Surname	Centre Number	Candidate Number
Other Names		0

GCSE

3410UB0-1

S19-3410UB0-1

THURSDAY, 16 MAY 2019 – MORNING

CHEMISTRY – Unit 2:
Chemical Bonding, Application of Chemical Reactions and Organic Chemistry

HIGHER TIER

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**9**	
2.	**7**	
3.	**4**	
4.	**9**	
5.	**7**	
6.	**12**	
7.	**11**	
8.	**13**	
9.	**8**	
Total	**80**	

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01

ADDITIONAL MATERIALS

In addition to this examination paper you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Question **7***(c)* is a quality of extended response (QER) question where your writing skills will be assessed.

The Periodic Table is printed on the back cover of this paper and the formulae for some common ions on the inside of the back cover.

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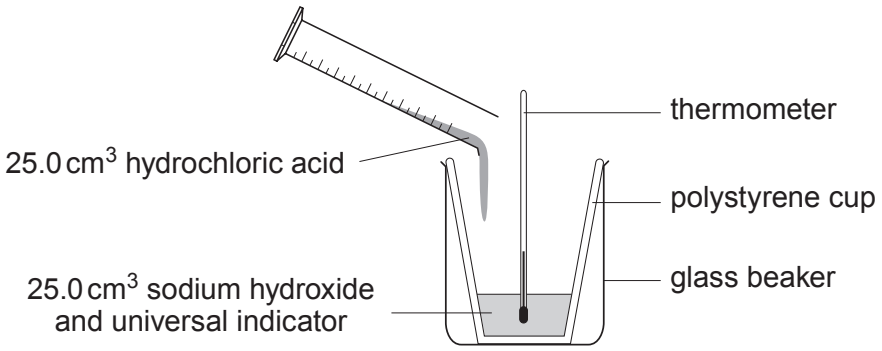
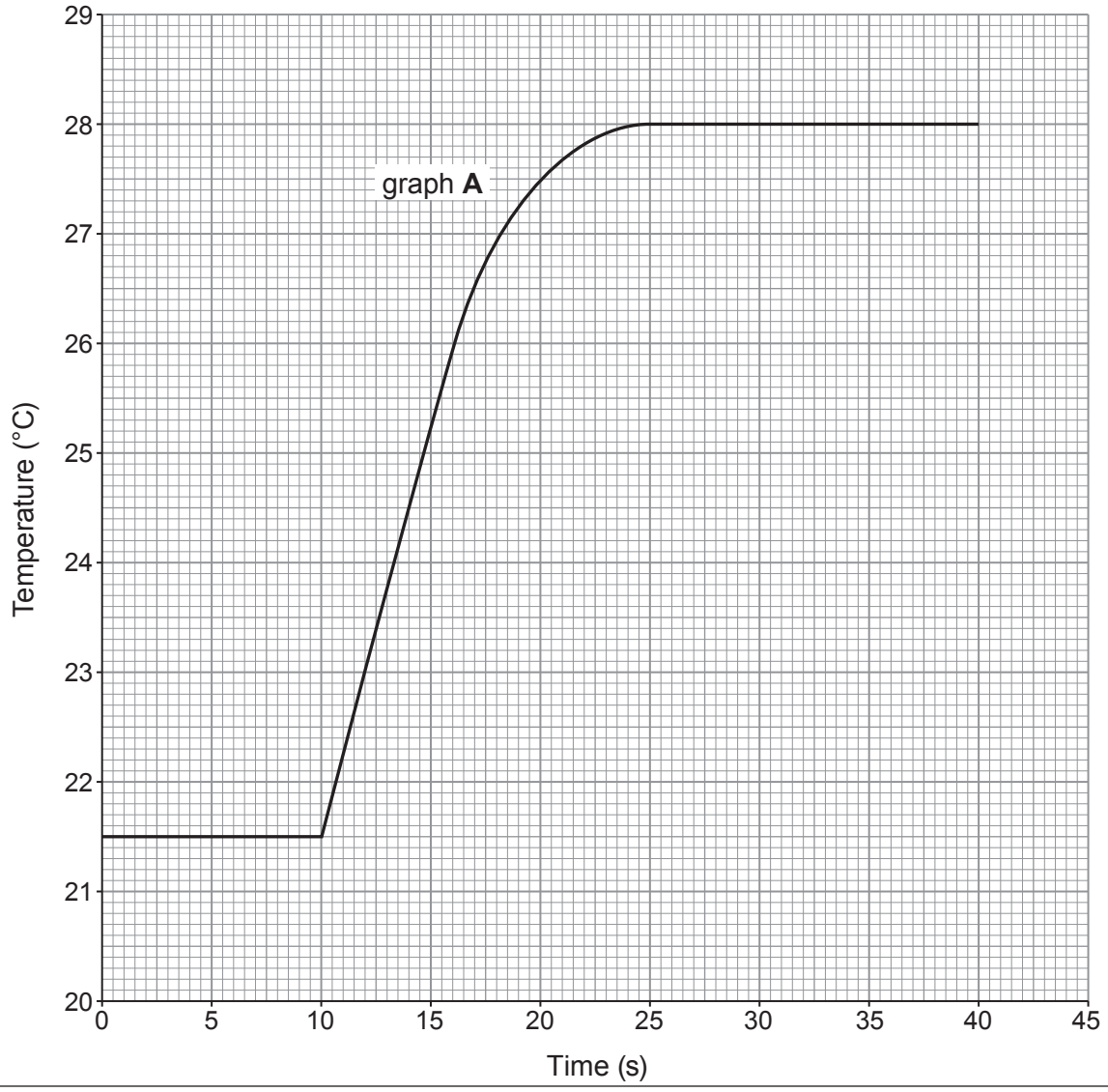
Answer **all** *questions*.

