

Centre Number	Candidate Number	Name
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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
General Certificate of Education Ordinary Level

**CHEMISTRY**

**5070/02**

Paper 2 Theory

October/November 2006

**1 hour 30 minutes**

Candidates answer on the Question Paper.  
Additional Materials: Answer Paper

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.  
Write in dark blue or black pen.  
Do not use staples, paper clips, highlighters, glue or correction fluid.

**Section A**

Answer **all** questions.  
Write your answers in the spaces provided on the Question Paper.

**Section B**

Answer any **three** questions.  
Write your answers on any lined pages and/or separate answer paper.

At the end of the examination, fasten all your work securely together.  
The number of marks is given in brackets [ ] at the end of each question or part question.  
A copy of the Periodic Table is printed on page 20.

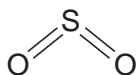
For Examiner's Use	
Section A	
B7	
B8	
B9	
B10	
Total	

## Section A

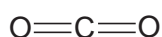
Answer **all** the questions in this section in the spaces provided.

The total mark for this section is 45.

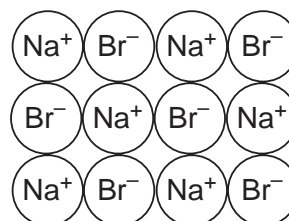
A1 The diagram shows the structures of various compounds.



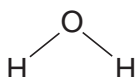
A



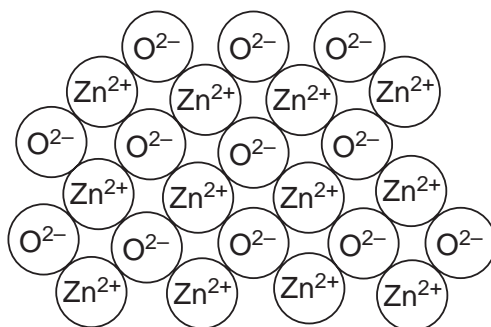
B



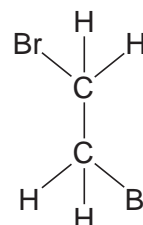
C



D



E



F

(a) Use the letters **A** to **F** to answer the following.

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

(i) Which **one** of these compounds is most likely to contribute to acid rain?

.....

[1]

(ii) Which **one** of these compounds is an amphoteric oxide?

.....

[1]

(iii) Which **two** of these compounds have giant structures?

..... and .....

[1]

(iv) Which **one** of these compounds when molten, releases a reddish brown gas at the anode on electrolysis?

.....

[1]

(b) What is the empirical formula of compound F?

.....

(c) Carbon monoxide is a poisonous atmospheric pollutant.  
State how this gas gets into the air.

.....

.....[1]

**A2** The table shows the decomposition temperatures of some metal carbonates.

metal carbonate	decomposition temperature / °C
magnesium carbonate	540
calcium carbonate	900
strontium carbonate	1280
barium carbonate	1360

(a) (i) Describe how the decomposition temperature depends on the position of the metal in the reactivity series.

.....

.....[1]

(ii) Write an equation for the thermal decomposition of magnesium carbonate.

.....[1]

(b) Petroleum fractions need to be cracked.

(i) Why do oil companies need to crack petroleum fractions?

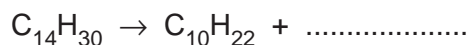
.....

.....[1]

(ii) State the conditions needed for cracking.

.....[2]

(iii) Complete the following equation for the cracking of tetradecane.



