Name	Class	Index Number

UNITY SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2019

SECONDARY FOUR EXPRESS

CHEMISTRY 6092/01 **19 SEP 2019**

PAPER 1 **1 HOUR**

Additional Materials : Optical Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use paper clips, highlighters, glue or correction fluid.
Write your name and index number on the Answer 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 separate Optical Answer Sheet.

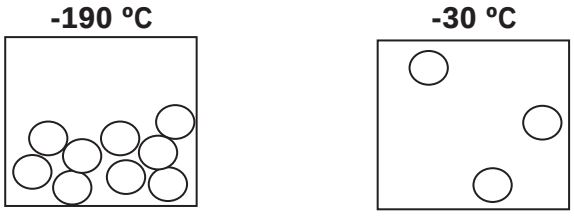
Read the instructions on the Answer Sheet very carefully.

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 15.
The total mark for this paper is 40 marks.

This paper consists of **15** printed pages, including this cover page.

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1 The following diagrams show the arrangement of particles of a substance at two different temperatures.

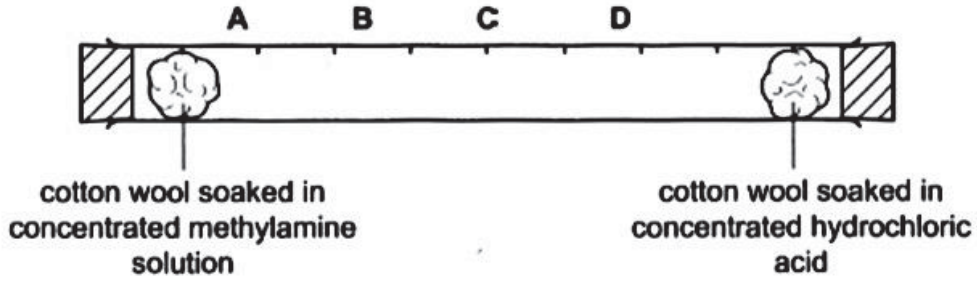


Which substance could the diagrams represent?

Substance	Melting point / ^{0}C	Boiling point / ^{0}C
A	−210	−50
B	−210	−10
C	−100	−50
D	−100	−10

2 When concentrated aqueous methylamine, CH_3NH_2 (*Mr* = 31) and concentrated hydrochloric acid, HCl (*Mr* = 36.5) are placed at opposite ends of a tube, a white ring of solid, methyl ammonium chloride, CH_3NH_3Cl is formed.

At which position **A**, **B**, **C** or **D**, will the white ring be found?



3 Which two gases each change the colour of damp red litmus paper?

A ammonia and chlorine
B ammonia and hydrogen chloride
C carbon dioxide and chlorine
D carbon dioxide and sulfur dioxide

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4 Four students were asked to test a solution for the presence of a cation by using various anions. The students obtained these results.

Student	chlorides	sulfates	carbonates
A	No precipitate	No precipitate	Precipitate
B	Precipitate	Precipitate	No precipitate
C	Precipitate	Precipitate	Precipitate
D	No precipitate	Precipitate	No precipitate

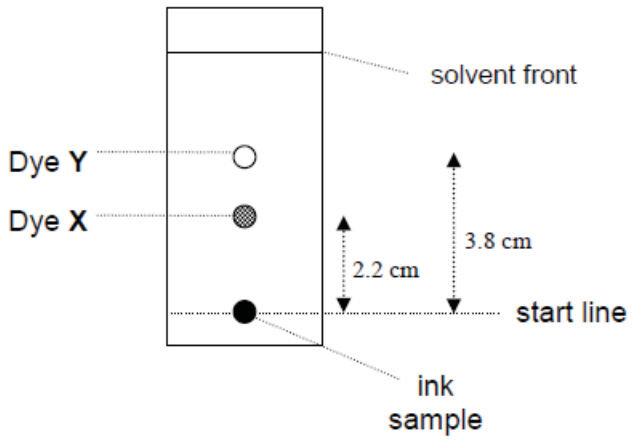
Each student concluded that Pb^{2+} was present.

Which student had results consistent with this conclusion?

5 Solid samples of ammonium chloride, silver chloride and sodium chloride were accidentally mixed together. Which of the following sequences outlines the best method to obtain the pure dry sample for each substance?

A dissolving, filtration, sublimation, crystallisation
B dissolving, fractional distillation, filtration, evaporation
C sublimation, filtration, evaporation, crystallisation
D sublimation, dissolving, filtration, evaporation

6 The results of a paper chromatography experiment carried out on an ink sample are shown below.



Given that the R_f value of Dye X is 0.40, what is the R_f value of Dye Y?

A 0.50
B 0.57
C 0.69
D 1.73

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7 An imaginary element Unitium (Um) has a proton number of 113 and a nucleon number of 237. Which of the following indicates the number of sub-atomic particles in the Unitium ion, Um^{3+}?

	Number of electrons	Number of neutrons	Number of protons
A	110	124	110
B	110	124	113
C	113	237	113
D	113	124	110

8 The relative atomic mass of naturally occurring chlorine on planet Jupiter is found to be exactly 36.0. What **cannot** be a reason for this?

A All the chlorine atoms on Jupiter have 19 neutrons.
B Half the chlorine atoms on Jupiter have 18 neutrons and the rest have 20 neutrons.
C There is only one type of chlorine atom found on Jupiter.
D The chlorine atoms on Jupiter have different number of protons but same number of neutrons.

9 How many covalent bonds are there in the molecule with the formula CH_2CHCH_3?

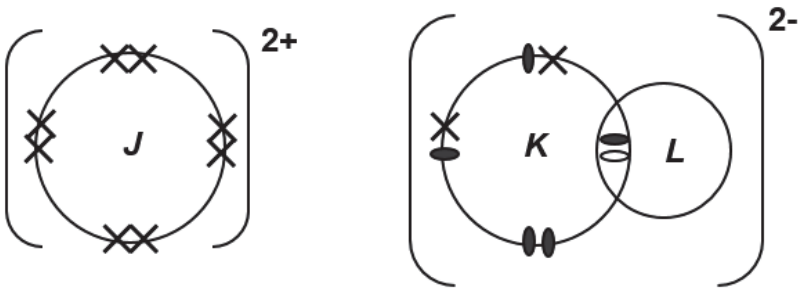
A 7
B 8
C 9
D 10

10 The proton numbers of elements, Q, R and Z are 4, 6 and 8 respectively. Which of the following lists give the correct formulae of the compounds formed between them?

A QZ RZ_2 QRZ_3
B QZ RZ_2 QRZ_4
C Q_2Z RZ QRZ_3
D Q_2Z RZ QRZ_4

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11 ***J***, ***K*** and ***L*** are three different elements in the Periodic Table. The electronic diagram (showing only the valence electrons) of the compound formed between ***J***, ***K*** and ***L*** is shown below:



Which of the following statements are correct?

I Element ***K*** could be nitrogen.
II Element ***J*** belongs to Group II of the Periodic Table.
III Element ***K*** and element ***L*** are bonded together by covalent bond.
IV Element ***L*** is a metal.

