YISHUN SECONDARY SCHOOL

We Seek, We Strive, We Soar

PRELIMINARY EXAMINATION

Name: _____ **Reg. No:** _____ **Class:** _____

Secondary 4 Express

Date: 29 August 2019

CHEMISTRY (6092/02)

PAPER 2

Duration: 1 hour 45 minutes

MAX MARKS: 80

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Section A

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

Section B

Answer all **three** questions in this section, the last question is in the form either/or.

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

At the end of the examination, fasten all your work securely together.

The number of marks is given in bracket [ ] at the end of each question or part question.

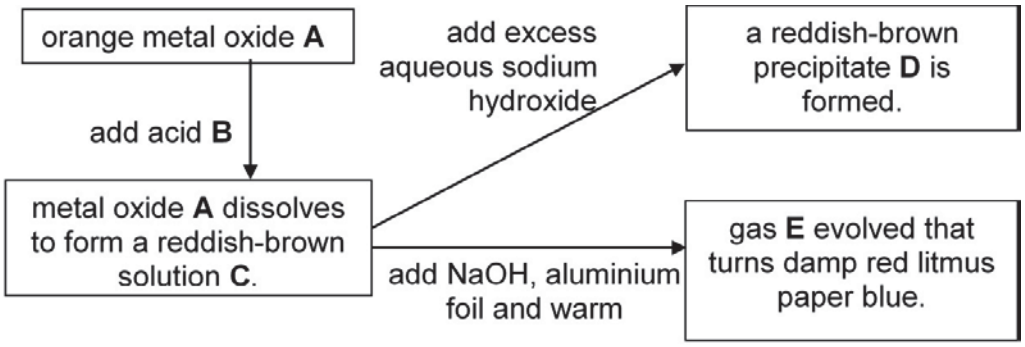
The use of an approved scientific calculator is expected, where appropriate.

The Periodic Table is on page 17.

For Examiner's Use Only		
PAPER TWO		
A		**50**
B8		**10**
B9		**10**
B10		**10**
Total		**80**

Section A: Structured Questions [50 marks]
Answer ALL questions in the spaces provided.

A1 The figure below shows the reaction scheme of an orange metal oxide, **A**, which undergoes a series of reactions.



Name the following

(a) metal oxide **A**, ……..[1]

(b) acid **B**, ……..[1]

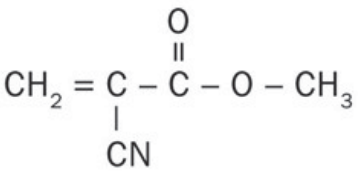
(c) solution **C**, ……..[1]

(d) precipitate **D**, ……..[1]

(e) gas **E**. ……..[1]

[total: 5]

A2 Superglue is a very strong adhesive used to fasten materials, such as wood, together.
The active ingredient in superglue is methyl cyanopropenoate, commonly known as methyl cyanoacrylate. The structure of methyl cyanopropenoate is shown below.



methyl cyanopropenoate

Superglue polymerises when exposed to moisture in the air. This causes the glue to set.

(a) Draw the structural formulae of the two functional groups present in methyl cyanopropenoate. Name these two functional groups.

[2]

(b) What type of polymerisation does methyl cyanopropenoate undergo when it forms superglue?

……..[1]

(c) Draw the structural formula of the polymer formed, showing two repeat units.

[1]

(d) Other than superglue, suggest another name for the polymer formed in **(c)**.

……...[1]

(e) (i) A sample of methyl cyanopropenoate is shaken with bromine water.

Describe what you would observe.

……

……...[2]

(ii) What type of reaction has occurred in **(e)(i)**?

……[1]

[total: 8]

A3 People with kidney problems are advised against eating starfruit as it contains a significant amount of oxalic acid.

The concentration of oxalic acid in starfruit is estimated to be at 0.020 mol/dm^3.

The acid concentration in starfruit can be determined by performing an acid-base titration with sodium hydroxide solution.

Assume that the oxalic acid found in starfruit is dibasic and can be represented by H_2A.

(a) Write a balanced chemical equation, with state symbols, for the reaction between oxalic acid and sodium hydroxide.

……...[2]

(b) A student suggested that 25.0 cm^3 of starfruit juice should be pipetted into a conical flask and titrated against 0.050 mol/dm^3 sodium hydroxide solution.

Based on the information provided, calculate the maximum volume of sodium hydroxide solution required for complete neutralisation.

maximum volume of sodium hydroxide solution required = …….. cm^3 [2]

(c) Oxalic acid is made up of carbon, oxygen and hydrogen and it contains 26.7 % carbon and 2.20 % hydrogen by mass.

(i) Determine the empirical formula of oxalic acid.

empirical formula: …….. [2]

(ii) The relative molecular mass of oxalic acid is 90.
Determine the molecular formula of oxalic acid.

molecular formula: …….. [1]

(d) A patient was advised by the doctor to consume not more than 0.05 g of oxalic acid per day. If a typical serving of starfruit contains 0.00011 mol of oxalic acid, calculate the maximum number of servings of starfruit the patient can eat in a day.

maximum number of servings = …… [1]

[total: 8]

A4 (a) The table shows some information about two homologous series of alcohol and ether.

name of alcohol	formula of alcohol	number of C atoms	formula of ether	name of ether
ethanol	C_2H_5OH	2	CH_3OCH_3	methoxymethane
propanol	C_3H_7OH	3	$CH_3OC_2H_5$	methoxyethane
butanol	C_4H_9OH	4	$CH_3OC_3H_7$	methoxypropane
pentanol	$C_5H_{11}OH$	5		

(i) Deduce the name and formula of the ether that contains 5 carbon atoms.

name: …….

formula: …….[2]

(ii) Suggest a **relationship** between alcohols and ethers by comparing the chemical formulae with the same number of carbon atoms.

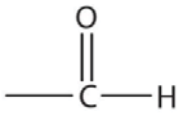
…….

…….[1]

(iii) Hence, calculate the relative molecular mass of the ether that contains 20 carbon atoms.

M_r of ether = ... [1]

(b) The table below shows some information about another homologous series of organic compounds called aldehydes. The functional group of the aldehydes is:



name	molecular formula	boiling point /°C
methanal	HCHO	– 19
ethanal	CH_3CHO	20
propanal	C_2H_5CHO	49
pentanal	C_4H_9CHO	103

(i) Use the information in the table to give two pieces of evidence that suggest that the aldehydes are a homologous series.

.....

.....

.....[2]

(ii) Deduce the name of the aldehyde that contains 4 carbon atoms and predict its boiling point.

name: .....

predicted boiling point: .....[2]

[total: 8]

A5 The relative positions of the elements rubidium (Rb), beryllium (Be) and bismuth (Bi) in the reactivity series are shown in the table below.

Position in the reactivity series (highest to lowest)
Rubidium
Sodium
Magnesium
Beryllium
Iron
Hydrogen
Bismuth
Copper
Silver

You may assume that these elements do not show variable valencies.

(a) An unknown photograph showing specks of silvery deposits with the caption

"Pure rubidium found on a tiny island in the Pacific Ocean"

was posted in the early morning of August 16, 2016, on social media. The post has since gone viral. Using the information above and your knowledge, discuss the validity of this post.

……...

……...

……...[2]

(b) Predict, with reasons, the reactions of beryllium with cold water and steam.

……...

……...

……...[3]

(c) Suggest a suitable method to extract bismuth from its ore.