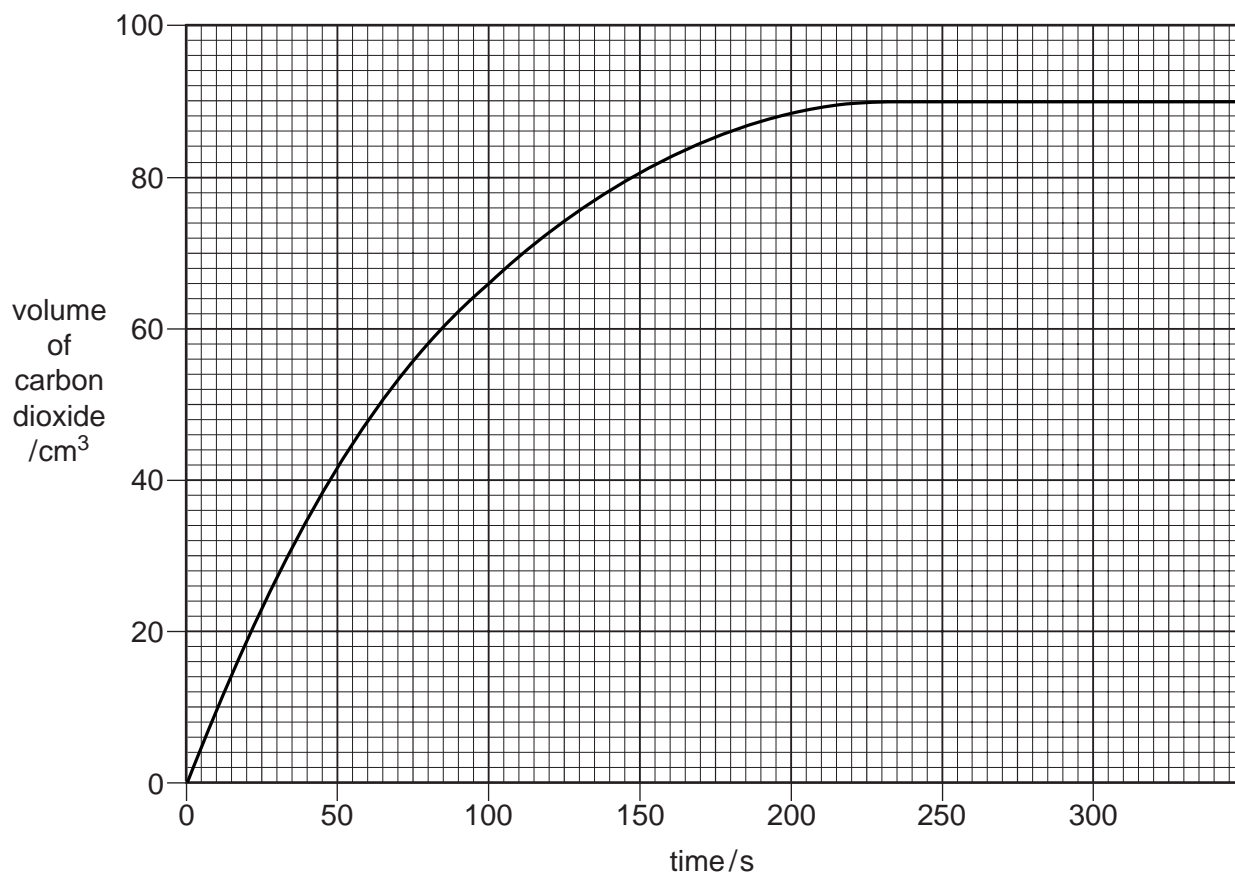
[1]

**A3** A student investigated the reaction of calcium carbonate with hydrochloric acid.



The student used large pieces of calcium carbonate and carried out the reaction at 20 °C. The concentration of hydrochloric acid was 1.0 mol/dm<sup>3</sup>.

The results of the experiment were plotted as a graph which is shown below.



**(a)** After how many seconds did the reaction stop?

.....[1]

**(b)** Calculate the number of moles of carbon dioxide released during the reaction.  
[The volume of one mole of any gas at r.t.p. is 24 dm<sup>3</sup>]

[1]

- (c) The student repeated the experiment using the same mass of calcium carbonate and the same concentration of acid at 20 °C.

This time the student used small pieces of calcium carbonate. On the grid opposite, sketch the graph for the reaction of small pieces of calcium carbonate with hydrochloric acid.

[2]

- (d) When the student repeated the experiment using hydrochloric acid of concentration 2.0 mol/dm<sup>3</sup>, the speed of reaction increased.

Use the kinetic particle theory to explain why the speed of this reaction increased.

.....

.....

.....[2]

**A4** Helium, neon, argon, krypton and xenon are noble gases.

(a) State a use for argon.

