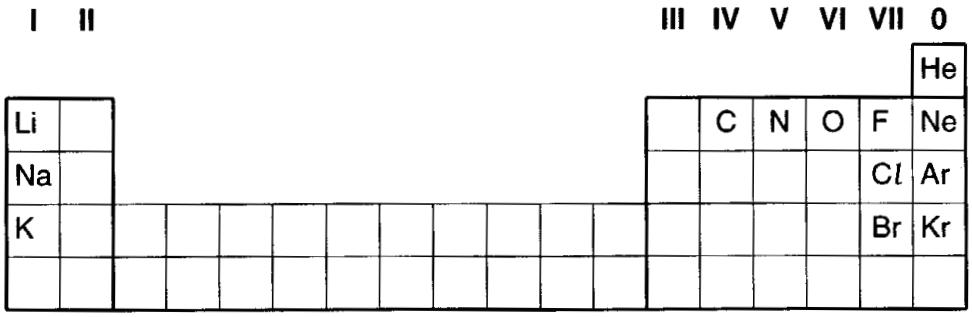
Core 1

The diagram shows part of the Periodic Table.



(a) Answer these questions using **only** the elements shown in the diagram.

(i) Write down the symbol for an element which contains diatomic molecules. ☐

(ii) Write down the symbol for an element which forms a basic oxide. ☐

(iii) Write down the symbol for an element with a smaller proton (atomic) number than lithium, Li. ☐

(iv) Write down the symbol for an element which contains atoms with a full outer shell of electrons. ☐

[4]

(b) Describe three things you would **see** when a small piece of sodium is added to a beaker of water.

1. .....

2. .....

3. .....

[3]

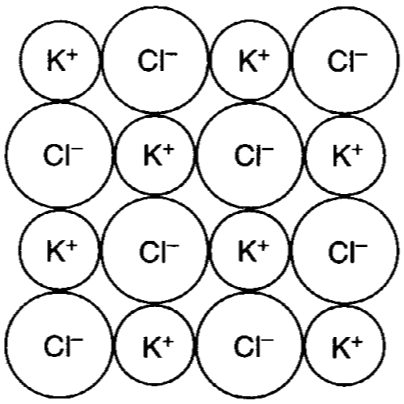
(c) Lithium (Li), sodium (Na), and potassium (K) are in the same group of the Periodic Table. The following table compares the properties and electronic structure of these elements. Suggest a value for the boiling point of sodium and complete the rest of the table.

element	*boiling point / °C*	*reaction with water*	*electronic structure*
lithium	1342	steady reaction	2.1
sodium		rapid reaction	
potassium	760		2.8.8.1

[3]

Core 1

(d) When potassium burns in chlorine, potassium chloride is formed. Part of the structure of potassium chloride is shown below.



(i) Describe the type of bonding in potassium chloride.

.....[1]

(ii) State the simplest formula for potassium chloride.

.....[1]

(iii) Explain why solid potassium chloride does not conduct electricity.

.....[1]

(iv) A solution of potassium chloride was acidified with nitric acid.
A few drops of silver nitrate solution were then added.

Describe what would be observed.

.....

.....[2]

Core 2

Zinc is used to galvanise iron. It is also a component of many alloys.

(a) **(i)** Explain the meaning of the term *galvanise*.

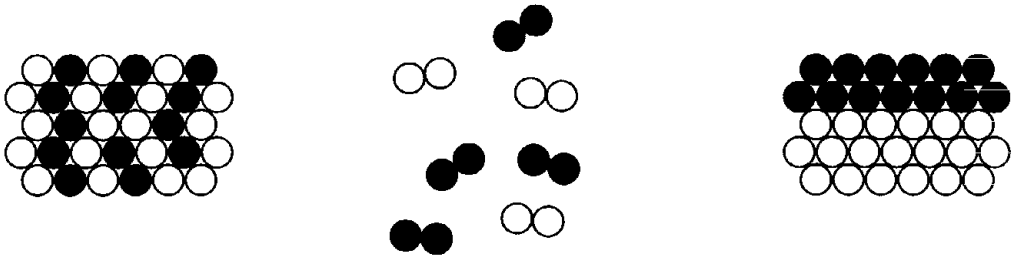
.....

.....[1]

(ii) What is the purpose of galvanising iron?

.....[1]

(iii) Which one of the following, **A**, **B** or **C**, is a correct representation of an alloy?
Put a ring around the correct answer.



