Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4 (O-Level Programme)

A

CHEMISTRY

6092/02

Paper 2

15 September 2020
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

For examiner's use only:

Total	/50

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 **12**.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **12** printed pages.

[Turn over

Section A

Answer **all** questions in this section.
The total mark for this section is 50.

A1 Use the table to answer the following questions.

substance	melting point/ °C	boiling point/ °C	percentage by volume in clean air/ %
argon	−189	−186	0.93
carbon dioxide	sublimes at −78		0.03
helium	−270	−269	0.0005
nitrogen	−210	−196	78.03
oxygen	−219	−183	20.99

(a) **(i)** Identify the substance with the lowest diffusion rate at room temperature and pressure.

..... [1]

(ii) Name a diatomic substance.

..... [1]

(iii) Name the substance which is a liquid over the largest range of temperatures.

..... [1]

(iv) Name a technique to separate nitrogen from a sample of clean air.

..... [1]

(b) Suggest why the percentages by volume in clean air do **not** add up to 100%.

..... [1]

(c) Draw a diagram in the box below to show the arrangement of particles in carbon dioxide at −77 °C.

Use “O” to represent the particles in carbon dioxide.

[1]

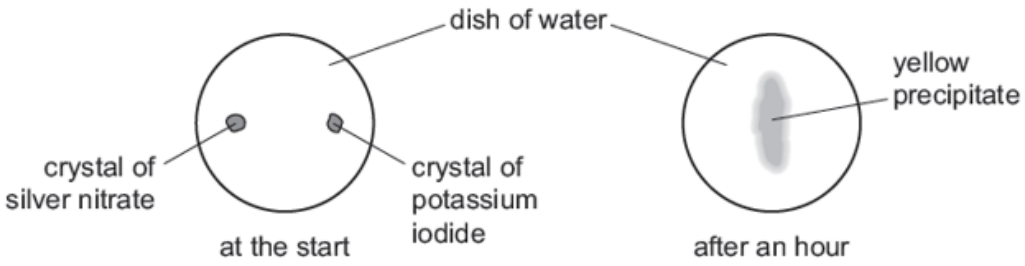
[Total: 6]

A2 A student placed a crystal of silver nitrate and a crystal of potassium iodide in a dish of water.

After an hour, he made two observations.

Observation 1: The crystals had disappeared.

Observation 2: A yellow precipitate had appeared near the middle of the dish.



(a) Explain observation 1.

_____ [1]

(b) Use your knowledge of the kinetic particle theory and reactions between ions to explain observation 2.

_____

_____

_____

_____ [3]

(c) Potassium iodide reacts with aqueous chlorine.

(i) Write a chemical equation, with state symbols, for this reaction.

_____ [2]

(ii) The student repeated the experiment by replacing the crystal of silver nitrate with a few drops of aqueous chlorine.

Give one difference between the results of the two experiments.

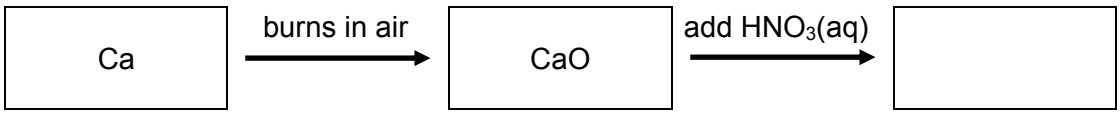
_____

_____ [1]

[Total: 7 marks]

A3 Calcium is the fifth most common element in the Earth's crust.
Calcium compounds occur in bones and teeth and also in many minerals.

Some reactions of calcium and its compounds are shown in the reaction scheme below.



(a) Complete the reaction scheme by writing the chemical formula of the substance that is formed. [1]

(b) **(i)** By referring to the reaction scheme above in part **(a)**, put a tick (✓) in one box in each row.

	oxidising agent	reducing agent	neither
Ca			
CaO			

[2]

(ii) Explain your answer for Ca.

.....

..... [1]

[Total: 4]

A4 Stainless steel cutlery contain iron, carbon, nickel and chromium. It contains at least 10.5% of chromium by mass.

Without chromium, steel will rust more easily.

(a) A student suggests that chromium is more reactive than iron. Do you agree with the student? Explain your answer.

_____

_____ [1]

(b) The student wants to confirm his suggestion.

He conducts an experiment by adding a strip of chromium metal into a beaker containing solution X.

(i) Suggest a possible reagent to be used as solution X for his experiment to work.

_____ [1]

(ii) Write two observations the student would expect to see if his suggestion is true.

_____

_____ [2]

(iii) Write an ionic equation for the reaction between chromium and solution X.

You may assume that
- chromium is more reactive than iron and;
- chromium forms a positive ion of +2 charge.

_____ [1]

(c) Mild steel is another alloy of iron. It contains about 0.25% of carbon and is commonly used to make car bodies.

(i) Define *alloy*.

_____

_____ [1]

(ii) Draw a diagram to show the structure of mild steel.