A I, II and III
B I, II and IV
C I, III and IV
D II, III and IV

12 A pure compound contains 24 g of carbon, 4 g of hydrogen and 32 g of oxygen. What is the empirical formula of the compound?

A CHO
B CH_2O
C CH_4O
D C_2H_2O

13 When solid sodium hydrogencarbonate (Mr = 84) is heated strongly, the following reaction occurs.

$$2NaHCO_3\ (s) \rightarrow Na_2CO_3\ (s) + H_2O\ (g) + CO_2\ (g)$$

What is the loss in mass when 25.2 g of solid sodium hydrogencarbonate is heated?

A 2.7 g
B 9.3 g
C 15.9 g
D 18.6 g

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14 In an experiment, 4.0 cm^3 of 1.0 mol/dm^3 copper(II) sulfate solution are mixed with 8.0 cm^3 of 1.0 mol/dm^3 sodium carbonate solution.

What does the reaction vessel contain?

A a green precipitate and a blue solution
B a colourless solution only
C a white precipitate and a colourless solution
D a green precipitate and a colourless solution

15 Concentrated aqueous iron (II) iodide is electrolysed using platinum electrode. Which of the following correctly describes the reactions at each electrode?

	Ions attracted to cathode	**Observations at anode**
A	I^- and OH^-	Colourless gas evolved
B	I^- and OH^-	Grey deposit formed
C	Fe^{2+} and H^+	Brown solution formed
D	Fe^{2+} and H^+	Colourless gas evolved

16 Four electrolytes are listed. Each is electrolysed using inert electrodes.

1 aqueous copper(II) chloride
2 concentrated aqueous sodium chloride
3 dilute aqueous sodium chloride
4 molten aluminium oxide

Which two of the electrolytes will result in a metal forming at the cathode?

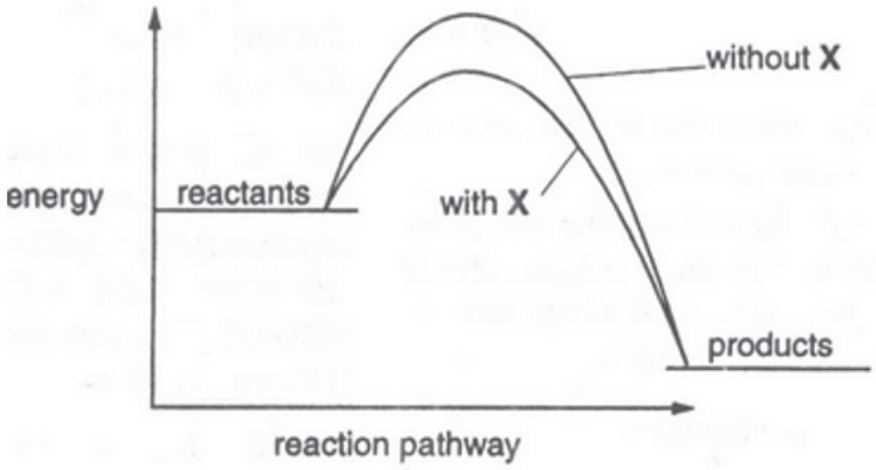
A 1 and 2
B 1 and 4
C 2 and 3
D 3 and 4

17 Which statement describes what happens when hydrogen and oxygen are used in a fuel cell?

A Electricity is generated directly.
B Electricity is used to produce water.
C Hydrogen is burned to form steam.
D Hydrogen reacts to form a hydrocarbon fuel.

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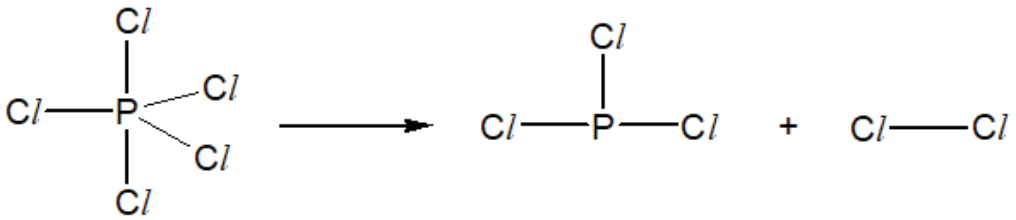
18 The energy profile diagram of a certain reaction is shown below. ***X*** is a catalyst.



Which one of the following statements is correct?

A More heat is absorbed in bond-breaking than is released in bond-making.
B The addition of ***X*** increases the yield of the products.
C The enthalpy change is decreased by the addition of ***X***.
D The frequency of effective collisions is increased by the addition of ***X***.

19 Gaseous phosphorus pentachloride can be decomposed into gaseous phosphorus trichloride and chlorine by heating.



Given that the bond energy of P-Cl is 330 kJ/mol and Cl-Cl is 240 kJ/mol, calculate the enthalpy change for the reaction.

A −420 kJ/mol
B −90 kJ/mol
C +90 kJ/mol
D +420 kJ/mol

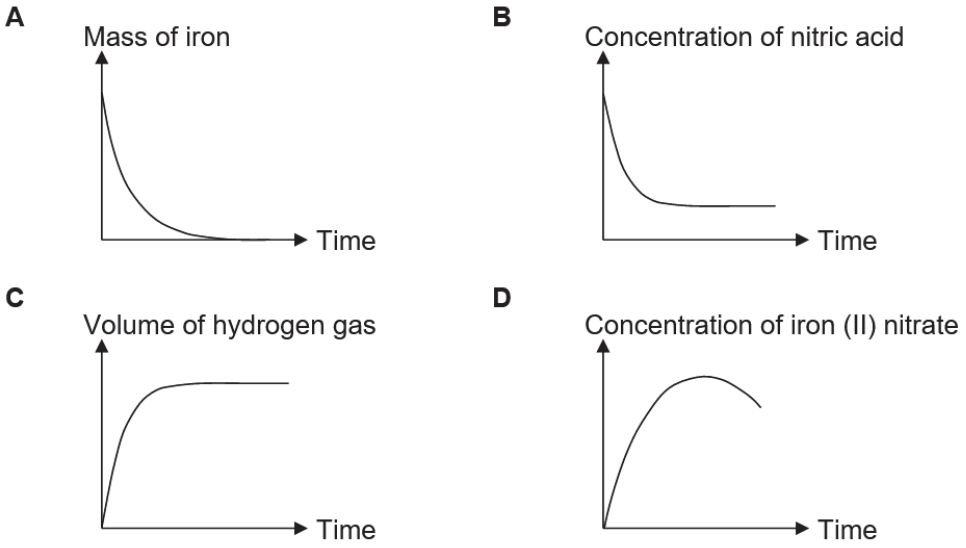
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20 When excess calcium carbonate pieces are added to dilute hydrochloric acid, the reaction gradually becomes slower and finally stops.

Which statement best explains why the rate of reaction becomes slower?

A An insoluble layer of calcium chloride is formed on calcium carbonate.
B The concentration of hydrochloric acid gradually reduces to zero.
C The mass of calcium carbonate decreases throughout the reaction.
D The pieces of calcium carbonate gradually become smaller.