1. A student investigated the temperature rise during a neutralisation reaction.



The student put 25.0 cm^3 of sodium hydroxide solution and 5 drops of universal indicator into a polystyrene cup and recorded the temperature of the alkali. After 10 seconds the student added 25.0 cm^3 of dilute hydrochloric acid to the alkali and recorded the temperature every 5 seconds for another 30 seconds. Graph **A** shows the results obtained.



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(a) (i) Use the graph to find the maximum temperature rise during the reaction. [1]

Temperature rise = ... °C

(ii) The energy given out can be calculated using the following formula.

energy given out = **total** volume of reaction mixture × 4.2 × temperature rise

Calculate the energy given out during the reaction. [2]

Energy given out = ... J

(iii) The temperature of the contents in the cup was recorded after 2 hours. Give the final temperature reading you would expect. Give the reason for your answer. [1]

Final temperature ..... °C

Reason .....

.....

(b) The student repeated the experiment using 25.0 cm^3 of ethanoic acid of the same concentration as the hydrochloric acid. The table shows the results obtained.

Time (s)	0	5	10	15	20	25	30	35	40
Temperature (°C)	21.5	21.5	21.5	24.0	26.0	26.9	27.0	27.0	27.0

Plot the results on the grid on page 2. Draw a suitable line. Label your graph **B**. [2]

(c) Use the graphs to state which of the two acids is the stronger – hydrochloric acid or ethanoic acid. Give the reason for your choice. [1]

Acid .....

Reason .....

.....

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(d) The temperature rises in both experiments were much **lower** than expected. The student suggested that using a temperature sensor instead of a thermometer would give temperature rises closer to the expected values.

(i) State why using a temperature sensor would still give a lower than expected temperature rise. [1]

.....

.....

(ii) What improvement to the apparatus would you suggest to the student to obtain temperature rises closer to the expected values? [1]

.....

.....

9

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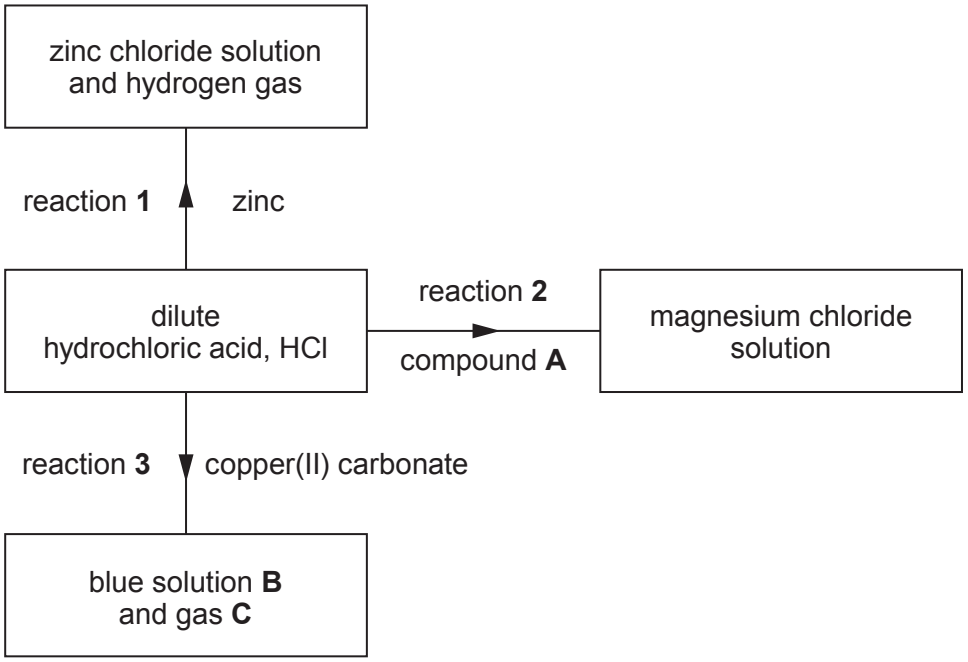
2. The diagram shows three reactions which are used to prepare soluble salts.



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(a) (i) Name compound **A**. [1]

.....

