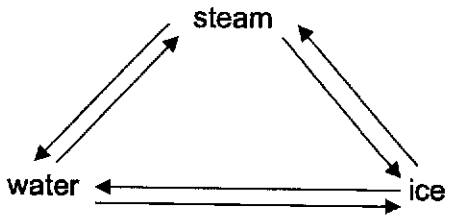
21 In which conversion do H_2O molecules lose speed?



A ice → water
B ice → steam
C steam → water
D water → steam

22 A student was asked to carry out the following steps in an experiment:

Step **I** : Hold about 200 cm^3 of solution **X**.
Step **II** : Transfer 25.0 cm^3 of solution **X** into a conical flask.
Step **III** : Add 34.60 cm^3 of aqueous hydrochloric acid into the conical flask.

Which row lists the most suitable piece of apparatus for each of the above three steps?

	Step I	Step II	Step III
A	beaker	pipette	burette
B	beaker	burette	pipette
C	conical flask	pipette	measuring cylinder
D	measuring cylinder	burette	measuring cylinder

23 Methanol boils at 65°C and water boils at 100°C. Methanol and water are completely miscible with each other.

Which method is used to separate a mixture of these two liquids?

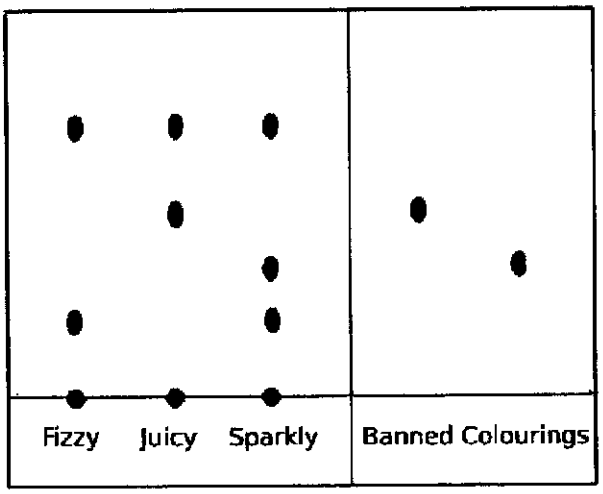
A evaporation
B filtration
C fractional distillation
D paper chromatography

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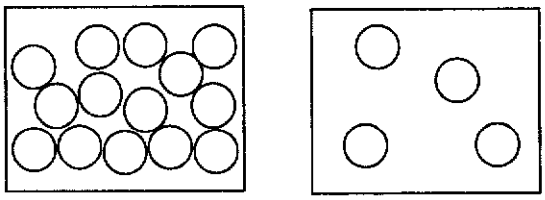
24 The chromatogram below shows three drinks, *Fizzy*, *Juicy* and *Sparkly*, analyzed for any banned colourings.



Which of the drinks contain banned colourings?

A Fizzy and Juicy
B Fizzy and Sparkly
C Juicy and Sparkly
D Sparkly only

25 The diagram below shows the particles of hexane at atmospheric pressure but at two different temperatures. Hexane melts at –95°C and boils at 70°C.



What could be the values of **X** and **Y**?

	X	Y
A	–100	0
B	–50	10
C	0	100
D	10	–50

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26 An element **Y** has two isotopes, ^{238}**Y** and ^{235}**Y**.

How does ^{238}**Y** differ from ^{235}**Y**.

A It has 3 more protons.
B It has 3 more neutrons.
C It has 3 more protons and 3 more electrons.
D It has 3 more neutrons and 3 more electrons.

27 Which ions are present in Cu_2SO_4?

A Cu^{2+}, S^{6+} and O^{2-}
B Cu^{2+} and SO_4^{2-}
C Cu^{+} and SO_4^{2-}
D Cu^{2+} and SO_4^{-}

28 Why does molten sodium chloride conduct electricity?

A Electrons in the sodium chloride are free to move.
B Sodium ions are strongly attracted to the chloride ions.
C The sodium ions and the chloride ions are free to move.
D Electrons in the valence shell of sodium atoms are transferred to chlorine atoms.

29 20 cm^3 of ethene is reacted with 30 cm^3 of hydrogen to form ethane gas. The equation for the reaction is shown.

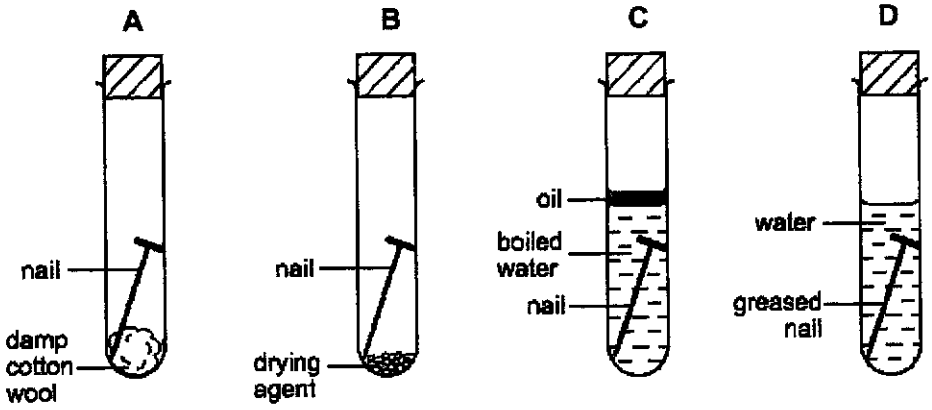
$$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$$

What is the volume of each of the gases at the end of the reaction?
(all volumes measured at r.t.p)

	volume of C_2H_4 / cm^3	volume of H_2 / cm^3	volume of C_2H_6 / cm^3
A	0	0	50
B	0	10	20
C	10	0	10
D	0	10	50

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30 In which test-tube is the iron nail most likely to rust?



