



BENENDEN

SIXTH FORM 2020

CHEMISTRY

1 hour 30 minutes

Name:
School:
Date:

Instructions to Candidates:

- *Fill in the boxes above with your name, school and the date*
- *Use black ink or ball point pen. If you change your mind about an answer please put a line through it and then write your new answer (no Tipex or correction fluid please)*
- *Answer **all** questions*
- *Answer the questions in the space provided*
- *Show all of the steps in any calculations and remember to include units*
- *You may use a calculator*
- *Use the periodic table provided*
- *Marks available for each question are indicated in brackets*
- *Total marks for this paper 100*

The Periodic Table of the Elements

		1	2	3	4	5	6	7	0											
		1 H hydrogen 1							4 He helium 2											
		Key relative atomic mass atomic symbol name atomic (proton) number																		
		9 Be beryllium 4	24 Mg magnesium 12																	
		7 Li lithium 3	23 Na sodium 11	39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	63.5 Cu copper 29	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
		85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	98 Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	127 I iodine 53	128 Te tellurium 52	131 Xe xenon 54	
		133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86	
		[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated							

* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

Q1.

Nitrogen and oxygen are present in the air.

Complete the sentence by putting a cross (☒) in the box next to your answer.

Oxygen has a low boiling point because there are

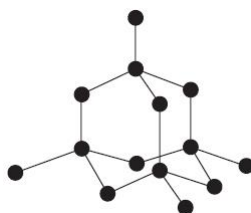
(1)

- A** weak covalent bonds between the oxygen atoms
- B** weak covalent bonds between the oxygen molecules
- C** weak forces of attraction between the oxygen atoms
- D** weak forces of attraction between the oxygen molecules

Q2.

Bonding and separation techniques

(a) The diagram shows the structure of diamond.



(i) Describe what each ● represents.

(2)

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(ii) State the type of bonding in the diamond structure.

(1)

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(b) Give the name of the process used to obtain oxygen from liquid air.

(2)

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(c) A colouring in some sweets was analysed using paper chromatography.

One of the dyes in the colouring moved 2 cm up the paper while the solvent moved 8 cm.

What is the R_f value of this dye?

Put a cross (☒) in the box next to your answer.

(1)

- A** 0.25
- B** 2
- C** 4
- D** 6

(d) Here is some information about magnesium, oxygen and magnesium oxide.

- The electronic configuration of magnesium atoms is 2.8.2
- The electronic configuration of oxygen atoms is 2.6
- Magnesium oxide is an ionic compound.
- When magnesium ribbon is heated, it reacts with oxygen from the air to form magnesium oxide, MgO.

Describe how the reaction can be carried out, including an explanation of what happens to the magnesium and oxygen atoms when they form magnesium oxide.

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(Total for question = 12 marks)

Q3.

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

Acids are neutralised by metal hydroxides to form

(1)

- A** salt only
- B** salt and hydrogen only
- C** salt and oxygen only
- D** salt and water only

(ii) Acids can also be neutralised by metal carbonates.

Dilute sulfuric acid is neutralised by copper carbonate as shown in the word equation.



Copper carbonate is a green powder.

Describe what you would **see** when copper carbonate powder is added to dilute sulfuric acid.

(2)

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Q4. (a) Drinks are often sold in cans.

These cans are made either of aluminium or of steel coated with tin.

The table gives information about these three metallic substances.

metal	cost of 1 kg / £	amount in Earth's crust / %
aluminium	1.31	8
steel (iron)	0.32	5
tin	12.6	0.0002

Use the table to give **two** reasons why it could be more important to recycle tin than to recycle aluminium or steel.

(2)

reason 1

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reason 2

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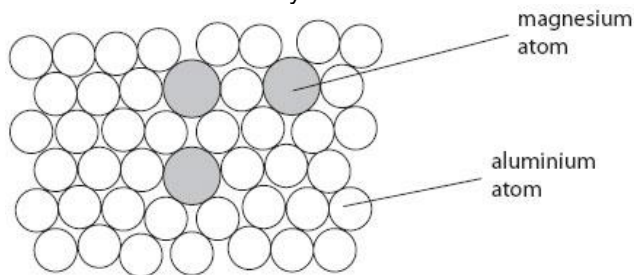
(b) Complete the sentence by putting a cross (☒) in the box next to your answer.

The reaction for the extraction of aluminium from its ore involves

(1)

- A** heating with carbon
- B** thermal decomposition
- C** reduction
- D** neutralisation

(c) Magnalium is an alloy of aluminium and magnesium.
The diagram shows the structure of this alloy.



(i) Explain what you understand by the term **alloy**.

(2)

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(ii) Explain, in terms of their structures, why magnalium is stronger than pure aluminium.

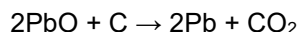
(3)

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(Total for Question = 8 marks)

Q5.

