

**Q1.**

This question is about the periodic table.

The figure below shows an early version of the periodic table published by a scientist.

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

- (a) The scientist left gaps in the periodic table in the figure above.

Each gap is represented by a question mark (?).

Give **one** reason why the scientist left gaps in this periodic table.

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(1)

- (b) Which scientist published the periodic table in above figure?

Tick (✓) **one** box.

Bohr

Chadwick

Mendeleev

(1)

- (c) The modern periodic table is different from the periodic table in above figure.

One extra group of elements has been added.

What is the name of the extra group of elements in the modern periodic table?

Tick (✓) **one** box.

Alkali metals

Halogens

Noble gases

(1)

- (d) Why do the elements in Group 1 of the modern periodic table have similar chemical properties?

Tick (✓) **one** box.

The elements all form negative ions.

The elements all have one electron in the outer shell.

The elements all have the same number of shells.

(1)

- (e) **Table 1** shows the melting points of the first five elements going down Group 1.

**Table 1**

Element	Melting point in °C
Lithium	181
Sodium	98
Potassium	<b>X</b>
Rubidium	39
Caesium	29

Predict value **X**.

**X** = \_\_\_\_\_ °C

(1)

- (f) Give **one** observation you would see when a small piece of potassium is added to water.

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(1)

- (g) **Table 2** shows information about the first five elements going down Group 7.

**Table 2**

Element	State at 150 °C	Symbol	Formula of the compound with hydrogen
Fluorine	gas	F	HF
Chlorine	_____	Cl	HCl
Bromine	gas	Br	HBr
Iodine	liquid	I	HI
Astatine	solid	At	_____

Complete **Table 2**.

(2)

(h) The elements in Group 7 consist of molecules.

What is the formula of a molecule of bromine?

Tick (✓) **one** box.

Br

Br<sub>2</sub>

Br<sup>2</sup>

2Br

(1)

(Total 9 marks)

## Q2.

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

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

**Table 1**

Element	Melting point in °C	Boiling point in °C
Fluorine	-220	-188
Chlorine	-101	-35
Bromine	-7	59

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

Use **Table 1**.

Tick (✓) **one** box.

Gas	<input type="checkbox"/>
Liquid	<input type="checkbox"/>
Solid	<input type="checkbox"/>

(1)

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

Use **Table 1**.

Temperature = \_\_\_\_\_ °C

(1)

(c) Complete the sentences.

Going down Group 7 the melting points \_\_\_\_\_ .

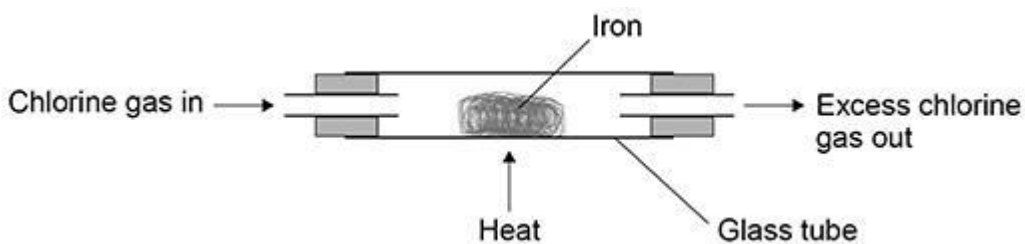
This is because the size of the molecules increases so the intermolecular forces

\_\_\_\_\_ .

(2)

A teacher investigated the reaction of iron with chlorine.

The diagram below shows the apparatus used.



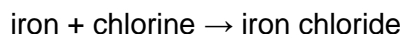
(d) Why did the teacher do the investigation in a fume cupboard?

Tick (✓) **one** box.

Chlorine gas is coloured.	<input type="checkbox"/>
Chlorine gas is flammable.	<input type="checkbox"/>
Chlorine gas is toxic.	<input type="checkbox"/>

(1)

(e) The word equation for the reaction is:



Iron chloride is a solid.

The teacher weighed the glass tube and contents:

- before the reaction
- after the reaction.

What happened to the mass of the glass tube and contents during the reaction?

