O

TAMPINES SECONDARY SCHOOL

Secondary Four Express
PRELIMINARY EXAMINATION 2020

NAME

CLASS | | | | **REGISTER NUMBER** | |

CHEMISTRY **6092/01**

Paper 1 **28 Aug 2020**

1 hour

: Nil

Additional Materials: Optical Mark Sheet.

READ THESE INSTRUCTIONS FIRST
Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and register number on the Optical Mark Sheet in the spaces provided.

There are **forty** questions on this paper. 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 in **soft pencil** on the Optical Mark Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

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

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

This document consists of **19** printed pages
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1 Which of the following about element, compound and mixture is/are correct?

I A compound contains only two types of elements.

II A molecule is formed by two different elements.

III An element is a substance that cannot be broken down into two or more simpler substances by chemical means.

IV A mixture has variable composition by mass.

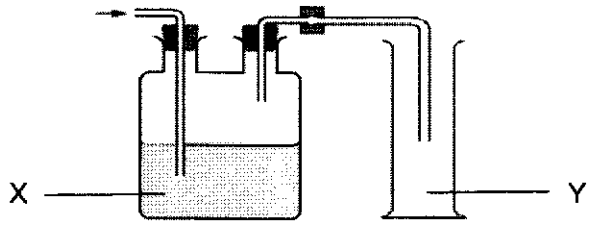
A I only

B I and II

C III and IV

D I, III and IV

2 The apparatus shown was used to collect a dry gas.



What are X and Y?

	X	Y
A	water	carbon dioxide
B	water	ammonia
C	concentrated sulfuric acid	carbon dioxide
D	concentrated sulfuric acid	ammonia

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3 The atmosphere of a planet contains mostly gases X, Y and Z. The melting and boiling points of these gases are shown in the table.

gas	melting point / °C	boiling point / °C
X	−219	−183
Y	−189	−186
Z	−210	−196

What temperature should the sample of air be cooled to if only gases Y and Z are to remain in the atmosphere?

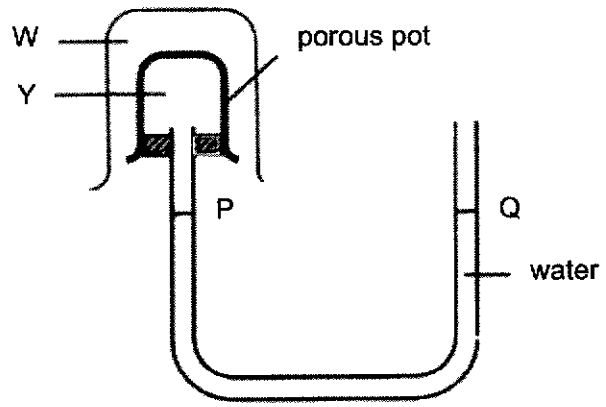
A −180 °C

B −185 °C

C −187 °C

D −190 °C

4 In the set-up below, gas W is composed of nitrogen gas.



What could be the identity of gas Y to cause the water level at point Q to rise initially?

A neon

B methane

C ethyne, C_2H_2

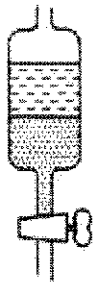
D butane, C_4H_{10}

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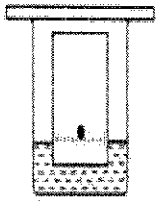
5 Compound X melts at 15 °C, boils at 128 °C and is not soluble in water.

Which apparatus can be used to obtain pure X from a mixture of X with water at room temperature and pressure?

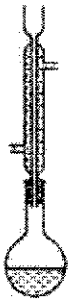
A



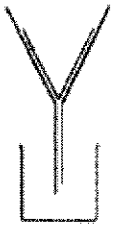
B



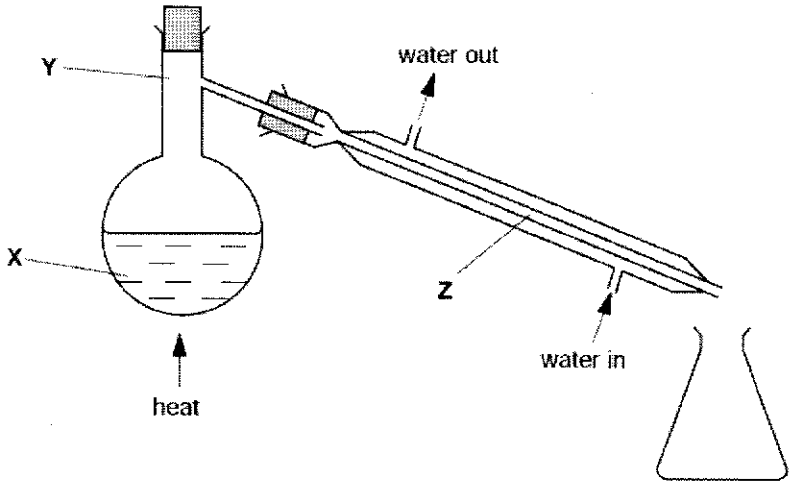
C



D



6 The diagram shows the apparatus used to distill seawater.



What are the likely temperatures recorded at each point, X, Y and Z, when the distillate is being collected at the conical flask?

	X	Y	Z
A	97 °C	100 °C	102 °C
B	100 °C	97 °C	102 °C
C	102 °C	97 °C	65 °C
D	102 °C	100 °C	65 °C

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7 An isotope of element Z has 17 protons and 18 neutrons in its nucleus.

Which symbol is correct for the ion of Z?

A $^{18}_{17}Z^-$

B $^{18}_{17}Z^+$

C $^{35}_{17}Z^-$

D $^{35}_{17}Z^+$

8 Copper has two main isotopes ^{63}Cu and ^{65}Cu.

If the relative atomic mass of naturally occurring copper is 63.6, what is their relative abundance?

	^{63}Cu	^{65}Cu
A	30 %	70 %
B	60 %	40 %
C	40 %	60 %
D	70 %	30 %

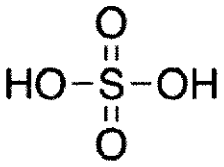
9 An element, R, has *p* protons and *n* neutrons.

Which row gives the possible number of subatomic particles in a positive ion of R?

	number of protons	number of neutrons	number of electrons
A	*p*	*n*	$p + 1$
B	*p*	*n*	$p - 1$
C	$p - 1$	$n + 1$	$p - 1$
D	$p - 1$	$n + 1$	$p + 1$

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10 How many valence electrons are **not** shared in the following molecule?



A 12

B 14

C 16

D 18

11 The list shows some substances that conduct electricity.

1 aqueous potassium nitrate
2 graphite
3 iron
4 molten sodium chloride

In which substance(s) is/are only ions involved in conducting electricity?

A 1 only

B 1 and 4 only

C 2 and 3 only

D 1, 2, 3, and 4

12 An element X forms a diatomic molecule. An atom of X requires three electrons to achieve a stable octet structure.

What can be deduced about element X?

A It is an element in Group VI of the Periodic Table.

B The electronic configuration of an atom of X can be 2.8.3.

C It reacts with sodium to form a compound Na_3X.

D It reacts with oxygen to form an ionic compound X_2O_3.

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13 The formula of sodium chlorite is $NaClO_2$ and the formula of thallium sulfate is $Tl_2(SO_4)_3$.

What is the formula of thallium chlorite?

A $TlClO_2$

B $Tl(ClO_2)_3$

C Tl_2ClO_2

D $Tl_2(ClO_2)_3$

14 Hydrogen chloride was bubbled into hexane, an organic solvent. This mixture was added to iron metal. However, no visible reaction took place.

What is a likely explanation for this?

A A coating of insoluble magnesium chloride formed around the metal.

B Hydrogen chloride did not ionise in hexane.

C Hydrogen chloride is insoluble in hexane.

D Iron is not a reactive metal.

15 The table below gives information about three indicators.

indicator	colour in strongly acidic solution	pH at which colour changes	colour in strongly alkaline solution
thymol blue	red	3	yellow
bromophenol blue	yellow	4.6	blue
thymolphthalein	colourless	10.5	blue

Which one of the following sets of colours would be obtained when each indicator was added separately to pure water?

	thymol blue	bromophenol blue	thymolphthalein
A	red	yellow	blue
B	red	blue	blue
C	yellow	yellow	colourless
D	yellow	blue	colourless

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16 Which statement about 11 g of carbon dioxide is correct?

