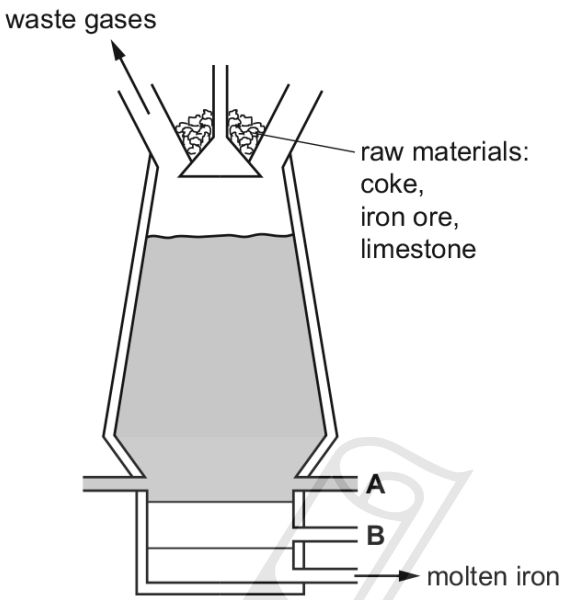
01. 0620_s21_qp_41 Q: 6

This question is about iron.

(a) Iron is extracted from its main ore in a blast furnace.



(i) Name the main ore of iron used in the blast furnace.

..... [1]

(ii) Name the substance that enters the blast furnace at **A**.

..... [1]

(iii) Name the substance that leaves the blast furnace at **B**.

..... [1]

(iv) Give **two** reasons for using coke in the blast furnace.

1 .....

2 .....

[2]

(b) Another ore of iron is iron pyrites, FeS_2. Iron pyrites contains the positive ion, Fe^{2+}.

Deduce the formula of the negative ion in FeS_2.

..... [1]

(c) Iron is a transition element.

A list of properties of iron is shown.

- Iron is a good conductor of electricity.
- Iron forms soluble salts.
- Iron forms coloured compounds.
- Iron has variable oxidation states.
- Iron acts as a catalyst.
- Iron forms a basic oxide.

(i) Give **two** properties from the list in which iron differs from Group I elements.

1 .....

2 .....
[2]

(ii) Give **two** properties from the list in which iron is similar to Group I elements.

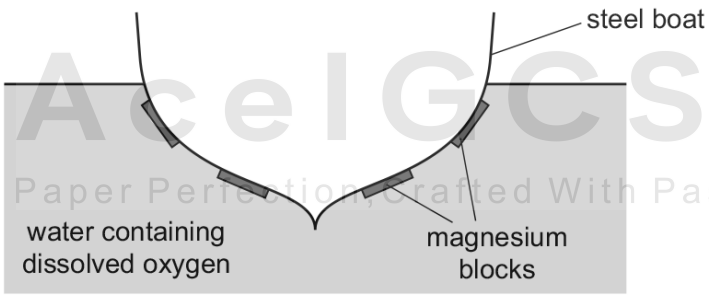
1 .....

2 .....
[2]

(d) Steel consists mainly of iron.

Iron forms rust when it reacts with water and oxygen.

Magnesium blocks can be attached to the bottom of steel boats. The magnesium does not completely cover the steel.



(i) Explain how the magnesium blocks prevent iron from rusting.

.....

.....

.....

..... [2]

(ii) Explain why replacing the magnesium blocks with copper blocks will **not** prevent the bottom of the boat from rusting.

.....

..... [1]

[Total: 13]

---

02. 0620_s21_qp_42 Q: 1

The symbols of the elements of Period 3 of the Periodic Table are shown.

Na	Mg	Al	Si	P	S	Cl	Ar

Answer the following questions about these elements.
Each element may be used once, more than once or not at all.

Write the symbol of an element which:

(a) is malleable

..... [1]

(b) has only two electrons in its outermost shell

..... [1]

(c) forms an oxide which leads to acid rain

..... [1]

(d) forms an ion with a 2– charge

..... [1]

(e) is extracted from an ore called bauxite

..... [1]

(f) does **not** form an oxide

..... [1]

(g) forms an oxide with a macromolecular structure

..... [1]

(h) forms an amphoteric oxide

..... [1]

(i) exists as diatomic molecules

..... [1]

(j) forms a binary compound with hydrogen that is a strong acid.

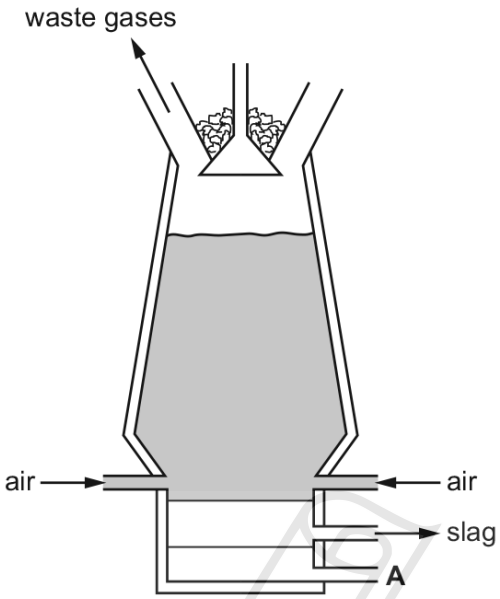
..... [1]

[Total: 10]

03. 0620_s21_qp_43 Q: 6

This question is about metals.

(a) Iron is extracted from its main ore in a blast furnace.



(i) Coke and iron ore are added at the top of the blast furnace.

Name one **other** substance that is added at the top of the blast furnace.

..... [1]

(ii) Name the substance that leaves the blast furnace at **A**.

..... [1]

(iii) Iron ore is mainly iron(III) oxide, Fe_2O_3.

Name a substance that reduces iron(III) oxide to iron in the blast furnace.

..... [1]

(iv) Temperatures inside a blast furnace can reach 2000 °C.

Name **two** substances that react together, in the blast furnace, to produce this high temperature.

..... [1]

(v) Name **two** waste gases that leave the blast furnace.

1 .....

2 .....

[2]

(b) Zinc is extracted from zinc blende.

(i) Name the main zinc compound that is present in zinc blende.

..... [1]

(ii) When zinc is extracted, it is formed as a gas.

The gaseous zinc is then converted into molten zinc.

State the name of this physical change.

..... [1]

(c) Name the alloy that contains zinc and copper only.

..... [1]

(d) Copper has the following properties.

- It has a high melting point.
- It has a high density.
- It is a good conductor of electricity.
- It has variable oxidation states.
- It forms a basic oxide.
- It forms soluble salts.

(i) Give **two** properties from the list in which copper differs from Group I elements.

1 .....

2 .....

[2]

(ii) Give **two** properties from the list in which copper is similar to Group I elements.

1 .....

2 .....

