Name :	Class	Index no.

DEYI SECONDARY SCHOOL

Preliminary Examination 2020
Secondary Four Express

Chemistry **6092/02**

28 August 2020
0800 – 0945h
1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

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

Section B
Answer all **three** questions, the last question is in the form of either/or.
Answer **all** questions in the spaces provided.

A copy of the Periodic Table is printed on page 21.

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

Section	Marks
A	/50
B	/30
Total	/80

Section A (50 marks)

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

A1 A list of reactions, represented by the letters **P** to **V,** is given below.

	reaction
P	Ba^{2+} (aq) + SO_4^{2-} (aq) → $BaSO_4$ (s)
Q	CO_3^{2-} (aq) + $2H^+$ (aq) → CO_2 (g) + H_2O (*l*)
R	Mg (s) + Fe^{2+} (aq) → Fe (s) + Mg^{2+} (aq)
S	H^+ (aq) + OH^- (aq) → H_2O (*l*)
T	Cu^{2+} (aq) + $2e^-$ → Cu (s)
U	2NaBr (aq) + C*l*$_2$ (g) → 2NaC*l* (aq) + Br_2 (aq)
V	$2F^-$ (aq) → F_2 (g) + $2e^-$

Use the letters **P** to **V** to answer the following questions. Each letter may be used once, more than once or not at all.

(a) Identify a reaction in which a white precipitate is formed.

[1]

(b) Identify a neutralisation reaction between an acid and an alkali.

[1]

(c) Identify a reaction during which a colour change from colourless to brown is observed.

[1]

(d) Identify a reaction that occurs at the anode of an electrolytic cell.

[1]

(e) Identify the reactions in which displacement occurs.

[2]

A2 A student wanted to investigate how different acids affect the rate of a reaction. He carried out three experiments, **X**, **Y** and **Z**, using three different acids as shown below.

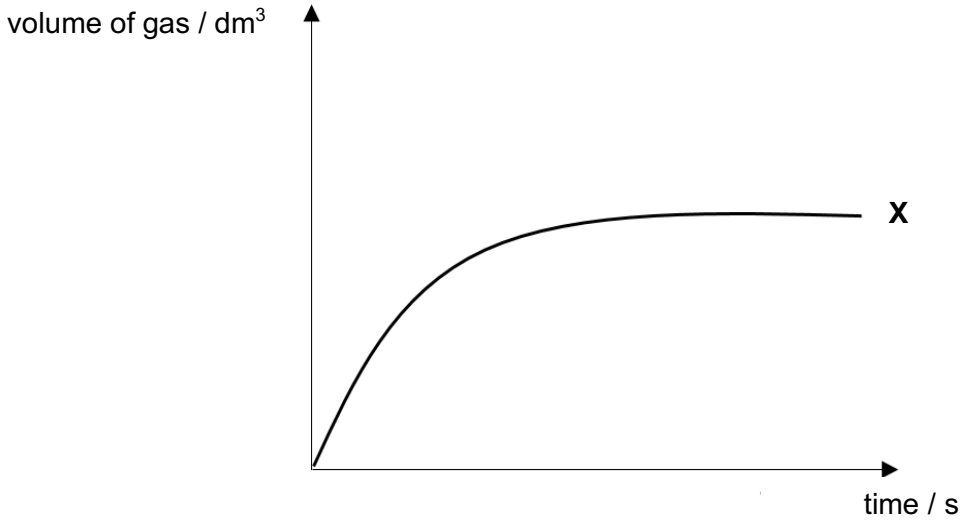
experiment	acid
X	250.0 cm^3 of 0.50 mol/dm^3 dilute hydrochloric acid
Y	250.0 cm^3 of 0.50 mol/dm^3 dilute sulfuric acid
Z	250.0 cm^3 of 0.50 mol/dm^3 dilute ethanoic acid

In each experiment, 6 g of magnesium powder was reacted with the acid. All experiments were carried out at room temperature and pressure.

(a) Write a balanced chemical equation, with state symbols, for the reaction in experiment **X**.