A It occupies the same volume as 2.22 g of fluorine at room temperature.

B It occupies the same volume as 6 dm^3 of methane, CH_4 at room temperature.

C It has the same number of molecules as 0.5 moles of oxygen at room temperature.

D It has the same mass as 3×10^{23} atoms of neon at room temperature.

17 A sample of an unknown metallic carbonate, MCO_3 has a mass of 1.875 g. The sample is decomposed by heating to form the metallic oxide and 0.66 g of carbon dioxide.

$$MCO_3(s) \rightarrow MO(s) + CO_2(g)$$

What is the identity of metal M?

A calcium

B manganese

C nickel

D zinc

18 Elements R, S and T are in the same period of the Periodic Table.

The oxide of R reacts with water to form a solution with a pH less than 7. The oxide of S reacts with water to form a solution that turns damp red litmus paper blue. The oxide of T reacts with both dilute hydrochloric acid and aqueous sodium hydroxide.

What is the order of elements R, S and T, in increasing proton number in the Periodic Table?

A R, T, S

B R, S, T

C S, T, R

D T, S, R

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19 Which of the following statements about strong and weak acids is true?

A There are no mobile OH^- ions present in all types of aqueous acids.

B A weak dibasic acid will always have a faster rate of reaction as compared to a strong monobasic acid of the same concentration.

C For the same basicity and concentration, weak acids have a lower pH than strong acids.

D Regardless of strength, monobasic acids of the same concentration and volume require the same number of moles of aqueous sodium hydroxide for complete neutralisation.

20 The formation of liquid water from hydrogen and oxygen may occur in three stages.

1 $2H_2(g) + O_2(g) \rightarrow 4H(g) + 2O(g)$

2 $4H(g) + 2O(g) \rightarrow 2H_2O(g)$

3 $2H_2O(g) \rightarrow 2H_2O(l)$

Which stages are exothermic?

A 1 only

B 1 and 2 only

C 2 and 3 only

D all of the above

21 W, X, Y and Z are metals. When various mixtures of one of the metals is heated with another metal oxide, the following results were obtained.

oxide of Z + W $\rightarrow$ no reaction

oxide of X + W $\rightarrow$ oxide of W + X

oxide of Z + Y $\rightarrow$ no reaction

oxide of W + Y $\rightarrow$ oxide of Y + W

Which of the following arrangements shows the metals in order of increasing reactivity?

A X, W, Y, Z

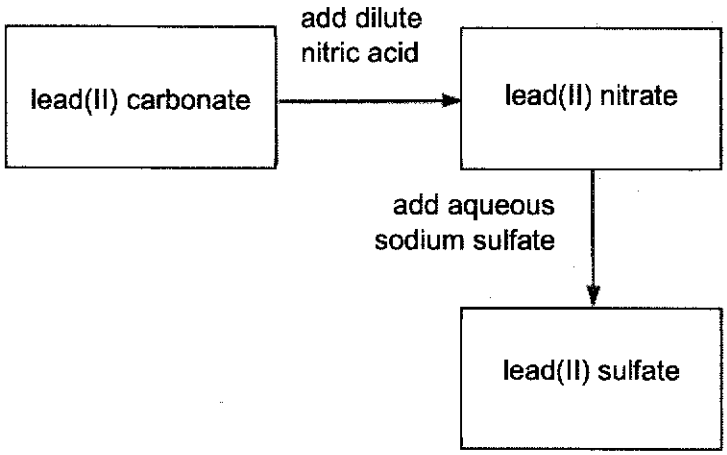
B Y, X, W, Z

C W, X, Y, Z

D Z, Y, W, X

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22 The diagram shows the reaction flow used to prepare lead(II) sulfate from lead(II) carbonate.



Which of the following steps is **incorrect** in the preparation of lead(II) sulfate from lead(II) carbonate as shown in the diagram?

A Collect lead(II) sulfate by filtration.

B Filter off unreacted lead(II) carbonate.

C Evaporate lead(II) sulfate until it crystallises.

D Add lead(II) carbonate until no more gas is produced.

23 A new highly reactive element with the chemical symbol Za has been discovered. An atom of Za has seven valence electrons.

Which of following are likely properties of Za?

I It conducts electricity.

II It exists as diatomic molecules.

III It forms positive ions with the symbol Za^+.

IV It forms a covalent compound with hydrogen.

A I and II only

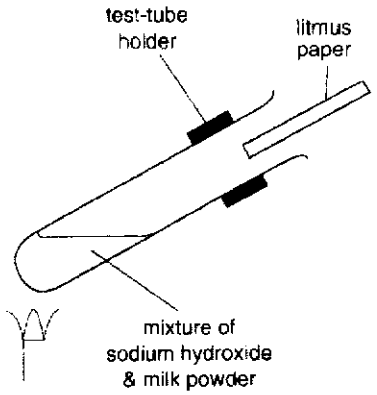
B II and III only

C II and IV only

D III and IV only

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24 A mixture of milk powder and sodium hydroxide is heated strongly in a test-tube as shown below.



On heating, the milk powder reacted with sodium hydroxide to form a gas which turned moist red litmus paper blue.

From this observation alone, which element can we infer to be present in milk powder?

A nitrogen

B carbon

C sulfur

D oxygen

25 Which statement is **not** true of noble gases?

A They exist as monatomic gases.

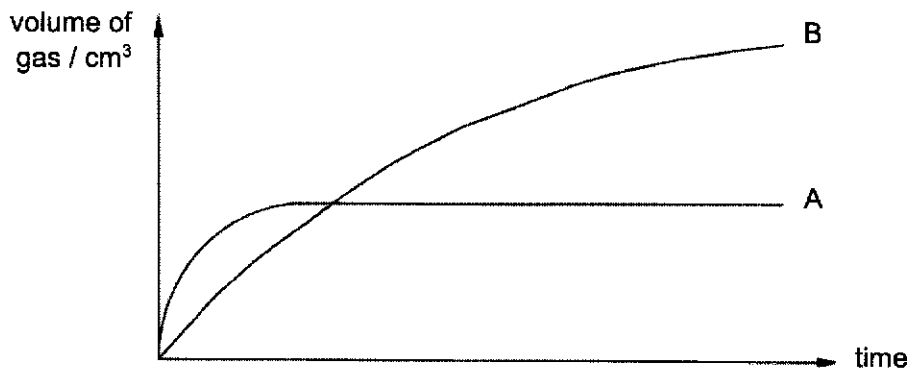
B They are colourless, odourless gases.

C They are chemically unreactive.

D Their melting points and boiling points decrease down Group 0.

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26 In the graph, curve A represents the results of reacting a mass of magnesium powder with an excess of acid at 40 °C.



Which change could produce curve B?

A adding a catalyst for the reaction

B double the mass of magnesium granules

C decreasing the temperature to 20 °C

D half the concentration of the acid

27 In which reaction is pressure **least** likely to affect the rate of reaction?

A $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$

B $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

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

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

28 In which of the following reactions does the oxidation state of nitrogen show the greatest increase?

A $NH_3 + HCl \rightarrow NH_4Cl$

B $4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$

C $2KNO_3 \rightarrow 2KNO_2 + O_2$

D $2NO + O_2 \rightarrow 2NO_2$

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29 Hydrogen peroxide, H_2O_2, reacts with silver oxide according to the following equation.

$$Ag_2O(s) + H_2O_2(l) \rightarrow 2Ag(s) + H_2O(l) + O_2(g)$$

What is the role of hydrogen peroxide in this reaction?

A an acid

B an oxidising agent

C a reducing agent

D a dehydrating agent

30 In which of the following experiments will a redox reaction occur?

A Adding nitric acid to aqueous ammonia.

B Adding copper turnings to aqueous silver nitrate.

C Adding aqueous chlorine to aqueous potassium fluoride.

D Adding aqueous sodium hydroxide to aqueous copper(II) nitrate.

31 In the Haber Process, nitrogen and hydrogen gas are mixed to produce ammonia gas.

Which statement about the Haber process is **incorrect**?

A It is a reversible reaction.

