01. 0620_s21_qp_42 Q: 3

Sodium hydrogencarbonate is found in baking powder.

When sodium hydrogencarbonate is heated it forms three products.

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

(a) Name the type of reaction that takes place when sodium hydrogencarbonate reacts in this way.

..... [1]

(b) Calculate the volume of carbon dioxide formed at room temperature and pressure when 12.6 g of $NaHCO_3$ is heated using the following steps:

- determine the mass of one mole of $NaHCO_3$

..... g

- calculate the number of moles of $NaHCO_3$ used

..... moles

- determine the number of moles of carbon dioxide formed

..... moles

- calculate the volume of carbon dioxide formed at room temperature and pressure.

..... dm^3
[4]

(c) Limewater is aqueous calcium hydroxide. Carbon dioxide turns limewater milky because a white precipitate forms.

Write the formula of:

- calcium hydroxide .....
- the white precipitate that forms when limewater turns milky. .....

[2]

[Total: 7]

02. 0620_w20_qp_41 Q: 4

Air is a mixture of gases.

(a) State the percentage of clean dry air which is oxygen. Give your answer to the nearest whole number.

..... % [1]

(b) Oxygen and nitrogen are useful gases that can be obtained from air.

(i) Name the process used to separate oxygen and nitrogen from liquid air.

..... [2]

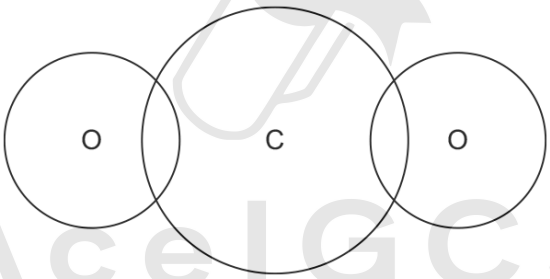
(ii) State the property of oxygen and nitrogen that allows these gases to be separated using this process.

..... [1]

(c) Carbon dioxide, CO_2, is a covalent molecule.

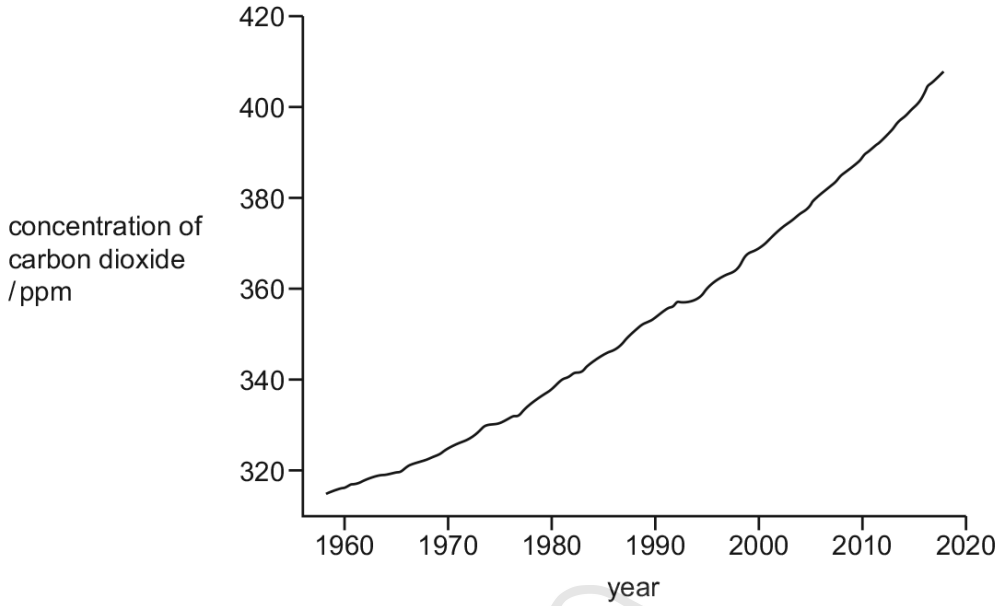
Complete the diagram to show the electron arrangement in one molecule of CO_2.

Show only the outer electrons.