31 Which statement is **not** true about an alloy?

A An alloy is a mixture.
B An alloy may contain a non-metal.
C The chemical properties of an alloy are similar to the elements that form it.
D The physical properties of an alloy are similar to the elements that form it.

32 Which reaction is a redox reaction?

A $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$
B $Ag^+ + Cl^- \rightarrow AgCl$
C $2SO_2 + O_2 \rightarrow 2SO_3$
D $MgO + 2HCl \rightarrow MgCl_2 + H_2O$

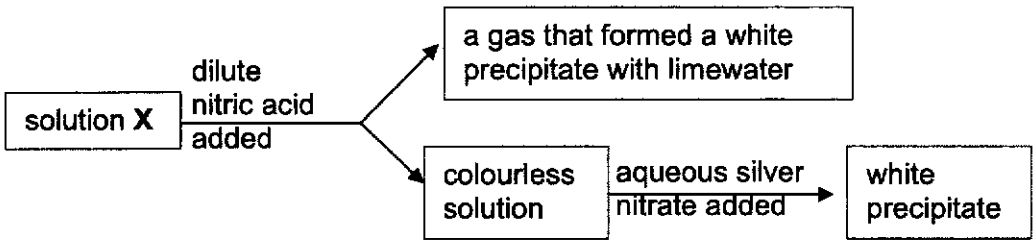
33 An oxide of element **V**, reacts with both dilute hydrochloric acid and sodium hydroxide solution to form salt and water.

Which row describes **V** and its oxide?

	V	**V** oxide
A	metal	basic
B	metal	amphoteric
C	non-metal	amphoteric
D	non-metal	acidic

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34 The diagram shows a reaction scheme for solution **X**.

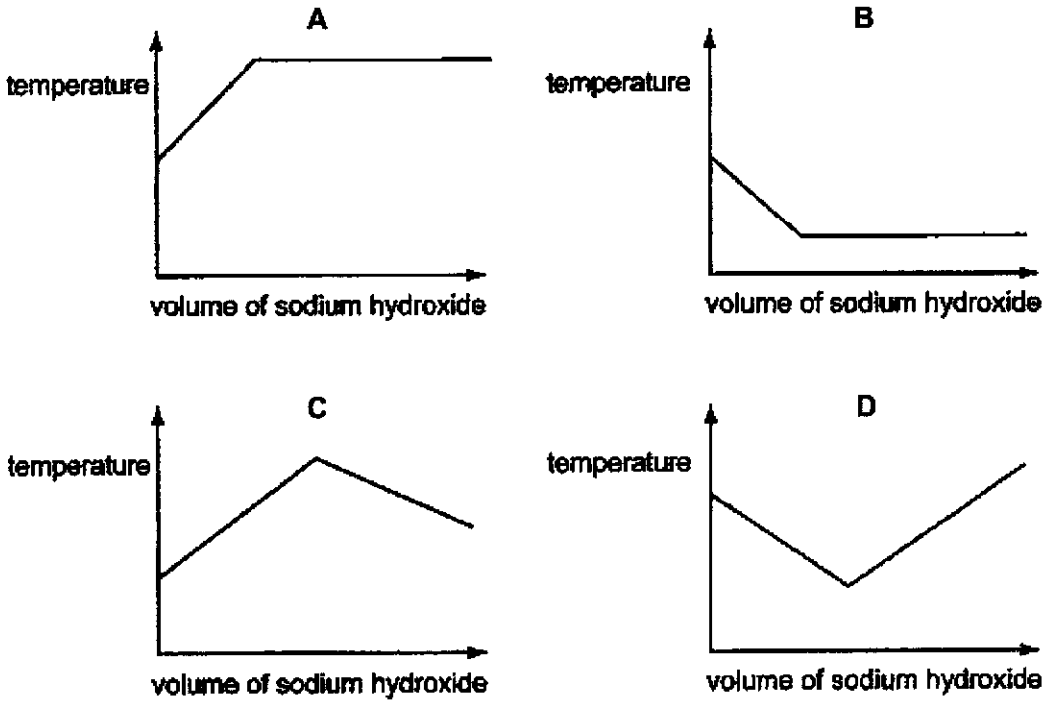


What is(are) the anion(s) in solution **X**?

A sulfate
B carbonate
C carbonate and sulfate
D carbonate and chloride

35 Aqueous sodium hydroxide and dilute hydrochloric acid are reacted together. The reaction is exothermic. Both the solutions are initially at room temperature.

