TEMASEK SECONDARY SCHOOL
Mid-Year Examination 2018
Secondary 4 Express

CHEMISTRY **6092/01**

Paper 1 **1 hour**

Question Booklet

Additional Material: OTAS

READ THESE INSTRUCTIONS FIRST

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

Write your name, index number and class on the OTAS.
Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.

You are not required to hand in this booklet at the end of the examination.

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 answer sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done on this booklet.

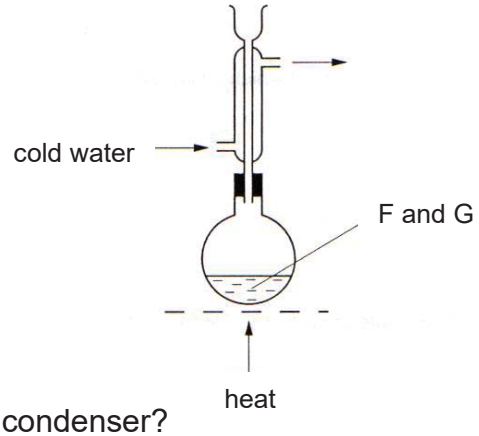
A copy of the **Periodic Table** is printed on **page 18**.

This document consists of **18** printed pages.

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1 The diagram shows the apparatus used for the slow reaction between liquid F (boiling point 57°C) and liquid G (boiling point 80°C).



What is the purpose of the condenser?

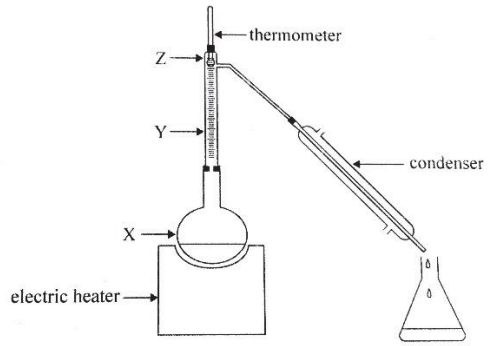
A to enable F and G to mix more efficiently

B to prevent the mixture from getting too hot

C to allow the product to escape as fast as it is formed

D to prevent F and G from escaping before the reaction is complete

2 A liquid mixture of 50% ethanol and 50% water was distilled in the apparatus shown below. The boiling point of ethanol is 78°C and that of water is 100°C. As the mixture was heated the temperature shown by the thermometer initially rose but then remained constant at 78°C for some time.



Which of the following statements about percentage of ethanol in the vapours shown at points X, Y and Z, when the temperature is at a constant 78°C, is true?

A The percentage of ethanol in the vapour at X is equal to 50%.

B The percentages of ethanol in the vapour increase in order at positions X, Y and Z.

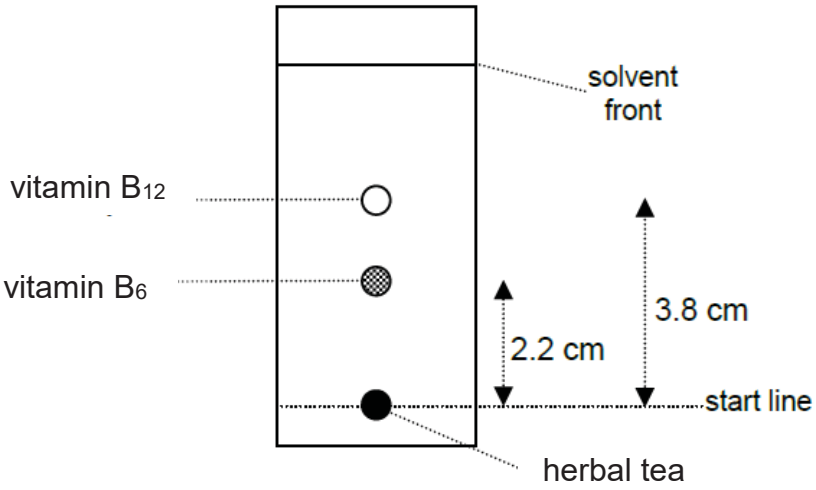
C The percentages of ethanol in the vapour at Y and Z are equal but greater than at X.

D The percentages of ethanol in the vapour at X, Y and Z are equal but greater than 50%.

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3 A sample of herbal tea containing two water- soluble vitamins was analysed during chromatography with water as a solvent. When the solvent front reached the position indicated, the chromatogram was placed under ultra-violet light. The following chromatogram was obtained.

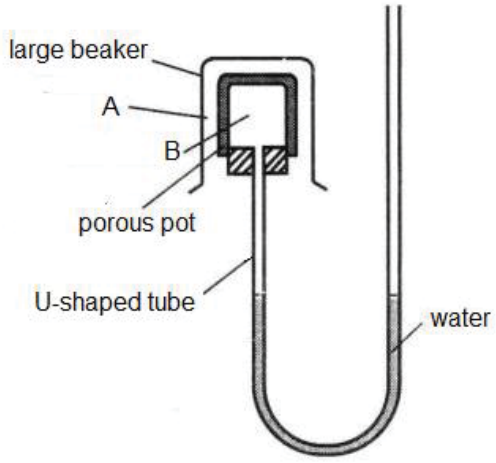


Given that the R_f value of vitamin B_{12} is 0.34, determine the R_f value of vitamin B_6.

A 0.20 **B** 0.50 **C** 0.56 **D** 0.73

4 The following diagram shows a set up.

Which pair of gases would cause a fall in the water level at the right side of the U shaped tube?



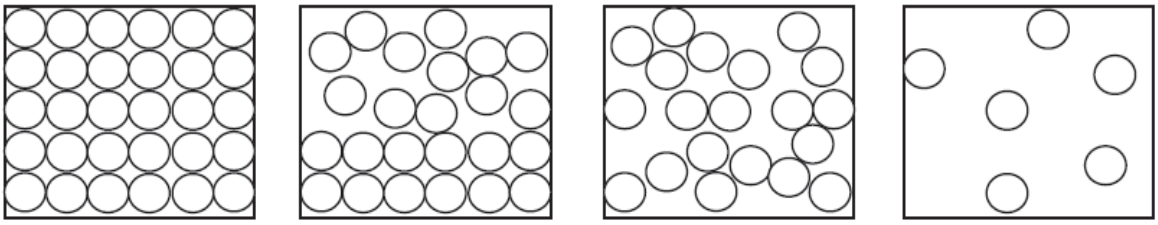
	gas A	gas B
A	Nitrogen dioxide	Chlorine
B	Carbon Monoxide	Nitrogen
C	Oxygen	Neon
D	Fluorine	Argon

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5 Bromine melts at -7°C and boils at 59°C. A tank filled with bromine at 30°C is cooled to -7°C.

Which diagram below best represents the arrangement of bromine particles at -7°C and at 30°C?



1 2 3 4

	-7ºC	30ºC
A	2	4
B	1	3
C	2	3
D	1	2

6 Fires are categorized into four different classes according to the type of fuel involved. The table below shows the various classes of fire.

class	fuel/heat Source	example
1	ordinarily combustible	solids like wood and coal on fire
2	flammable liquids	petrol, oil on fire
3	flammable gases	natural gas, carbon monoxide on fire
4	combustible metals	sodium or potassium on fire

In a selection test, a potential firefighter is required to match four substances according to their class of fire.

Which of the following has been incorrectly matched?
(Assume room temperature and pressure).

	melting point/°C	boiling point/°C	class of fire
A	98	883	4
B	-184	-164	3
C	-117	78	1
D	5	80	2

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7 The table gives data about three different particles.

particle	nucleon number	number of protons	number of neutrons	number of electrons
Xe	131	54	T	54
Se^{2-}	79	U	45	36
Be^{2+}	9	4	5	V

What are the correct values of T, U and V?

	T	U	V
A	54	36	4
B	54	34	2
C	77	36	4
D	77	34	2

8 The table shows details of the particles present in the following 4 atoms or ions.

atoms/ ions	number of neutrons	number of electrons
J^-	17	18
K	16	16
L^{2+}	20	18
M	20	17

Which of the following atoms is an isotope of **J**?

A K **B** L **C** M **D** None of the above

9 A table listing the atomic numbers of 4 elements P, Q, R and S is given below.

element	P	Q	R	S
atomic Number	5	12	15	18

Using the above information only, it can be deduced that

A one atom of Q is heavier than one atom of R.