[2]

[Total: 13]

04. 0620_w20_qp_41 Q: 1

(a) This question is about elements.

aluminium
carbon
iron
hydrogen
oxygen
silicon
sodium
sulfur

Answer the following questions about these elements.

Each element may be used once, more than once or not at all.

(i) Name the element that can be used as a fuel.

..... [1]

(ii) Name the element that forms an oxide with a similar structure to diamond.

..... [1]

(iii) Name the element that forms an amphoteric oxide.

..... [1]

(iv) Name the element that has oxidation states of +2 and +3.

..... [1]

(v) Name the element extracted from bauxite.

..... [1]

(vi) Name the element that has atoms with the electronic structure 2,6.

..... [1]

(b) Iron rusts when it is in contact with oxygen and water.

(i) Explain how sacrificial protection prevents rusting.

.....

.....

.....

..... [2]

(ii) State one **other** method of rust prevention.

..... [1]

[Total: 9]

---

05. 0620_w20_qp_41 Q: 3

(a) Aqueous ammonium sulfate, $(NH_4)_2SO_4$, is warmed with aqueous sodium hydroxide.

The pungent-smelling gas ammonia, NH_3, is produced.

Balance the equation for this reaction.

$$(NH_4)_2SO_4 + ...NaOH \rightarrow .....NH_3 + ...H_2O + Na_2SO_4$$ [1]

(b) A 2.8 g sample of impure ammonium sulfate is found to contain 0.7 g of impurities.

Calculate the percentage of ammonium sulfate in this sample.

percentage of ammonium sulfate = ... % [1]

(c) Describe a test for ammonia gas.

test .....

result .....
[2]

(d) Ammonia gas is prepared at the front of a laboratory.

The pungent smell of ammonia spreads throughout the laboratory slowly.

(i) Name the process that occurs when ammonia gas spreads throughout the laboratory.

..... [1]

(ii) Explain, using ideas about particles, why ammonia gas spreads throughout the laboratory.

.....

.....

.....

..... [2]

(iii) Explain why carbon dioxide gas, CO_2, will spread throughout the laboratory at a slower rate than ammonia gas, NH_3.

.....

..... [1]

(e) Ammonia is produced in the Haber process.

The equation for the reaction is shown.

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

(i) In the Haber process, a temperature of 450 °C and a pressure of 200 atmospheres are used in the presence of finely-divided iron.

A larger equilibrium yield of ammonia would be produced if a lower temperature and a higher pressure are used.

Explain why a lower temperature and a higher pressure are **not** used.

lower temperature .....

.....

higher pressure .....

..... [2]

(ii) State the role of iron in the Haber process.

..... [1]

(f) Ammonia is a weak base.

(i) Explain the meaning of the term *base*.

.....

..... [1]

(ii) Suggest the pH of aqueous ammonia.

..... [1]

[Total: 13]

06. 0620_w20_qp_43 Q: 1

The names of nine substances are shown.

aluminium oxide

ammonia

carbon monoxide

anhydrous cobalt(II) chloride

hydrated copper(II) sulfate

iron(III) oxide

nitrogen dioxide

silver

steel

Answer the following questions using these substances. Each substance may be used once, more than once or not at all.

Name the substance that is:

(a) the main constituent of hematite ..... [1]

(b) a gas produced in car engines which causes acid rain ..... [1]

(c) an alkaline gas ..... [1]

(d) an element ..... [1]

(e) a gas formed by the incomplete combustion of fossil fuels ..... [1]

(f) used to test for the presence of water. ..... [1]

[Total: 6]

07. 0620_m19_qp_42 Q: 1

Period 3 of the Periodic Table is shown.

sodium	magnesium	aluminium	silicon	phosphorus	sulfur	chlorine	argon

Answer the following questions using only these elements.
Each element may be used once, more than once or not at all.

State which element:

(a) is a gas at room temperature and pressure

..... [1]

(b) forms a basic oxide with a formula of the form X_2O

..... [1]

(c) is made of atoms which have a full outer shell of electrons

..... [1]

(d) forms an oxide which causes acid rain

..... [1]

(e) is extracted from bauxite

..... [1]

(f) forms an oxide which has a macromolecular structure

..... [1]

(g) consists of diatomic molecules.

..... [1]

[Total: 7]

08. 0620_m19_qp_42 Q: 5

Titanium is extracted from an ore called rutile. Rutile is an impure form of titanium(IV) oxide, TiO_2.

(a) Rutile is mixed with coke and heated in a furnace through which chlorine gas is passed. The product is gaseous titanium(IV) chloride, $TiCl_4$.

$$TiO_2(s) + 2C(s) + 2Cl_2(g) \rightarrow TiCl_4(g) + 2CO(g)$$

The gaseous titanium(IV) chloride produced is condensed into the liquid state. The titanium(IV) chloride is then separated from liquid impurities.

(i) Suggest the name of the process by which liquid titanium(IV) chloride could be separated from the liquid impurities.

..... [1]

(ii) Carbon monoxide, CO(g), is also produced in the reaction.

Why should carbon monoxide **not** be released into the atmosphere?

..... [1]

(b) Calculate the volume of chlorine gas, $Cl_2(g)$, at room temperature and pressure, that reacts completely with 400 g of $TiO_2(s)$ using the following steps.

$$TiO_2(s) + 2Cl_2(g) + 2C(s) \rightarrow TiCl_4(g) + 2CO(g)$$

- Calculate the relative formula mass, M_r, of TiO_2.

M_r of TiO_2 = ...

- Calculate the number of moles in 400 g of TiO_2.

..... mol

- Determine the number of moles of Cl_2 that react with 400 g of TiO_2.

moles of Cl_2 = ... mol

- Calculate the volume of Cl_2 that reacts with 400 g of TiO_2.

volume of Cl_2 = ... dm^3

[4]

(c) Titanium(IV) chloride, $TiCl_4$, is heated with an excess of magnesium, in an atmosphere of argon.

(i) Balance the chemical equation for the reaction.

$$TiCl_4 + \text{.....} Mg \rightarrow Ti + \text{.....} MgCl_2$$

[1]

(ii) Titanium(IV) chloride can be reacted with sodium instead of magnesium.

The reaction between titanium(IV) chloride and sodium is similar to the reaction between titanium(IV) chloride and magnesium.

Write a chemical equation for the reaction between titanium(IV) chloride and sodium.

..... [1]

(iii) Suggest why the reaction between titanium(IV) chloride and magnesium is done in an atmosphere of argon and **not** in air.

.....

..... [1]

(d) After titanium(IV) chloride is heated with magnesium, the unreacted magnesium is removed by adding an excess of dilute hydrochloric acid to the mixture.

The dilute hydrochloric acid also dissolves the magnesium chloride.
The dilute hydrochloric acid does **not** react with the titanium or dissolve it.