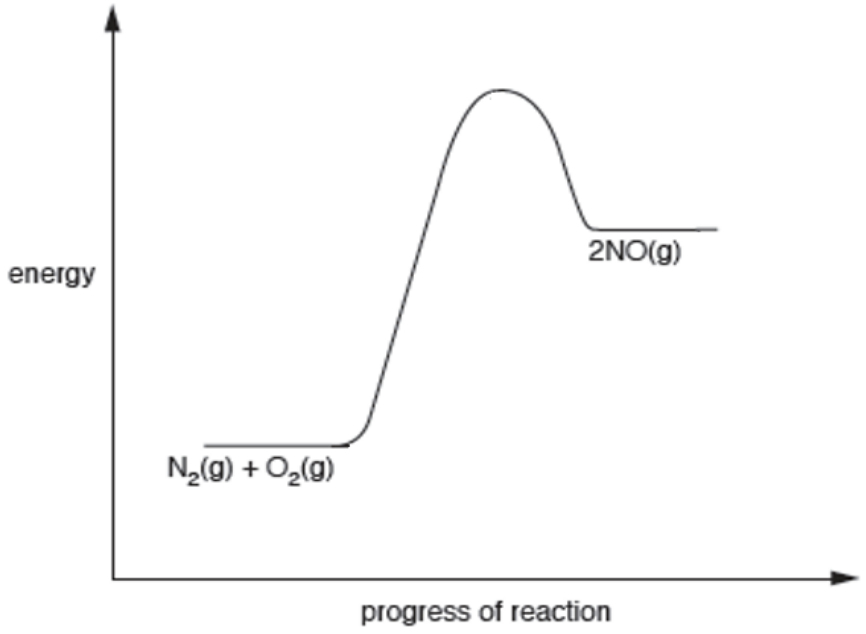
[1]

[Total: 7]

A5 Oxides of nitrogen are atmospheric pollutants. Nitrogen monoxide, NO, is formed in combustion engines when nitrogen and oxygen react together.

$$N_2(g) + O_2(g) \rightarrow 2NO(g)$$

The diagram shows the energy profile for this reaction.



(a) Label clearly the reaction enthalpy change and the activation energy on the energy profile above. [2]

(b) The reaction between nitrogen and oxygen is endothermic.

(i) Explain how you can tell from the diagram that the reaction is endothermic.

.....

.....

[1]

(ii) 2019 proved to be one of the hottest years on record in Singapore, with the annual mean temperature hitting 28.4 °C.

Describe and explain how a hotter day affects the activation energy of the formation of nitrogen monoxide in combustion engines.

.....

.....

.....

[2]

(c) Cars have catalytic converters fitted to reduce pollution problems caused by some of the exhaust gases.

Write an equation to show how one exhaust gas is converted to a harmless substance within the catalytic converter.

.....

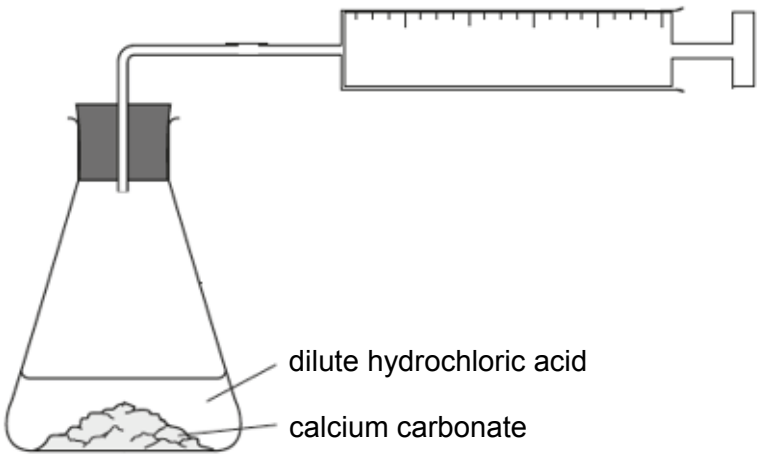
[1]

[Total: 6]

A6 Calcium carbonate reacts with dilute hydrochloric acid.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

A student investigates the rate of this reaction at three different temperatures using the apparatus shown.