B the number of neutrons in one atom of R is more than that in one atom of Q.

C R can be converted into Q by removing three electrons from each atom of R.

D Q has a higher tendency to lose electrons than R.

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10 The formulae of the ions of some elements are shown below:

P^{3-} O^{2-} Cl^{-} Na^{+} Ca^{2+}

Which of the following statements about these ions is correct?

A All have stable noble gas configuration.

B All have the same number of electron shells.

C All have the same number of neutrons in their nuclei.

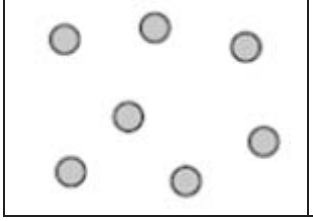
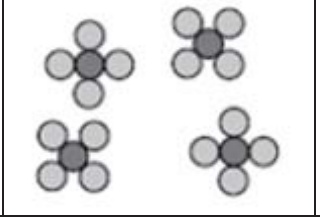
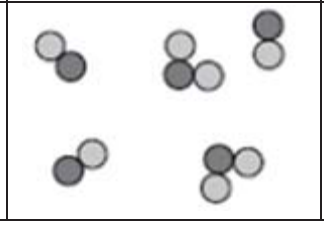
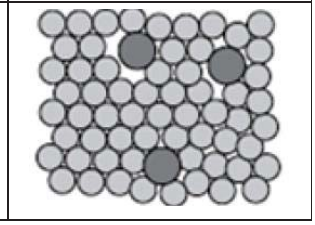
D All have more electrons than protons.

11 Solid iodine readily forms iodine vapour when heated.

What can be deduced about the nature of the particles in these two states of iodine?

	solid	**vapour**
A	atomic	ionic
B	atomic	molecular
C	molecular	atomic
D	molecular	molecular

12 Which of the following diagrams represents a mixture of elements?

A	**B**	**C**	**D**
			

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13 A sample of a white crystalline substance is heated in the absence of oxygen. It melts sharply at 120°C, but on further heating, gives off smoky fumes and a black solid remains.

From this information, we may deduce that the white crystalline substance is

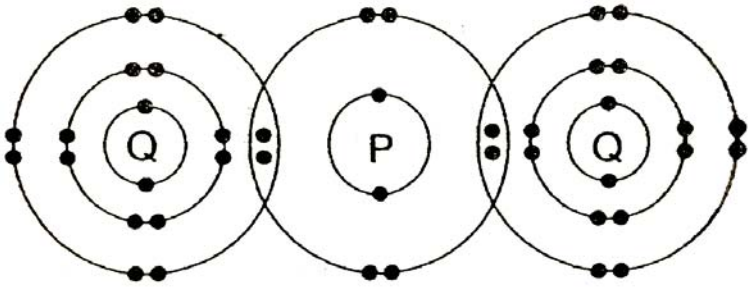
A an element which combusted to form two products.

B a mixture of substances which combined chemically.

C a compound which combusted to form two products.

D a compound which decomposed to form simpler substances.

14 The diagram below shows the bonding between P and Q in the covalent molecule, PQ_2.



What are the electronic structures of atoms P and Q before combining together to form the above molecule?

	P	Q
A	2.6	2.8.6
B	2.4	2.8.7
C	2.6	2.8.7
D	2.8	2.8.8

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15 The equation below shows the reaction between a metal E and dilute sulfuric acid.

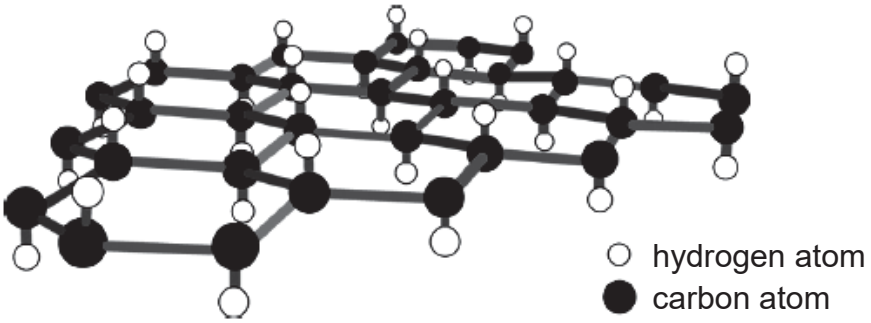
$$E\ (s) + H_2SO_4\ (aq) \rightarrow ESO_4\ (aq) + H_2\ (g)$$

A test on electrical conductivity showed that both the reagents and the resulting solution are good conductors of electricity.

Which particles are responsible for the electrical conductivity in metal E, sulfuric acid and ESO_4?

	Metal E	Sulfuric acid	ESO_4 (aq)
A	Electrons	Cations	Cations and anions
B	Electrons	Cations and anions	Cations and anions
C	Cations	Electrons	Anions
D	Cations and anions	Cations	Electrons

16 Graphane has a similar structure to graphite, except that, it has an additional hydrogen atom attached to each carbon as shown in the diagram.



Which set of properties will graphane have?

1	It has a high melting and boiling point.
2	It has a giant molecular structure.
3	It conducts electricity in the solid state.

A 1 and 2

B 1 and 3

C 2 and 3

D 1, 2 and 3

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17 A solution contains 12.60 g/dm^3 of the acid H_3ZO_3.

25.0 cm^3 of this solution reacted with an equal volume of 0.100 mol/dm^3 NaOH as shown in the equation.

$$NaOH + H_3ZO_3 \rightarrow NaH_2ZO_3 + H_2O$$

What is element Z?

A arsenic **B** nitrogen

C silicon **D** sulfur

18 A sample of insecticide DDT, $C_{14}H_9Cl_5$, was found to contain 0.120 g of carbon.

What mass of chlorine was present in the sample?

A 0.127 g **B** 0.253 g

C 0.994 g **D** 1.01 g

19 Nitrogen(II) oxide and chlorine react according to the equation shown below.

$$2NO_2(g) + Cl_2(g) \rightarrow 2NOCl(g) \qquad \Delta H = -38 \text{ kJ}$$

The activation energy for the forward reaction is 62 kJ.

What is activation energy for the reverse reaction?

A - 62 kJ **B** 24 kJ

C 38 kJ **D** 100 kJ

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20 The conversion of graphite to diamond has an only small value for enthalpy change as shown.

$$C\ (graphite) \rightarrow C\ (diamond) \quad \Delta H = +2.1\ kJ/mol$$

However, the production of synthetic diamonds using this reaction is very difficult.

Which statement helps to explain this?

A Diamond has a larger number of covalent bonds than graphite.

B Only exothermic reactions can occur readily.

C The activation energy of the reaction is large.

D The reaction between diamond and graphite is reversible.

21 Ammonium chloride dissolves in water according to the equation shown below.

$$NH_4Cl\ (s) \rightarrow NH_4Cl\ (aq) \quad \Delta H = +15.0\ kJ/mol$$

When 0.2 moles of ammonium chloride dissolves in 50.0 cm^3 of water,

1	the concentration of the solution is 4.0 mol/dm^3.
2	the energy level of NH_4Cl increases.
3	the heat liberated is 3.0 kJ.
4	the temperature of the solution falls.

Which one of the following statements are correct?

A 1, 2 and 3 **B** 1, 2 and 4

C 1, 3 and 4 **D** 2, 3 and 4

22 Disproportionation is a reaction in which the same element is both oxidised and reduced.

Which reaction is an example of disproportionation?

A $3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$

B $2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$

C $2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$

D $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

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23 The equation below is one of the reactions which occur in catalytic converters.

$$2C_8H_{18}(g) + 50NO(g) \rightarrow 16CO_2(g) + 25N_2(g) + 18H_2O(g)$$

Which statement is correct?

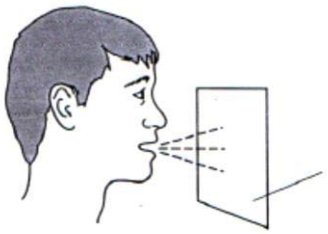
A Carbon dioxide is formed by the reduction of carbon containing compounds.

B Nitrogen is produced by the oxidation of nitrogen monoxide.

C Nitrogen monoxide is a reducing agent.

D C_8H_{18} is a reducing agent.

24 Acidified potassium manganate(VII) can be used to detect the presence of ethanol vapour in the breath of a person who has consumed alcohol.



