Name: ……………………………………….. (   )

ASSUMPTION ENGLISH SCHOOL
PRELIMINARY EXAMINATION 2020

CHEMISTRY
6092 / 01

LEVEL: Sec 4 Express **DATE:** 31 August 2020

CLASS: Sec 4/2 **DURATION:** 1 hour

Additional materials provided: 1 sheet of OAS paper

INSTRUCTIONS TO CANDIDATES
Do not open this booklet until you are told to do so.

Write your NAME and INDEX NUMBER at the top of this page and on the OAS paper.
Shade your index number on the OAS paper.

Paper 1
MULTIPLE CHOICE QUESTIONS (40 marks)
There are 40 questions in this section.
Answer **all** questions.
For each question, there are four possible answers **A**, **B**, **C** and **D**.

Choose the correct answer and record your choice in soft or 2B pencil on the OAS paper provided.
DO NOT fold or bend the OAS paper.

For Examiner's use:	
Paper 1	/ 40

A copy of the Periodic Table is printed on page 19.

At the end of the examination, hand in your OAS paper and question booklet separately.

This Question Paper consists of 19 printed pages including this page.

Multiple Choice Questions (40 marks)

There are **forty** questions in this section. Answer **ALL** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice on the OAS in soft pencil.

1 Chlorine crystals are obtained by freezing oxygen at -102 ºC.

What will the chlorine crystals contain?

A chlorine atoms and molecules

B chloride ions and oxygen atoms

C chlorine molecules only

D chlorine atoms only

2 The atmosphere of Earth contains mainly nitrogen, oxygen and argon. The melting and boiling points of these gases are shown in the table.

gas	melting point / ºC	boiling point / ºC
argon	-189	-186
nitrogen	-210	-196
oxygen	-219	-183

If only liquid oxygen is to be obtained from a sample of atmospheric air, what temperature should the sample of air be decreased to?

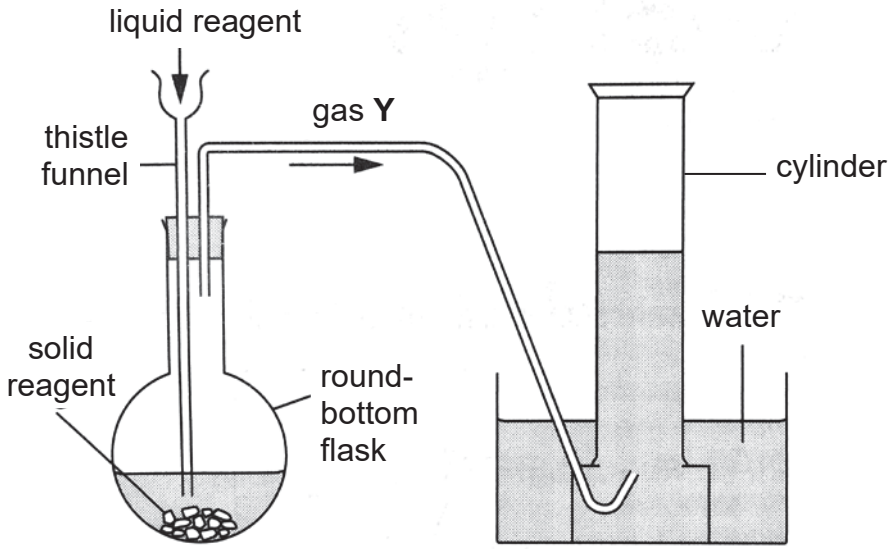
A -180 ºC

B -185 ºC

C -187 ºC

D -198 ºC

3 A liquid reagent was poured into the round-bottom flask and react with a solid reactant. The gas, **Y**, was collected in the cylinder over water as shown below.



Which statement is true?

A Gas **Y** is soluble in water.

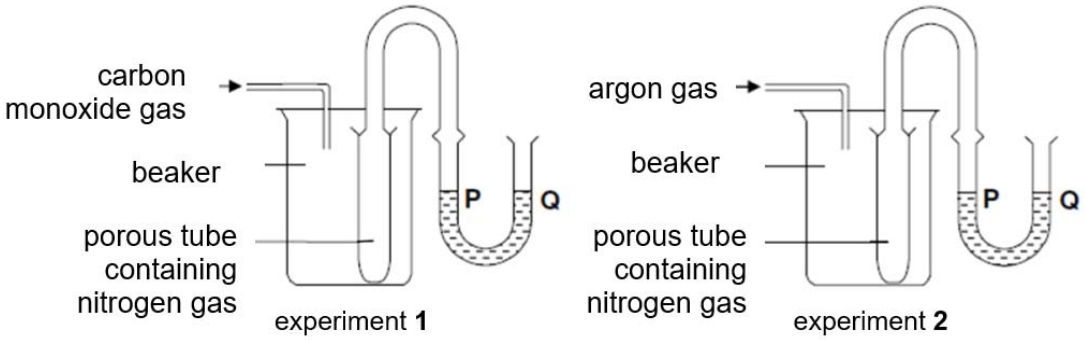
B Gas **Y** is not soluble or only slightly soluble in water.

C Some of gas **Y** has escaped from the thistle funnel.

D The cylinder contains impure gas **Y**.

4 Two experimental set-ups used to demonstrate diffusion of gases are shown in the diagram below. The gas in each porous tube is nitrogen.

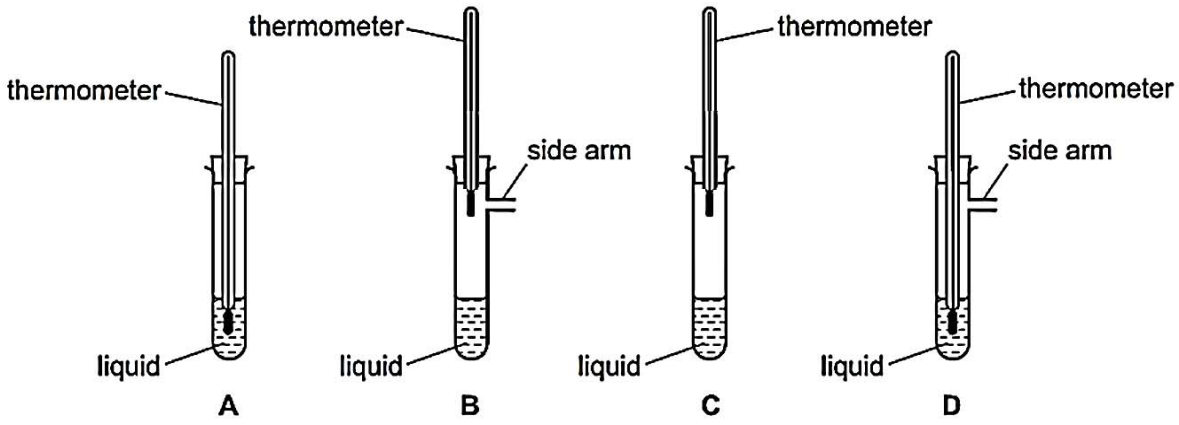
In experiment **1**, the gas introduced into the beaker is carbon monoxide, while in experiment **2**, the gas is argon.



What changes, if any, to the water levels at **P** and **Q** would you expect to see in both experiments?

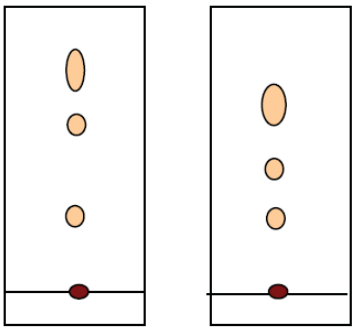
	experiment **1**	experiment **2**
A	**P** and **Q** remain at the same level	**P** is at a higher level than **Q**
B	**P** and **Q** remain at the same level	**Q** is at a higher level than **P**
C	**P** is at a higher level than **Q**	**P** is at a higher level than **Q**
D	**P** is at a higher level than **Q**	**Q** is at a higher level than **P**

5 The tubes shown below contain a dilute solution of a solid dissolved in a liquid.



Which apparatus is most suitable to determine the exact boiling point of the liquid?