(ii) Give the names of blue solution **B** and gas **C** formed in reaction **3**. [2]

blue solution **B** .....

gas **C** .....

(b) Write the balanced symbol equation for reaction **1**. [2]

.....

(c) Reaction **1** was repeated using magnesium instead of zinc. Explain the difference, if any, that you would expect to see. [2]

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.....

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7

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3. The tables show the molecular formulae of some alkanes and alkenes.

Alkanes
CH_4
C_2H_6
C_3H_8
C_4H_{10}

Alkenes
C_2H_4
C_3H_6

(a) The general formula for the alkene family is C_nH_{2n}. Give the general formula for the alkane family. [1]

.....

(b) When alkanes and alkenes completely burn in air they form the same two products.

Give the chemical formulae for both products. [1]

..... and .....

(c) Draw the structural formula for propene. [1]

(d) Bromine water is used to distinguish alkenes from alkanes. Describe the colour **change** seen when bromine water is added to an alkene. [1]

.....

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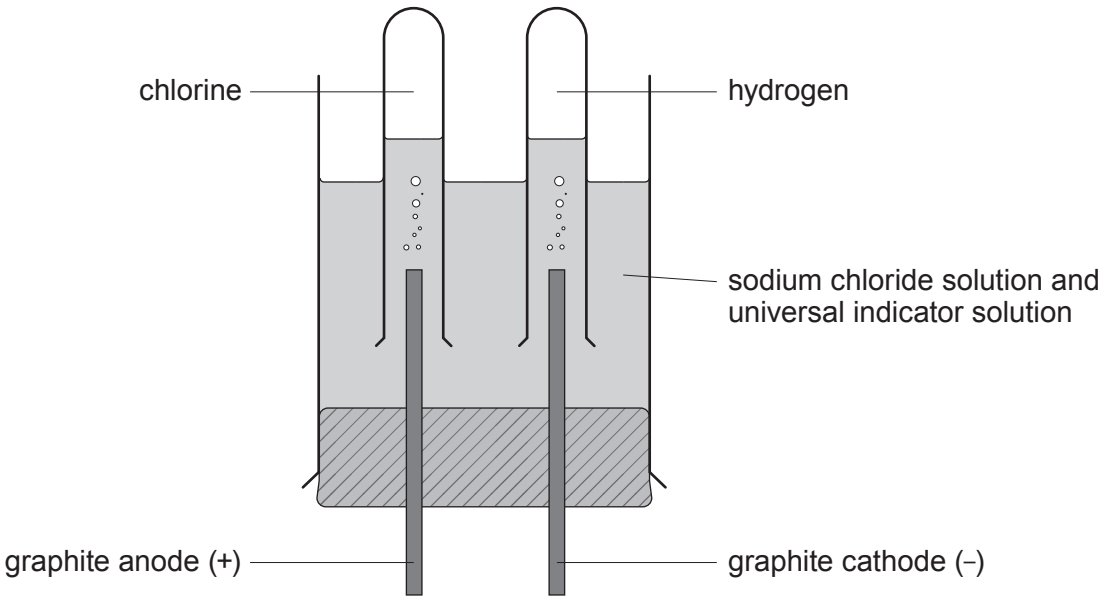
4. *(a)* The diagram shows apparatus that can be used for the electrolysis of sodium chloride solution.



(i) Explain why hydrogen, and **not** sodium, is formed at the cathode. [1]

.....

.....

.....

(ii) Complete the electrode equation for the reaction at the anode. [1]

$2Cl^- \longrightarrow Cl_2 +$ .....

(iii) Explain why the universal indicator turns purple during electrolysis. [2]

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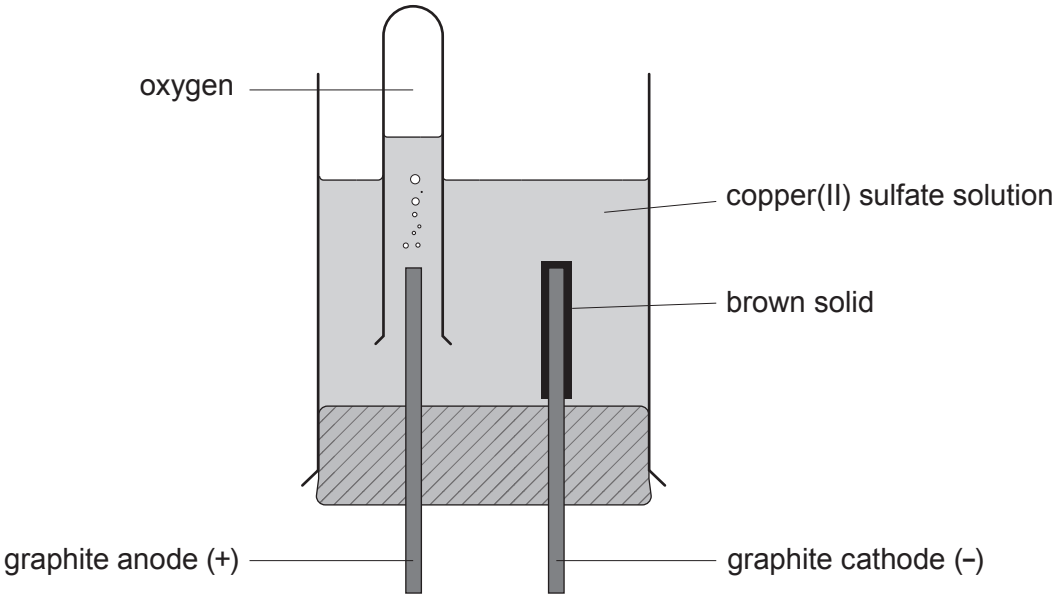
(b) The diagram shows the electrolysis of copper(II) sulfate solution.