[2]

(d) The graph shows the concentration of carbon dioxide in the atmosphere over a 60-year period, measured in parts per million (ppm).



The data shown in the graph is of global concern.

Explain why.

.....

.....

.....

.....

.....

..... [3]

(e) Name the process in the carbon cycle by which plants remove carbon dioxide from the atmosphere.

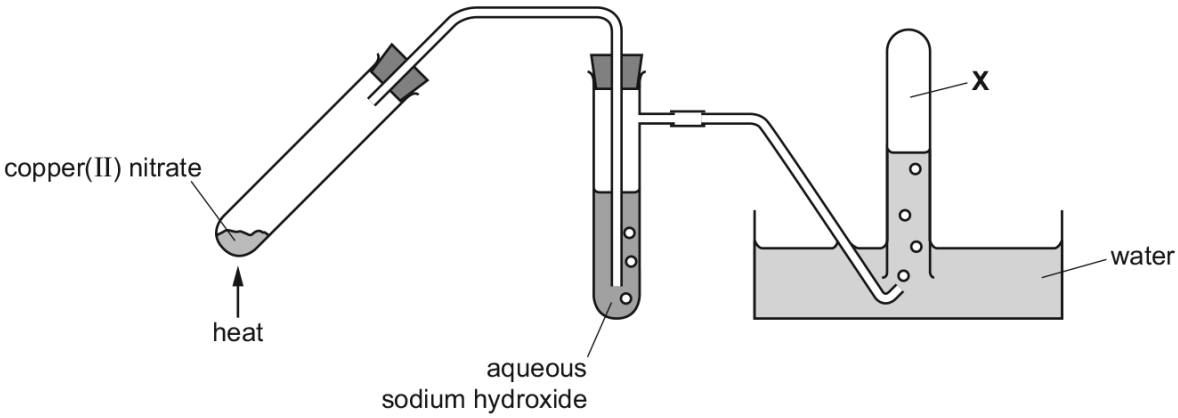
..... [1]

[Total: 10]

03. 0620_w18_qp_41 Q: 3

(a) Copper(II) nitrate decomposes when heated. Two gases, oxygen and nitrogen dioxide, and a solid are made in the reaction.

A sample of copper(II) nitrate was decomposed using the apparatus shown.



(i) Complete the chemical equation for the reaction.

$$2Cu(NO_3)_2 \rightarrow O_2 + \text{.....}NO_2 + \text{.....} \quad [2]$$

(ii) Only oxygen gas is collected at **X**.

Explain why.

.....

..... [1]

(b) Nitrogen dioxide and other oxides of nitrogen are formed in car engines.

Explain how nitrogen dioxide is formed in car engines.

.....

.....

.....

..... [2]

(c) A teacher heated 18.8 g of copper(II) nitrate.

(i) Calculate the number of moles of copper(II) nitrate present in the 18.8 g.

..... mol [2]

(ii) Calculate the maximum number of moles of oxygen that can be made by heating 18.8 g of copper(II) nitrate.

..... mol [1]

(iii) Calculate the maximum volume of oxygen at room temperature and pressure, in cm^3, that can be made by heating 18.8 g of copper(II) nitrate.

..... cm^3 [1]

(d) A sample of copper(II) nitrate was dissolved in water to form an aqueous solution.

The aqueous solution was split into three portions. A separate test was done on each portion as shown.

test	reagent added	result
1	aqueous sodium hydroxide	light blue precipitate forms
2	zinc powder	solution changes from blue to colourless and a brown solid forms
3		ammonia gas is produced

(i) Give the formula of the light blue precipitate formed in **test 1**.

..... [1]

(ii) Explain the changes seen in **test 2**.

.....

.....

.....

..... [3]

(iii) Identify the **two** reagents that must be added to the aqueous copper(II) nitrate in **test 3**.

1 .....

2 .....

[2]

(e) Copper(II) nitrate can be made by reacting copper(II) carbonate with nitric acid. One of the products is carbon dioxide.

(i) Write a chemical equation for the reaction of copper(II) carbonate with nitric acid.

..... [2]

(ii) Carbon dioxide is added to the air by living things.