.....[1]

(b) Use ideas about electronic structure to explain why the noble gases are unreactive.

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

(c) Complete the table to show the number of particles in two isotopes of argon.

isotope	number of protons	number of electrons	number of neutrons
${}_{18}^{36}\text{Ar}$			
${}_{18}^{40}\text{Ar}$			

[2]

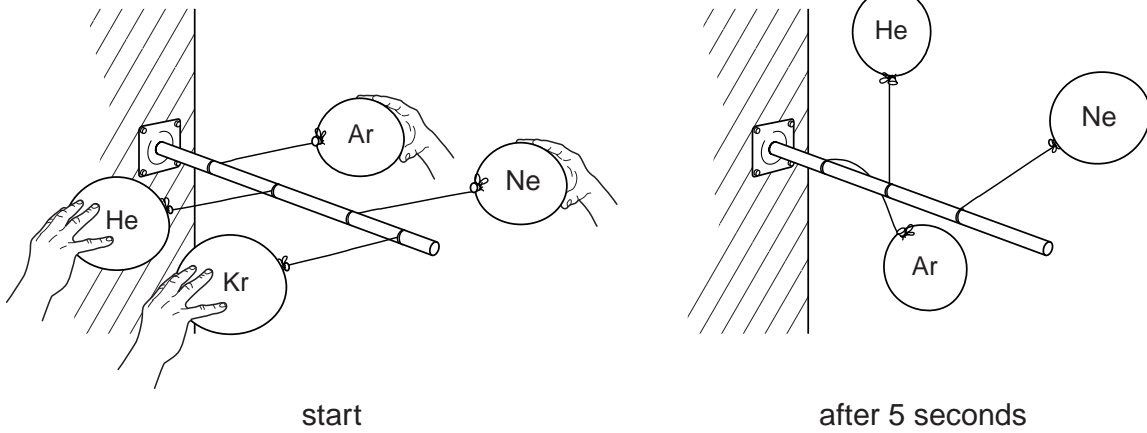
(d) Explain why potassium comes after argon in the Periodic Table even though it has a relative atomic mass which is lower than that of argon.

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

(e) Compounds of xenon with fluorine were first made in the 1960s.  
Xenon reacts with fluorine at 400 °C to form xenon tetrafluoride, XeF<sub>4</sub>.  
Write a symbol equation for this reaction.

[1]

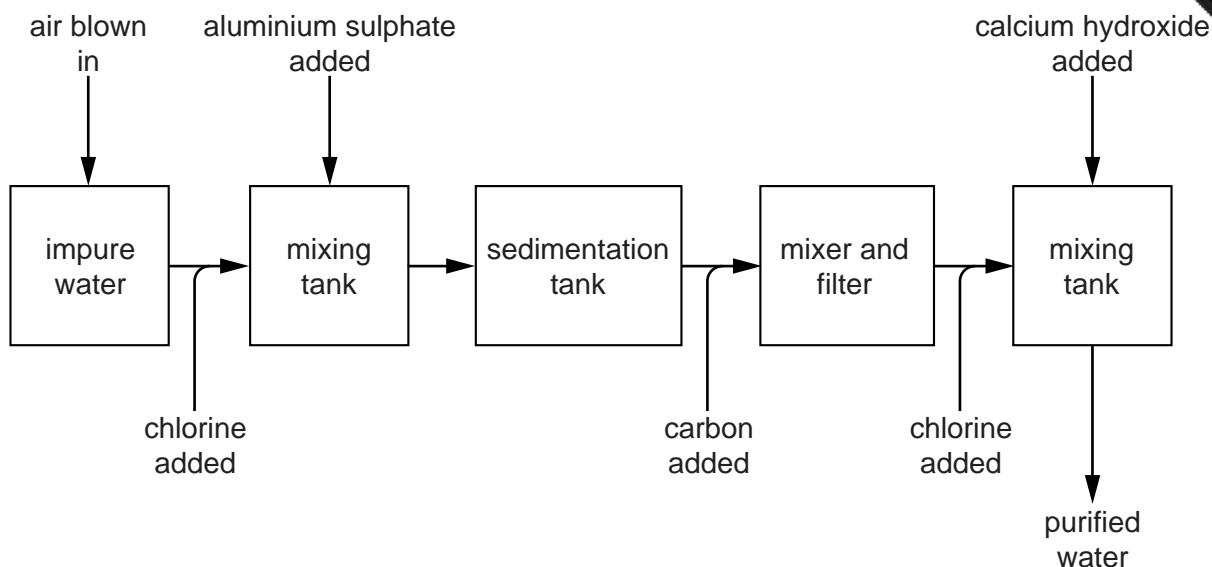
- (f) Balloons filled with helium, neon, argon and krypton were tied to a bar. They were held horizontally at the same height and then released. The position of three of the balloons 5 seconds after release is shown in the diagram.