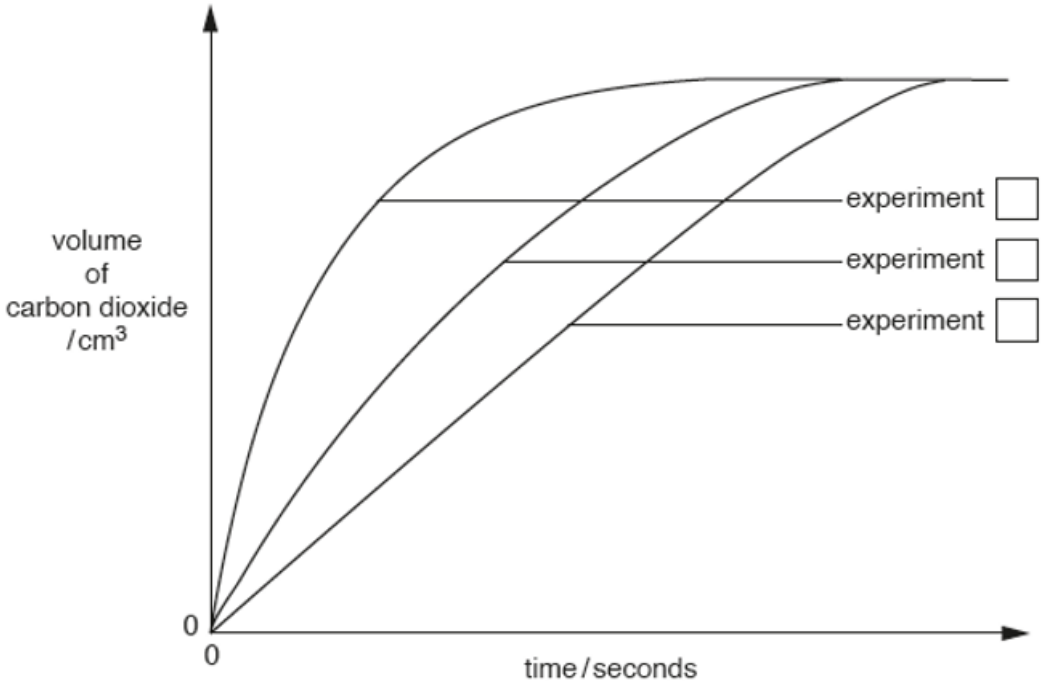


In each experiment, the student adds the same volume and concentration of dilute hydrochloric acid to an excess of calcium carbonate. The volume of carbon dioxide is recorded every 30 seconds.

(a) The student does three experiments.

- experiment 1 at 20 °C
- experiment 2 at 40 °C
- experiment 3 at 60 °C

The student plots a graph of the results.



Label the three experiments in the graph above. [1]

(b) The student repeated experiment 1 using twice the mass of calcium carbonate.

State how the volume of carbon dioxide gas will compare with experiment 1.
Explain.

[2]

[Total: 3]

A7 Electrolysis involves the decomposition of a compound by the passage of an electric current.

(a) **(i)** Complete the table, which shows information about the electrolysis of different solutions using inert electrodes.

electrolyte	product at anode	product at cathode
concentrated aqueous sodium chloride		
dilute aqueous copper(II) chloride		copper
dilute aqueous potassium nitrate		

[3]

(ii) Explain why the electrolysis of dilute aqueous copper(II) chloride liberates copper rather than hydrogen at the cathode.

[1]

(b) In a separate experiment, dilute aqueous copper(II) chloride was electrolysed using pure and impure copper electrodes at the cathode and anode respectively.

The anode lost mass as copper(II) ions were formed and the cathode gained mass as copper atoms were formed.

(i) State one industrial application of this electrolysis set-up.

[1]

(ii) State the difference between the change in mass of the anode and the cathode.
Explain.

[2]

The results of an electrolysis experiment involving aqueous copper(II) chloride are shown below.

experiment	temperature of electrolyte/ °C	current used/ A	time of electrolysis/ s	mass of copper formed at cathode/ g
1	20	1.0	1000	0.329
2	20	2.0	1000	0.658
3	20	2.0	2000	1.320
4	25	2.0	2000	1.320
5	30	1.0	1000	0.329

A student wrote two conclusions for the experiment.

Conclusion 1: Increasing the temperature has no effect on the mass of copper formed at the cathode.

Conclusion 2: Increasing the current used increases the mass of copper formed at the cathode.

(c) Explain how the information in the table supports

(i) conclusion 1;

.....

..... [1]

(ii) conclusion 2.

.....

..... [1]

(d) Explain

(i) conclusion 1;

.....

..... [1]

(ii) conclusion 2.

.....

..... [1]

[Total: 11]

A8 Electronegativity is a measure of the tendency of an atom to attract a bonding pair of electrons.

The Pauling scale is used to measure the electronegativity of elements. The higher the electronegativity of an element, the larger its electronegativity value on the Pauling scale.

(a) Explain why the electronegativity values of elements increase across a period.

_____

_____

_____ [2]

(b) The difference in electronegativity value between two elements can be used to determine the type of bonding undergone by the two elements.

difference in electronegativity	bond present
≥2	ionic
<2	covalent

Element X and Y react with chlorine to produce the chlorides shown. (X and Y are not the actual symbols of the elements.)

chloride	difference in electronegativity values of the elements
XC*l*	2.2
YCl_2	0.3

(i) Draw a 'dot-and-cross' diagram to show the bonding in XC*l*. Show the outer shell electrons only.

[2]

(ii) Deduce if the melting point of YCl_2 is high or low. Explain your answer by referring to the structure and bonding of YCl_2.

_____

_____

_____ [2]

[Total: 6]

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.).