(i) Explain, using the reaction occurring at the cathode, the meaning of the term *reduction*. [1]

.....

.....

(ii) Over time the electrolyte turns from blue to colourless. State the change you would make to the apparatus so that the electrolyte remains blue during the process. Give a reason for your answer. [2]

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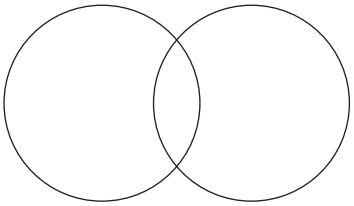
(iii) The electronic structure of oxygen is (2,6). Complete the diagram showing the outer shell electrons in an oxygen molecule, O_2. [2]



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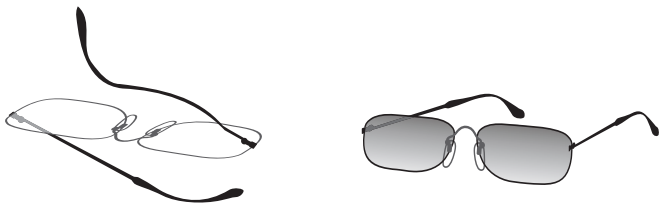
5. *(a)* Smart materials are used to make the frames and lenses of certain spectacles.



Give the names of the different types of smart material used. Describe the unusual property of each. [2]

Frames .....

.....

.....

Lenses .....

.....

.....

Examiner only

(b) Titanium dioxide has been used in sun creams for decades. Sun screens available today use nano-scale titanium dioxide particles. Some people believe using creams containing nano-particles is unsafe.

(i) Give the advantage of using nano-scale titanium dioxide particles rather than larger titanium dioxide particles to make sun screens. [1]

.....

.....

(ii) Explain why some people are concerned about the use of nano-scale titanium dioxide particles in sun screens. [2]

.....

.....

.....

(iii) **Approximately** how many times bigger are common titanium dioxide particles (3×10^{-7} m) than nano-scale titanium dioxide particles (2.5×10^{-10} m)? [2]

Answer = ...

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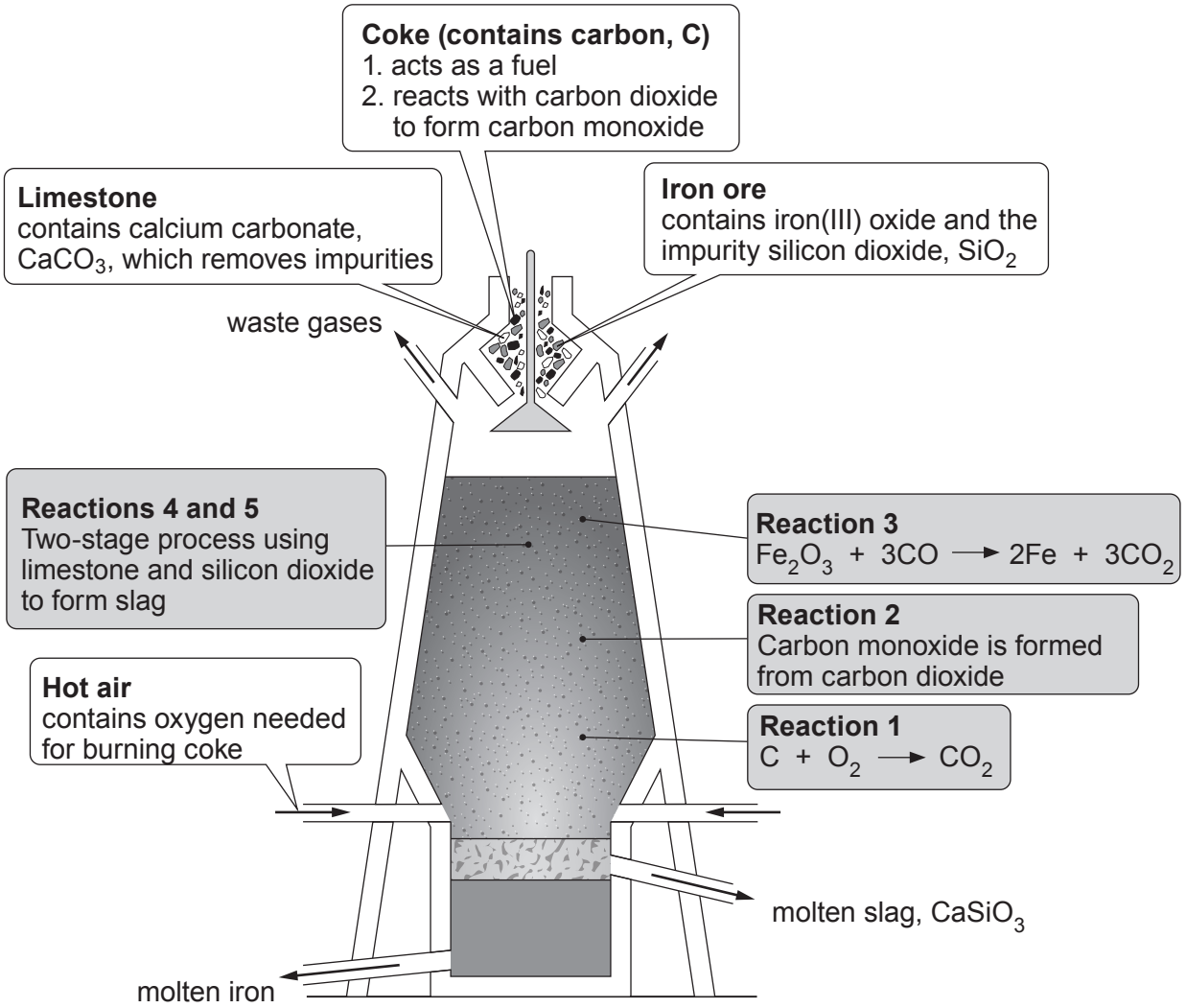
6. *(a)* Iron is extracted from its ore in the blast furnace.