Which graph shows how the temperature changes when aqueous sodium hydroxide is added to dilute hydrochloric acid until the alkali is present in excess?



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36 Metals **W**, **X**, **Y** and **Z** are placed in salt solutions as shown in the table.

metals	result of placing metal in solution of			
	salt of **W**	salt of **X**	salt of **Y**	salt of **Z**
W	no reaction	**X** displaced	**Y** displaced	no reaction
X	no reaction	no reaction	no reaction	no reaction
Y	no reaction	**X** displaced	no reaction	no reaction
Z	**W** displaced	**X** displaced	**Y** displaced	no reaction

What is the order of reactivity of the metals from most reactive to least reactive?

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

37 Which substance represents a metal?

	state at room temperature	melting and boiling point	malleability	conduction of heat and electricity
A	liquid	low	non-malleable	poor
B	solid	high	malleable	good
C	solid	high	malleable	poor
D	solid	low	non-malleable	good

38 A student tests four solutions with Universal Indicator.

solution	**P**	**Q**	**R**	**S**
colour with universal indicator	purple	green	red	yellow

What are the pH values of the four solutions?

	P	**Q**	**R**	**S**
A	2	9	4	7
B	4	7	8	9
C	9	5	12	2
D	12	7	2	5

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39 Part of the Periodic Table is shown.

Period	Group								
	I	II		III	IV	V	VI	VII	O
1									
2	V	W						X	
3	Y							Z	

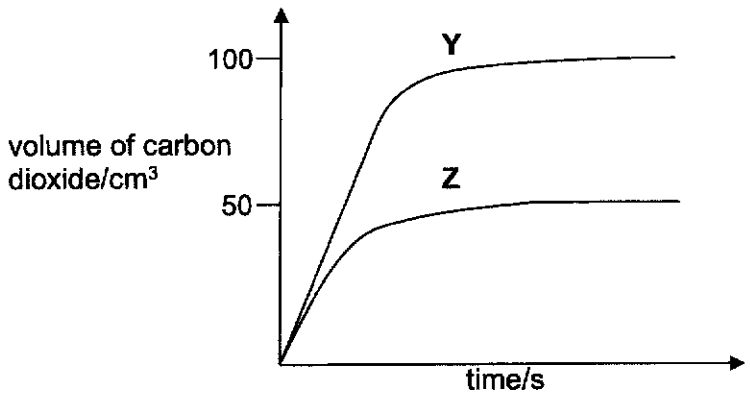
The letters are not the symbols of the elements.

Which statement is correct?

A **V** is more reactive than **Y**.
B **W** has more metallic character than **V**.
C **Y** has a higher melting point than **V**.
D **Z** is less reactive than **X**.

40 Some crystals of magnesium carbonate were added to an excess of sulfuric acid at room temperature. The volume of carbon dioxide produced was measured over a period of time. The results are shown in graph **Y**.

The experiment was repeated and graph **Z** was obtained.



Which change was used to obtain the results shown in graph **Z**?

A Using a lower temperature.
B Half the mass of magnesium carbonate was used.
C Larger crystals of magnesium carbonate were used.
D Acid of the same volume and half the original concentration was used.

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Data Sheet

Colours of Some Common Metal Hydroxides

calcium hydroxide	white
copper(II) hydroxide	light-blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
lead(II) hydroxide	white
zinc hydroxide	white

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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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Section A (45 marks)

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

1 Iron is extracted from iron ore in the Blast Furnace.

The equations **A**, **B**, **C**, **D** and **E** show some reactions that happen in the Blast Furnace.

A $C + O_2 \rightarrow CO_2$

B $CO_2 + C \rightarrow 2CO$

C $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

D $CaCO_3 \rightarrow CaO + CO_2$

E $SiO_2 + CaO \rightarrow CaSiO_3$

Use the letters **A**, **B**, **C**, **D** and **E** to answer the following equations. You may use each letter once, more than once or not at all.

(a) Which equation shows combustion?

..... [1]

(b) Which equation shows thermal decomposition?

..... [1]

(c) Which equation shows a reaction between an acidic compound and a base?

..... [1]

(d) Which equation shows the formation of a toxic gas?

..... [1]

(e) Which equation shows a redox reaction?

..... [1]

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2 Carbon disulfide is a simple covalent compound used in manufacturing polymers and fibres.

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

Show the valence shell only.

[2]

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

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

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

[2]

(c) **(i)** Sulfur reacts with magnesium to form an ionic compound called magnesium sulfide. Draw a 'dot-and-cross' diagrams to show the arrangement of outer shell electrons in its ions and its charges.

magnesium ion sulfide ion [2]

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(ii) Explain in terms of bonding, why magnesium sulfide has a high melting and boiling point.

.....

.....

..... [2]

3 The rate of reaction between dilute hydrochloric acid and sodium thiosulfate solution can be investigated using a cross drawn on a piece of paper as shown in Figure 3.1.