……...[1]

[total: 6]

A6 One important property of a rocket fuel mixture is the large volume of gaseous products formed which provide thrust. Hydrazine, N_2H_4, is often used as a rocket fuel. The combination of hydrazine with oxygen is represented by the equation:

$$N_2H_4(g) + O_2(g) \rightarrow N_2(g) + 2H_2O(g) \qquad \Delta H = -585 \text{ kJ/mol}$$

(a) Explain if the reaction is a redox reaction.

…….....

…….....

……...[2]

(b) Hydrazine can also react with fluorine to produce gaseous nitrogen and hydrogen fluoride. The amount of energy produced is 1179 kJ/mol. Write a balanced equation for this reaction, including the state symbols and the enthalpy change.

……...[2]

(c) Suggest, giving **two** reasons based on the information given, whether a mixture of hydrazine and oxygen is a better rocket fuel than a mixture of hydrazine and fluorine.

……...

……...

……...

……...[2]

(d) The local government promotes the use of hydrazine with oxygen due to the environmental safety of the products. Explain why this is so.

……...

……...

……...[2]

[total: 8]

A7 Isotopes are variants of a particular chemical element and most elements have several naturally-occurring isotopes.

(a) Define the term 'isotopes'.

……...

……...[1]

(b) Hydrogen, deuterium and tritium are isotopes of one another.

Using this information, complete the table below.

name	formula	number of protons	number of neutrons	number of electrons
hydrogen atom	$^{1}_{1}H$	1		1
deuterium ion	$^{2}_{1}H^{+}$			0
tritium ion			2	2

[3]

(c) The table below gives the relative abundance of each isotope in a mass spectrum of sample of germanium, Ge.

mass	70	72	74
relative abundance (%)	24.4	32.4	43.2

Use the data in the table to calculate the relative atomic mass (A_r) of this sample of germanium.

A_r of germanium = ……. [2]

(d) A student commented, "Isotopes of an element should all have the same chemical properties." Do you agree with the student? Give a reason for your answer.

……...

……...[1]

[total: 7]

End of Section A

Section B: Essay Questions [30 marks]
Question B8 and B9 are compulsory. Question B10 is an Either/Or.

B8 Changing of variables in reversible reactions

Most chemical reactions only proceed in one direction. But some reactions can be reversed. They are known as reversible reactions.

In reversible reactions, the forward and backward reactions take place at the same time. At the end of the reaction, a mixture of reactants and products is present.

When the forward and backward reactions become equal in speed, the mixture is said to be in equilibrium. At equilibrium, the forward and backward reactions do not stop.

To alter the yield of products in a reversible reaction, we can change the experimental conditions such as temperature and pressure. The change in the yield of products in a reversible reaction follows the *Le Chatelier's Principle*.

According to *Le Chatelier's Principle*, the reaction will shift either to the left towards the backward reaction or to the right towards the forward reaction to reduce the effect of the new condition.

Changing temperature

When hydrogen iodide, HI, is heated in a closed tube, the following equilibrium is established.

Reaction 1 $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ $\Delta H = +9.6$ kJ/mol

The equation shows the forward reaction producing hydrogen and iodine is endothermic. An increase in temperature shifts the reaction to the right to reduce the temperature. This increase the yield of hydrogen and iodine.

The table shows the concentrations of HI(g) and $I_2(g)$ in the equilibrium mixture at 2 different temperatures when the same concentration of HI(g) was injected into the tube at the start of the experiment.

substance	concentration in mol/dm^3 at 25 °C	concentration in mol/dm^3 at 450 °C
HI(g)	0.94	0.79
$H_2(g)$	0.033	0.11
$I_2(g)$	0.033	0.11

Changing pressure

Changing pressure affects reactions involving gases. However, there must be different number of gas molecules on either side of the equation.

The greater the number of gas molecules in the same volume, the greater the pressure the gas exerts.

Reaction 2 $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $\Delta H = -197$ kJ/mol

The equation shows a reaction used to change sulfur dioxide into sulfur trioxide. An increase in pressure shifts the reaction to the right. As there are more molecules on the left side of the equation, the reaction shifts to the right side with lesser number of molecules to reduce the pressure.

The conditions for reaction 2 are:

Pressure: atmospheric pressure
Catalyst: vanadium(V) oxide
Temperature: 450 °C

The conditions chosen are a compromise between speed of reaction and yield of SO_3. Using these conditions, the yield of SO_3 is 95%.

(a) A change in temperature or pressure does not affect the yield for the reaction between sodium hydroxide and hydrochloric acid to form sodium chloride.
Suggest why.

……..[1]

(b) Explain the differences in the concentrations of reactant and products at 25 °C and 450 °C in reaction 1.

……..

……..

……...[2]

(c) With reference to the table, state the concentration of HI(g) injected into the tube at the start of the experiment, giving your answer to 3 significant figures.

……...[1]

(d) Suggest why reaction 2 is carried out at 450 °C, and not at a higher or lower temperature.

……..

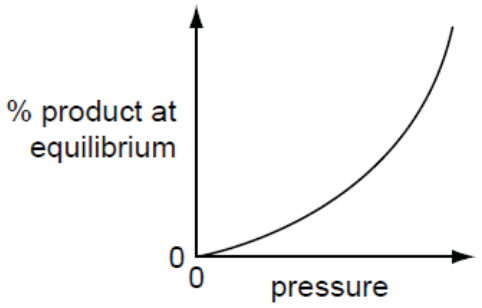
……..

……...[2]

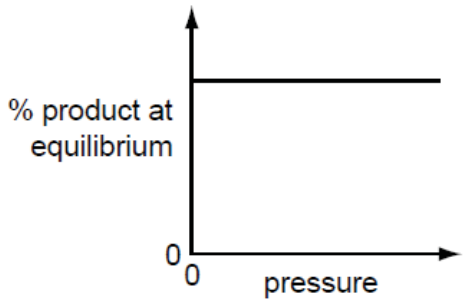
(e) Explain why reaction 2 is carried out at atmospheric pressure even though an increase in pressure shifts the position of the equilibrium further to the right.

……...[1]

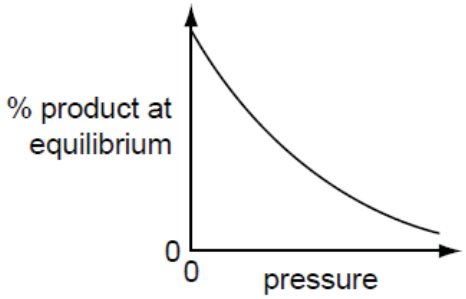
(f) The following graphs show how the percentage of products of a reversible reaction at equilibrium could vary with pressure.
Match reaction 1 and reaction 2 to a graph each. Give a reason for your choice.



Graph A



Graph B



Graph C

……...

……...[3]

[total: 10]

B9 Nickel is a transition element. It is manufactured in a four-stage process from nickel(II) sulfide, NiS.

Stage 1 – nickel(II) sulfide is heated in air to form nickel(II) oxide and sulfur dioxide
Stage 2 – nickel(II) oxide is heated with carbon to give impure nickel
Stage 3 – impure nickel is reacted with carbon monoxide to make nickel tetracarbonyl, $Ni(CO)_4$
Stage 4 – nickel tetracarbonyl is decomposed to give pure nickel

(a) (i) Construct the balanced equation for the reaction in stage 1.

