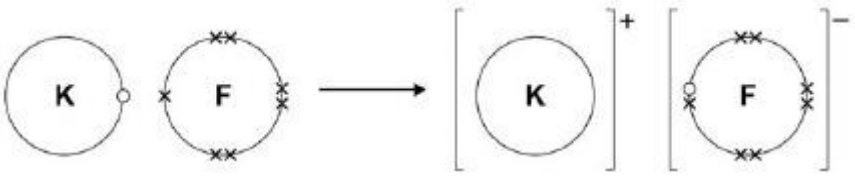
Melting ☐

(1)

Potassium reacts with fluorine to produce the ionic compound potassium fluoride (KF).

Figure 3 shows the transfer of electrons during the reaction.

Figure 3



(d) Describe what happens when potassium reacts with fluorine to produce potassium fluoride.

Write about electron transfer in your answer.

(5)

(e) Potassium fluoride is an ionic compound.

Explain why ionic compounds have high melting points.

Use the following words in your answer:
- attraction
- energy
- ions.

(4)

(Total 13 marks)

Q7.

John Newlands arranged the known elements into a table in order of atomic weight.

Figure 1 shows part of Newlands' table.

Figure 1

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

(a) What are the names of the elements in Group 5 of Newlands' table?

Tick **one** box.

- Calcium and sulfur ☐
- Carbon and silicon ☐
- Chlorine and silver ☐
- Chromium and tin ☐

(1)

(b) In what order is the modern periodic table arranged?

Tick **one** box.

- Atomic mass ☐
- Atomic number ☐
- Atomic size ☐
- Atomic weight ☐

(1)

(c) Give **two** differences between Group 1 of Newlands' table and Group 1 of the periodic table.

_____

_____

_____

_____

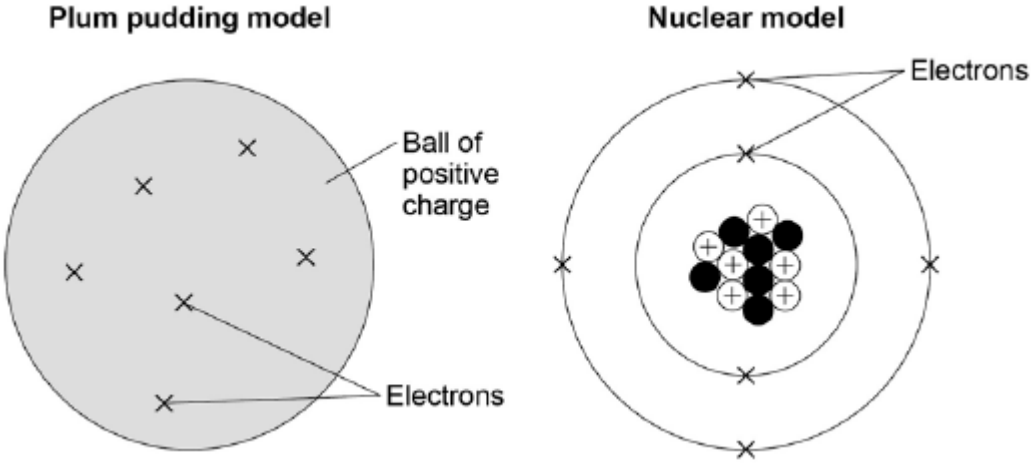
(2)

(d) In 1864, atoms were thought to be particles that could not be divided up into smaller particles.

By 1898, the electron had been discovered and the plum pudding model of an atom was proposed.

Figure 2 shows the plum pudding model of an atom of carbon and the nuclear model of an atom of carbon.

Figure 2



Compare the position of the subatomic particles in the plum pudding model with the nuclear model.

_____

_____

_____

_____

_____

_____

_____

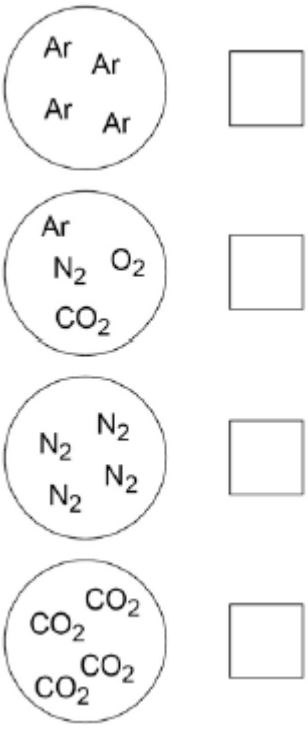
_____

(4)

(e) Models are used to show the differences between elements, compounds and mixtures.

Which circle shows a model of a mixture?

Tick **one** box.



(1)

(f) **Figure 3** shows a model of carbon dioxide.

Figure 3

What does each line between the atoms in **Figure 3** represent?

Tick **one** box.

Covalent bond ☐

Intermolecular force ☐

Ionic bond ☐

Metallic bond ☐

(1)

(Total 10 marks)

Q8.

The three states of matter are solid, liquid and gas.

(a) Lithium reacts with water to produce lithium hydroxide solution and hydrogen.

Use the correct state symbols from the box to complete the chemical equation.

aq	g	l	s

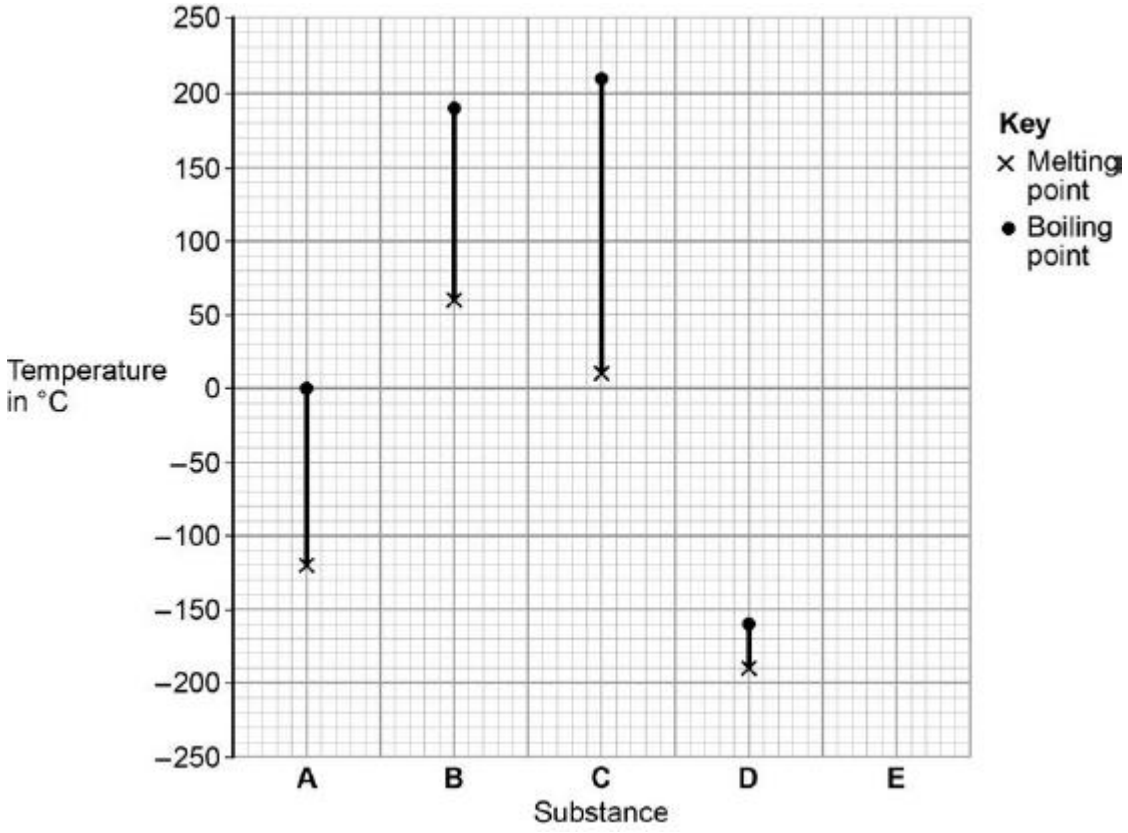
$2Li(s) + 2H_2O(l) \rightarrow 2LiOH(\_\_\_\_) + H_2(\_\_\_\_)$

lithium + water → lithium hydroxide + hydrogen

(2)

(b) **Figure 1** shows the melting points and the boiling points of four substances, **A**, **B**, **C** and **D**.

Figure 1



Which substance is liquid over the greatest temperature range?

Tick **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(c) Which **two** substances are gases at 50 °C?

Tick **one** box.

A and **B** ☐

B and **C** ☐

C and **D** ☐

A and **D** ☐

(1)

(d) A different substance, **E**, has:

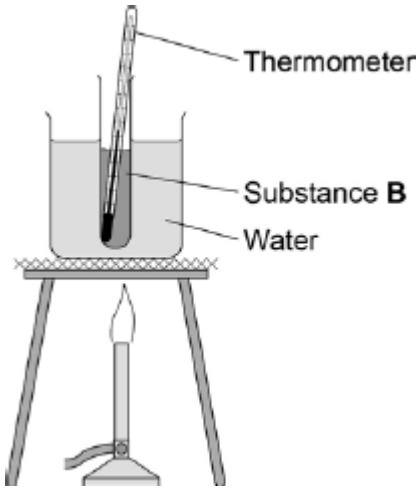
- a melting point of −50 °C
- a boiling point of +120 °C

Plot these two values on **Figure 1**.

