O

GAN ENG SENG SCHOOL
Preliminary Examination 2014

CANDIDATE NAME

CLASS **INDEX NUMBER**

CHEMISTRY

5073/01
9 May 2014
1 hour

Secondary 4 Express

Paper 1 Multiple Choice

Additional Materials: OTAS

Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

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

There are forty questions in this paper. Answer all questions. For each question there are four possible answers A, B, C, and D. Choose the one you consider correct and record your choice in soft pencil on the separate OTAS.

Read the instructions on the OTAS very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

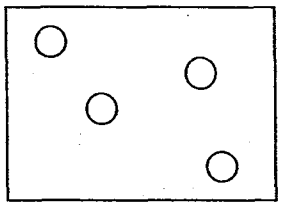
Any rough working should be done in this booklet.

A copy of the Periodic Table is on page 13.

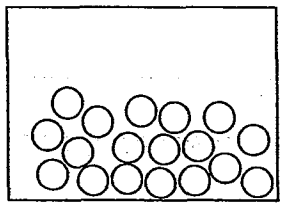
Total Marks
40

1 Diagrams **I**, **II** and **III** show the particles of three substances at room temperature and pressure.

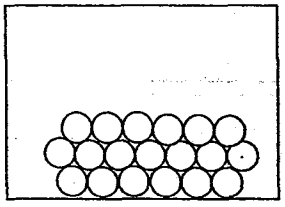
I



II



III



In which of the following are the substances corresponding to the diagram correctly?

	I	**II**	**III**
A	methane	sodium chloride	copper
B	ethanol	hydrogen chloride	dry ice
C	water	argon	mercury
D	helium	mercury	zinc

2 A student attempts to dry ammonia gas by using a drying agent. Which of the following is most suitable for use as a drying agent?

A calcium oxide
B concentrated sulfuric acid
C dilute sulfuric acid
D fused calcium chloride

3 A dye **X** melts at 50°C and boils at 105°C. It does not dissolve in water nor react with water. Which method is **most** suitable for separating **X** from a mixture of **X** and water?

A chromatography
B Filtration
C fractional distillation
D separating funnel

4 Which of the following statements about $^{32}_{15}P$ and $^{32}_{16}S$ are correct?

I The phosphorus atom has more neutrons than the sulfur atom.
II If a neutron is added to the nucleus of $^{32}_{15}P$, $^{32}_{16}S$ is produced.
III Both contain 32 electrons.

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

5 Strontium is used in fireworks to produce crimson flames. Naturally occurring strontium has three isotopes:

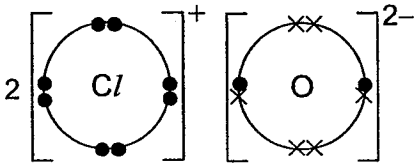
$$^{86}_{38}Sr\ (10\%);\ ^{87}_{38}Sr\ (7\%);\text{and}\ ^{88}_{38}Sr$$

What is the relative atomic mass of naturally occurring strontium?

A 38.0 **B** 87.0
C 87.7 **D** 88.0

6 Which one of the following best represents the bonding in the yellow-red gas of chlorine(I) oxide, Cl_2O?

A



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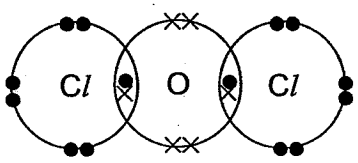
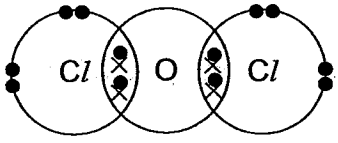
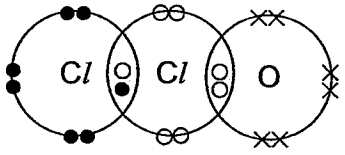


C



D



7 In 'dry ice' (solid carbon dioxide), what does the solid structure consist of?

A simple ions **B** atoms
C simple molecules **D** giant molecules

8 Four elements identified only as **W**, **X**, **Y** and **Z** are all found in the third period of the Periodic Table. Use the following information to determine the most likely order of arrangement of these elements from left to right in the third period.

I The atomic size of **Z** is less than that of **X**.
II The energy to remove the first electron from the atom of **Y** is greater than that from the atom of **Z**.
III **W** forms an ion which has a larger size than an atom of **W**.
IV **X**, **Y** and **Z** form ions which are smaller than their parent atoms.

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

9 Which pair of molecules has the same number of protons?

A O_2 and N_2 **B** SO_2 and CO_2
C CH_4 and NH_3 **D** NO_2 and Br_2

10 Which one of the following substances will cause a redox reaction with aqueous iron(II) sulfate?

A acidified aqueous potassium iodide **B** aqueous ammonia
C aqueous barium nitrate **D** oxygen

11 Which of the following is an example of a redox reaction?

A $2K_2CrO_4 + H_2SO_4 \rightarrow K_2Cr_2O_7 + K_2SO_4 + H_2O$
B $CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$
C $2Na + Cl_2 \rightarrow 2NaCl$
D $BaSO_3 + 2HCl \rightarrow BaCl_2 + H_2O + SO_2$

12 The equation for the reaction between manganate(VII) ions and sulfite ions in acid solution is as follow:

$$2MnO_4^- + 5SO_3^{2-} + 6H^+ \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$$

Which one of the following statements is **not** true?

A The manganate(VII) ion is acting as the oxidising agent in this reaction.
B As the reaction proceeds, the pH of the solution decreases.
C The hydrogen ions are neither reduced nor oxidised during the reaction.
D The sulfite ions are oxidised during the reaction.

13 Haemoglobin of the red blood corpuscles contains approximately 0.33% of iron by mass. Given the relative molecular mass of haemoglobin is approximately 68 000, what is the number of iron atom(s) per molecule of haemoglobin?

A 1 **B** 4
C 220 **D** 400

14 The equation for the burning of hydrogen in oxygen is shown below.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

Which information does this equation give about the reaction?