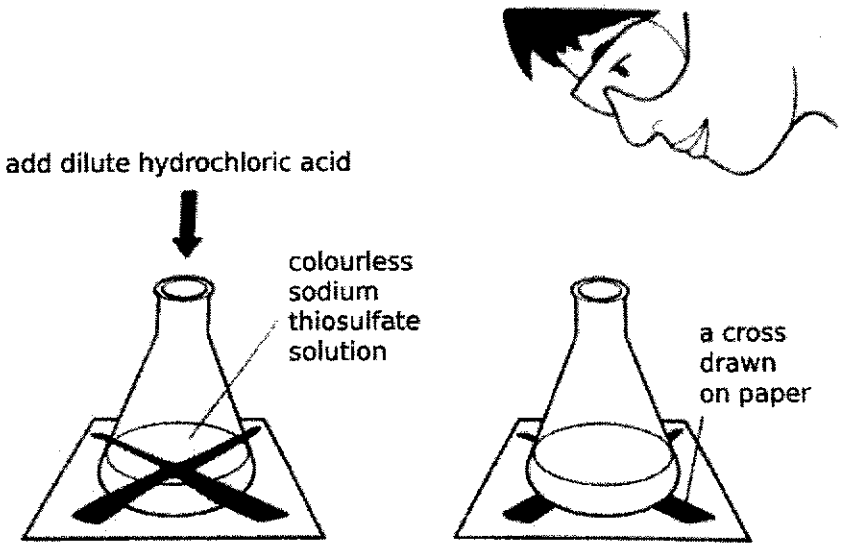


Figure 3.1

As the reaction progresses, it becomes more difficult to see the cross through the solution.

(a) Look at the equation for the reaction.

$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + S(s) + SO_2(g) + H_2O(l)$

Explain why it becomes more difficult to see the cross as the reaction progresses.

.....

.....

..... [2]

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(b) Table 3.1 shows the results of an experiment to investigate the rate of reaction using different concentrations of sodium thiosulfate solutions.

A student measured the time from when the acid was added until the cross can no longer be seen.

Table 3.1

Concentration of $Na_2S_2O_3$ / mol/dm^3	Time taken until cross cannot be seen / s
1.0	8
0.8	10
0.4	20
0.2	39

(i) How does the rate of reaction changes with the decrease in concentration of sodium thiosulfate solution?

..... [1]

(ii) Use ideas about collisions between particles to explain the trend given in part **(b)(i)**.

.....

.....

..... [2]

(iii) State two variables that needed to be kept constant in order to make it a fair experiment.

.....

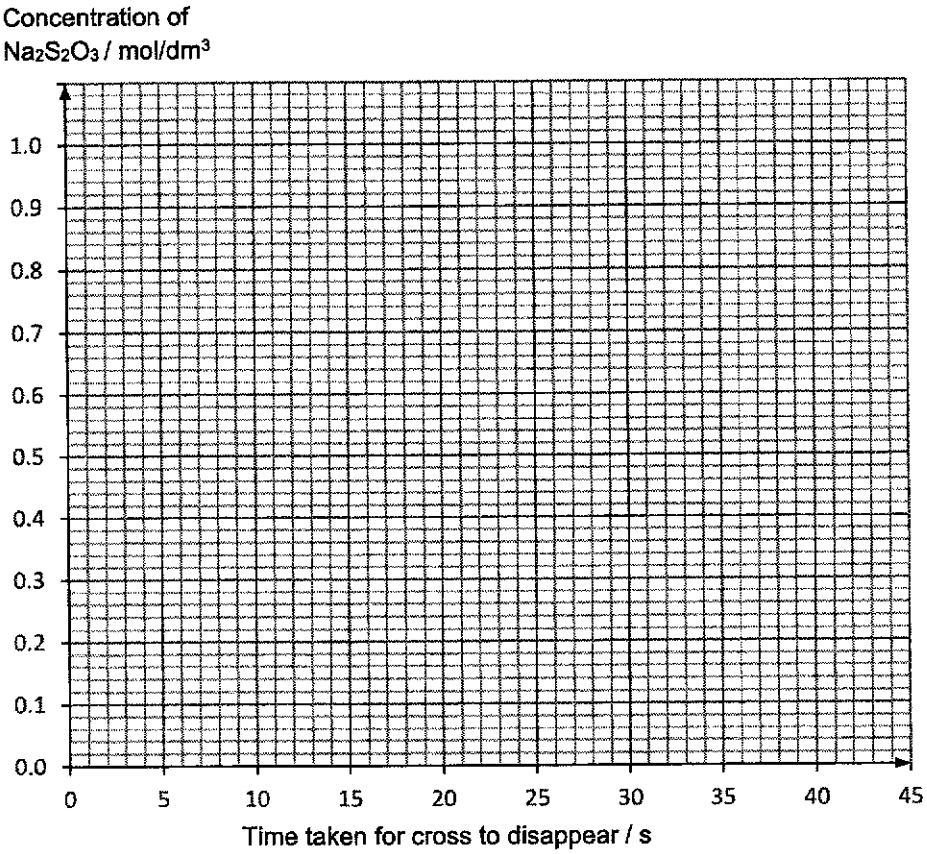
..... [1]

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(iv) Using the results obtained in Table 3.1, plot a graph of concentration of sodium thiosulfate against time taken until the cross cannot be seen.