Lead can be obtained by heating its oxide with carbon.
The balanced equation for the reaction is



Calculate the atom economy for the production of lead in this reaction.

(relative atomic masses: C = 12, O = 16, Pb = 207

relative formula masses: PbO = 223, CO₂ = 44)

Give your answer to two significant figures.

(4)

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atom economy = %

(Total for question = 4 marks)

Q6.

(a) The table shows the number of electrons, neutrons and protons in particles P, Q, R, S, T and V.

particle	number of		
	electrons	neutrons	protons
P	1	0	1
Q	3	4	3
R	8	8	8
S	13	14	13
T	18	16	16
V	18	20	20

(i) Which particle is a negatively charged ion?
Put a cross (■) in the box next to your answer.

(1)

- A** P
- B** S
- C** T
- D** V

(ii) Which particles are atoms of metals?
Put a cross (■) in the box next to your answer.

(1)

- A** P and R
- B** Q and R
- C** Q and S
- D** Q, S and V

(b) Each element has an atomic number.

(i) State what is meant by **atomic number**.

(1)

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(ii) The atomic number of boron is 5.

Boron exists as two isotopes boron-10 and boron-11.

Use this information to explain why boron-10 and boron-11 are isotopes.

(2)

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(c) (i) Explain what is meant by the term relative atomic mass.

(2)

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(ii) A sample of boron contains
19.7% of boron-10.
80.3% of boron-11.

Use this information to calculate the relative atomic mass of boron.

(3)

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(Total for Question = 10 marks)

Q7.

A sample of aluminium chloride was analysed.
It was found that 0.270 g of aluminium was combined with 1.065 g of chlorine in this chloride.

Calculate the empirical formula of aluminium chloride.
(relative atomic masses: Al = 27, Cl = 35.5)

You must show your working.

(3)

empirical formula of aluminium chloride =

(Total for question = 3 marks)

Q8.

During fermentation glucose, $C_6H_{12}O_6$, reacts to form ethanol, C_2H_5OH , and carbon dioxide.



(relative formula masses: $C_6H_{12}O_6 = 180$, $C_2H_5OH = 46$;
volume of 1 mol of gas at room temperature and pressure = 24 dm^3)

Calculate the maximum volume, in dm^3 , of carbon dioxide that can be produced when 75 kg of glucose reacts completely.

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volume = dm^3

(Total for question = 3 marks)

Q9.

Diamond and carbon dioxide are both covalent substances.

(i) Draw a dot and cross diagram to show the covalent bonding in a molecule of carbon dioxide, CO₂.
Show outer electrons only.

(2)

(ii) Diamond has a very high melting point.
Explain why the melting point of diamond is very high.

(2)

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(Total for question = 4 marks)

Q10.

Calcium nitrate, Ca(NO₃)₂, is an ionic solid.
State the formulae of the ions in calcium nitrate.

(2)

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(Total for question = 2 marks)

Q11.

(a) Sodium chloride is a metal chloride which is soluble in cold water.

(i) Give the name of a metal chloride which is insoluble in cold water.
Put a cross (☒) in the box next to your answer.

(1)

- A** copper chloride
- B** lead chloride
- C** magnesium chloride
- D** potassium chloride

(ii) Sodium chloride has a melting point of 801 °C.
Explain why the melting point of sodium chloride is high.

(2)

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(iii) Describe how you would test for the presence of chloride ions in a solution of sodium chloride.

(3)

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(b) Magnesium has an electronic configuration of 2.8.2.

Oxygen has an electronic configuration of 2.6.

Explain, in terms of their electronic configurations, how magnesium and oxygen atoms react to form the ionic compound magnesium oxide, MgO, and include a description of the structure of solid magnesium oxide.

(6)

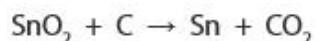
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(Total for Question = 12 marks)

Q12.

Metals

(a) In the extraction of tin from tin oxide, tin oxide is heated with carbon.



Complete the sentence by putting a cross (☒) in the box next to your answer.
When the tin oxide reacts with carbon to form the products

(1)

- A tin is oxidised
- B tin oxide is reduced
- C carbon is reduced
- D carbon dioxide is oxidised

(b) Pure gold is too soft to be used for some jewellery.

(i) Gold alloys contain other metals such as copper and silver.

In terms of the arrangement of metal atoms, explain why gold alloys are stronger than pure gold.