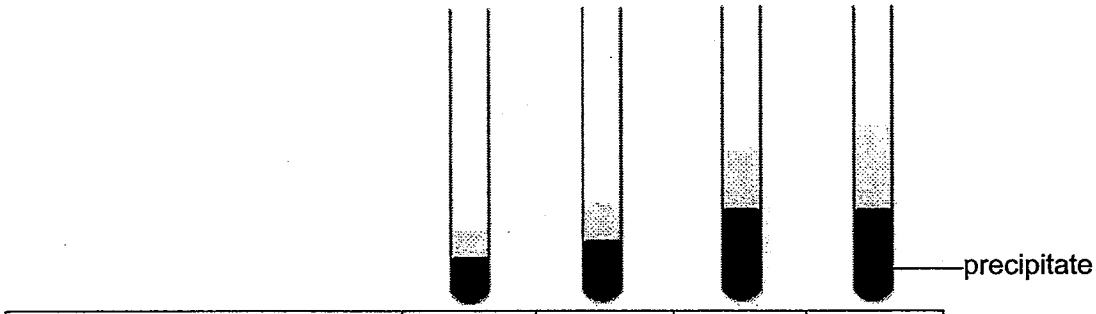
A 2 atoms of hydrogen combine with 2 atoms of oxygen
B 2 moles of steam can be obtained from 1 mole of oxygen
C 2 g of hydrogen combine with 1 g of oxygen
D 36 g of steam can be obtained from 16 g of oxygen

15 35.0 cm^3 of 0.500 mol/dm^3 hydrochloric acid were added to 1.41 g of a sample of sodium carbonate containing some sodium chloride as impurity. The excess acid was neutralised by 15.0 cm^3 of 0.400 mol/dm^3 sodium hydroxide solution.

What is the percentage purity of the sodium carbonate in the sample?

A 43.2% **B** 45.1%
C 86.5% **D** 90.2%

16 A 3 cm^3 sample of a solution of the nitrate of metal **Q**, concentration 1.0 mol/dm^3, was added to 2 cm^3 of potassium fluoride, concentration 1.0 mol/dm^3. When the precipitate had settled, its height was measured. The experiment was then repeated using different volumes of potassium fluoride solution. The results are shown in the diagram below.



Volume of potassium fluoride solution added / cm^3	2	4	6	8

What is the formula of the fluoride of metals **Q**?

A Q_2F **B** QF
C QF_2 **D** QF_3

17 A piece of magnesium ribbon does not react when placed in a solution of hydrogen chloride which is dissolved in methylbenzene. Which of the following changes will cause a reaction?

A Add water and stir well.
B Bubble more hydrogen chloride gas into the solution to increase its concentration.
C Remove the layer of oxide on magnesium ribbon before placing it in the solution.
D Using magnesium powder instead of magnesium ribbon as rate will be faster.

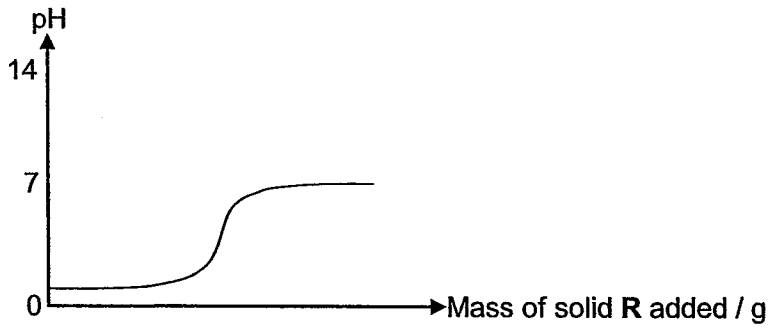
18 Which of the following salts is best prepared using a burette and pipette?

A iron(II) sulfate **B** potassium nitrate
C magnesium nitrate **D** calcium sulfate

19 How can barium sulfate be best prepared from barium carbonate?

A by adding dilute sulfuric acid
B by adding dilute hydrochloric acid followed by dilute sulfuric acid
C by adding sodium chloride solution followed by dilute sulfuric acid
D by heating until there is no further change followed by dilute sulfuric acid

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



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

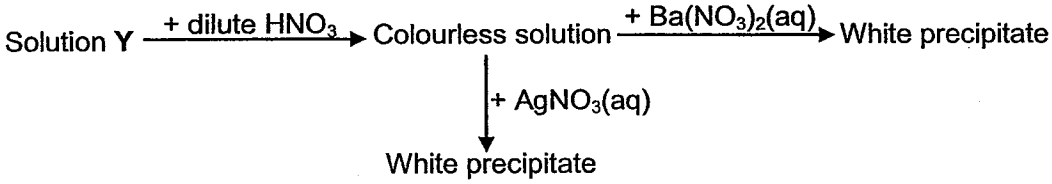
	R	**S**
A	Sodium oxide	Hydrochloric acid
B	Ethanoic acid	Sodium hydroxide
C	Zinc oxide	Hydrochloric acid
D	Dry ice	Sodium hydroxide

21 **X** is a white powder which on heating gives off a colourless gas readily. The gas is moderately soluble in water and could produce a solution with a pH less than 7. The residue is soluble in aqueous solutions of sodium hydroxide, ammonia and hydrogen chloride.

Which of the following substances is most likely **X**?

A	aluminium carbonate	**B**	aluminium hydroxide
C	zinc carbonate	**D**	zinc nitrate

22 Solution **Y** contains a mixture of two salts. The scheme below shows some reactions of solution **Y**.



Which of the following could be the two salts present in solution **Y**?

A copper(II) sulfate and sodium chloride
B lead(II) chloride and sodium sulfate
C magnesium sulfate and zinc chloride
D potassium nitrate and calcium chloride

23 Which of the following reagents, when mixed and heated with ammonium sulfate, liberates ammonia?

A	limewater	**B**	aqueous bromine
C	dilute hydrochloric acid	**D**	acidified potassium dichromate(VI)

24 Hydrated sodium tungstate has the formula $Na_2WO_4.2H_2O$. What is the oxidation number of tungsten in the tungstate ion?