(2)

(e) **Figure 2** shows the apparatus a student used to determine the melting point and the boiling point of substance **B** in **Figure 1**.

Figure 2



Explain why the student could not use this apparatus to determine the boiling point of substance **B**.

_____

_____

_____

_____

(2)

(f) Suggest **one** reason why the student could not use this apparatus to determine the exact melting point of substance **B**.

_____

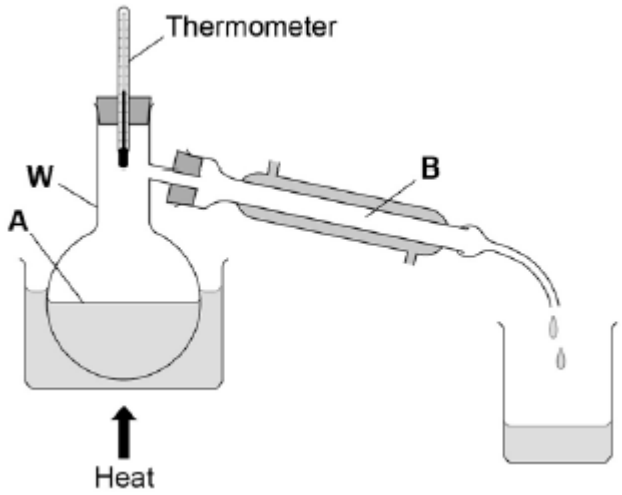
_____

(1)

(Total 9 marks)

Q9.

The apparatus in the figure below is used to separate a mixture of liquids in a fuel.



(a) What is apparatus **W** on above the figure above?

Tick **one** box.

Beaker ☐

Boiling Tube ☐

Flask ☐

Jug ☐

(1)

(b) What is the name of this method of separation?

Tick **one** box.

Crystallisation ☐

Electrolysis ☐

Filtration ☐

Distillation ☐

(1)

(c) Name the changes of state taking place at **A** and **B** in the figure above.

Use words from the box.

boiling	**condensing**	**freezing**	**melting**

Change of state at **A**: _____

Change of state at **B**: _____

(2)

(d) **Table 1** shows the boiling points of the hydrocarbons in the fuel.

Table 1

Hydrocarbon	**Boiling point in °C**
Pentane	36
Hexane	69
Heptane	98
Octane	125

Which hydrocarbon will be the last to collect in the beaker?

Tick **one** box.

Pentane ☐

Hexane ☐

Heptane ☐

Octane ☐

(1)

(e) The fuel is a mixture of liquids that has been designed as a useful product.

What name is given to this type of mixture?

Tick **one** box.

Catalyst ☐

Formulation ☐

Polymer ☐

Solvent ☐

(1)

(f) Describe how this fuel is different from crude oil.

_____

_____

_____

_____

(2)

(g) A student measured the melting point of a solid hydrocarbon four times.

The student's results are in **Table 2**.

Table 2

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Melting point in °C	35	48	37	37

Calculate the mean melting point of the hydrocarbon, leaving out any anomalous result.

Give your answer to two significant figures.

_____

_____

Mean melting point = _____ °C

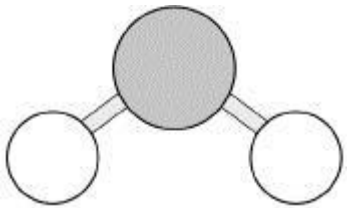
(2)

(Total 10 marks)

Q10.

This question is about substances with covalent bonding.

(a) The diagram below shows a ball and stick model of a water molecule (H_2O).



Suggest **one** limitation of using a ball and stick model for a water molecule.

_____

_____

_____

(1)

(b) Ice has a low melting point.

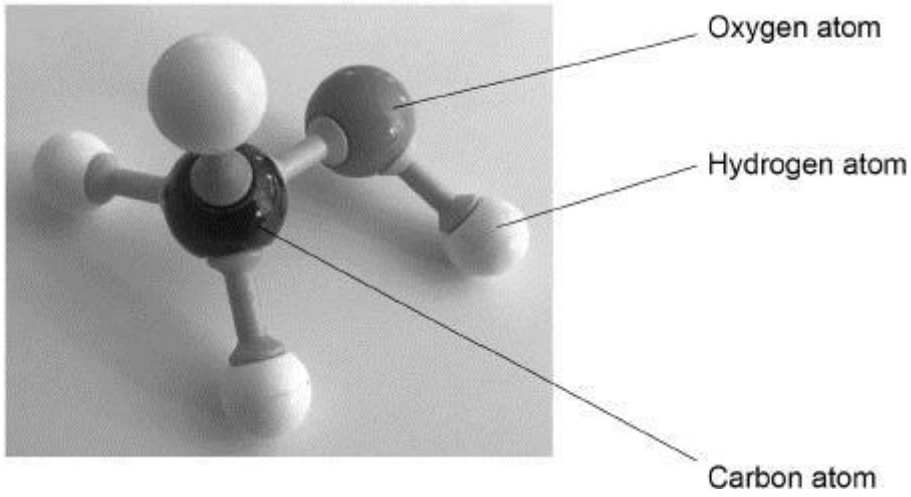
Water molecules in ice are held together by intermolecular forces.

Complete the sentence.

Ice has a low melting point because the intermolecular forces are _____.

(1)

(c) The image below shows the structure of a molecule.



What is the molecular formula of the molecule in the above image?

_____

_____

(1)

Diamond has a giant covalent structure.

(d) What is the number of bonds formed by each carbon atom in diamond?

Tick (✓) **one** box.

2 ☐ 3 ☐ 4 ☐ 8 ☐

(1)

(e) Give **two** physical properties of diamond.

1. _____

2. _____

(2)

(f) Name **two** other substances with giant covalent structures.

1. _____

2. _____

(2)

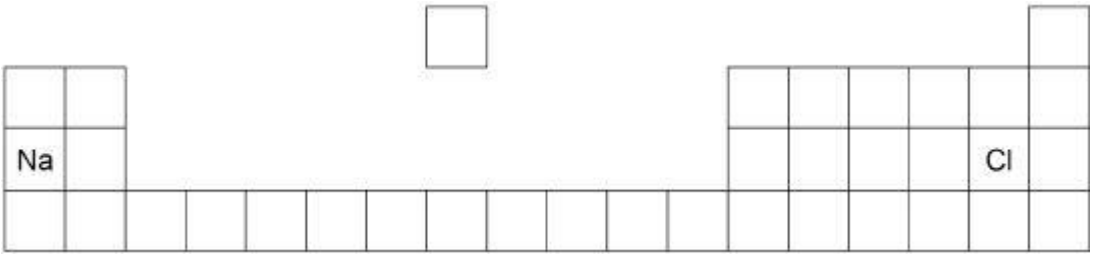
(Total 8 marks)

Q11.

This question is about sodium and chlorine.

Figure 1 shows the positions of sodium and chlorine in the periodic table.

Figure 1



(a) State **one** difference and **one** similarity in the electronic structure of sodium and of chlorine.

Difference _____

_____

Similarity _____

_____

(2)

(b) Sodium atoms react with chlorine atoms to produce sodium chloride (NaCl).

Describe what happens when a sodium atom reacts with a chlorine atom.

Write about electron transfer in your answer.

_____

_____

_____

_____

_____

_____

_____

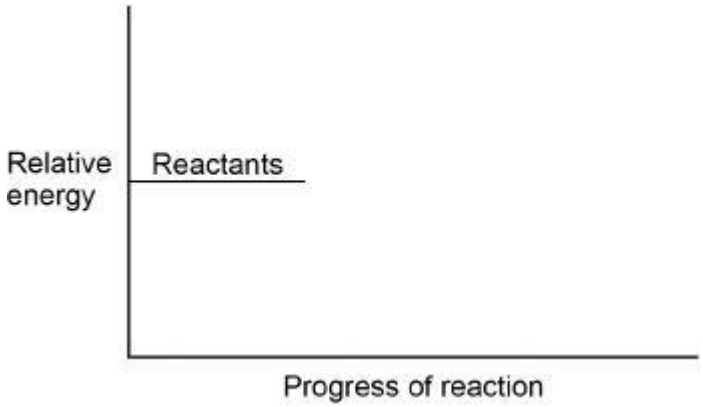
_____

(4)

(c) The reaction between sodium and chlorine is an exothermic reaction.

Complete the reaction profile for the reaction between sodium and chlorine.

Figure 2



(2)

(Total 8 marks)

Q12.

Three substances are all solid at room temperature.

The table describes tests and the result of each test on the three substances.

Substance	Effect of large force applied	Effect of heating gently at first, then strongly	Effect of passing electricity through solid	Effect of passing electricity through liquid
A	Breaks into many pieces	Easily melts and then boils	Does not conduct	Does not conduct
B	Breaks into many pieces	No change	Does not conduct	Conducts
C	Becomes thinner	No change	Conducts	Conducts

(a) The covalent bonds in the molecules are not overcome when substance **A** is heated.

What forces are overcome when substance **A** melts?