Name the chemical process by which living things add carbon dioxide to the air.

..... [1]

(iii) Carbon dioxide is removed from the air by plants.

Name the chemical process by which plants remove carbon dioxide from the air.

..... [1]

[Total: 19]

04. 0620_m16_qp_42 Q: 3

Carbon dioxide and silicon(IV) oxide are oxides of Group IV elements.

(a) Complete the following table.

	carbon dioxide	silicon(IV) oxide
formula		SiO_2
melting point / °C	–56	1610
physical state at 25 °C	gas	
conduction of electricity	non-conductor	
structure		macromolecular

[4]

(b) (i) Name the type of bonds that exist between the atoms in silicon(IV) oxide.

..... [1]

(ii) Explain why silicon(IV) oxide has a very high melting point.

.....

..... [1]

(iii) Explain, in terms of attractive forces between particles, why carbon dioxide has a very low melting point.

.....

..... [1]

(iv) Explain, in terms of particles, why carbon dioxide is a non-conductor of electricity.

.....

..... [1]

(c) Suggest a chemical equation for the reaction between sodium hydroxide solution and carbon dioxide.

..... [2]

(d) (i) Name the type of chemical reaction in which carbon dioxide is produced from fossil fuels.

..... [1]

(ii) Name the chemical process in which green plants convert carbon dioxide into carbohydrates.

..... [1]

(iii) Name the chemical process in which living things produce carbon dioxide.

..... [1]

[Total: 13]

05. 0620_s16_qp_42 Q: 1

(a) For each of the following, give the name of an element from Period 2 (lithium to neon), which matches the description.
Elements may be used once, more than once or not at all.

(i) an element which is gaseous at room temperature and pressure

..... [1]

(ii) an element which forms an oxide that is a reactant in photosynthesis

..... [1]

(iii) an element that is a product of photosynthesis

..... [1]

(iv) an element that makes up approximately 78% by volume of the air

..... [1]

(v) an element which has atoms with a full outer shell of electrons

..... [1]

(vi) an element which exists as both diamond and graphite

..... [1]

(vii) an element that reacts vigorously with cold water

..... [1]

(viii) a soft metallic element which is stored in oil

..... [1]

(b) Give the formula of a compound that contains

(i) only boron and oxygen, ... [1]

(ii) only lithium and nitrogen. ..... [1]

[Total: 10]

06. 0620_w16_qp_42 Q: 3

Clean, dry air contains a small amount of carbon dioxide.

(a) The percentages of the **other** gases present in clean, dry air are shown in the table.

Complete the table by inserting the names of these gases.

name of gas	percentage present
	78
	21
	1

[2]

(b) Oxides of nitrogen are atmospheric pollutants which can cause acid rain.

Describe the formation of oxides of nitrogen and suggest how they can cause acid rain.

.....

.....

.....

..... [3]

(c) Methane contributes to the greenhouse effect.

State **two** sources of methane.

1 .....

2 .....

[2]

(d) Combustion and respiration add carbon dioxide to the atmosphere.

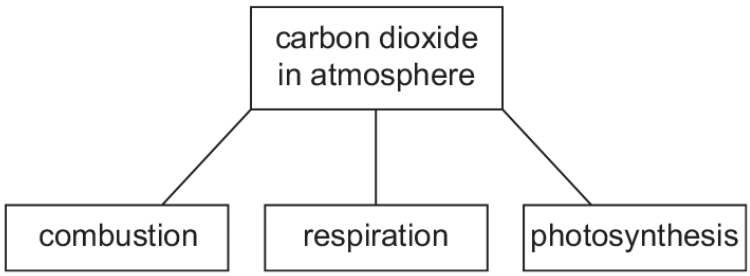
Name **one** natural process which removes carbon dioxide from the atmosphere.

..... [1]

[Total: 8]

07. 0620_s13_qp_32 Q: 3

The diagram shows some of the processes which determine the percentage of carbon dioxide in the atmosphere.



(a) Explain how the following two processes alter the percentage of carbon dioxide in the atmosphere.

(i) combustion

.....

.....

..... [3]

(ii) respiration

.....

.....