(i) Give **two** observations and write a chemical equation for the reaction that occurs when dilute hydrochloric acid reacts with magnesium.

1 .....

2 .....

chemical equation .....

[3]

(ii) Name the process that is used to separate the titanium from the mixture after all the magnesium has been removed.

..... [1]

(iii) Titanium does not react with the dilute hydrochloric acid or dissolve in it.

Suggest why titanium does **not** react with dilute hydrochloric acid.

..... [1]

(e) Magnesium cannot be produced by electrolysis of aqueous magnesium chloride using inert electrodes.

(i) Name the product formed at the negative electrode (cathode) during the electrolysis of aqueous magnesium chloride.

..... [1]

(ii) Suggest how magnesium can be produced from magnesium chloride by electrolysis.

..... [1]

[Total: 16]

---

09. 0620_s19_qp_42 Q: 2

(a) $^{22}_{11}Na$, $^{23}_{11}Na$ and $^{24}_{11}Na$ are isotopes of sodium.

(i) Describe how these sodium isotopes are the same and how they are different in terms of the total number of protons, neutrons and electrons in each.

same .....

.....

different .....

.....

[3]

(ii) Why do all **three** isotopes have an overall charge of zero?

.....

..... [1]

(iii) Why do all **three** isotopes have the same chemical properties?

.....

..... [2]

(iv) Why do sodium ions have a charge of +1?

.....

..... [1]

(b) Carbon is an element which exists in different forms.

(i) Name **two** forms of the element carbon that have giant covalent structures.

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

(ii) Name the oxide of carbon that is a toxic gas.

..... [1]

[Total: 9]

---

10. 0620_w18_qp_43 Q: 3

Tin is a metallic element in Group IV. Its main ore is cassiterite which is an impure form of tin(IV) oxide, SnO_2.
Tin also occurs in stannite, Cu_2FeSnS_4.

(a) Calculate the relative formula mass, M_r, of Cu_2FeSnS_4.

M_r of Cu_2FeSnS_4 = ... [1]

(b) The M_r of SnO_2 is 151.

Calculate the percentage of tin by mass in SnO_2.

percentage of tin by mass in SnO_2 = ... [1]

(c) The percentage of tin by mass in Cu_2FeSnS_4 is 27.6%.

Use this information and your answer to **(b)** to suggest whether it would be better to extract tin from SnO_2 or Cu_2FeSnS_4.
Explain your answer.

.....

..... [1]

(d) Tin can be extracted by heating tin(IV) oxide with carbon. Carbon monoxide is the other product.

Write a chemical equation for this reaction.

..... [2]

(e) The position of tin in the reactivity series is shown.

iron	most reactive
tin	↑
copper	least reactive

A student added iron to a solution containing Sn^{2+} ions.

The student then separately added tin to a solution containing Cu^{2+} ions.

Complete the ionic equations. If there is no reaction write 'no reaction'.

$Fe + Sn^{2+} \rightarrow$ .....

$Sn + Cu^{2+} \rightarrow$ .....
[2]

(f) Copper(II) nitrate, $Cu(NO_3)_2$, decomposes when it is heated. The only solid product is copper(II) oxide, CuO. There are two gaseous products. One of the gaseous products is oxygen.

(i) Describe a test for oxygen.

test .....

result .....
[2]

(ii) Name the other gaseous product. Describe its appearance.

name .....

appearance .....
[2]

(iii) Write a chemical equation for the thermal decomposition of copper(II) nitrate.

..... [1]

(g) Iron does not rust when it is completely coated with zinc. When the zinc is scratched, the iron still does not rust.

(i) Explain why the iron does **not** rust when it is completely coated with zinc.

..... [1]

(ii) Explain why the iron still does **not** rust when the zinc is scratched.

.....

.....

.....

.....

.....

..... [3]

[Total: 16]

11. 0620_m17_qp_42 Q: 5

Iron is extracted from its ore using a blast furnace.

(a) In the blast furnace, coke burns in oxygen to produce heat energy and carbon dioxide.

How is this carbon dioxide converted into carbon monoxide in the blast furnace?

..... [1]

(b) Calcium carbonate added to the blast furnace decomposes to form calcium oxide.
Calcium oxide removes silicon(IV) oxide impurities from the iron in a neutralisation reaction.

Write a chemical equation for the reaction of calcium oxide with silicon(IV) oxide. Suggest why it is a neutralisation reaction.

.....

.....

..... [3]

(c) The main impurity in iron obtained from the blast furnace is carbon.

(i) Why must the high levels of carbon be lowered before the iron becomes a useful material?

..... [1]

(ii) How is the carbon removed from the iron?

.....

..... [1]

(d) Zinc is extracted from its ore. The ore contains zinc sulfide. The zinc sulfide is roasted in air to produce zinc oxide and sulfur dioxide.

Zinc is then obtained from the zinc oxide using a blast furnace.

(i) Give the name of the ore of zinc that contains zinc sulfide.

..... [1]

(ii) Write a chemical equation for the reaction that takes place when zinc sulfide is roasted in air.

..... [1]

(iii) Suggest why the sulfur dioxide should **not** be released into the atmosphere.

.....

..... [2]

(iv) The temperature inside the blast furnace in which zinc is extracted is about 1000 °C.

The table gives some information about substances in the blast furnace in which zinc is extracted.

substance	melting point / °C	boiling point / °C
carbon	sublimes at 4330 °C	
silicon(IV) oxide	1610	2230
zinc	420	907

Use the data in the table to explain why the zinc obtained does **not** contain high levels of impurities such as silicon(IV) oxide and carbon.

.....

.....

..... [2]

[Total: 12]

12. 0620_s17_qp_42 Q: 2

Carbon and silicon are elements in Group IV of the Periodic Table. Both carbon and silicon exist as more than one isotope.

(a) Define the term *isotopes*.

.....

..... [2]

(b) Complete the following table which gives information about carbon atoms and silicon atoms.

	carbon	silicon
proton number		
electronic structure		
nucleon number	12	28
number of neutrons in one atom		

[3]

(c) Silicon has a giant structure which is similar to the structure of diamond.

(i) Name the type of bond which is present between silicon atoms in silicon.

..... [1]

(ii) Suggest **two** physical properties of silicon.
Use your knowledge of structure and bonding to explain why silicon has these physical properties.

property 1 .....

reason 1 .....

property 2 .....

reason 2 .....

[4]

(d) Samples of air taken from industrial areas are found to contain small amounts of carbon monoxide.

(i) Explain how this carbon monoxide is formed.

.....

..... [2]

(ii) State why carbon monoxide should **not** be inhaled.

..... [1]

(e) Carbon dioxide, CO_2, is a gas at room temperature and pressure, whereas silicon(IV) oxide, SiO_2, is a solid.