_____

(1)

(b) What could substance **A** be?

Tick **one** box.

Graphite ☐

Iron ☐

Sodium chloride ☐

Sulfur ☐

(1)

(c) Suggest why substance **B** conducts electricity as a liquid but does **not** conduct electricity as a solid.

_____

_____

_____

_____

_____

_____ **(3)**

(d) Suggest why substance **C** becomes thinner when a large force is applied.

_____

_____

_____

_____

(2)

(e) What could substance **C** be?

Tick **one** box.

Copper	☐
Diamond	☐
Iodine	☐
Magnesium oxide	☐

(1)

(Total 8 marks)

Q13.

This question is about calcium.

(a) What type of compound is calcium oxide?

Tick **one** box.

An acid ☐

A base ☐

A carbonate ☐

A salt ☐

(1)

(b) Ionic compounds, such as calcium oxide, have high melting points.

Complete the sentences. Use words from the box.

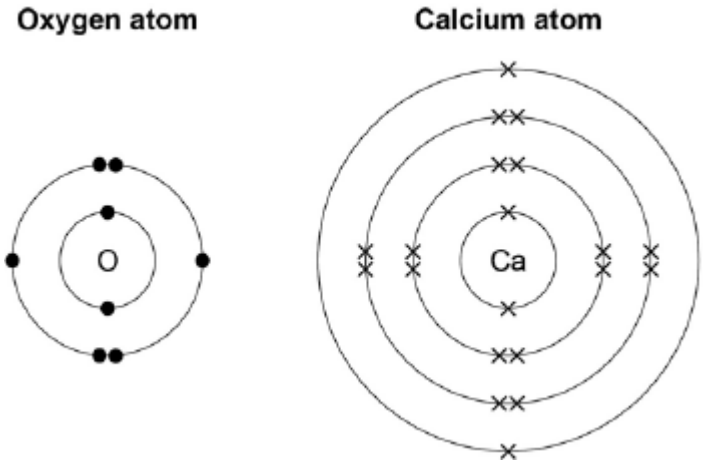
bonds	**forces**	**ions**	**layers**

Calcium oxide has a giant ionic lattice in which there are strong electrostatic

_____ of attraction in all directions.

(1)

(c) The figure below shows the electronic structure of an oxygen atom and a calcium atom.



Describe how the calcium atom and the oxygen atom forms calcium oxide.

You should give the charge on each ion formed.

_____

_____

(4)
(Total 6 marks)

Q14.

This question is about elements.

Caesium is in Group 1 of the periodic table.

(a) Explain what happens to caesium atoms and to oxygen atoms when caesium reacts with oxygen to produce caesium oxide.

You should answer in terms of electrons.

(4)

(b) Explain why caesium is more reactive than sodium.

You should answer in terms of electrons.

(4)

(c) The diagram below shows part of Mendeleev's periodic table.

16 **O**	19 **F**
32 **S**	35.5 **Cl**
79 **Se**	80 **Br**
128 **Te**	127 **I**

Explain why the early periodic tables placed iodine (I) before tellurium (Te), but then Mendeleev placed tellurium before iodine.

_____

_____

_____

_____

_____

_____

(3)

(Total 11 marks)

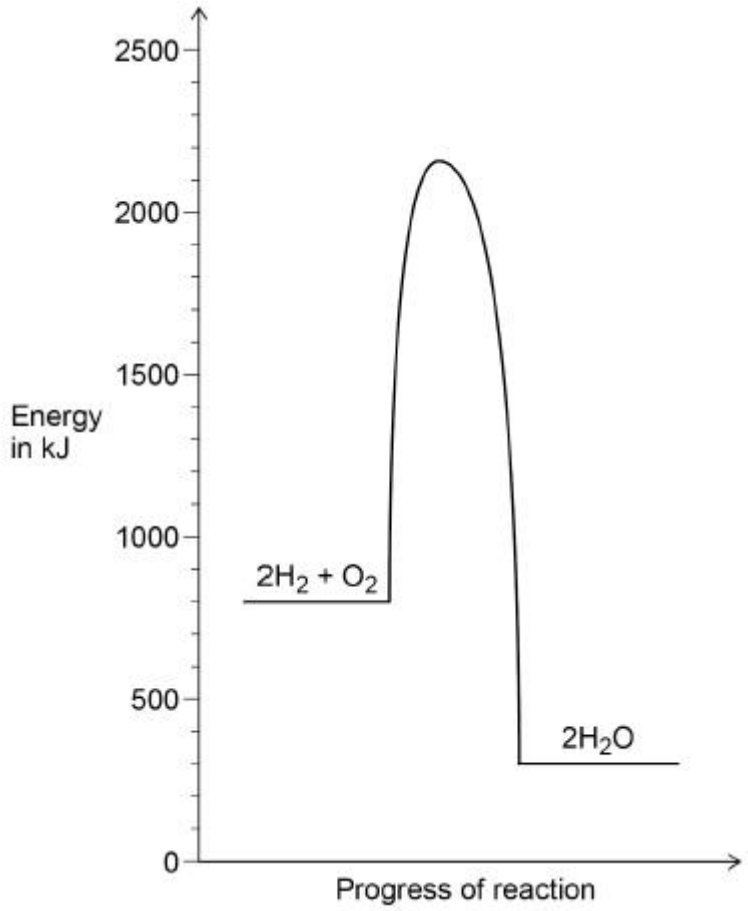
Q15.

This question is about oxygen.

(a) Hydrogen reacts with oxygen.

$$2\ H_2\ (g) + O_2\ (g) \longrightarrow 2\ H_2O\ (g)$$

Figure 1 shows the relative energies of the reactants and products at a certain temperature.



Label the activation energy on **Figure 1**.

(1)

(b) Determine the overall energy change for the reaction between hydrogen and oxygen shown in part (a).

Use **Figure 1**.

_____

_____

_____

_____

Energy change = _____ kJ

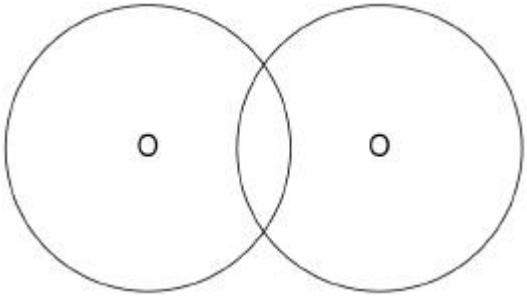
(2)

(c) Oxygen is in Group 6 of the periodic table.

Figure 2 shows the outer energy levels in one molecule of oxygen (O_2).

Draw the electrons in the outer energy levels in **Figure 2**.

Figure 2



(2)

(d) The equation shows the decomposition of hydrogen peroxide.

The table shows the bond energies.

Bond	**O–O**	**O=O**	**O–H**
Bond dissociation energy in kJ per mole	138	496	463

Calculate the overall energy change for the reaction.

Energy change = _____ kJ

(3)

(Total 8 marks)

Q16.

This question is about elements in the periodic table.

(a) What order did scientists use to arrange elements in early periodic tables?

_____

_____

(1)

(b) In the early periodic tables some elements were placed in the wrong groups.

Mendeleev overcame this in his periodic table.

Give **one** way Mendeleev did this.

_____

_____

(1)

The table shows the boiling points of fluorine, chlorine and bromine.

Element	**Boiling point in °C**
Fluorine	−186
Chlorine	−34
Bromine	+59

(c) Explain why the boiling points in the table are low.

_____

_____

_____

_____

(2)

(d) Explain the trend in the boiling points in the table above.

_____

_____

_____

_____

_____

_____

(3)

(e) Explain why neon is unreactive.

Give the electronic structure of neon in your answer.

_____

_____

_____

_____

(2)

(f) How many atoms are there in 1 g of argon?

The Avogadro constant is 6.02×10^{23} per mole.

Relative atomic mass (A_r): Ar = 40

_____

_____

_____

_____

Number of atoms in 1 g = _____

(2)

(Total 11 marks)

Q17.

This question is about sodium.

(a) Sodium reacts with chlorine.

What is the balanced equation for the reaction?

Tick (✓) **one** box.

$Na + Cl \longrightarrow NaCl$ ☐

$Na + Cl_2 \longrightarrow NaCl_2$ ☐

$2\ Na + Cl_2 \longrightarrow 2\ NaCl$ ☐

$2\ Na + Cl \longrightarrow Na_2Cl$ ☐

(1)

(b) Hot sodium is put in a gas jar of chlorine.

Describe the observations made before, during and after the reaction.

Before reaction _____

_____

During reaction _____

_____

After reaction _____

_____

(3)

(c) Explain why sodium is less reactive than potassium.

_____

_____

_____

_____

_____

_____

_____

_____ **(4)**

(d) Chlorine reacts with sodium and with hydrogen.

Compare the structure and bonding in sodium chloride and hydrogen chloride.

(6)

(Total 14 marks)

Q18.

This question is about the halogens.

(a) Write the state symbol for chlorine at room temperature.