(2)

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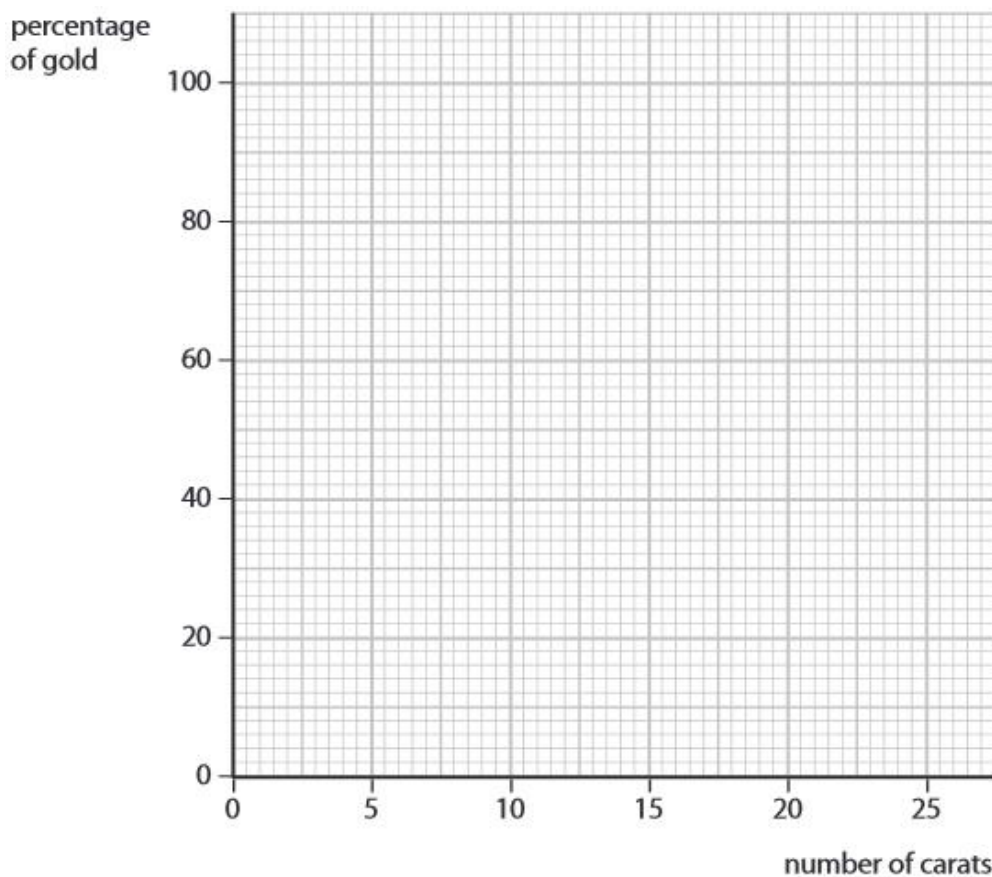
(ii) The purity of gold is often measured in carats.

The data shows how the number of carats is related to the percentage of gold.

number of carats	percentage of gold
24	100
22	92
18	75
9	38

On the grid provided, draw a graph of the percentage of gold against the number of carats.

(2)



(iii) A gold ring is 14 carat gold.
Use the graph to determine the percentage of gold in the ring.

(1)

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(c) Metals are obtained from the Earth's crust by different methods.

Some metals are found uncombined but others have to be extracted from their ores by electrolysis or by heating the ore with carbon.

Explain, using aluminum, gold and iron as examples, how the method used to obtain the metal is related to its position in the reactivity series and to the cost of the extraction process.

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(Total for question = 12 marks)

Q13.

A solution is made by dissolving calcium chloride in water.

11.1 g of calcium chloride are dissolved in water.

The volume of the solution is made up to 500 cm³.

Calculate the concentration, in mol dm⁻³, of calcium chloride, CaCl₂, in this solution.

(relative atomic masses: Cl = 35.5, Ca = 40.0)

(3)

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concentration =mol dm⁻³

Q14.

(a) A student investigated the rate of a reaction.

The student investigated the reaction between zinc and dilute sulfuric acid.

The products are zinc sulfate, ZnSO₄, and hydrogen.

(i) Write the balanced equation for this reaction.

(2)

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(ii) The student carried out two experiments.

The same mass of zinc and the same sized pieces of zinc were used in each experiment.

The results are shown in the table.

	experiment 1	experiment 2
concentration of sulfuric acid / mol dm ⁻³	0.5	1.5
temperature / °C	20	40
rate of reaction	slow	fast

Evaluate these results, explaining the reasons why the rate of reaction in experiment 2 is faster than the rate of reaction in experiment 1.

In your answer you should refer to the frequency and energy of collisions between particles.

(6)

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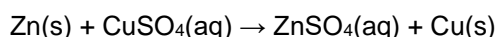
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(b) Zinc is reacted with copper sulfate solution.

The equation for the reaction is



(i) What type of reaction is this?

