KENT RIDGE SECONDARY SCHOOL
MID-YEAR EXAMINATION 2017

SCIENCE (CHEMISTRY) **5076**

SECONDARY 3 EXPRESS

Tuesday 9 May 2017 **1 hour 15 minutes**

Name: ____________________________( ) **Class: Sec** __________

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number clearly in the spaces provided at the top of this page.

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

Section A
There are **ten** questions. 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 the table on page 6.

Section B
Answer **all** questions.
Write your answers in the spaces provided in the question paper.

Section C
Answer any **two** questions.
Write your answers in the spaces provided in the question paper.

FOR EXAMINER'S USE	
Section A	10
Section B	20
Section C	
Q...........	10
Q...........	10
Total	50

At the end of exam, enter the numbers of the **Section C** questions you have answered in the grid above.

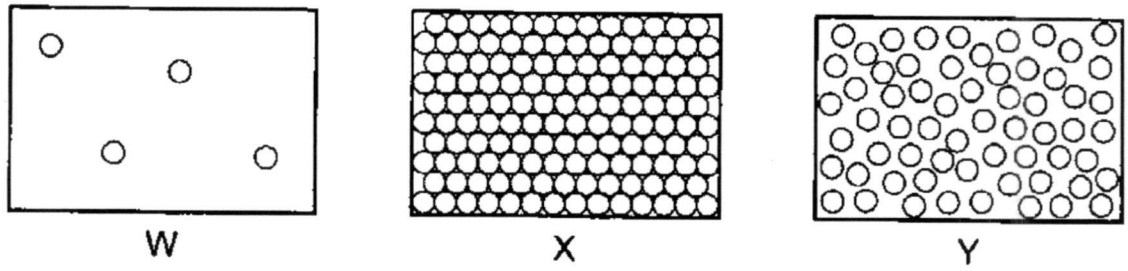
The number of marks is given in brackets [ ] at the end of each question or part of question.

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

Section A

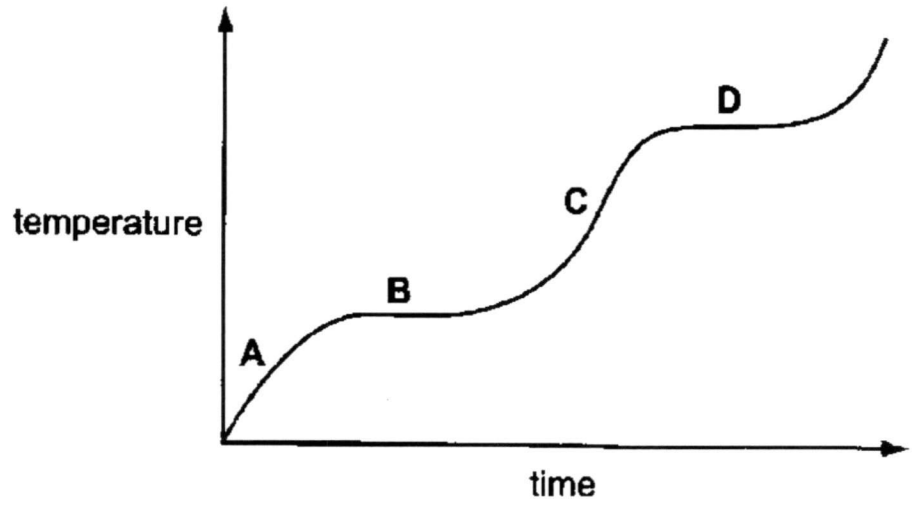
The total mark for this section is 10.

1 Diagrams W, X and Y show how the particles of a substance are packed at different temperatures.



The graph shows the temperature changes which occur on warming the substance.

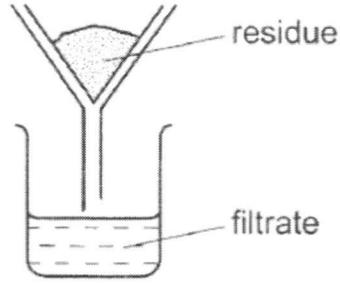
In which region of the graph would **all** the particles be packed as in Y?



2 The table below shows the colours and the solubilities in water of four solids.

solid	colour	solubility in water
W	blue	insoluble
X	blue	soluble
Y	white	insoluble
Z	white	soluble

A mixture containing two of the solids is added to excess water, stirred and filtered.
A blue filtrate and a white residue are obtained.



Which two solids are present in the mixture?