Use information from the diagram and your knowledge to answer parts (i) and (ii).

(i) Write a balanced symbol equation for reaction **2**. [2]

.....

(ii) Describe the two-stage process to form slag. [3]

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Examiner only

(b) Iron(III) oxide reacts with dilute hydrochloric acid forming iron(III) chloride and water.

(i) Balance the symbol equation for this reaction. [1]

$$Fe_2O_3(s) + \square\ HCl(aq) \longrightarrow \square\ FeCl_3(aq) + \square\ H_2O(l)$$

(ii) Sodium hydroxide solution can be used to detect the presence of aqueous iron(III) ions.

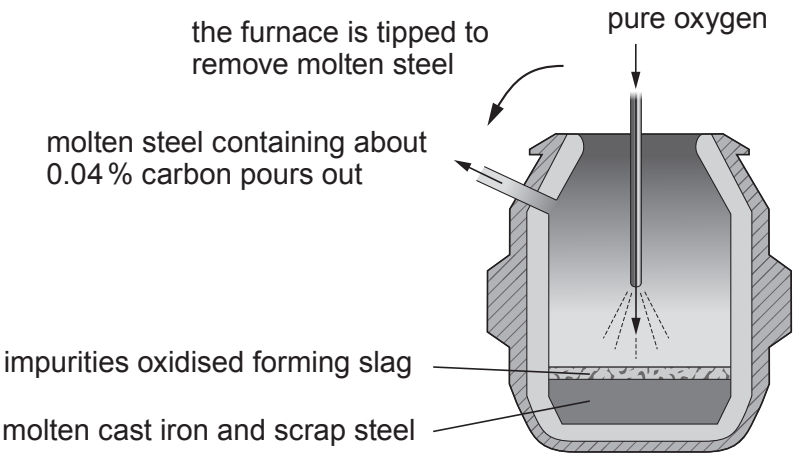
The symbol equation below represents the reaction occurring between solutions of sodium hydroxide and iron(III) chloride.

$$3NaOH(aq) + FeCl_3(aq) \longrightarrow 3NaCl(aq) + Fe(OH)_3(s)$$

Write the **ionic** equation for the formation of the precipitate. [2]

.....

(c) **Steel manufacture in the UK**



Basic Oxygen Furnace

One of the major steelmaking processes used today in the UK is the Basic Oxygen Furnace, BOF. The raw materials for the BOF are cast iron from a blast furnace and scrap steel. Oxygen (>99.5 % pure) is "blown" into the BOF at supersonic speed. The impurities are oxidised producing great quantities of heat which melts the scrap steel.

Steel can be described in general terms as iron containing small amounts of carbon, to make it tougher and more ductile. There are many types of steel, each with its own specific chemical composition and properties to meet the needs of the many different applications. **Figure 1** below shows the relationships between the carbon content of steel and its ductility, tensile strength and hardness.

