Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

8377892639

CHEMISTRY **5070/22**

Paper 2 Theory **May/June 2023**

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **20** pages. Any blank pages are indicated.

1 Choose from the following oxides to answer the questions.

CO
CO_2
CaO
CuO
Fe_2O_3
H_2O
SO_2
SiO_2
ZnO

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

State which oxide:

(a) is neutral

..... [1]

(b) reacts with calcium oxide to form slag in the blast furnace

..... [1]

(c) reacts with warm dilute hydrochloric acid to give a blue coloured solution

..... [1]

(d) is amphoteric

..... [1]

(e) contains an ion with an oxidation number of +3

..... [1]

(f) decolourises acidified aqueous potassium manganate(VII).

..... [1]

[Total: 6]

2 Group VII includes the elements fluorine, chlorine, bromine and iodine.

(a) Chlorine is a green gas at room temperature and pressure.

State the appearance of iodine at room temperature and pressure.

..... [2]

(b) Chlorine reacts with aqueous potassium iodide in a displacement reaction.

$$Cl_2(aq) + 2I^-(aq) \longrightarrow 2Cl^-(aq) + I_2(aq)$$

(i) Explain, in terms of electrons, why chlorine is an oxidising agent in this reaction.

.....

..... [1]

(ii) State the oxidation number of iodine in I_2.

..... [1]

(iii) Describe what is observed during the displacement reaction.

..... [1]

(c) The rate of diffusion of fluorine gas is greater than that of chlorine gas under the same conditions of temperature and pressure.

(i) State what is meant by the term diffusion.

.....

.....

..... [1]

(ii) Explain why the rate of diffusion of fluorine is greater than that of chlorine under the same conditions.

.....

.....

..... [1]

(iii) The rate of diffusion of fluorine increases as the temperature increases.

Suggest why using ideas about kinetic particle theory.

.....

..... [1]

[Total: 8]

3 This question is about the preparation of salts.

(a) Zinc nitrate is a soluble salt.

It is prepared by the reaction of an insoluble carbonate with a dilute acid.

The equation for this reaction is shown.

$$ZnCO_3(s) + 2HNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + H_2O(l) + CO_2(g)$$

A sample of 4.50 g of zinc carbonate is added to 50.0 cm^3 of 1.30 mol / dm^3 nitric acid.

(i) Show by calculation that the zinc carbonate is in excess.

[3]

(ii) Once the reaction has finished the mixture is filtered.

State why the mixture is filtered.

.....

..... [1]

(iii) Describe how to make pure, dry zinc nitrate crystals from an aqueous solution of zinc nitrate.

.....

.....

.....

.....

..... [3]

(b) Lead chloride is an insoluble salt.

It is prepared using a precipitation reaction.

Name **two** aqueous solutions that react together to give a precipitate of lead chloride.

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

(c) Ammonium sulfate is a soluble salt.

It is prepared by the reaction of an alkali and an acid.

Name the alkali and the acid used.

alkali .....

acid .....

[1]

[Total: 9]

4 This question is about compounds that contain magnesium and nitrogen.

(a) The formula for a nitride ion can be written as $^{15}_{7}N^{3-}$.

Complete Table 4.1 to show the number of particles in this nitride ion.

Table 4.1

particle	number of particles
electron	
neutron	
proton	

[3]

(b) State why the formula for a magnesium ion is Mg^{2+} rather than Mg^{+} or Mg^{3+}.

.....

..... [1]

(c) The formula for a nitride ion is N^{3-}.

Deduce the formula for magnesium nitride.

..... [1]

(d) Magnesium nitrate, $Mg(NO_3)_2$, is an ionic compound.

Predict **two** physical properties of magnesium nitrate.

1 .....

2 .....

[2]

(e) Calculate the percentage by mass of nitrogen in magnesium nitrate.

Give your answer to **two** significant figures.

percentage by mass ..... [2]

[Total: 9]

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5 Carbon reacts with steam to make carbon monoxide and hydrogen.

This reaction is reversible. The forward reaction absorbs thermal energy.

$$C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$$

(a) An equilibrium mixture is formed when the reversible reaction happens in a closed system.