Give **one** reason for your answer.

The mass of the glass tube and contents \_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

(2)

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

**Table 2** shows the results.

**Table 2**

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

(f) Fluorine is above chlorine in Group 7.

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

Use **Table 2**.

\_\_\_\_\_

\_\_\_\_\_

(1)

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



(1)

(h) Calculate the relative formula mass ( $M_r$ ) of  $\text{FeBr}_3$

Relative atomic masses ( $A_r$ ): Fe = 56 Br = 80

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Relative formula mass ( $M_r$ ) = \_\_\_\_\_

(2)

(Total 11 marks)

**Q3.**

The following article appeared recently in the *Manchester Gazette*.

**Sodium Drum Blaze Scare**

A 20 litre drum containing sodium burst into flames when it reacted violently with rainwater at a Manchester factory. It is believed that the sodium, which is normally stored under oil, had been accidentally left outside with the lid off.

A factory worker put out the blaze before the fire services arrived, and a leading fire fighter said, "It was fortunate that potassium wasn't involved as it would have reacted more violently and exploded. These Group 1 *alkali metals* can be very dangerous".

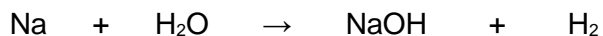
- (a) Group 1 metals are stored under oil.

Suggest why.

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(1)

- (b) Balance the equation which represents the reaction between sodium and water.



(1)

- (c) Explain why the Group 1 metals are called the *alkali metals*.

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(1)

- (d) Explain, in terms of electrons, why potassium reacts more violently than sodium.

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(3)  
(Total 6 marks)

**Q4.**

This question is about the halogens (Group 7).

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

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(1)

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

Sodium bromide is an ionic compound.

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

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(1)

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

Complete the word equation for the reaction.

chlorine + sodium bromide  $\longrightarrow$  bromine + \_\_\_\_\_

(1)

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

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(1)

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

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

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(1)  
(Total 5 marks)

**Q5.**

This question is about elements and the periodic table.

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

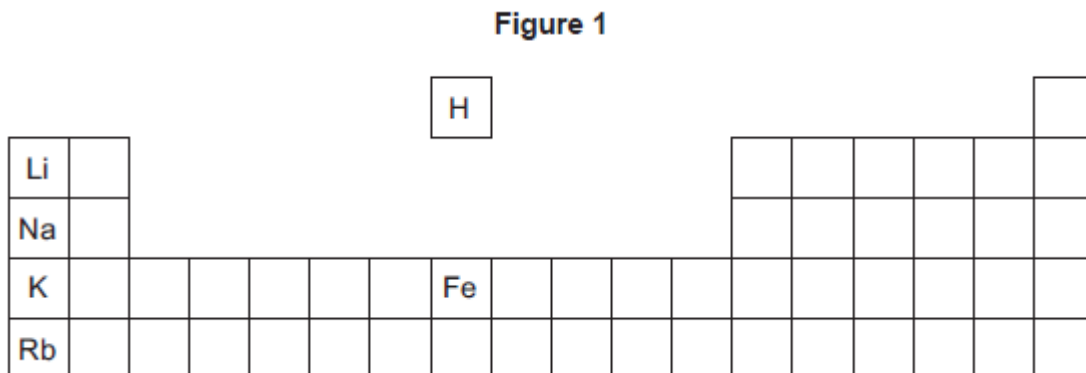
atoms	atomic weights	electrons	proton numbers
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Newlands' and Mendeleev's periodic tables show the elements in order of their \_\_\_\_\_ .

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

(3)

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



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

\_\_\_\_\_

(1)

(ii) Complete the sentence.

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

(1)

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

Tick (✓) **one** box.

Lithium (Li)

Sodium (Na)

Potassium (K)

(1)

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

Tick (✓) **two** boxes.

Iron has a higher density than potassium.

Iron is softer than potassium.