..... [3]

(b) Photosynthesis reduces the percentage of carbon dioxide in the atmosphere.

(i) Complete the word equation for photosynthesis.

carbon dioxide + water → ..... + ... [2]

(ii) State **two** essential conditions for the above reaction to occur.

.....

..... [2]

[Total: 10]

08. 0620_w13_qp_32 Q: 4

For centuries, iron has been extracted from its ore in the blast furnace. The world production of pig iron is measured in hundreds of million tonnes annually.

(a) The following raw materials are supplied to a modern blast furnace.

iron ore which is hematite, Fe_2O_3
limestone which is calcium carbonate
carbon in the form of coke
air

Describe the essential reactions in the blast furnace. Each of the four raw materials must be mentioned at least once. Give the equation for the reduction of hematite.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

(b) Each year, blast furnaces discharge millions of tonnes of carbon dioxide into the atmosphere. This will increase the percentage of atmospheric carbon dioxide.

(i) Explain why this increased percentage of carbon dioxide may cause problems in the future.

.....

..... [2]

(ii) Until the early eighteenth century, charcoal, not coke, was used in the blast furnace. Charcoal is made from wood but coke is made from coal. Explain why the use of charcoal would have a smaller effect on the level of atmospheric carbon dioxide.

.....

.....

..... [2]

(iii) A method being developed to produce iron with lower emissions of carbon dioxide is by electrolysis. Hematite, Fe_2O_3, is dissolved in molten lithium carbonate and electrolysed. The ore is spilt into its constituent elements.

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

.....

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

.....O^{2-} → ..... + ... [3]

[Total: 13]

01. 0620_s21_ms_42 Q: 3

Question	Answer	Marks
(a)	(thermal) decomposition	1
(b)	84 (1) 12.6 / 84 = 0.15(00) (1) 0.15(00) / 2 = 0.075(00) (1) 0.075(0) × 24.0 = 1.8 (1)	4

Question	Answer	Marks
(c)	$Ca(OH)_2$ (1) $CaCO_3$ (1)	2

02. 0620_w20_ms_41 Q: 4

Question	Answer	Marks
(a)	21	1
(b)(i)	fractional (1) distillation (1)	2
(b)(ii)	(different) boiling point	1
(c)	2 double bonds (1) whole molecule correct (2 pairs of lone pairs on each O) (1)	2
(d)	increase in (concentrations of) carbon dioxide (carbon dioxide is) greenhouse gas/greenhouse effect contributes to climate change/global warming	3
(e)	photosynthesis	1

03. 0620_w18_ms_41 Q: 3

(a)(i)	$4NO_2$ 2CuO **M1** CuO as a product (1) **M2** rest fully correct (1)	**2**
(a)(ii)	nitrogen dioxide is acidic **OR** nitrogen dioxide reacts with sodium hydroxide	**1**

(b)	**M1** nitrogen and oxygen (from the air) **M2** (react) at high temperatures (in engine) **or** (electrical) spark (in engine)	**2**
(c)(i)	**M1** 188 **M2** (18.8 / 188) = 0.1(00)	**2**
(c)(ii)	0.05	**1**
(c)(iii)	1200	**1**
(d)(i)	$Cu(OH)_2$	**1**
(d)(ii)	Any three from: **1** zinc more reactive than copper **2** displacement / redox reaction **OR** zinc displaces copper **OR** zinc reacts with copper **ions** **3** copper is solid / copper is brown **4** zinc nitrate is colourless (solution) **OR** blue colour disappears because Cu^{2+} ions removed (from solution)	**max 3**
(d)(iii)	**M1** sodium hydroxide / NaOH **M2** aluminium / Al	**2**
(e)(i)	$CuCO_3 + 2HNO_3 \rightarrow Cu(NO_3)_2 + CO_2 + H_2O$ **M1** carbon dioxide and water as products **M2** rest correct	**2**
(e)(ii)	respiration	**1**
(e)(iii)	photosynthesis	**1**

04. 0620_m16_ms_42 Q: 3

(a)	CO_2;	**4**
	solid;	
	poor conductor / non-conductor;	
	simple molecular / simple (covalent);	
(b)(i)	covalent;	**1**