A W and X

B W and Y

C X and Y

D X and Z

3 Which of the following is likely to be a pure compound?

A a white crystal powder which dissolves in water

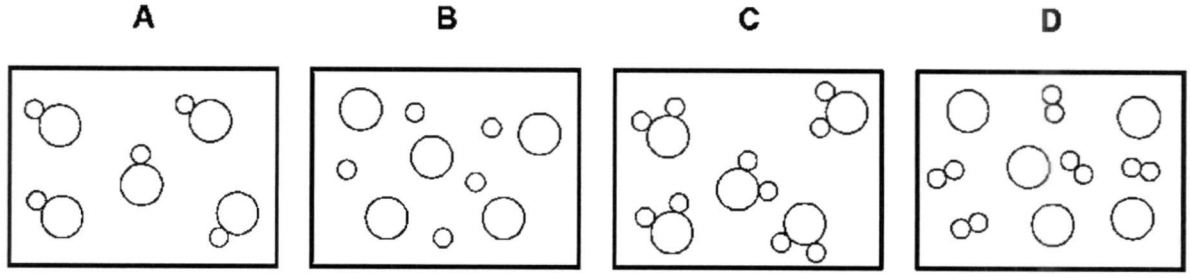
B green crystals which melt at 58 °C

C blue crystals which melt over the range 55 °C to 60 °C

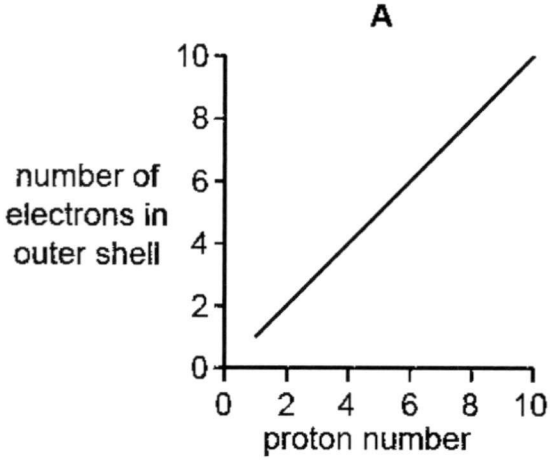
D a liquid which gives two fractions when distilled

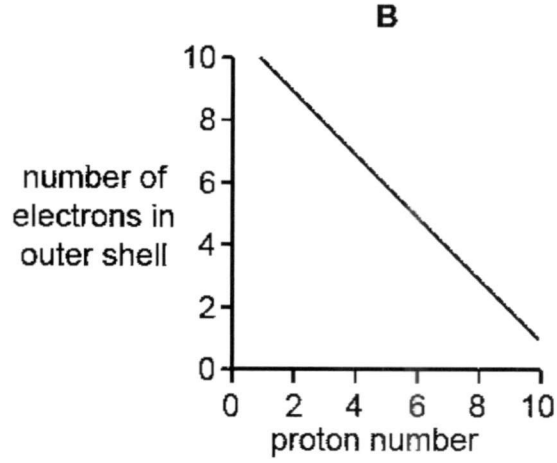
4 In the diagrams, circles of different sizes represent atoms of different elements.

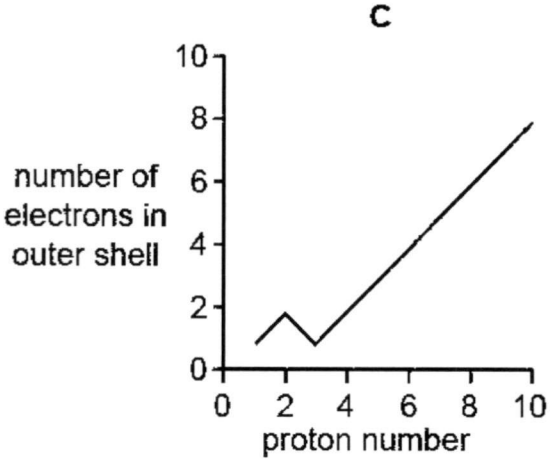
Which diagram represents water vapour?

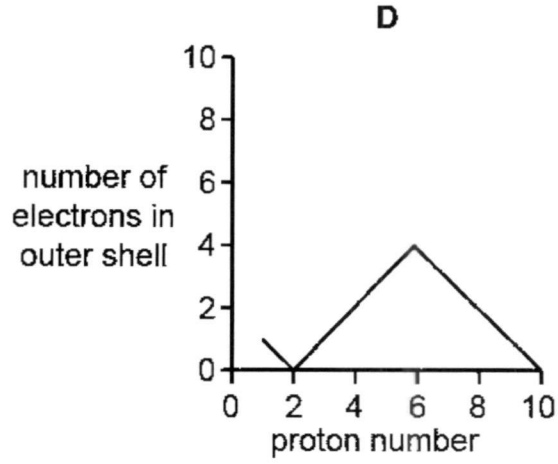


5 Which graph shows the number of electrons in the outer shell of an atom, plotted against the proton (atomic) number for the first ten elements in the Periodic Table?