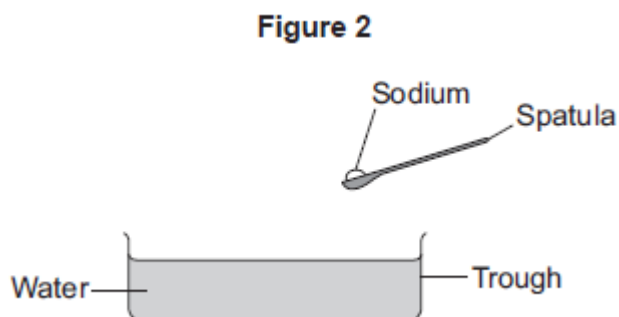


Iron reacts vigorously with water.

Iron forms ions that have different charges.

(2)

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



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

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_

(3)

(Total 11 marks)

### Q6.

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

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

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

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

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

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

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(1)

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

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(1)

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

The reactivity of the halogens decreases down the group.

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



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

In terms of electrons, what is meant by reduction?

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(1)

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



(2)

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

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(3)

(Total 8 marks)

**Q7.**

This question is about Group 7 elements.

Chlorine is more reactive than iodine.

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

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(1)

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

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(3)

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

Explain why hydrogen chloride is a gas at room temperature.

Answer in terms of structure and bonding.

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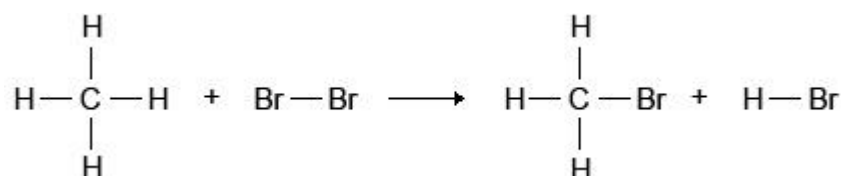
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(3)

- (d) Bromine reacts with methane in sunlight.

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



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

	<b>C—H</b>	<b>Br—Br</b>	<b>C—Br</b>	<b>H—Br</b>	<b>Overall energy change</b>
<b>Energy in kJ/mol</b>	412	193	<b>X</b>	366	-51

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

Use the diagram and the table above.

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Bond energy **X** = \_\_\_\_\_ kJ/mol

(4)

(Total 11 marks)

**Q8.**

This question is about Group 1 elements.

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

**Table 1**

<b>Atom</b>	<b>Number of electrons</b>	<b>Electronic structure</b>
Sodium	11	2,8,1
Potassium	19	

(1)

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

Tick (✓) **one** box.

They have the same number of electron shells.

They have the same number of outer shell electrons.

They have two electrons in the first shell.

(1)

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

Tick (✓) **one** box.

Covalent

Ionic

Metallic

(1)

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

**Table 2**

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

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

Write your answers in **Table 2**.

(2)

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

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(1)

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

1 \_\_\_\_\_

2 \_\_\_\_\_

(2)

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

Tick (✓) **one** box.

Carbon dioxide

Hydrogen

Nitrogen

Oxygen

(1)

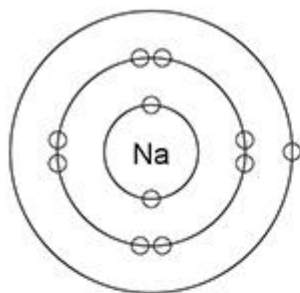
- (h) Sodium fluoride is an ionic compound.

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

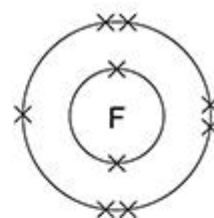
Complete the diagram below to show what happens when a sodium atom and a fluorine atom react to produce sodium fluoride.

You should:

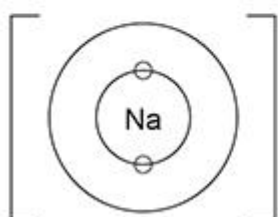
- complete the electronic structures of the sodium ion and the fluoride ion
- give the charges on the sodium ion and the fluoride ion.