Predict the position of the balloon filled with krypton.

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

A5 The diagram shows the stages in water purification.



(a) After the air is blown in, the impure water contains iron(III) ions.

(i) What is the approximate percentage of oxygen in the air?

.....[1]

(ii) Describe a test for iron(III) ions.

test.....

result.....[2]

(b) Aluminium sulphate is added to clump tiny particles of clay together to form larger particles of solid.

(i) Suggest how the solids are separated from the water.

.....[1]

(ii) Aluminium sulphate contains  $Al^{3+}$  ions and  $SO_4^{2-}$  ions.  
Deduce the formula of aluminium sulphate.

.....[1]



(c) Why are the following added during the water purification process?

(i) carbon

.....[1]

(ii) chlorine

.....[1]

(d) Calcium hydroxide is added to neutralise the acidic solution formed after chlorine has been added. This solution contains hydrochloric acid.

(i) Write an equation for the reaction of calcium hydroxide with hydrochloric acid.

.....[1]

(ii) Write the ionic equation for this reaction.

.....[1]

A6 Methane, CH<sub>4</sub>, is the major constituent of natural gas.

(a) Draw a dot-and cross-diagram to show how the outer shell electrons are arranged in methane.

show hydrogen electrons as •  
show carbon electrons as x

[1]

(b) At a temperature of -5 °C and a pressure of 26 atmospheres, methane combines with water and forms an ice-like structure called methane hydrate. Large quantities of methane hydrate have been found underground.

(i) Describe the arrangement and motion of the particles in solid methane hydrate.

.....  
.....[2]

(ii) The methane hydrate underground has not yet been extracted in large amounts. When it is extracted, large volumes of methane are released.

Suggest **two** reasons why methane hydrate decomposes when it is extracted.

.....  
.....  
.....[2]

(iii) Describe how the presence of methane in the atmosphere may affect the environment.

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

(c) A very small quantity of methane is present in the atmosphere.

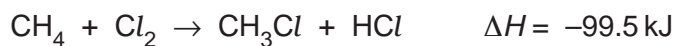
State another source of this gas.

.....[1]

(d) State a use of methane.

.....[1]

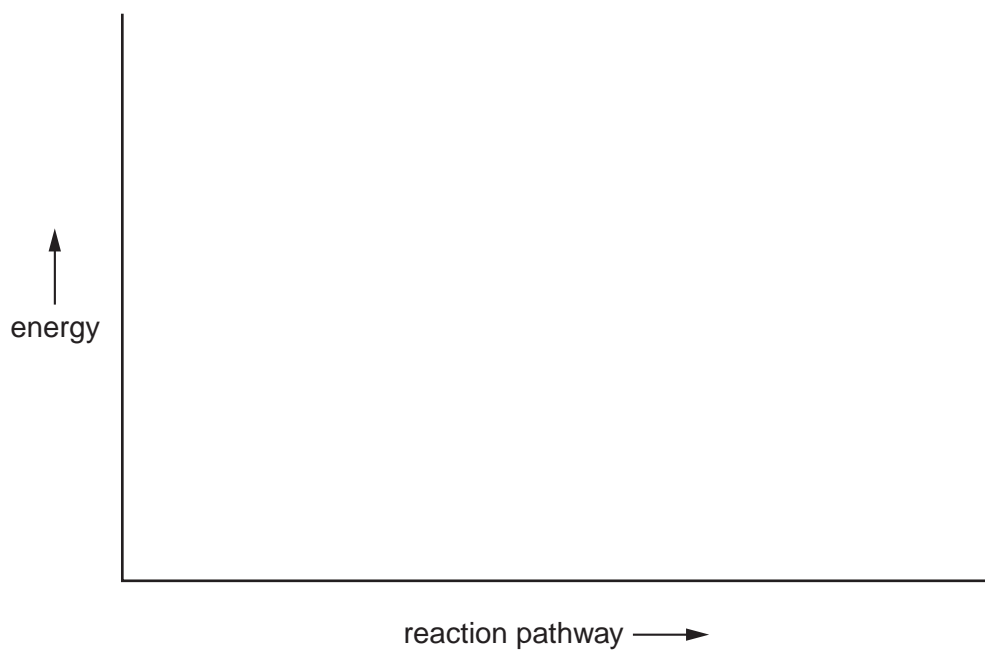
(e) In the presence of light methane reacts with chlorine.