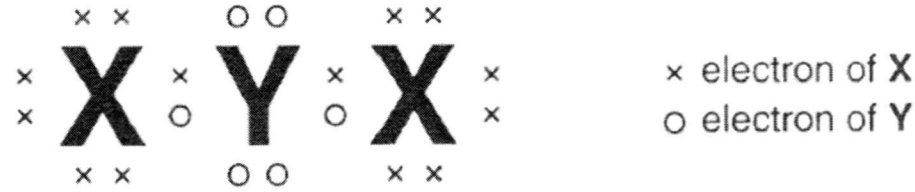




6 Which row represents an ion?

	number of protons	number of neutrons	number of electrons
A	1	0	1
B	3	4	3
C	6	6	6
D	11	12	10

7 The structure of a molecule, X_2Y is shown.



What are elements X and Y?

	X	Y
A	fluorine	carbon
B	fluorine	oxygen
C	nitrogen	carbon
D	nitrogen	oxygen

8 In which line do all the atoms or ions have eight electrons in their outer shells?

A F^-, Na^+, Mg^{2+}

B H^+, Na^+, Ne

C F^-, He, Mg^{2+}

D Li^+, He, Ne

9 What is the formula of aluminium oxide?

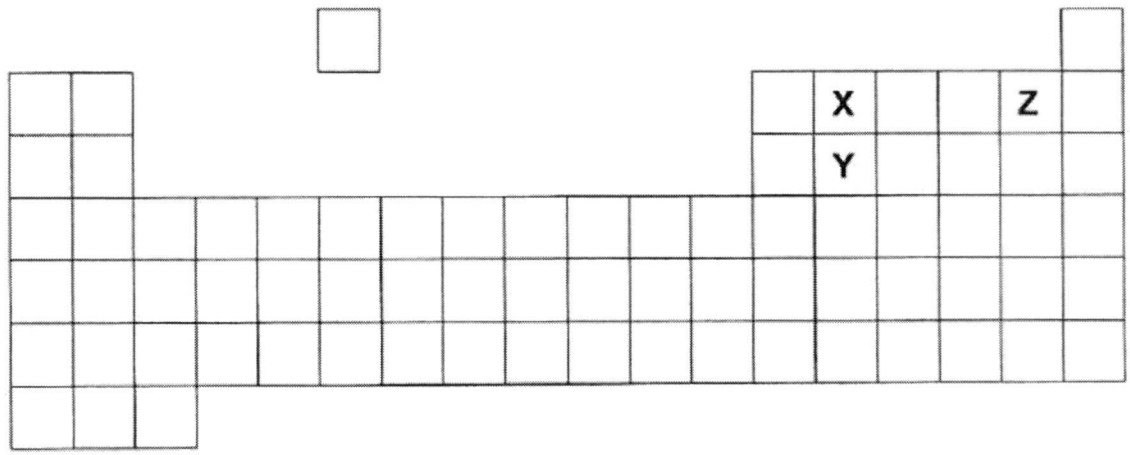
A AlO

B Al_2O_2

C Al_2O_3

D Al_3O_2

10 The chart shows part of the Periodic Table. The elements X, Y and Z all have proton (atomic) numbers of less than 20.



Which statement is correct?

A The proton number of X is the same as that of Z.

B The proton number of Z is three more than that of X.

C The proton number of Y is one more than that of X.

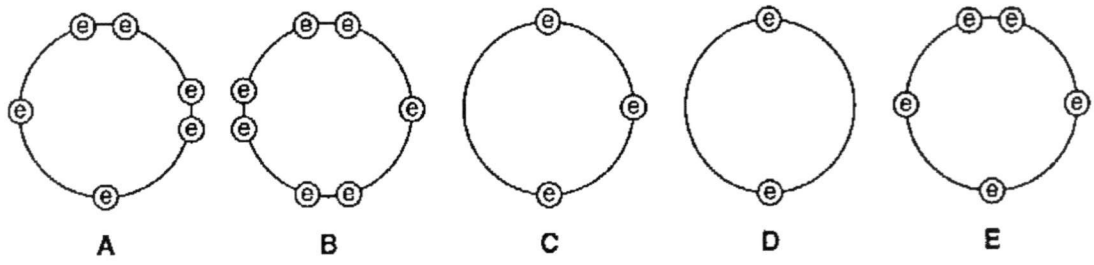
D The proton number of Y is eight less than that of X.

Question Number	1	2	3	4	5	6	7	8	9	10
Answer										

Section B

The total mark for this section is 20.