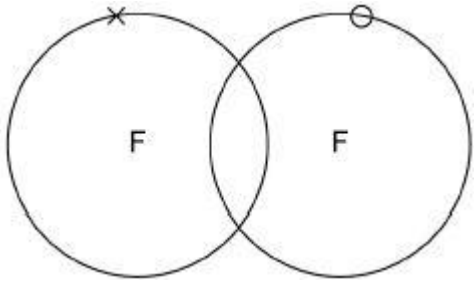
Cl_2 (_____)

(1)

(b) The diagram below represents one molecule of fluorine.

Complete the dot and cross diagram on the diagram above.

You should show only the electrons in the outer shells.



(2)

(c) A fluorine atom can be represented as $^{19}_{9}F$

What is the total number of electrons in a fluorine molecule (F_2)?

Tick **one** box.

9 ☐ 14 ☐ 18 ☐ 38 ☐

(1)

(d) Aluminium reacts with bromine to produce aluminium bromide.

Complete the balanced chemical equation for this reaction.

_____Al + _____Br_2 ⟶ 2_____

(2)

(e) When chlorine reacts with potassium bromide, chlorine displaces bromine.

$$Cl_2 + 2\ KBr \longrightarrow Br_2 + 2\ KCl$$

Explain why chlorine is more reactive than bromine.

_____

_____

_____

_____

(3)

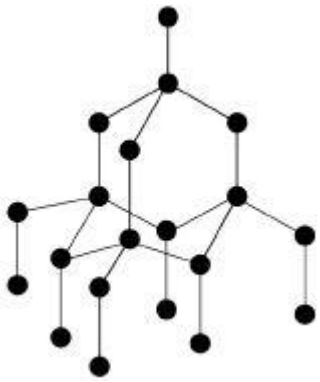
(Total 9 marks)

Q19.

This question is about structure and bonding.

(a) **Figure 1** shows part of the structure and bonding in diamond.

Figure 1

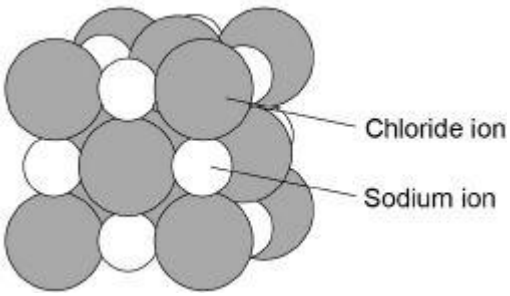


Explain why diamond has a high melting point.

(3)

(b) **Figure 2** shows part of the structure and bonding in sodium chloride (NaCl).

Figure 2

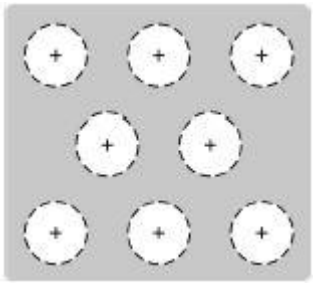


Explain the conditions needed for sodium chloride to conduct electricity.

(3)

(c) **Figure 3** shows the structure of sodium.

Figure 3



Describe how sodium conducts thermal energy.

(3)

(Total 9 marks)

Q20.

Fertilisers are formulations.

(a) What is a formulation?

_____

_____

(1)

(b) A bag of fertiliser contains 14.52 kg of ammonium nitrate (NH_4NO_3).

Relative formula mass (M_r): $NH_4NO_3 = 80$

Calculate the number of moles of ammonium nitrate in the bag of fertiliser.

Give your answer in standard form to 2 significant figures.

_____

_____

_____

_____

_____

_____

_____

_____

Moles of ammonium nitrate = _____ mol

(4)

(c) The fertiliser also contains potassium chloride.

Explain why potassium chloride has a high melting point.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 9 marks)

Q21.

This question is about fluorine.

(a) Calcium reacts with fluorine to produce calcium fluoride (CaF_2).

Explain how oxidation and reduction have taken place in this reaction.

Write about electron transfer in your answer.

(4)

(b) Explain why calcium fluoride has a high melting point.

(4)

(c) Fluorine reacts with sulfur to produce sulfur hexafluoride (SF_6).

$$S + 3F_2 \rightarrow SF_6$$

Relative formula masses, M_r: $F_2 = 38$ $SF_6 = 146$

Calculate the mass of sulfur hexafluoride produced when 0.950 g of fluorine is reacted with an excess of sulfur.

Give your answer to 3 significant figures.

Mass = _____ g

(5)

(Total 13 marks)

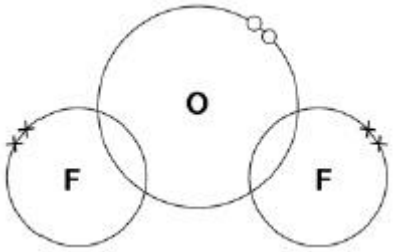
Q22.

This question is about oxygen.

(a) One oxygen atom shares one pair of electrons with each fluorine atom in oxygen difluoride (OF_2).

Complete the dot and cross diagram of oxygen difluoride below.

You should show only the electrons in the outer shells.



(2)

(b) Oxygen difluoride (OF_2) has a melting point of – 224 °C and a boiling point of –145 °C

What is the state of oxygen difluoride at room temperature?

Explain your answer in terms of structure and bonding.

_____

_____

_____

_____

_____

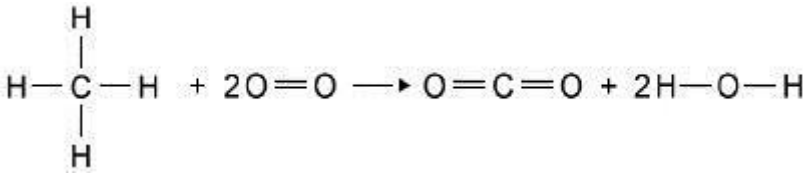
_____

_____

_____

(4)

(c) The equation shows the reaction of methane with oxygen.



The table shows the bond energies.

Bond	**C–H**	**O=O**	**C=O**	**O–H**
Bond energy in kJ per mole	412	496	803	463

Calculate the overall energy change for the combustion of one mole of methane.

Energy change = _____ kJ mol^{-1}

(3)

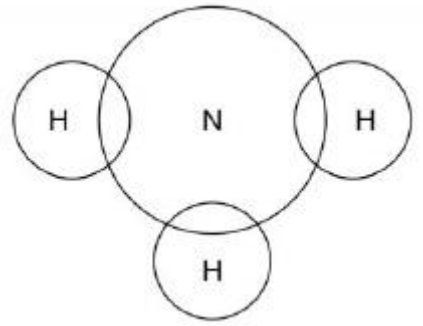
(Total 9 marks)

Q23.

This question is about ammonia (NH_3).

(a) Complete the diagram to show the bonding electrons in ammonia.

Show the outer electrons only.



(2)

Ammonia is produced from nitrogen and hydrogen.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

(b) A low pressure is used.

Explain the effect on the yield of ammonia.

_____

_____

_____

_____

(2)

(c) A high temperature is used.

Explain the effect on the yield of ammonia.

_____

_____

_____

_____

(2)

(d) Ammonia is removed from the reaction mixture.

Explain the effect on the position of equilibrium.

_____

_____

_____

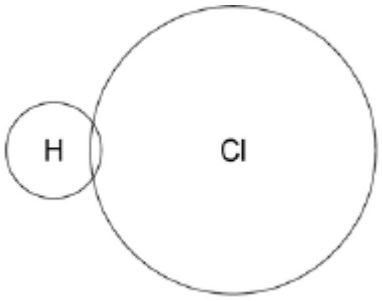
_____

(2)
(Total 8 marks)

Q24.

Hydrogen chloride (HCl) is a gas.

(a) Complete the diagram to show all of the arrangement of the outer shell electrons of the hydrogen and chlorine atoms in hydrogen chloride.



(1)

(b) Hydrochloric acid is a strong acid.
Ethanoic acid is a weak acid.

Describe a reaction that could be used to show the difference between a weak acid and a strong acid.

You should explain why the weak acid and the strong acid give different results.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 7 marks)

Q25.

The picture shows a student filling in a multiple choice answer sheet using a pencil.

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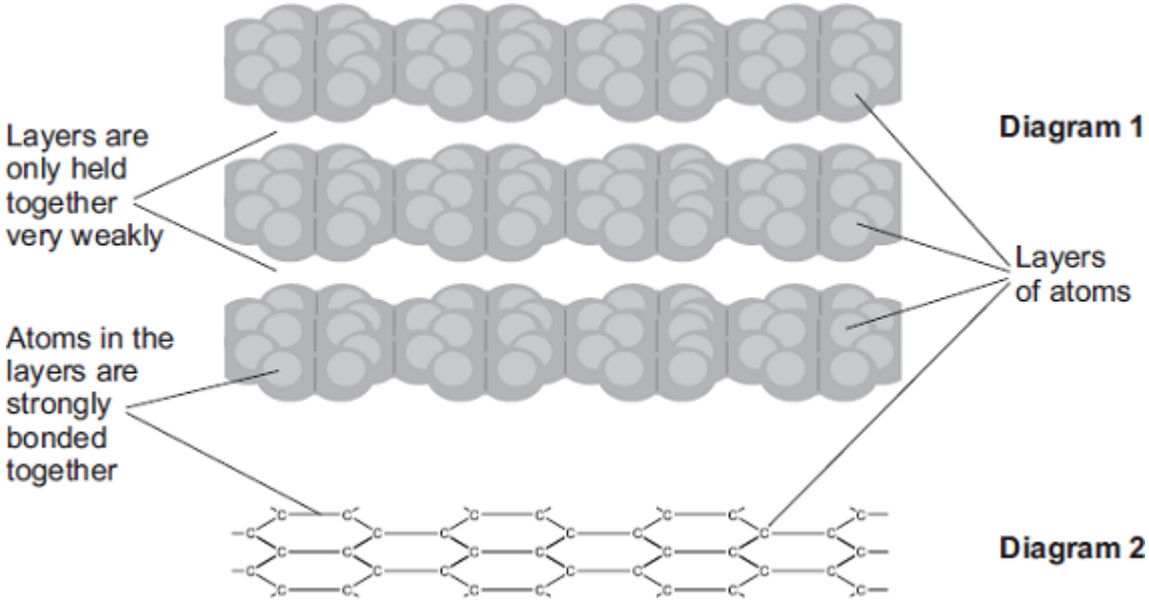
The pencil contains graphite. Graphite rubs off the pencil onto the paper.