A	–2	**B**	+2
C	+4	**D**	+6

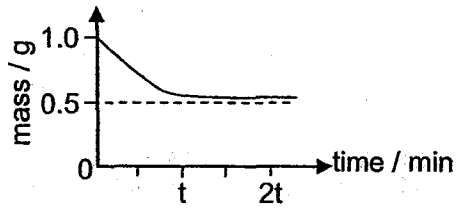
25 Dilute sulfuric acid reacts with copper(II) oxide and copper(II) carbonate. In what way are these two reactions alike?

A Water is a product.
B An insoluble salt is precipitated.
C An acid is neutralised by an alkali.
D Sulfuric acid is reacting as an oxidising agent.

26 Which substance in the fumes from car exhausts is **not** a pollutant?

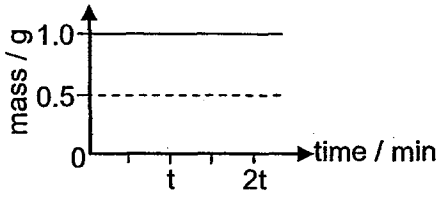
A	carbon monoxide	**B**	nitrogen
C	nitrogen dioxide	**D**	lead compounds

27 The graph represents the change in mass that occurs when 1.0 g of powdered calcium carbonate, $CaCO_3$, is heated at a temperature, T°C.



Which graph would be obtained by heating 1.0 g of powdered magnesium carbonate, $MgCO_3$, at T°C?

A



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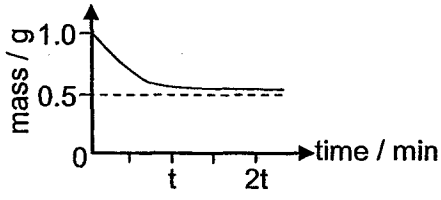

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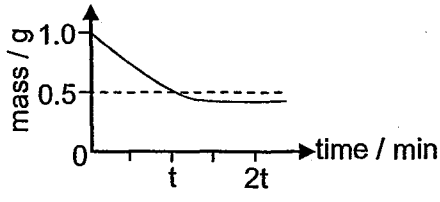

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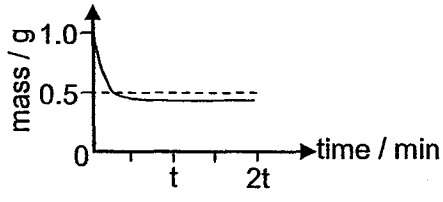
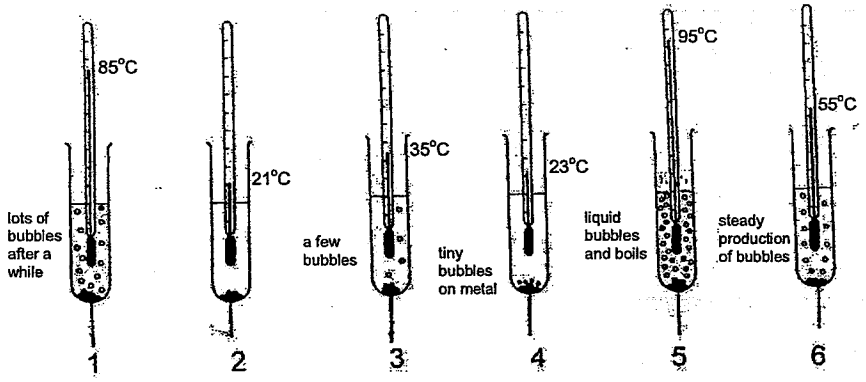


28 Calcium reacts slowly with cold water. If dropped into hot water, the reaction is much more vigorous. Which of the following statements best explains the observed increase in the rate of reaction?

A	At the higher temperature, the number of collisions per second increases. This increases the rate of the reaction.
B	The activation energy is lower at the higher temperature. More particles thus have enough energy to react.
C	The metal expands at the higher temperature. This increases its surface area and the rate of reaction.
D	The number of particles with energy greater than the activation energy is much greater at the higher temperature. This increases the rate of reaction.

29 Different metals 1 to 6 are reacted with hydrochloric acid at 20 °C. The thermometers show the highest temperatures reached for the reactions. Study the diagrams below to determine the relative reactivity of the metals used.



Which of the following combinations would show a positive reaction?

I	Metal 5 and aqueous salt of metal 1
II	Metal 6 and aqueous salt of metal 2
III	Metal 4 and aqueous salt of metal 3

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

30 Which of the following statements is **not** true about the reaction between zinc and excess dilute sulfuric acid?

A As the reaction proceeds, it becomes slower.
B The mass of the reaction vessel and contents decreases.
C The rate of reaction is constant.
D The reaction stops when all the zinc is used up.

31 The equation below represents the solution of sodium thiosulfate in excess water.

$$Na_2S_2O_3(aq) \rightarrow 2Na^+(aq) + S_2O_3^{2-}(aq) \qquad \Delta H = +7.15 \text{ kJ/mol}$$

When 0.010 mol of sodium thiosulfate is dissolved in 100 cm^3 of pure water in a thermally insulated container, the water will .....

A become warmer due to the reaction
B remain at the same temperature but heat will be given off to the surroundings
C become colder due to the reaction
D remain at the same temperature but heat will be absorbed from the surroundings

32 The energy released by the following reaction is 564 kJ/mol.

$$2CO(g) + O_2(g) \rightarrow 2CO_2(g)$$

How much energy is released when 1 mole (28 g) of CO is burnt?