(i) Name the type of structure which the following compounds have.

carbon dioxide ..... [1]

silicon(IV) oxide ..... [1]

(ii) Use your knowledge of structure and bonding to explain why carbon dioxide is a gas at room temperature and pressure, whereas silicon(IV) oxide is a solid.

.....

.....

.....

..... [3]

(f) Silicon(IV) oxide is an acidic oxide. When silicon(IV) oxide reacts with alkalis, the salts formed contain the ion SiO_3^{2-}.

Write a chemical equation for the reaction between silicon(IV) oxide and aqueous sodium hydroxide.

..... [2]

[Total: 20]

13. 0620_s16_qp_43 Q: 3

Clean dry air contains mainly nitrogen and oxygen.

(a) Name **two** other gases that are in clean dry air.

.....

..... [2]

(b) Air often contains pollutants.

Identify **three** common gaseous pollutants in air and state how each of these pollutants are produced.

pollutant gas 1 .....

how it is produced .....

.....

pollutant gas 2 .....

how it is produced .....

.....

pollutant gas 3 .....

how it is produced .....

.....

[6]

[Total: 8]

14. 0620_w15_qp_32 Q: 2

(a) Polluted air contains two oxides of carbon and two oxides of nitrogen. A major source of these pollutants is motor vehicles.

(i) Describe how carbon dioxide and carbon monoxide are formed in motor vehicle engines.

.....

.....

.....

..... [3]

(ii) State **one** adverse effect of each of these gases.

.....

..... [2]

(iii) Nitrogen monoxide, NO, is released by motor vehicle exhausts.

Explain how nitrogen monoxide is formed in motor vehicle engines.

.....

..... [2]

(iv) When nitrogen monoxide is released into the atmosphere, nitrogen dioxide, NO_2, is formed.

Suggest an explanation why this happens.

..... [1]

(b) Predict the possible adverse effect on the environment when this non-metal oxide, NO_2, reacts with water and oxygen.

.....

..... [2]

(c) How are the amounts of carbon monoxide and nitrogen monoxide emitted by modern motor vehicles reduced? Include an equation in your answer.

.....

.....

..... [3]

[Total: 13]

15. 0620_s13_qp_32 Q: 1

Air is a mixture of gases. The main constituents are the elements oxygen and nitrogen.

(a) (i) Name another element in air.

..... [1]

(ii) Give the formula of a compound in unpolluted air.

..... [1]

(b) Common pollutants present in air are the oxides of nitrogen and sulfur dioxide.

(i) How are the oxides of nitrogen formed?

.....

.....

..... [2]

(ii) How is sulfur dioxide formed?

.....

.....

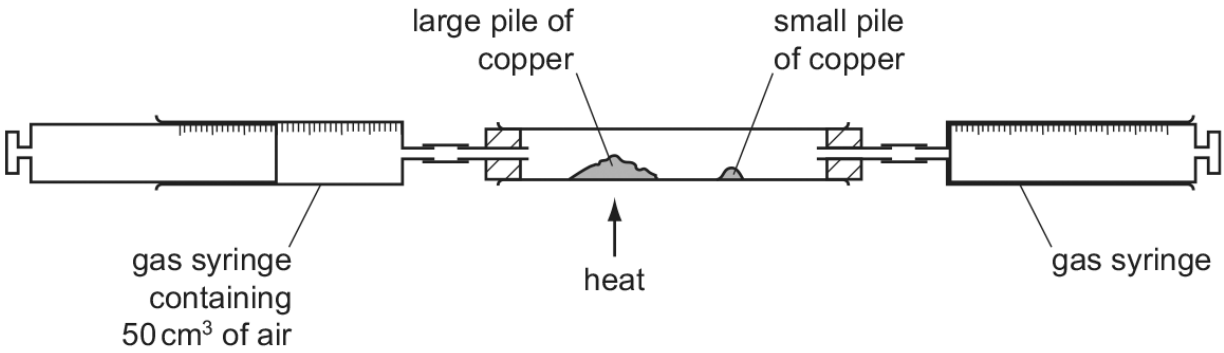
..... [2]

(iii) These oxides are largely responsible for acid rain.
State **two** harmful effects of acid rain.

.....

..... [2]

(c) The percentage of oxygen in air can be determined by the following experiment.



The gas syringe contains 50 cm^3 of air. The large pile of copper is heated and the air is passed from one gas syringe to the other over the hot copper. The large pile of copper turns black. The gas is allowed to cool and its volume measured.

The small pile of copper is heated and the remaining gas passed over the hot copper. The copper does not turn black. The final volume of gas left in the apparatus is less than 50 cm^3.

(i) Explain why the copper in the large pile turns black.

.....

..... [2]

(ii) Why must the gas be allowed to cool before its volume is measured?

..... [1]

(iii) Explain why the copper in the small pile did not turn black.

..... [1]

(iv) What is the approximate volume of the gas left in the apparatus?

..... [1]

[Total: 13]

16. 0620_w13_qp_33 Q: 3

The main uses of zinc are preventing steel from rusting and making alloys.

(a) The main ore of zinc is zinc blende. Zinc blende consists mainly of zinc sulfide, ZnS. There are two major methods of extracting zinc from its ore. They are the direct reduction of zinc oxide to zinc and by electrolysis. In both methods, zinc oxide is made from the zinc sulfide in the ore.

(i) How is zinc oxide made from zinc sulfide?

.....

..... [1]

(ii) Write an equation for the reaction used to reduce zinc oxide to zinc.

..... [1]

(b) In the electrolytic method, zinc oxide reacts with sulfuric acid to form impure aqueous zinc sulfate. This solution contains Ni^{2+}, Co^{2+} and Cu^{2+} ions as impurities.

(i) Write the equation for the reaction between zinc oxide and sulfuric acid.

..... [1]

(ii) Nickel, cobalt and copper are all less reactive than zinc. Explain why the addition of zinc powder removes these ions from the solution.

.....

..... [2]

(c) The solution of zinc sulfate is electrolysed using inert electrodes.
This electrolysis is similar to that of copper(II) sulfate with inert electrodes.

(i) Write the equation for the reaction at the negative electrode (cathode).

..... [1]

(ii) Complete the equation for the reaction at the positive electrode (anode).

$$\text{.....}OH^- \rightarrow 2H_2O + \text{.....} + \text{.....}e^-$$ [2]

(iii) The electrolyte changes from zinc sulfate to

..... [1]

(d) (i) Brass is an alloy of copper and zinc. Suggest **two** reasons why brass is often used in preference to copper.

.....

..... [2]

(ii) Sacrificial protection is a method of rust prevention. Explain in terms of electron transfer why steel, which is in electrical contact with zinc, does not rust.

.....

.....

.....

..... [4]

[Total: 15]

17. 0620_s12_qp_32 Q: 3

The uses of a substance are determined by its properties.