(1)

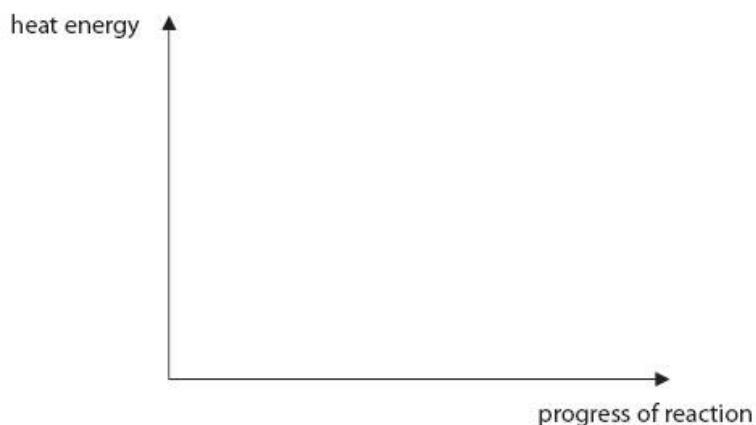
Put a cross (☒) in the box next to your answer.

- A decomposition
- B displacement
- C dissolving
- D neutralisation

(ii) This reaction is exothermic.

On the diagram below draw labelled lines to show the relative energies of the reactants and products in this reaction.

(2)



(Total for Question = 11 marks)

Q15.

A solution of hydrochloric acid has a pH of 1.

Explain the pH change when 10 cm³ of this acid is diluted with water to make 100 cm³ of solution.

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(Total for question = 2 marks)

Q16.

Some polymers are polyesters.

What type of reaction takes place when polyesters are formed?

(1)

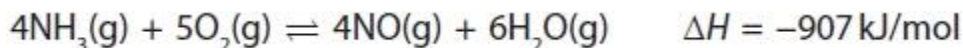
- A addition
- B condensation
- C neutralisation
- D precipitation

(Total for question = 1 mark)

Q17.

Ammonia is manufactured on a large scale and is used to make fertilisers such as ammonium nitrate (NH_4NO_3).

(a) The first stage in the manufacture of ammonium nitrate is to react ammonia gas with oxygen gas.

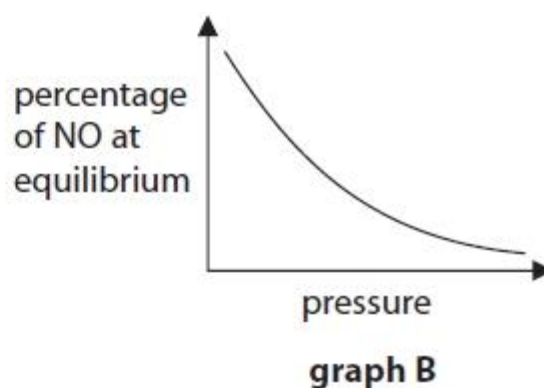
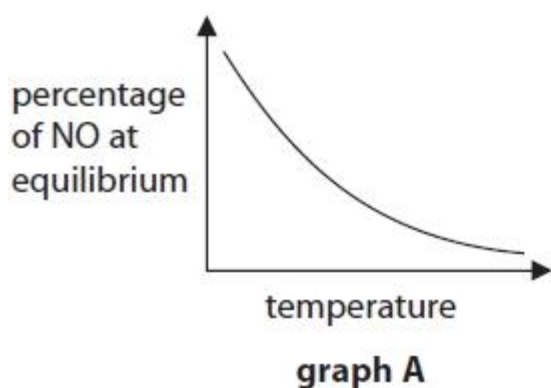


The reaction is carried out at a pressure of about 10 atm and at a temperature of 800 °C, in the presence of a catalyst.

If the mixture is left for long enough in a sealed container, the reaction reaches a position of dynamic equilibrium.

Graph A shows how the percentage of nitrogen monoxide (NO) in the equilibrium mixture varies with temperature at constant pressure.

Graph B shows how the percentage of nitrogen monoxide (NO) in the equilibrium mixture varies with pressure at constant temperature.



(i) Explain why the percentage of NO at equilibrium decreases in each case.

(4)

Graph A

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Graph B

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(ii) Explain why the use of a catalyst has no effect on the position of equilibrium in a reversible reaction.

(2)

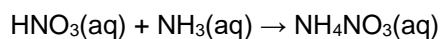
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(b) The second stage in the manufacture of ammonium nitrate is to convert the nitrogen monoxide into nitric acid. The nitric acid is then reacted with concentrated aqueous ammonia as shown in this equation.



(i) State, in terms of proton transfer, why this reaction is classified as an acid-base reaction. (1)

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(ii) Calculate the volume of 14.8 mol / dm³ aqueous ammonia that is required to exactly neutralise 150 dm³ of a solution of nitric acid of concentration 15.8 mol / dm³. (2)

volume of aqueous ammonia = dm³

(Total for question = 9 marks)

END OF EXAM