A $\frac{564}{2}$ kJ

B 564 × 28 kJ

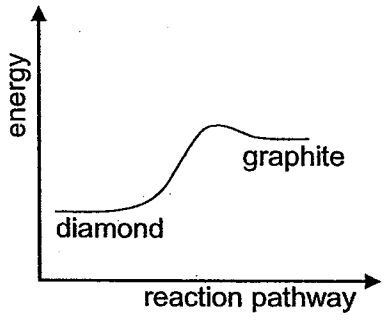
C 564 kJ

D 564 × 2 kJ

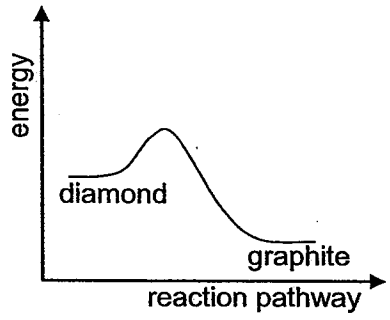
33 The conversion of diamond into graphite is exothermic by 2 kJ/mol. Diamond does not readily change into graphite.

Which energy diagram best represents this conversion?

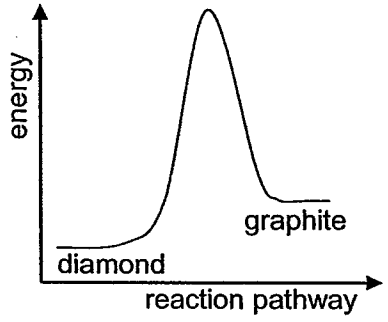
A



B



C



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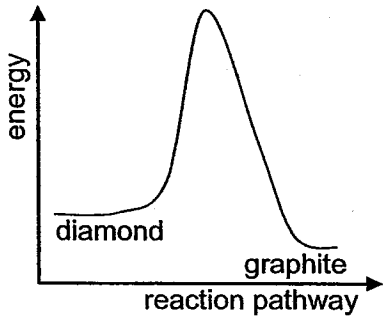
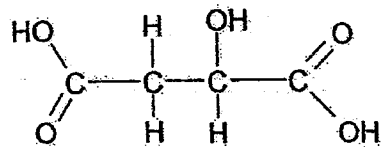


34 Carbon burns in air to give carbon dioxide and heat.

Which of the following describes this reaction correctly?

A catalytic and exothermic
B catalytic and oxidation
C exothermic and oxidation
D catalytic, exothermic and oxidation

35 The diagram shows the structure of a molecule that is commonly found in apples.



How can this molecule be classified?

A alkene and alcohol
B alkene and organic acid
C alcohol and organic acid
D alkene, alcohol and organic acid

36 A compound **X** has the properties below:

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

What could **X** be?

A ethane
B ethanol
C ethanoic acid
D ethyl ethanoate

37 Bread can be prepared from a mixture of flour, yeast and sugar. Carbon dioxide produced by a reaction within the mixture causes the dough to rise.

Which of the following could be the other main product from this reaction?

A CH_3COOH
B CH_3CH_2OH
C $C_6H_{12}O_6$
D H_2O

38 An organic liquid **Y** is tested with some reagents and the results are given in the table below.

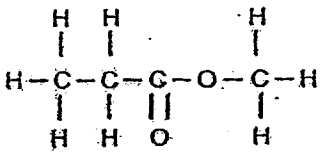
Reagent	Observation
sodium	effervescence produced
aqueous bromine	aqueous bromine decolourised
Acidified aqueous potassium dichromate(VI)	no visible reaction

Which structural formula best fits liquid **Y**?

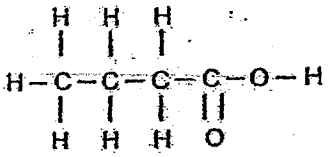
A $CH_2 = CHCOOH$
B $CH_3 - \overset{\overset{O}{\|}}{C} - CH = CH_2$
C CH_3CH_2COOH
D $CH_3CH_2CH_2OH$

39 The structures of three compounds **P**, **Q** and **R** are shown below.

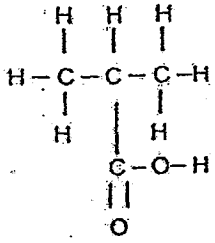
P



Q



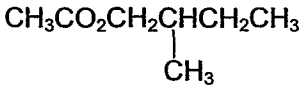
R



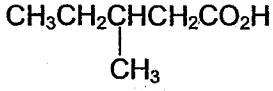
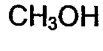
Which compounds are isomers of each other?

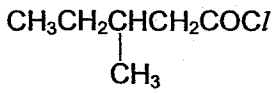
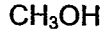
A **P** and **Q** only
B **P** and **R** only
C **Q** and **R** only
D **P**, **Q** and **R**

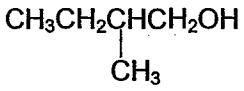
40 An ester with an odour of banana has the following formula:

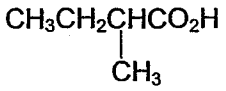


Which of the following substances will react together to produce this ester?

A  + 

B  + 

C  + 

D  + 

END OF PAPER

The Periodic Table of the Elements

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

*58-71 Lanthanoid series

†90-103 Actinoid series

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

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

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

Answers

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

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GAN ENG SENG SCHOOL
Preliminary 1 Examination 2014

CANDIDATE NAME

CLASS

INDEX NUMBER

CHEMISTRY

5073/02
12 May 2014
1 hour 45 minutes

Paper 2

Secondary 4 Express

Candidates answer on the Question Paper.
Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

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

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

Section B
Answer all **three** questions, the last question is in the form either/or.
Write your answers on the lined paper provided.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is on page 21.

	For Examiner's Use
Section A	.....
Section B	
B10	.....
B11	.....
B12 *Either / OR *Circle where appropriate	.....
Total	80

Section A (50 marks)

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

A1 The table below shows a list of substances, **A** to **E** and some information about them. Use the letters in the table to answer the following questions. A substance may be used once, more than once or not at all.