A colour change is observed. This shows that ethanol is

A a reducing agent because it reduces the oxidation state of the manganese ions.

B an alkali because the final colour is purple.

C an oxidising agent because the manganese atoms gain oxygen atoms.

D neutralised by acidified potassium manganate(VII) solution.

25 In which of the following pairs is the oxidation number of chromium more than that of manganese?

A	K_2CrO_4	$KMnO_4$
B	$CrCl_3$	MnO_2
C	$Cr_2(SO_4)_3$	$MnSO_4$
D	$K_2Cr_2O_7$	MnO_4^-

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26 Which one of the following elements burns in excess oxygen to form a neutral oxide?

A carbon

B sulfur

C calcium

D hydrogen

27 The following steps were carried out to prepare magnesium chloride.

I	Add excess magnesium carbonate to hydrochloric acid.
II	Heat the solution until it is saturated.
III	Filter , wash and dry the crystals.

Which of the following steps should be taken to ensure that the procedure is successful in order to obtain the pure salt?

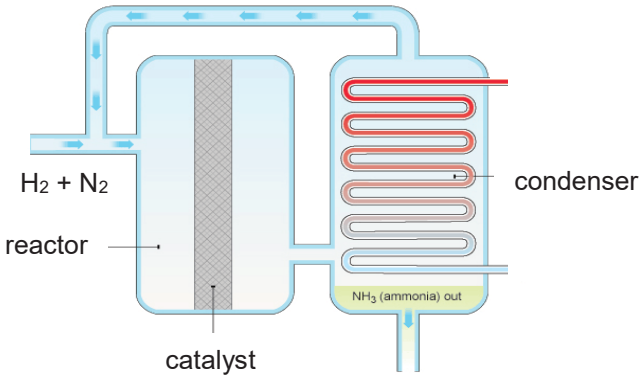
A Filter to get rid of the excess magnesium carbonate before carrying out step II.

B Add excess hydrochloric acid instead of magnesium carbonate in step I.

C Evaporate the solution to dryness in step III.

D The crystals should not be washed in step III.

28 Ammonia is produced by Haber process as shown in the diagram.



Which one of the following processes separates ammonia from the reaction mixture?

A cooling the gaseous mixture

B distillation of the gaseous mixture

C filtering out the other gases by passing through the condenser

D pass the gaseous mixture through fused calcium oxide

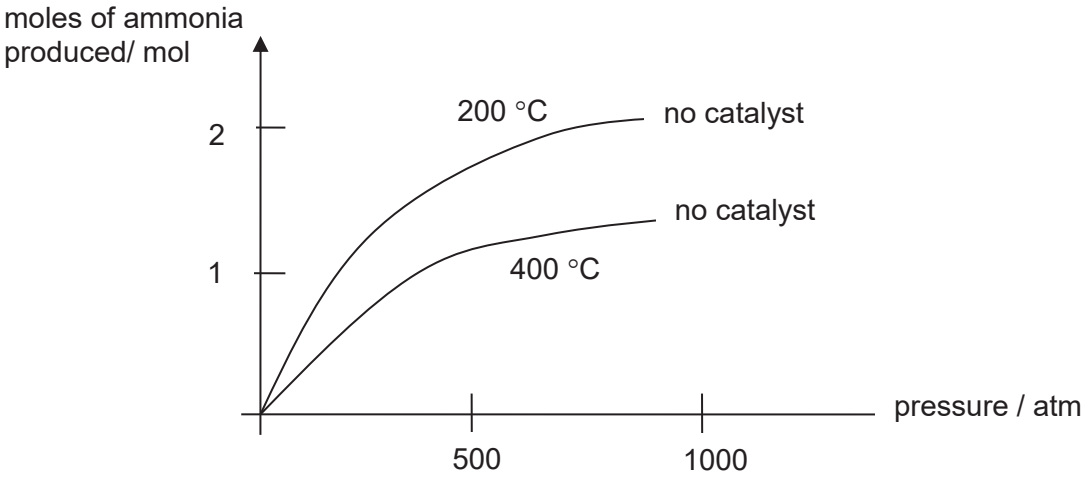
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29 When heated, nitrogen and hydrogen react according to the equation:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

The graph below shows the number of moles of ammonia produced from 1 mole of nitrogen at different temperatures and pressures.



Which one of the following statements may be deduced from this information?

1	At 500 atm pressure, the number of moles of ammonia produced is greater at 200 °C than at 400 °C.
2	An increase of pressure increases the number of moles of ammonia produced both at 200 °C and at 400 °C.
3	At 500 atm pressure and 300 °C, the number of moles of ammonia produced is likely to be greater than one.

A 1, 2, and 3 are correct

B 2 and 3 only are correct

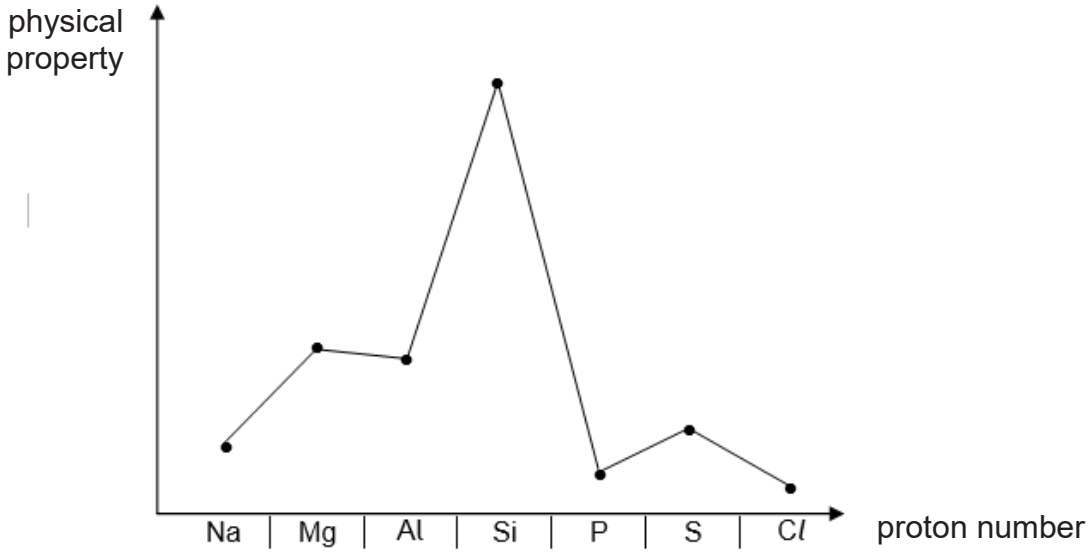
C 1 and 2 only are correct

D 1 only is correct

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30 The graph shows the variation of a physical property with proton number for the elements from sodium to chlorine in the Periodic Table.



What is the physical property that varies?

A atomic radius **B** electrical conductivity

C melting point **D** density

31 An element R forms compounds with the following chemical formulae:

MgR H_2R CR_2 Li_2R

In which group of the Periodic Table would element R be placed?

A Group II **B** Group IV

C Group V **D** Group VI

32 Transition metals are often used as catalysts in industries.

Which of the following is not an example of a transition metal acting as a catalyst?

A platinum in catalytic converters

B iron in Haber Process

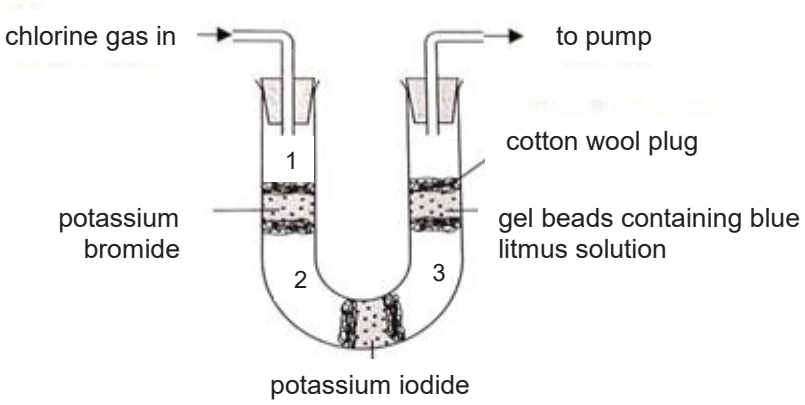
C aluminium in catalytic cracking

D nickel in making of margarine

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33 Gaseous chlorine was passed through the following apparatus. The apparatus was continuously heated and the observations were recorded below.