1 These diagrams show the electron arrangement in the outer shells of five elements, **A** to **E**. All elements are from Period 3 of the Periodic Table.



Use the letters **A** to **E** to answer the following questions.

You may use each letter once, more than once or not at all.

(a) Which elements are most likely to be metals?

_____ [1]

(b) Which element has an atomic number of 13?

_____ [1]

(c) Which element will form two covalent bonds when it forms a compound?

_____ [1]

(d) Which two elements will form an ionic compound with the formula of the type XY_2?

_____ [1]

2 Most substances can be placed into only one of the five groups listed in the table.

group	letter
element	**A**
compound	**B**
mixture of elements	**C**
mixture of compounds	**D**
mixture of elements and compounds	**E**

Which of the groups, A, B, C, D and E, best describes each of the following substances?

Air .....

Brass .....

Hydrogen .....

Sodium fluoride ..... [2]

3 Carbon disulfide, CS_2, is a covalent compound used in manufacturing polymers and fibres.

(a) Draw a 'dot-and-cross' diagram to show the bonding in carbon disulfide.

Show the outer shell electrons only.

[Proton numbers: C, 6; S, 16]

[2]

(b) Using your understanding of bonding and structure, which of these statements would you predict to be true and which would you predict to be false?

Put a tick (✓) in one box in each row.

	true	false
Carbon disulfide has a low boiling point.		
Carbon disulfide has good electrical conductivity when molten.		
Carbon disulfide is very soluble in water.		
Carbon disulfide is a crystalline solid at room temperature.		

[2]

(c) Sulfur react with magnesium to form an ionic compound called magnesium sulfide.

Draw 'dot-and-cross' diagrams to show the arrangement of outer shell electrons and charges in a magnesium ion and a sulfide ion.

[Proton numbers: Mg, 12; S, 16]

[2]

4 This table shows information about some ions in seawater.

name	formula	percentage by mass in sea water / %
chloride	Cl^-	55
	Na^+	31
sulfate		8
magnesium		4
calcium	Ca^{2+}	1.5
other ions	various	

(a) Complete the table by filling in the boxes. [2]

(b) When sea water evaporates, the ions crystallise out as ionic solids.

(i) Give the name and formula of the ionic solids that would form in **the largest amount** from this sea water.

name _____ formula _____ [2]

(ii) Explain your reasoning.

_____

_____ [1]

(iii) Give the name and formula of one **other** ionic solid that would form when the sea water evaporates.

name _____ formula _____ [2]

(c) Drinking water can be extracted from sea water.

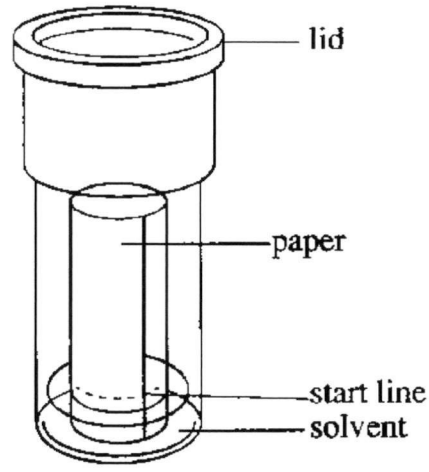
Give the name of a process by which drinking water is extracted from sea water.

_____ [1]

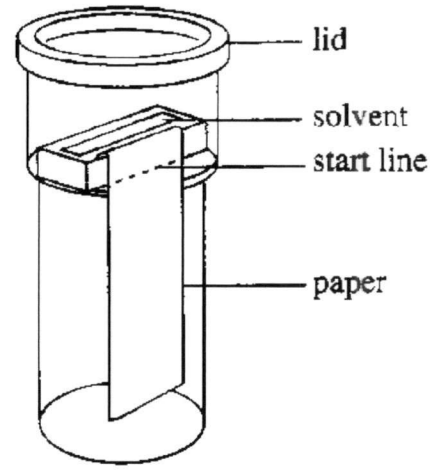
Section C

The total mark for this section is 20.
Answer any **two** questions.

5 The diagrams show two methods for paper chromatography. In the ascending method, the solvent travels up the paper whereas in the descending method, the solvent flows down the paper.



ascending method



descending method

(a) (i) Which method allows the solvent to travel faster? Give a reason to support your answer.

[1]

(ii) For the ascending method, the starting line must be above the solvent level. Why is this so?