(a) Plastics are poor conductors of electricity. They are used as insulation for electric cables. Which other **two** properties of plastics make them suitable for this purpose?

.....

..... [2]

(b) Chromium is a hard, shiny metal. Suggest **two** reasons why chromium is used to electroplate steel.

.....

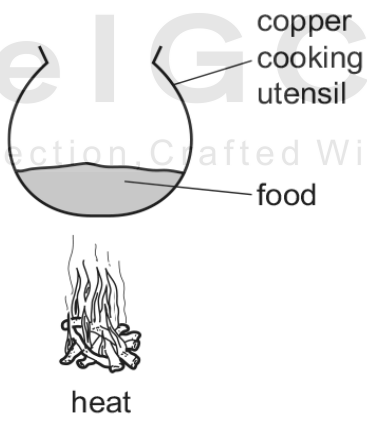
..... [2]

(c) Why is aluminium used extensively in the manufacture of aeroplanes?

.....

..... [2]

(d) Why is copper a suitable material from which to make cooking utensils?



.....

..... [2]

(e) Describe the bonding in a typical metal.

.....

.....

..... [2]

[Total: 10]

18. 0620_w12_qp_31 Q: 3

The speed (rate) of a chemical reaction depends on a number of factors which include temperature and the presence of a catalyst.

(a) Reaction speed increases as the temperature increases.

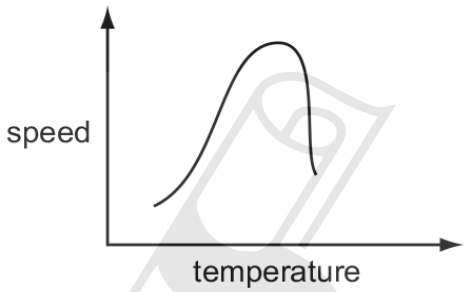
(i) Explain why reaction speed increases with temperature.

.....

.....

..... [3]

(ii) Reactions involving enzymes do not follow the above pattern.
The following graph shows how the speed of such a reaction varies with temperature.



Suggest an explanation why initially the reaction speed increases then above a certain temperature the speed decreases.

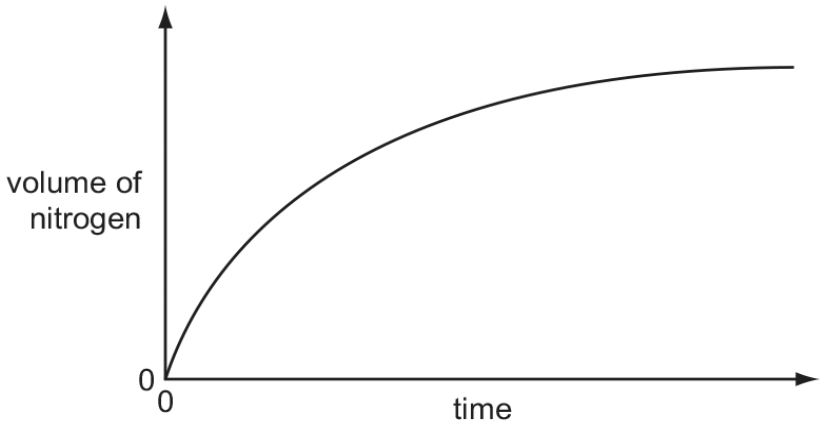
.....

..... [2]

(b) An organic compound decomposes to give off nitrogen.

$$C_6H_5N_2Cl(aq) \rightarrow C_6H_5Cl(l) + N_2(g)$$

The speed of this reaction can be determined by measuring the volume of nitrogen formed at regular intervals. Typical results are shown in the graph below.



(i) The reaction is catalysed by copper.
Sketch the graph for the catalysed reaction on the diagram above. [2]

(ii) How does the speed of this reaction vary with time?

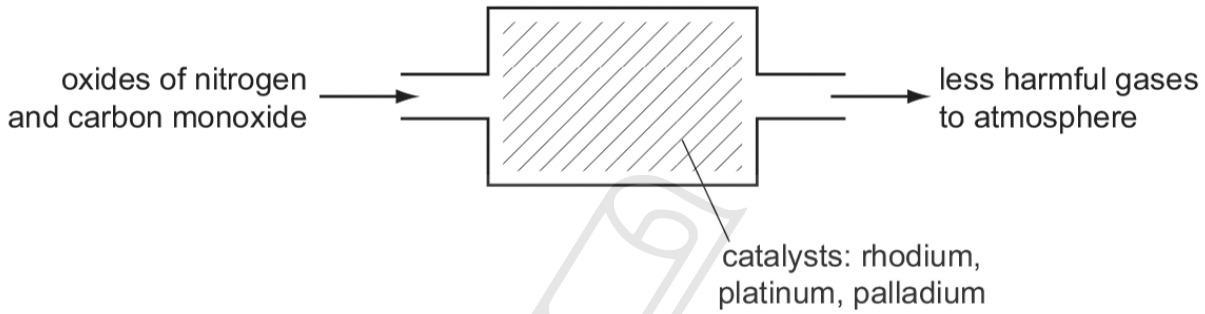
..... [1]

(iii) Why does the speed of reaction vary with time?

.....

..... [2]

(c) Catalytic converters reduce the pollution from motor vehicles.



(i) Describe how carbon monoxide and the oxides of nitrogen are formed in car engines.

.....

.....

.....

..... [4]

(ii) Describe the reaction(s) inside the catalytic converter which change these pollutants into less harmful gases. Include at least one equation in your description.

.....

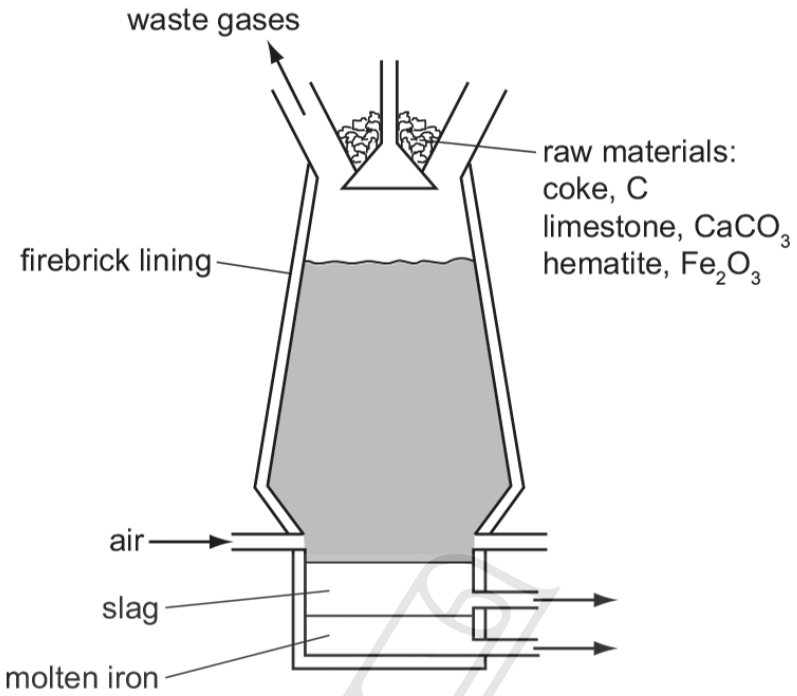
.....