(i) Explain why the reversible reaction must be in a closed system for an equilibrium mixture to be formed.

.....

..... [1]

(ii) Predict what happens to the **position of equilibrium** when the temperature is decreased and the pressure remains constant.

Explain your answer.

prediction .....

explanation .....

.....

.....
[2]

(iii) Predict what happens to the **position of equilibrium** when the pressure is decreased and the temperature remains constant.

Explain your answer.

prediction .....

explanation .....

.....

.....
[2]

(b) Predict what happens to the **rate of the backward reaction** when the temperature is decreased and the pressure remains constant.

Explain your answer.

prediction .....

explanation .....

.....

.....

.....

[2]

(c) Predict what happens to the **rate of the backward reaction** when the pressure is increased and the temperature remains constant.

Explain your answer.

prediction .....

explanation .....

.....

.....

.....

[2]

[Total: 9]

6 This question is about the energy changes that take place during chemical reactions.

(a) Nitrogen reacts with oxygen to make nitrogen monoxide.

The reaction is endothermic.

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

Draw, on the axes provided in Fig. 6.1, the reaction pathway diagram for this reaction.

Include labels for the:

- axes
- reactants
- product
- enthalpy change of reaction, ΔH
- activation energy, E_a.

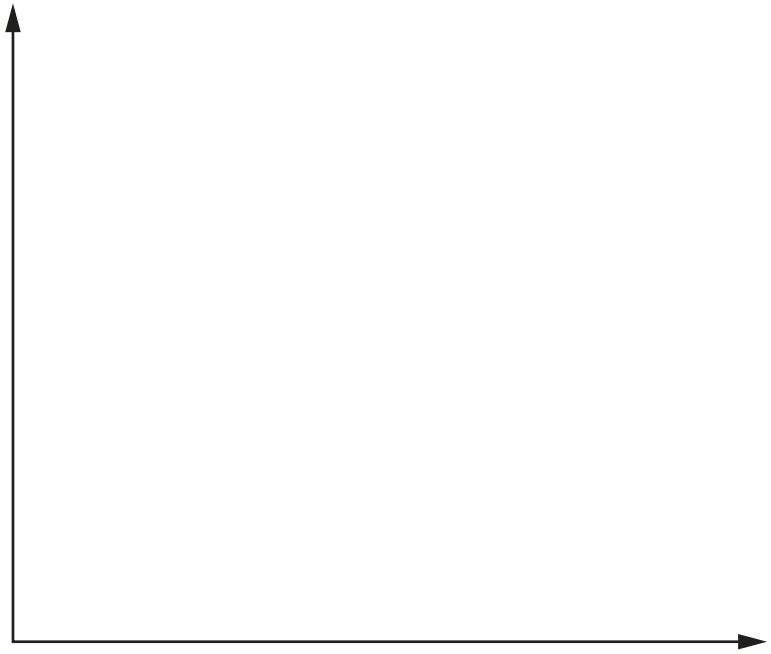


Fig. 6.1

[5]

(b) Hydrogen reacts with bromine to make hydrogen bromide.

$$H—H + Br—Br \rightarrow 2H—Br$$

Calculate the enthalpy change of this reaction.

Use the bond energies in Table 6.1.

Table 6.1

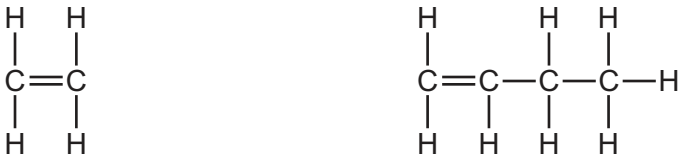
bond	bond energy in kJ / mol
H—H	436
Br—Br	193
H—Br	366

enthalpy change of reaction ..... kJ / mol [3]

[Total: 8]

7 Ethene, but-1-ene and but-2-ene are alkenes.

The displayed formulae of ethene and but-1-ene are shown in Fig. 7.1.



ethene but-1-ene

Fig. 7.1

(a) State the general formula of the homologous series of alkenes.

..... [1]

(b) But-1-ene and but-2-ene are structural isomers.

(i) State the meaning of the term structural isomers.

.....

..... [1]

(ii) Draw the displayed formula for but-2-ene.