(b)(ii)	all bonds are (very) strong or bonds; **or** bonds need a lot of energy or heat to break; **or** (there are) no weak bonds / no (weak) intermolecular forces;	**1**
(b)(iii)	weak forces between molecules; **or** weak intermolecular forces or weak van der Waals' forces; **or** low amount of energy needed to break intermolecular / van der Waals' forces;	**1**
(b)(iv)	no (moving) ions / no mobile or moving electrons / all electrons used in bonding / made of uncharged molecules;	**1**
(c)	$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$ **or** $NaOH + CO_2 \rightarrow NaHCO_3$ formula of Na_2CO_3 / $NaHCO_3$; whole equation correct;	**2**
(d)(i)	(complete) combustion / burning;	**1**
(d)(ii)	photosynthesis;	**1**
(d)(iii)	respiration;	**1**

05. 0620_s16_ms_42 Q: 1

(a)(i)	nitrogen / oxygen / fluorine / neon;	1
(a)(ii)	carbon;	1
(a)(iii)	oxygen;	1
(a)(iv)	nitrogen;	1
(a)(v)	neon;	1
(a)(vi)	carbon;	1
(a)(vii)	lithium / fluorine;	1
(a)(viii)	lithium;	1
(b)(i)	B_2O_3;	1
(b)(ii)	Li_3N;	1

06. 0620_w16_ms_42 Q: 3

(a)	nitrogen (78%) **AND** oxygen (21%) noble gases **OR** argon (1%)	2
(b)	nitrogen **AND** oxygen (from the air) react (in the) high temperatures of a car engine NO_x / oxides of nitrogen react with or dissolve in water (to form an acid)	3
(c)	any 2 from: (named) ruminant animal / cattle / (anaerobic) digestion / flatulence (in animals) / animal waste / (animal) dung decomposing vegetation / animals / organisms / decaying (organic) matter / (fractional distillation / cracking of) petroleum / crude oil / hydrocarbons / natural gas / coal /	2
(d)	photosynthesis	1

07. 0620_s13_ms_32 Q: 3

(a) (i) complete combustion / combustion in excess oxygen [1]

of fuels containing carbon / fossil fuels / hydrocarbon (fuels) [1]

produce carbon dioxide / increase percentage of CO_2 in atmosphere [1]

(ii) living things / cells / plants / animals / humans / micro-organisms [1]

(oxidise / react with) oxygen **and** food / foodstuff / named foodstuff / carbohydrate / sugar / glucose [1]

produces carbon dioxide [1]

(b) (i) glucose **or** starch **or** carbohydrate [1]

oxygen [1]

(ii) light / sunlight / sun / UV [1]

chlorophyll **accept:** chloroplast [1]

08. 0620_w13_ms_32 Q: 4

(a) Any one of:
$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$
$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$
$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
for correct equation (2)
not balanced = (1) only

any four of:

coke burns to form carbon dioxide / $C + O_2 \rightarrow CO_2$

this reacts with more carbon to form carbon monoxide / $C + CO_2 \rightarrow 2CO$

calcium carbonate decomposes to form calcium oxide and carbon dioxide / $CaCO_3 \rightarrow CaO + CO_2$

calcium oxide / calcium carbonate reacts with silica / silicon oxide / silicon(IV) oxide (in ore) to form calcium silicate / slag / $CaO + SiO_2 \rightarrow CaSiO_3$ **or** $CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$

the reaction between carbon and oxygen is exothermic / produces heat / coke is used as a fuel / the slag floats on the (molten) iron / the slag and molten iron can be run off separately
[6]

(b) **(i)** greenhouse effect / CO_2 is a greenhouse gas [1]
global warming / ice caps melting / suitable example [1]

(ii) burning or combustion of charcoal produces carbon dioxide [1]
trees use carbon dioxide (in photosynthesis) [1]

(iii) cathode reaction $Fe^{3+} + 3e \rightarrow Fe$ [1]

anode reaction $2O^{2-} \rightarrow O_2 + 4e$ [2]
not balanced = (1) only

[Total: 13]