6 Two students carried out a chromatography experiment on the same black ink to examine the dyes found in the ink. The chromatograms obtained by each of them are shown below.



Why were the chromatograms different?

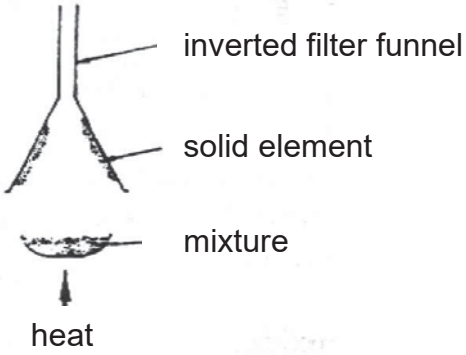
A The two students used different solvents.

B The two students used different volumes of solvent.

C The two students used different quantities of the black ink.

D The two students ran the chromatography for different durations.

7 The diagram below shows a method by which a certain solid element can be separated from a mixture of that solid with sodium chloride.



What could the solid element likely be?

A carbon

B iodine

C copper

D magnesium

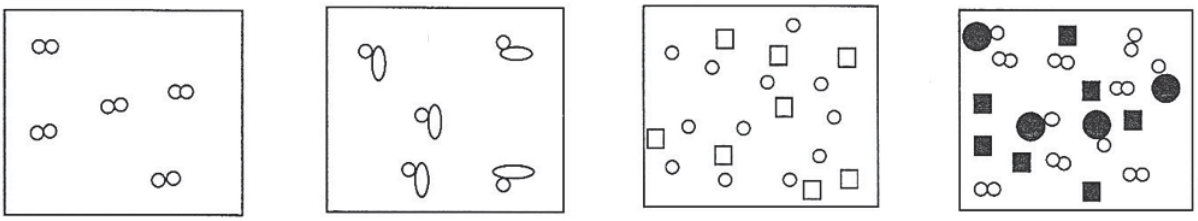
8 The diagrams below can be used to illustrate the following.

I pure element

II a mixture of elements

III pure compound

IV a mixture of elements and compound



W X Y Z

What is the correct order of the diagrams?

	I	II	III	IV
A	W	X	Y	Z
B	Z	W	X	Y
C	W	Y	X	Z
D	X	Z	W	Y

9 The table shows the isotopic composition of iron.

isotope	percentage abundance / %
^{54}Fe	5.8
^{56}Fe	91.6
^{57}Fe	2.2
^{58}Fe	0.4

What is the relative atomic mass of iron?

A 55.9 **B** 56.0

C 56.1 **D** 56.2

10 Elements **A** and **B** react to form compound **C** which is a solid at room condition. The formula of **C** is $\mathbf{A_2B}$. If **B** is a group VI element, what element is **A** likely to be?

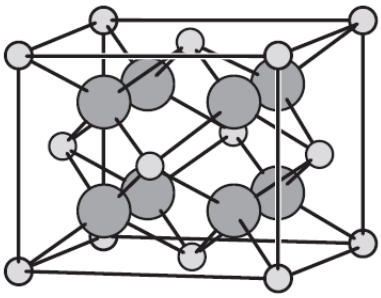
A hydrogen

B phosphorous

C silicon

D sodium

11 The diagram shows the structure of an ionic compound.



What is a possible formula for this compound?

A CaF_2 **B** SO_2

C KF **D** MgO

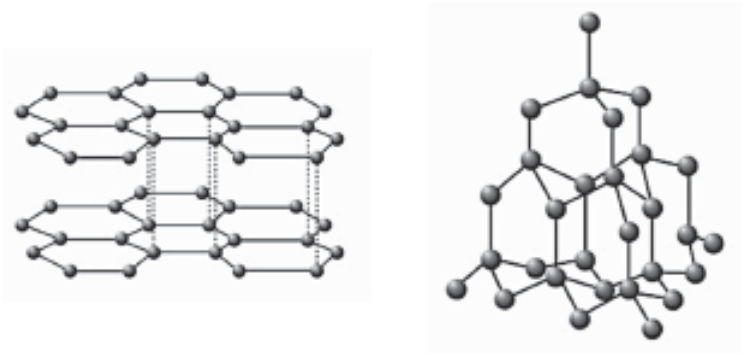
12 The table gives information about the ability of four substances to conduct electricity.

substance	electrical conductivity
P	does not conduct under any condition
Q	does not conduct under any condition
R	conducts only when molten
S	conducts when in solid and molten state

What could the four substances be?

	P	Q	R	S
A	S	CH_4	Pb	MgO
B	S	Pb	CH_4	MgO
C	CH_4	S	MgO	Pb
D	Pb	S	MgO	CH_4

13 The diagrams show the arrangement of atoms and structures in two different forms of a solid element, **P** and **Q**.

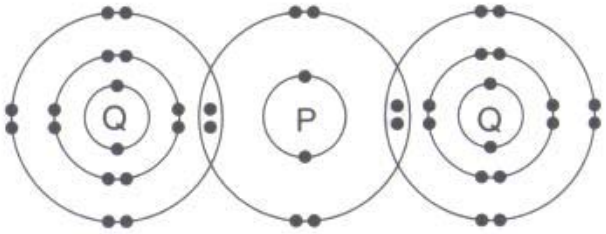


P **Q**

Which option suggests the correct uses of structures **P** and **Q**?

	structure P	**structure Q**
A	pencil lead	lubricant for hot machines
B	lubricant for hot machines	tips of drill bits
C	protective coating for steel objects	jewellery
D	lubricant for hot machines	waterproof coats

14 The diagram below shows the bonding between elements **P** and **Q** in the covalent molecule, $\mathbf{PQ_2}$.



Which option represents the electronic structures of atoms **P** and **Q** before combining together to form the above molecule?

	P	**Q**
A	2.4	2.8.6
B	2.4	2.8.7
C	2.6	2.8.7
D	2.8	2.8.8

15 Metals have positive ions in a ‘sea of electrons’.

Which metal atom provides the most electrons per mole of atoms?

A aluminium
B calcium
C sodium
D zinc

16 How many atoms are there in 34 g of ammonia?

A 3.0×10^{23}
B 1.2×10^{24}
C 2.4×10^{24}
D 4.8×10^{24}

17 A compound has the percentage composition by mass; 38.7% carbon, 9.75% hydrogen and 51.55% oxygen.

What is the empirical formula of the compound?

A CHO
B CH_3O
C $C_2H_6O_2$
D C_4HO_5

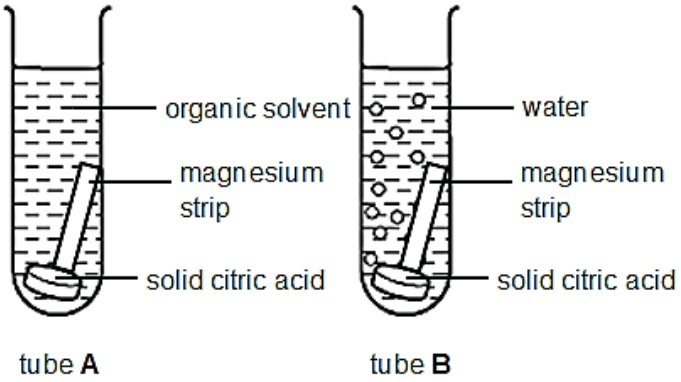
18 When 20 g of impure calcium carbonate (M_r = 100) is heated, 6.6 g of carbon dioxide (M_r = 44) is obtained.