……[1]

(ii) Calculate the mass of sulfur dioxide that is formed when 182 kg of nickel(II) sulfide is heated in air.

mass of sulfur dioxide = …… kg [2]

(b) Nickel tetracarbonyl is a liquid with a boiling point of 43 °C.

Suggest, with a reason, the type of structure and bonding in nickel tetracarbonyl.

……

……

……[2]

(c) In an experiment, small amounts of three metals were added to three aqueous metal nitrate solutions. The results are shown in the table.

	aqueous zinc nitrate	**aqueous nickel(II) nitrate**	**aqueous copper(II) nitrate**
zinc	no reaction	green solution turn colourless and zinc coated with a grey solid	blue solution turn colourless and zinc coated with a pink solid
nickel		no reaction	
copper	no reaction	no reaction	no reaction

Predict the observations when nickel is added to separate solutions of zinc nitrate and copper(II) nitrate.

with zinc nitrate ……

……

with copper(II) nitrate ……

……

[3]

(d) Explain why this 4-stage process cannot be used to manufacture magnesium.

……

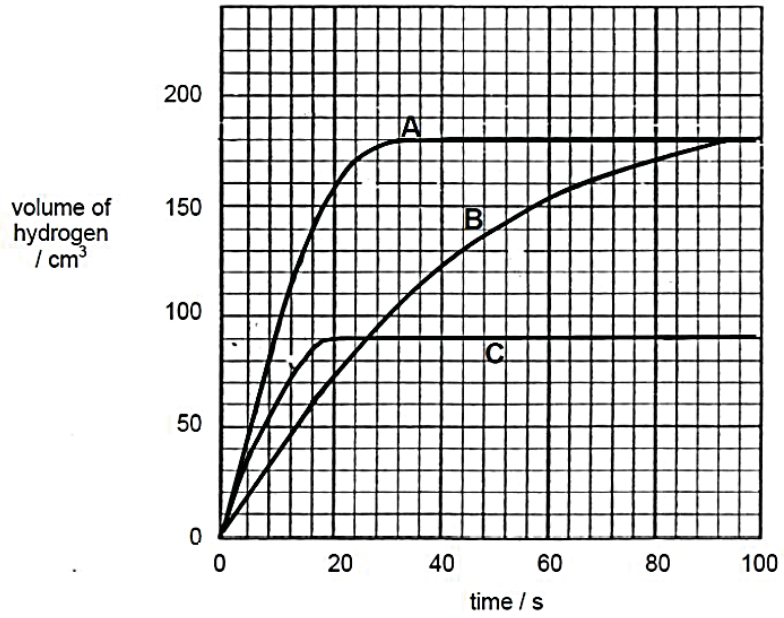
……...[2]

[total: 10]

Either

B10

A student carried out two separate reactions between 0.488 g of zinc and two acids, hydrochloric acid and sulfuric acid. The volume and concentration of the acids used were both 20.0 cm^3 and 2.00 mol/dm^3. The curves **A** and **B** shown in the graph below show the results of the reactions.



He carried out a third reaction with **C** with 20.0 cm^3 of a 2.00 mol/dm^3 acid, but forgot to weigh the mass of zinc as well as take note of which acid, hydrochloric acid or sulfuric acid, was used.

(a) Explain, with relevant calculations, why the same volume of gas was produced for both curves **A** and **B**.

……...

……...

……...

……...

……...[3]

(b) Between curves **A** and **B**, identify the curve for the reaction that used sulfuric acid. Explain your choice.

……...

……...

……...[2]

(c) In experiment **C**, identify the acid used and calculate the mass of zinc the student had used.

……...

……...

……...[2]

(d) The student repeated experiment **C** using the same mass of zinc and the same volume and concentration of the acid, but this time, he added in a small amount of copper(II) sulfate crystals to the reaction mixture.

He noted that the effervescence was more vigourous and a brown deposit was formed. The volume of hydrogen collected was slightly less than in experiment **C**.

(i) Explain why less hydrogen was collected.

……

……

……[2]

(ii) The student concluded that copper(II) sulfate acted as a catalyst.

Comment, with a reason, whether the student's conclusion was right or wrong.

……

……[1]

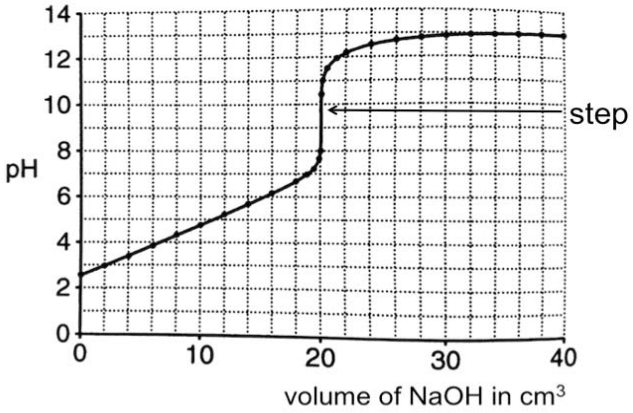
[total: 10]

Or

B10

Graph 1 shows the changes in pH level when 20.0 cm^3 of ethanoic acid (CH_3COOH) is titrated with 0.1 mol/dm^3 of sodium hydroxide.

Graph 1



The endpoint of a titration is reached when a 'step' occurs. At this point, all the acid has been fully neutralised.

(a) What is the name and formula of the salt formed in the titration?

……...[1]

(b) Using information from **Graph 1**, calculate the concentration of the ethanoic acid used in the reaction.

concentration of ethanoic acid = …….. [2]

(c) An indicator changes colour when the endpoint of a titration is reached. The table below shows the colours of some indicators at different pH values. The best indicator for a titration gives a distinct colour change when a 'step' occurs.

indicator	low pH	pH range where indicator changes colour	high pH
methyl orange	red	3.1 to 4.4	yellow
thymolphthalein	colourless	9.3 to 10.5	blue
phenolphthalein	colourless	8.3 to 10.0	pink

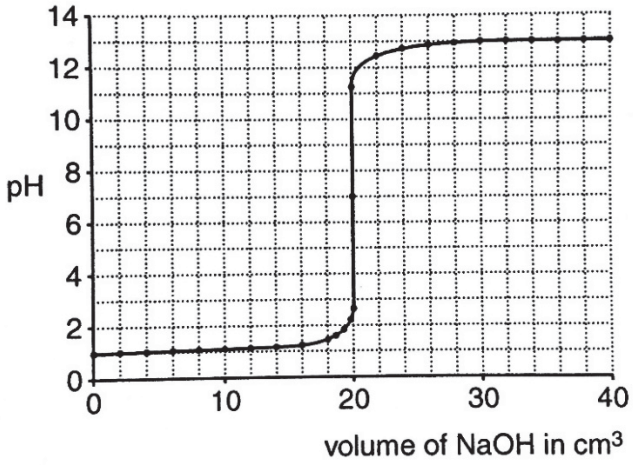
Using information from **Graph 1** and the table, explain which indicator will **not** be suitable for use when titrating ethanoic acid with sodium hydroxide.

……..

……...[2]

(d) The titration was repeated using the same concentration and volume of hydrochloric acid instead of ethanoic acid, with all other variables remaining constant. **Graph 2** shows the changes in pH level for this reaction.

Graph 2



(i) Explain how and why the time taken for the endpoint to be reached is different from that in the experiment using ethanoic acid.