A **B** **C** [1]

(b) Zinc is a metal. State three physical properties that **all** metals have in common.

1. .....

2. .....

3. .....

[3]

(c) Zinc is extracted from zinc sulphide ore. The ore is first heated in air. The oxygen in the air reacts with the zinc sulphide.

zinc sulphide + oxygen → zinc oxide + sulphur dioxide

(i) Which one of the substances in this equation causes acid rain if it escapes into the atmosphere?

.....[1]

(ii) Write the formula for a molecule of oxygen.

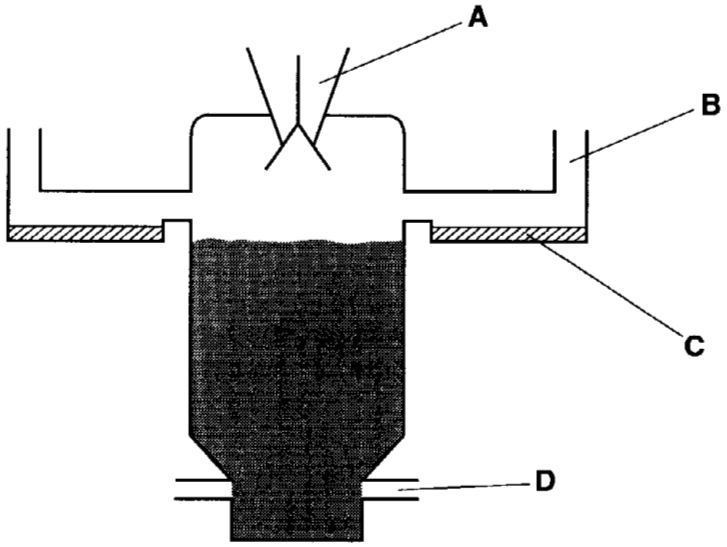
.....[1]

(d) 5 tonnes of zinc oxide are needed to produce 4 tonnes of zinc.
Calculate the mass of zinc produced from 20 tonnes of zinc oxide.

mass of zinc ..... tonnes [1]

(e) Zinc is extracted by heating the zinc oxide with coke in a blast-furnace. Hot air is pumped through pipes near the bottom of the furnace. Zinc forms as a vapour which rises to the top of the furnace. The zinc condenses in pans at the top of the furnace. The diagram shows a blast-furnace used for extracting zinc.

Answer the following questions using the letters, **A**, **B**, **C** or **D** from the diagram below.



(i) Where is the mixture of zinc oxide and coke added to the furnace? ☐

(ii) Where is the air blown in? ☐

(iii) Where does the zinc condense? ☐

[3]

(f) In the blast-furnace, the coke reduces the zinc oxide to zinc. Some of the coke also burns to form carbon monoxide.

(i) What is meant by *reduction*?

.....[1]

(ii) State the formula for carbon monoxide.

.....[1]

Core 3

6 Carbon-14 is a radioactive isotope which is formed in the upper atmosphere.

(a) Explain the meaning of the terms

(i) *radioactive,* .....

.....[1]

(ii) *isotope.* .....

.....[2]

(b) State one medical use of radioactive isotopes.

.....[1]

(c) Carbon-14 has a nucleon (mass) number of 14.
Complete the table below to show the type of charge and number of particles present in one atom of carbon-14.

type of particle	*type of charge on the particle*	*number of particles present*
proton		
neutron		
electron		

[6]

Core 3

(d) Carbon-14 slowly changes into atoms of nitrogen. These nitrogen atoms have 7 protons, 7 neutrons and 7 electrons.

(i) State the nucleon (mass) number of these nitrogen atoms.

.....[1]

(ii) Draw a diagram to show the arrangement of the electrons in a nitrogen atom.

[2]

(iii) Name **one** other element having the same number of valency electrons as nitrogen.

.....[1]

Core 4

Platinum is a shiny metal which was first discovered in Colombia in South America, where small amounts were found along with silver. Platinum is very unreactive but is very useful as a catalyst.