Which of the following observations would be made at regions 1, 2 and 3?

	region 1	region 2	region 3
A	red-brown gas	black solid	violet gas
B	violet gas	red-brown gas	black solid
C	yellow-green gas	red-brown gas	violet gas
D	yellow-green gas	violet gas	brown gas

34 The diagram shows the positions of elements L, M, Q, R and T in the Periodic Table. These letters are not the chemical symbols of the elements.



Which statement about the properties of these elements is correct?

A M reacts more vigorously with water than does L.

B Q, R and T are all metals.

C T is more reactive than R.

D T exists as diatomic molecules.

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35 Which of the following combinations below correctly states how the increase in the percentage of carbon in steel affects its properties?

	strength	malleability	melting point	brittleness
A	↑	↑	↓	↓
B	↑	↓	↑	↓
C	↑	↓	↓	↑
D	↓	↑	↑	↓

Key:

↑ = increase

↓ = decrease

36 The positions of three metals X, Y and Z are indicated in the reactivity series below.

Most reactive	potassium
	X
	sodium
	zinc
	Y
	iron
Least reactive	Z

How are the metals obtained from their ores?

	electrolysis	reduction with carbon	found uncombined
A	X	Y	Z
B	X	Z	Y
C	Y	X	Z
D	Z	X	Y

37 The table shows a list of metal carbonates and the time taken for a fixed volume of carbon dioxide to be collected upon heating a fixed mass of each metal carbonate.

metal carbonate	time taken / min
WCO_3	0.5
XCO_3	2
Y_2CO_3	10
ZCO_3	5

Using the results shown, arrange the order of the metals in order of increasing reactivity.

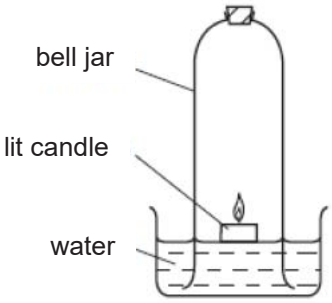
A W, Z, X, Y **B** W, X, Z, Y

C Y, X, Z, W **D** Y, Z, X, W

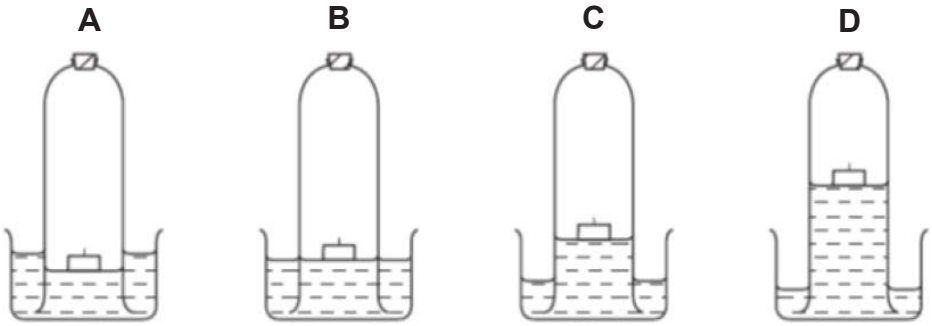
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38 The diagram shows an experiment to determine the percentage of oxygen in air.



Which diagram shows the correct level of water after the candle stops burning?



39 Acid rain contains sulfuric acid and can cause lakes to become acidic. Acidic lakes may be treated with powdered limestone, impure $CaCO_3$, to neutralize the acidity forming calcium sulfate. If large lumps of limestone are used, instead of powder, the reaction starts but soon stops, leaving most of the limestone unreacted.

Which statement explains why the reaction starts but soon stop?

A Limestone only contains small amounts of calcium carbonate.

B The acid reacts with calcium sulfate instead of the calcium carbonate.

C Powdered limestone is more reactive that lumps of limestone.

D A layer of insoluble calcium sulfate forms on the surface of the lumps.

40 Which of the following is not responsible for the destruction of the ozone layer in the stratosphere?

A CFCs

B fluorine atoms

C chlorine atoms

D UV light

END OF PAPER 1

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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

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Name: _____ Index Number:_____ Class: _____

TEMASEK SECONDARY SCHOOL
Mid-Year Examination 2018
Secondary 4 Express

CHEMISTRY **6092/02**

Paper 2 (Section A) **Total duration for Sections A and B: 1 hour 45 minutes**

Question and Answer Booklet

READ THESE INSTRUCTIONS FIRST

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

Hand in this booklet at the end of the paper.

Write your name, index number and class in all the work you hand in.
Write in dark blue or black pen.

Answer all questions in the spaces provided on the question paper.

At the end of the examination, submit **Section A and B separately**.

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 12**.

FOR EXAMINER'S USE	
Section A	/50

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

A1 The table below shows some information about substances **A** to **F**.

substances	melting point/°C	boiling point/°C	conducts electricity when solid	dissolves in water
A	Turns directly from solid to gas		No	slightly
B	1583	2862	Yes	No
C	1873	2230	No	No
D	-114	78	No	Yes
E	0	100	No	-
F	-97	40	No	No

Using the information provided, suggest the best separation technique to separate the following mixture.

(a) **A** and **B** ……

(b) **C** and **D** ……

(c) **D** and **E** ……

(d) **E** and **F** ……

[4]

A2 This question is about ammonia.

(a) Describe briefly how you would prepare ammonia using an ammonium salt.

……

…… [1]

(b) Explain why it is not advisable to dry ammonia using concentrated sulfuric acid.

……

…… [1]

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(c) Suggest a suitable substance to dry ammonia.

……..…… [1]

(d) When dry ammonia is passed over heated sodium, hydrogen and solid sodamide ($NaNH_2$) are formed.

Suggest why ammonia must be dried before reacting with sodium?

……

……..…… [1]

(e) Explain how hydrogen can be collected from the gaseous mixture from **(d)**.

……

……

……

……..…… [2]

(f) Construct the equation for the reaction between sodium and ammonia. Include state symbols.

……..…. [2]

(g) If 240 cm^3 of hydrogen were formed at room temperature and pressure, calculate the mass of sodamide obtained.

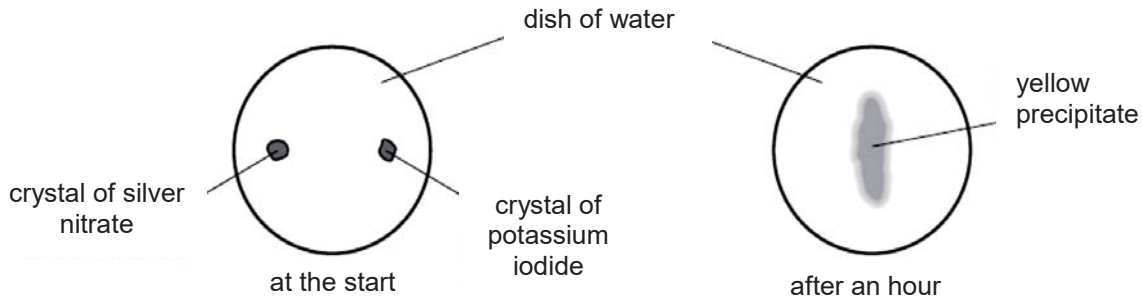
[2]

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A3 A student placed a crystal of silver nitrate and a crystal of potassium iodide in a dish of water.

After an hour she observed that the crystals had disappeared and a yellow precipitate had appeared near the middle of the dish.



Use your knowledge of the kinetic particle theory and reactions between ions to explain these observations.