[1]

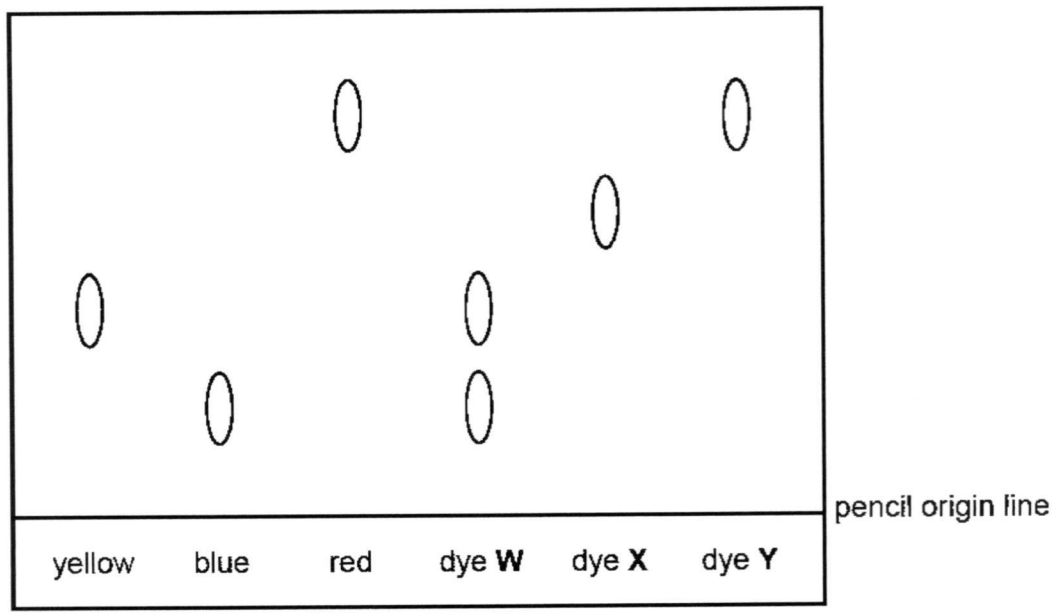
(iii) For both the ascending and descending methods, the container is covered with a lid. Why is this necessary?

[1]

(iv) Longer sheets of paper can be used in the descending method as compared to the ascending method. Why is the use of a longer piece of paper often preferred?

[1]

(b) The diagram shows a paper chromatogram obtained from three banned coloured dyes and three unknown dyes **W**, **X** and **Y** used in food.



(i) Explain why the origin line on the chromatography paper is drawn using a pencil rather than a pen.

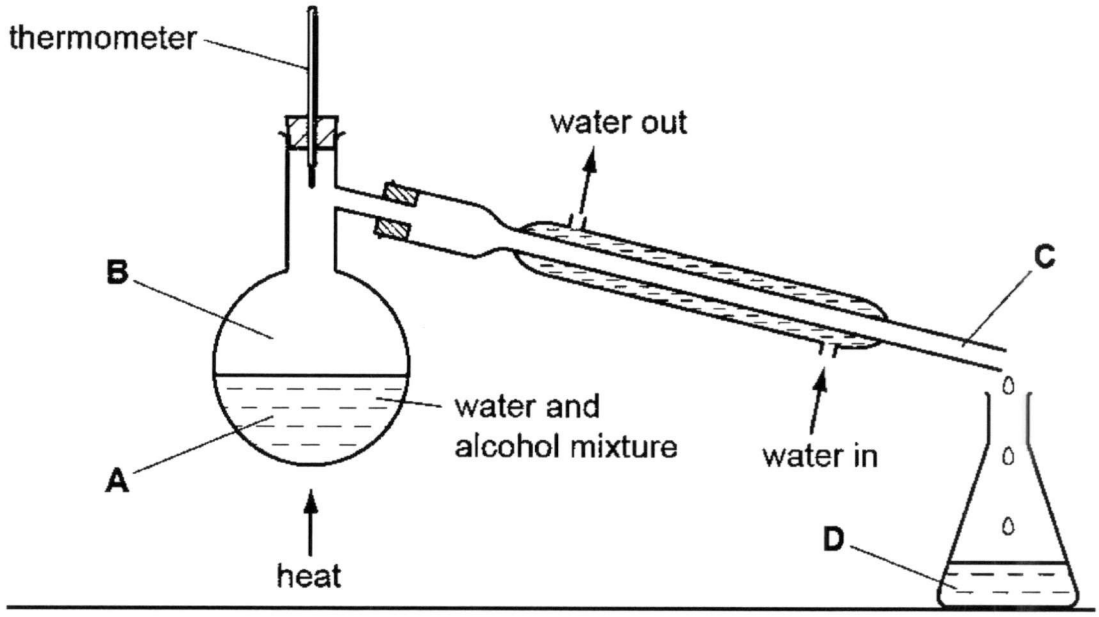
[1]

(ii) Which of the unknown dyes **W**, **X** or **Y** is pure and could be safe to be used in food substance?