B A high pressure increases the yield of ammonia.

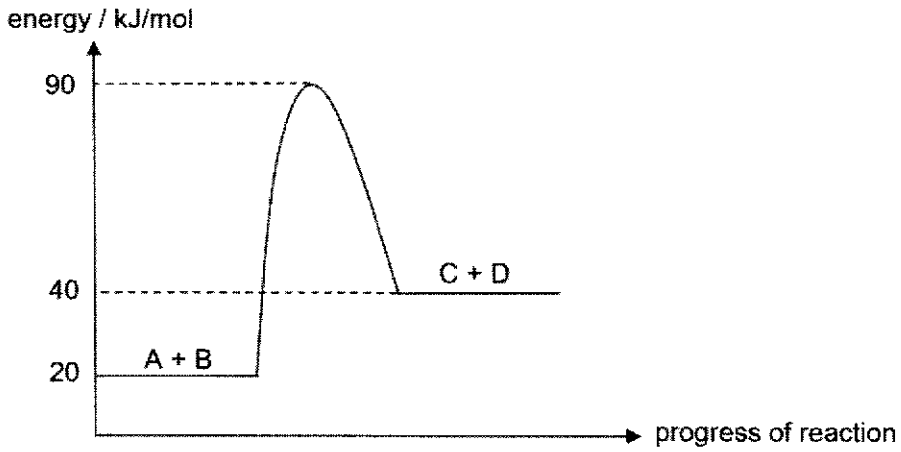
C A low temperature increases the yield of ammonia.

D Finely divided iron catalyst is used to increase the yield of ammonia.

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32 The energy profile diagram of a reversible reaction is shown below.

$$A + B \rightleftharpoons C + D$$



Which of the following statements is correct about the reaction?

A Activation energy of the forward reaction is given by +90 kJ/mol.

B Enthalpy change of the forward reaction is given by –20 kJ/mol.

C Activation energy of the backward reaction is given by +50 kJ/mol.

D Enthalpy change of the backward reaction is given by +20 kJ/mol.

33 Which metal is the strongest reducing agent?

A sodium

B lithium

C calcium

D beryllium

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34 Limestone can be changed into slaked lime in two chemical reactions.

1 When limestone is heated it decomposes into lime, CaO.

2 Water is slowly dripped onto the cooled lime. The lime appears to expand and steam is produced. Slaked lime, $Ca(OH)_2$, is formed.

Which row shows the correct description of each of the chemical reactions?

	reaction 1	reaction 2
A	endothermic	endothermic
B	endothermic	exothermic
C	exothermic	endothermic
D	exothermic	exothermic

35 Some of our environmental problems are stated below.

I depletion of the ozone layer

II melting of polar ice caps

III photochemical smog

The above problems are related to the following atmospheric chemicals:

W chlorofluorocarbons

X ozone

Y methane

Which atmospheric chemical is responsible for each problem?

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

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36 Diesel and petrol are commonly used as fuels for cars. The combustion of these fuels produces air pollutants. The table below shows the mass of air pollutants found in exhaust fumes when 1 kg of each fuel is combusted under identical conditions.

air pollutant produced	mass of air pollutant after diesel is combusted / g	mass of air pollutant after petrol is combusted / g
carbon monoxide	15	300
unburnt hydrocarbons	20	25
oxides of nitrogen	95	40

Which of the following can be inferred from the above data?

A Burning of petrol contributes more towards acid rain.

B Petrol requires less oxygen for complete combustion.

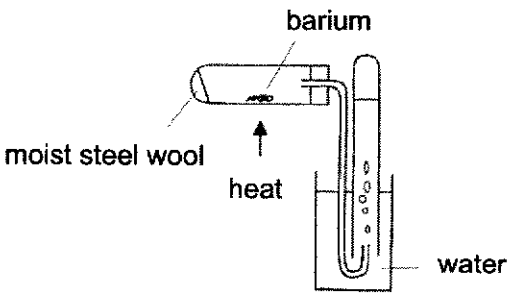
C Combustion of petrol is more exothermic than that of diesel.

D A diesel engine has a higher temperature than a petrol engine.

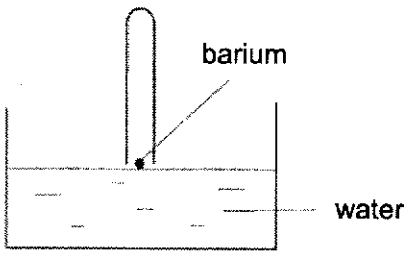
37 Barium is near sodium in the reactivity series. Its density is 3.5 g/cm^3.

Which experimental arrangement is most suitable for investigating the reaction of barium with water?

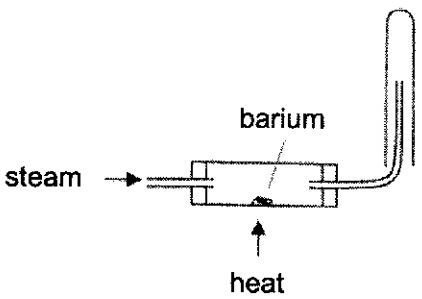
A



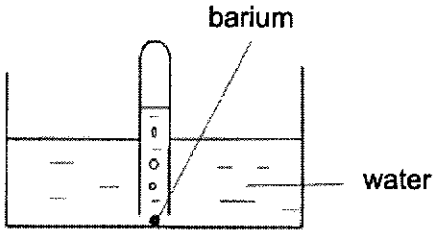
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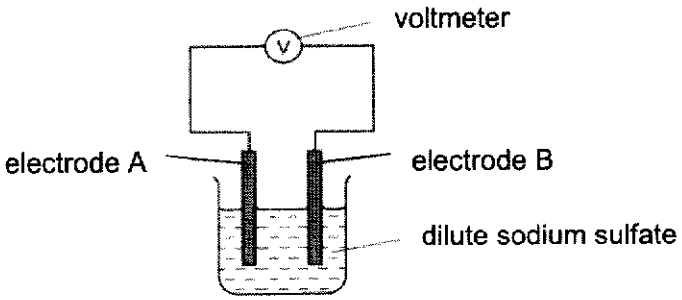


D



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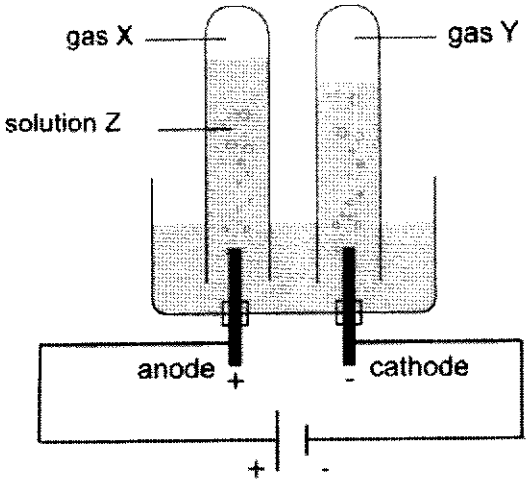
38 Electricity could be generated by the simple cell as shown.



Which pair of electrodes would give the largest voltage, and which electrode will be the positive terminal?

	electrode A	electrode B	positive terminal
A	silver	magnesium	silver
B	magnesium	copper	magnesium
C	copper	zinc	zinc
D	zinc	iron	iron

39 The diagram below is a typical electrolysis set-up that collects gaseous products.

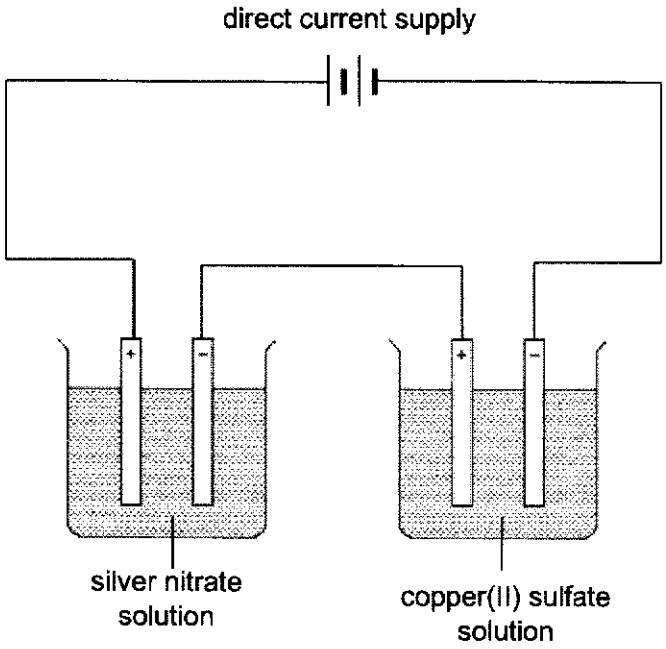


Which of the following correctly shows the identities of solution Z, gas X and Y?

	solution Z	gas X	gas Y
A	hydrochloric acid	chlorine	hydrogen
B	sodium sulfate	hydrogen	oxygen
C	sulfuric acid	oxygen	hydrogen
D	concentrated sodium chloride	chlorine	hydrogen

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40 Two electrolytic cells are set up as shown in the diagram. In all the cells, only carbon electrodes are used and the electrolytes are different aqueous salt solutions.