……

……

……

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……

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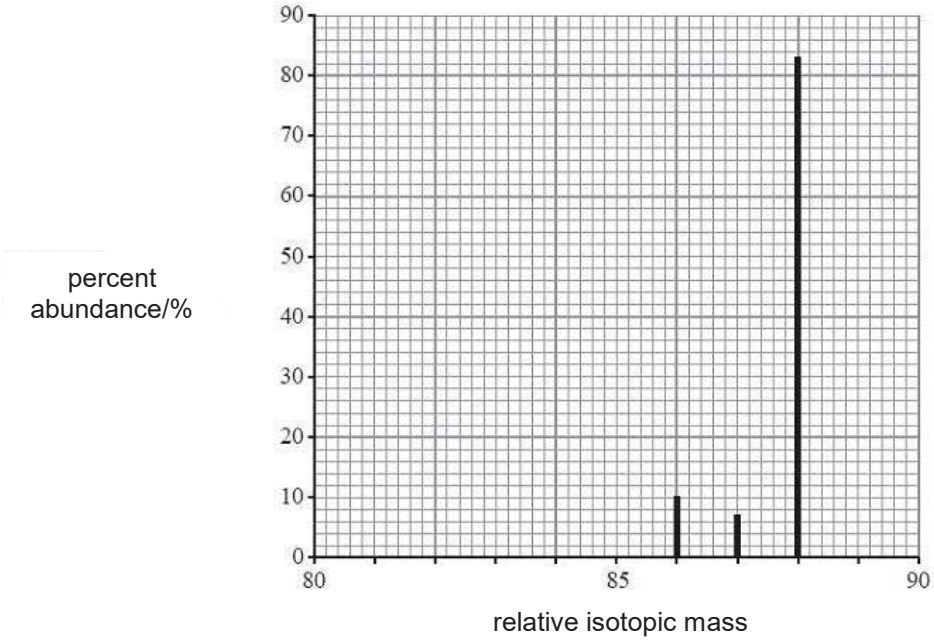
……

…… [3]

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A4 The graph below shows the percent abundance (%) and relative masses of three naturally occurring isotopes of element **Z**.



(a) Define the term 'isotopes'.

……

…… [1]

(b) Using the graph, calculate the relative atomic mass of element **Z**.

[2]

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(c) **(i)** **Z** has a melting point of 777°C and a boiling point of 1382°C.

A solid sample of **Z** was heated from room temperature to 1500°C. There was a larger increase in volume at the boiling point than at the melting point.

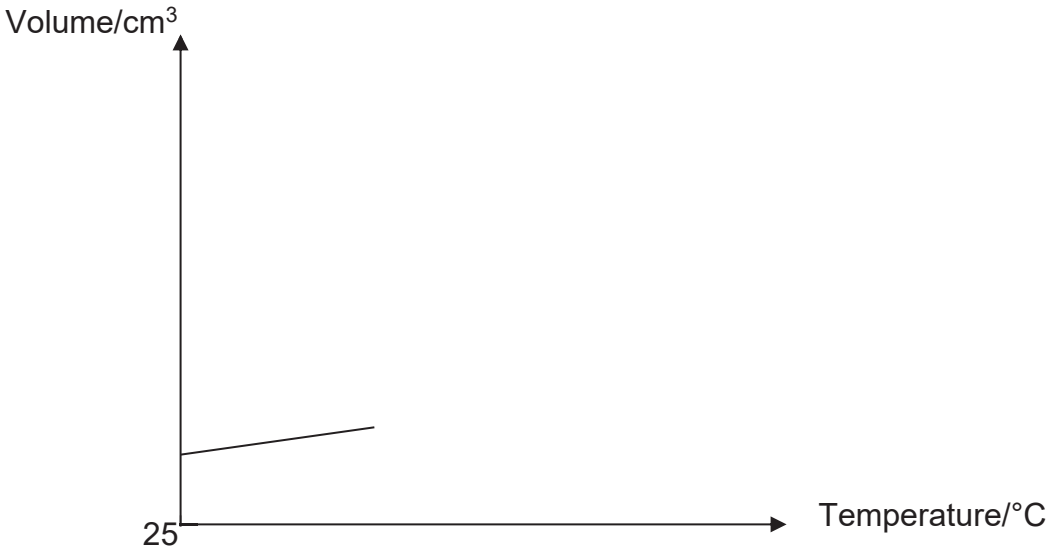
Explain, in terms of arrangement and movement of the particle, why there was a larger increase in volume at the boiling point.

……

……

…… [2]

(ii) Complete the graph below to show changes in volume of solid sample Z against temperature. Label all temperatures clearly.



[1]

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A5 The labels of eight substances below had fallen off from their containers.

Zn(s)	Na_2CO_3(aq)	HCl(aq)	$BaCO_3$(s)
$CuSO_4$(aq)	NaOH(aq)	H_2SO_4(aq)	NH_4Cl(aq)

A qualitative analysis was conducted in an attempt to identify the eight substances.

	substance 1	substance 2	substance 3	substance 4
substance 5	Soluble salt formed by titrating substances 1 & 5.	Effervescence seen. Soluble salt formed.	Effervescence seen. Soluble salt formed.	Effervescence seen. Soluble salt formed.
substance 6	Blue precipitate formed.	Green insoluble salt formed.	No visible observation.	Pink solid formed.
substance 7	Soluble salt formed by titrating substances 1 & 7.	Effervescence seen. Soluble salt formed.	Effervescence seen. Insoluble salt formed.	Effervescence seen. Soluble salt formed.
substance 8	Alkaline gas formed.	No visible observation.	No visible observation.	No visible observation.

Identify substances 1 to 8.

Substance 1 …….. [1]

Substance 2 …….. [1]

Substance 3 …….. [1]

Substance 4 …….. [1]

Substance 5 …….. [1]

Substance 6 …….. [1]

Substance 7 …….. [1]

Substance 8 …….. [1]

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A6 Hydrazine, N_2H_4, is commonly used as a liquid rocket fuel. It reacts with oxygen in the equation shown below.

$$N_2H_4 + O_2 \rightarrow N_2 + 2H_2O$$

(a) Suggest why the combustion of hydrazine has negligible adverse environmental impact.

……

…… [1]

(b) Do the reactants or products have stronger bonds? Explain your answer.

……

……

……

…… [3]

(c) Sketch a labeled energy profile diagram for the above reaction.

[2]

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(d) 10 g of hydrazine was burnt in 50 dm^3 of air.

(i) Did the hydrazine undergo complete combustion? Show your working.

[3]

(ii) Given that 194 kJ of energy was involved in the burning of 10g of hydrazine, calculate the enthalpy change in kJ/ mol for the reaction of hydrazine with oxygen.

[2]

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A7 The reactivity of some metals can be compared using the data in the table below.

metals	displacement reactions	reaction with water and steam	observations during reaction with steam
mercury	Mercury does not displace any of the metals.	Has no reaction with steam	Silvery metal remains unchanged.
magnesium	$Mg + Zn(NO_3)_2 \rightarrow Mg(NO_3)_2 + Zn$	Reacts slowly with cold water. Burns in steam.	Grey solid turns white.
nickel	$Ni + Hg(NO_3)_2 \rightarrow Ni(NO_3)_2 + Hg$	Has no reaction with water. Reacts slowly with steam.	Silvery solid turns green.
zinc	$Zn + Ni(NO_3)_2 \rightarrow Zn(NO_3)_2 + Ni$	Has no reaction with water. Reacts slowly with steam.	Grey solid turns yellow when hot.

(a) Using the data from the table, arrange the metals in increasing order of reducing ability.

……. [1]

(b) **(i)** Solution containing nickel(II) ions are green.

State what you would expect to observe when magnesium is added to nickel(II) nitrate solution.

……

……..... [2]

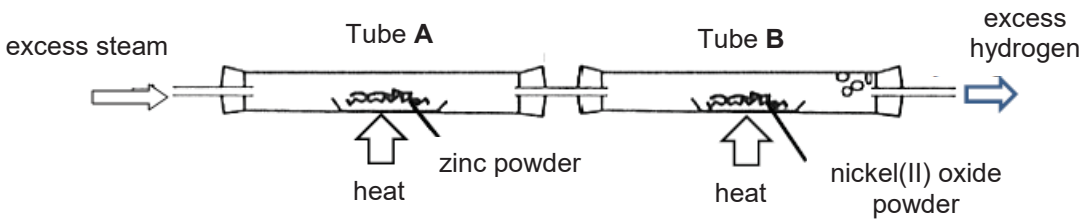
(ii) Write an ionic equation for the reaction in **(b)(i)**. Include state symbols.

……..... [2]

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(c) Steam was passed through the apparatus set up below.



(i) Write an equation for the reaction that occurred in Tube **A**.

……..…… [1]

(ii) Given that nickel lies between iron and lead in the reactivity series, what would you observe in Tube **B**?

Explain your answer.

……..……

……..……

……..…… [2]

END OF SECTION A

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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

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Name: _____ Index Number:_____ Class: _____

TEMASEK SECONDARY SCHOOL
Mid-Year Examination 2018
Secondary 4 Express

CHEMISTRY **6092/02**

Paper 2 (Section B) **Total duration for Sections A and B: 1 hour 45 minutes**

Question and Answer Booklet

READ THESE INSTRUCTIONS FIRST

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

Hand in this booklet at the end of the paper.