Assume that none of the impurities produce carbon dioxide on heating.

What is the percentage purity of the sample of calcium carbonate?

A 15.0%
B 25.0%
C 55.0%
D 75.0%

19 Two experiments, **A** and **B**, were conducted to investigate the properties of citric acid.



Effervescence was observed in tube **B** but not in tube **A**.

What can be concluded from both experiments?

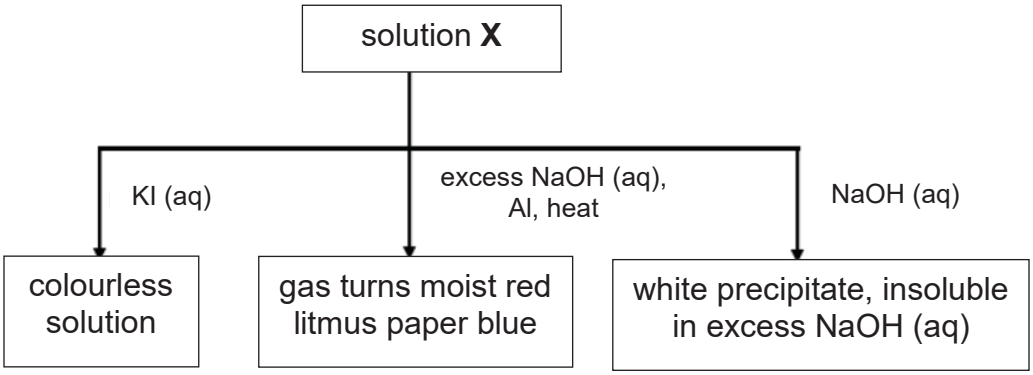
A Water is required for any chemical reaction.

B The organic solvent does not produce hydrogen ions.

C Water releases hydrogen ions in citric acid.

D Citric acid ionises partially in water to produce hydrogen ions to react with the magnesium strip.

20 The diagram below shows the reactions of solution **X**.



What is a possible identity of solution **X**?

A aluminium chloride

B calcium nitrate

C lead(II) chloride

D zinc nitrate

21 Which salt would **not** be prepared by a method involving precipitation?

A barium sulfate

B magnesium carbonate

C silver chloride

D sodium nitrate

22 In the Haber process to manufacture ammonia, which statements are correct?

I The catalyst used is a transition metal.

II Unreacted nitrogen and hydrogen are circulated back into the system.

III Both reactants are obtained from the fractional distillation of liquefied air.

IV The reaction is never complete and the yield is only about 10 – 15%.

A I, II and III only

B I, II and IV only

C II, III and IV only

D I, II, III and IV

23 Which methods would produce ammonia?

1 Heating aqueous sodium nitrate with sodium hydroxide and aluminium powder.

2 Heating aqueous ammonium chloride with aqueous calcium hydroxide.

3 Heating solid ammonium sulfate with solid potassium hydroxide.

4 Heating aqueous ammonium chloride with dilute hydrochloric acid

A 1 and 2 only

B 1 and 4 only

C 1, 2 and 3 only

D 1, 2 and 4 only

24 A portion of acidified potassium manganate(VII) solution was added to a sample of solution **X**. Solution **X** decolourised the potassium manganate(VII) solution. The resulting solution **Y** was brown. When starch solution was added to a sample of solution **Y**, the solution turned dark blue.

What conclusion can be drawn about solution **X**?

A It is a reducing agent and it contains bromide ions.

B It is a reducing agent and it contains iodide ions.

C It is an oxidising agent and it contains bromide ions.

D It is an oxidising agent and it contains iodide ions.

25 Brass, made of copper and zinc, is suitable to make musical instruments as compared to pure copper because brass is harder than pure copper.

Which statement best explains why brass is harder than pure copper?

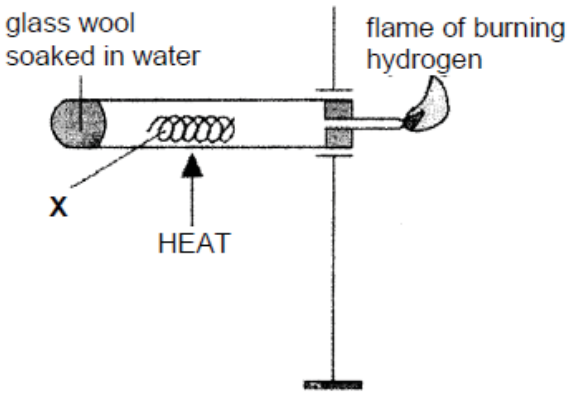
A The zinc atoms have more valence electrons than copper atoms.

B The zinc atoms form strong metallic bonds with copper atoms in brass.

C The zinc atoms prevent the 'sea of electrons' from moving freely in the lattice.

D The zinc atoms prevent layers of copper atoms from sliding over each other easily.

26 A substance **X** is heated in the setup shown in the diagram. A flame is produced.



What is substance **X** most likely to be?

A **X** is a metal above hydrogen in the reactivity series.

B **X** is a metal below hydrogen in the reactivity series.

C **X** is an oxide of a metal that is above hydrogen in the reactivity series.

D **X** is an oxide of a metal that is below hydrogen in the reactivity series.

27 Which is **not** an essential raw material in the extraction of iron in a blast furnace?

A air **B** coke

C haematite **D** sand

28 About 40 % of all steel and iron is produced by recycling.

I Iron, when obtained by a recycling process, produces less carbon dioxide than the blast furnace process.

II Scrap steel contains a higher percentage of iron than iron ore.

III Scrap steel, if not recycled, would cause environmental problems due to its disposal by landfill.

Which statements are correct reasons for recycling iron?

A I and II only **B** I and III only

C II and III only **D** I, II and III

29 Different types of steel differ in how much carbon they contain.

What are the properties of a high carbon steel?

A soft and brittle

B soft and easily shaped

C strong and brittle

D strong and easily shaped

30 In which electrolysis experiment would there be no change in the concentration of the solution?

	electrodes	electrolyte
A	carbon	aqueous copper(II) sulfate
B	copper	aqueous copper(II) sulfate
C	platinum	dilute sulfuric acid
D	carbon	concentrated aqueous sodium chloride

31 In the electrolysis of molten sodium chloride, 46 g of sodium is formed at the cathode.

How many mole(s) of chlorine gas is / are formed at anode?

A 0.5 **B** 1.0

C 2.0 **D** 4.0

32 Which property cannot be predicted from the position of an element in the Periodic Table?

A the acidic or basic nature of its oxide

B the formula of its oxide

C the metallic or non-metallic character

D the number of isotopes it has

33 Thallium is in Group III but resembles Group I elements in several properties.

Which property of thallium does **not** resemble that of Group I elements?

A Thallium is a soft metal.

B Thallium chloride is white.

C Thallium forms the oxide Tl_2O_3.

D Aqueous thallium hydroxide turns red litmus blue.

34 **P**, **Q**, **R** and **S** are elements in the Periodic Table.

- **Q** and **R** are formed as elements at the anode during electrolysis.
- **P** and **S** both conduct electricity.
- **P** has a higher melting point than **S**.
- **Q** displaces **R** from aqueous solutions containing $\mathbf{R}^-$ ions.

Which statement could be correct?

A **Q** could be bromine and **R** could be iodine.

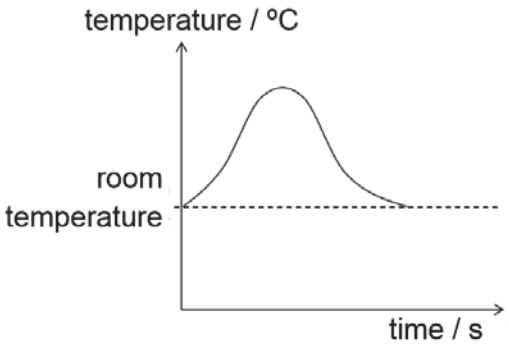
B **P** could be sodium and **S** could be lithium.