Draw an energy profile diagram for this reaction.

Show:

- the reactants and products,
- the activation energy,
- the enthalpy change.



[3]

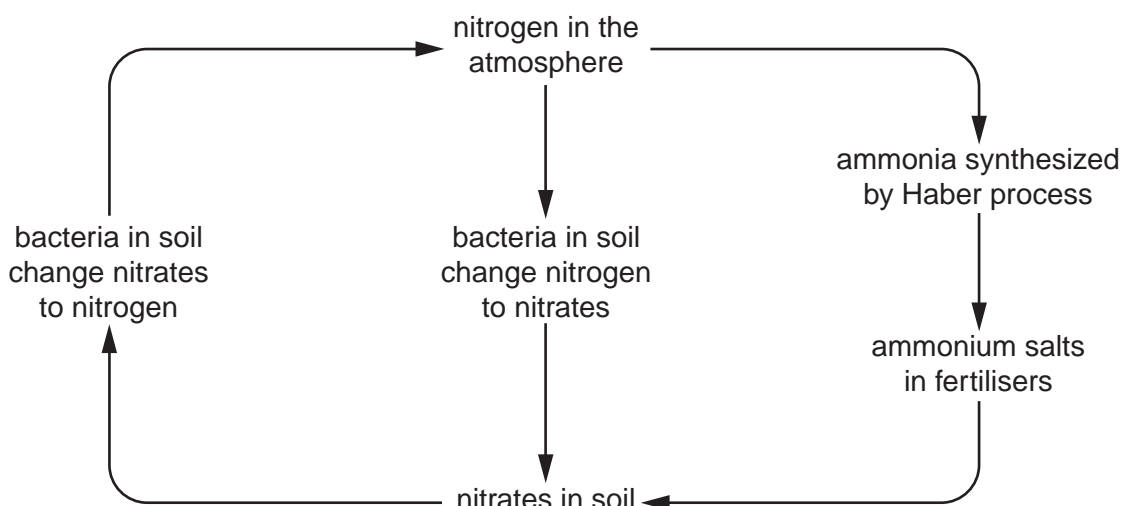
## Section B

Answer **three** questions from this section on the lined pages at the end of this booklet.

Tie any extra sheets loosely to this booklet.

The total mark for this section is 30.

**B7** A simplified diagram of the nitrogen cycle is shown below.



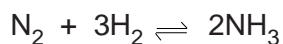
- (a) Although certain bacteria in the soil convert nitrogen gas into nitrates, other bacteria convert nitrogen into ammonium salts. The ionic equation for this second reaction is



Explain why this is a reduction reaction. [1]

- (b) In the presence of hydrogen ions, a different type of bacterium converts nitrate ions into nitrogen gas and water. Give the ionic equation for this reaction. [1]