..... [3]

[Total: 17]

19. 0620_w12_qp_32 Q: 4

Iron is extracted from its ore, hematite, in the blast furnace.



(a) The temperature inside the blast furnace can rise to 2000 °C.
Write an equation for the exothermic reaction which causes this high temperature.

..... [1]

(b) Carbon monoxide is formed in the blast furnace. This reduces the ore hematite, Fe_2O_3, to iron.

(i) Explain how carbon monoxide is formed in the blast furnace.

.....

..... [2]

(ii) Write an equation for the reduction of hematite by carbon monoxide.

..... [2]

(c) Explain why it is necessary to add limestone, calcium carbonate, to the blast furnace.
Include an equation in your explanation.

.....

.....

..... [3]

(d) Most of the iron from the blast furnace is converted into mild steel. A method of preventing the steel from rusting is coating it with zinc.

(i) What is the name of this method of rust prevention?

..... [1]

(ii) Explain, using the idea of electron transfer, why zinc-coated steel does not rust even when the coating is scratched and the steel is in contact with oxygen and water.

.....

.....

.....

..... [3]

[Total: 12]

01. 0620_s21_ms_41 Q: 6

Question	Answer	Marks
(a)(i)	hematite	1
(a)(ii)	air	1
(a)(iii)	slag / calcium silicate	1
(a)(iv)	any two from: • (coke) releases heat (when it reacts with oxygen or reacts in air) **OR** (acts as a) fuel **OR** increases temperature (in the furnace) / heats (the furnace) **OR** source of energy • (coke or carbon monoxide) reduces iron oxide **OR** is a reducing agent **OR** converts iron oxide to iron / removes oxygen from iron oxide • (coke) reacts with oxygen to **form** carbon monoxide **OR** reacts with carbon dioxide to **form** carbon monoxide	2
(b)	S_2^{2-} **or** S^-	1
(c)(i)	any two from: • (iron forms) coloured compounds • (iron has) variable oxidation states • (iron acts as a) catalyst	2
(c)(ii)	any two from: • (iron is) good conductor of electricity • (iron) forms a basic oxide • (iron salts are) soluble (in water)	2

Question	Answer	Marks
(d)(i)	magnesium is **more** reactive than iron / steel **ORA** (1) iron is not oxidised **OR** iron does not lose electrons **OR** magnesium loses electrons **more easily** than or **in preference** (to iron) **ORA** **OR** magnesium is oxidised **more easily or** reacts with oxygen **more easily or** corrodes **more easily** or **in preference** (to iron) **ORA** (1)	2
(d)(ii)	copper is less reactive than iron / copper is lower in the reactivity series than iron **ORA**	1

02. 0620_s21_ms_42 Q: 1

Question	Answer	Marks
(a)	Na or Mg or A*l*	1
(b)	Mg	1
(c)	S	1
(d)	S	1
(e)	A*l*	1
(f)	Ar	1
(g)	Si	1
(h)	Al	1
(i)	C*l*	1
(j)	C*l*	1

03. 0620_s21_ms_43 Q: 6

Question	Answer	Marks
(a)(i)	limestone	1
(a)(ii)	(molten) iron	1
(a)(iii)	coke / carbon / carbon monoxide	1
(a)(iv)	(reaction between) coke / carbon and oxygen	1

Question	Answer	Marks
(a)(v)	nitrogen (1) carbon dioxide (1)	2
(b)(i)	zinc sulfide	1
(b)(ii)	condensation/condensing	1
(c)	brass	1
(d)(i)	any two from (copper has): • high density • high melting point • variable oxidation states	2
(d)(ii)	any two from (copper): • good conductor of electricity • forms a basic oxide • soluble salts	2

04. 0620_w20_ms_41 Q: 1

Question	Answer	Marks
(a)(i)	hydrogen / carbon	1
(a)(ii)	silicon	1
(a)(iii)	aluminium	1
(a)(iv)	iron	1
(a)(v)	aluminium	1
(a)(vi)	oxygen	1
(b)(i)	metal higher in reactivity series / metal more reactive (than iron) / allow named metal e.g. magnesium or zinc (1) zinc corrodes/oxidises/reacts in preference to iron (1)	2
(b)(ii)	any barrier method e.g. painting	1

05. 0620_w20_ms_41 Q: 3

Question	Answer	Marks
(a)(i)	$2 \rightarrow 2 + 2$	1
(b)	75(%)	1
(c)	test: (damp red) litmus paper (1) result: (litmus goes) blue (1)	2
(d)(i)	diffusion	1
(d)(ii)	particles move from an area of high to low concentration particles move randomly	2
(d)(iii)	CO_2 **molecules** are heavier (than NH_3)	1
(e)(i)	lower temperature: (rate of reaction) slower (1) higher pressure: expensive/specialist equipment	2
(e)(ii)	catalyst	1
(f)(i)	proton acceptor	1
(f)(ii)	any value greater than 7 up to 12	1

06. 0620_w20_ms_43 Q: 1

Question	Answer	Marks
(a)	iron(III) oxide	1
(b)	nitrogen dioxide	1
(c)	ammonia	1
(d)	silver	1
(e)	carbon monoxide	1
(f)	anhydrous cobalt(II) chloride	1

07. 0620_m19_ms_42 Q: 1

(a)	chlorine / argon	1
(b)	sodium	1
(c)	argon	1
(d)	sulfur	1
(e)	aluminium	1
(f)	silicon	1
(g)	chlorine	1

08. 0620_m19_ms_42 Q: 5

(a)(i)	fractional distillation	1
(a)(ii)	carbon monoxide is toxic/poisonous	1
(b)	□ 80 □ 5 □ 10 □ 240	4
(c)(i)	$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$	1

(c)(ii)	$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$	1
(c)(iii)	magnesium burns in air or oxygen **OR** reacts with air or oxygen / argon is unreactive or inert	1
(d)(i)	**M1 / 2** bubbles / fizzing / effervescence(1) **M1 / 2** (magnesium or solid) dissolves / disappears / **forms** solution(1) **M3** $Mg + 2HCl \rightarrow MgCl_2 + H_2$(1)	3
(d)(ii)	filtration	1
(d)(iii)	titanium is below hydrogen in the reactivity series **ORA** **OR** titanium less reactive than hydrogen **ORA** **OR** titanium coated with an oxide layer	1
(e)(i)	hydrogen	1
(e)(ii)	Heat until magnesium chloride is molten and electrolyse	1