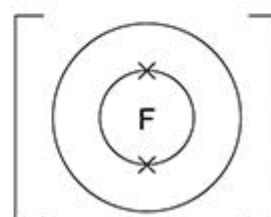
Sodium atom



Fluorine atom



Sodium ion



Fluoride ion

(3)  
(Total 12 marks)

## Mark schemes

### Q1.

- (a) for elements that had not been discovered (at that time)

*allow for missing elements*

**or**

so that elements with similar properties are grouped together

*ignore references to atomic number / mass / weight*

1

- (b) Mendeleev

1

- (c) noble gases

1

- (d) the elements all have one electron in the outer shell

1

- (e) 63 (°C)

*allow a value in the range 49 to 88 (°C)*

1

- (f) any **one** from:

- floats
- moves (on the surface)
- melts

*allow forms a ball*

- fizzes / bubbles
- flame

*ignore colour of flame*

*allow explodes / disappears*

*ignore references to heat / temperature / sounds*

1

- (g)

Element	State at 150 °C	Symbol	Formula of the compound with hydrogen
Fluorine	gas	F	HF
Chlorine	<b>gas</b>	Cl	HCl
Bromine	gas	Br	HBr
Iodine	liquid	I	HI
Astatine	solid	At	<b>HAt</b>

2

- (g) Br<sub>2</sub>

1



**Q2.**

- (a) gas 1
- (b) -35 (°C)  
*allow any value between -35 °C and -100 °C* 1
- (c) increase 1  
increase  
*allow become stronger* 1
- (d) chlorine gas is toxic 1
- (e) increased 1  
chlorine (atoms) are now part of the solid (iron chloride)  
**or**  
the mass of the chlorine (atoms) is now also measured 1
- (f) burns very vigorously 1  
*allow burns violently*  
*allow brighter (orange) glow*  
*allow (orange) flame*  
*allow explodes*
- (g)  $2 \text{ Fe} + 3 \text{ Br}_2 \rightarrow 2 \text{ FeBr}_3$  1  
*allow multiples*
- (h)  $56 + (3 \times 80)$  1  
 $= 296$   
*ignore units* 1

[11]

**Q3.**

- (a) acts as barrier between sodium and air / oxygen / water (vapour)  
*accept because they are reactive*  
*ignore oil will not react* 1
- (b)  $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$

*allow multiples / fractions*

1

(c) these metals react with water producing an alkaline solution

**or**

produce solution with pH greater than 7 / high pH

*owtte*

*allow produce OH. ions*

**not** these metals are / form alkalis

*ignore 'strong' pH*

1

(d) *it = potassium*

outer electron must be mentioned once for all **3** marks

bigger atom

**or**

outer shell electron further from nucleus

**or**

more shells

**or**

*converse argument for sodium less reactive provided sodium is specified*

1

less attraction to nucleus

**or**

more shielding

**not** less magnetic attraction

1

outer electron more easily lost

**ignore** potassium reacts more easily

1

[6]

#### Q4.

(a) increase

1

(b) (i) Na<sup>+</sup> **and** Br<sup>-</sup>

*both required*

1

(ii) sodium chloride

*allow NaCl*

*do not allow sodium chlorine*

1

(iii) chlorine is more reactive than bromine

*allow converse argument*

*allow symbols Cl, Cl<sub>2</sub>, Br and Br<sub>2</sub>*

*allow chlorine / it is more reactive*  
*do not allow chloride or bromide*

1

(iv) fluorine

*allow F / F<sub>2</sub>.*

*do not allow fluoride.*

1

[5]

**Q5.**

(a) atomic weights

*must be in this order*

1

electrons

1

proton numbers

1

(b) (i) H/hydrogen

*allow H<sub>2</sub> or h*

1

(ii) one / 1

*allow alkali metals*

1

(iii) Potassium (K)

1

(iv) Iron has a higher density than potassium

1

Iron forms ions that have different charges

1

(c) any **three** from:

- melts
- fizzes / bubbles / effervesces  
*allow gas produced*
- sodium floats
- size of the sodium decreases  
*allow dissolves / disappears*
- sodium moves

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

3

[11]