21 Which of the following graphs shows the correct change with time when nitric acid reacts with excess iron filings?



22 A textbook writes 'Nitric acid, HNO_3, is a strong oxidising agent'.

Which of the following **cannot** be a product of nitric acid in its reaction with a reducing agent?

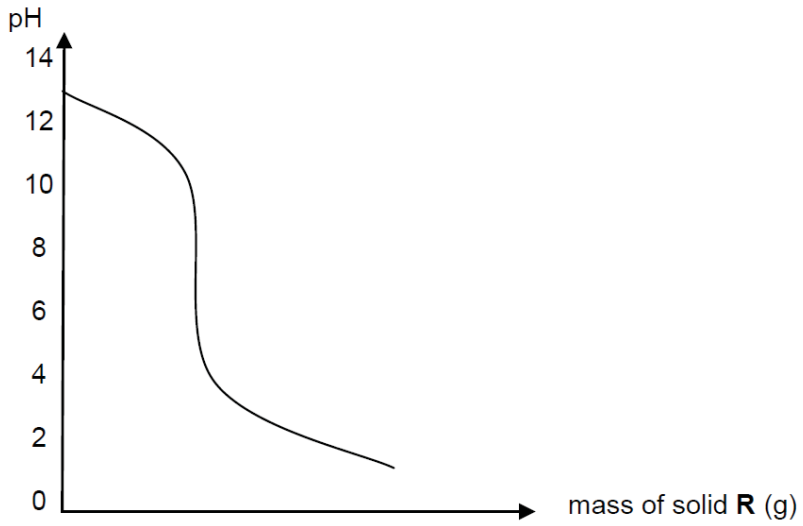
A N_2O_5
B N_2
C NO
D NO_2

23 Which of the following pairs of reactants will **not** give a neutral solution when they are mixed together in equal number of moles?

A Sodium hydroxide and nitric acid
B Calcium hydroxide and sulfuric acid
C Potassium hydroxide and hydrochloric acid
D Barium hydroxide and nitric acid

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24 Solid **R** is gradually added to aqueous solution **S**. The changes in pH are shown on the graph.



What are substances **R** and **S**?

	Substance **R**	Substance **S**
A	insoluble metal oxide	nitric acid
B	soluble metal oxide	hydrochloric acid
C	soluble non-metal oxide	aqueous ammonia
D	soluble non-metal oxide	sodium hydroxide

25 A new indicator has just been produced in the laboratory. It changes colour according to the table below:

pH	**Colour**
0 - 3	Red
4 - 7	Green
8 - 14	Dark blue

This indicator will be suitable to distinguish between

A aqueous ammonia and sodium hydroxide.
B aqueous sodium chloride and water.
C aqueous sodium nitrate and sodium hydroxide.
D dilute hydrochloric acid and dilute sulfuric acid.

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26 Which of these statements are true in Haber Process?

I The hydrogen needed can be obtained by cracking of petroleum.
II The reaction chamber is pressurized to speed up the reaction.
III The ammonia formed is removed by condensation.

A I and II
B I and III
C II and III
D I, II and III

27 Many properties of an element and its compounds can be predicted from the position of the element in the Periodic Table.

Which property could **not** be predicted in this way?

A the acidic or basic nature of its oxide
B the formula of its oxide
C the number of isotopes it has
D its metallic or non-metallic properties

28 A large volume of copper(II) sulfate solution is left in an iron container overnight.

Which statement describes what happens?

A The solution evaporates completely and some copper(II) sulfate crystals are left behind.
B The part of the container in contact with the solution is coated with copper.
C Some fine iron particles are formed in the solution.
D Atmospheric oxygen reacts with the copper(II) sulfate to give black copper(II) oxide.

29 The Apple® Watch (Sport) is made up of an alloy comprising aluminium and tightly controlled amounts of magnesium and zinc.

Which of the following is **not** a good reason for alloying metals?

A It is cheaper to use alloys than pure metals.
B The use of alloys enhances the appearances of the product.
C The use of alloys enhances the strength of the product.
D The use of alloys makes the product less susceptible to corrosion.

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30 The haemoglobin molecule in our blood contains 0.33% by mass of iron. If the molar mass of haemoglobin is 68 000 g, how many iron atoms are there in one mole of haemoglobin?

A 4
B 8
C 224
D 401

31 Petrol and diesel are two common fuels used by cars and buses respectively. The combustion of these fuels produces air pollutants.

The table shows the mass of pollutants found in exhaust fumes when 1 kg of each fuel is burnt.

pollutant produced	mass of pollutant after petrol is burnt / g	mass of pollutant after diesel is burnt / g
carbon monoxide	240	10
oxides of nitrogen	30	60
sulfur dioxide	1	4
unburnt hydrocarbons	25	20

Which of the following statements can be inferred using the data in the table?

A All the pollutants listed can be removed by installing a catalytic converter.
B Carbon monoxide is produced by complete combustion of the fuels.
C Petrol contributes more towards the formation of acid rain.
D The temperature in petrol engine is lower than that in diesel engine.

32 Which of the following changes does **not** happen in a catalytic converter?

A carbon monoxide → carbon dioxide
B nitrogen dioxide → nitrogen
C nitrogen monoxide → nitrogen dioxide
D unburnt hydrocarbons → carbon dioxide and water

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33 Four alkanes, **H**, **I**, **J** and **K** were extracted from a fractional distillation sample of crude oil.

K is more viscous compared to **I**.
J burns with a less sooty flame compared to **I** and **K**.
H is less flammable than **K**.

Which of the following shows the sequence in which the alkanes were collected, in order of increasing boiling point?

A **J, H, K, I**
B **H, I, K, J**
C **K, H, J, I**
D **J, I, K, H**

34 A molecule of $C_{17}H_{36}$ undergoes catalytic cracking. The products of the reaction are one butane molecule, one propene molecule and some ethene molecules. How many ethene molecules are produced during the reaction?

A 5
B 6
C 7
D 8

35 200 cm^3 of methane is burned in 300 cm^3 of oxygen.

When cooled to room temperature, what could be the resulting mixture of gases?

A CH_4, CO, CO_2
B CH_4, CO, H_2O
C CH_4, CO_2, O_2
D CO_2, H_2, O_2

36 Some cooking oils contain a mixture of water with molecules of saturated and unsaturated fats. A pure fat molecule has a relative molecular mass of 300.

75 g of the fat reacts with 120 g aqueous bromine.

How many double bonds are there in each molecule of the fat?

A 2
B 3
C 4
D 6

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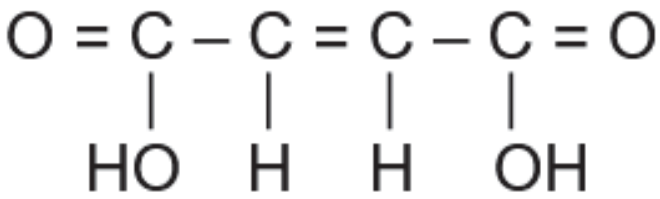
37 A compound ***X*** has all of the following properties:

- It is a liquid at room temperature and atmospheric pressure.
- It does not mix completely with water.
- It does not decolourise acidified potassium manganate (VII).