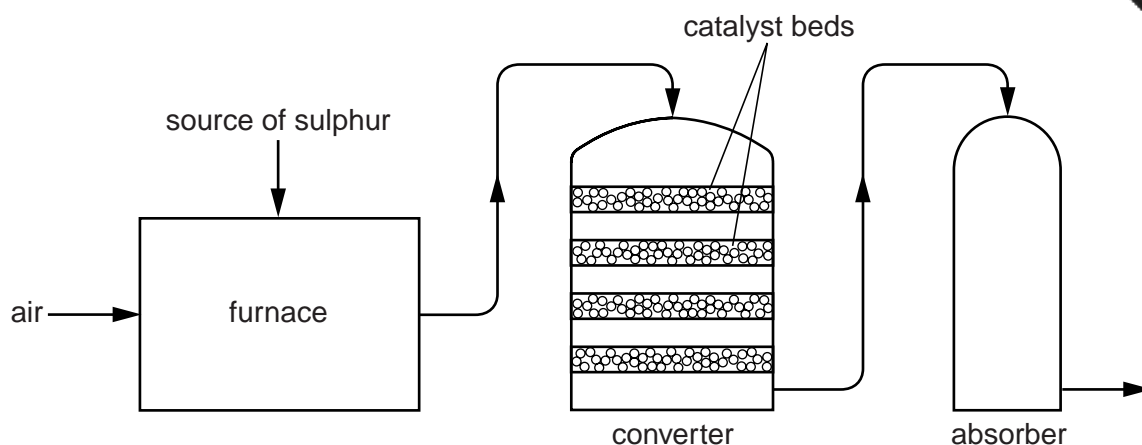
- (c) Ammonia is synthesized by the Haber process.



- (i) State the sources of both the nitrogen and hydrogen needed for the Haber process. [2]
- (ii) State the essential conditions for the Haber process. [2]

- (d) Fertilisers are added to the soil to improve crop yields. A farmer has the choice of two fertilisers, ammonium nitrate,  $\text{NH}_4\text{NO}_3$ , or diammonium hydrogen phosphate,  $(\text{NH}_4)_2\text{HPO}_4$ .
- Show by calculation which of these fertilisers contains the greater percentage of nitrogen in its mass.  
You must show your working. [3]
- (e) State one major problem caused when the nitrates from fertilisers leach from the soil into streams and rivers. [1]

**B8** The diagram shows the stages in the manufacture of sulphuric acid.



- (a) In the furnace, an ore containing zinc sulphide,  $\text{ZnS}$ , is heated in oxygen to make zinc oxide,  $\text{ZnO}$ , and sulphur dioxide.

Write an equation for this reaction. [1]

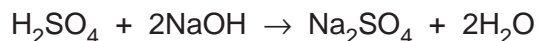
- (b) In the converter, sulphur dioxide and oxygen are passed over a series of catalyst beds at a temperature of about  $420^\circ\text{C}$ .



- (i) An increase in pressure increases the yield of sulphur trioxide. Explain the reason for this effect. [1]
- (ii) Even though an increase in pressure increases the yield of sulphur trioxide, the reaction in the converter is carried out at atmospheric pressure. Suggest a reason for this. [1]
- (iii) In some sulphuric acid plants, the gases are cooled when they pass from one catalyst bed to the next. Use the equation to explain why the gases need to be cooled. [2]
- (c) When sulphuric acid is reacted with excess iron powder, iron(II) sulphate and hydrogen are produced.

Suggest how crystals of iron(II) sulphate could be prepared from this reaction mixture. [2]

- (d)  $12.0 \text{ cm}^3$  of an aqueous solution of sulphuric acid exactly neutralised  $20.0 \text{ cm}^3$  of a solution of sodium hydroxide of concentration  $0.150 \text{ mol/dm}^3$ .



Calculate the concentration, in  $\text{mol/dm}^3$  of the aqueous sulphuric acid. [3]