(v) Draw a best fit curve through the points.



[2]

(vi) The experiment was repeated with another concentration of sodium thiosulfate.

The cross could not be seen after 14 s. From your graph in part **(iii)**, suggest the concentration of sodium thiosulfate that was used.

Concentration of sodium thiosulfate : ..... mol/dm^3 [1]

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4 Cars have catalytic converters fitted to reduce the problems caused by some of the exhaust gases. Figure 4.1 shows some of the gases that enter and leave a catalytic converter.

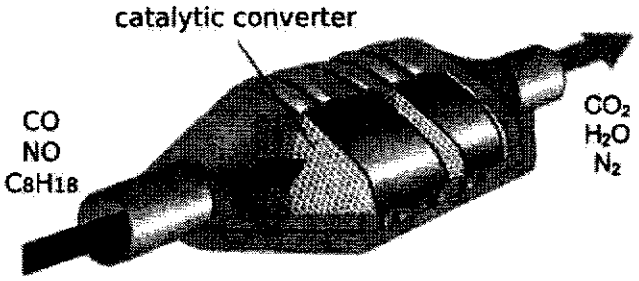


Figure 4.1

(a) Carbon monoxide and nitrogen monoxide react in the catalytic converter as shown by the equation below.

$$2CO + 2NO \rightarrow 2CO_2 + N_2$$

Complete Table 4.1 to show the oxidation states of carbon and nitrogen in the reactants and products of the reaction.

Circle the keywords to reach the correct conclusion of the oxidation and reduction of carbon and nitrogen in this reaction.

Table 4.1

	Oxidation state in reactants	Oxidation state in products	Conclusion
carbon	+2		Carbon in carbon monoxide is <u>oxidised / reduced</u> as its oxidation state <u>increased / decreased</u>.
nitrogen		0	Nitrogen in nitrogen monoxide is <u>oxidised / reduced</u> as its oxidation state <u>increased / decreased.</u>

[4]

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(b) Briefly describe the harmful effects of nitrogen oxides and carbon monoxide.

nitrogen oxides : .....

.....

.....

carbon monoxide : .....

.....

..... [2]

(c) Petrol contains mainly octane, C_8H_{18} which is the main pollutant of unburnt hydrocarbons in exhaust gases of cars. Octane is converted to carbon dioxide and water in the catalytic converters as well as shown by the equation below.

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

(i) Calculate the relative molecular mass of octane.
[Relative atomic masses, A_r : C, 12 ; H, 1]

M_r of octane = ... [1]

(ii) 132g of octane is found in the exhaust gases of an old car. Calculate the number of moles of octane.

number of moles of octane = ... [1]

(iii) Calculate the number of moles of oxygen needed to react with 132g of octane.

number of moles of oxygen = ... [1]

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5 The flow chart in Figure 5.1 shows some reactions of dilute sulfuric acid. Five unknown substances **V**, **W**, **X**, **Y** and **Z** are shown in the chart.

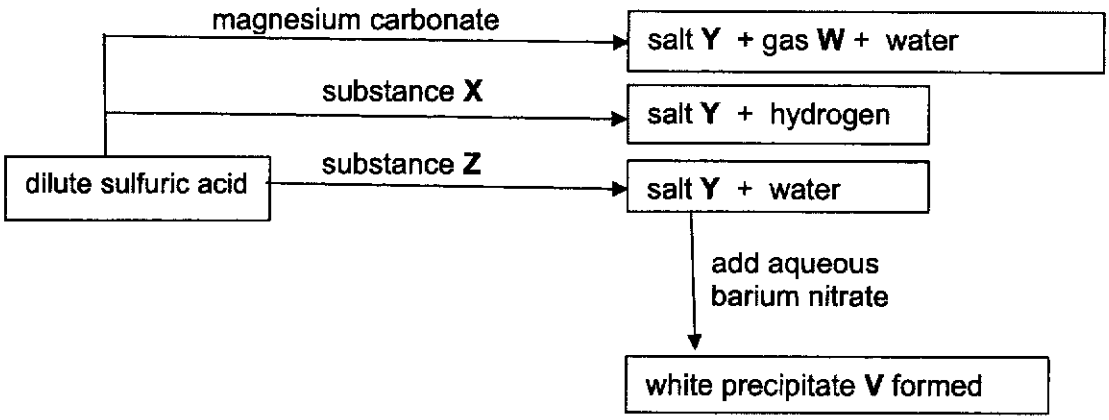


Figure 5.1

(a) Suggest the identities of substances **V**, **W**, **X**, **Y** and **Z**

(i) **V** .....

(ii) **W** .....

(iii) **X** .....

(iv) **Y** .....

(v) **Z** ..... [5]

(b) Write an ionic equation with state symbols for any one of the reaction in the flowchart.