[1]

The results of experiment **X** is shown in the graph below.



(b) On the axes above, sketch the graphs for experiments **Y** and **Z**. Label the graphs clearly. Your sketch should include the volume of gas formed. [4]

(c) The student then repeated experiment **X** at a higher temperature.

(i) On the same axes in **(b)**, sketch a graph to show how an increase in temperature affects the results. Label this graph **W**. [1]

(ii) In terms of particle collision theory, explain the shape of graph **W**.

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[3]

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A3 Oxides of nitrogen in the stratosphere cause damage to the ozone layer in a two-step process as shown below.

step 1: $NO + O_3 \rightarrow NO_2 + O_2$
step 2: $NO_2 + O_3 \rightarrow NO + 2O_2$

(a) Refer to steps 1 and 2 to answer the following questions.

(i) Explain why one nitrogen monoxide molecule can destroy thousands of ozone molecules.

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[2]

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(ii) Derive the overall equation for the reaction that damages ozone molecules.

[1]

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(b) Oxides of nitrogen are removed from car exhaust emissions by catalytic converters. In such converters, the oxides of nitrogen react with carbon monoxide. Eventually, nitrogen and carbon dioxide gases are released into the atmosphere.

(i) Suggest two health hazards that may arise should the catalytic converters fail to work.

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[2]

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(ii) Draw a dot-and-cross diagram to show the bonding in carbon dioxide. Show only the valence electrons. [2]

A4 Sodium bisulfite ($NaHSO_3$) is a food additive. When sodium bisulfite comes into contact with chlorine bleach (NaC*l*O), sodium bisulfate ($NaHSO_4$) and sodium chloride are formed. Heat is released in this reaction.

(a) Write a balanced chemical equation for the above reaction.

[1]

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(b) Using ideas about oxidation state, explain why the reaction in **(a)** is a redox reaction.

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[2]

(c) The activation energy for the reaction is 15.6 kJ/mol and the enthalpy change is – 81.3 kJ/mol.

(i) Explain why the enthalpy change includes a negative sign.

[1]

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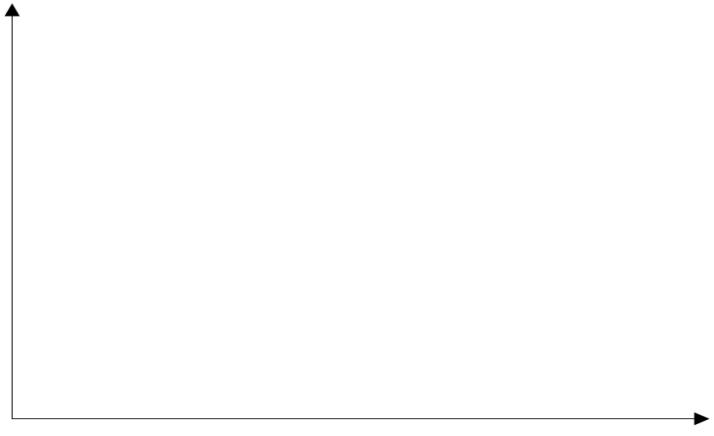
(ii) Complete the energy profile diagram below for the reaction between sodium bisulfite and chlorine bleach. Include formulae of reactants and products, activation energy, enthalpy change and axes labels in the diagram. [3]



(iii) In terms of bond breaking and bond forming, explain the shape of the energy profile diagram in **(c)(ii)**.