[1]

(c) But-1-ene is an unsaturated hydrocarbon.

(i) State why but-1-ene is an unsaturated compound.

.....

..... [1]

(ii) State why but-1-ene is a hydrocarbon.

.....

..... [1]

(d) But-1-ene reacts with steam in the presence of a catalyst and reacts with bromine.

(i) Draw the structural formula of the product of the reaction with steam in the presence of a catalyst.

[1]

(ii) Draw the structural formula of the product of the reaction with bromine.

[1]

(e) Ethene is a covalent substance.

(i) Draw a dot-and-cross diagram to show the bonding in a molecule of ethene.

Include only the outer shell electrons of each atom.

[2]

(ii) Explain why ethene has a low melting point.

.....

..... [1]

[Total: 10]

8 This question is about electrolysis.

(a) The table shows some information about the electrolysis of three different electrolytes using graphite electrodes.

Complete Table 8.1 with the names of the products at each electrode.

Table 8.1

electrolyte	product at anode	product at cathode
concentrated aqueous potassium iodide		
dilute sulfuric acid		
molten lead(II) bromide		

[3]

(b) Give **two** reasons why graphite is a suitable material from which to make electrodes.

1 .....

2 .....

[2]

(c) Aluminium is manufactured by the electrolysis of aluminium oxide dissolved in molten cryolite.

At the anode, oxide ions react to make oxygen molecules.

Construct the ionic half-equation for this electrode reaction.

..... [1]

[Total: 6]

9 A sample of clean, dry air contains 0.0400% carbon dioxide by volume.

(a) Calculate the number of molecules of carbon dioxide in 480 dm^3 of clean, dry air at room temperature and pressure.

One mole of any gas contains 6.02×10^{23} molecules.

number of molecules ..... [3]

(b) Complete combustion of fuels such as gasoline makes carbon dioxide.

One of the hydrocarbons in gasoline has the molecular formula C_9H_{20}.

Construct the equation for the complete combustion of C_9H_{20}.

..... [1]

(c) Higher levels of atmospheric carbon dioxide lead to increased global warming.

(i) Give **one** adverse effect of global warming.

..... [1]

(ii) Describe how the presence of gases such as carbon dioxide in the atmosphere causes global warming.

.....

.....

..... [2]

(d) Carbon dioxide is removed from the atmosphere by photosynthesis.

State the word equation for photosynthesis.

..... [1]

[Total: 8]

10 Proteins and PET are polymers made by a reaction called condensation polymerisation.

(a) The diagram in Fig. 10.1 shows the structure of a section of a protein.

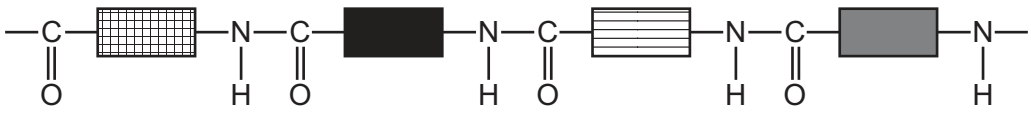


Fig. 10.1

(i) Draw the general structure of the amino acid monomers used to make proteins.

[1]

(ii) Proteins are polyamides.

Name one **other** polyamide.

..... [1]

(b) PET is a polymer used to make plastic bottles.

The diagram in Fig. 10.2 shows the structure of PET.

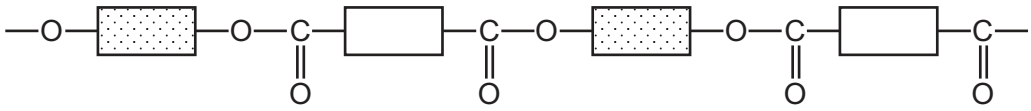


Fig. 10.2

(i) Name the linkage present in PET.

..... [1]

(ii) Proteins and PET are both made by condensation polymerisation.

Describe the differences between condensation polymerisation and addition polymerisation.

.....

.....

.....

..... [2]

(c) Describe **two** environmental challenges caused by the disposal of plastics such as PET.

1 .....

.....

2 .....

.....

[2]

[Total: 7]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

Key

atomic number
atomic symbol
name
relative atomic mass

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.).