Substance	Melting Point/°C	Boiling Point/°C	Electrical Conductivity	
			Solid	Aqueous
A	-189	-186	None	None
B	327	1613	Good	Good
C	852	Decomposes at very high temperature	None	Good
D	-73	-10	None	Good
E	17	118	None	Good

Using the list of substances, **A** to **E**, answer the following questions.

(a) Which is a gas at room temperature and pressure? ..... [1]

(b) Which is a metal? ..... [1]

(c) Which is likely to be sodium carbonate? ..... [1]

(d) Which is likely to be ethanoic acid? ..... [1]

[Total: 4]

A2 A student made crystals of sodium sulfate from sodium hydroxide solution and dilute sulfuric acid using the following procedure.

Some sodium hydroxide solution was placed in an evaporating dish and a few drops of litmus solution added. The dilute sulfuric acid was then added slowly from a measuring cylinder until the litmus solution changed colour.
The solution in the evaporating dish was then heated strongly until all the water has evaporated.

(a) State the colour change of the litmus solution.

..... [1]

(b) Why is litmus solution needed?

.....

[1]

(c) (i) Identify any *two* key errors or poor techniques in this procedure.

....

....

....

....

.... [2]

(ii) For one of the errors or poor techniques you identified in (c)(i), state how this part of the experiment should be carried out. Explain how your method improves on the result.

....

....

....

....

.... [2]

[Total: 6]

A3 The following is an account of how an English physicist, Rayleigh, performed a series of experiments to determine with great accuracy, how much a litre of nitrogen weighs, i.e. its density:

It is not hard to get pure nitrogen from the air. Ever since the time of Scheele and Lavoisier everyone knew that air was four parts nitrogen to one part oxygen.
All that was necessary was to get rid of the oxygen, and a little carbonic acid gas and water vapour, and you have pure nitrogen.
Rayleigh proceeded in this way. He passed the air through a series of chemical traps: in one the carbonic acid gas was absorbed, another took out all the oxygen; a third absorbed the water vapour.
In this way, Rayleigh drew out all the oxygen, carbonic acid gas, and moisture. This left him with pure nitrogen and Rayleigh weighed it.

(a) (i) What is the "carbonic acid gas" commonly known as now?

.... [1]

(ii) Suggest how the "carbonic acid gas" could be removed from the air.

....

[1]

(b) Rayleigh removed oxygen from the air by passing it over heated copper.
Explain why this method works.

.....

..... [1]

As a check on his results Rayleigh decided to try obtaining nitrogen by another method instead of from the air. If the density of both agreed, then it would mean his results were correct. Rayleigh proceeded to extract nitrogen from ammonia. He purified it according to all the rules, then weighed it.
To his dismay the weights of the two gases, both nitrogen, did not agree. A litre of nitrogen from the air weighed 1.2572 grams. A litre of nitrogen obtained from ammonia weighed 1.2560 gram – that is 1/1000 of a gram less.

[Adapted from "The Chemical Elements"by Nechaev & Jenkins]

(c) (i) Nitrogen can be obtained from ammonia by heating with copper(II) oxide.
Write the chemical equation for this reaction.

..... [1]

(ii) From the extract above, suggest an explanation why the nitrogen from the air was heavier than the nitrogen obtained from ammonia (assuming that it was not due to experimental error).

.....

.....

..... [1]

[Total: 5]

A4 The table below shows the properties of the different types of oxides formed by the Group IV elements.

Element	**Formula of oxides formed**	**Stability of oxide**	**Nature of oxide**
Carbon	CO	Readily oxidised to dioxide	React with neither acids nor alkalis
	CO_2	Stable even at high temperatures	Acidic
Silicon	SiO	Readily oxidised to dioxide	React with neither acids nor alkalis
	SiO_2	Stable even at high temperatures	Acidic
Germanium	GeO	Readily oxidised to dioxide	Amphoteric
	GeO_2	Stable even at high temperatures	Amphoteric
Lead	PbO	Stable	Amphoteric
	PbO_2	Decomposes to PbO on warming	Amphoteric

(a) Elements in the same group of the Periodic Table have similar chemical properties. From the data given in the table, state **one** similarity in the oxides formed from the elements in Group IV of the Periodic Table.

.....

.....

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.....

.....

..... [2]

(b) Using information from the table, state **two** trends in terms of the properties of the oxides down Group IV.

.....

.....

.....

.....

.....

..... [2]

(c) What does the trend in the nature of the oxides suggest about the metallic character of the elements in Group IV?

..... [1]

(d) Lead(IV) oxide, PbO_2, is a strong oxidising agent.
Lead(IV) oxide reacts with hydrochloric acid to form chlorine and lead(II) chloride.

$$PbO_2 + 4HCl \rightarrow PbCl_2 + Cl_2 + 2H_2O$$

Explain how lead(IV) ions in lead(IV) oxide act as an oxidising agent in this reaction.

.....

.....

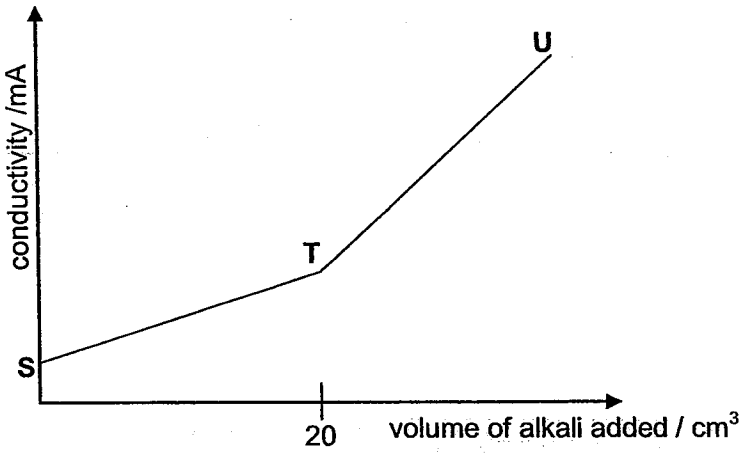
.....