C **R** would be more pale in colour than **Q**.

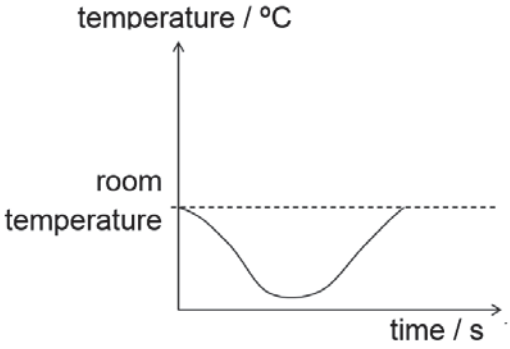
D **S** exists as diatomic molecules.

35 Which graph shows how the temperature alters as ammonium chloride is added to water and then the resulting solution is left to stand?

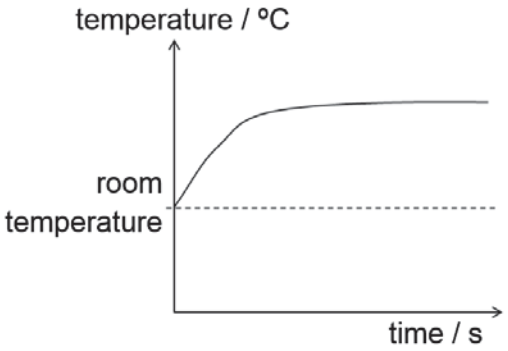
A



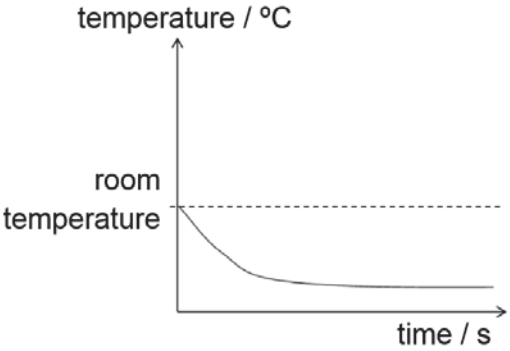
B



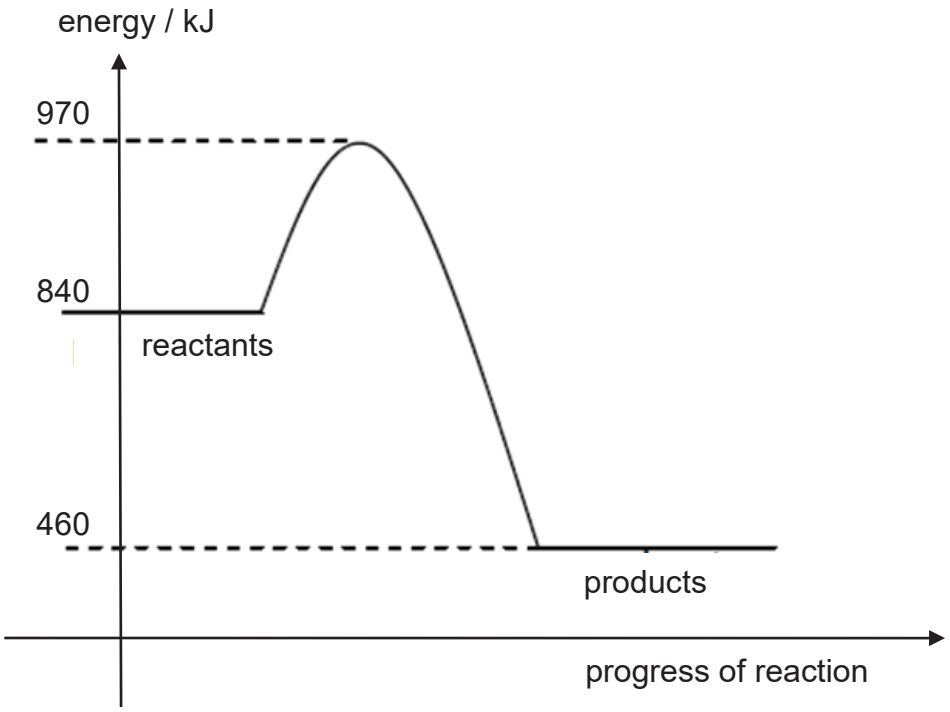
C



D



36 The diagram below shows the energy profile diagram for a chemical reaction.



Which statement is true?

A The reaction is endothermic with activation energy of 970 kJ.

B The reaction is endothermic and 460 kJ of heat energy is taken in.

C The reaction is exothermic with activation energy of 510 kJ.

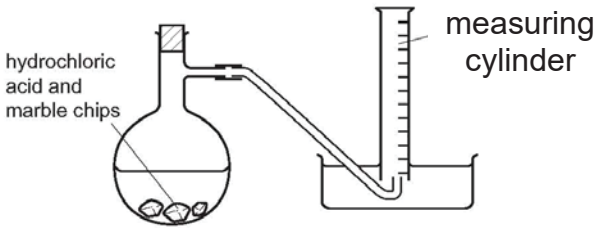
D The reaction is exothermic and 380 kJ of heat energy is given out.

37 A student wants to carry out an experiment to follow the rate of the reaction between hydrochloric acid and marble chips as shown in the equation below.

hydrochloric

$$CaCO_3 + 2\,HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

1



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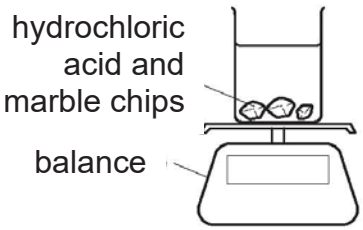

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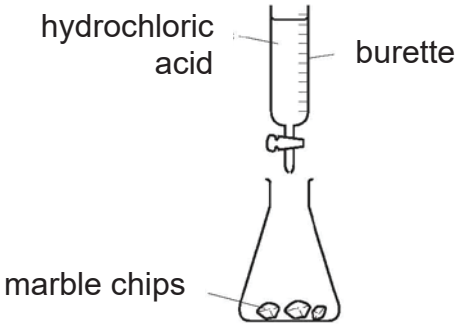

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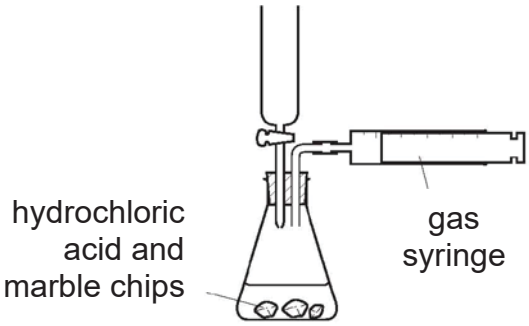


Which diagram(s) show(s) apparatus that is suitable for this experiment?