Explain your answer.

[1]

(c) The diagram shows a mixture of water and alcohol being separated by distillation. The boiling point of alcohol is 78 °C.



(i) Draw in the boxes below to show the arrangement of particles at **B** and **C**.

[2]

Particles at **B** Particles at **C**

(ii) Explain, using Kinetic Particle Theory, what happens to the particles in **A** when it is heated from room temperature to 100 °C.

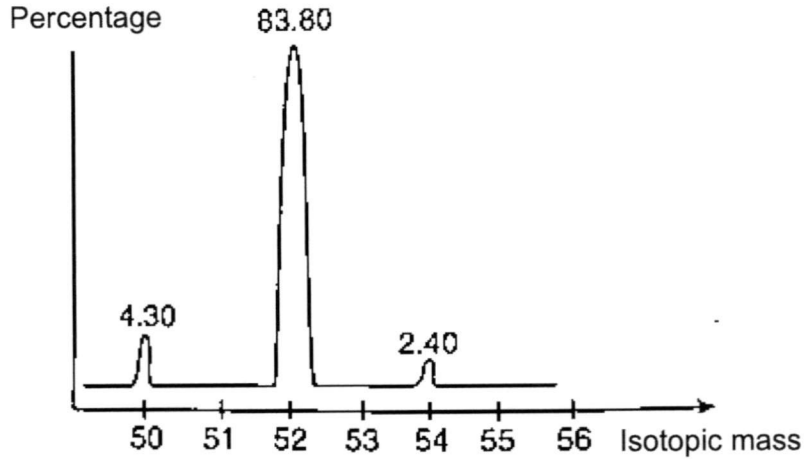
.....

.....

.....

[2]

6 **(a)** An element X has an atomic number of 24 and a relative atomic mass of 52.06.The natural element consists of four isotopes. The mass spectrum of the element X produced the following peaks of three of the isotopes on the chart recorder.



(i) Identify element X.

[1]

(ii) Define the term 'isotopes'.

[1]

(iii) Calculate the percentage abundance of the fourth isotope of element X.

[1]

(iv) Given the isotopic mass of the fourth isotopes is 53.03, draw a peak for the 4^{th} isotope on the mass spectrum shown. [1]

(ii) Element X has a relative atomic mass of 52.06. Explain why the relative atomic mass of element X is not a whole number.

[1]

(b) The radii of atoms and ions can be measured. The tables show some information about atomic radii and ionic radii of some Group I and Group VII elements.

element	number of shells of electrons in atom	atomic radii / pm	number of shells of electrons in +1 charged ion	ionic radii / pm
lithium	2	152		68
sodium	3	185		98
potassium	4	227		133

element	number of shells of electrons in atom	atomic radii / pm	number of shells of electrons in -1 charged ion	ionic radii / pm
fluorine	2	71		133
chlorine	3	99		181
bromine	4	115		196

(1 000 000 000 000 pm = 1 m)

(i) Complete the table to show the number of shells of electrons in the ions of Group I and Group VII elements. [2]

(ii) Suggest why the radius of a lithium atom changes in this way when it forms a lithium ion.

[1]

(iii) Draw diagrams to show the arrangement of electrons in a lithium atom and a lithium ion to support your answer in **(b)(ii)**.

lithium atom	lithium ion

[2]

7 The Periodic Table contains an element with proton number 9 and another element with proton number 17.

(a) Identify and name these **two** elements and the group of the Periodic Table in which they are positioned.

[3]

(b) Give the electronic structures of these two elements. Use these to explain why both elements appear in the same group of the Periodic Table.

[3]

(c) Elements with proton number 9, 17 and 35 are in the same group of the Periodic Table. For these **three** elements, suggest **two** similarities in their properties and **two** trends in their properties.

[4]

END OF PAPER

The Periodic Table of Elements

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

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

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

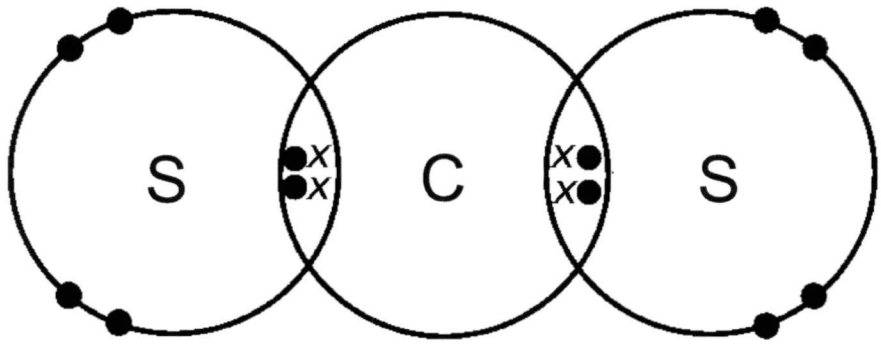
KENT RIDGE SECONDARY SCHOOL
Secondary 3 Express
Mid-Year Examination 2017
SCIENCE (CHEMISTRY)
Mark Scheme