……

……

……

……

……

……[4]

(ii) Sketch on **Graph 2**, the graph you would obtain if dilute sulfuric acid of the same concentration and volume is used instead.

[1]

[total: 10]

End of Section B

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
							1 H Hydrogen 1									4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	43 Tc Technetium	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 +															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
+90-103 Actinoid series

Key: a X b
a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

YISHUN SECONDARY SCHOOL

We Seek, We Strive, We Soar

PRELIMINARY EXAMINATION

Name: _____ **Reg. No:** _____ **Class:** _____

Secondary 4 Express — Date: 20 September 2019

CHEMISTRY (6092/01)

PAPER 1 — Duration: 1 hour

MAX MARKS: 40

Additional Materials: OTAS Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name and register number on the OTAS Sheet provided.

There are **forty** questions in 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 OTAS Sheet.

Read the instructions on the OTAS 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.

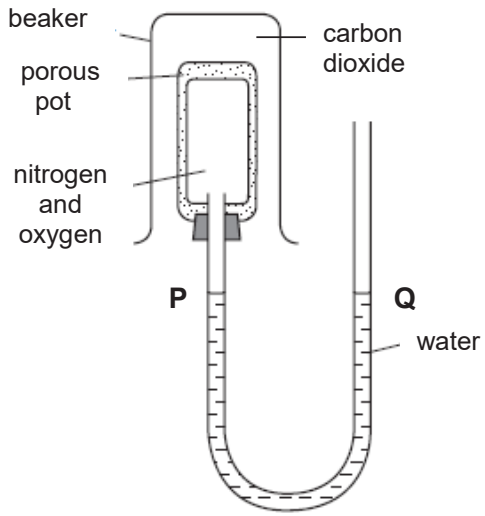
A copy of the Periodic Table is printed on page 15.

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

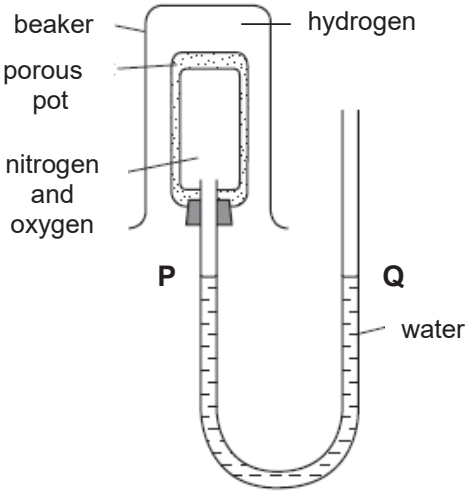
Paper 1 [40 marks]
Shade your answers in the OTAS sheet provided.

1 Two experimental set-ups used to demonstrate diffusion of gases are shown in the diagrams below. Each porous pot contains a mixture of nitrogen and oxygen.

Experiment 1



Experiment 2



In the first experiment, the gas introduced into the beaker is carbon dioxide while in the second experiment, it is hydrogen.

What changes, if any, to the water levels **P** and **Q**, would you expect to see in both experiments?

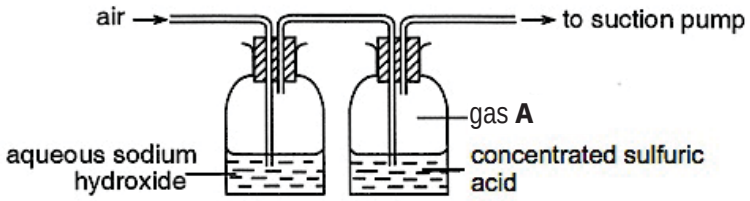
	Experiment 1	Experiment 2
A	**P** and **Q** remain the same	**P** and **Q** remain the same
B	**P** and **Q** remain the same	**Q** is higher than **P**
C	**P** is higher than **Q**	**Q** is higher than **P**
D	**Q** is higher than **P**	**Q** is higher than **P**

2 A substance dissolves in water to form a colourless solution. This solution reacts with aqueous silver nitrate in the presence of dilute nitric acid to give a yellow precipitate.

What is the possible identity of the substance?

A calcium iodide
B copper(II) chloride
C iron(II) iodide
D sodium chloride

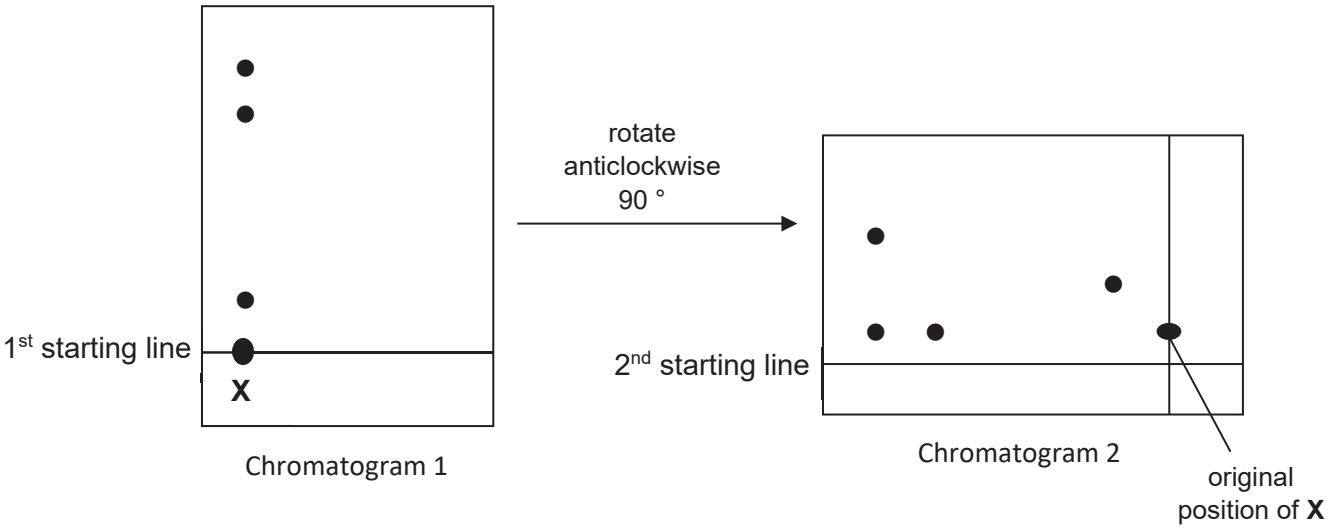
3 A sample of air is passed through the apparatus shown below.



What would be the composition of gas **A** after passing air through aqueous sodium hydroxide and then concentrated sulfuric acid?

A noble gases only
B oxygen, carbon dioxide, nitrogen
C oxygen, nitrogen, water vapour
D noble gases, oxygen, nitrogen

4 Chromatogram 1 below shows the separation of coloured inks in mixture **X**, using solvent **A**. Chromatogram 2 shows the separation using the same piece of paper after it has been rotated anti-clockwise 90 ° in another solvent, **B**.



How many different types of ink are present in mixture **X**?

A 3
B 4
C 5
D 7

5 A new substance was discovered and a series of experiments were conducted on it.

Which observation suggests that the substance **cannot** be an element?

A It has a fixed boiling point.
B It dissolves in water to form a yellow-green solution.
C When heated strongly, a brown solid and a yellow gas are produced.
D When heated in air, it can form oxides with two different chemical formulae.