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[3]

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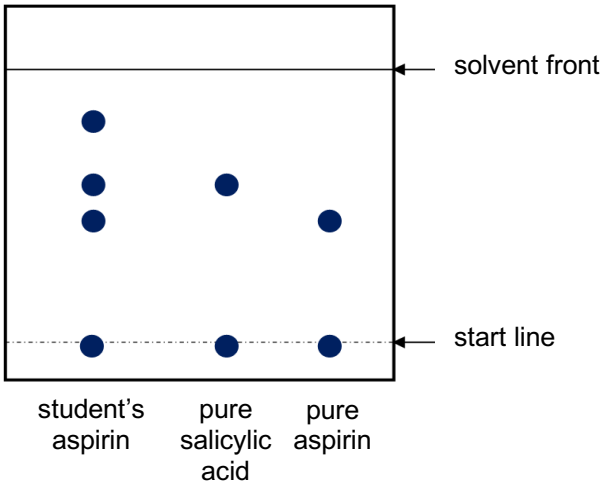
A5 Aspirin is a medicine that is commonly used as a painkiller. A student makes a sample of aspirin from salicylic acid in the laboratory. He then performs chromatography using his sample of aspirin. He obtained the chromatogram shown below.



(a) With reference to the chromatogram, state whether the student's sample of aspirin is pure. Explain your answer.

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[2]

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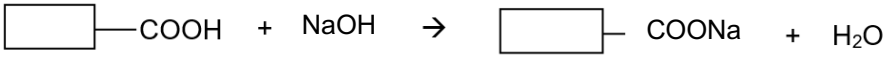
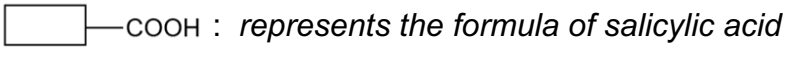
(b) In a second experiment, the student analyses only pure samples of aspirin and salicylic acid using chromatography. The R_f values of aspirin and salicylic acid are shown in the table below.

substance	aspirin	salicylic acid
R_f value	0.56	0.654

The solvent was allowed to travel 9 cm from the start line. Calculate the distance travelled by aspirin. [1]

(c) In a third experiment, the student performed a titration using crushed aspirin tablets and aqueous sodium hydroxide. The equation for the reaction can be represented as shown below.





The results of the titration are shown in the table below.

concentration of NaOH	0.10 mol/dm^3
volume of aqueous NaOH needed for complete neutralisation	15.90 cm^3
relative molecular mass of aspirin	180

(i) Calculate the mass of aspirin, in mg, in one tablet. [3]
(1 g = 1000 mg)

(ii) Brand **P** of aspirin tablets also contains citric acid. Explain why the mass of aspirin calculated from titrating brand **P** tablets with aqueous sodium hydroxide is inaccurate.

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[2]

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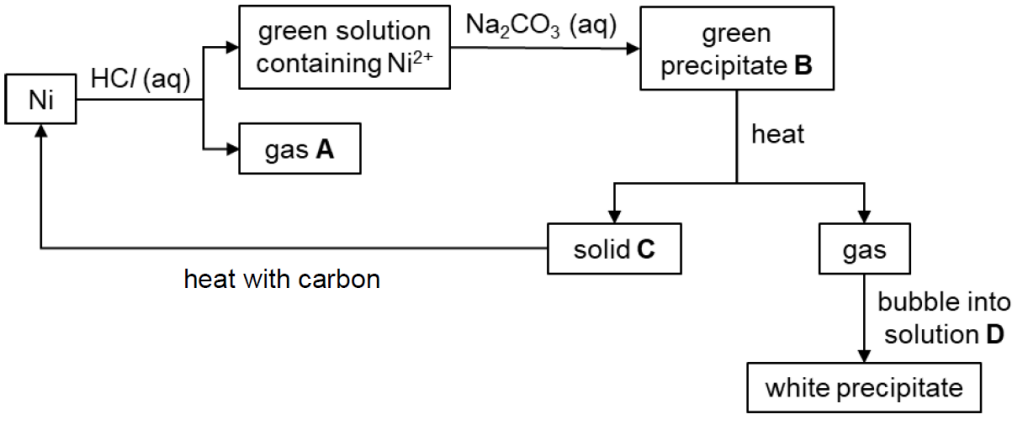
A6 A sample of copper(II) chloride is dissolved in concentrated aqueous potassium chloride, and the resulting solution is evaporated. Crystals of the salt produced was found to have the following composition by mass: 31.5% K, 25.6% Cu and the remaining C*l*.