Section A (10 marks)

Question Number	1	2	3	4	5	6	7	8	9	10
Answer	C	C	B	C	C	D	B	A	C	B

Section B [40 marks]

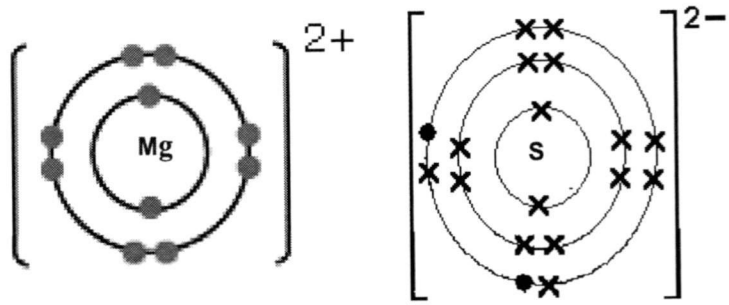
<table>
<tr><th colspan="2">S/No.</th><th>Answers</th><th>Marks</th></tr>
<tr><td>1</td><td>(a)</td><td>C and D</td><td>1</td></tr>
<tr><td></td><td>(b)</td><td>C</td><td>1</td></tr>
<tr><td></td><td>(c)</td><td>A</td><td>1</td></tr>
<tr><td></td><td>(d)</td><td>B and D</td><td>1</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td><table><tr><td>air</td><td>E</td></tr><tr><td>brass</td><td>C</td></tr><tr><td>hydrogen</td><td>A</td></tr><tr><td>sodium fluoride</td><td>B</td></tr></table></td><td>2

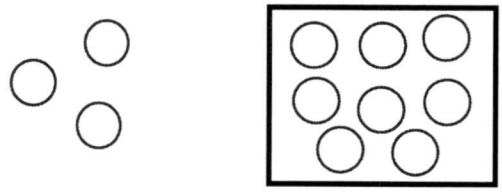
4 correct: 2 m
3–2 correct: 1 m
1–0 correct: 0 m</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>(a)</td><td> 

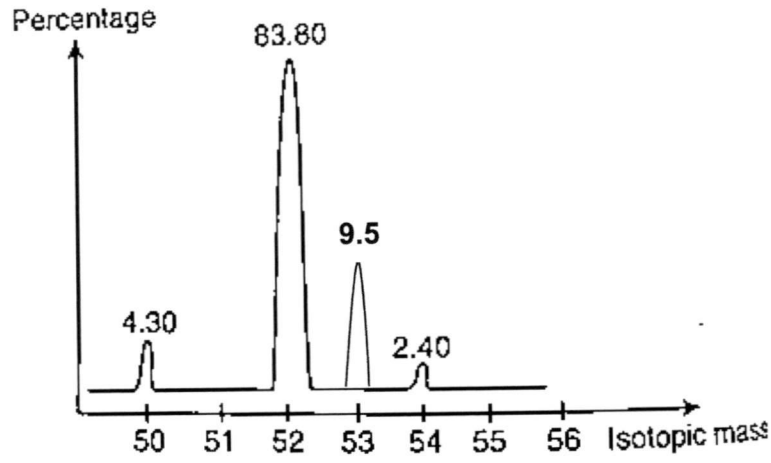
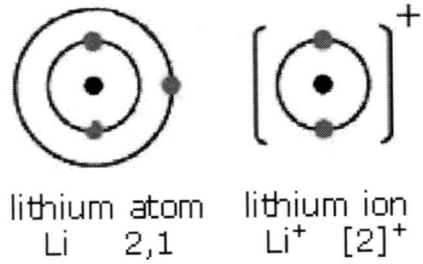
allow: all electrons shown</td><td>1- correct number of electron in valence shell

1- correct pair of shared electrons</td></tr>
<tr><td></td><td>(b)</td><td><table><tr><th></th><th>true</th><th>false</th></tr><tr><td>Carbon disulfide has a low boiling point.</td><td>✓</td><td></td></tr><tr><td>Carbon disulfide has good electrical conductivity when molten.</td><td></td><td>✓</td></tr><tr><td>Carbon disulfide is very soluble in water.</td><td></td><td>✓</td></tr><tr><td>Carbon disulfide is a crystalline solid at room temperature.</td><td></td><td>✓</td></tr></table></td><td>1 mark for every 2 correct answers