What could **X** be?

A ethane
B ethanoic acid
C ethanol
D ethyl ethanoate

38 Which prediction about the compound below is **not** likely to be true?



A It forms salts with bases.
B It reacts with ethanol.
C It reacts with hydrogen to form a saturated compound.
D It can be oxidised by acidified potassium manganate (VII).

39 The reaction between a carboxylic acid, $C_xH_yCO_2H$, and an alcohol, $C_nH_{2n+1}OH$, produces an ester.

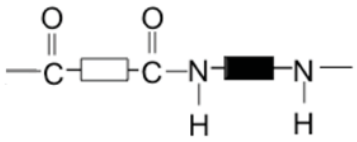
How many hydrogen atoms does one molecule of the ester contain?

A y + 2n
B y + 2n + 1
C y + 2n + 2
D y + 2n + 3

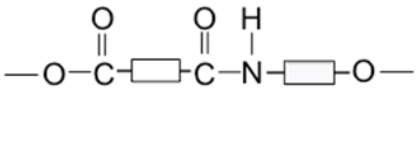
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40 Which of the following shows the repeating unit of terylene?

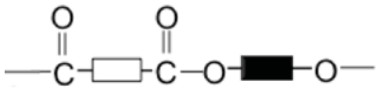
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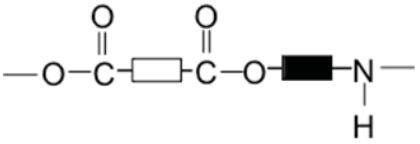
C



B



D



End of Paper 1

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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.).

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Name	Class	Index Number

UNITY SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2019

SECONDARY FOUR EXPRESS

CHEMISTRY 6092/02 **20 SEP 2019**

PAPER 2 **1 HOUR 45 MINUTES**

READ THESE INSTRUCTIONS FIRST

Write your name and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** 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 21.
The total mark for this paper is 80 marks.

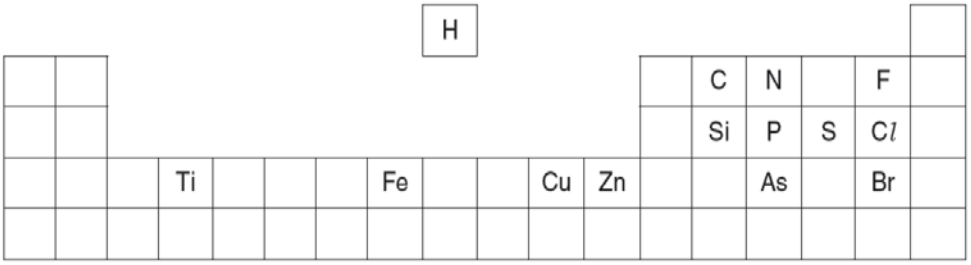
This paper consists of **21** printed pages, including this cover page.

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Section A

Answer all questions in this section in the spaces provided.
The total mark for this section is 50.

A1 The diagram shows part of the Periodic Table. Only some of the elements are shown.



(a) Answer each of the following questions using only the elements shown in the diagram.
Each element may be used once, more than once or not at all.
State one element which

(i) has a melting point below room temperature but a boiling point above room temperature [1]

……

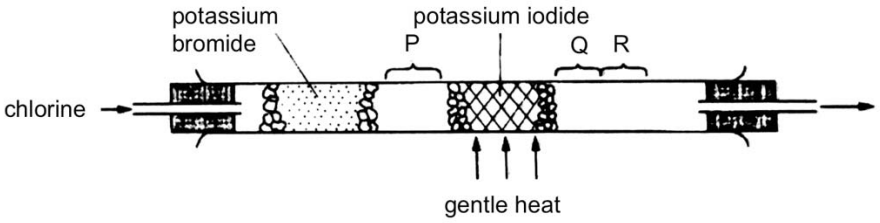
(ii) has an atom with three occupied electron shells, the outer of which has only five electrons. [1]

……

(iii) is colourless, diatomic gas [1]

……

(b) Chlorine was passed through a tube as shown below. After some time, coloured substances were seen at **P**, **Q** and **R**.



State the observations seen at each of the region.

[3]

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Region	Observations
P	
Q	
R	

(c) Arsenic reacts with oxygen to form arsenic(III) oxide, As_2O_3.
Arsenic(III) oxide is slightly soluble in water. A weak acid, arsenous acid, H_3AsO_3, is formed.

Use the kinetic particle theory to explain why a 0.05 mol/dm^3 solution of arsenous acid reacts much more slowly with magnesium ribbon than a 0.05 mol/dm^3 solution of hydrochloric acid. [2]

……

……

……

……

A2 The chemical equation for the thermal decomposition of calcium nitrate is shown below.

$$2\ Ca(NO_3)_2\ (s) \rightarrow 2\ CaO\ (s) + 4\ NO_2\ (g) + O_2\ (g)$$

(a) What is the total volume of gases produced at room temperature and pressure when 49.2 g of calcium nitrate undergoes thermal decomposition? [2]

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(b) State the oxidation state of nitrogen in calcium nitrate. [1]

……

(c) Explain, using oxidation state, whether the nitrogen in calcium nitrate is oxidized or reduced during the reaction. [2]

……..

……..

……..

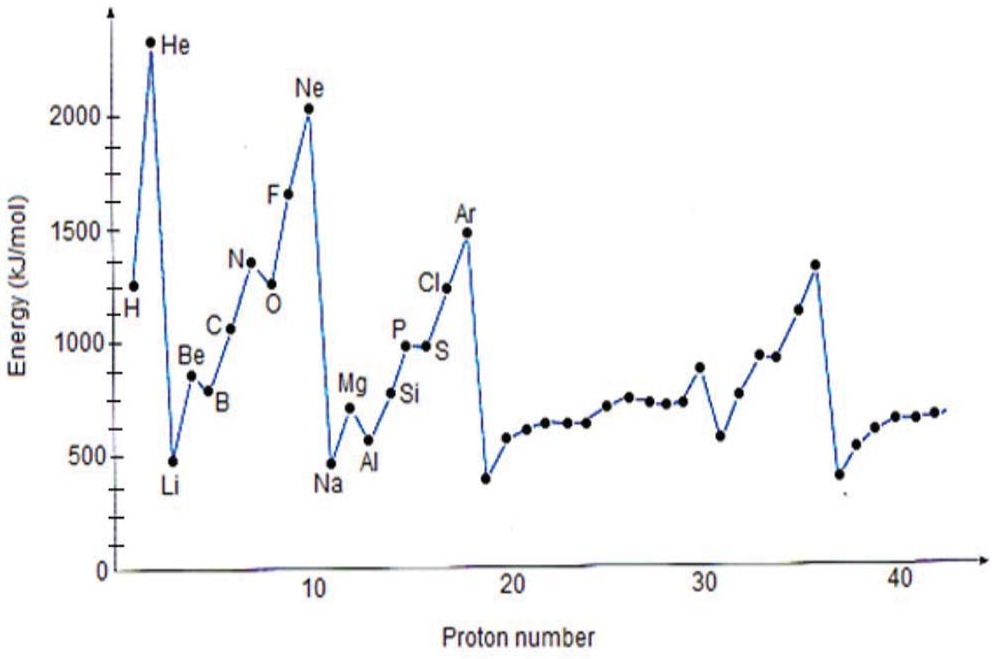
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A3 The graph below shows the first ionisation energy of the atoms of elements in the Periodic Table. The first ionisation energy is the amount of energy needed to remove the most loosely held electron in the atom to form a positive ion.