Diagrams **1** and **2** show how the atoms are arranged in graphite.



(a) Use the diagrams to help you explain why graphite can rub off the pencil onto the paper.

_____

_____

_____

_____

(2)

(b) Draw a ring around the type of bond which holds the atoms together in each layer.

covalent **ionic** **metallic**

(1)

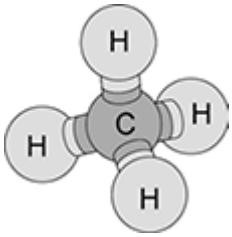
(Total 3 marks)

Q26.

There are several different forms of carbon and many different carbon compounds.

(a) **Figure 1** shows a 3D model of a molecule of methane (CH_4).

Figure 1

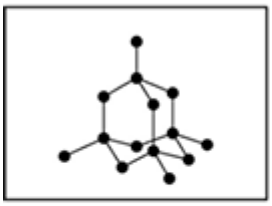
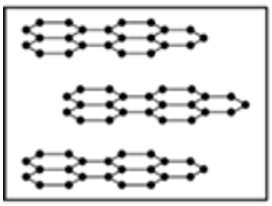
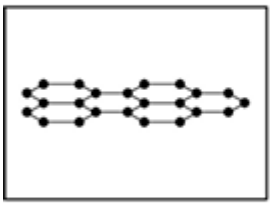


Draw the 2D structure of a methane molecule.

(1)

(b) Different forms of carbon have different bonding and structure.

Draw **one** line from the form of carbon to the bonding and structure.

Form of carbon	Bonding and structure
	Each carbon atom is bonded to three other carbon atoms in a single layer
	Each carbon atom is bonded to four other carbon atoms
	Layers of carbon atoms with no covalent bonds between the layers
	Carbon ions held together by strong electrostatic forces
	Pairs of carbon atoms with no covalent bonds between the molecules

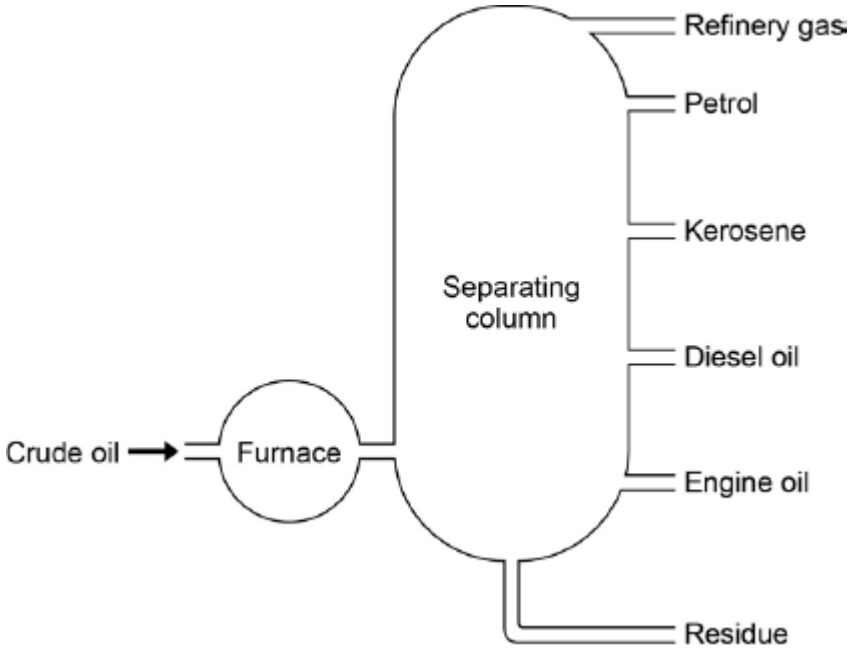
(3)

(c) Crude oil is a mixture of many different carbon compounds.

Crude oil can be separated into useful fractions by fractional distillation.

Figure 2 shows a column used to separate crude oil.

Figure 2



Complete the sentences.

Use words from the box.

condense	**evaporate**	**freeze**

Crude oil is heated so that most of the compounds _____

At different temperatures the compounds cool and _____

(2)

(d) Which fraction is the most **viscous**?

Tick **one** box.

Engine oil ☐

Diesel oil ☐

Kerosene ☐

Petrol ☐

(1)

(e) Which fraction is the most **flammable**?

Tick **one** box.

- Diesel oil ☐
- Kerosene ☐
- Petrol ☐
- Refinery gas ☐

(1)

(f) Why does kerosene separate out of the mixture before diesel oil?

_____

_____

(1)

(Total 9 marks)

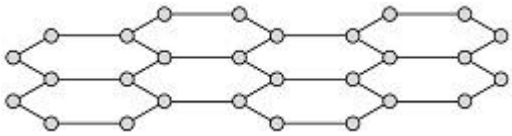
Q27.

This question is about graphene and graphite.

Graphene is a single layer of graphite.

Figure 1 represents part of the structure of graphene.

Figure 1



(a) Graphene is one atom thick. The diameter of the atom is 3.4×10^{-10} m

What is the thickness of a graphene layer in nanometres?

1 nm = 10^{-9} m

Tick (✓) **one** box.

- 0.034 nm ☐
- 0.34 nm ☐
- 3.4 nm ☐
- 34 nm ☐

(1)

(b) Which is **one** use of graphene?

Tick (✓) **one** box.

- As a detergent ☐
- As a solvent ☐
- In composites ☐
- To produce polymers ☐

(1)

(c) Graphene and graphite are used in electronics.

Suggest **one** reason why graphene is a more suitable material for use in electronics than graphite.

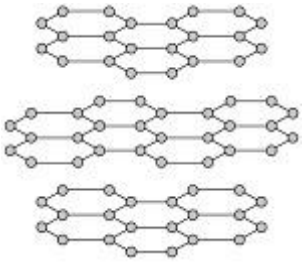
_____

_____

(1)

(d) **Figure 2** represents part of the structure of graphite.

Figure 2



Graphite is used as a contact in electric motors because graphite:

- conducts electricity
- is slippery

Explain why graphite has these properties.

You should refer to the structure and bonding of graphite in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

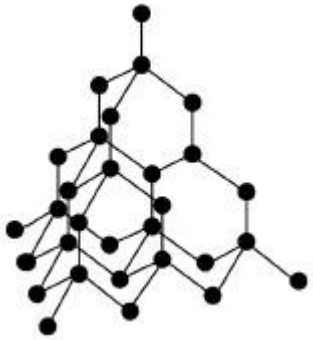
(Total 9 marks)

Q28.

This question is about diamond and graphite.

Figure 1 shows part of the structure of diamond.

Figure 1



(a) Complete the sentence.

Choose the answer from the box.

calcium	**carbon**	**chromium**	**cobalt**

Diamond is a form of _____ .

(1)

(b) Which **two** statements about diamond are correct?

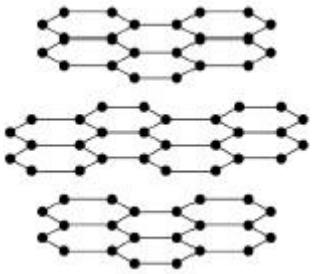
Tick **two** boxes.

Diamond has a giant structure.	☐
Diamond has ionic bonds.	☐
Diamond is made of layers.	☐
Diamond has weak bonds.	☐
Each atom is joined to four other atoms.	☐

(2)

Figure 2 shows part of the structure of graphite.

Figure 2



(c) Explain why graphite is soft and slippery.

Use **Figure 2** and your own knowledge.

_____

_____

_____

_____

_____

_____

(3)

(d) Graphite has covalent bonds between the atoms.

How many covalent bonds does each atom form?

Tick **one** box.

1 ☐ 2 ☐ 3 ☐ 4 ☐

(1)

(e) Explain why graphite can conduct electricity.

You should include a reference to electrons in your answer.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q1.

(a) $\frac{8}{10} \times 100$ **or** 0.8×100

1

= 80 (%)

*if no other mark awarded allow **1** mark for 20 (%)*

1

(b) any **two** from:

- conducts electricity
- conducts thermal energy

  allow conducts heat
- ductile
- high melting point

  allow high boiling point
- malleable

  allow can be bent / shaped
- shiny
- strong

  allow dense

  allow sonorous

  ignore chemical properties

2

(c) $2\ Na + Cl_2 \rightarrow 2\ NaCl$

allow multiples

1

(d) electrostatic attractions

1

(e) (heat sodium chloride until) molten / liquid

1

dissolve in water

allow form aqueous solution

allow add water

1

[8]

Q2.

