

1

Transition elements and their compounds have many uses.

Iron oxide and cobalt oxide have been added to the glazes on pottery for hundreds of years.



(a) State why transition metal oxides are added to pottery glazes.

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(1)

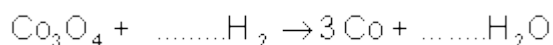
(b) Use the table of ions on the Data Sheet to help you work out the formula of iron(III) oxide.

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(1)

(c) Cobalt oxide is reacted with hydrogen to form cobalt.

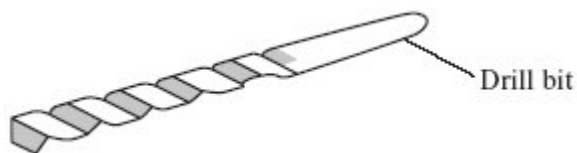
(i) Balance the equation for this reaction.



(1)

(ii) Cobalt is mixed with other transition metals to make alloys.

These alloys are used to make cutting tools which remain sharp at very high temperatures. They can cut through other metals.



Suggest **two** properties of transition metals that make them suitable for making cutting tools.

1

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2

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(2)
(Total 5 marks)

2

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

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

Number of protons

Number of neutrons

Number of electrons

(3)

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

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(1)

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

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

	Transition elements		Group 1 elements	
	Chromium	Iron	Sodium	Caesium
Melting point in °C	1857	1535	98	29
Formula of oxides	CrO Cr ₂ O ₃ CrO ₂ CrO ₃	FeO Fe ₂ O ₃ Fe ₃ O ₄	Na ₂ O	Cs ₂ O

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

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(6)
(Total 10 marks)

3

The extract below was taken from a leaflet on the uses of platinum. One of the uses described was in making electrodes for spark plugs in car engines. The spark plug produces the spark which ignites the fuel in the engine.

Spark Plugs

The electrodes in a spark plug have to conduct electricity very well. Since they project into the combustion chamber of the engine, they must also be able to withstand extremely high temperatures in a very corrosive atmosphere.

Nickel-based plugs have been produced for many years. They only last a fairly short time. As the electrodes wear, combustion becomes less efficient and the petrol is not burnt completely.

Platinum and other precious metals can now be used in spark plugs. These last much longer and are more efficient. This can help to reduce air pollution.

The table below gives some information about platinum and nickel.

	MELTING POINT (° C)	BOILING POINT (° C)	POSITION IN REACTIVITY SERIES	COST (£/kg)
nickel	1455	2920	Higher than gold	2.5
platinum	1769	4107	below gold	6110

(a) Compare nickel and platinum for use in making the electrodes in spark plugs.

A good answer should give advantages and disadvantages of each metal linking these to the properties of the metals. Marks will be given for the way in which you organise your answer.

You will need a sheet of lined paper.

(8)

(b) (i) Describe the structure and bonding in metals.

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(3)

(ii) Explain why metals such as nickel and platinum are good conductors of electricity.

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(2)

(Total 13 marks)

Mark schemes

1	(a) colour		1
	(b) Fe_2O_3 or $(\text{Fe}^{3+})_2 (\text{O}^{2-})_3$	<i>2 and 3 should be below halfway on Fe and O</i>	1
	(c) (i) 4 4	<i>or correct multiples</i>	1
	(ii) any two from:	<i>ignore references to malleable / ductile / conductivity / stiff / boiling point / density</i>	
		<ul style="list-style-type: none">• high melting point <i>accept can withstand high temperatures</i>• strong / tough <i>accept <u>not</u> brittle</i>• hard <i>do not accept flexible</i>• not (very) reactive	2
			[5]
2	(a) 13 (protons)	<i>The answers must be in the correct order. if no other marks awarded, award 1 mark if number of protons and electrons are equal</i>	1
	14 (neutrons)		1
	13 (electrons)		1
	(b) has three electrons in outer energy level / shell	<i>allow electronic structure is 2.8.3</i>	1

(c) **Level 3 (5–6 marks):**

A detailed and coherent comparison is given, which demonstrates a broad knowledge and understanding of the key scientific ideas. The response makes logical links between the points raised and uses sufficient examples to support these links.

Level 2 (3–4 marks):

A description is given which demonstrates a reasonable knowledge and understanding of the key scientific ideas. Comparisons are made but may not be fully articulated and / or precise.

Level 1 (1–2 marks):

Simple statements are made which demonstrate a basic knowledge of some of the relevant ideas. The response may fail to make comparisons between the points raised.

0 marks:

No relevant content.

Indicative content

Physical

Transition elements

- high melting points
- high densities
- strong
- hard

Group 1

- low melting points
- low densities
- soft

Chemical

Transition elements

- low reactivity / react slowly (with water or oxygen)
- used as catalysts
- ions with different charges
- coloured compounds

Group 1

- very reactive / react (quickly) with water / non-metals
- not used as catalysts
- white / colourless compounds
- only forms a +1 ion

6
[10]

3

(a) 8 marks Particularly well structured answer with most points mentioned.

7-6 marks Well structured answer. The two metals will have been compared rather than simply listing advantages/disadvantages. Most of the advantages and disadvantages of each metal have been mentioned.

5-3 marks Some structure to the answer. An attempt to compare the metals by giving some advantages and disadvantages.

2-1 marks Little structure or attempt to compare. Marks gained by listing a few advantages or disadvantages.

Advantages of Nickel:

Relatively low cost which makes the sparking plugs cheaper to produce.
Quite high melting point which is needed because the temperature in the engine is very high.

Good conductor of electricity needed to carry electricity into combustion chamber to produce spark.

Disadvantages of Nickel:

Subject to corrosion in engine which means they only last a short time
because nickel is higher in reactivity than platinum.

Idea that this leads to reduced efficiency, unburnt petrol and air pollution.

Advantages of Platinum:

Less susceptible to corrosion (not corroded) because platinum is very low in reactivity.
Idea that this improves efficiency and reduces pollution.-

Higher melting point than nickel to withstand the high temperatures in the combustion chamber.

Last a lot longer than nickel electrodes due to low reactivity.

(Sensible extension here could be longer service intervals etc.)-

Good conductor of electricity as for nickel.

Extension here could be linked to the idea that the conductivity does not deteriorate as quickly as nickel.)

Disadvantages of Platinum:

Cost *which will make the sparking plug more expensive.*

A good candidate might justify cost by longer life, better fuel consumption and less pollution.

8

- (b) (i) giant structure/lattice/regular arrangements of atoms
any for 1 mark

of atoms/of ions (provided free electrons mentioned)
either for 1 mark

delocalised or free electrons
for 1 mark

3

- (ii) electrons free/can move
for 1 mark each

2

[13]