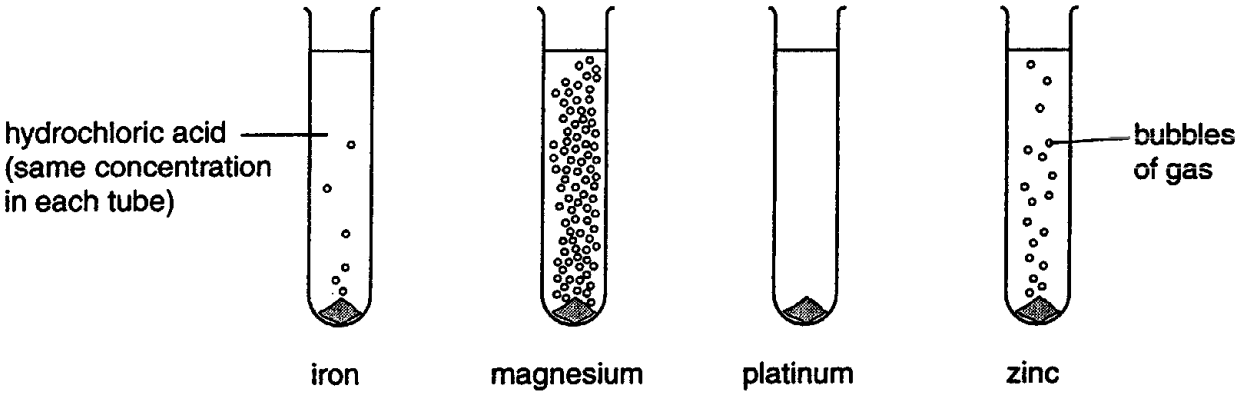
(a) Suggest a use for platinum **other than** as a catalyst.

.....[1]

(b) What is the function of a catalyst?

.....[1]

(c) A student compared the reactivity of different metals with dilute hydrochloric acid. The drawing shows the student's observations five seconds after each piece of metal had been added to the acid.



(i) Put the metals in order of their reactivity.

most reactive .....

.....

.....

least reactive .....

(ii) Complete the word equation for the reaction of magnesium with hydrochloric acid.

magnesium + hydrochloric acid → ..... + ...

.....

(iii) Platinum is a transition element and magnesium is in Group II of the Periodic Table. Complete the following sentences about the physical properties of these two elements.

Platinum has a ..... density than magnesium.

Magnesium has a ..... boiling point than platinum.

[5]

(d) Several substances which are harmful to the environment are found in the fumes from car exhausts. Platinum is used in the catalytic converters of cars to help remove some of these substances.
State why the following substances are harmful to the environment.

(i) carbon monoxide .....

(ii) nitrogen oxides .....

(iii) lead compounds .....

[3]

Extension 1

The element scandium, proton (atomic) number, $Z = 21$, was discovered by L Nilson in Sweden in 1879.

(a) It forms only one ion which has the formula $^{45}_{21}Sc^{3+}$.

(i) How many electrons, protons and neutrons are there in this ion?

number of electrons .....

number of protons .....

number of neutrons .....

(ii) Predict the electron distribution of this ion.

.....

[4]

(b) The main ore of scandium is thortveitite, $Sc_2Si_2O_7$. This is converted into scandium fluoride which reacts with calcium to produce scandium metal.

(i) Balance the ionic equation for the reaction between scandium fluoride and calcium.

$$.....Ca + ...Sc^{3+} \longrightarrow ....Ca^{2+} + ...Sc \qquad [1]$$

(ii) Which change in the above reaction is oxidation? Give a reason for your choice.

.....

.....

.....[2]

(iii) An alternative method of extracting scandium is by the electrolysis of a molten mixture that contains scandium chloride. Write ionic equations for the reactions at the electrodes.

reaction at cathode .....

reaction at anode .....[2]

(c) The density of scandium is 2.99 g/cm^3 and it has only one valency of three. Scandium compounds are white solids and form colourless solutions. Titanium is a more typical transition metal, predict how its properties would be different from those of scandium.

.....

.....

.....[2]

Extension 2

Germanium is an element in Group IV. It was first isolated in Germany by C Winkler in 1886.

(a) It has a similar macromolecular structure to diamond. Predict **two** physical properties of germanium.

.....

.....[2]

(b) Explain why graphite, which is also a macromolecular form of carbon, has different physical properties to diamond and germanium.

.....

.....[2]

(c) The electron distribution of a germanium atom is 2.8.18.4.
Draw a diagram to show the arrangement of the valency electrons in the covalent compound germanium tetrachloride.

Use o to represent an electron from germanium.
Use x to represent an electron from chlorine. [3]

(d) Germanium forms a series of saturated compounds with hydrogen which resemble the alkanes.