Write your name, index number and class in all the work you hand in.
Write in dark blue or black pen.

Answer **three questions** from this section.
Question B10 is in the form of either/or and only one of the alternatives should be attempted.

Write your answers in the spaces provided.

At the end of the examination, submit **Section A and B separately**.

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 12** of **Section A**.

FOR EXAMINER'S USE	
Section B	**/30**

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Section B
Answer three questions from this section.
Question B10 is in the form of either/or and only one of the alternatives should be attempted.
Write your answers in the spaces provided.

B8 The table below shows some physical properties and common oxidation states of the Period 4 metals.

name of element	chemical symbols of element	density (g/cm^3)	melting point (°C)	common oxidation state(s)
potassium	K	0.9	64	+1
calcium	Ca	1.5	842	+2
scandium	Sc	3.0	1541	+3
titanium	Ti	4.5	1660	+2,+3,+4
vanadium	V	6.1	1917	+2,+3,+4,+5
chromium	Cr	7.9	1857	+2,+3,+4,+5,+6
manganese	Mn	7.2	1244	+2,+3,+4,+5,+6,+7
iron	Fe	7.9	1537	+2,+3,+4,+6
cobalt	Co	8.7	1494	+2,+3,+4
nickel	Ni	8.9	1455	+2,+3,+4
copper	Cu	8.9	1084	+1,+2

(a) Quoting data from the table above, state two ways the main group metals, potassium and calcium differ in their physical properties from the transition metals, titanium to copper.

……

……

……

……

……

…… [2]

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(b) State two differences that can be observed when the metals potassium and iron are added to dilute hydrochloric acid respectively.

……

……

……

……

…… [2]

(c) Describe the general pattern for the oxidation states exhibited by the transition metals from titanium to copper.

……

……

…… [1]

(d) Explain why the main group metals, potassium and calcium have only one oxidation state of +1 and +2 respectively.

……

……

…… [1]

(e) Manganese(II) nitrate decomposes upon strong heating to form manganese(IV) oxide and nitrogen dioxide gas.

Explain, with the aid of an equation, whether the decomposition of manganese nitrate is a redox reaction in terms of oxidation state.

……

……

……

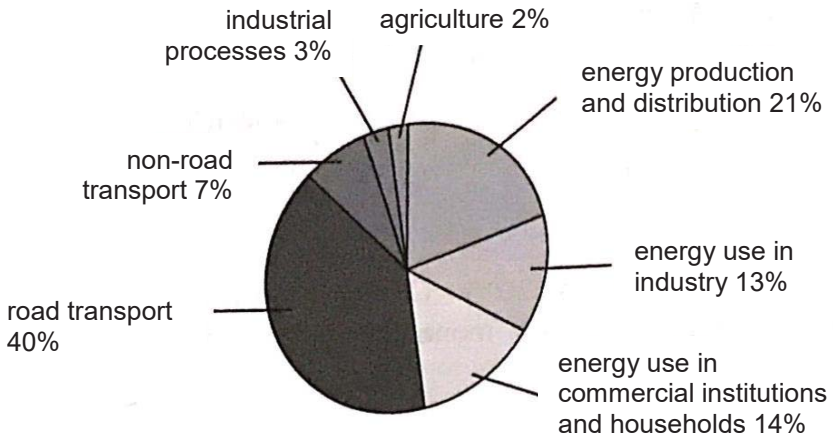
……

…… [3]

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(f) The pie chart below shows how oxides of nitrogen, NO_x production is contributed by the different activities.



(i) Describe how oxides of nitrogen are formed in car engines.

……

…….....…. [1]

(ii) Based on the statistics given in the chart, suggest one way to drastically reduce NO_x emissions.

……

……

…….....…. [1]

(iii) Describe an impact of NO_x emissions on the environment.

……

…….....…. [1]

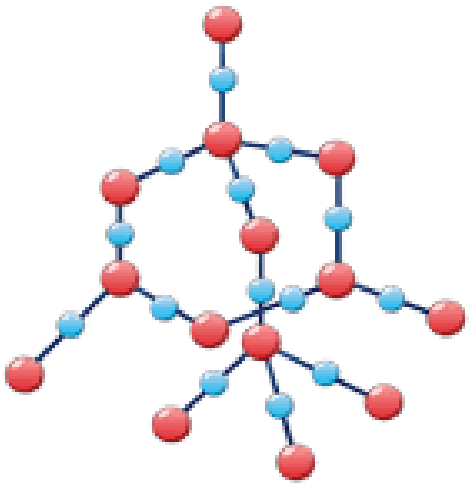
[Total: 12 marks]

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B9 Silicon dioxide, also known as silica, is a chemical compound that is an oxide of silicon. Silica, in the form of sand is used as the main ingredient in sand casting for the manufacture of various metallic components in engineering.

A diagram of a silicon dioxide is shown below.



(a) State one similarity and one difference between the structure of silicon dioxide and structure of diamond.

……

……

……

…… [2]

(b) Both diamond and silicon dioxide are poor electrical conductors.

State the name of another form of carbon which can conduct electricity.

How is this form of carbon different in structure from silicon dioxide which allows it to conduct electricity?

……

……

……

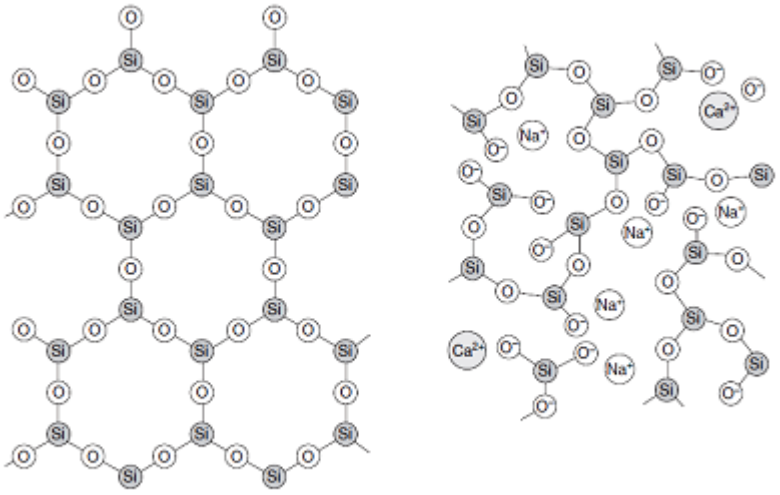
…… [2]

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(c) Soda-lime glass is made by heating a mixture of calcium carbonate, sodium carbonate and sand in a furnace to a high temperature.

Other glasses contain compounds called silicates. The structures of soda-lime glass and silicate are shown in **Fig. 9**



silicate

soda- lime glass

Fig.9

(i) State one structural difference between soda-lime glass and silicate.

……

…….... [1]

(ii) Is soda-lime able to conduct electricity? Explain your answer.

……

……

……

……

……

…….... [3]

[Total: 8 marks]

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B10 Either

Read the information below about the oxides of elements in Period 3 of the Periodic Table.

Elements and their oxides

The table below show the properties of the oxides formed by elements in Period 3.

element	formula of oxide	melting point of oxide/°C	boiling point of oxide/°C
Na	Na_2O	1132	1950
Mg	MgO	2852	3600
Al	Al_2O_3	2072	2977
Si	SiO_2	1600	2230
P	P_4O_6	24	173
	P_4O_{10}	340	360
S	SO_2	-72	-10
	SO_3	17	45
Cl	Cl_2O	-121	2
	Cl_2O_7	-92	82

(a) Describe the pattern for the ratio of each metallic element to oxygen across period 3. Include ratios in your answer.

……

…… [1]

(b) Account for the melting and boiling points of the oxides formed by elements in Period 3 in terms of structure and bonding.

……

……

……

……

……

……

……

…… [3]

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(c) Suggest a reason for the difference in the melting and boiling points between the two oxides of sulfur.