A 1 only

B 4 only

C 1 and 2 only

D 2 and 4 only

38 Which gas will not be removed from the exhaust gas of a petrol powered car by its catalytic converter?

A carbon dioxide

B carbon monoxide

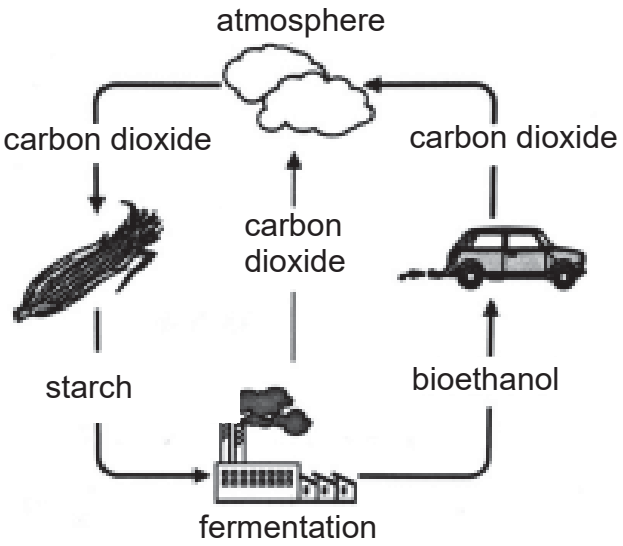
C nitrogen dioxide

D unburnt hydrocarbons

39 Which option shows both the correct source and the correct effect of the named pollutant?

	pollutant	source	effect
A	carbon monoxide	incomplete combustion of carbon-containing fuel	acid rain
B	oxides of nitrogen	lightning activity	global warming
C	methane	combustion of fuels in factories	global warming
D	sulfur dioxide	volcanic eruptions	acid rain

40 Biofuels are fuels made from biological sources instead of fossil fuels. The diagram shows stages in the production and use of bioethanol, which is an example of a biofuel.



Which statement explains why bioethanol is often described as 'carbon-neutral'?

A Cars produce less carbon dioxide than production of bioethanol.

B Corn is a renewable fuel source.

C Corn plants take in as much carbon dioxide during photosynthesis as carbon dioxide produced from the production and combustion of bioethanol.

D The amount of carbon dioxide produced during combustion and production of bioethanol is insignificant as compared to the carbon dioxide taken in during photosynthesis.

– END OF PAPER –

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		Key: proton (atomic) number / atomic symbol / name / relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Name: ……………………………………….. (   )

ASSUMPTION ENGLISH SCHOOL
PRELIMININARY EXAMINATION 2020

CHEMISTRY
6092 / 02

LEVEL: Sec 4 Express **DATE:** 25 August 2020

CLASS: Sec 4/2 **DURATION:** 1 hour 45 minutes

Additional materials provided: Nil

INSTRUCTIONS TO CANDIDATES
Do not open this booklet until you are told to do so.
Write your NAME and INDEX NUMBER at the top of this page.

This paper consists of 2 sections.

SECTION A
SHORT STRUCTURED QUESTIONS (50 marks)
Answer **all** questions in the spaces provided on the question paper.

SECTION B
FREE RESPONSE QUESTIONS (30 marks)
Answer all **three** questions, the last question is in the form of an either / or and only one of the alternatives should be attempted. Write your answers in the spaces provided on the question paper.

For Examiner's use:	
Paper 1	/ 40
Paper 2	/ 80
Paper 3	/ 40
Total	/ **160**
Total (%)	/ **100**

A copy of the Periodic Table is printed on page 23.

This Question Paper consists of 23 printed pages including this page.

Section A – Short-Structured Questions (50 marks)
Answer **all** questions in the spaces provided.

1 The formulae of some substances are given in the following list.

Zn	N_2	Fe	CaO
C	H_2	CH_4	Cu

Using the list of substances given, answer the questions.

(a) Which substance can be used for galvanisation?

…….. [1]

(b) Which substance is added to soil to reduce acidity?

…….. [1]

(c) Which substance is an element with giant molecular structure?

…….. [1]

(d) Which substance is a component in the alloy, brass?

…….. [1]

(e) Which substance contributes largely to the air composition?

…….. [1]

2 Four substances undergo different chemical reactions and the observations are recorded in the table below.

	copper(II) nitrate	substance **1**
substance **2**	blue precipitate formed	soluble salt formed by titrating substances **1** & **2**
substance **3**	no visible observation	effervescence; insoluble white precipitate formed; reaction stops quickly
substance **4**	pinkish brown solid formed	lighted splint extinguished with a "pop" sound; soluble salt formed

Using the list from the table below, identify substances **1** to **4**.

barium carbonate	calcium oxide	hydrogen	magnesium
silver	sodium carbonate	sodium hydroxide	sulfuric acid

(a) Substance **1**: …….. [1]

(b) Substance **2**: …….. [1]

(c) Substance **3**: …….. [1]

(d) Substance **4**: …….. [1]

3 Aqueous potassium manganate (VII) can react with aqueous hydrogen peroxide according to the equation:

$$3\ H_2SO_4 + 2\ KMnO_4 + 5\ H_2O_2 \rightarrow 2\ MnSO_4 + 5\ O_2 + 8\ H_2O + K_2SO_4$$

(a) Complete the table.

oxidation state of manganese in:		oxidation state of oxygen in:	
potassium manganate (VII)	manganese sulfate	hydrogen peroxide	oxygen
+7			0

[2]

(b) Use the information from part **(a)** to explain why aqueous potassium manganate (VII) is an oxidizing agent.

……..

……..

…….. [2]

4 An ice-cream maker, from the olden days, rely on crushed ice and salt as refrigerant coolant to keep his ice-cream cold. However he was confused on which salt, lithium chloride or sodium chloride, to use to make the refrigerant coolant.

The table below shows the enthalpy of solution of the two salts. The enthalpy of solution of a substance is the enthalpy change when one mole of the solid substance dissolves in water.

substance	enthalpy of solution (kJ/mol)
solid LiC*l*	–35.0
solid NaC*l*	+4.3

Using the above data to compare and contrast both salts, recommend the suitable salt to make the refrigerant coolant. Explain your answer.

……..……

……..……

……..…… [3]

5 Calcium nitrate, $Ca(NO_3)_2$ is a soluble salt, used in wastewater pre-conditioning for odour emission prevention.

Using standard laboratory apparatus and reagents, explain how you would obtain dry crystals of calcium nitrate.

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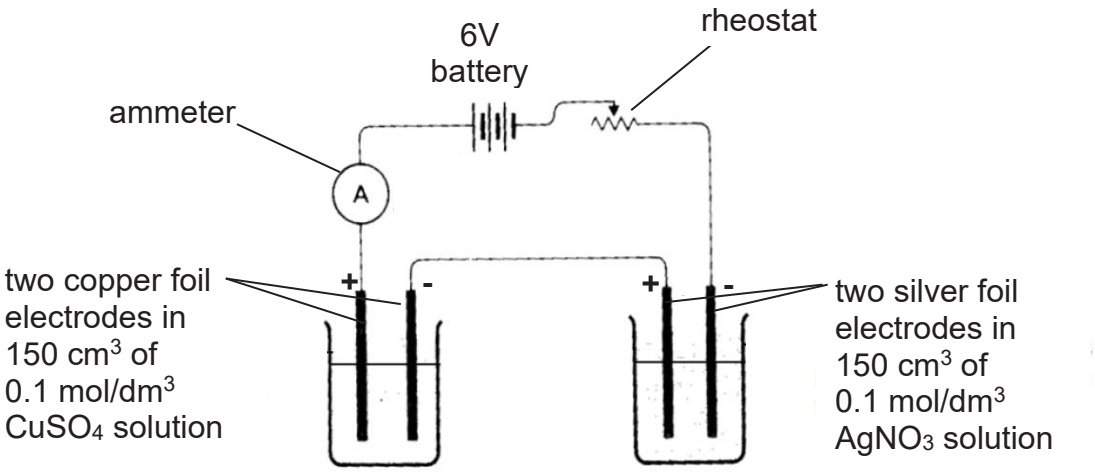
……... [4]