09. 0620_s19_ms_42 Q: 2

(a)(i)	**M1** protons (are the same) / 11 protons (1) **M2** electrons (are the same) / 11 electrons (1) **M3** neutrons (are different) / 11,12,13 neutrons (1)	3
(a)(ii)	same number of protons and electrons (1)	1
(a)(iii)	**M1** same **number** of electrons (1) **M2** (same number of) electrons in outer shell (1)	2
(a)(iv)	(they all have) 1 more proton than electrons / 11 protons and 10 electrons	1
(b)(i)	diamond / graphite / graphene **ANY TWO**	1
(b)(ii)	carbon monoxide	1

10. 0620_w18_ms_43 Q: 3

(a)	[(64 □ 2) + 56 + 119 + (32 □ 4) =] **431**	1
(b)	[(119 / 151) □ 100 =] **78.8 (%)**	1
(c)	SnO_2 because the percentage of tin is **larger** in SnO_2 **or** answer to **(b)** □ 27.6 %	1
(d)	$SnO_2 + 2C \rightarrow Sn + 2CO$ **M1 all** formulae correct **M2** equation fully correct	2
(e)	**M1** (→) $Fe^{2+} + Sn$ **OR** $2Fe + 3Sn^{2+} \rightarrow 2Fe^{3+} + 3Sn$ **M2** (→) $Sn^{2+} + Cu$ **OR** $Sn + 2Cu^{2+} \rightarrow Sn^{4+} + 2Cu$	2
(f)(i)	**M1** glowing splint **M2** relights / rekindles	2

<table>
<tr><td>(f)(ii)</td><td>M1 nitrogen dioxide / nitrogen(IV) oxide

M2 brown (gas)</td><td>2</td></tr>
<tr><td>(f)(iii)</td><td>$2Cu(NO_3)_2 \rightarrow 2CuO + 4NO_2 + O_2$</td><td>1</td></tr>
<tr><td>(g)(i)</td><td>zinc acts as a barrier which prevents contact between iron and water and air / oxygen</td><td>1</td></tr>
<tr><td>(g)(ii)</td><td>SUMMARY
<table><tr><td>M1</td><td>comparison of reactivity</td></tr><tr><td>M2</td><td>zinc loses electrons</td></tr><tr><td>M3</td><td>where electrons move to OR iron does not lose electrons</td></tr></table>M1 zinc is more reactive than iron / steel ORA

M2 zinc loses electrons / zinc is oxidised

M3 electrons are transferred to iron / iron is not oxidised / iron does not lose electrons</td><td>3</td></tr>
</table>

11. 0620_m17_ms_42 Q: 5

(a)	carbon dioxide reacts with carbon / coke **OR** $CO_2 + C \rightarrow 2CO$	**1**
(b)	**M1** $CaO + SiO_2 \rightarrow CaSiO_3$	**1**
	M2 CaO is a base	**1**
	M3 SiO_2 is an acid	**1**
(c)(i)	(the carbon makes the iron too) brittle	**1**
(c)(ii)	reacted with oxygen / oxygen blown in	**1**
(d)(i)	zinc blende	**1**
(d)(ii)	$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$	**1**
(d)(iii)	any 2 from: □ forms acid rain □ kills trees / plants □ kills fish □ damages (limestone / marble) buildings / statues □ causes breathing difficulties	**2**
(d)(iv)	**M1** zinc boils	**1**
	M2 (both) impurities do not boil because their boiling point is above 1000 °C	**1**

12. 0620_s17_ms_42 Q: 2

(a)	atoms of the same element / atoms with the same proton number / atoms with the same atomic number	1
	different neutron **number** / different nucleon **number** / different mass number	1
(b)	<table><tr><th></th><th>carbon</th><th>silicon</th><th></th></tr><tr><td>proton number</td><td>6</td><td>14</td><td>**M1**</td></tr><tr><td>electronic structure</td><td>2,4</td><td>2,8,4</td><td>**M2**</td></tr><tr><td>nucleon number</td><td>12</td><td>28</td><td></td></tr><tr><td>number of neutrons in one atom</td><td>6</td><td>14</td><td>**M3**</td></tr></table>	3
(c)(i)	covalent	1
(c)(ii)	award 1 mark for each correct property and one mark for each correct matching reason.	4
	property: high melting point / high boiling point reason: bonds between atoms are strong **OR** covalent bonds are strong / **bonds** need large amount of energy to break	
	property: non-conductor / poor conductor(of electricity) / insulator reason: no moving charged particles / no moving ions / no moving electrons / all (outer shell) electrons used in bonding	
	property: hard reason: bonds between atoms are strong **OR** covalent bonds are strong	
	property: brittle reason: bonds between atoms are strong **OR** covalent bonds are strong / bonds are directional	
	property: insoluble reason: does not form hydrogen bonds with water / no ions that can be hydrated	
(d)(i)	incomplete combustion / incomplete burning / combustion in insufficient air / oxygen	1
	of **fossil** fuels / named fossil fuel / named petroleum fraction / name or formula of a type of substance containing carbon	1
(d)(ii)	toxic / poisonous / combines with or binds to haemoglobin	1

(e)(i)	carbon dioxide: (simple) molecular / simple covalent	1
	silicon(IV) dioxide: macromolecular / giant molecular / giant covalent / giant atomic	1
(e)(ii)	carbon dioxide: **weak** (**force of**) **attraction** between molecules / **weak** intermolecular forces / **weak** van der Waals' forces / **weak** dispersion forces / **weak** London forces	1
	silicon(IV) dioxide: covalent bonds are **strong** / force of attraction between atoms is **strong** / no weak bonds (are present) / **all** bonds are **strong**	1
	(weak) **forces of attraction** in carbon dioxide need small amounts of **energy** or heat to break / **less energy** or heat needed to break **forces of attraction** in carbon dioxide **OR** (strong) **bonds** in silicon(IV) dioxide need large amounts of **energy** or heat to break / **more energy** or heat needed to break **bonds** in silicon(IV) dioxide	1
(f)	$2NaOH + SiO_2 \rightarrow Na_2SiO_3 + H_2O$ **IF** full credit is not awarded, allow 1 mark for Na_2SiO_3 **OR** $2OH^- + SiO_2 \rightarrow SiO_3^{2-} + H_2O$ **M1** species correct **M2** balancing	2

13. 0620_s16_ms_43 Q: 3

(a)	any 2 from: carbon dioxide; nitrogen; any named noble gas;	**2**
(b)	any 6 from: carbon monoxide; from incomplete combustion (of carbon-containing fuel); sulfur dioxide; from burning fossil fuels / roasting ores which contain sulphur / volcanoes; oxides of nitrogen; nitrogen reacting with oxygen in car engines / lightning; methane; from anaerobic decomposition / anaerobic decay;	**6**