……

……

…… [2]

(d) The table below shows the variation of atomic and ionic radius across Period 3.

element	atomic radius/nm	simple ion	ionic radius/nm	number of electron shells in simple ion
Na	0.191	Na^+	0.102	
Mg	0.160	Mg^{2+}	0.072	
Al	0.130	Al^{3+}	0.054	
Si	0.118	*	-	-
P	0.110	P^{3-}	0.212	
S	0.102	S^{2-}	0.184	
Cl	0.099	Cl^-	0.181	
Ar	0.095	-	-	-

*Si does not form simple ions and thus the data is omitted from the table

(i) Complete the table above to show the number of shells of electrons in the ions of period 3 elements. [1]

(ii) Use the information from the table to explain the difference between the radii of anions and cations in the same period.

……

……

……

…… [2]

(iii) Suggest why there is no value stated for the ionic radius of argon.

……

…… [1]

[Total: 10 marks]

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B10 OR

Read the information below about the chlorides of elements in Period 3 of the Periodic Table.

Elements and their chlorides

The formulae and chemical properties of the chlorides of the elements change across Period 3.

The chlorides behave differently when they are added to water. Some the chlorides dissolve in water to form a solution. Some hydrolyse when they are added to water. This means that they react chemically with water to produce new products.

element	metal / non-metal	formula of main chloride	bonding in chloride	effect of adding chloride to water	products of adding chloride to water
Na	metal	$NaCl$	ionic	dissolves	$NaCl(aq)$
Mg	metal	$MgCl_2$	ionic	dissolves	$MgCl_2(aq)$
Al	metal	$AlCl_3$	covalent	hydrolyses	Complex mixture of products including $HCl(aq)$
Si	non-metal	$SiCl_4$	covalent	hydrolyses	$SiO_2(s)$ $HCl(aq)$
P	non-metal	PCl_3	covalent	hydrolyses	$H_3PO_3(aq)$ $HCl(aq)$
S	non-metal	S_2Cl_2	covalent	hydrolyses	complex mixture of products including $HCl(aq)$
Cl	non-metal	Cl_2	covalent	hydrolyses	$HClO(aq)$ $HCl(aq)$

The chlorides have a different formulae and the ratio of the element to chlorine changes across Period 3. Some examples are shown in the table below.

formula of chloride	ratio of element to chlorine
$NaCl$	1:1
$MgCl_2$	1:2
$AlCl_3$	1:3

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(a) Describe the pattern for the ratio of each element to chlorine across period 3. Include ratios in your answer.

……

……

…… [2]

(b) **(i)** Which chloride forms a precipitate when it is added to water?

…… [1]

(ii) Write a balanced equation for the reaction of phosphorus (III) chloride with water.

…… [1]

(c) Two students talk about the data.

Student 1: 'I think that whether or not the chloride hydrolyses is linked to the metal or non-metal character of the element.

Student 2: 'I think that whether or not the chloride hydrolyses is linked to the bonding of the chloride.'

Does the information in the table support the ideas of the students?

Explain your reasoning.

……

……

……

……

…… [3]

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(d) Another student performs an experiment to test whether some other chlorides dissolve or hydrolyse when they are added to water.

He adds each chloride to water and tests the pH of the mixture.

Explain how the result of a pH test shows whether or not a chloride has hydrolysed.

……

……

……

…… [2]

(e) Suggest a reason why argon is not included in the table of information about Period 3 chlorides.

……

…… [1]

[Total: 10 marks]

END OF SECTION B

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Sec 4E Chemistry 6092
Mid Year Examination 2018
Mark Scheme

Paper 1

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

Paper 2 Section A

A1 **(a)** Sublimation [1]

(b) Filtration [1]

(c) Fractional distillation [1]

(d) Using separating funnel [1]

A2 **(a)** Heating of ammonium salt with an alkali. [1]

(b) Ammonia is an alkaline gas and will react with /be neutralized by concentrated sulfuric acid, forming a salt. [1]

(c) Calcium oxide/fused calcium chloride [1]

(d) Sodium will react vigorously with water to form sodium hydroxide and hydrogen gas. [1]

(e)
- Pass the gaseous mixture through water / collect by displacement over water. [1] [2]
- As ammonia is very soluble in water, it will be absorbed by the water. Only hydrogen will be collected as it is insoluble in water. [1]

(f) $2NH_3\ (g) + 2Na\ (s) \rightarrow H_2\ (g) + 2NaNH_2\ (s)$ [2]

[1] for balanced equation
[1] for correct state symbols

(g) No of moles of hydrogen
= 0.24/ 24
= 0.0100 [1]

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Mole ratio of H_2 : $NaNH_2$
1 : 2
0.0100 : 0.0200

Mass of sodamide
= 0.0200 x (23+14+ 2)
= 0.780 g [1]

[2]

A3 Crystal of silver nitrate and potassium iodide dissolve in the dish of water [1] and form ions which diffuse from a region of higher concentration at the 2 spots to a region of lower concentration at the middle of the dish [1].
Silver ions and iodide ions react to form insoluble silver iodide [1] which is yellow in colour

A4 **(a)** Isotopes are atoms of the same element with same number of proton but different number of neutrons. [1]

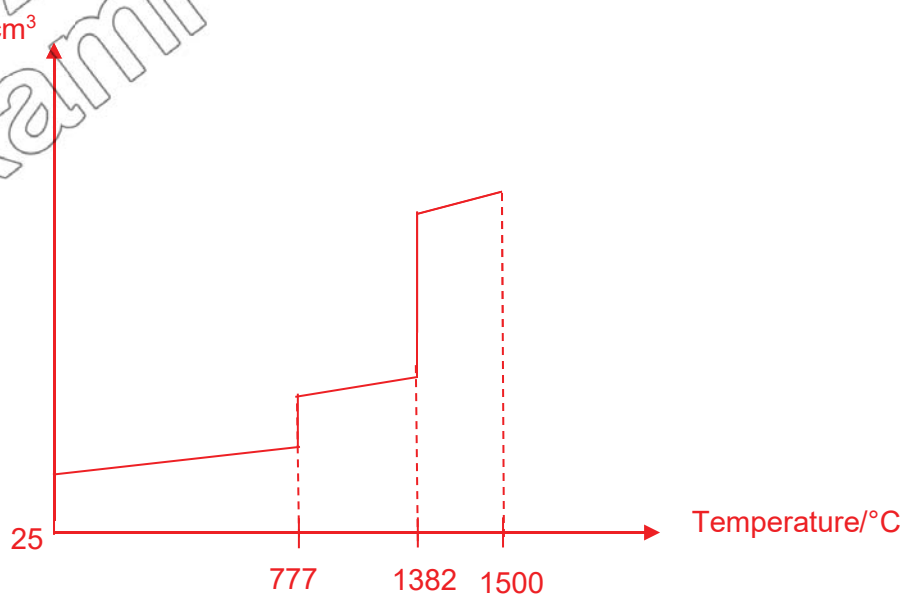
(b)

A_r of Z = $\frac{(10 \times 86) + (7 \times 87) + (83 \times 88)}{100}$ [1]

= 87.7 (3sf) [1]

(c) **(i)** There was a change in state from liquid to gas.
The particles moved faster in all directions / randomly [1]
and were spaced further apart / large spaces between particles. [1]

(ii)



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The vertical line at 1382 must be longer than that at 777.
All the 3 values (777, 1382 and 1500) must be indicated clearly.

A5

Substance 1	NaOH / sodium hydroxide	[1]
Substance 2	Na_2CO_3 / sodium carbonate	[1]
Substance 3	$BaCO_3$ / barium carbonate	[1]
Substance 4	Zn / zinc	[1]
Substance 5	HCl / hydrochloric acid	[1]
Substance 6	$CuSO_4$ / copper(II) sulfate	[1]
Substance 7	H_2SO_4 / dilute sulfuric acid	[1]
Substance 8	NH_4Cl / ammonium chloride	[1]

A6

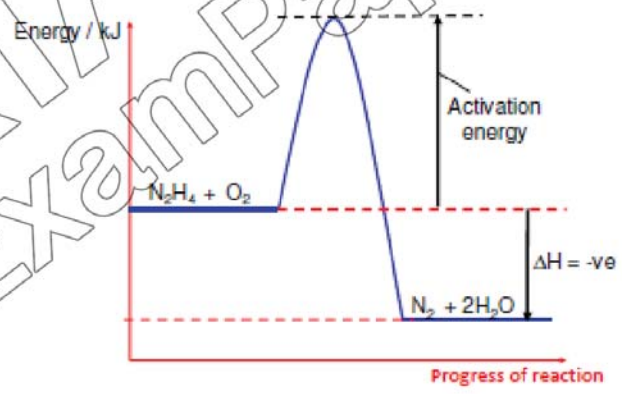
(a) The only products of the combustion are nitrogen and water vapour which are components of clean air. [1]