.....

..... [2]

[Total: 7]

A5 The graph shows conductivity changes when sodium hydroxide solution is added to aqueous ethanoic acid.



(a) Explain the low conductivity value at **S**.

.....

.....

..... [1]

(b) Write an equation, including state symbols for the reaction between aqueous ethanoic acid and sodium hydroxide solution.

..... [2]

(c) Explain why the conductivity increases as sodium hydroxide solution is added to aqueous ethanoic acid?

.....

.....

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.....

.....

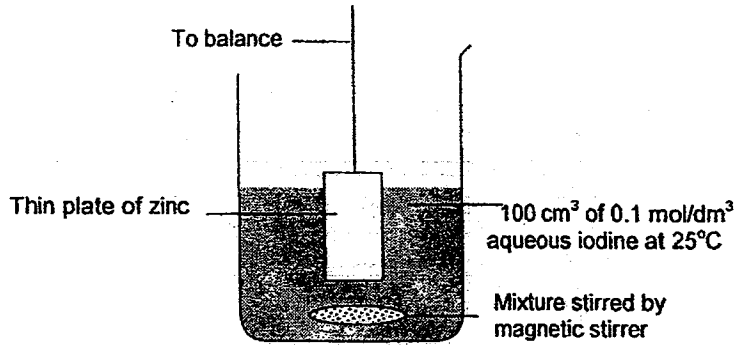
..... [2]

(d) If the concentration of the acid is half the concentration of the alkali solution, state the volume of acid used in the flask at the start of the reaction.

..... [1]

[Total: 6]

A6 The following apparatus was used to measure the rate of the reaction between zinc and iodine.



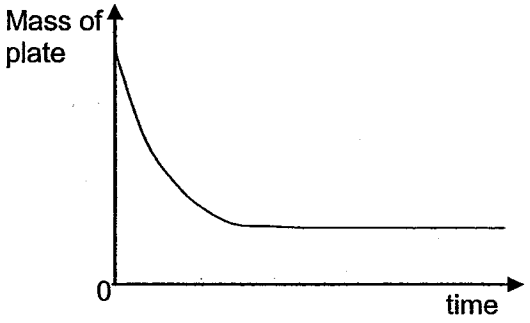
The mass of the zinc plate was measured every minute until the reaction was complete.

(a) Write a chemical equation, including state symbols, for the redox reaction that occurred between zinc and iodine.

.....

[1]

(b) From the results of the experiment, the following graph was plotted.



(i) Which reagent, iodine or zinc is in excess? Give a reason for your answer.

.....

.....

[1]

(ii) Sketch on the graph if 100 cm^3 of 0.05 mol/dm^3 iodine had been used instead and label this graph **G**. [1]

(c) Describe how you would show that an aqueous solution contains zinc ions.

.....

.....

.....

.....

[2]

[Total: 5]

A7 Some information about four metals, **W**, **X**, **Y** and **Z** is shown in the table.

Element	W	X	Y	Z
number of electrons in outer shell	4	1	1	1
density in g/cm^3	2.22	8.9	0.9	11.3
melting point / °C	3720	1083	64	328
atomic radius / pm	77	135	203	154
ions formed	W^{4+}	X^{+} and X^{2+}	Y^{+}	Z^{2+} and Z^{4+}
formulae and appearance of chlorides	WCl_4 – a colourless liquid	XCl – a white solid XCl_2 – a green solid	YCl – a white solid	ZCl_2 – a white solid ZCl_4 – a colourless liquid

(a) Which one of the elements would react most vigorously with dilute sulfuric acid? Using the information from the table, explain your answer.

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..... [2]

(b) Which one of the elements is a transition metal? Give **three** evidence from the table to support your answer.

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..... [3]

[Total: 5]

A8 Some hydrated ionic solids when heated release their water of crystallization and dissolve in this water. When the solution is cooled the solid recrystallises and heat is released. One example is calcium chloride hexahydrate ($CaCl_2.6H_2O$) and the process is described by the equation:

$$CaCl_2.6H_2O\ (s) \rightleftharpoons CaCl_2.2H_2O(l) + 4H_2O(l) \qquad \Delta H = +37.2\ kJ$$

This process can be repeated many times and can be used to store solar energy. Energy from the sun heats the solid calcium chloride hexahydrate and its temperature increases. At 29°C the solid melts and the energy required for the chemical change described above is absorbed from the solar radiation. At night as the solution cools, it solidifies and heat is given back to the surroundings.

(a) **(i)** Is the reaction taking place at night an endothermic or exothermic reaction? Give a reason for your answer.

.....

..... [1]

(ii) Describe the changes in the movement and arrangement of particles as the solution cools and solidifies at night.

.....

.....

.....

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.....

..... [2]

(b) Draw a fully labelled energy level diagram for the above (forward i.e. left to right) reaction.

[2]

(c) Calculate the energy absorbed when 100kg of calcium chloride hexahydrate undergoes the above reaction. Leave your answer to the nearest kJ.

[2]

[Total: 7]

A9 The table below gives information about car exhaust emissions.

Pollutant	Petrol car (without catalytic converter)	Petrol car (with catalytic converter)	Diesel car (without catalytic converter)	Diesel car (with catalytic converter)
Nitrogen oxides	xxx	x	xx	xx
Carbon monoxide	xxx	xx	xx	x
Hydrocarbons	xxx	xx	xx	x
Particulates	xx	x	xxx	xx
Carbon dioxide	xx	xxx	x	xx

Key:

Highest emissions: xxx
Intermediate: xx
Lowest emissions: x

(a) Particulates are very small particles of a black solid. Suggest the name of this black solid.

.....

[1]

(b) Explain how the oxides of nitrogen are formed in car engines.

.....

.....

.....

.....

[2]

(c) Based on the data given, describe the effect of installing a catalytic converter on car exhaust emissions.