(a) atomic weight

1

(b) (because) properties were similar
or
(because) iodine has similar / same properties as bromine / chlorine / fluorine
allow symbols

1

(c) solid

1

(d) scale on the y-axis up to 180
ignore scale beyond 180

1

bar for sodium at 98 (°C)
allow a tolerance of ± half a small square

1

bar for potassium at 63 (°C)
allow a tolerance of ± half a small square

1

*max **2** marks if reference to incorrect particle / bonding*

(e) lithium (atom) loses one electron

1

chlorine (atom) gains one electron

1

any **one** from:
- ions are formed
  allow ionic bonding
- lithium forms positive ion
- chlorine forms negative ion
- form a full outer shell(s) / level(s)
  allow noble gas structure is formed

1

allow energy levels for shells
allow converse for lithium

(f) any **two** from:

- reactivity of elements increases going down the group
- potassium has more shells
- potassium can lose an (outer) electron more easily
- potassium has an outer shell / electron further away from the nucleus
- potassium has more shielding (of the outer shell / electron)
- potassium has a weaker attraction between nucleus and outer shell / electron

2 **[11]**

Q3.

(a) (g)

allow g

ignore formulae

1

(b) 40 (%)

1

(c) $\frac{3.76 + 3.98 + 4.09}{3}$ **or** $\frac{11.83}{3}$

*an answer of 3.94 (g) scores **3** marks*

= 3.943(333333333333333)

1

= 3.94 (g)

allow a correctly written answer to 3 significant figures from an incorrectly calculated mean

1

(d) one shared pair in each overlap

allow combination of circles, dots, crosses or $e^{(-)}$

*do **not** accept extra electron(s) on outer shell of hydrogen*

1

4 non-bonding electrons in outer shell of oxygen

ignore any inner shell electrons

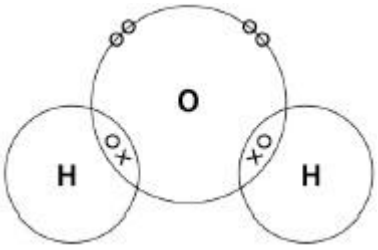


diagram scores 2 marks

1

(e) covalent

1

(f) high<u>er</u> (than)

1

strong<u>er</u>
(than between oxygen molecules)

1

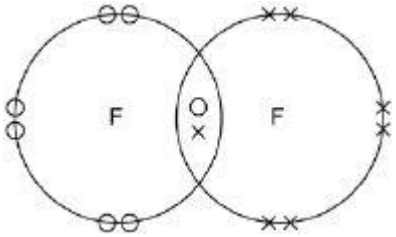
[10]

Q4.

(a) group 7

1

(b)



*one shared pair anywhere in overlap between two circles **or** on intersection*

6 other electrons on each atom

*allow dots **or** crosses **or** mixture for all marks*

ignore any inner shell electrons

1

1

(c) bromine

1

potassium chloride

1

either order

allow correct chemical formulae

(d) displacement

1

(e) (an) electron

1

(f) smaller than

1

(g) (chlorine has) fewer levels / shells (of electrons)

allow converse for bromine

allow (chlorine has) fewer electrons

allow Cl has 3 levels / shells and Br has 4 levels / shells

ignore atomic number
***or** mass number*
***or** number of protons*

1

*mark independent of answer to part **(f)***

(h) 3

allow multiples

1

(i) there are weak forces

*do **not** accept weak bonds*

1

between <u>molecules</u>

1

*allow weak intermolecular forces for the first **2** marks*

which require little <u>energy</u> to overcome / break

allow does not need much <u>energy</u> to boil

1

[13]

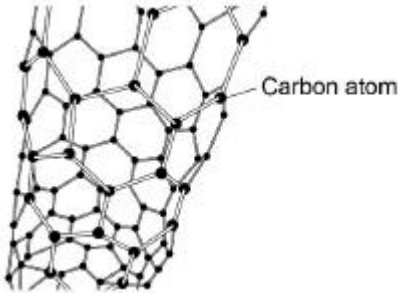
Q5.

(a) carbon

1

(b) conduct electricity

1

(c) 

1

(d) carbon

hydrogen

either order

2

(e) a polymer

1

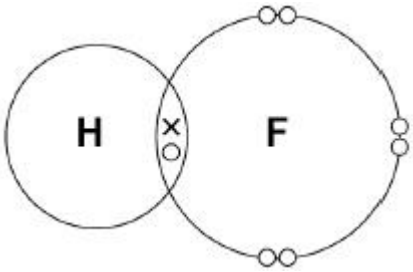
(f) slide

1

[7]

Q6.

(a)



1 *mark for one shared pair of electrons*
1 *mark for six unbonded electrons on F*

2

(b) liquid (l)

1

(c) freezing

1

(d) K loses

1

one electron

1

(to) form a positive ion

1

F gains one electron

1

(to) form a negative ion

1

(e) lattice / giant structure
allow many ions

1

strong attraction

1

between K^+ and F^- ions / oppositely charged ions

1

(so) a lot of energy is needed to overcome / break
allow strong bonds

1

[13]

Q7.

(a) Carbon and silicon

1

(b) Atomic number

1

(c) Hydrogen / fluorine / chlorine are not in Group 1 of the periodic table
or
Hydrogen and fluorine / chlorine are not in the same group of the periodic table

1

Lithium / sodium / potassium are in Group 1 of the periodic table

1

(d) plum pudding model has a single ball of positive charge and nuclear model has positive charges in the centre / nucleus

1

plum pudding model has electrons in random positions and nuclear model has electrons in fixed positions

1

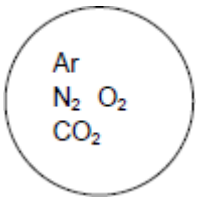
plum pudding model has no nucleus and the nuclear model has a nucleus

1

plum pudding model has no neutrons and the nuclear model has neutrons in the nucleus

1

(e)



1

(f) Covalent bond

1

[10]

Q8.

(a) LiOH (aq)

this order

1

H_2 (g)

1

(b) **C**

1

(c) **A** and **D**

1

(d) point x at −10 °C

1

point ● at +150 °C

1

(e) substance **B** will not reach its boiling point of 190 °C

1

because the boiling point of water is only 100 °C

1

(f) there is too much substance **B** to melt instantly.

allow answers based on thermal conductivity or temperature gradient from the wall of the test tube to the thermometer

1

[9]

Q9.

(a) Flask

1

(b) Fractional distillation

1

(c) **A** – boiling

in this order

1

B – condensing

1

(d) Octane

1

(e) Formulation

1

(f) the fuel is a pure compound

1

and crude oil is a mixture

or

the fuel is made up of four hydrocarbons

allow crude oil contains a large number of compounds and the fuel contains four

and crude oil could have many more

1

(g) (35 + 37 + 37 / 3) = 36.33

1

36

1

*allow (35 + 48 + 37 + 37 / 4 =) 39(.25) for **1** mark*

[10]

Q10.

(a) any **one** from:

- not to scale
  allow size of atoms incorrect
- not 3 dimensional / D
- incorrect arrangement in space
  allow atoms are separated
- electrons / shells not shown
  ignore properties of water

1

(b) weak
allow weaker

1

(c) CH_4O
allow CH_3OH

1

(d) 4

1

(e) any **two** from:

- (very) hard
  allow strong
- (very) high melting point
- does not conduct electricity
  allow high thermal conductivity
  ignore shiny

2

(f) graphite
allow graphene

1

silicon dioxide
allow silica
allow silicon
allow polymer(s)
or *allow (named) polymer(s)*
allow fullerene
or *allow carbon nanotubes*
ignore buckminsterfullerene

1

[8]

Q11.

(a) (difference)
sodium has one and chlorine has seven electrons in outer level / shell
or
number of electrons

number of electrons must be correct if quoted

1

(similarity)
both have three / same number of levels / shells
or
have electrons in third level / shell
or
both have incomplete (outer) levels / shells

allow both have 2 electrons in inner shell
or
both have 8 electrons in second shell
or
both are one electron away from full outer level / shell

1

(b) sodium (atom) loses

allow moves / transfers for loses
*do **not** accept sodium ion loses*

1

one (outer shell electron)

1

chlorine (atom) gains

*do **not** accept chloride*

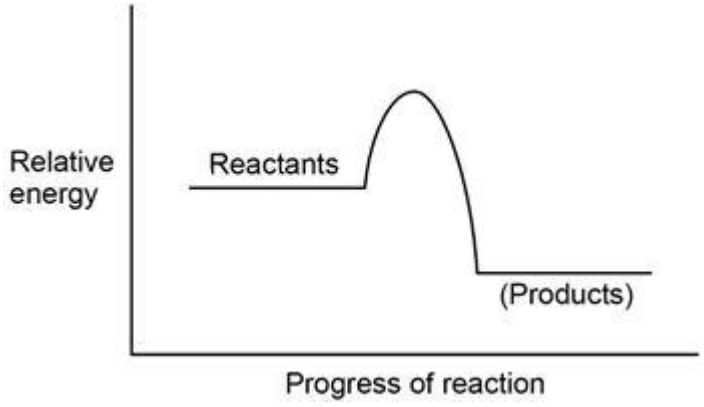
1

one (electron)

1

*transfer of 1 electron from chlorine to sodium **max 2** marks*
*reference to sharing or covalent bonding **max 3** marks*
allow marks from suitable diagram(s)

(c)



ignore labels
any curve / line going up and then down
products line below reactants

allow curve to start / finish anywhere along reactant / product lines

1
1

[8]

Q12.