Which of the following correctly gives the masses of metals deposited at the cathode of each cell if 2 mole of electrons flows through the circuit?

	mass of silver / g	mass of copper / g
A	216	64
B	216	128
C	108	64
D	216	256

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							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 –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (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.).

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TAMPINES SECONDARY SCHOOL

Secondary Four Express
PRELIMINARY EXAMINATION 2020

NAME

CLASS | | | | **REGISTER NUMBER** | |

CHEMISTRY **6092/02**

PAPER 2 **1 Sep 2020**

1h 45 min

Candidates answer on the Question Paper.

No additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in blue or black ink on both sides of the paper.
Do not use staples, paper clips, glue or correction fluid.

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

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

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.

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

For Examiner's Use	
Section A	
Section B	

This document consists of **20** printed pages
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[Turn over

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Section A

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

Write your answers in the spaces provided on the question paper.

A1 Choose from the following elements to answer the questions.

calcium
carbon
chlorine
chromium
hydrogen
nitrogen
oxygen
sodium
zinc

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

Which element

(a) shows both metallic and non-metallic character,

.....[1]

(b) forms an oxide which reacts with the impurities in a blast furnace to form slag,

.....[1]

(c) is produced at the platinum anode during the electrolysis of aqueous sodium nitrate?

.....[1]

(d) forms a gaseous compound which combines with water to form acid rain,

.....[1]

(e) can have lubricating properties,

.....[1]

(f) turns aqueous potassium bromide reddish brown?

.....[1]

[Total: 6]

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A2 Titanium is extracted from an ore which contains titanium(IV) oxide, TiO_2.

$$TiO_2 + 2C + 2Cl_2 \rightarrow TiCl_4 + 2CO$$

(a) Identify the reducing agent in the reaction. Use the oxidation states to explain your answer.

.....

.....

.....[2]

(b) Titanium is a transition element.
Sodium is a Group I element.

Describe **two** differences in the physical properties of titanium and sodium.

1 .....

.....

2 .....

.....

[2]

[Total: 4]

A3 Our stomachs secrete hydrochloric acid. Antacid tablets can reduce excess acidity in our stomachs. A student carried out six experiments to study the speed of reaction between an antacid tablet and excess hydrochloric acid.

Experiment	Volume used in the mixture/cm^3		Temperature at the start of the experiment/°C	Time taken for the tablet to react completely with the acid/s	
	Acid	Water		Crushed tablet	Whole tablet
1	10	40	20	30	35
2	20	30	22	24	30
3	30	20	28	18	21
4	30	20	22	22	25
5	20	30	20	26	32
6	10	40	29	24	29

(a) How would the student know that the tablet had reacted completely with the acid?

.....

.....[1]

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(b) Explain why the total volume of the acid–water mixture was kept constant in **all** the experiments.

.....

.....[1]

(c) Using the results of the experiments in the table, explain the effect of increasing the temperature on the speed of reaction between the acid and the tablet.

.....

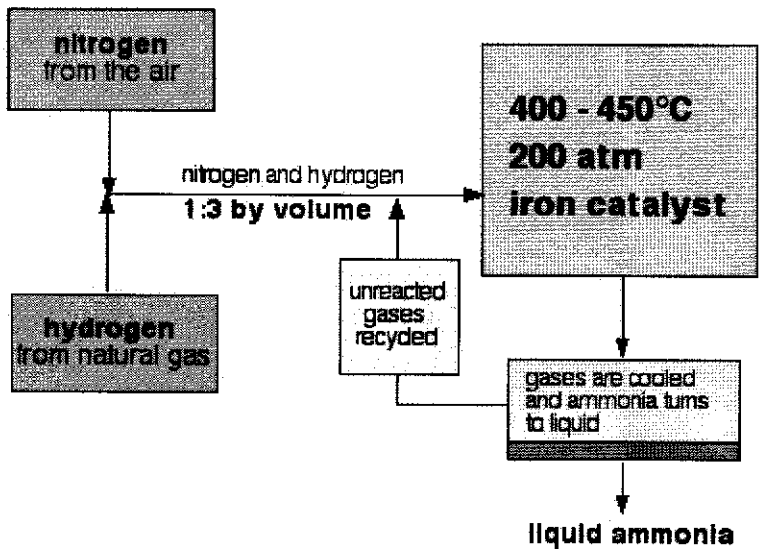
.....

.....[2]

[Total: 4]

A4 Ammonia is manufactured by combining nitrogen and hydrogen at high temperature and pressure.

$$N_2\,(g) + 3H_2\,(g) \rightarrow 2NH_3\,(g)$$



(a) **(i)** Nitrogen and hydrogen are mixed in a 1 : 3 ratio by volume.
Explain why the gases are mixed in a 1 : 3 ratio.

.....

..... [1]

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(ii) Jamie thinks that the nitrogen and hydrogen are also mixed are in a 1:3 ratio by mass. Do you agree with her? Explain.

.....

..... [1]

(b) (i) The mixture of nitrogen and hydrogen is passed over finely divided iron. What effect does iron have on the final percentage of ammonia produced?

..... [1]

(ii) The gases leaving the reactor contains unreacted nitrogen and hydrogen and about 15% ammonia by volume. Unreacted nitrogen and hydrogen are fed back into the reactor in stage 2.

Give one reason why the unreacted gases are fed back into the reactor.

.....

..... [1]

(iii) Explain, in terms of collision between reacting particles, how a higher pressure affects the rate of reaction on the reactor.

.....

.....

.....

..... [2]

(c) Ammonia is used to make fertilisers such as ammonium phosphate, $(NH_4)_3PO_4$. Calculate the percentage by mass of nitrogen in ammonium phosphate.

[2]

[Total: 8]

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A5 **(a)** **(i)** Silane is a compound made up of silicon and hydrogen. Paints, inks and coatings often use silane to increase resistance to abrasions as well as increased adhesion, thermal stability and cross-linking.

Draw the 'dot-and-cross' diagram for silane. You only need to show the outer shell electrons.

[2]

(ii) Using ideas about structure and bonding, suggest why silane has a low boiling point while diamond as high boiling point.

.....

.....

.....

..... [2]

(b) Although most of the noble gases are unreactive, Chemists have discovered that some noble gases can form compounds.

A 1.000 g sample of one of these compounds contains 0.549 g of xenon, 0.134 g of oxygen and 0.317 g of fluorine.

(i) Calculate the empirical formula of this compound.

empirical formula .....[2]

(ii) What extra information is needed to deduce the molecular formula of this compound?

.....[1]

[Total: 7]

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A6 Insoluble salts can be made by precipitation reactions.
A student mixed solutions of some soluble salts. The results the student obtained are shown in the table.

		second salt solution		
		$Co(NO_3)_2$ (aq)	$AgNO_3$ (aq)	$Pb(NO_3)_2$ (aq)
first salt solution	NaI (aq)	no change	yellow precipitate	yellow precipitate
	Na_2CO_3 (aq)	purple precipitate	yellow precipitate	white precipitate
	Na_2SO_4 (aq)	no change	white precipitate	white precipitate

All sodium salts are soluble in water.

Use only results from the table to answer the following questions.

(a) Name an insoluble yellow lead salt.

.....[1]

(b) Write the chemical equation for the reaction in which silver carbonate is formed, including state symbols.