**Q6.**

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

- one electron in the outer shell / energy level

- form ions with a 1+ charge 1
- (ii) any **one** from:
- hydrogen is a non-metal
  - (at RTP) hydrogen is a gas
  - hydrogen does not react with water
  - hydrogen has only one electron shell / energy level
  - hydrogen can gain an electron **or** hydrogen can form a negative / hydride / H<sup>-</sup> ion
  - hydrogen forms covalent bonds **or** shares electrons
- accept answers in terms of the Group 1 elements* 1
- (b) (i) (bromine) gains electrons
- it = bromine*
- do **not** accept bromide ion gains electrons*
- ignore loss of oxygen* 1
- (ii) I<sub>2</sub>
- must both be on the right hand side of the equation* 1
- + 2e<sup>-</sup>
- 2I - 2e<sup>-</sup> → I<sub>2</sub> for 2 marks* 1
- (iii) fluorine is the smallest atom in Group 7 **or** has the fewest energy levels in Group 7 **or** has the smallest distance between outer shell and nucleus
- the outer shell **must** be mentioned to score 3 marks* 1
- fluorine has the least shielding **or** the greatest attraction between the nucleus and the outer shell 1
- therefore fluorine can gain an electron (into the outer shell) more easily 1

[8]

**Q7.**

- (a) potassium chloride **and** iodine
- either order*
- allow KCl for potassium chloride and I<sub>2</sub> for iodine* 1
- (b) (chlorine's) outer electrons / shell closer to the nucleus
- allow chlorine has fewer shells*
- allow chlorine atom is smaller than iodine atom*
- ignore chlorine has fewer outer shells* 1
- (so) the chlorine nucleus has greater attraction for outer electrons / shell

*allow chlorine has less shielding  
do **not** accept incorrect types of attraction*

1

(so) chlorine gains an electron more easily

1

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

*allow converse statements*

*allow energy levels for shells throughout*

(c) hydrogen chloride is made of small molecules

*allow hydrogen chloride is simple molecular*

1

(so hydrogen chloride) has weak intermolecular forces\*

1

(intermolecular forces) require little energy to overcome\*

1

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

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

1

(bonds formed =  $3(412) + 366 + \mathbf{X} =$ )  $1602 + \mathbf{X}$

1

$-51 = 1841 - (1602 + \mathbf{X})$

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

1

( $\mathbf{X} =$ ) 290 (kJ/mol)

*allow a correctly calculated answer from use of  
 $-51 = \text{bonds formed} - \text{bonds broken}$*

1

**OR**

alternative method ignoring the 3 unchanged C–H bonds

$(412 + 193 =)$  605 (1)

$366 + \mathbf{X}$  (1)

$-51 = 605 - (366 + \mathbf{X})$  (1)

( $\mathbf{X} =$ ) 290 (kJ/mol) (1)

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

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

*an incorrect answer for one step does **not***

*prevent allocation of marks for subsequent steps*

[11]

**Q8.**

- (a) 2,8,8,1 1
- (b) they have the same number of outer shell electrons 1
- (c) metallic 1
- (d) any **two** from:
- bubbles (very) quickly
  - melts (into a ball)
  - floats
  - moves (very) quickly
- allow flame*
- 2
- (e) (reactivity) increases (down the group) 1
- (f) any **two** from:
- increasing speed of movement
  - increasing rate of bubble production
  - doesn't melt → melts
  - no flame → flame
- or**
- flame → explosion
- 2
- (g) hydrogen 1
- (h) sodium ion structure 2,8 1

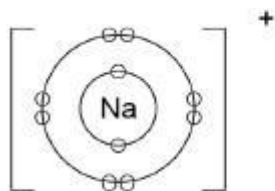
fluoride ion structure 2,8

*allow any combination of circles, dots, crosses or e<sup>-</sup>*

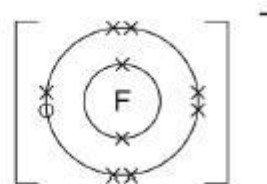
1

+ charge on sodium ion **and**  
- charge on fluoride ion

an answer of



sodium ion



fluoride ion

scores **3** marks

1

[12]