**B9** Both ethanoic acid and butanoic acid are found in some plants and bacteria.

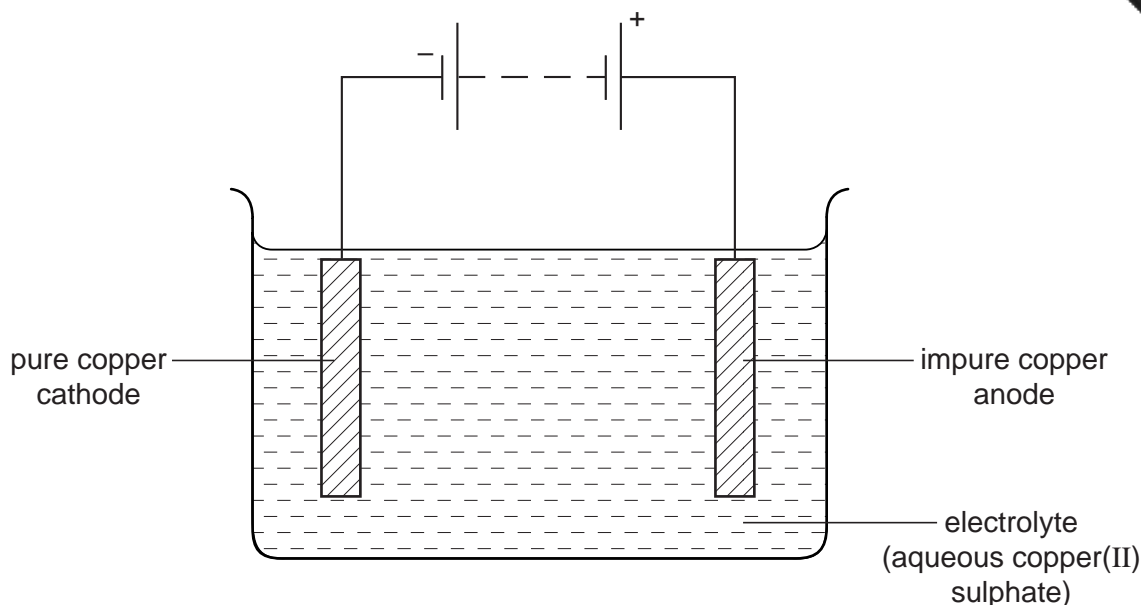
- (a) Draw the structure of butanoic acid showing **all** atoms and bonds.
- (b) Explain:
- (i) what is meant by a weak acid, [1]
  - (ii) how you could show that butanoic acid is a weak acid. [2]
- (c) Butanoic acid can be converted into an ester by heating it with an alcohol and a few drops of concentrated sulphuric acid.

A sample of an ester contains 0.18 g of carbon, 0.03 g of hydrogen and 0.08 g of oxygen. The relative molecular mass of the ester is 116.

Calculate both the empirical and molecular formulae of this ester. [3]

- (d) Ethanoic acid can be produced by the bacterial fermentation of glucose,  $C_6H_{12}O_6$ . During this process glucose is first oxidised to ethanol.
- (i) Write an equation for the fermentation of glucose to form ethanol and carbon dioxide. [1]
  - (ii) State the reagents and conditions required for ethanol to be oxidised to ethanoic acid in the laboratory. [2]

**B10** The diagram shows a cell for purifying copper.



- (a) Describe what you would observe during this electrolysis and write the equations for the reactions at the electrodes. [3]
- (b) The electrodes and the electrolyte conduct electricity.
- (i) Explain how the structure of metals allows copper electrodes to conduct electricity. [1]
- (ii) Explain why solid copper(II) sulphate does not conduct electricity but an aqueous solution of copper(II) sulphate does conduct. [2]
- (c) Describe how the apparatus shown in the diagram could be modified in order to electroplate an iron object, such as a knife, with nickel. [2]
- (d) Bronze is an alloy of copper and tin. Bronze is less malleable than pure copper. Use ideas about the structure of metals and alloys to explain why bronze is less malleable than pure copper. [2]



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**DATA SHEET**  
**The Periodic Table of the Elements**

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7	9	<b>Li</b> Lithium 3	<b>Be</b> Beryllium 4	<table border="1" style="margin: auto; border-collapse: collapse;"> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;"><b>H</b> Hydrogen 1</td> </tr> </table>										1	<b>H</b> Hydrogen 1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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39	40	<b>K</b> Potassium 19	<b>Ca</b> Calcium 20	45	48	51	52	55	56	59	64	65	70	73	75	79	84	88	89	91	93	96	101	106	112	115	119	122	128	131	137	139	178	181	184	186	190	192	195	197	201	204	207	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947