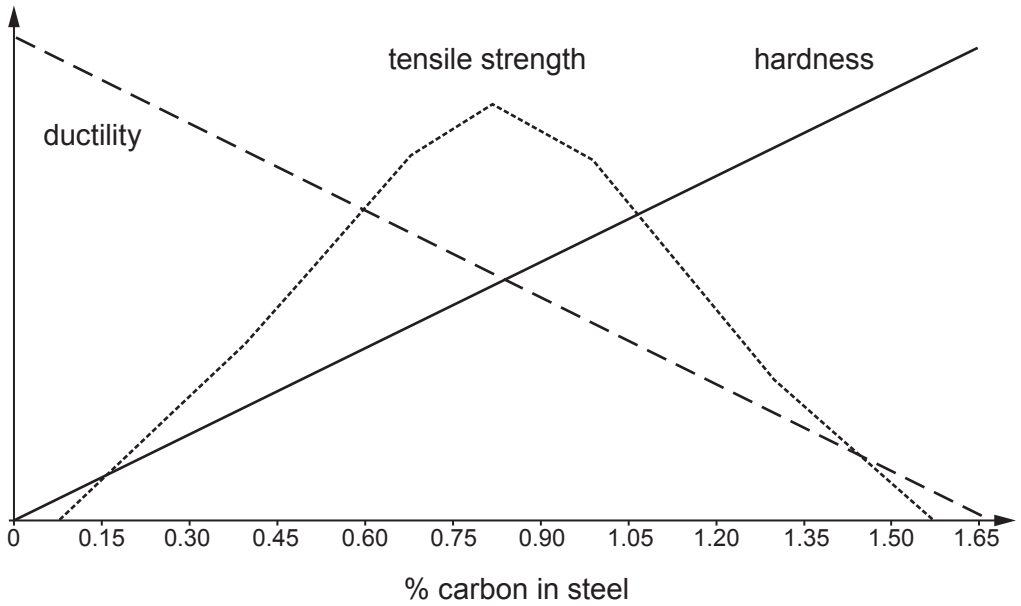


Figure 1

Ductility is a material's ability to be pulled into a wire.

Tensile strength is a measurement of the force required to pull something such as wire to the point where it breaks.

Hardness is a measure of how resistant a material is to permanent shape change when a compressive force is applied.

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Figure 2 shows the percentage of carbon in various alloys of iron.

Name of alloy	Percentage of carbon
low carbon steel	0.0 – 0.6 %
medium carbon steel	0.6 – 0.8 %
high carbon steel	0.8 – 1.3 %
very high carbon steel	1.3 – 1.6 %

Figure 2

(i) Tick (✓) the box next to the statement which best describes **one** way that production costs are reduced. [1]

high purity oxygen is used ☐

impurities are oxidised forming heat ☐

oxygen is blasted in at supersonic speed ☐

scrap steel is used in the process ☐

(ii) Tick (✓) the box next to the statement which best describes the effect of increasing the percentage of carbon in steel from 0 % to 0.45 %. [1]

ductility increases, hardness increases ☐

tensile strength increases, ductility increases ☐

ductility decreases, tensile strength increases ☐

hardness increases, tensile strength decreases ☐

(iii) A steel manufacturer wants to design an alloy with a high tensile strength but low ductility. Tick (✓) the box next to the approximate value for the percentage of carbon that should be included. [1]

0.2 ☐ 0.6 ☐ 1.0 ☐ 1.5 ☐

(iv) Name the alloy which is the most easily pulled into a wire and withstands the least compressive force. [1]

.....

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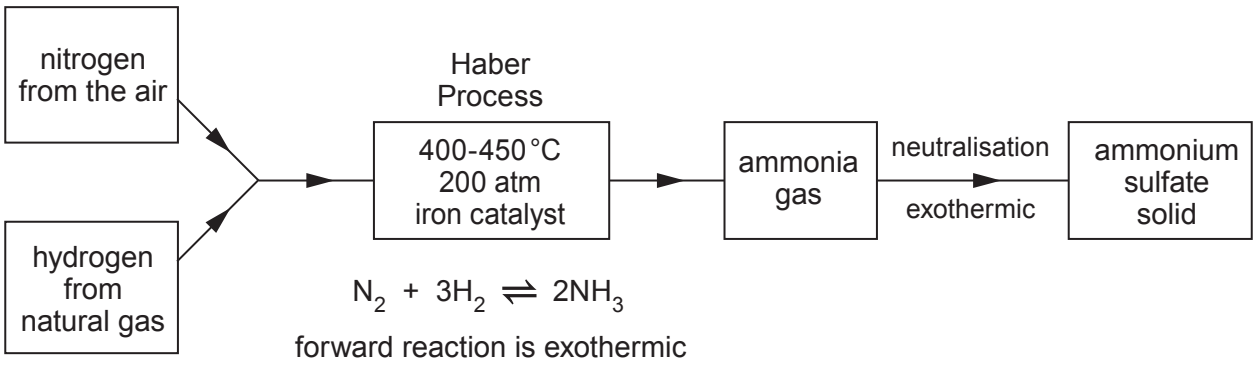
7. The flow diagram outlines the manufacture of ammonia by the Haber Process followed by the production of ammonium sulfate by neutralisation.