..... [2]

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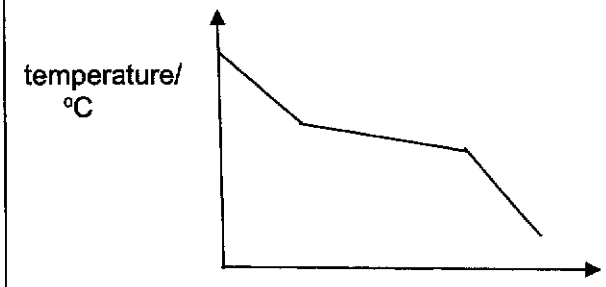
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6 (a) Figure 6.1 shows five boxes describing two solids, two liquids and a gas.

F
When a magnet is passed over a grey powdered solid **F**, some of the powder is attracted to the magnet

G
Liquid **G** is the only chemical formed when hydrogen burns in oxygen.

H
The curve resulted when cooling liquid **H**



I
Solid **I** will not conduct electricity when it is a solid but melts at a fixed temperature to become a conductor.

J
All the atoms in a molecule of gas **J** are identical.

placing a tick (✓) in the appropriate column in the table below.

substances	element	compound	mixture
F			
G			
H			

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I			
J			

[5]

(b) Describe fully two differences between a compound and a mixture.

difference 1 : .....

.....

.....

difference 2 : .....

.....

..... [2]

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Section B (20 marks)

Answer any **two** questions in this section. Write your answers in the spaces provided.

7 Sodium has a proton number 11.

(a) The Periodic Table lists the elements in groups and periods. An inspection of the electronic structure or configuration of an element's atom can give its group and period. Explain using sodium as an example.

.....

.....

..... [3]

(b) Sodium and potassium have similar chemical reactions. Describe two of these similar reactions by referring to their reactants and the type of products they form.

Write a chemical equation for one of the reactions using any one of the two metals. Include state symbols.

.....

.....

.....

.....

..... [4]

(c) Sodium and neon are from two different groups in the Periodic Table and thus have very different chemical reactivity. State the names of the groups they belong to and use their electronic structures to explain the difference in reactivity.

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.....

.....

.....

[3]

.....

8 Not all atoms of chlorine are identical. All chlorine atoms have the same chemical properties but they can have different masses.

(a) State the name given to different atoms of the same element.

..... [1]

(b) Explain why different atoms of chlorine can have different masses but have the same chemical properties?

.....

.....

..... [2]

(c) The different masses of the chlorine atoms are averaged out to arrive at the *relative atomic mass* of chlorine which is 35.5.

(i) Define the term *relative atomic mass.*

.....

..... [1]

(ii) Chlorine–35 and chlorine–37 are the two major isotopes of chlorine. The table below shows their percentage abundance.

	chlorine–35	chlorine–37
percentage abundance / %	75	25

By using these values, show your working to calculate the relative atomic mass of chlorine.

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[1]

(d) Draw the electronic structure of an atom of chlorine–35. Show in your structure the number of protons and neutrons as well.

[3]

(e) Chlorine reacts with carbon monoxide to produce phosgene gas with the formula $COCl_2$.

$$Cl_2(g) + CO(g) \rightarrow COCl_2(g)$$

Calculate volume of phosgene than can be produced if 142g of chlorine was used. [Relative atomic masses, A_r : C, 12 ; O, 16; C*l*, 35.5]

[2]

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9 **(a)** Pure crystals of sodium sulfate can be made from a solution of sodium sulfate.

Describe the process of preparing this solution using a solution of sodium hydroxide and an acid.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

(b) Calculate the mass of sodium hydroxide contained in 250 cm^3 of a solution of sodium hydroxide of concentration of 2.0 mol/dm^3.
[Relative atomic masses, A_r : Na, 23 ; O, 16; H, 1]

.....

.....

..... [2]

(c) Write the ionic equation with state symbols that describes the neutralisation of any alkali by any acid.

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..... [2]

END OF PAPER
Data Sheet

Colours of Some Common Metal Hydroxides

calcium hydroxide	white
copper(II) hydroxide	light-blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
lead(II) hydroxide	white
zinc hydroxide	white

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The Periodic Table of Elements

Group I	II											III	IV	V	VI
						1 H hydrogen 1									
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32
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
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
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 –
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 darmstadium –	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
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 –

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

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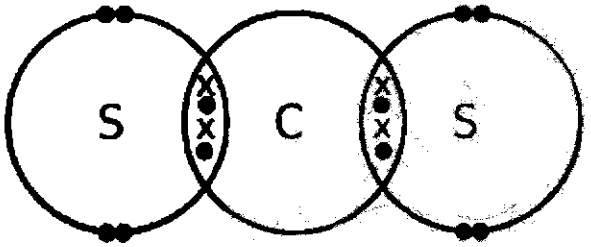
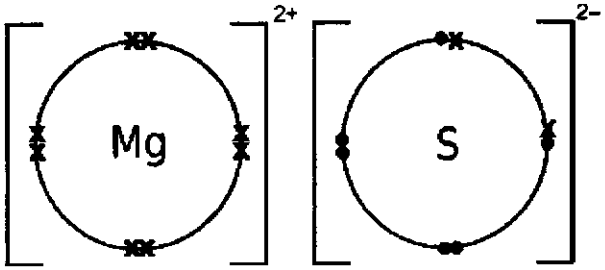
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Sec 4E/5N Science Chemistry Preliminary Exam 2021
Answer Scheme

