

1 The Group I metals show trends in both their physical and chemical properties.

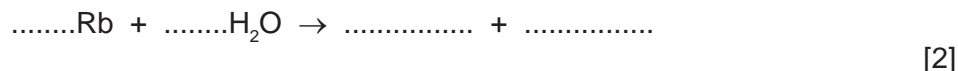
(a) How do their melting points vary down the Group?

..... [1]

(ii) Which element in the Group has the highest density?

..... [1]

(iii) All Group I metals react with cold water. Complete the following equation.



(b) Lithium reacts with nitrogen to form the ionic compound, lithium nitride.

(i) State the formula of the lithium ion. [1]

(ii) Deduce the formula of the nitride ion. [1]

(iii) In all solid ionic compounds, the ions are held together in a lattice.
Explain the term *lattice*.

.....
..... [1]

(iv) What is the ratio of lithium ions to nitride ions in the lattice of lithium nitride?
Give a reason for your answer.

..... lithium ions : nitride ions
.....
..... [2]

[Total: 9]

2 Vanadium is a transition element. It has more than one oxidation state. The element and its compounds are often used as catalysts.

(a) Complete the electron distribution of vanadium by inserting one number.

$$2 + 8 + \dots + 2$$

[1]

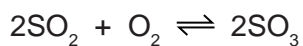
(b) Predict **three** physical properties of vanadium which are typical of transition elements.

1.

2.

3. [2]

- (c) Vanadium(V) oxide is used to catalyse the exothermic reaction between sulfur dioxide and oxygen in the Contact Process.



The rate of this reaction can be increased either by using a catalyst or by increasing the temperature. Explain why a catalyst is used and not a higher temperature.

.....
.....
..... [2]

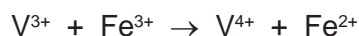
- (d) The oxidation states of vanadium in its compounds are V(+5), V(+4), V(+3) and V(+2). The vanadium(III) ion can behave as a reductant or an oxidant.

- (i) Indicate on the following equation which reactant is the oxidant.



[1]

- (ii) Which change in the following equation is oxidation?
Explain your choice.



.....
..... [2]

[Total: 8]

3 The table below includes information about some of the elements in Period 2.

element	carbon	nitrogen	fluorine	neon
symbol	C	N	F	Ne
structure	macromolecular	simple molecules N ₂	simple molecules F ₂	single atoms Ne
boiling point/°C	4200	-196	-188	-246

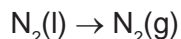
(a) Why does neon exist as single atoms but fluorine exists as molecules?

.....
..... [2]

(b) What determines the order of the elements in a period?

..... [1]

(c) When liquid nitrogen boils the following change occurs.



The boiling point of nitrogen is very low even though the bond between the atoms in a nitrogen molecule is very strong. Suggest an explanation.

.....
..... [2]

(d) Draw a diagram showing the arrangement of the outer shell (valency) electrons in a molecule of nitrogen.

[2]

[Total: 7]

4 For each of the following, select an element from Period 4, potassium to krypton, which matches the description.

(a) A metal that reacts rapidly with cold water to form a compound of the type $M(OH)_2$ and hydrogen.

..... [1]

(b) Its only oxidation state is 0. [1]

(c) It has a macromolecular oxide, XO_2 , which has similar physical properties to those of diamond.

..... [1]

(d) This is one of the metals alloyed with iron in stainless steel. [1]

(e) It can be reduced to an ion of the type X^- [1]

(f) It can form a covalent hydride having the formula H_2X [1]

(g) Its soluble salts are blue and its oxide is black. [1]

(h) It is a liquid at room temperature. [1]

[Total: 8]

5 Zinc alloys have been used for over 2500 years.

(a) Explain the phrase *zinc alloy*.

.....
..... [1]

(ii) Making alloys is still a major use of zinc. State **one** other large scale use of zinc.

..... [1]

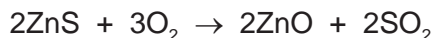
(iii) Describe the bonding in a typical metal, such as zinc, and then explain why it is malleable. You may use a diagram to illustrate your answer.

.....
.....
..... [3]

(iv) Suggest why the introduction of a different atom into the structure makes the alloy less malleable than the pure metal.

.....
..... [2]

(b) Zinc metal is made by the reduction of zinc oxide. The major ore of zinc is zinc blende, ZnS. Zinc blende contains silver and lead compounds as well as zinc sulfide. Zinc blende is converted into impure zinc oxide by heating it in air.



(i) Describe how zinc oxide is reduced to zinc.

..... [1]

(ii) Some of the zinc oxide is dissolved in sulfuric acid to make aqueous zinc sulfate. Write a balanced symbol equation for this reaction.

..... [2]

- (iii)** This impure solution of zinc sulfate contains zinc ions, silver(I) ions and lead ions. Explain why the addition of zinc powder produces pure zinc sulfate solution. Include at least one ionic equation in your explanation.

.....

.....

.....

.....

..... [4]

- (iv)** Describe how zinc metal can be obtained from zinc sulfate solution by electrolysis. A labelled diagram is acceptable. Include all the products of this electrolysis. The electrolysis is similar to that of copper(II) sulfate solution with inert electrodes.

[4]

[Total: 18]

6 Selenium and sulfur are in Group VI. They have similar properties.

(a) One of the main uses of selenium is in photoelectric cells. These cells can change light into electrical energy.

(i) Name a process which can change light into chemical energy.

.....

(ii) Name a device which can change chemical energy into electrical energy.

..... [2]

(b) The electron distribution of a selenium atom is 2 + 8 + 18 + 6.

(i) Selenium forms an ionic compound with potassium. Draw a diagram which shows the formula of this ionic compound, the charges on the ions and the arrangement of the **valency** electrons around the negative ion.

Use o to represent an electron from an atom of potassium.

Use x to represent an electron from an atom of selenium.

- (ii) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound selenium chloride.
Use x to represent an electron from an atom of selenium.
Use o to represent an electron from an atom of chlorine.

[3]

- (iii) Predict **two** differences in the physical properties of these two compounds.

.....
..... [2]

- (c) The selenide ion reacts with water.



What type of reagent is the selenide ion in this reaction? Give a reason for your choice.

.....
..... [3]

[Total: 13]

7 Choose an element from the list below which best fits the description.

Rb Fe Si I P Sr

- (a) An element which reacts with cold water. [1]
- (b) It is a solid at room temperature and exists as diatomic molecules, X_2 [1]
- (c) It can form two oxides, XO and X_2O_3 [1]
- (d) This element has a hydride of the type XH_3 [1]
- (e) It has a macromolecular structure similar to that of carbon. [1]

[Total: 5]