6 Which substance is **wrongly** matched with the type of particles it contains?

	substance	type of particles
A	HC*l* (g)	ions
B	I_2 (s)	molecules
C	LiBr (s)	ions
D	graphite	atoms

7 A student is given the nucleon number of an atom as well as its position in the Periodic Table.

What can be deduced about the structure of the atom?

A number of protons only
B number of neutrons only
C number of neutrons and protons
D number of neutrons, protons and electrons

8 Two elements, **P** and **Q**, have the electronic configuration 2,8,1 and 2,6 respectively. A student describes the compound formed by **P** and **Q** using the following statements.

1 It is insoluble in water.
2 It has a high melting and boiling point.
3 It has a crystal lattice structure similar to that of sodium sulfide.
4 The elements in it can be separated by electrolysis.

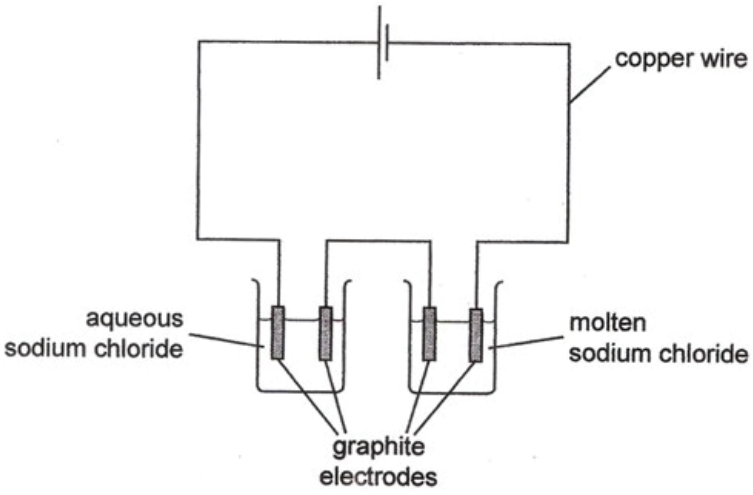
Which of the above statements correctly describe the compound formed by **P** and **Q**?

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

9 Titanium tetrachloride has a structure similar to tetrachloromethane. What is the property of titanium tetrachloride?

A Titanium tetrachloride conducts electricity in all states.
B Titanium tetrachloride is insoluble in organic solvent.
C Titanium tetrachloride has a high melting point.
D Titanium tetrachloride has a high volatility.

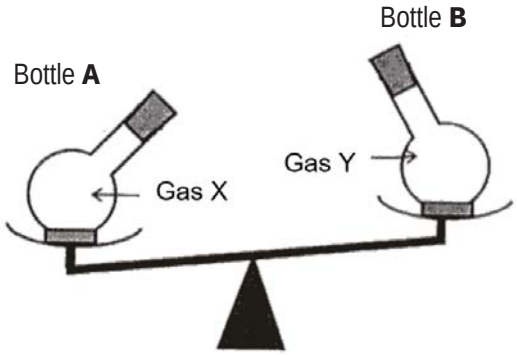
10 The diagram shows an electrolysis set-up involving two electrolytes.



Which substance contains both positive ions and mobile electrons?

A aqueous sodium chloride
B copper wire
C graphite electrodes
D molten sodium chloride

11 At room temperature and pressure, two identical flasks which have been filled up with gas X and Y were put on a balance. The result is shown below.



Which statement is correct?

A The number of gas particles in bottle **A** is greater than the number of gas particles in bottle **B**.

B The number of moles of gas particles in bottle **A** is greater than the number of moles of gas particles in bottle **B**.

C The molar mass of gas particles in bottle **A** is greater than the molar mass of gas particles in bottle **B**.

D The molar volume of gas particles in bottle **A** is greater than the molar volume of gas particles in bottle **B**.

12 To identify an oxide of nitrogen, 0.1 mol of the oxide is mixed with an excess of hydrogen and passed over a catalyst at a suitable temperature.

$$N_xO_y \xrightarrow[\text{catalyst}]{H_2\,(g)} xNH_3 + yH_2O$$

The water produced weighs 7.20 g. The ammonia produced is neutralised by 200 cm^3 of 1.0 mol/dm^3 HCl.

What is the formula of the oxide of nitrogen?

A NO
B NO_2
C N_2O
D N_2O_4

13 A 10 cm^3 sample of a gaseous hydrocarbon is completely burnt in oxygen. The total volume of the products is 70 cm^3.

All gas volumes are measured at room temperature and pressure.

Which equation represents the combustion of the hydrocarbon?

A $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$
B $C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$
C $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$
D $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$

14 Elements X, Y and Z are in the same period of the Periodic Table.

Oxides of X reacts with both alkali and acid.
Oxides of Y dissolves in water to form solution with pH < 7.
Solid Z conducts electricity.

In which order do the elements appear in the Periodic Table.

A X → Y → Z
B Y → X → Z
C Z → X → Y
D Z → Y → X

15 Excess bromine is bubbled through three different solutions.

What are the observations in the respective solutions when the reactions are completed?

	potassium iodide solution	**potassium chloride solution**	**acidified potassium manganate(VII)**
A	brown	colourless	purple
B	colourless	colourless	colourless
C	brown	greenish yellow	colourless
D	colourless	greenish yellow	purple

16 Which of the following, when added to water, makes a solution that is a good conductor of electricity?

A calcium sulfate
B copper
C ethanol
D sodium hydroxide

17 A black powder is burned in air.

The gas produced dissolves in water to form solution **R**. The pH of **R** is close to 7.

The gas is readily absorbed in aqueous sodium hydroxide.

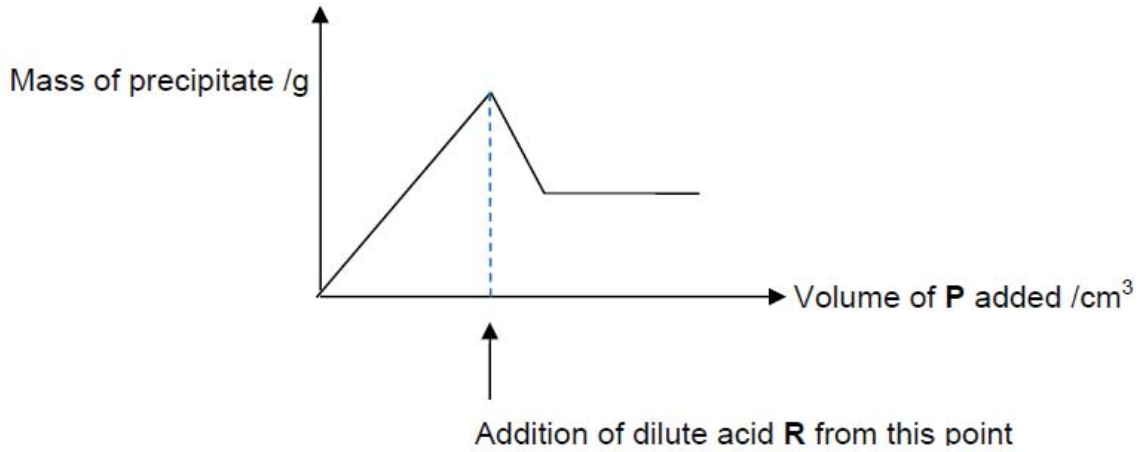
What type of substance is present in solution **R**?