Paper 1 - MCQ Answers

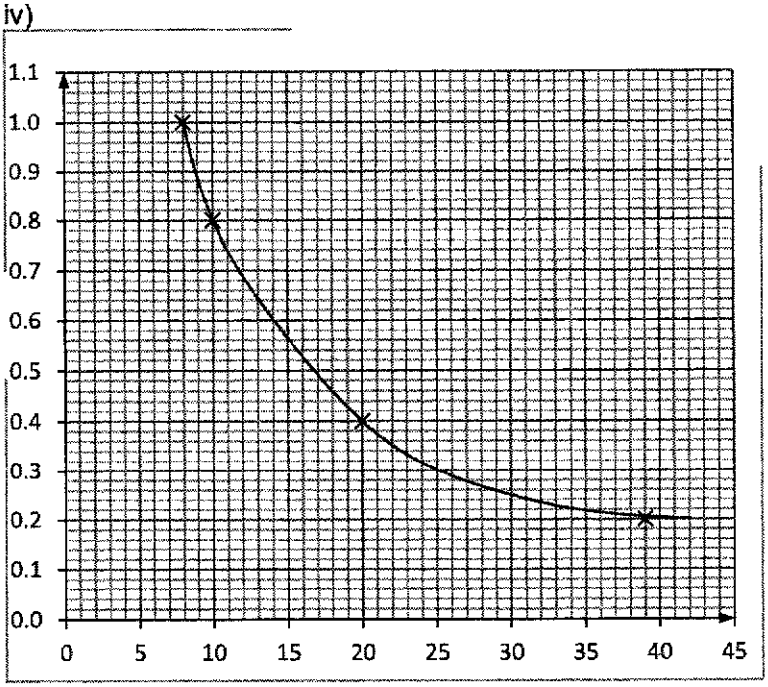
21. C	22. A	23. C	24. C	25. C	26. B	27. C	28. C	29. B	30. A
31. D	32. C	33. B	34. D	35. C	36. C	37. B	38. D	39. D	40. B

Paper 3 - Section A – Structured Questions

		Answers	Mark	Remarks for markers
1	a)	A	1M	
	b)	D	1M	
	c)	E	1M	
	d)	B	1M	
	e)	A, B or C	1M	
2	a) –		2M	Formula for CS_2 must be correct first to award any mark 1M for bonding electrons between C and S 1M for other electrons of S
	b)		2M	4 correct – 2M 2-3 correct – 1M 1 correct – 0M
	c)	i) 	2M	1M for each ion correctly drawn inclusive of charges 2M total If inner electrons are drawn, it must be correct, otherwise no mark is awarded Best practice : 2 crosses for sulfur (or vice versa) should be denoted that it came from magnesium (but marks can be awarded if it's all drawn using the same symbol)

	True	False
……..low boiling point	✓	
…. very soluble in water		✓
…..good electrical conductivity when molten		✓
….. crystalline solid at room temperature		✓

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		ii) It has a high melting and boiling point as it has strong electrostatic forces of attraction between oppositely charged ions. Thus it requires a lot of energy to overcome them.	1M 1M	
3	**a)**	Sulfur is formed and is an insoluble solid. Thus as more sulfur is formed, it blocks the cross from being seen/obscures the cross (OWTTE)	1M 1M	[idea of solid formed] [idea of blocking/covering cross]
	b)	i) It (Rate of reaction) decreases (as concentration decreases)	1M	Words in brackets not necessary as it's mentioned in the question.
		ii) lower concentration → less reactant particles per unit volume/in a given volume lower frequency of effective collisions	1M 1M	
		iii) any 2 temperature of acid/thiosulfate solution volume of acid volume of thiosulfate solution concentration of acid	1M	*Temperature* **or** *temperature of surroundings. [Accepted]*
		iv)  		2M 1M for plots 1M for curve drawn (smooth curve)
		v) 0.55 to 0.6 mol/dm^3	1M	Any acceptable value based on a curve drawn.
4	**a)**	+4 - oxidised / increased +2 - reduced / decreased	4M	1M each for oxidation states 1M -both oxidised/increased 1M -both reduced/ decreased