(b) [3]

- The products have stronger bonds. [no marks]
- The total energy absorbed during the breaking of bonds in N_2H_4 and O_2 is less than the the total energy released during the forming of bonds in N_2 and H_2O
- as reaction of hydrazine with oxygen is an exothermic reaction. [1]

[1] for idea that energy absorbed during bond breaking is less than energy released released during bond forming
[1] correct relation of substances in bond breaking and bond forming

(c) [2]



[1] for correct energy profile

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[1] for labeled axes, reactants, products, activation energy & ΔH

(d) **(i)** No of moles of hydrazine
= 10 / (14x2 + 4)
= 0.313 [1]

Volume of oxygen in air
= 21% x 50
= 10.5 dm^3

No. of moles of oxygen
= 10.5/24
= 0.438 [1]

Mole ratio of O_2 : N_2H_4
1 : 1
0.438 : 0.438

Since 0.438 moles of N_2H_4 is required and only 0.313 moles is available, N_2H_4 is the limiting reagent and is completely used up and hence, underwent complete combustion. [1]

[3]

(ii) 0.313 moles of hydrazine releases 194 kJ of energy
1 mole of hydrazine releases 194/ 0.313 [1]
= 621 kJ

Hence, ΔH = - 621 kJ/mol [1]

[2]

A7 **(a)** Mercury, nickel , zinc , magnesium [1]

(b) **(i)** Solution changes from green to colorless. [1] [2]

Silvery solid is formed. [1]

(ii) $Mg\ (s) + Ni^{2+}\ (aq) \rightarrow Mg^{2+}\ (aq) + Ni\ (s)$

[2]

[1] for balanced ionic equation
[1] for state symbols

(c) **(i)** $Zn + H_2O \rightarrow ZnO + H_2$ [1]

(ii) Silvery solid is formed. [1] [2]

Nickel(II) oxide has been reduced to grey solid nickel by hydrogen [1]

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Paper 2 Section B

B8 **(a)** The density of main group metals, potassium and calcium, are lower (0.9 g/cm^3 and 1.5 g/cm^3 respectively) than the transition metals (ranges from 4.5 g/cm^3 to 8.9 g/cm^3) or vice versa. [1m with quoted data from table]

The melting points of the main group metals, potassium and calcium, (64^{o}C and 842 ^{o}C) are lower than that of the transition metals (1084 ^{o}C and above/ranges from 1084 ^{o}C to 1917 ^{o}C) [1m with quoted data from table]

(b)

- For potassium, the solution remains colourless but for iron, the solution changes from colourless to green.
- Potassium took a shorter time to disappear than iron.
- The rate of effervescence for potassium with dilute hydrochloric acid is greater as compared with iron.

Any 2 observations [2m]

(c) The oxidation states exhibited by the elements increase from titanium with 3 different oxidations states to manganese with 6 different oxidations states and then decreases from manganese to copper with 2 different oxidation states.

1 mark for correct trend + quoted evidence

(d) Potassium and calcium has a fixed number of valence electrons of 1 and 2 respectively and lose their valence electrons

to achieve a stable octet configuration/noble gas configuration [1m].

This explains why they have only one oxidation state at +1 and +2 respectively.

(e) $Mn(NO_3)_2 \rightarrow MnO_2 + 2NO_2$ [1]

$Mn(NO_3)_2$ is oxidised to MnO_2 as the oxidation state of manganese increases from +2 to +4. [1]

$Mn(NO_3)_2$ is reduced to NO_2 as the oxidation state of nitrogen decreases from +5 to +4. [1]

Since oxidation and reduction occurs simultaneously, this a redox reaction.

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(f) **(i)** Under high temperature, the nitrogen and oxygen in the air of car engine reacts to form oxides of nitrogen.

(ii) The largest contributor of 40% to the production of NOx is road transport. Hence we can,

- Fit catalytic converters in the exhaust pipes of cars
- Reduce vehicular activity by encouraging greener transportation activities such as public transport and cycling

Any 1

(iii) NO_x dissolve in rain water and react with oxygen to form acid rain which leads to:

- weathering of limestone buildings and metal structures.
- causing soil to be acidic and leaches nutrients from soil, resulting in poor plant growth, damaging trees and forests
- water being acidic and destroying aquatic life

Any one impact.

B9 **(a)** Both has a giant tetrahedral arrangement. OR
There are strong covalent between atoms in both silicon dioxide and diamond. [1]

Silicon dioxide is made of silicon and oxygen atoms covalently bonded together whereas diamond is made up of only carbon atoms covalently bonded together. [1]

(b) Graphite. [correct but no marks]

Each carbon atom in graphite uses only 3 out of its 4 valence electrons for covalent bonding. There is one delocalized electron form each carbon atom which is free to move to carry electric charges whereas

there are no free electrons in silicon dioxide to carry electric charges. [1]

(c) **(i)**

silicate	soda-lime glass
Has regular arrangement of atoms/ arranged in hexagonal rings	Has irregular arrangement of atoms /ions
Absence of ions	Presence of calcium/ sodium ions
All the oxygen atoms are each covalently bonded to 2 silicon atoms	Some oxygen atoms are covalently bonded to only one silicon atom

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Contains covalent bonds	Contains covalent and ionic bonds

Any one difference

(ii) It is not able to conduct electricity in the solid state but is able to conduct electricity in the molten state. [1] ***[Reject aqueous state]***

In the solid state, the calcium and sodium ions are in fixed positions and are not free to move to conduct electricity.[1]

In the molten state, the ions are free to move to conduct electricity. [1]

B10 Either

(a) The ratio of each metallic element to oxygen across period 3 decreases from 2:1 to 2:3 from sodium to aluminium.

(b) Na_2O, MgO and Al_2O_3 has a giant ionic lattice structure. Large amount of energy is needed to overcome the strong electrostatic forces of attraction between the oppositely charged ions. [1] Thus they have a high melting and boiling point.

SiO_2 has a giant molecular structure. Large amount of energy is needed to overcome the strong covalent bond between the silicon and oxygen atoms. [1] Thus it has a high melting and boiling point.

Oxides of P, S and Cl have a simple molecular structure. Small amount of energy is needed to overcome the weak intermolecular forces of attraction/weak van der waals forces between molecules. [1] Thus they have a low melting and boiling point.

if ans does not relates to m.p and b.p minus 1m

(c) SO_3 has a higher melting and boiling point compared to SO_2 because it has a higher relative molecular mass [1]
Thus the intermolecular forces of attraction is stronger. More energy is needed to overcome it. [1]

(d) **(i)** 2;2;2;
3;3;3

(ii) The radii of anions are generally larger than that of cations
+ quoted evidence from table eg average radii of cation vs anions [1]

as anions consist of 1 more electron shells [1] compared to cations.

Thus radii of anions are generally larger.

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(ii) Argon has a stable electronic configuration/stable octet configuration and thus do not gain or lose electrons to form ions/ chemically unreactive/inert [1] and will not affect the radius.

B10 OR

(a) Across period 3, the ratio of each element to chlorine decreased from 1:1 in NaCl to 1:4 in $SiCl_4$ respectively [1]
and then increased from 1:3 to 1:1 in PCl_3 to S_2Cl_2. [1]

(b) **(i)** Silicon tetrachloride or silicon(IV) chloride or $SiCl_4$
(ii) $PCl_3 + 3H_2O \rightarrow H_3PO_3 + 3\ HCl$

(c) The information supports the idea of student 2 but not student 1.

The information supports student's 2 idea as covalent chlorides formed from aluminium to sulfur hydrolyse [1] whereas ionic chlorides like those of sodium and magnesium only dissolve. [1]

The information does not support student 1 as chlorides of both metals like aluminium and non-metals from silicon to sulfur hydrolyse. [1]

(d) Based on the information in the table, if a chloride has hydrolysed, dilute hydrochloric acid will be produced.
Hence, a pH level lower than 7 will mean that the chloride has hydrolysed. [1]
If the chloride is not hydrolysed, the pH remains at 7. [1]

(e) Argon has a attain a stable electronic configuration of 8 electrons in the outermost shell/ stable octet configuration.
Hence, it is chemically unreactive/inert and will not react with chlorine to form a chloride.

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