.....

.....

.....

..... [2]

[Total: 5]

Section B (30 marks)

Answer all **three** questions. The last question is in the form **either/or**.
Write your answers on the lined paper provided provided.

B10 Below is a table of data corresponding to the following balanced equation:

$$2ClO_2\,(aq) + 2OH^-\,(aq) \rightarrow ClO_3^-\,(aq) + ClO_2^-\,(aq) + H_2O\,(l)$$

Six experiments were carried out with differing concentrations of ClO_2 and OH^- in each experiment.
The measurement of how quickly ClO_2 disappears is given in the table for each of the six experiments. How quickly a reactant disappears is a good measurement of how fast a reaction takes place.

Expt	Concentration of ClO_2 / mol dm^{-3}	Concentration of OH^- / mol dm^{-3}	Initial rate of disappearance of ClO_2 / mol dm^{-3} s^{-1}
1	0.020	0.030	0.00276
2	0.040	0.030	0.01104
3	0.020	0.060	0.00552
4	0.040	0.060	0.02208
5	0.040	0.090	0.03312
6	0.120	0.030	0.09936

(a) What is the relationship between the concentrations of the reactants and the rate of reaction? Justify your answer using the results in the table, stating clearly the experimental data you are using.

[3]

(b) Explain the effect of concentration on the rate of reaction in terms of collisions between particles.

[2]

(c) Does the reaction rate depend on the concentration of ClO_2 and OH^- *equally*? Explain your answer using results from the table. State which experimental data you are using, and show how you arrived at your answer clearly.

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.....

.....

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..... [4]

(d) Predict the initial rate of disappearance of ClO_2 if the experiment was conducted using 0.040 mol/dm^3 of ClO_2 and 0.120 mol/dm^3 of OH^-.

..... [1]

(e) In the reaction between ClO_2 and OH^-, chlorine in ClO_2 is said to be both oxidised and reduced simultaneously. Explain why.

.....

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.....

.....

..... [2]

[Total: 12]

B11 In Shakespearean time, actors in theatre were literally "in the limelight". This was because limestone was heated strongly in front of the stage illuminating the actors.
Limestone, containing a natural occurring form of calcium carbonate, decomposed on heating to produce two products and emitting a bright light at the same time.

(a) Write a balanced chemical equation, including the state symbols, for the thermal decomposition of limestone.

.....[1]

(b) Describe two **other** industrial uses of calcium carbonate.

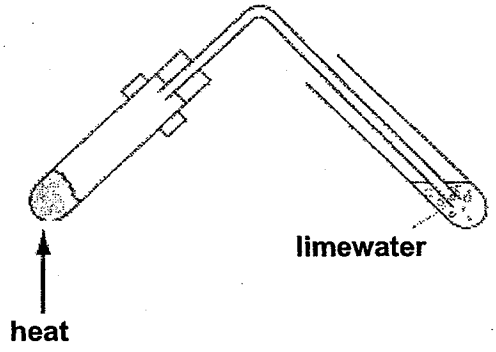
.....

.....

.....[2]

(c) Dolomite proved to be less effective as stage lighting. This is because dolomite contains both calcium and magnesium carbonate.
Magnesium carbonate does not emit light when it decomposes.

A student carried out the following experiment to determine which of the two carbonates decomposes readily.



(i) Describe the change you would see in limewater, if the carbonate decomposes on heating.

.....[1]

(ii) The student used the same number of moles of carbonate rather than the same mass of carbonate to get a fair comparison. Explain why.

.....

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.....[2]

(iii) Describe how you could use the above experiment to show that magnesium carbonate decomposes more readily than calcium carbonate.

Hence, explain why magnesium carbonate decomposes more readily than calcium carbonate.

.....

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.....

.....

..... [2]

[Total: 8]

EITHER

B12 (a) Ethanol is an important industrial chemical with about 200,000 tonnes manufactured in the UK each year. The usual method of manufacture is by the hydration of ethene with steam in the presence of a catalyst at 300°C and high pressure. The reaction occurs as shown in the following equation:

$$C_2H_4(g) + H_2O(g) \rightarrow C_2H_5OH(g) \qquad \Delta H = -46 \text{ kJ/mol}$$

(i) The boiling points of the three chemicals involved in this reaction are shown in the table below:

Compound	C_2H_4	H_2O	C_2H_5OH
Boiling point / °C	–104	100	78

Suggest how the ethanol could be separated from the mixture.

.....

.....

.....

.....

..... [2]

Alcohols such as ethanol can be used as alternative fuels to petrol. The combustion of ethanol tends to be more complete than the combustion of the alkanes in petrol, partly because less oxygen is required for combustion.

(ii) With the aid of chemical equations, calculate the amount (number of moles) of oxygen required per gram of each fuel burned. [Use octane, C_8H_{18}, as the typical alkane in petrol for your equation.]

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.....

.....

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..... [4]

(iii) Suggest why there is this difference between the amounts of oxygen required per gram for these two fuels.

.....

.....

..... [1]

(b) The structure of the silkworm moth sex attractant, bombykol, is

$$H_3C-(CH_2)_2-CH=CH-CH=CH-(CH_2)_8-CH_2OH$$

Predict, with reasons,

(i) the solubility of bombykol in water;

.....

.....

.....

.....

..... [2]

(ii) what you will observe if aqueous bromine is added to bombykol.

.....