6 A student carried out a series of experiments. He electrolysed aqueous copper(II) sulfate

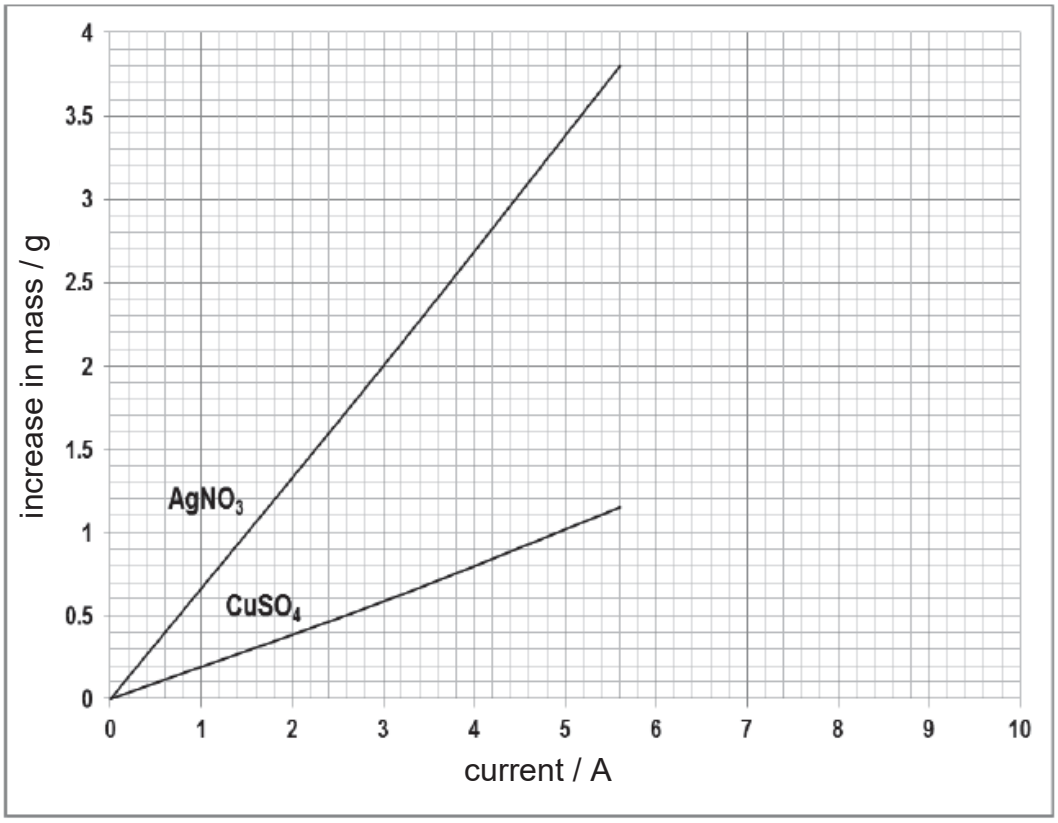
and aqueous silver nitrate using the apparatus shown.



He repeated the experiment a few times using the same concentration of copper(II) sulfate and silver nitrate, but changed the current that passes through the solution. He ran each experiment for 10 minutes.

At the end of 10 minutes, the student weighed the mass of the negative electrodes and worked out the increase in mass of the electrodes.

The graph below shows the results of his investigations.



(a) Describe the relationship between the current and the increase in mass of the

negative electrode as shown by the graph.

……..

…….. [1]

(b) Use the graph to predict the increase in mass of the negative electrode in copper(II) sulfate solution if the experiment is carried out using an electric current of 2.0 A for 5 min.

……..

…….. [1]

(c) During the electrolysis, copper and silver are deposited at the negative electrodes.

With the aid of ionic equations, account the difference between the masses of copper and silver formed given the same amount of current used.

……..……

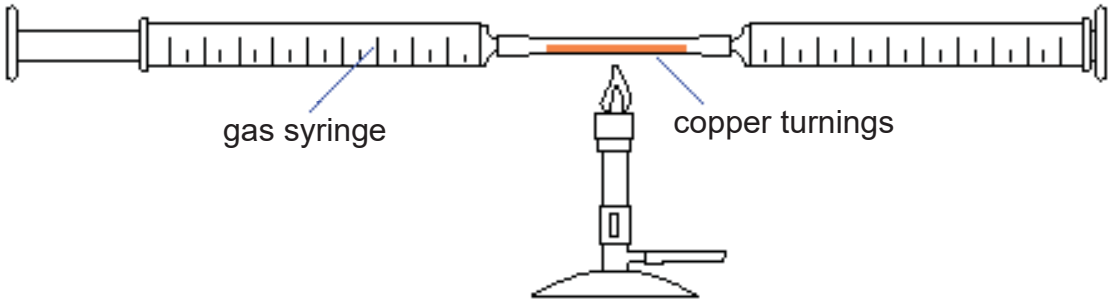
……..……

……..……

……..…… [3]

7 The atmosphere of a planet from another solar system was analysed and it was found to

contain nitrogen, carbon dioxide, oxygen and argon. The following set-up was used to determine the volume of oxygen in the planet's atmosphere.



The volume of air used for the experiment was originally 1000 cm^3 while the original mass of copper used was 5.00 g.

After the experiment, the copper turnings were separated from the black solid formed, by dissolving in excess hydrochloric acid. The mixture was filtered and the turnings obtained as the residue weighed 3.40 g.

(a) Write the balanced equation for the formation of the black solid.

…….. [1]

(b) Calculate the number of moles of copper reacted with air.

[1]

(c) Calculate the volume of oxygen reacted.

[2]

(d) Calculate the percentage of oxygen present in the planet's atmosphere.

[1]

8 The reactivity of some metals can be compared using the data in the table.

metals	displacement reactions	reaction with water and steam	observations during reaction with steam
mercury	mercury does not displace any metals	has no reaction with steam	silvery metal remains unchanged
magnesium	$Mg + Zn(NO_3)_2 \rightarrow Mg(NO_3)_2 + Zn$	- reacts slowly with cold water - burns in steam	grey solid turns white
nickel	$Ni + Hg(NO_3)_2 \rightarrow Ni(NO_3)_2 + Hg$	- has no reaction with water - reacts slowly with steam	silvery solid turns green
zinc	$Zn + Ni(NO_3)_2 \rightarrow Zn(NO_3)_2 + Ni$	- has no reaction with water - reacts slowly with steam	grey solid turns yellow when hot

(a) Using the data from the table, arrange the metals in increasing order of reactivity.

…….. [1]

(b) Solution containing nickel(II) ions are green.

(i) State what you would expect to observe when magnesium is added to nickel(II) nitrate solution.

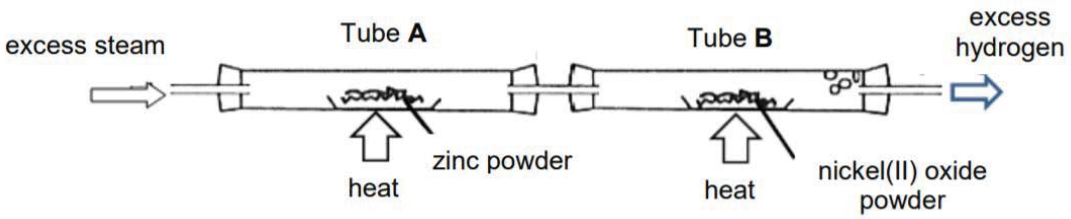
……

…… [2]

(ii) Write an ionic equation for the reaction in part **(b)(i)**. Include state symbols.

…… [1]

(c) Steam was passed through the apparatus set up as shown.



(i) A gas is produced when excess steam reacts with zinc powder. Describe a test to identify the gas.