Max 2</td></tr>
</table>

	(c)		1- correct charge 1- correct valence electrons Max 2
4	(a)	<table><tr><th>name</th><th>formula</th><th>percentage by mass in sea water / %</th></tr><tr><td>chloride</td><td>Cl^-</td><td>55</td></tr><tr><td>sodium</td><td>Na^+</td><td>31</td></tr><tr><td>sulfate</td><td>SO_4^{2}</td><td>8</td></tr><tr><td>magnesium</td><td>Mg^{2+}</td><td>4</td></tr><tr><td>calcium</td><td>Ca^{2+}</td><td>1.5</td></tr><tr><td>other ions</td><td>various</td><td>0.5</td></tr></table>	1 mark for every 2 correct answers Max 2
	(b)(i)	sodium chloride; NaCl	2
	(b)(ii)	The percentage by mass of sodium and chloride ion is the highest / most. **allow:** 1. answer quoted value of the percentage of ions in and showed understanding of having the largest percentage 2. percentage by mass of sodium chloride is the highest/most **reject:** only quote percentage mass of either sodium or chloride ion as the highest	1
	(b)(iii)	Accept any answer: Sodium sulfate; Na_2SO_4 Calcium chloride; $CaCl_2$ Magnesium chloride; $MgCl_2$	2 Name: 1m Formula: 1m

		Calcium sulfate; $CaSO_4$ Magnesium chloride; $MgSO_4$ **allow:** sodium chloride; NaCl, if students did not write this in part (a)	
	(c)	Distillation **accept:** Simple distillation / desalination	1
5	**(a)(i)**	Descending method, Solvent in <u>flowing</u> down in the <u>direction of gravity</u> **allow** : solvent is <u>flowing</u> down / gravity pulls the solvent/ink down / indication of gravity's effect on the speed of the results **reject**: stating 'gravity' <u>without explanation</u>.	1
	(a)(ii)	This is to prevent the ink/dye on the starting line from <u>dissolving back into the solvent</u>	1
	(a)(iii)	To prevent the <u>loss of solvent due to evaporation</u> **allow**:solvent is volatile / solvent has a low bp	1
	(a)(iv)	Spots from the ink/dye will <u>travel over a longer distance</u> as the flow of the solvent is in the direction of gravity **accept**: a greater/better separation between the spots in the descending method	1
	(b)(i)	Pencil marking is <u>insoluble in the solvent</u> (and hence will not affect the accuracy of the results) ORA Allow: if student did not mention solvent	1
	(b)(ii)	Dye **X** , it is a pure substance with a <u>single spot</u> ___ <u>not contain any of the banned coloured dyes</u>.	1
	(c)(i)	 Particle at B Particle at C	2
		As temperature increase, particles at A, <u>gain energy</u> and <u>move faster</u>. When suffiecient energy is gained, the particles <u>overcome the strong forces of attraction between molecules</u> and move <u>further apart</u> in all direction to form a gas structure.	1 1
6	**(a)(i)**	Chromium **Allow:** Cr	1

	(a)(ii)	Isotopes are atoms of the same element, with the same number of protons and electrons but different number of neutrons.	1
	(a)(iii)	Percentage = 100% - 4.30 – 83.80 – 2.40 = 9.5 %	1
	(a)(iv)		1 (ecf)
	(a)(v)	The <u>average</u> of the <u>mass</u> of all the <u>isotopes</u>.	1
	(b)(i)	Group I: 1 ; 2; 3 Group VII: 2, 3, 4	1 1
	(b)(ii)	Lithium ion has a smaller radii, as lithium atom loses 1valence electron to form a lithium ion.	1
			1 – each Max 2
7	**(a)**	Fluorine and Chlorine Group VII Reject: incorect spelling	2 1

		Reject: Group 7	
	(b)	Fluorine: 2, 7 Chlorine: 2, 8, 7 Both belongs to Group VII as they have 7 valence electrons **Allow**: Both need to gain 1 electron to achieve a completely filled valence shell	1 1 1
	(c)	Similarities [any 2] - Coloured substance - Reactive non-metals - Toxic substances - "These elements" with low mp /bp - Made up of diatomic molecules - Atomic structure with 7 valence electrons / form ion of charge -1 **reject**: non-metals / halogens/ Group VII Trends [any 2] - Reactivity decreases down the group - Colour of their element darkens down the group - Mp/bp increases down the group **allow**: down the group, state of elements changes from gas to liquid to solid, [only if student did not describe trends in mp/bp] statements that describe changes	2 (1 mark each) 2 (1 mark each)

END OF PAPER