(a) intermolecular

1

(b) sulfur

1

(c) ions

1

fixed in solid

1

mobile in liquid

1

(d) layers of atoms

allow ions

1

slide over each other

1

(e) copper

1

[8]

Q13.

(a) A base

1

(b) forces

1

(c) calcium loses electrons and oxygen gains electrons

max 3 for incorrect reference to atom / ion or to oxygen / oxide

1

two electrons are transferred

1

calcium has a 2^+ charge

1

oxide has a 2^- charge

1

[6]

Q14.

(a) caesium atom loses one electron

1

(and) oxygen atom gains two electrons

1

(so) two caesium atoms react with one oxygen atom

allow (to produce) Cs_2O

*max **3** marks if reference to incorrect particles / bonding / structure*

1

any **one** from:

- (to form) Cs^+ and O^{2-}
- (to form) caesium ion(s) and oxide ion(s)
- (to form) ions with full outer shells / levels

1

(b) (caesium has) more energy levels
or
(caesium has) more shells

allow converse for sodium

1

(so the) outer electron / shell is further from nucleus
or
outer electron / shell is more shielded

1

(so) weaker attraction between nucleus and outer electron / shell

1

(so) outer electron is more easily lost

allow (so) less energy needed to remove outer electron

1

(c) early periodic tables were arranged with elements in order of their atomic weights

ignore atomic mass

1

iodine has a lower atomic weight than tellurium

allow converse for tellurium

1

(so) Mendeleev placed iodine with elements with same / similar properties

allow F / Cl / Br for elements

or

(so) Mendeleev placed tellurium with elements with same / similar properties

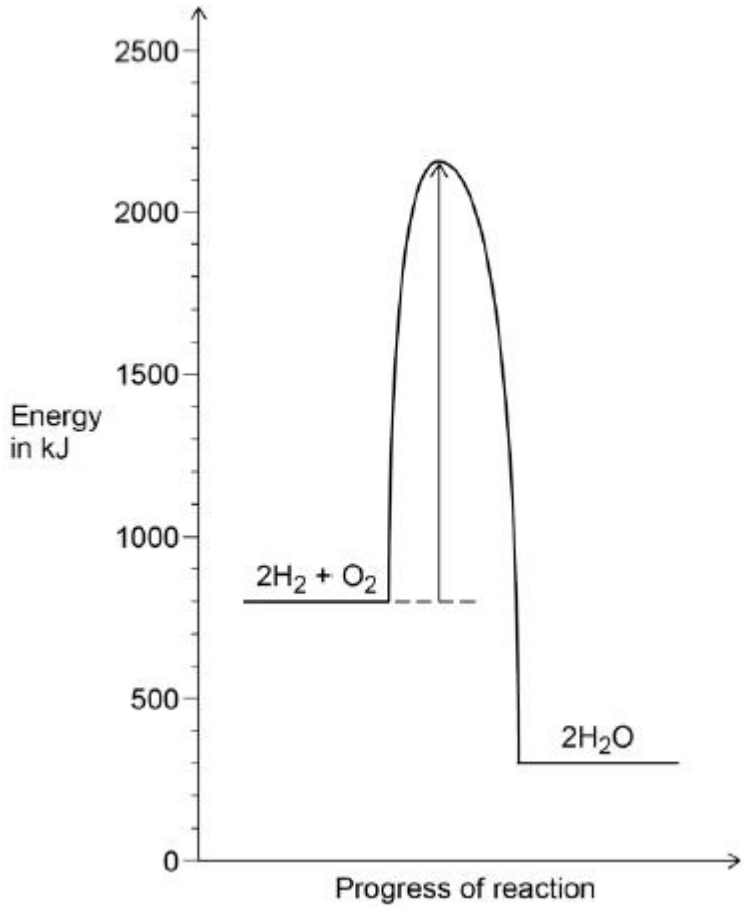
allow O / S / Se for elements

1

[11]

Q15.

(a) line from reactants to top of curve (i.e. from 800 to 2160)



ignore arrowheads

1

(b) reads levels of reactants (800 kJ) and products (300 kJ)

1

(800 − 300) = 500 (kJ)

allow correct subtraction of one incorrect value determined for the energy change

1

*an answer of (–) 500 (kJ) scores **2** marks ignore sign*

(c)

allow combination of circles, dots, crosses or $e^{(-)}$

two shared pairs in overlap

1

all non-bonding electrons in outer shell (4 electrons on each O atom)

ignore any inner shell electrons

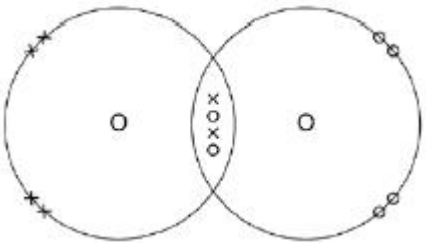


diagram scores 2 marks

1

(d) (bonds broken)
((4 × 463) + (2 × 138) =) **2128**

1

(bonds made)
((4 × 463) + (496) =) **2348**

1

(energy change =
bonds broken – bonds made)
(2128 – 2348 =) (–) **220** (kJ)

ignore energy change sign

allow correct calculation using incorrect values from step 1 and/or step 2

1

alternative approach:

(bonds broken)
(2 × (O–O) = (2 × 138) =) **276** (1)

(bonds made)
(1 × (O=O) =) **496**(1)

(energy change =
bonds broken – bonds made)
(276 − 496 =) (–) **220** (kJ) (1)

*an answer of (–) 220 (kJ) scores **3** marks*

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

[8]

Q16.

(a) atomic weight

*do **not** accept atomic mass or A_r*

1

(b) left gaps / spaces

or

changed the order based on atomic weights

allow placed them in correct groups according to properties

*do **not** accept reference to atomic number*

1

(c) weak forces between the molecules

or

weak intermolecular forces

allow weak intermolecular bonds

*do **not** accept incorrect references to covalent bonds*

1

(so) little energy required to overcome / break the forces between molecules

or

(so) little energy required to overcome / break the intermolecular forces

allow (so) little energy required to separate the molecules

allow (so) little energy required to overcome / break the intermolecular bonds

ignore less energy

1

(d)

allow converse explanation in terms of boiling point

(the) molecules get larger going down the group

1

(so the) forces <u>between the molecules</u> increase

or

(so the) intermolecular forces increase

1

(so the) boiling points increase going down the group

or

(so the) boiling points increase with increasing relative atomic mass

allow (so) more energy is needed to separate the molecules

1

(e) 2,8

allow diagram or description

1

(so) stable arrangement of electrons

or

(so) full outer shell

1

(f)

*an answer of 1.51 × 10^{22} scores **2** marks*

$\frac{1}{40}$ × 6.02 × 10^{23}

or

0.025 × 6.02 × 10^{23}

1

1.51 × 10^{22}

allow 1.505 × 10^{22}

1

[11]

Q17.

(a) $2\ Na + Cl_2 \longrightarrow 2\ NaCl$

1

(b) (before)
silver solid / liquid / metal
allow grey solid / metal
or
green (gas)
allow yellow (gas)

1

(during)
yellow flame
allow orange / white flame
or
white smoke
or
green colour fades / disappears

1

allow vigorous reaction

(after)
white solid / powder

1

(c)
allow converse for potassium

(sodium has) fewer energy levels / shells
allow diagrams of electron structure

1

outer electron / shell is closer to nucleus
or
outer electron / shell is less shielded

1

(so) greater attraction between nucleus and outer electron / shell

1

(so) outer electron is less easily lost
allow (so) loses an / one electron less easily
allow (so) more energy needed to remove an / one electron

1

(d) **Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.

4–6

Level 1: Relevant features are identified and differences noted.

1–3

No relevant content

0

Indicative content

	sodium chloride	hydrogen chloride
differences in bonding	ionic	covalent
	metal & non-metal	two **non**-metals
	transferring electrons	sharing electrons
	ions (Na^+ and Cl^-)	molecules
	charged particles	neutral **or** no overall charge
differences in structure	**giant** structure or lattice	**small / simple / discrete** molecules
	electrostatic	intermolecular forces
	(electrostatic forces) are **strong**	(intermolecular forces) are **weak**
	act in all directions	random **or** between the molecules
	regular	irregular / random
similarities in bonding	full shells **or** stability	full shells **or** stability
	(transferring) electrons	(sharing) electrons
	strong bonds	**strong** (covalent) bonds
	act in all directions	random **or** between the molecules
similarities in structure	(electrostatic) forces	(intermolecular) forces

ignore properties eg melting points, conduct electricity

to access level 2 there must be a comparison of the structure **and** bonding **and** magnitude of both sodium chloride **and** hydrogen chloride.