Example of the first two elements is given as follows:

$H \rightarrow H^+ + e$ First ionisation energy = 1250 kJ/mol

$He \rightarrow He^+ + e$ First ionisation energy = 2300 kJ/mol



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(a) Based on the graph,

(i) which element is the least reactive between the proton number of 10 to 20? [1]

……

(ii) estimate the first ionization energy of Krypton. [1]

……

(iii) suggest an explanation for the difference in the first ionization energy between beryllium and magnesium. [2]

……

……

……

……

……

……

(b) Oxygen contains two isotopes, **O-16** and **O-18**. Do you think that the first ionization energy of both the isotopes is the same? Give a reason for your answer. [1]

……..

……..

……..

A4 Sodium phosphate is a soluble salt used as a water softener in detergents. It can be prepared by reacting phosphoric acid, H_3PO_4, with sodium hydroxide in a neutralization reaction.

(a) Give the formula of sodium phosphate. [1]

……

(b) Write a chemical equation for the reaction between phosphoric acid and sodium hydroxide. [1]

……..

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(c) 50.0 cm^3 of 1.0 mol/dm^3 phosphoric acid reacted completely with sodium hydroxide to form sodium phosphate solution.

(i) Calculate the mass of sodium phosphate formed. [2]

(ii) Describe how you would obtain pure, dry crystals of sodium phosphate from the salt solution. [3]

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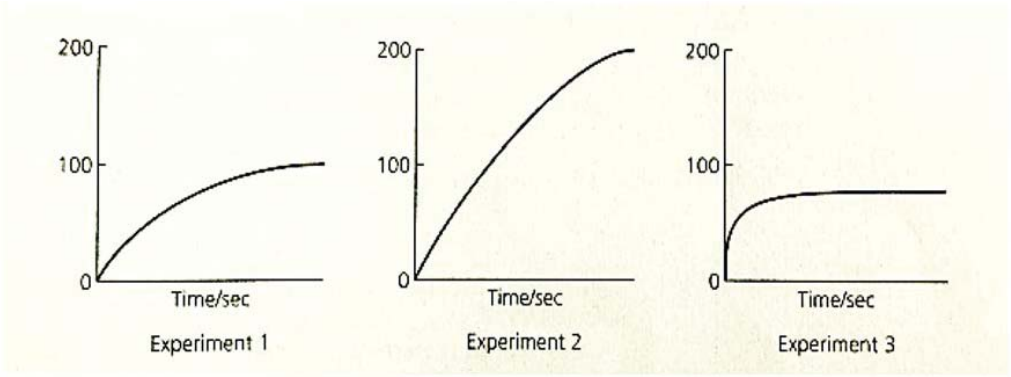
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A5 Experiments were carried out on the rate of reaction of zinc with dilute sulfuric acid. In each experiment, excess sulfuric acid was used. The results are shown in the following graphs.
In **Experiment 1**, 0.26 g of powdered zinc were used. All three experiments were carried out at room temperature.



(a) The x-axis has been labelled for you. Suggest the label for the y-axis. [1]

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(b) Suggest, with a reason, how the condition might have been altered to produce the results for **Experiment 2**. [2]

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(c) In **Experiment 3**, some copper(II) sulfate was added. Suggest **two** reasons for the results obtained for this experiment. [2]

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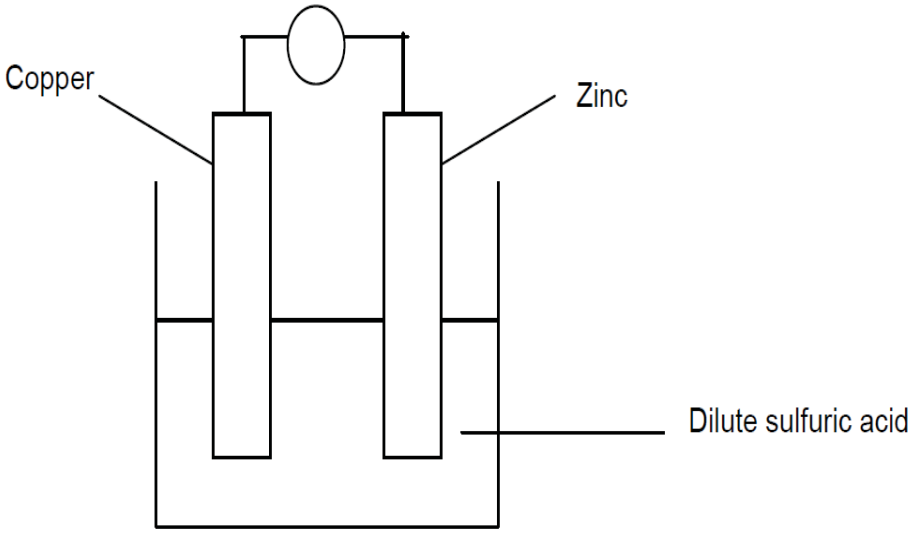
(d) Explain why attaching a piece of zinc to an iron pipe prevents the pipe from rusting. [1]

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A6 The diagram shows an electric cell.



(a) **(i)** Draw an arrow on the diagram to show the direction of the flow of electrons in the wire. [1]

(ii) Write a half-equation with state symbols for the reaction taking place at the negative electrode. Explain why it happens that way. [2]

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(b) The zinc electrode is now replaced by iron.

(i) State and explain the change in the ammeter reading obtained. [2]

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(ii) State one other observation that will be different from the original set-up. [1]

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A7 The table below shows the enthalpy of combustion of three fuels.

fuel	enthalpy change of combustion (kJ/mol)
ethanol	−1370
hydrogen	−256
octane	−5510

(a) Using ideas about bond-breaking and bond-forming, explain why the enthalpy change of combustion for ethanol is negative. [2]

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(b) Ethanol and octane both undergo combustion to produce carbon dioxide. The equation for the combustion of ethanol and octane are given below.

combustion of ethanol: $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

combustion of octane: $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

(i) Calculate the volume of carbon dioxide that will be produced when ethanol undergoes combustion to produce 200 kJ of energy. [2]

(ii) Calculate the volume of carbon dioxide that will be produced when octane undergoes combustion to produce 200 kJ of energy. [2]

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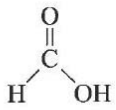
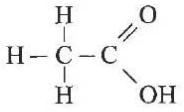
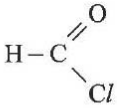
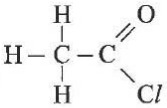
(iii) Green fuel is a fuel that produces lesser carbon dioxide when burnt. An example of green fuel is biogas. [1]

Is ethanol "necessarily" a greener fuel? Explain.