(a) Explain the choice of temperature used in the Haber Process and the reason why a catalyst is used. [3]

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(b) Powdered ammonium sulfate is industrially formed by spraying sulfuric acid into a reaction chamber filled with ammonia gas. The exothermic reaction that occurs evaporates all water present in the system, forming a powdery salt.

Write a balanced symbol equation for this reaction. [2]

.....

Examiner only

(c) In the laboratory ammonium sulfate is prepared by reacting ammonium hydroxide solution with dilute sulfuric acid.

Describe the titration method for making pure crystals of ammonium sulfate in the laboratory. Explain each stage of your method. [6 QER]

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8. Methanol, ethanol and butanol all belong to the homologous series of alcohols.

(a) The table shows information about two different methods for the manufacture of ethanol.

	Method **A** fermentation	Method **B** addition reaction
Raw material	sugar from sugar cane	ethene from crude oil
Reaction	yeast catalyst $C_6H_{12}O_6(aq) \longrightarrow 2C_2H_5OH(aq) + 2CO_2(g)$	phosphoric(V) acid catalyst $C_2H_4(g) + H_2O(g) \longrightarrow C_2H_5OH(l)$
Operating pressure	1 atm	60 atm
Type of process	batch (stop-start)	continuous (runs all the time)

Use the information in the table and your knowledge to answer the following question.

Explain **two** advantages and **two** disadvantages of method **A** compared with method **B**. [4]

Advantages

1. .....

.....

2. .....

.....

Disadvantages

1. .....

.....

2. .....

.....

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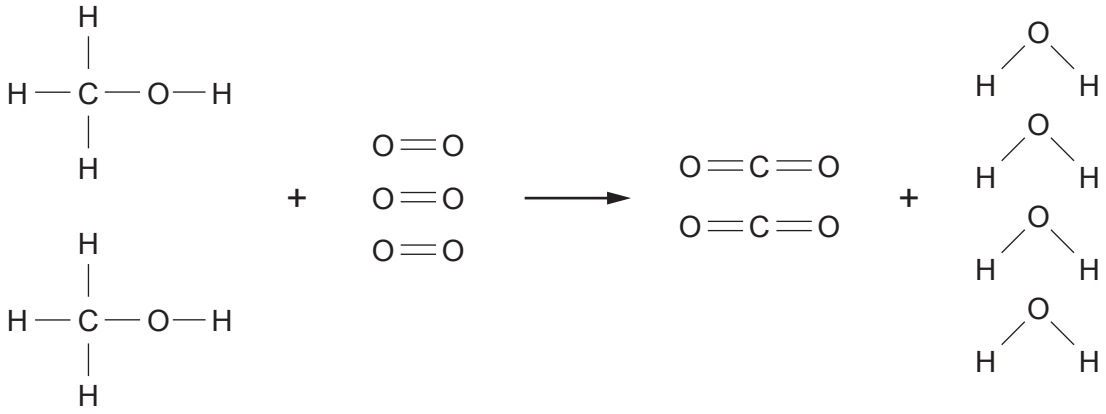
(b) Ethanol is found in alcoholic drinks. Alcoholic drinks turn sour when left exposed to air because ethanol is oxidised to ethanoic acid and water.

Complete the balanced symbol equation for this reaction. [1]

$C_2H_5OH + O_2 \longrightarrow$ .....

(c) Methanol readily burns in air. The diagram shows the bonds which are broken and the bonds which are formed during the combustion of methanol.



Some relevant bond energies are shown in the table.

Bond	Bond energy (kJ)
C—H	413
C—O	358
C=O	805
O—H	464

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(i) The total energy needed to break all the bonds in the reactants is 5616 kJ. The energy needed to break the bonds in one molecule of methanol is 2061 kJ.

Use this information to calculate the amount of energy needed to break **one** O═O bond. [2]

Energy needed = ... kJ

(ii) Calculate the total energy released when all the bonds in the products are formed. [2]

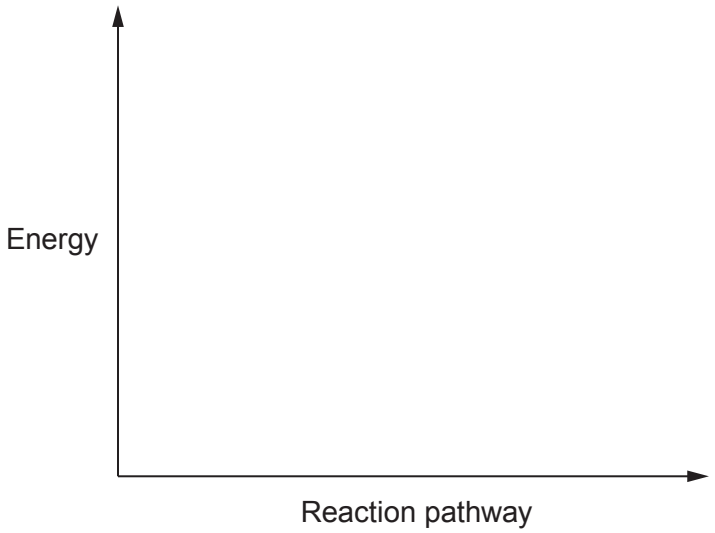
Energy released = ... kJ

(iii) The burning of methanol gives out heat and is said to be exothermic. Use the total energy value 5616 kJ and your answer to part (ii) to show that this is correct. [1]

.....