Calculate the empirical formula of the salt crystal formed.
Show all working. [3]

A7 A reaction scheme involving nickel is shown.



(a) **(i)** Identify the following substances.

A: .....

B: .....

C: .....

D: ..... [4]

(ii) Write an ionic equation for the formation of **B**.

..... [1]

(b) Describe the observations when excess nickel powder is added to aqueous copper(II) sulfate.

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..... [2]

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Section B (30 marks)

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

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B8 **(a)** The table shows some properties of four Group VII elements, fluorine, chlorine, bromine and iodine. However, some of the information for these elements have been accidentally deleted and they are not arranged according to their positions in the Group.

element	boiling point /°C	reaction with hydrogen
X	+185	reacts if heated strongly
fluorine	-218	explosive reaction in dim light
bromine	+59	
Y	-34	explosive reaction in sunlight

Figure 8.1 shows the trend in atomic radius of these four elements in Group VII.

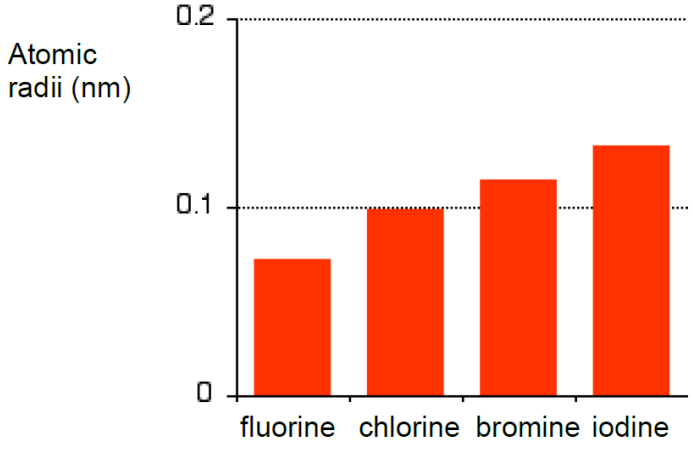

Figure 8.1

The radius of an atom is governed by

- the number of electron shells around the nucleus
- the pull of the outer electrons from the nucleus.

(i) Using information in the table above and the periodic trends of the elements in Group VII, suggest the identity of **X** and **Y**. Explain how you arrived at your conclusion.

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[3]

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(ii) Using information from Figure 8.1 and the trend in reactivity of Group VII elements, describe and explain the reaction of bromine with hydrogen.

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[3]

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(b) Group I elements also show a similar trend of increasing atomic radius down the Group.

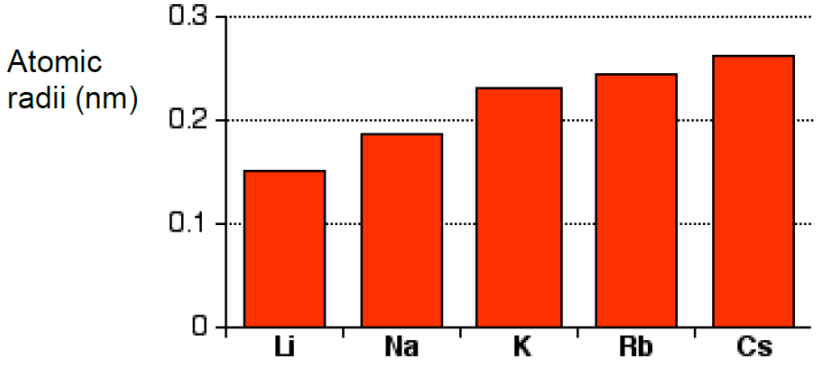

Figure 8.2

(i) Describe and explain, using information from Figure 8.2, the trend in the reactivity of elements in Group I with hydrogen gas.

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[2]

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(ii) Compare figure 8.1 and 8.2 and state a difference in terms of atomic radii of the elements in both Groups. Explain the difference.