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A8 Acyl chlorides belong to a class of organic compounds that are analogous to carboxylic acids. Methanoyl chloride and ethanoyl chloride are the first two members of the acyl chloride homologous series.

homologous series	displayed formula of first member	displayed formula of second member
carboxylic acid	 methanoic acid	 ethanoic acid
acyl chloride	 methanoyl chloride	 ethanoyl chloride

(a) (i) Define the term *homologous series*. [1]

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(ii) Describe and explain how the boiling point of ethanoyl chloride compares with that of methanoyl chloride. [2]

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(iii) Draw the full structural formula of the fourth member of the acyl chloride homologous series. [1]

(b) Acyl chlorides undergo the same type of reaction with alcohols as their carboxylic acid counterparts to form the same ester.

For example, methanoic acid and ethanol react to form ethyl methanoate. Methanoyl chloride reacts with ethanol to also form ethyl methanoate.

Using your answer from **(a)(iii)**, draw the full structural formula of the ester formed between the fourth member of the acyl chloride homologous series and methanol. Name this ester.

[2]

Name of ester: ……..

Full structural formula of ester:

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Section B

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

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

B9 Glass is a mixture of oxides, made up of three components: *formers*, *fluxes* and *stabilizers*.

- *Formers* make up the largest percentage of the mixture to be melted to produce the glass.
- *Fluxes* lower the temperature at which the formers will melt.
- *Stabilizers* make the glass strong and weather resistant.

The composition of a type of glass (percentage by mass of their components) is shown in the table below.

chemical present	soda lime silica glass
silica, SiO_2	73.6%
soda, Na_2O	16.0%
potash, K_2O	0.6%
alumina, Al_2O_3	1.0%

Note: not all the components of glass are shown in the table above

(a) (i) Identify the chemical that serves as the *former*. [1]

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(ii) Explain, based on structure and bonding, why the chemical in **(a)(i)** can withstand high temperatures. [2]

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(b) Soda and potash are commonly used as *fluxes*. These *fluxes* have to be thermally stable.

Which flux, soda or potash is more thermally stable? Explain your answer. [2]

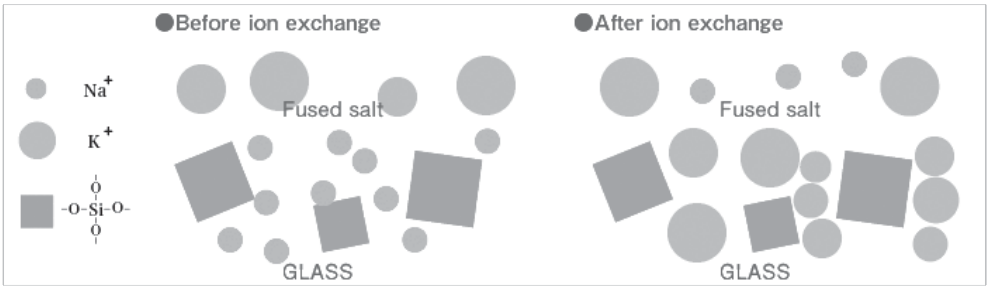
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(c) The Gorilla Glass is a type of scratch-resistant glass made by the company, Corning. Glass sheets are dipped into a molten potassium salt bath at about 400 ºC, where the potassium ions undergo an exchange with the sodium ions (see diagram below).

The larger potassium ions now present in the glass structure exert a "compressive effect" on the glass (similar to what happens in an alloy) that strengthens it.



particle	ionic radii / 10^{-12} m
sodium ion	116
potassium ion	142

(i) Explain why the molten potassium salt bath has to be at 400 ºC. [2]

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(ii) Explain, using data, how the ion-exchange process strengthens the glass through the "compressive effect". [2]

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(iii) As part of the quality control process, a sample of Gorilla Glass was immersed in two solvents and the weight loss per unit surface area was measured after some time. [1]

	time / hours	**weight loss / mg cm^{-2}**
HCl	24	0.12
NaOH	6	1.42

Explain the results in the table above.

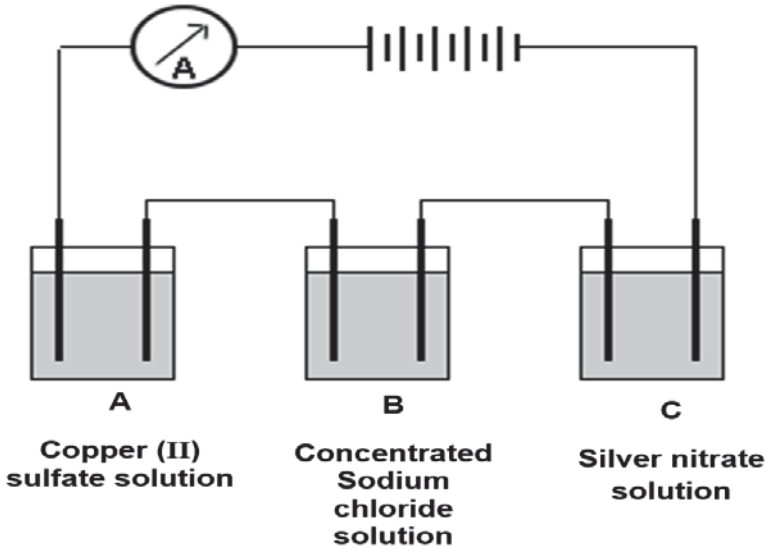
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B10 The diagram shows the electrolysis of three different solutions using inert electrodes.



(a) **(i)** Write equations for the reactions that happen at each electrode in cell **B** during electrolysis. Include state symbols. [2]

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(ii) Describe **two** observations that take place at cell **B**.
Explain your observations. [4]

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(b) 6.0 dm^3 of oxygen is liberated from cell **A**, at room temperature and pressure.

(i) Calculate the increase in mass of the cathodes in cells **A** and **C**. [2]

(ii) What is another observation in cell **A**?
Explain your observation. [2]

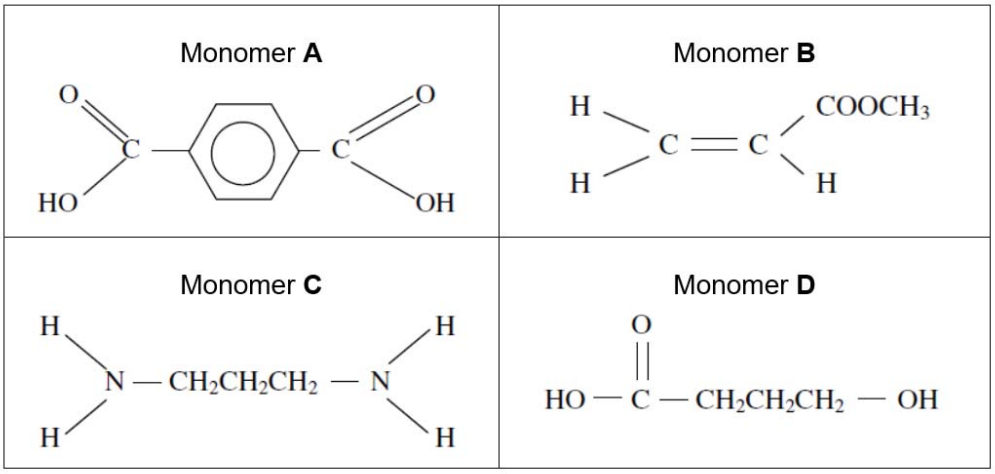
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B11 EITHER

The diagram shows four monomers.