.....[2]

(c) Write the ionic equation for the reaction in which lead(II) iodide is formed.

.....[2]

(d) Aqueous silver nitrate produces a yellow precipitate with both iodide ions and carbonate ions.

When testing an unknown solution for iodide ions, the aqueous silver nitrate is acidified.
Explain why the aqueous silver nitrate is acidified.

.....

.....

.....

.....[2]

[Total: 7]

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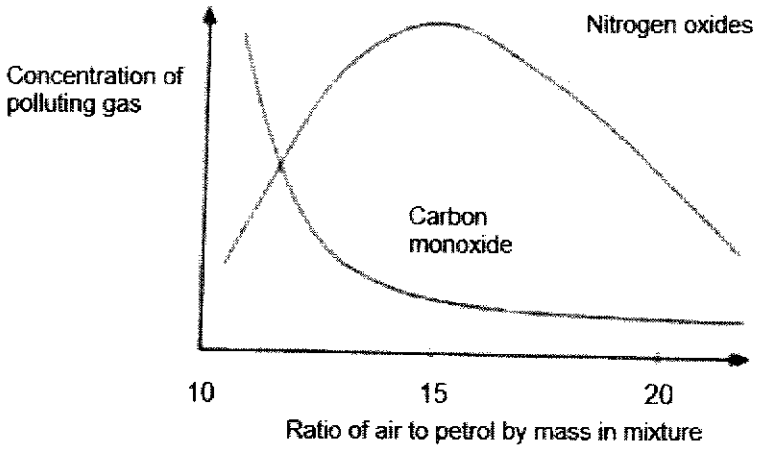
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A7 In a car engine, petrol vapour is mixed with air and a combustion takes place.

(a) Name the two main products of combustion of petrol in an excess of air.

.....[2]

(b) The amount of air mixed with petrol vapour in a car engine can be varied. Two pollutants in the exhaust gases from a car are carbon monoxide and nitrogen oxides.
The graph below shows how the amounts of these pollutants in the exhaust gases depend on the composition of the air and petrol mixture.



(i) Explain how carbon monoxide and nitrogen oxides are produced in the car engine.

.....

.....

.....

.....[2]

(ii) Describe how the concentration of carbon monoxide varies as the air to petrol ratio is increased in the engines.

.....

.....[1]

(iii) It was found that cars produced the maximum amount of energy when the air to petrol ratio is about 15. Suggest why the maximum amount of nitrogen oxides is produced under this condition.

.....

.....

..... [2]

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(c) Name one other gaseous pollutant produced by car engines, other than carbon monoxide and nitrogen oxides.

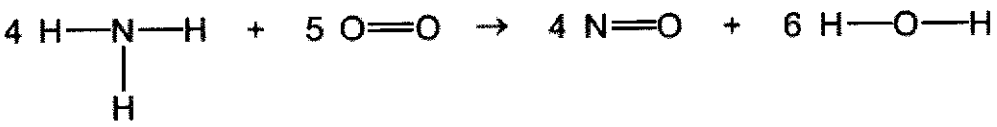
.....[1]

[Total: 8 m]

A8 Ammonia reacts with oxygen as shown.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

(a) The chemical equation for the reaction can be represented as shown.



Use the bond energies in the table to calculate the energy change, in kJ / mol, which occurs when **one** mole of NH_3 reacts.

bond	N–H	O=O	N=O	O–H
bond energy in kJ / mol	391	498	587	464

(i) Calculate the energy needed to break bonds.

..... kJ [1]

(ii) Calculate the energy released when bonds are formed.

..... kJ [1]

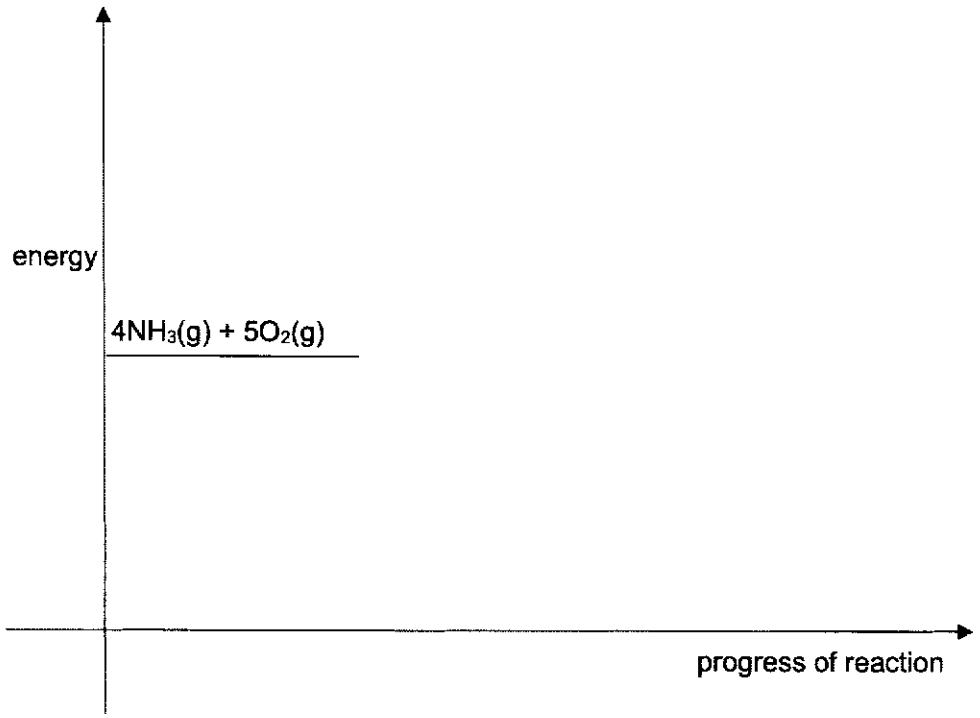
(iii) Calculate the energy change when **one** mole of NH_3 reacts.

energy change = ... kJ / mol [2]

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(b) Complete the energy profile diagram for the reaction of ammonia with oxygen.

Your diagram should include
- the **formulae of the products** of the reaction.
- a label for the **enthalpy change of reaction** and **activation energy** of the reaction.



[2]
[Total: 6]

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Section B

Answer **all** the questions from this section.
Write your answers in the spaces provided.

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

B9 The First Periodic Table

In 1869, a Russian chemist, Dmitri Mendeleev, was the first scientist to devise a Periodic Table as shown in Fig. 9.1. He arranged the elements known at the time in order of relative atomic mass. He realised that by arranging the elements in this order, certain types of element occurred regularly, for example a reactive non-metal was directly followed by a very reactive light metal, then a less reactive light metal.

			Ti 50	Zr.... 90	? 180
			V.....51	Nb... 94	Ta ...182
			Cr 52	Mo .. 96	W....186
			Mn.....55	Rh...104.4	Pt....197.4
			Fe 56	Ru ..104.4	Ir....198
			Ni, Co..59	Pd...106.6	Os...199
H.....1			Cu.....63.4	Ag...108	Hg.. 200
	Be.... 9.4	Mg ...24	Zn.....65.2	Cd...112	
	B.....11	Al.....27.4	? 68	Ur...116	Au ..197
	C.....12	Si.....28	? 70	Sn ...118	
	N.....14	P.....31	As..... 75	Sb...122	Bi...210
	O.....16	S.....32	Se 79.4	Te....128 ?	
	F.....19	Cl....35.5	Br.....80	I.....127	
	Na.....23	K.....39	Rb.....85.4	Cs...133	Tl....204
		Ca....40	Sr.....87.6	Ba...137	Pb...207
		? 45	Ce 92		
		? Er ..56	La 94		
		? Y ...60	Di.....95		
		? In...75.6	Th.....118		

Fig. 9.1.

In the modern Periodic Table, the properties of the elements are a function of their atomic numbers. Fig. 9.2. gives a series of curves when the atomic radii of elements in successive periods are plotted against the atomic numbers.