A strong acid
B strong base
C weak acid
D weak base

18 Which test is best used to distinguish between calcium chloride and calcium carbonate?

A adding aqueous sodium hydroxide
B adding dilute hydrochloric acid
C using damp litmus paper
D using silver nitrate solution

19 In a qualitative analysis, reagent **P** is added gradually to solution **Q**, followed by the addition of a dilute acid **R**.

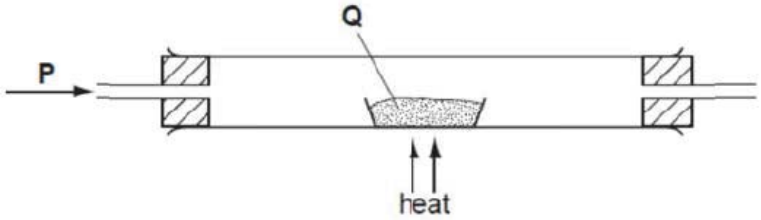


The graph shows how the mass of the precipitate changes as the reagents are added.

Which of the following entries is correct?

	P	Anions in Q	R
A	aqueous silver nitrate	Cl^- and CO_3^{2-}	dilute nitric acid
B	aqueous silver nitrate	Cl^-	dilute nitric acid
C	aqueous barium chloride	Cl^- and CO_3^{2-}	dilute hydrochloric acid
D	aqueous barium chloride	CO_3^{2-}	dilute hydrochloric acid

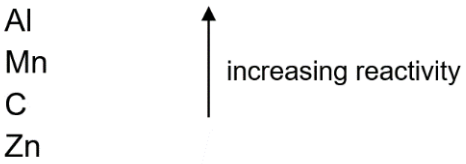
20 In the apparatus shown, gas **P** is passed over solid **Q**.



No reaction occurs if **P** and **Q** are

	P	Q
A	hydrogen	copper(II) oxide
B	hydrogen	magnesium oxide
C	oxygen	carbon
D	oxygen	sulfur

21 Given the following reactivity series,



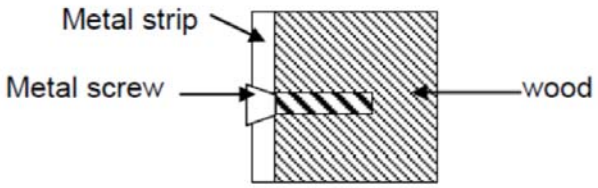
Which action would **not** result in a chemical reaction?

A adding dilute hydrochloric acid to manganese
B heating manganese(II) carbonate strongly
C heating manganese(IV) oxide with carbon
D mixing zinc sulfate solution with manganese powder

22 One of the raw materials used in the extraction of iron in the blast furnace is calcium carbonate. Which statement best explains the use of calcium carbonate?

A To produce slag as a by-product.
B To oxidise haematite to iron.
C To remove the basic impurities in the ore.
D To speed up the rate of reaction.

23 Metal strips are secured on the outside of the wooden box by means of screws. After a few weeks of being exposed to the wind and rain, the screws are heavily corroded but the metal strips are not.



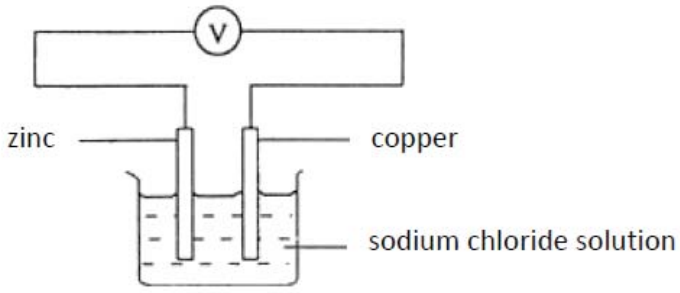
Which statement best explains the observation?

A The metal screw loses electrons less readily than the metal strip.
B The metal screw stops oxygen in the air from getting to the metal strip.
C The metal strip has a protective oxide layer but not the metal screw.
D The metal screw is a pure metal and the metal strip is an alloy.

24 In an electrolysis experiment, the same amount of electrical charge deposited 65 g of zinc and 394 g of gold. What was the charge on the gold ion?

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

25 Consider the following chemical cell:



Which of the following changes would lead to an increase in the voltage of the cell?

1 The copper electrode is replaced with an iron electrode.
2 The sodium chloride solution is replaced with a sugar solution.
3 The zinc electrode is replaced with a magnesium electrode.

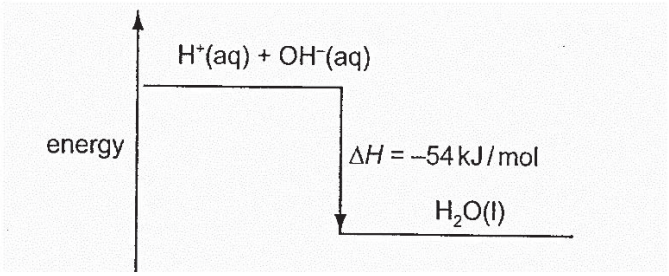
A 1 and 2
B 1 and 3
C 2 only
D 3 only

26 When one mole of ethanol (CH_3CH_2OH) undergoes complete combustion, 1370 kJ of energy are released. When one mole of dimethyl ether (CH_3OCH_3) undergoes complete combustion, 1460 kJ of energy are released.

What causes this difference in the amount of energy released?

A The two compounds have different boiling points.
B The two compounds have different relative molecular masses.
C The two compounds have different bonds within the molecules.
D The two compounds have different products of combustion.

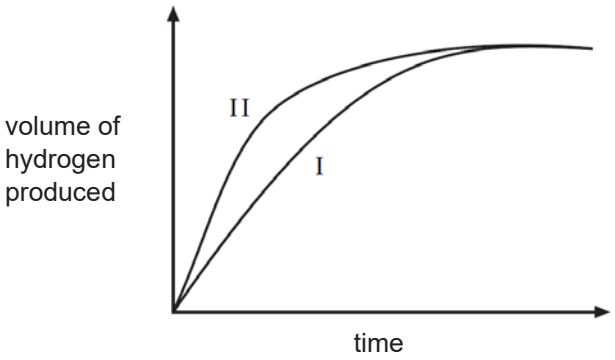
27 The energy level diagram for the reaction between sodium hydroxide and hydrochloric acid is shown below.



What can be deduced from the diagram?

A The reaction is rapid.
B Heat is needed to start the reaction.
C The OH^- ions have more energy than the H^+ ions.
D The products contain less energy than the reactants.

28 Excess zinc was added to 100 cm^3 of 1.0 mol/dm^3 hydrochloric acid and was represented by Graph I.



Which condition could Graph II be representing?

A Excess zinc reacting with 100 cm^3 of 2.0 mol/dm^3 hydrochloric acid.
B Excess zinc reacting with 100 cm^3 of 1.0 mol.dm^3 sulfuric acid.
C Excess zinc reacting with 100 cm^3 of 1.0 mol/dm^3 ethanoic acid.
D Excess magnesium reacting with 100 cm^3 of 1.0 mo/dm^3 hydrochloric acid.

29 Nitrogen and hydrogen react to form ammonia in the Haber process. Which statement is correct about this process?

A A high yield of ammonia is favoured by high temperature.
B Increasing the pressure speeds up the reaction.
C Nickel catalyst is used to increase the production of ammonia.
D The reaction between nitrogen and hydrogen is irreversible.