(a) Monomer **B** was formed by reacting propenoic acid, $CH_2CHCOOH$ with another compound, **X**. State the conditions of the reaction and name compound **X**. [2]

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(b) **(i)** Which of these monomers can be used to produce a polymer through condensation polymerisation by itself? [1]

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(ii) Which of these monomers will undergo polymerisation without a change in percentage composition? Explain your answer. [1]

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(c) **(i)** Using two monomers above, draw a repeat unit of the polymer formed, which has the same linkages as found in nylon. [1]

(ii) Explain why the polymer formed in **(c)(i)** should not be disposed by burning. [2]

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(d) A student has four solutions containing monomers **A** to **D** each. Describe chemical tests the student could do to identify the four solutions. [3]

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B11 OR

Haematite and coke are used to make iron in the blast furnace. A series of chemical reaction occurs within the furnace before molten iron is collected. Iron from the blast furnace contains carbon and silicon as impurities.

(a) Explain, with the help of equations, why coke is essential to the process of making iron from haematite. [4]

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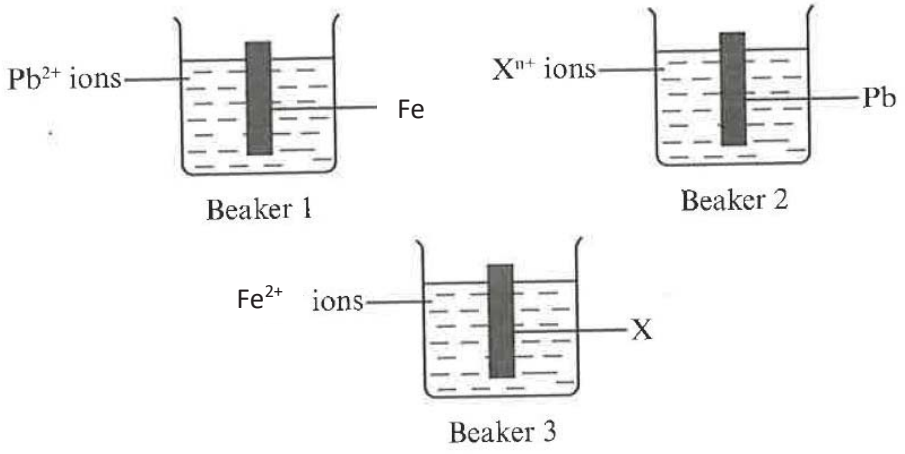
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(b) Three beakers were set up to study the reactivities of iron, lead and an unknown metal **X**.



After some time, it was observed that the metal pieces in beakers 1 and 3 decreased in size. However, the metal piece in beaker 2 remained the same.

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Deduce the order of the reactivities of iron, lead and metal **X**, starting with the least reactive metal. Explain your answer. [3]

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(c) Iron was reacted with dilute sulfuric acid to obtain a solution. Adding some aqueous ammonia to the solution in a test-tube resulted in a green precipitate. After some time, the green precipitate started to turn reddish-brown.

(i) Write an ionic equation for the formation of the green precipitate. [1]

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(ii) Name the brown solid and explain how it was formed. [2]

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End of Paper 2

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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											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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UNITY SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2019
SECONDARY 4 CHEMISTRY

Paper 1

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

Paper 2

A1	ai	Br	1
	ii	P	1
	iii	N or H	1
	b	P – brown gas is seen	1
		Q – purple fumes/vapour seen	1
		R – purple-black solid condensed on surface of tube	1
	c	Arsenic acid being a weak acid ionises to form a few hydrogen ions only. At any time, there are only a few hydrogen ions colliding with the magnesium ribbon causing little reaction. Lesser number of colissions result in a lower proabability of effective colissions with magnesium. Thus rate of reaction is slow.	1 1
A2	a	49.2 g of calcium nitrate Number of mol = 49.2/164 = 0.3 0.3 mol of calcium nitrate produces 0.6 mol of NO_2 and 0.15 mol of O_2. Total volume of gases = (0.6 + 0.15) x 24 dm^3 = 18 **dm^3**	1 1
	b	+5	1

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	c	Oxidation state of nitrogen in calcium nitrate (+5) decreased to +4 nitrogen dioxide; decrease in oxidation state; so reduced	1 1
A3	ai	Argon	1
	ii	1375 kJ/mol [Range: 1300 – 1400 kJ accepted]	1
	iii	The two valence electrons of magnesium is in the third shell that is further away from nucleus as compared to beryllium's valence electron in second shell which is nearer to the nucleus. Hence, attraction between the valence electron and the positively charged nucleus is **less strong in magnesium** and needs lesser ionization energy.	1 1
	b	Should be the same; as the difference between the two isotopes is only the number of neutrons. The number of protons is the same and hence the attractive force will be the same.	1
A4	a	Na_3PO_4	1
	b	$H_3PO_4 + 3NaOH \rightarrow Na_3PO_4 + 3H_2O$	1
	ci	Number of mol of H_3PO_4 = 0.05 x 1 = 0.05 mol 0.05 mol acid → 0.05 mol of sodium phosphate Mass of sodium phosphate = 0.05 x 164 = **8.2 g**	1 1 1
	ii	Pour the solution into an evaporating dish and heat it till the saturation point. Let the hot saturated solution to cool for crystals to form. Filter to get the crystals, rinse with distilled water and dry by pressing between filter papers.	1 1 1
A5	a	y-axis : Volume of hydrogen gas/ cm^3	1
	b	The volume of hydrogen gas produced is double that of expt 1. Since zinc is the limiting reactant, they used double the mass of zinc; 0.52 g of zinc was used	1 1
	c		1