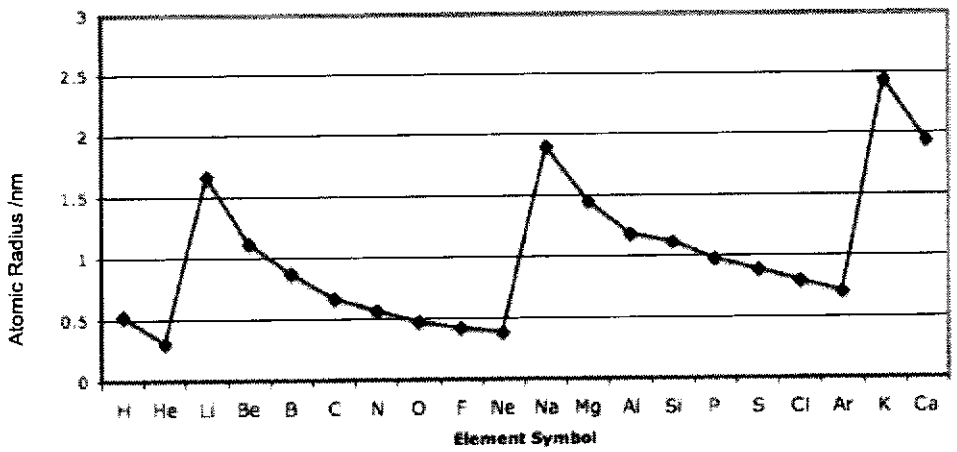


Fig. 9.2.

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The radius of an atom is determined mainly by two factors. One factor is the attraction between the positively charged nucleus and the electrons. The second factor is the 'screening' of the outer electrons from the nucleus by electrons in the inner shells. This screening effect is caused by the mutual repulsion between the electrons in the inner shells and those in outer shells.

(a) Describe three differences between Mendeleev's Periodic Table and the modern Periodic Table.

.....

.....

.....

.....

.....

.....[3]

(b) What is the current symbol of the element on the modern Periodic Table, which is represented by **J** on Mendeleev's?

.....[1]

(c) With reference to Mendeleev's Periodic Table, give one example of 'a reactive non-metal followed by a reactive light metal then a less reactive light metal'.

.....[1]

(d) With reference to the information given in Fig. 9.2., describe the trend in atomic radii across period 2 and 3. Explain the trend.

.....

.....

.....

.....

.....

.....[3]

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(e) A student makes the following statement on atomic radii.

'The reactivity of Group I metals and halogens is closely related to the trend of atomic radii for these elements.'

Do you support her statement? Explain your reasoning.

.....

.....

.....

.....

.....

.....[3]

(f) In period 4 and subsequent periods, the trend in atomic radii is interrupted by certain elements. What are these elements?

.....

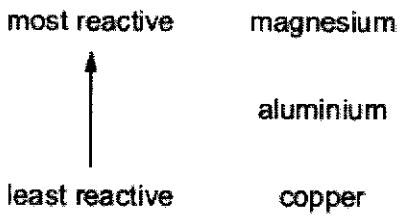
.....[1]

[Total: 12]

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B10 The positions of some common metals in the reactivity series are shown.



(a) **(i)** When magnesium is placed in aqueous copper(II) sulfate a displacement reaction occurs immediately.

Write an ionic equation for the reaction. Include state symbols.

.....[1]

(ii) State **two** observations you would make when magnesium is placed in aqueous copper(II) sulfate.

1 .....

.....

2 .....

.....

[2]

(iii) When aluminium foil is added to aqueous copper(II) sulfate no immediate reaction takes place. Explain why.

.....

.....[1]

(b) Recycling used cans uses less energy and produces less waste than extraction of aluminium from bauxite.

Give one other reason why recycling metals such as aluminium is important.

.....

.....[1]

(c) Some aluminium is used to make *Duralumin*. *Duralumin* has many uses, including to build aircraft.
Duralumin is a mixture of aluminium with added copper, magnesium and manganese.
Suggest why *Duralumin* is more useful for building aircraft than pure aluminium.

.....

.....

.....[2]

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(d) Zinc is used to galvanise iron to prevent the iron from rusting.

Explain how galvanising prevents iron from rusting.

.....

.....[1]

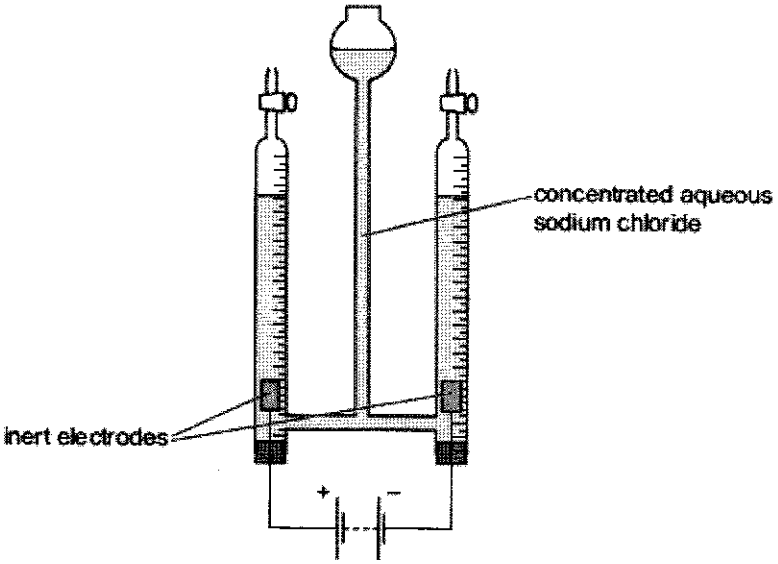
[Total: 8]

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EITHER

B11 **(a)** A student used the following apparatus to electrolyse concentrated aqueous sodium chloride using inert electrodes.



(i) Suggest the name of a metal that could be used as the inert electrodes.

.....[1]

(ii) Name the gas formed at the positive electrode.

.....[1]

(iii) Write ionic half-equation for the reactions at the cathode and anode.

at the cathode

at the anode

[2]

(iv) How, if at all, does the pH of the solution change during the electrolysis? Explain your answer.

.....

.....

.....

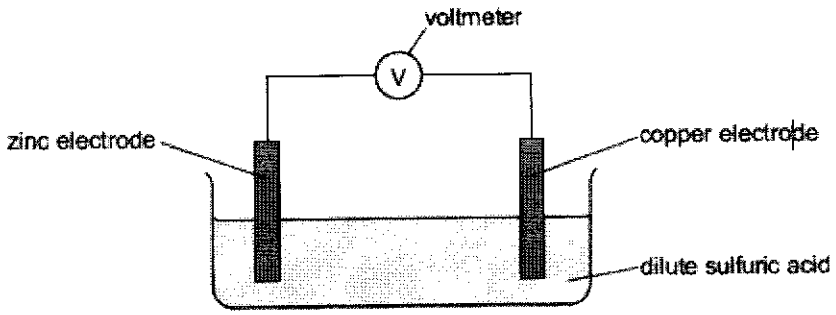
.....

.....[2]

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(b) A student used the following electrochemical cell.
The reading on the voltmeter was +1.10 V.



(i) Draw an arrow on the diagram to show the direction of electron flow. [1]

(ii) Suggest the change, if any, in the voltmeter reading if the zinc electrode was replaced with an iron electrode. Explain your answer.

.....

.....

.....

.....[2]

(iii) The zinc electrode was replaced with a silver electrode. The reading on the voltmeter was –0.46 V.

Suggest why the sign of the voltmeter reading became negative.

.....