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[2]

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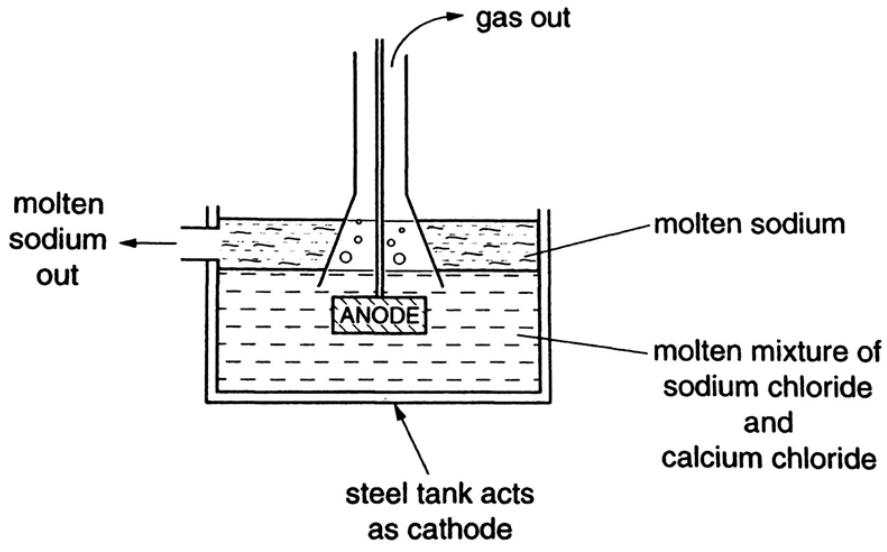
B9 Sodium metal is extracted from molten sodium chloride by electrolysis. Some calcium chloride may be added to make the process cheaper to run as shown below.



(a) **(i)** Write ionic half equations for the reactions that take place at the anode and cathode. [2]

anode: .....

cathode: .....

(ii) Write an equation for the overall reaction that takes place during the electrolysis.

[1]

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(b) Suggest how the addition of calcium chloride makes the process cheaper to run.

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[2]

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(c) The molten sodium collected contains metallic impurities. Name the main metallic impurity present.

[1]

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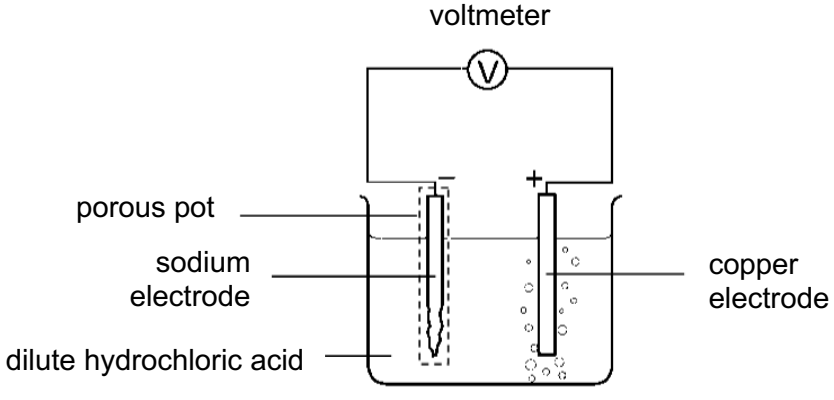
(d) Sodium can be used in a simple cell set-up with copper, as shown below.



(i) Explain how the porous pot ensures safety of the set-up.

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[1]

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(ii) Explain why the sodium electrode decreases in size.

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[1]

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(iii) Describe a test that would identify the gas being evolved at the copper electrode.

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[2]

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EITHER

B10 Zircaloy-4 is a material used to make parts of nuclear power plants because of its great tensile strength and ability to withstand high temperatures. The composition of zircaloy-4 is shown in the table below.

element	composition / %
zirconium	98.0
tin	1.50
iron	0.50

(a) Explain why zircaloy-4 has great tensile strength.

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[2]

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(b) With reference to the Periodic table, name two elements which have similar chemical properties as zirconium.