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..... [1]

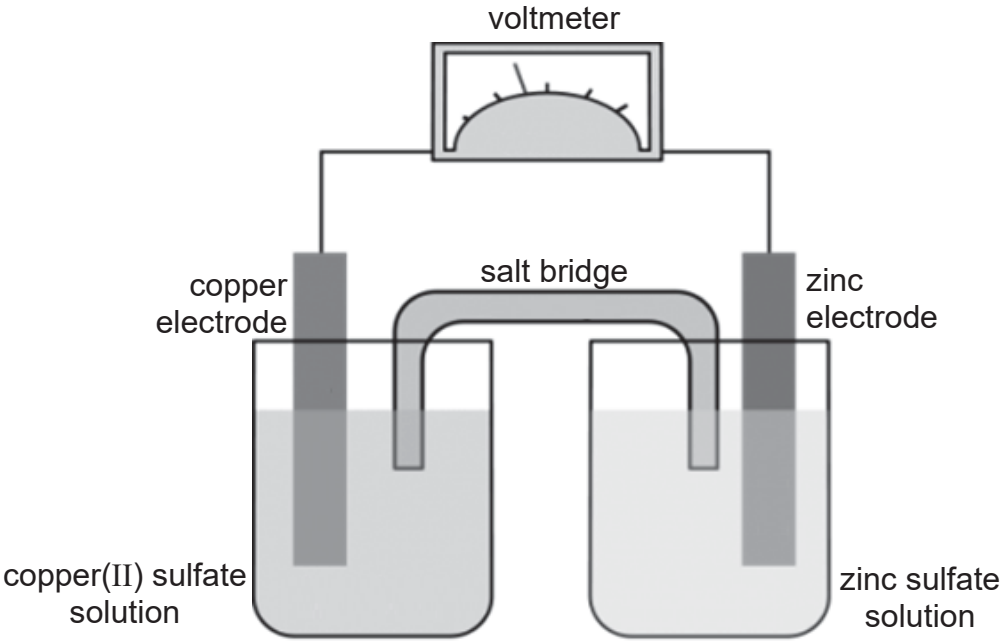
(ii) Given that nickel lies between iron and lead in the reactivity series, state and explain what you would observe in Tube **B**.

.....

.....

..... [2]

9 The simple cell shown below used copper and zinc plates immersed in copper(II) sulfate and zinc sulfate solutions respectively. The two half cells are separated to prevent side reactions and reach maximum voltage. Hence, it is connected by a salt bridge (a porous membrane) which allows ions from the zinc half-cell to pass to the copper half-cell and vice versa.



(a) Describe the observations at the zinc and copper electrode respectively.

……..

…….. [2]

(b) Suggest and explain which electrode is the negative electrode.

……..

……..

…….. [2]

(c) Explain what would happen if two half cells are not separated but immersed in the same beaker of copper(II) sulfate solution.

……..

……..

…….. [2]

10 **(a)** A student had four test-tube samples; **A**, **B**, **C** and **D**, each containing exactly 6.2 g of zinc carbonate. The equation of the thermal decomposition is as shown:

$$ZnCO_3 \rightarrow ZnO + CO_2$$

He was instructed to heat, cool and weigh each sample. Each sample was then to be reheated, cooled and weighed three more times. The student made a number of errors during the experiment. The results he obtained are given in the table below.

sample	mass of solid after heating / g			
	1st attempt	2nd attempt	3rd attempt	4th attempt
A	5.8	5.5	4.0	4.0
B	5.9	5.4	4.8	4.2
C	5.3	4.8	4.0	4.0
D	5.7	5.7	4.0	4.0

(i) Calculate the mass of zinc oxide formed from the decomposition of 6.2 g of zinc carbonate.

[2]

(ii) Which sample's set of results contain the weighing error?
Give a reason for your answer.

……

…… [1]

(iii) Explain why there is no further change in mass for the 3rd and 4th attempts in samples **A**, **C** and **D**.

……

…… [1]

(b) The student decides to investigate the thermal stability of the carbonates of

three metals, copper, sodium and zinc. He heats each metal carbonate in a test-tube and bubbles the gas given off through limewater.

(i) State the results that he should record.

……

…… [1]

(ii) Describe how he can use his results stated in part **(b)(i)** to place the metal carbonates in order of thermal stability.

……

……

…… [2]

SECTION B: FREE-RESPONSE QUESTIONS [30 MARKS]

Answer **all** the questions in the spaces provided. The last question is in the form of an EITHER / OR and only one of the alternatives should be attempted.

11 Read the information about fuel cells used in automobiles.

Fuel cells are devices that convert chemical energy from fuel to electrical energy commonly through a reaction with oxygen.

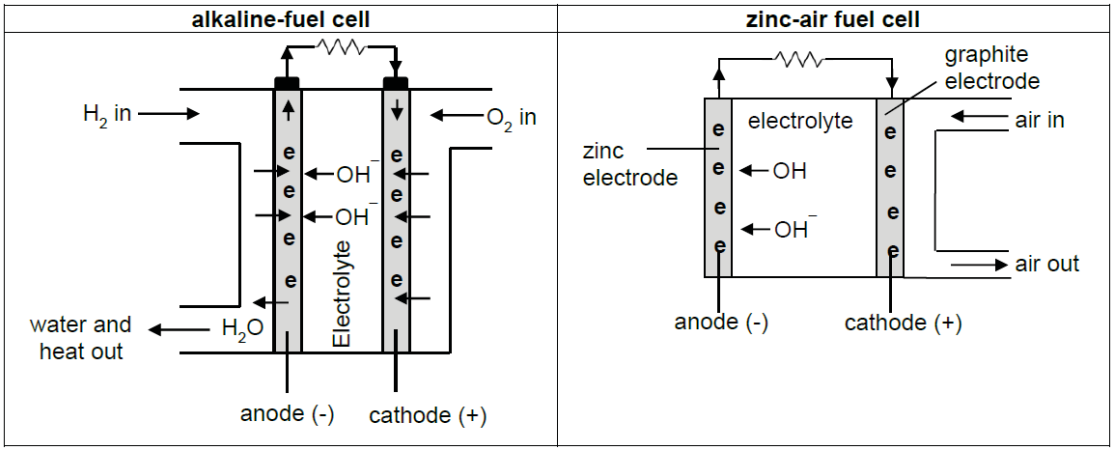
Alkaline Fuel Cells

Hydrogen and oxygen are combined to give water and electrical energy using porous carbon electrodes mixed with nickel nanoparticles and aqueous alkaline solution as the electrolyte. The energy produced is renewable.

Zinc-Air Fuel Cell

Electricity is generated by the reaction between oxygen and zinc using aqueous alkaline electrolyte to produce zinc oxide and electrical energy. The zinc anode is separated from the oxygen passing through the electrolyte by a mechanical separator. The energy produced is renewable because zinc oxide can be converted to fresh zinc using electricity from an electrolyser.

The diagrams show how an alkaline-fuel cell and zinc-air fuel cell work.



One major issue with both fuel cells is electrolyte degradation caused by the precipitation of metal carbonate crystals when hydroxide ions in the electrolyte react with atmospheric carbon dioxide.

The table below shows some information about the two types of cells.

	alkaline-fuel	zinc-air
working temperature / °C	150	40
*energy density in watt-hour per kilogram / Wh/kg	300	1370
other points	storing hydrogen fuel is challenging	cheap to manufacture, zinc fuel is easy to maintain

*Energy density refers to the amount of energy stored per unit mass

Source:
http://www.rsc.org/images/Hydrogen%20Fuel%20Cells-Fuelling%20The%20Future_tcm18-208020.pdf
http://www.electric-fuel.com/evtech/ef-tech-brochure.pdf

(a) In both fuel cells, it is important that carbon dioxide from the air do not pass through the porous electrode in both fuel cells. Explain why.

……

……

…… [2]

(b) Write down the ionic half-equations for the reactions that occur at the cathode and anode in an alkaline-fuel cell.

Cathode: ……

Anode: …… [2]

(c) Other than fuel storage, fuel cell cost and maintenance, give one **other** advantage of using a zinc-air fuel cell instead of an alkaline-fuel cell.

……

…… [1]

(d) A student commented that producing energy from both fuel cells is non-polluting. Do you agree? Explain your answer.