.....[1]

[Total: 10]

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OR

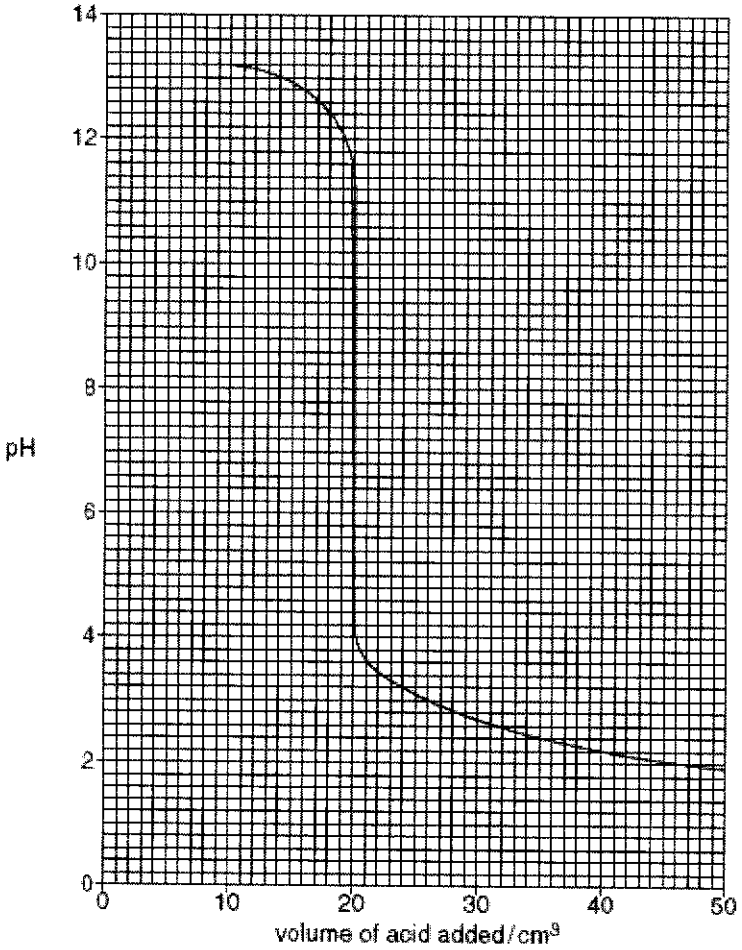
B11 Sulfuric acid reacts with the alkali sodium hydroxide.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

(a) Write the ionic equation for this reaction.

.....[1]

(b) The graph below shows how the pH changes when aqueous sulfuric acid from a burette is added slowly to 45.0 cm^3 of 0.150 mol / dm^3 sodium hydroxide until the acid is in excess.



(i) What volume of acid has been added when the pH is 7?

.....[1]

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(ii) Use your answer to part (i) to calculate the concentration, in mol / dm^3, of the sulfuric acid.

concentration = ... mol / dm^3 [3]

(c) The experiment was repeated using ethanoic acid of the same concentration as the sulfuric acid. The same volume and concentration of aqueous sodium hydroxide was used.

(i) The volume of ethanoic acid required to neutralise the aqueous sodium hydroxide was twice as great compared with the volume of sulfuric acid.

Explain why.

.....

.....

.....[1]

(ii) Suggest the value of the pH after excess ethanoic acid has been added.

.....[1]

(d) (i) Sulfuric acid is one of the acids present in acid rain.
Suggest how sulfuric acid is formed in the atmosphere.

.....

.....

.....

.....[2]

(ii) State one effect of sulfur dioxide on human health.

.....

.....

.....[1]

[Total: 10]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							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 –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lantharum 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.).

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4E Chemistry Prelims 2020 Answer Key

Paper 1

1	C	11	B	21	A	31	D
2	C	12	C	22	C	32	C
3	B	13	B	23	C	33	A
4	D	14	B	24	A	34	B
5	A	15	D	25	D	35	B
6	D	16	B	26	B	36	D
7	C	17	D	27	D	37	D
8	D	18	C	28	B	38	A
9	B	19	D	29	C	39	C
10	C	20	C	30	B	40	A

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CHEMISTRY

2020 SEC 4E PRELIMINARY EXAMINATION-ANSWER SCHEME

Section A

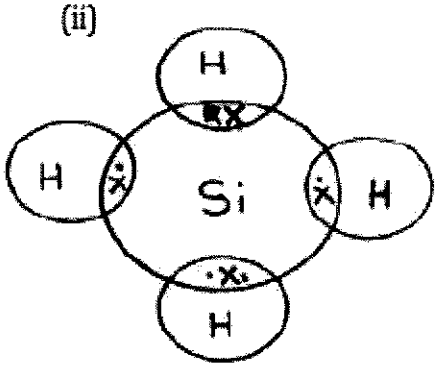
A1		
(a)	zinc	[1]
(b)	calcium	[1]
(c)	oxygen	[1]
(d)	nitrogen	[1]
(e)	carbon	[1]
(f)	chlorine	[1]

A2		
(a)	Carbon is the reducing agent. It reduces and causes the oxidation state of Chlorine to <u>increases</u> from <u>0 in Cl_2</u> to <u>-1 in $TiCl_4$</u>, while itself is oxidized.	[1] [1]
(b)	1. Titanium has high melting point while sodium has low melting point. 2. Titanium has high density while sodium has low density.	[1] [1]

A3		
(a)	When the tablet had dissolved completely in the acid	[1]
(b)	The total volume was kept constant so that the concentration of the acid in each experiment would be proportional to the volume of acid used.	[1]
(c)	The speed of reaction increased. Comparing the results of Experiments 2 and 5 (or 3 and 4), in which the concentration of the acid was kept constant, a shorter time was needed for the tablet to react completely.	[1] [1]

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A4			
(a)	(i)	The mole ratio is of nitrogen to hydrogen is 1: 3, the volume of gas is proportional to mole ratio.	[1]
	(ii)	No. The molar mass of nitrogen and hydrogen are different and the mass is not proportional to the mole ratio.	[1]
(b)	(i)	It has no effect on the percentage of ammonia produced.	[1]
	(ii)	To save cost of production. / To reduce wastage of nitrogen and hydrogen gas.	[1]
	(iii)	When there is higher pressure, the reacting particles are closer together, there is a greater number of particles per unit volume/ concentration of reacting particles increases the number of effective collisions per unit time increases. The rate of reaction increases.	[1] [1]
(c)		Mr of $(NH_4)_3PO_4$ = 18 x 3 +31+16 x 4 = 149 % of N = 14 x3/149 x 100 = 28.2 % (3.s.f.)	[1] [1]

A5			
(a)	(i)	(ii)  	Correct ratio of atoms [1] Correct number of bonding pairs of electrons [1]
	(ii)	Silane has low melting and boiling point as it has simple molecular structure, a small amount of energy is required to overcome the weak intermoecular forces of attractions between the molecules.	[1]

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<table>
<tr><td></td><td></td><td>Diamond has high melting and boiling point as it has giant molecular structure. A large amount of energy is required to overcome ths strong covalent bonds between the carbon atoms.</td><td>[1]</td></tr>
<tr><td>(b)</td><td>(i)</td><td>
<table>
<tr><td></td><td>Xe</td><td>O</td><td>F</td></tr>
<tr><td>mass</td><td>0.549</td><td>0.134</td><td>0.317</td></tr>
<tr><td>A_r</td><td>131</td><td>16</td><td>19</td></tr>
<tr><td>no. of mole</td><td>0.549/131 = 0.004</td><td>0.134/16 = 0.008</td><td>0.317/19 = 0.016</td></tr>
<tr><td>ratio</td><td>1</td><td>2</td><td>4</td></tr>
</table>
Empirical formula = XeO_2F_4
</td><td>[1]

[1]</td></tr>
<tr><td></td><td>(ii)</td><td>The relative molecular mass or the molar mass.</td><td>[1]</td></tr>
</table>

<table>
<tr><td>A6</td><td></td><td></td></tr>
<tr><td>(a)</td><td>Lead(II) iodide</td><td>[1]</td></tr>
<tr><td>(b)</td><td>Na_2CO_3 (aq) + $2AgNO_3$ (aq) → Ag_2CO_3 (s) + $2NaNO_3$ (aq)</td><td>Correct balanced equation [1]
Correct state symbols [1]</td></tr>
<tr><td>(c)</td><td>Pb^{2+}(aq) + $2I^-$ (aq) → PbI_2 (s)</td><td>Correct balanced equation [1]
Correct state symbols [1]</td></tr>
<tr><td>(d)</td><td>Silver nitrate is acidified so as to remove any carbonate ions that could be present.</td><td>[1]