.....

(iv) On the axes below draw the energy profile for the combustion of methanol and use the symbol (↕) to show the activation energy for the reaction. [1]



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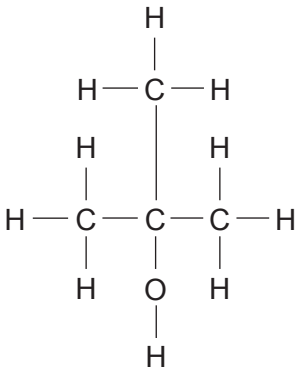
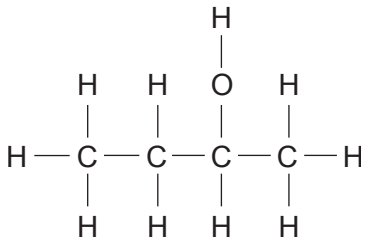
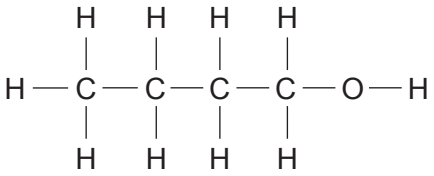
(d) Butanol has the molecular formula C_4H_9OH. It has four positional isomers, **A**, **B**, **C** and **D**.



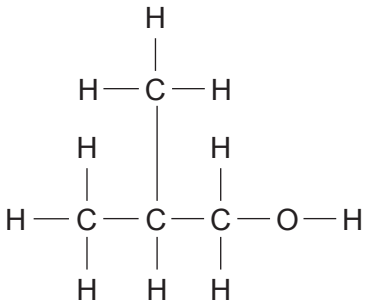
A



B



C



D

Give the **letter** of the isomer corresponding to each of the names in the table. [2]

Name	Isomer
butan-1-ol	
butan-2-ol	
2-methylpropan-1-ol	
2-methylpropan-2-ol	

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9. *(a)* A student carries out a series of chemical tests on solutions of three unknown compounds, **A**, **B** and **C**. Her results are recorded in the table.

	A	**B**	**C**
Add dilute HCl	no reaction	fizzes	no reaction
Add $BaCl_2(aq)$	white precipitate forms	no reaction	no reaction
Add NaOH(aq)	green precipitate forms	pungent smelling gas given off, turns damp red litmus paper blue	no reaction
Add $AgNO_3(aq)$	no reaction	no reaction	cream precipitate forms
Flame test	no colour	no colour	apple-green flame

Use the information provided to give the **chemical name** for each of the compounds. [3]

Compound **A** .....

Compound **B** .....

Compound **C** .....

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(b) A technician wants to prepare 250 cm^3 of a 0.25 mol / dm^3 solution of lead nitrate, $Pb(NO_3)_2$.

(i) Calculate the number of moles of lead nitrate required to make the solution. [2]

Number of moles = ... mol

(ii) Calculate the mass of solid lead nitrate that should be dissolved to make the solution. [2]

A_r(Pb) = 207 A_r(O) = 16 A_r(N) = 14

Mass = ... g

(iii) The only electronic balance available to the technician has a precision of ± 0.01 g.

Exactly how much lead nitrate should the technician weigh out to ensure that the concentration of the solution is as close as possible to 0.25 mol / dm^3 ? [1]

Mass ..... g

8

END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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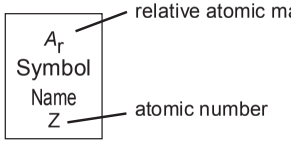
FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	**Formula**	**Name**	**Formula**
aluminium	Al^{3+}	bromide	Br^{-}
ammonium	NH_4^{+}	carbonate	CO_3^{2-}
barium	Ba^{2+}	chloride	Cl^{-}
calcium	Ca^{2+}	fluoride	F^{-}
copper(II)	Cu^{2+}	hydroxide	OH^{-}
hydrogen	H^{+}	iodide	I^{-}
iron(II)	Fe^{2+}	nitrate	NO_3^{-}
iron(III)	Fe^{3+}	oxide	O^{2-}
lithium	Li^{+}	sulfate	SO_4^{2-}
magnesium	Mg^{2+}		
nickel	Ni^{2+}		
potassium	K^{+}		
silver	Ag^{+}		
sodium	Na^{+}		
zinc	Zn^{2+}		

THE PERIODIC TABLE

Group 1	2											3	4	5	6	7	0
						1 H Hydrogen 1											4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
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	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 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	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 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	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key



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