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	b)	Forms acid rain → *any 1 harmful effect of acid rain* • leaches nutrients from the soil and harm plant growth • acidifies lakes (closed water bodies), streams, rivers and harm aquatic life • corrodes buildings and structures made of limestone and metals Or irritates the eyes/ cause breathing difficulties – irritate the lungs/throat / inflammation of the lungs/causes bronchities binds irreversibly/reacts with red blood cells(haemoglobin) and deprive them of oxygen can result if fatigue, headaches, feeling faint or even death	1M 1M	
	c)	i) 114	1M	
		ii) 1.16	1M	(ecf from part(i)-accepted)
		iii) 14.5	1M	(ecf from part(ii)-accepted)
5	**a)**	i) barium sulfate / $BaSO_4$	1M	
		ii) carbon dioxide / CO_2	1M	
		iii) magnesium / Mg	1M	
		iv) magnesium sulfate $MgSO_4$	1M	
		v) magnesium oxide / MgO OR magnesium hydroxide / $Mg(OH)_2$	1M	
5	**b)**	$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ OR $Mg(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$ $MgCO_3(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + CO_2(g) + H_2O(l)$ $MgO(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2O(l)$ $Mg(OH)_2(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + 2H_2O(l)$	1M	MgO and $Mg(OH)_2$ are taken as insoluble (due to their low solubility)
6	**a)**	<table><tr><th>substances</th><th>element</th><th>compound</th><th>mixture</th></tr><tr><td>F</td><td></td><td></td><td>✓</td></tr><tr><td>G</td><td></td><td>✓</td><td></td></tr><tr><td>H</td><td></td><td></td><td>✓</td></tr><tr><td>I</td><td></td><td>✓</td><td></td></tr><tr><td>J</td><td>✓</td><td></td><td></td></tr></table>	5M	1M for each tick
	b)	• A **mixture** has a **variable composition** of its **constituent substances** but a **compound has a fixed composition** of its **constituent elements**. - A mixture has a **variable ratio of its components** but the **elements in a compound are found in a fixed ratio**.		Keywords in bold are necessary to illustrate the concept Same point.

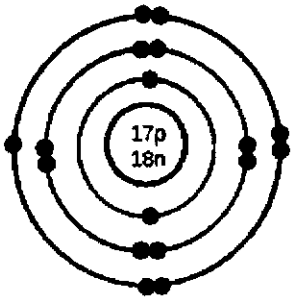
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		• No chemical reaction takes place when a mixture is formed but a chemical reaction takes place when a compound is formed from its elements. • The **chemical properties of a mixture** are the **same as its constituent substances**. The physical and **chemical properties of a compound are different from those of the elements** it is made up from. • A mixture has variable melting and boiling points but a compound has a fixed melting and boiling point. (this is an elaboration of point C) • The **components of a mixture** can be **separated by physical methods** but the **elements of a compound can only be separated by chemical methods** or reactions.		If student just compared chemical properties, did not state physical properties, its ok This is accepted as it is comparing physical properties.

Section B – Free – Response Questions

		Answers	Mark allocation	Remarks
7	a)	Sodium has an electronic configuration of 2,8,1. It has 1 valence electron and is in Group I. It has 3 electron shells and is thus in period 3	1M 1M 1M	
	b)	• Both of them react with water to form a metal hydroxide (or an alkali) and hydrogen gas. • Both of them react with oxygen to form metal oxides. • Both of them react with halogens to form metal halides. $2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$ OR $4K(s) + O_2(g) \rightarrow 2K_2O(s)$ $2K(s) + Cl_2(g) \rightarrow 2KCl(s)$	1M 1M 2M	 Eqn can be done with Na also 1M for correct and balanced equation 1M for state symbols
	c)	Sodium is from the group called Alkali metals. Neon is from the group called Noble gases. sodium atom is very reactive as its atom has 1 valence electron and it loses it easily *[to obtain a completely filled valence shell.]* Neon has a complete (or completely filled) valence shell and thus is unreactive. **does not need to be mention if a comparison to neon is done (with neon having a complete valence shell – linked to it being unreactive)*	1M 1M 1M	For both. Group I and 0 not accepted. The idea of reactivity/unreactive linked to incomplete/complete valence shells must be stated
8	a)	Isotopes	1M	
	b)	They have different masses as the atoms have different number of neutrons. They have the same chemical properties as they have the same number of valence electrons. (or 7 valence electrons.	1M 1M	

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	c)	i) Relative atomic mass is the **average** mass of an atom of the element as compared to 1/12th the mass of a carbon-12 atom.	1M	
		ii) $\frac{75}{100}$ x 35 + $\frac{25}{100}$ x 37 = 35.5	1M	
	d)		3M	1M for no. of protons 1M for no. of neutrons 1M for correct no. of shells and electrons (nucleus outline drawn or not doesn't matter)
	e)	Mr of Cl_2 = 71 No. of moles of Cl_2 = 142/71 = 2 Mole ratio > Cl_2 : $COCl_2$ 1 : 1 2 : 2 Volume of phosgene = 2 x 24 = 48 dm^3	 1M 1M	
9	**a)**	• Pipette 25.0cm^3 of sodium hydroxide solution into a conical flask. • Add a few drops of methyl orange indicator. • Titrate the sodium hydroxide solution with a solution of sulfuric acid from a burette. • Stop the titration when the indicator change colour. • Record the volume of acid used. • Repeat the titration using the volume of acid recorded without the indicator.	1M 1M 1M 1M 1M 1M	A suitable indicator. Universal indicator – Rej. Acid must be correct in order to award this mark If student reverse the substances in the conical flask/burette. It is also accepted.
	b)	No. of moles of sodium hydroxide = 0.250 x 2 = 0.5 Mass of NaOH = 0.5 x 40 = 20 g	1M 1M	
	c)	$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$	2M	1M for correct balanced eqn. 1M for state symbols

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