14. 0620_w15_ms_32 Q: 2

(a)(i)	combustion / burning of a motor vehicle fuel or a named fuel which can act as a motor vehicle fuel; incomplete combustion would produce CO; complete combustion would produce CO_2;	**3**
(a)(ii)	*carbon dioxide*: climate change / global warming / greenhouse effect; *carbon monoxide*: poisonous / toxic;	**2**
(a)(iii)	nitrogen and oxygen react or combine; at high temperatures or in presence of spark;	**2**
(a)(iv)	it reacts or combines with oxygen / $NO + ½O_2 \rightarrow NO_2$;	**1**
(b)	any two from: • acid rain is formed; • lowers pH or acidifies lakes / rivers or kills fish / aquatic animals; • changes composition of soils or reduces fertility of soil or reduces crop yields / deforestation or kills crops or trees or plants or leaves / lowers pH of soil or increases acidity of soil; • attacks (limestone) buildings or statues; attacks metal (structures) / bridges;	**2**

(c)	use of a catalytic converter; $2NO + 2CO \rightarrow 2CO_2 + N_2$ species; balancing;	**3**

15. 0620_s13_ms_32 Q: 1

(a) (i) named noble gas [1]
accept: any noble gas
accept: symbol

(ii) H_2O / CO_2 [1]
not: names **not:** equations

(b) (i) oxygen and nitrogen (in air) (react) [1]
at high temperature [1]
accept: in engines / lightning **not:** in exhausts

(ii) fossil fuels / fuels which contain sulfur [1]
accept: named fossil fuel such as coal / oil / natural gas
burn / combust [1]

(iii) any two from:
damage buildings / soil acidification / leaching from soil / soil nutrients become unavailable / kill microbes / acidify lakes / kill fish / damage trees / reduction in plant growth / crop loss [2]

(c) (i) oxygen reacts with copper [1]
to form copper oxide (which is black) [1]

(ii) measure volume at room temperature / gas has different volumes at different temperatures / volume of gas depends on temperature / hot gas has higher volume / heat causes expansion (of gases) / ORA [1]

(iii) no oxygen left **or** all the oxygen has reacted (with copper) [1]

(iv) 39–40 cm^3 **note:** units required [1]

16. 0620_w13_ms_33 Q: 3

(a) (i) roast or heat or burn in air / roast or heat or burn in oxygen [1]
need both of the above

(ii) $ZnO + C \rightarrow Zn + CO$ / $2ZnO + C \rightarrow 2Zn + CO2$ / $ZnO + CO \rightarrow Zn + CO_2$ [1]

(b) (i) $ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$ [1]

(ii) zinc reduces / gives electrons / displaces (copper / cobalt / nickel ions) [1]

forming copper / cobalt / nickel (metal which is precipitated) [1]

(c) (i) $Zn^{2+} + 2e \rightarrow Zn$ [1]

(ii) $OH^- \rightarrow 2H_2O + O_2 + ...e$ (1) only
$4OH^- \rightarrow 2H_2O + O_2 + 4e$ [2]

(iii) sulfuric acid / hydrogen sulfate [1]
ACCEPT: sulfuric acid

(d) (i) Any two of:
appearance
more resistant to corrosion
harder (accept stronger)
easier to cast [2]

(ii) zinc more reactive (than iron or steel) [1]
zinc loses electrons [1]
electrons move (from zinc) to iron [1]
zinc reacts (with air and water) / zinc corrodes / is oxidised / forms positive ions / anodic
or
iron and steel don't react (with air and water) / not oxidised / do not form ions / do not lose electrons [1]

[Total: 15]

17. 0620_s12_ms_32 Q: 3

(a) flexible / easily form different shapes / easily moulded / bends (without cracking); [1]
non-biodegradable / unreactive / don't corrode / prevent corrosion / prevent oxidation (of the conducting metal) / water resistant / waterproof; [1]

(b) improve appearance / decorative / makes appearance shiny; [1]
prevent corrosion / rusting / protect steel / chromium will not corrode / chromium is not oxidised / chromium protected by an oxide layer; [1]

(c) low density / light / protected by oxide layer / no need to paint / resists corrosion / (high) strength / strong;; **any two** [2]
note: high strength to weight ratio = 2

(d) high mpt / withstands high temperature / good conductor (of heat) / heats up quickly / malleable / ductile / resists corrosion / good appearance / unreactive (or example of lack of reactivity e.g. does not react with food or water or acid or air);; **any two** [1]

(e) (lattice) positive ions / cations / metal ions and sea of electrons / delocalised or free or mobile or moving electrons; [1]
attraction between positive ions and electrons; [1]

18. 0620_w12_ms_31 Q: 3

(a) (i) any three from:
particles have more energy;
move faster;
collide more frequently;
more successful collisions; [3]
accept: atoms or molecules for particles
not: electrons
not: vibrate more

(ii) reaction faster with temperature increase; [1]
enzymes denatured / destroyed;
not: killed [1]

(b) (i) bigger initial gradient; [1]
same final volume of nitrogen; [1]

(ii) decrease / slows down; [1]

(iii) concentration of organic compound decreases; [2]
compound used up = [1]
or: fewer particles;
collision rate decreases;

(c) (i) carbon monoxide-incomplete combustion; [1]
carbon - containing fuel / fossil fuel / petrol; [1]

oxides of nitrogen - oxygen and nitrogen react; [1]
at high temperature / in engine; [1]
not: in exhaust

(ii) carbon monoxide to carbon dioxide; [1]
oxides of nitrogen to nitrogen; [1]
correct balanced equation; [1]

[Total: 17]

19. 0620_w12_ms_32 Q: 4

(a) $C + O_2 \rightarrow CO_2$ [1]

(b) (i) CO_2 already formed (from C burning or from $CaCO_3$); [1]
then carbon reacts with carbon dioxide; [1]
or
$C + CO_2 \rightarrow 2CO$ = [2] If equation not balanced = [1]

(ii) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ [2]
not balanced = [1]
not: reduction by carbon

(c) to remove / neutralise silica / silicon dioxide / silicon(IV) oxide / sand; [1]
reacts with limestone to form slag / calcium silicate; [1]
$CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$ [1]
or $CaO + SiO_2 \rightarrow CaSiO_3$
or $CaCO_3 \rightarrow CaO + CO_2$

(d) (i) galvanising / galvanisation / sacrificial protection; [1]

(ii) sacrificial protection / zinc is sacrificed;
zinc corrodes rather than iron;
zinc is oxidised in preference to iron;
zinc reacts with oxygen and / water in preference to iron;
zinc more reactive / electropositive than iron;
zinc loses electrons more readily than iron;
electrons move on to iron
any **three** [3]

[Total: 12]