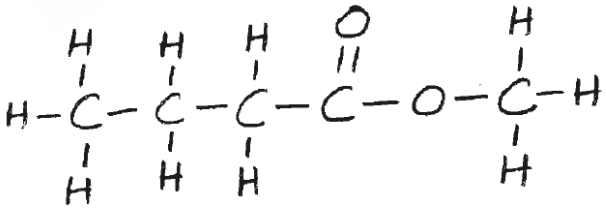
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		Copper(II) sulfate could have acted as a catalyst; which makes the rate of reaction faster as indicated by a steeper gradient. Some zinc could have reacted with the copper(II) sulfate in displacement reaction; thus less zinc reacted with the acid. Hence the volume of hydrogen is lesser.	1
	d	Zinc being more reactive than iron, provides sacrificial protection to iron. It corrodes by reacting with the oxygen and protects the iron.	1
A6	ai	Electron flow from zinc to copper in the wire	1
	ii	$Zn\ (s) \rightarrow Zn^{2+}\ (aq) + 2e^-$ Zinc is more reactive than copper so it loses electrons easily to form zinc ions.	1 1
	bi	Ammeter will record a lower reading than that for zinc. This is because iron is closer to copper in the reactivity series as compared to zinc and copper.	1 1
	ii	The container will have a light green solution whereas it was colourless when zinc was used.	1
A7	a	Ethanol burns in oxygen to form carbon dioxide and water. In this combustion reaction, the energy needed to break the bonds (C-C, O-H, C-H,) in ethanol and oxygen molecules (O=O) is **much lower than** the energy released in forming the bonds (C=O) in carbon dioxide and (O-H) bonds in water; hence the enthalpy change is negative.	1 1
	bi	From the table, 1 mol of ethanol gives out 1370 kJ of energy. 1370 kJ of energy from 1 mole 200 kJ of energy will come from = 1/1370 x 200 = 0.146 mol of ethanol No of mol of CO_2 produced = 0.146 x 2 =0.292 Volume of CO_2 = 0.292 x 24 dm^3 = **7.01 dm^3**	1 1
	bii	1 mol of octane gives out 5510 kJ of energy. 5510 kJ of energy from 1 mole	1

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		200 kJ of energy will come from = 1/5510 x 200 = 0.0363 mol of octane No of mol of CO_2 produced = 0.0363 x 8 = 0.290 Volume of CO_2 = 0.290 x 24 dm^3 = **6.97 dm^3**	1
	c	Ethanol is **not necessarily a greener fuel** because it produces slightly more carbon dioxide than octane in combustion when the same amount of energy is released.	1
A8	ai	It refers to a group of organic compounds having similar chemical properties and the same functional group.	1
	ii	Ethanoyl chloride will have a higher boiling point than methanoyl chloride. This is because ethanoyl chloride is a bigger molecule and there are stronger forces of attraction between the molecules as compared to that in methanoyl chloride.(smaller molecule)	1 1
	iii		
	b	Name of ester: **methyl butanoate** Structure: 	

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B9	ai	Silica / SiO_2 ;	1
	ii	Silica has a giant molecular structure where all the silicon and oxygen atoms are held together by a network of strong covalent bonds.; A lot of energy is required to overcome these bonds, hence, it can withstand high heat.;	1 1
	b	Potash is more thermally stable ; because K is a more reactive metal than Na and forms a more stable compound with oxygen.	1 1
	ci	Potassium salt is an ionic compound and ions are held by strong electrostatic forces of attraction. ; Only in the molten state will the ions be free to move / mobile. ; hence the temperature is high	1 1
	ii	The potassium ions have a larger ionic radii of 142×10^{-12} m while the sodium ions only have an ionic radii of 116×10^{-12} m. ; potassium ions fills up the structure and prevents the atoms (and ions) in the glass from moving/sliding easily, hence increasing its strength. ; Accept: - K^+ ions were larger / larger ionic radii than Na^+ ions - Reduces the empty spaces between particles / limits movement between particles.	1 1
	iii	Silicon dioxide is the main component in the Gorilla glass and is an acidic oxide that reacts with an alkali. ;	1
B10	ai	Anode: $2Cl^-$ (aq) → Cl_2 (g) + $2e^-$ Cathode: $2H^+$ (aq) + $2e^-$ → H_2 (g)	1 1
	ii	Bubbles of gases (yellow-green) will be seen at anode	1 1

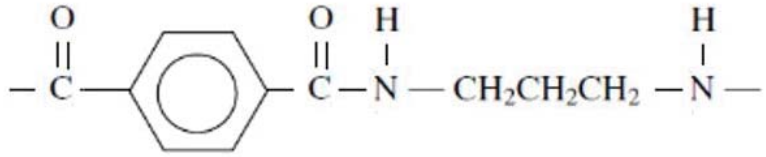
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		This is because although both chloride and hydroxide ions are attracted to the anode, it is the chloride ions that are preferentially discharged due to its higher concentration Bubbles of gas (colourless) also formed at cathode This is because although hydrogen ions and sodium ions are attracted to the cathode, due to the ease of discharge, hydrogen ions are preferentially discharged.	1 1
	bi	Number of mol of oxygen gas = 6/24 = 0.25 mol $4OH^-$ (aq) → $2H_2O$ + O_2 + $4e^-$ When 1 mol of oxygen is formed at anode, 4 mol of e are lost. Since only ¼ mol of oxygen is formed, only 1 mol of e are lost. Cu^{2+} (aq) + $2e^-$ → Cu (s) From this, 1 mol of e can only produce ½ mol of Cu Mass of copper formed = ½ x 64 g = 32 g Ag^+ (aq) + e^- → Ag (s) 1 mol of e can produce 1 mol of silver Mass of silver formed = 108 g	1 1
	ii	The blue solution turned colourless when all the copper ions had been discharged from the solution. Or Reddish-brown solid is formed at cathode as copper ions are being discharged to form copper metal.	1 1
B11		**Either**	
	a	The compound X is methanol. Concentrated sulfuric acid is needed as a catalyst and the mixture must be heated.	1 1
	bi	Monomer D	1
	ii	Monomer B which has C=C bonds in it. It undergoes addition polymerisation where atoms are not lost.	1
	ci	Monomer A and C	

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			1
	ii	It has amide group in it with nitrogen atoms; on burning it may form the harmful gases, nitrogen monoxide and nitrogen dioxide. These nitrogen oxides may give rise to the formation of acid rain that corrodes buildings and affects vegetation.	1 1
	d	Adding some **bromine solution** separately into all the four solutions. Only **monomer B, having the C=C bond, will decolourise** the red-brown iodine solution. Add **acidified potassium manganite(VII)** solution to the three remaining solutions and heat. **Monomer D**, having the hydroxyl group, will get oxidised and there will be a colour change in the solution. **Purple solution will turn colourless**. In the remaining two solutions, add a piece of **magnesium ribbon**. The one which **produces bubbles of gas** will be **monomer A** as it is an acid. The monomer which does not react in all the three reactions above is monomer C.	1 1 1
B11		**OR**	
	a	Coke is essential in the blast furnace for the following two reactions. Firstly, coke is needed to burn in oxygen to form carbon dioxide. $C + O_2 \rightarrow CO_2$ Secondly, it is needed to reduce carbon dioxide to carbon monoxide. $CO_2 + C \rightarrow 2CO$ We need this carbon monoxide because, carbon monoxide will reduce the iron(III) oxide in haematite to produce iron. $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$	 1 1 1 1
	b	Order of reactivity: lead, iron, metal X (least reactive to most reactive) In beaker 1, iron displaces lead; iron is more reactive. In beaker 3, X displaces iron, metal X is more reactive than iron.	1 1 1

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		In beaker 2, lead cannot displace X; as X is most reactive	
	ci	Fe^{2+} (aq) + $2OH^-$ (aq) → $Fe(OH)_2$ (s)	1
	ii	The brown solid is iron(III) hydroxide. It is formed when green iron(II) hydroxide gets oxidised to brown iron(III) hydroxide by the atmospheric oxygen.	1 1

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