[2]

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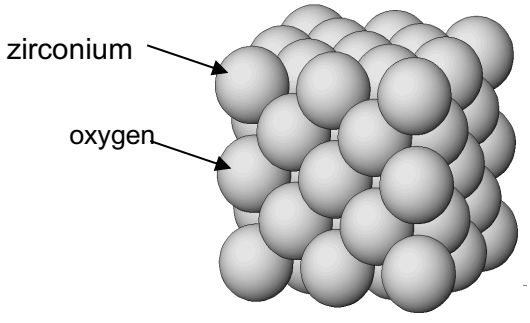
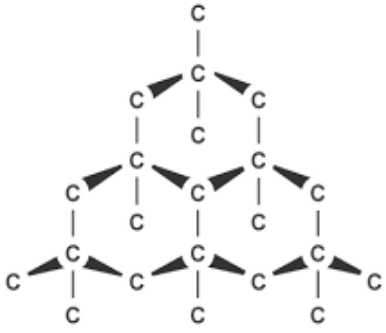
(c) Zirconium reacts readily with oxygen to form zirconium dioxide. Zirconium dioxide is commonly used in the jewellery industry as its appearance resembles that of diamond. The structures of zirconium dioxide and diamond are shown below.



zirconium dioxide



diamond

(i) Describe the similarities and differences between the **bonding** and **structures** of zirconium dioxide and diamond.

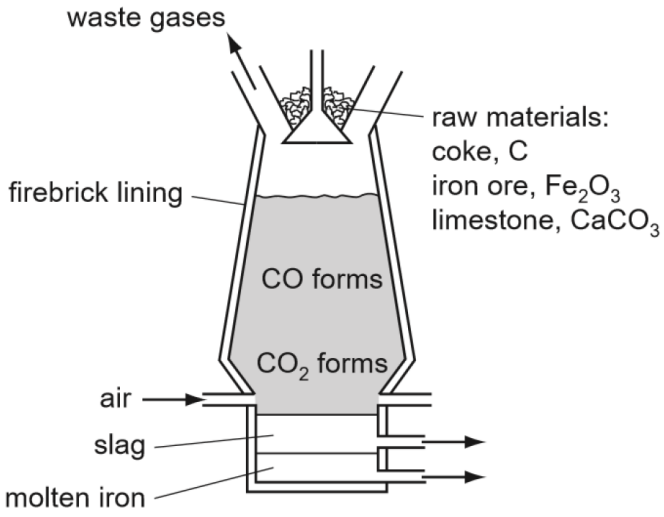
[4]

(ii) Explain the statement *"zirconium dioxide is an oxidising agent whilst diamond is a reducing agent"*.

[2]

OR

B10 **(a)** Iron is extracted from its ore in a blast furnace as shown below.



(i) Suggest why carbon monoxide is formed higher up in the blast furnace.

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[1]

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(ii) Explain why the molten iron does not react with air.

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[1]

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(iii) Describe how silicon impurities are removed from the molten iron during the extraction.

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[2]

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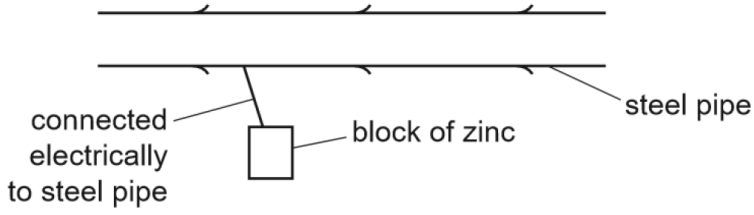
(b) Iron and steel undergo rusting. One method of rust prevention is sacrificial protection as shown below.



Explain how the steel pipe is prevented from rusting.

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[2]

(c) Iron is an element whilst iron(II) oxide is a compound. Construct a table to show the differences between iron and iron(II) oxide in terms of their

(i) electrical conductivity at room temperature and pressure and

(ii) chemical reactions with hydrochloric acid. [4]

- 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.).