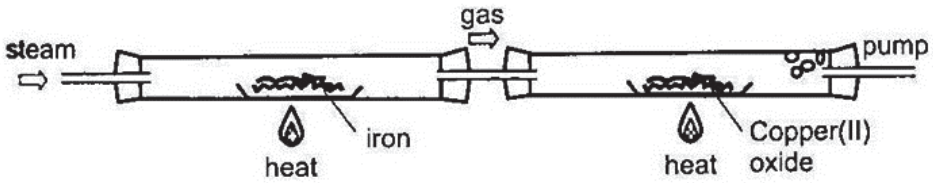
30 Sodium hypochlorite undergoes decomposition according to the following equation.

$$3NaClO \rightarrow 2NaCl + NaClO_3$$

Which option shows the correct oxidation states of chlorine respectively?

	NaClO	**NaCl**	**$NaClO_3$**
A	-1	-1	+5
B	+1	-1	+5
C	+1	-1	+7
D	+2	+1	+7

31 Which of the following is **not** a product of the reaction sequence shown below?



A copper
B iron(III) oxide
C oxygen
D water vapour

32 Which two gases do **not** damage limestone buildings?

A nitrogen and carbon monoxide
B nitrogen dioxide and carbon monoxide
C nitrogen dioxide and carbon dioxide
D sulfur dioxide and carbon dioxide

33 Chlorine atoms are involved in the decomposition of ozone by reacting with ozone in a two-step reaction.

$$Cl + O_3 \rightarrow ClO + O_2 \quad \textbf{step 1}$$
$$ClO + O_3 \rightarrow Cl + 2O_2 \quad \textbf{step 2}$$

Which observation is true for the reaction?

A The reaction is reversible.
B Chlorine atoms are reduced in step 1.
C Chlorine atoms act as catalysts in the reaction.
D Each chlorine atom causes one ozone molecule to decompose.

34 The fractions obtained from the fractional distillation of petroleum mainly contain alkanes.

Which of the following molecules are most likely to be found in kerosene, naphtha and diesel oil respectively?

	kerosene	naphtha	diesel oil
A	C_8H_{18}	$C_{13}H_{28}$	$C_{20}H_{42}$
B	C_8H_{18}	$C_{20}H_{42}$	$C_{13}H_{28}$
C	$C_{13}H_{28}$	C_8H_{18}	$C_{20}H_{42}$
D	$C_{20}H_{42}$	C_8H_{18}	$C_{13}H_{28}$

35 The general formula of alkanes is C_nH_{2n+2}.

Which property decreases as n increases?

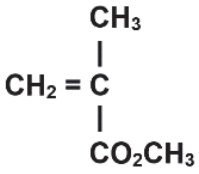
A boiling point
B flammability
C melting point
D viscosity

36 Linoleic acid is found in sunflower oil. The molecular formula of linoleic acid is $C_{18}H_{32}O_2$.

How many double bonds between carbon atoms are present in one molecule of linoleic acid?

A 1
B 2
C 3
D 4

37 In an artificial hip joint, bone cement is used to attach the poly(ethane) cup for the joint to the pelvic girdle. Bone cement is formed by the polymerisation of methyl 2-methylpropenoate and the process is highly exothermic.



methyl 2-methylpropenoate

Which statement is true about bone cement?

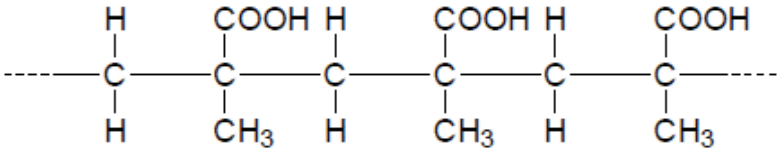
A Aqueous bromine is decolourised by bone cement.
B Less energy is released in the formation of C-C bond than the energy absorbed in the breaking of C=C bond.
C The empirical formula of bone cement is $C_5H_8O_2$.
D Water is formed in the polymerisation of methyl 2-methylpropenoate.

38 An ester is formed from a carboxylic acid and an alcohol.

How does the number of carbon, hydrogen and oxygen atoms in an ester differ from the total number of these atoms in the carboxylic acid and alcohol from which the ester is formed?

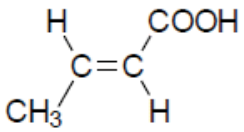
	carbon atoms	hydrogen atoms	oxygen atoms
A	fewer	fewer	fewer
B	fewer	same	fewer
C	same	fewer	fewer
D	same	same	same

39 The structure below shows a section of a polymer.

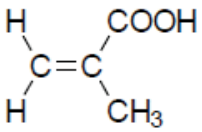


Which monomer was used to make the polymer?

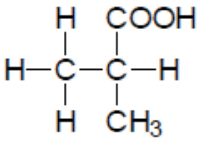
A



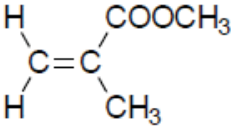
B



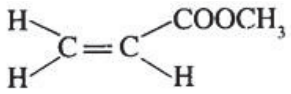
C

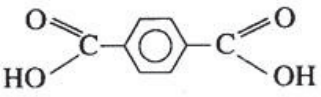


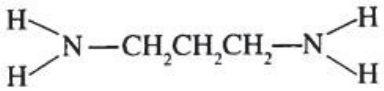
D

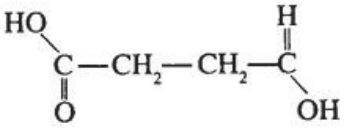


40 The following are monomers of a few compounds. Which of them can be used to produce a polymer via condensation polymerisation?

I 

II 

III 

IV 

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

End of paper 1

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
							1 H Hydrogen 1									4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radius 88	227 Ac Actinium 89 +															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
+90-103 Actinoid series

Key: a / X / b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

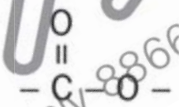
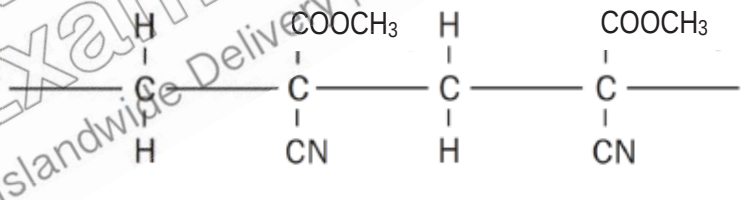
The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Yishun Secondary School
Preliminary Examination 2019
Secondary 4 Express Chemistry (6092)
Mark Scheme