(i) Predict the general molecular formula of these compounds of germanium and hydrogen.

.....[1]

(ii) Draw the structural formula for one of the above compounds that contains four germanium atoms per molecule.

[1]

Extension 2

(e) When aqueous solutions of germanium(II) chloride and of iron(III) chloride are mixed, the following reaction occurs.

$$GeCl_2 + 2FeCl_3 \longrightarrow 2FeCl_2 + GeCl_4$$

or $Ge^{2+} + 2Fe^{3+} \longrightarrow 2Fe^{2+} + Ge^{4+}$

(i) Is the germanium(II) chloride acting as an oxidising agent or reducing agent? Explain your choice using the idea of electron transfer.

.....

.....[2]

(ii) Describe a test to show that an iron(III) salt had been changed into an iron(II) salt.

test .....

result for iron(III)salt .....

result for iron(II) salt .....

[3]

Core 1

a(i) N / O / F / Cl / Br not N_2 etc

(ii) Li / Na / K

(iii) He

(iv) He / Ne / Ar / Kr

b any three observations such as
- floats on water
- moves about
- bursts into flame
- fizzes
- bubbles
- dissolves
- disappears
- goes into a ball

c

boiling point	reaction with water	electronic structure
900 – 1100	very vigorous	2.8.1

d(i) ionic / electrovalent

(ii) KCl

(iii) ions are not free to move

(iv) white
precipitate

Core 2

a(i) coating iron or other less reactive metal with zinc

(ii) prevents rusting / corrosion

(iii) A

b any three from
- conduct heat
- conduct electricity
- malleable
- ductile
- sonorous
- shiny

c(i) sulphur dioxide / SO_2

(ii) O_2

d 16 tonnes

e(i) A

(ii) D

(iii) C

f(i) removal of oxygen from a compound or substance
gain of electrons
decrease on oxidation number
addition of hydrogen

(ii) CO

Core 3

a(i) ionising particles given off or named radiation, α, β and γ

(ii) atoms with the same number of protons / same element / same atomic number

different numbers of neutrons / different mass numbers

b any suitable such as
finding out how well an organ is carrying out its function
treating cancers
sterilising surgical instruments

c

+	6
none	8
-	6

d(i) 14

(ii) diagram showing 2 electrons in inner shell, 5 electrons in outer shell

(iii) any other group V element

Core 4

a any suitable use such as jewellery, electrodes, alloys

b speeds up reaction / increases rate of reaction
lowers activation energy / easier pathway for the reaction
description of catalyst bringing molecules together on surface

c(i) magnesium
zinc
iron
platinum

(i) magnesium chloride + hydrogen

(ii) higher / greater density

lower / smaller boiling point

d(i) breathing difficulties / combines with red blood pigment

(i) acid rain / forms nitrogen dioxide which is poisonous / damage to ozone layer

(ii) harms nervous system / brain / poisonous

Extension 1

a(i) 18e
21p
24n

(ii) 2.8.8

b(i) $3Ca + 2Sc^{3+} \longrightarrow 3Ca^{2+} + 2Sc$

(ii) Ca (to Ca^{2+}) (electron loss)

(iii) $Sc^{3+} + 3e \longrightarrow Sc$

$2Cl^{-} \longrightarrow Cl_2 + 2e$

c any two from
higher density
coloured compounds / solution / ion
more than one valency / oxidation state
higher melting point
catalytic activity

Extension 2

a any two from
- hard
- high melting point
- poor conductor (heat and elecricity)
- brittle

b consists of layers or planes or 2D macromolecules

weak bonds between layers or can slip

or delocalised electrons

c 8e around Ge
8e around each Cl
$GeCl_4$

d(i) Ge_nH_{2n-2}

(iii) in either format

GeH_3-GeH_2-GeH_2-GeH_3

GeH_3-GeH-GeH_3
I
GeH_3

e(i) reducing
Ge^{2-} loses / donates electrons
germanium loses / donates electrons
$Ge^{2+} - 2e \longrightarrow Ge^{4+}$
Fe^{3+} gains electrons
iron gains electrons
$Fe^{3+} + e \longrightarrow Fe^{2+}$

(ii) <u>test</u> sodium hydroxide or aqueous ammonia
<u>result for Fe(III) salt</u> brown precipitate
<u>result for iron(II) salt</u> green precipitate