[14]

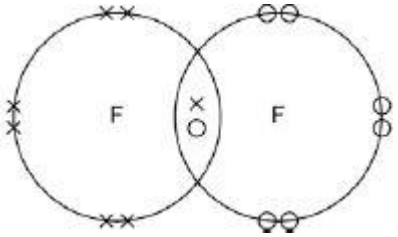
Q18.

(a) g

*do **not** accept upper case (G)*
*do **not** accept gas*

1

(b)



*one shared pair anywhere in overlap between two circles **or** on intersection*

1

6 other electrons on each atom

1

*allow dots **or** crosses **or** mixture for all marks*
ignore any inner shell electrons

(c) 18

1

(d) $AlBr_3$

1

2 Al + 3 Br_2 (⟶ 2 $AlBr_2$)

1

*allow **1** mark for balancing their equation with an incorrect product*

(e) chlorine is a smaller atom
or has fewer energy levels
or outer shell closer to nucleus

ignore chlorine has fewer electrons

1

chlorine has less shielding
or
has the greater attraction between the nucleus and the outer shell **or** incoming electron

1

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

1

*if no other marks awarded allow **1** mark for correct trend in reactivity in Group 7*

*do **not** accept reference to incorrect particles e.g. chloride atom*

***max 2** if outer shell / level not mentioned*
'it' refers to chlorine
allow converse reasons for bromine being less reactive

[9]

Q19.

(a) covalent bonds

1

giant structure / macromolecule

allow each C has 4 bonds
*allow giant covalent structure for **2** marks*
*allow giant ionic / lattice structure for **1** mark*
ignore lattice

1

lots of <u>energy</u> needed to break / overcome

allow disrupt structure

ignore heat and high temperature

*if no other marks awarded allow **1** mark for strong / many bonds*

1

(b) dissolved (in water) **or** aqueous

allow in solution

1

molten / liquid

1

so ions are mobile **or** free moving

1

***max 2** for incorrect reference to particles or bonds*

(c) <u>delocalised</u> electrons (from outer shell)

1

(free to) move

1

energy transferred (through structure)

ignore conducts thermal energy
ignore electricity

*if no other mark awarded allow **1** mark for ions / atoms vibrate*

1

[9]

Q20.

(a) a mixture designed as a useful product

1

(b) mass = 14 520 g

1

$(=)\frac{14\,520}{80\ (\text{mol})}$

allow correct substitution of incorrectly converted mass
must use M_r given (80) to gain marks in steps 2 and 3

1

(=) 181.5 (mol)

1

(=) 1.8×10^2 (mol)

allow answer correctly given in standard form to correct sig figs from an incorrect calculation

1

*an answer of 1.8×10^2 (mol) gains **4** marks*

(c) (giant) lattice

allow giant structure

1

ionic

1

strong bonds **or** strong electrostatic forces

*do **not** accept strong intermolecular forces / bonds*

1

large amounts of energy needed to overcome

ignore heat

1

***max 2 marks** for incorrect reference to bonding **or** structure **or** particles*

[9]

Q21.

(a)

Level 2: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	3-4
Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1-2
No relevant content	0
Indicative content Ca / calcium (atom) loses two electrons / both outer electrons and is oxidised to Ca^{2+} ion F / fluorine (atom) gain one / an electron and is reduced to F^- ion **supporting points** • fluorine / F (atoms) gain electron(s) • negative ion produced • calcium (atoms) lose electron(s) • positive ion produced • reduction is gain of electrons • oxidation is loss of electrons	

4

(b) (because there are) strong electrostatic forces of attraction
or
ionic bonding

1

between Ca^{2+} and F^- ions / oppositely charged ions

1

(in a) giant structure / lattice

1

so a lot of energy is needed to overcome / break this attraction

1

(c) amount of $F_2 = \frac{0.95}{38} = 0.025$ moles
mark is for ÷ 38

1

amount of $SF_6 = \frac{1}{3} \times 0.25 = 0.008333$ moles
mark is for ×1/3

1

mass of $SF_6 = 0.008333 \times 146$
mark is for ×146

1

mass = 1.2166666

1

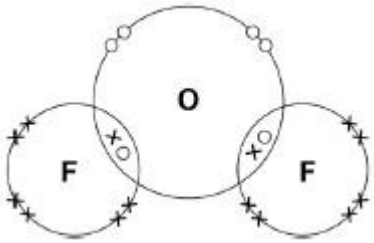
mass = 1.22 (g) 3 sig figs

1

[13]

Q22.

(a)



two shared pair of electrons
all outer shells complete

1
1

(b) gas

1

small molecules

1

(with) intermolecular forces

1

(so require) little energy to overcome

1

(c) calculates sum of all bonds broken:

4× (C–H) + 2× (O=O) = (4×412) + (2×496) = 2640

1

calculates sum of all bonds made:

4× (O–H) + 2(C=O) = (4×463) + (2×803) = 3458

1

overall energy change =

bonds broken – bonds made =

2640 – 3458 = (–)**818**

1

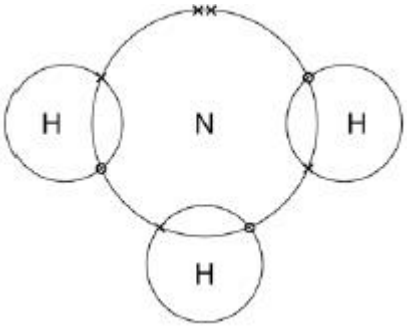
[9]

Q23.

(a) 3 × bonding pairs of electrons

1

2 × unbonded electrons on nitrogen



2

(b) decreases yield

1

more moles on left hand side

1

(c) decreases yield

1

exothermic reaction

1

(d) moves to right hand side

or

more ammonia produced

1

to replace the ammonia

1

[8]

Q24.

(a) bonded pair of electrons and

6 non-bonded electrons on chlorine

1

(b) **Level 3 (5–6 marks):**
A detailed and coherent explanation of comparative results of a reaction in terms of concentration and ionisation. The response makes logical links between the points raised and uses sufficient examples to support these links.

Level 2 (3–4 marks):
A description of a reaction with results is given but may miss some details. Links are made but may not be fully articulated and / or precise.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content

Indicative content

Simple statements / descriptions of a reaction

- correct comparative pH, such as, 0–3 (strong) 4–6 (weak)
- named reaction, such as, with a reactive metal or a named carbonate
- comparative results or observations of the named reaction, such as, faster reaction (strong) or greater volume of gas produced in a given time (strong)

Explanations of different results

- weak acids are only partially ionised in aqueous solution
- strong acids are completely ionised in aqueous solution / greater concentration of H^+ ions
- aqueous solutions of acids at the same concentration / same state of division of metal / powder, same temperature

6

[7]

Q25.

(a) <u>layers</u>

which have weak forces / attractions / bonds between them

second mark must be linked to layers

1

or

which can slide over each other **or** separate

ignore references to rubbing

1

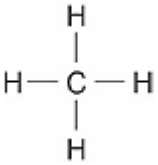
(b) covalent

1

[3]

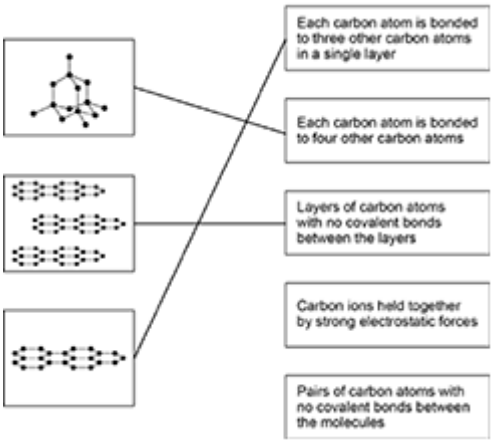
Q26.

(a)



1

(b) **Form of carbon** **Bonding and structure**



extra lines from the left negate the mark

3

(c) evaporate

1

condense

1

(d) Engine oil

1

(e) Refinery gas

1

(f) because its boiling point is lower

1

[9]

Q27.

(a) 0.34 nm

1

(b) in composites

1

(c)

must be comparative

(graphene)

allow converse for graphite

any **one** from:

- better conductor (of electricity)
- allows greater miniaturisation of electronic circuits

allow thinner

- stronger
- harder
- more flexible

1

(d) **Level 3**: Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

Structure and bonding

- giant structure / lattice
- of carbon atoms
- in layers
- of hexagonal rings
- covalent (bonds)
- strong (covalent) bonds
- where each (carbon) atom bonded to three other (carbon) atoms
- one electron on each atom is delocalised
- delocalised / free electrons

Explanation for conductivity

- delocalised / free electrons
- (which) carry charge through the structure

or

- (which) move through the structure

Explanation for graphite being slippery

- layers free to slide over each other
- (because) no covalent bonds between layers

or

(because) only weak (intermolecular) forces between layers

[9]

Q28.

(a) carbon

1

(b) diamond has a giant structure

1

each atom is joined to four other atoms

1

(c) contains layers

1

no covalent / strong bonds between layers

allow which have weak forces between them

1

so (the layers) can slide over each other

1

(d) 3

1

(e) has delocalised electrons

allow each (carbon) atom has one free electron

1

which can move <u>through the whole structure</u>
or
which carry the current

1

[9]