Paper 1

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

Paper 2

Qn no.	Key marking points	Remarks
A1a	iron(III) oxide;	
b	nitric acid;	
c	iron(III) nitrate;	
d	iron(III) hydroxide;	
e	ammonia;	
A2a	 carbon-carbon double bond;  ester;	
b	Addition polymerisation;	
c		
d	Poly(methyl cyanopropenoate);	
ei	Red brown; aqueous bromine turns colourless;	
ii	Addition reaction / addition of aqueous bromine / bromination;	
A3a	H_2A (aq) + 2 NaOH (aq) → Na_2A (aq) + 2 H_2O (*l*) Correct equation; Correct state symbols;	
b	$\frac{(25/1000) \times 0.02}{V \times 0.05} = \frac{1}{2}$; $V = 20\ cm^3$;	

ci	<table><tr><td></td><td>carbon</td><td>hydrogen</td><td>oxygen</td></tr><tr><td>mass (in 100g)</td><td>26.7</td><td>2.2</td><td>71.1</td></tr><tr><td>no of moles</td><td>2.225</td><td>2.2/1 = 2.2</td><td>4.44</td></tr><tr><td>lowest ratio</td><td>1</td><td>1</td><td>2</td></tr></table>working; Empirical formula of oxalic acid = CHO_2 ;	
ii	n (12 + 1 + 32) = 90 n = 2 molecular formula of oxalic acid = $C_2H_2O_4$;	
d	mass of oxalic acid in one star fruit = 0.00011 X 90 = 0.0099 g maximum amount of serving = 0.05 g/0.0099 g = 5;	
A4ai	methoxybutane ; $CH_3OC_4H_9$;	
ii	isomers with the same number of carbon, both the alcohol and ether has the same molecular formula ;	no marks given without comparison
iii	298;	
bi	same general formula of $C_nH_{2n}O$ / $C_nH_{2n+1}CHO$; same functional group of –CHO;	must make ref to the table
ii	butanal ; any temp between 70 – 80°C (midpoint of 49°C & 103°C);	
A5a	the photograph is unlikely to show deposits of pure rubidium / hoax Rubidium is a highly reactive metal /more reactive than sodium ; so will react violently when exposed to air / water ;	no mark without explanation
b	Beryllium is less reactive than magnesium ; no reaction with cold water / reacts very much slower than magnesium with water ; react with steam to form beryllium oxide and hydrogen gas ;	
c	reduction by carbon / carbon monoxide ;	
A6a	Oxidation state(O.S) of N increases from -2 in N_2H_4 to 0 in N_2, and O.S of O decreases from 0 in O_2 to -2 in H_2O ; N_2H_4 is oxidised while O_2 is reduced ;	or using any definition of [O] or [R]
b	$N_2H_4(g) + 2F_2(g) \rightarrow N_2(g) + 4HF(g)$; ΔH = -1179 kJ/mol ;	ΔH must be negative
c	hydrazine and fluorine is a better rocket fuel *any 2 of the following reasons*: (produces larger volume of gases and more thrust, 5 moles of gases compared to hydrazine and oxygen which produces 3 moles of gases ;) amount of energy produced per mole by the fluorine mixture is more / is a more energy efficient fuel ; does not use oxygen as a reactant; more energy release, causing a larger increase in the volume of gases;	no mark without reasons
d	reaction of hydrazine with fluorine produces HF which is acidic compared to water which is neutral ; HF is likely to cause acid rain which is harmful to the environment and aquatic life ;	

<table>
<tr><td>A7a</td><td>atoms of the same element with the same number of protons but different number of neutrons / nucleon number ;</td><td></td></tr>
<tr><td>b</td><td>
<table>
<tr><th>Name</th><th>Formula</th><th>Number of protons</th><th>Number of neutrons</th><th>Number of electrons</th></tr>
<tr><td>Hydrogen atom</td><td>$^{1}_{1}H$</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>Deuterium ion</td><td>$^{2}_{1}H^{+}$</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>Tritium ion</td><td>$^{3}_{1}H^{-}$</td><td>1</td><td>2</td><td>2</td></tr>
</table>
3m – all correct; 2m – 3 to 4 correct; 1m – 1-2 correct;
</td><td></td></tr>
<tr><td>c</td><td>Ar of Ge = ((24.4/100) x 70) + ((32.4/100) x 72) +((43.2/100) x 74) ;
= 72.4 (3sf) ;</td><td></td></tr>
<tr><td>d</td><td>Agree
all isotopes of the same element have same number of valence electrons ;</td><td>no mark if no reason given</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>B8a</td><td>reaction is not reversible ;</td><td></td></tr>
<tr><td>b</td><td>endothermic reaction causes the temperature to decrease ;
at a higher temperature of 450 °C, the reaction shifts to the right to increase the concentration of products and decrease concentration of reactants; ;</td><td></td></tr>
<tr><td>c</td><td>1.01 mol/dm^3;</td><td>3 s.f.</td></tr>
<tr><td>d</td><td>higher temperatures would shift reaction in favour of forming the reactants, lowering yield;
at lower temperatures rate of reaction is slower;</td><td>accept: high cost to maintain high temperature</td></tr>
<tr><td>e</td><td>high yield of sulfur trioxide without increasing pressure /
increase in pressure would be expensive (for marginal increased yield) ;</td><td></td></tr>
<tr><td>f</td><td>Reaction 1 – graph B
Vr = Vp ;
Reaction 2 – graph A
Vr > Vp ;</td><td>both graphs must be correct

accept: moles of gas / molecules of gas as an alternative to volume</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>B9</td><td>$2NiS + 3O_2 \rightarrow 2NiO + 2SO_2$;</td><td></td></tr>
<tr><td></td><td>no. of moles of NiS= $\frac{182000}{59+32}$ =2000 mol ;
2000 x (32 +16x2) = 128 kg ;</td><td></td></tr>
<tr><td>b</td><td>simple covalent molecule/ simple molecular structure with weak intermolecular bonds/FOA ;
low boiling point;</td><td></td></tr>
<tr><td>c</td><td>with zinc nitrate - no reaction;
with copper(II) nitrate - blue solution turned green;
nickel coated with pink solid;</td><td></td></tr>
<tr><td>d</td><td>magnesium is more reactive than carbon ;
thus manufacture by electrolysis (of its ore);</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Either</td><td>$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$</td><td></td></tr>
</table>

B10a	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$ Mol of zinc = 0.488/65 = 0.00751 ; Mol of acid = 2.0 x 20.0/1000 = 0.04mol ; Zinc is the limiting reagent and will produce the same volume (180 cm^3) of hydrogen ;	
b	A – sulfuric acid, dibasic → due to twice the concentration of $H^{\pm}$ and higher rate; B – hydrochloric acid, due to lower concentration of H^+ and lower rate;	
c	C – sulfuric acid, as same gradient as A ; mol of hydrogen = 90/24000 = 0.00375 mass of zinc = 0.00375 x 65 = 0.244 g ; Or half the volume of hydrogen, therefore half the mass of zinc so 0.488/2 = 0.244 g ;	no mark if no calculation presented
di	zinc displaces copper from copper(II) sulfate to produce brown copper deposit ; less zinc reacts with acid to produce less hydrogen ;	
ii	Wrong copper(II) sulfate forms copper, but a catalyst should remain chemically unchanged after the reaction ;	no mark given without reason
Or B10a	sodium ethanoate + CH_3COONa ;	
b	From graph, volume of NaOH used = 20 cm^3 mole of NaOH = 20/1000 X 0.1 = 0.002mol ; 1 mole of CH_3COOH = 1 mole of NaOH conc of CH_3COOH = mole / vol = 0.002 / (20/1000) = 0.1 mol/dm^3 ;	
c	Methyl orange ; 'Step' occurs at pH 9, but methyl orange only changes colour between 3.1 to 4.4 / does not change colour at pH 9 ;	accept OWTTE
di	hydrochloric acid ionises/ dissociate completely while ethanoic acid ionises/ dissociate partially / hydrochloric acid is a strong / stronger acid while ethanoic acid is a weak / weaker acid ; so hydrochloric acid has a higher concentration / no of moles per unit volume of $H^{\pm}$ ions so frequency of effective collision increases ; thus time taken is shorter ;	
ii	Volume of NaOH = 10cm^3 and same shape ;	