……..…..…

……..……..…

……..…….. [2]

(e) Write down the overall equation for the reaction in the zinc-air fuel cell.

……..…..… [1]

(f) Calculate the energy density per mole of fuel for zinc-air fuel cell in Wh/mol.

[2]

12 Three experiments were carried out to study the speed of reaction between excess dilute acid and magnesium ribbon.

The table shows the amount of acid, mass of magnesium ribbon used, drops of copper(II) sulfate used and the time taken to collect 50 cm^3 of hydrogen gas for each experiment.

experiment	amount of dilute acid used	mass of magnesium ribbon used / g	drops of aqueous copper(II) sulfate used	time taken / s
I	25.0 cm^3, 1.0 mol/dm^3 sulfuric acid	2.5	0	28.0
II	25.0 cm^3, 1.0 mol/dm^3 hydrochloric acid	2.5	0	52.0
III	25.0 cm^3, 1.0 mol/dm^3 sulfuric acid	2.5	5	17.0

(a) Explain, in terms of collision theory, why the time taken for Experiment **I** is shorter than Experiment **II**.

……

……

……

…… [3]

(b) Using the information from the table, explain the role of aqueous copper(II) sulfate in Experiment **III**.

……

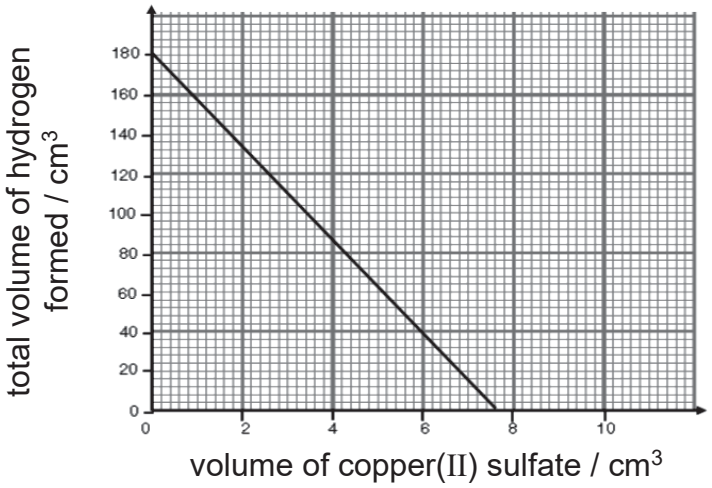
……

…… [2]

(c) Experiment **I** was repeated using magnesium powder.
Sketch a graph of volume of hydrogen gas produced against time taken for experiments using both magnesium ribbon and powder.
Label your graphs clearly.

[3]

(d) Further experiments of the reaction between a fixed mass of magnesium and excess sulfuric acid were carried out. In these experiments, various volumes of aqueous copper(II) sulfate (1.0 mol/dm^3) were added to the sulfuric acid. The graph shows the volume of hydrogen gas decreased with the various volumes of aqueous copper(II) sulfate.



Predict the change in the volume of hydrogen gas produced if aqueous potassium sulfate is used in place of aqueous copper(II) sulfate. Explain your answer.

……

……

…… [2]

EITHER

13 Nitrogen was discovered by the Scottish physician Daniel Rutherford in 1772. It is the fifth most abundant element in the universe and makes up about 78% of the earth's atmosphere.

(a) The Haber Process combines nitrogen from the air with hydrogen derived mainly from natural gas, into ammonia. When ammonia gas is dissolved in water, an ammonia solution is formed.

(i) State the likely pH of ammonia solution.

…… [1]

(ii) A few drops of Universal Indicator is added to the ammonia solution.

Explain the colour change that occurs.

……

……

…… [2]

(iii) Ammonia has a strong smell.
A beaker of aqueous ammonia was placed in front of a class of students.
At first, the students at the back of the class could not smell the ammonia.
After a few minutes they could smell the ammonia.

Explain these observations using the kinetic particle model.

……

……

……

…… [3]

(b) Ammonia is used in the manufacture of nitric acid.

(i) Balance the chemical equation for the first step in the process.

$$4\ NH_3 + 5\ O_2 \rightarrow \ldots\ldots\ NO + \ldots\ldots\ H_2O$$ [1]

(ii) The reaction is exothermic.

Using the ideas of bond breaking and bond forming, describe what is meant by *exothermic*.

……...

……... [1]

(iii) The NO produced in the first step then reacts with oxygen to produce nitrogen dioxide, NO_2, according to the equation below.

$$2\ NO + O_2 \rightarrow 2\ NO_2$$

State, with a reason, how this equation shows which substance is oxidised.

……...

……... [1]

(c) Oxides of nitrogen are atmospheric pollutants.

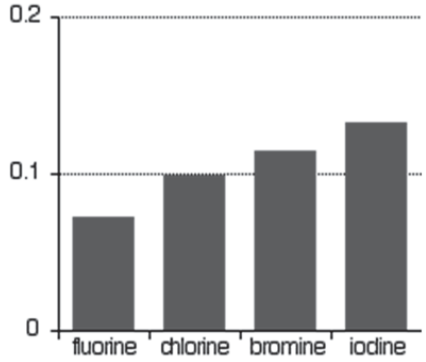
State one adverse effect of oxides of nitrogen on health.

…….. [1]

OR

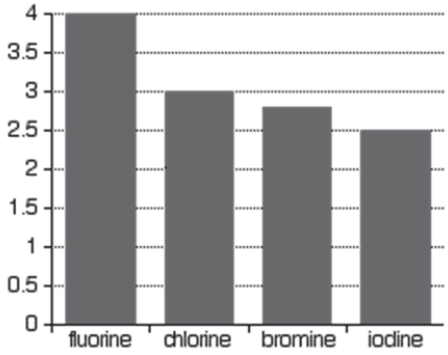
13 The graphs below show some properties of Group VII elements, the halogens. Graph 1 shows the atomic radii and Graph 2 shows the electronegativity of the Group VII elements. Electronegativity is a measure of the tendency of an atom to attract a bonding pair of electrons. It is usually measured on the Pauling scale, on which the most electronegative element (fluorine) is given an electronegativity of 4.0.

atomic radii



Graph 1

electronegativity



Graph 2

(a) Use the trend seen in Graph 1 to explain why the atomic radii of the halogens increase on going down the group.

……

……

…… [2]

(b) Predict the reactivity of the halogens on going down the group using Graph 2. Explain your prediction using the electronegativity property in Graph 2.

……

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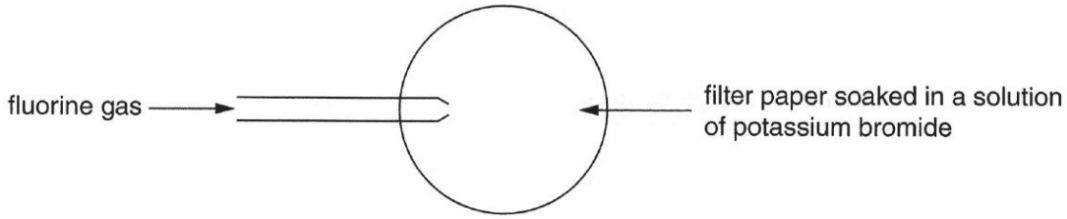
…… [2]

(c) Fluorine is the first element in Group VII.

A jet of fluorine gas is aimed at a filter paper soaked in a solution of potassium bromide.



The solution on the filter paper quickly turns brown.

Explain why the solution turns brown.
Include an ionic equation to support your answer.

……

……

…… [3]

(d) Helium is an element that is not included in Group VII elements.

(i) Draw the electronic configuration of helium.

[1]

(ii) Hence, give a reason why helium is not included in Group VII elements.

……

…… [1]

(iii) Some people think that the use of helium to fill party balloons should be discouraged. Suggest a reason why they think this.

……

…… [1]

– END OF PAPER –