[1]</td></tr>
</table>

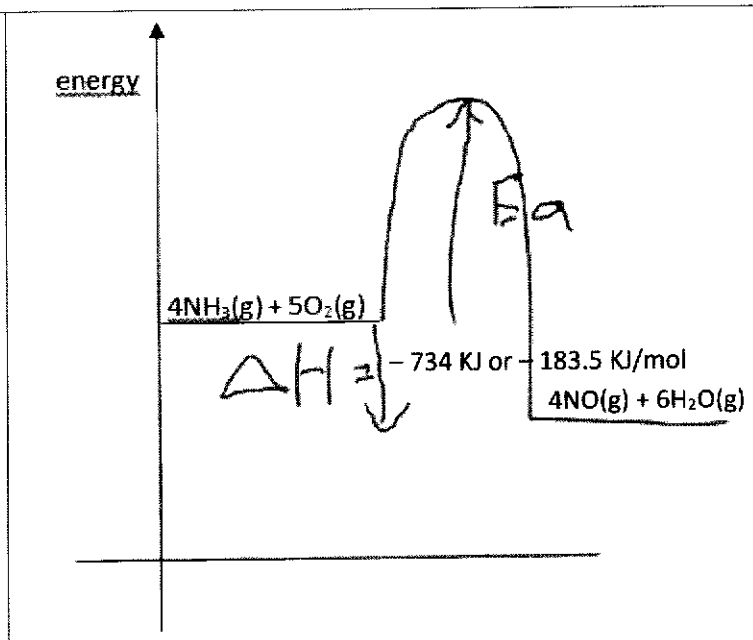
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	This is ensure silver ions react with the iodide ion to produce the yellow precipitate of silver iodide **Or** to prevent the silver ions from reacting with carbonate ions to form the yellow precipitate of silver carbonate/	

A7			
(a)		Carbon dioxide and water	[1] [1]
(b)	**(i)**	Carbon monoxide is produced by the incomplete combustion of carbon containing fuels. In the engine when the temperature is high, nitrogen combines with oxygen in the air to form nitrogen oxides.	[1] [1]
	(ii)	The concentration of carbon monoxide decreases.	[1]
	(iii)	Nitrogen oxides are formed at high temperature. As the maximum amount of energy is produced, the car engine is at high temperature, more nitrogen oxides would be formed.	[1] [1]
(c)		Unburnt hydrocarbon	[1]

A8			
(a)	**(i)**	Bonds broken [4 x 3 x 391] + [5 x 498] = 4692 + 2490 = 7182 kJ	[1]
	(ii)	Bonds formed [4 x 587] + [12 x 464] = 2348 + 5568 = 7916 kJ	[1]
	(iii)	Energy change = 7182 – 7916 = –734 kJ Energy change per mole of NH_3 = –734 / 4 = –183.5 kJ/mol	[1] [1]

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(b)		Correct labelling of the products, enthalpy change and activation energy [1] Correct shape of the graph [1]

Section B

B9		
(a)	**Any three of the following:** • Elements in Mendeleev's were arranged in order of increasing atomic mass while the elements in the modern Periodic Table in order of increasing proton/atomic number. • There are no noble gases found in Mendeleev's unlike the modern Periodic Table. • In the modern Periodic Table the transition elements are listed out as a separate block while in Mendeleev's the transition elements are listed with the main elements • There are about 114 elements in the modern Periodic Table as compared to Mendeleev's with only about slightly over 60 elements. • Mendeleev left gaps for elements yet to be discovered while most of the gaps are filled up in the main Periodic Table. • Except for Group II elements, the same period in the modern Periodic Table occurs in the same column in Mendeleev's. Accept Mendeleev Periodic Table does not shows the Periods according to the number of shells while the modern timetable shows the Periods.	Total: 3m
(b)	I (Iodine)	[1]

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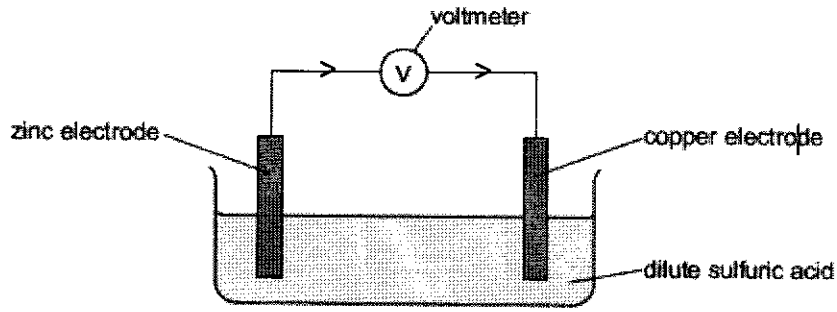
(c)	F, Na, Mg **OR** C*l*, K, Ca B*r*, Rb, S*r*	[1]
(d)	The atomic radii of elements decrease across the period Across the period, the atomic number increases and hence the attraction of the nucleus for the outer electrons increases while the number of occupied shells remains the same across the period. Many mentioned the trends at length but did not explain and elaborate the reason behind the trends.	[1] [1] [1]
(e)	I agree. • The atomic radius of both Group I elements and halogens increases down the group. Hence **the electrostatic forces of attraction between the nucleus and valence electrons decrease.** • **As the number of electron shells increases, the screening effect increases due to the repulsion between the inner and outer shell electrons.** • Down Group I, **the ease to lose the outer electron to from positive ion increases**, AND hence the • **reactivity of alkali metals increases down the group**. • Down Group VIII, **the ease to gain an additional electron to from negative ion decreases**, AND hence the • **reactivity of halogens decreases down the group**.	All 6 point, 3m 4-5 points, 2m 2-3 points, 1m Total:3m
(f)	Transition elements	[1]

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B10			
(a)	(i)	$Mg(s) + Cu^{2+}(aq) \rightarrow Mg^{2+}(aq) + Cu(s)$	[1]
	(ii)	The magnesium dissolves and a pinkish brown solid is formed. The aqueous solution turns from blue to colourless Effervescence produced.	[1] [1]
	(iii)	There is a layer of insoluble aluminium oxide which will gradually react with the copper(II) sulfate solution.	[1]
(b)		It is to conserve the limited natural resource of aluminium.	[1]
(c)		Duralumin contains different sized atoms which makes it harder for the layers to slide past one another and make the material longer.	[1] [1]
(d)		Zinc, being a more reactive metal, will undergo sacrificial protection by corroding in place of iron. Do not accept "Prevent oxygen and water from reacting with iron (protective layer)	[1]

B11	Either		
(a)	(i)	Platinum	[1]
	(ii)	Chlorine gas	[1]
	(iii)	Cathode $2H^+(aq) + 2e^- \rightarrow H_2(g)$ Anode $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$	[1] [1]
	(iv)	The pH of the solution increases. This is because the hydrogen ions are discharged at the cathode, there are more hydroxide ions in the solution. These hydroxide ions combined with Na^+ and resulted in an alkaline solution.	[1] [1]

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(b)	**(i)**		[1]
	(ii)	The voltmeter reading will decrease. This is because the difference in the reactivity between iron and copper is lower than the difference in reactivity between zinc and copper.	[1] [1]
	(iii)	The direction of the flow of electron is reversed/the opposite as the electrons flow from copper metal to silver metal instead.	[1]

B11	**Or**		
(a)		H^+ (aq) + OH^- (aq) → H_2O (l) Accept without state symbols.	[1]
(b)	**(i)**	20.00 cm^3	[1]
	(ii)	No.of moles of NaOH = C_m X V(dm^3) = 0.150 x 45.0/1000 = 0.00675 mol No. of mole of H_2SO_4 = 0.00675/2 = 0.003375 mol No.of moles of H_2SO_4 = Cm X V(dm^3) 0.003375 = Cm x 20.00/1000 C_m = 0.003375 / 0.020 = 0.169 mol/dm^3 (3. s.f)	[1] [1] [1]
(c)	**(i)**	Each molecule of ethanoic acid ionises to produce one H^+ while sulfuric acid ionises to produce two H^+. Or Sulfuric acid ionises to produce double the number of H^+ as compared to ethanoic acid. Or 1 mole of sulfuric acid produces 2 moles of H^+ while ethanoic acid produces 1 mole of H^+.	[1]
	(ii)	The pH is 3 or 5.	
(d)	**(i)**	Sulfur dioxide produced from the combustion of fossil fuels in power station/ volcanic eruption	[1]

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		Dissolves in the rain water to form sulfuric acid. Sulfur dioxide is an acidic oxide./ Sulfur dioxide dissolves in the rain water to form sulfurous acid which further reacts with oxygen to form sulfuric acid.	[1]
	(ii)	It may cause lung problems like asthma and bronchitis.	[1]

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