..... [1]

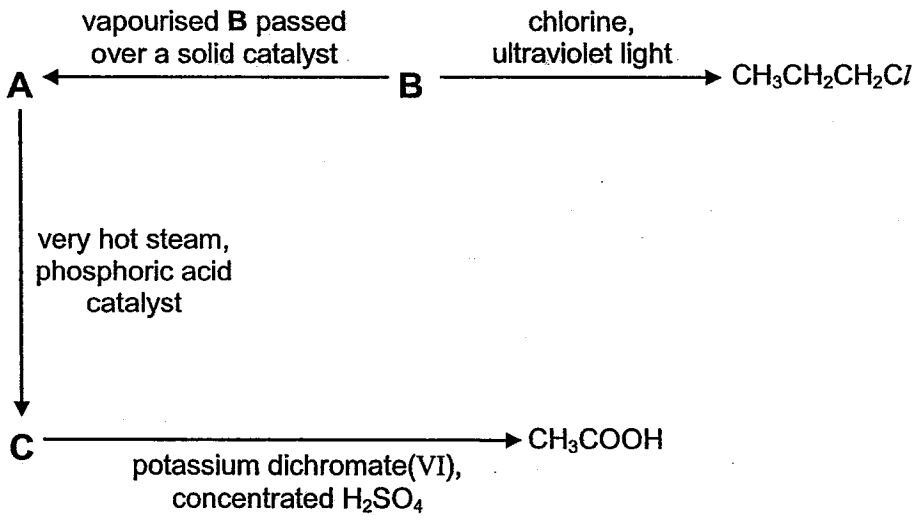
[Total: 10]

OR

B12 **(a)** Draw a dot-and-cross diagram to represent the bonding in trichloromethane, $CHCl_3$.

[2]

(b)



It is known that compound **B** is a hydrocarbon.

(i) State the molecular formula of compound **B**.

.....[1]

(ii) State the type of reaction that **A** undergoes to form **C**.

.....[1]

(iii) Name and draw the structure of the organic product that is formed when **C** is reacted with propanoic acid.

Name: .....

[2]

(iv) State the formula of the product, other than **A**, which is formed when vapourised **B** is passed over a solid catalyst.

..... [1]

(c) The aldehydes are a group of organic compounds which contain hydrogen, carbon and oxygen. The table below shows some information about aldehydes and alkanes:

Alkanes	**Aldehydes**	
formula	*name*	*formula*
C_2H_6	ethanal	CH_3CHO
C_3H_8	propanal	C_2H_5CHO
C_4H_{10}	butanal	C_3H_7CHO
C_5H_{12}	pentanal	C_4H_9CHO

(i) Deduce the general formula for the aldehydes.

..... [1]

(ii) Would you expect pentanal to have a higher boiling point than butanal? Explain your answer.

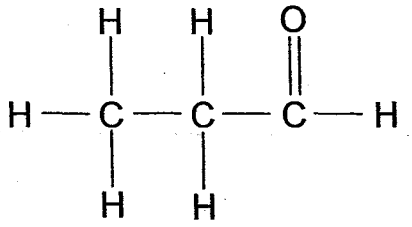
.....

.....

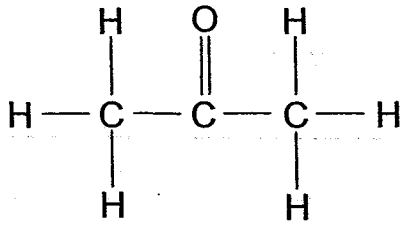
.....

..... [1]

(d) The functional group of the aldehydes is the – **CHO** group. The structural formulae of propanal, C_2H_5CHO, and one of its isomers with a different functional group are given below:



propanal



isomer of propanal with a different functional group

Draw the structure of another isomer of propanal which has a different functional group from the above two compounds.

[1]

[Total: 10]

END OF PAPER

The Periodic Table of the Elements

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

*58-71 Lanthanoid series

†90-103 Actinoid series

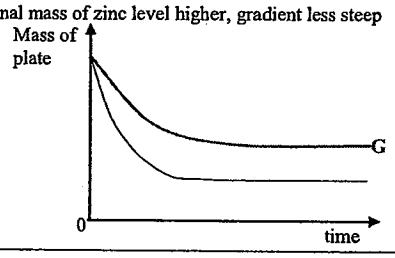
140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium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

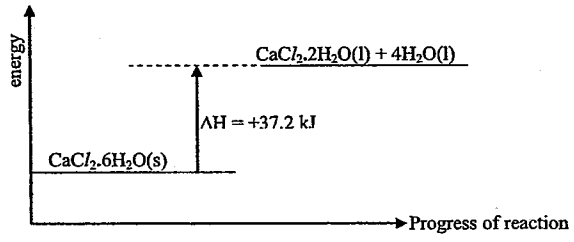
Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

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

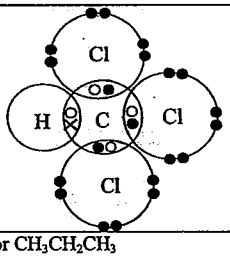
Marking Scheme for Paper 2

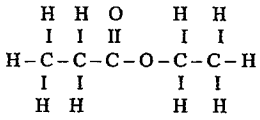
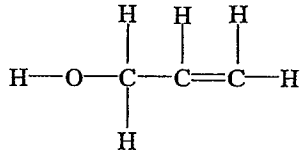
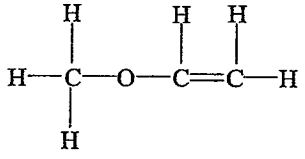
Qn	Possible answers
A1(a)	**A** or **D**
(b)	**B**
(c)	**C**
(d)	**E**
A2(a)	The litmus changes from blue to red.
(b)	Litmus is needed to indicate when the sodium hydroxide solution has been completely neutralised.
(c)(i)	Error 1: - A measuring cylinder should not have been used to add the acid. Error 2: - The procedure was not repeated without the indicator. OR - The solution should not have been heated strongly until all the water has evaporated.
(ii)	Error 1: - The acid should have been added drop by drop / dropwise from a burette instead of a measuring cylinder. - This would improve accuracy, ensuring that the alkali is exactly neutralised by the acid. Error 2: - The volume of acid needed to neutralise the alkali is noted and the procedure should be repeated without the use of indicator. - This would prevent the salt from being contaminated by the indicator. OR -The solution should be heated until saturated and then leave to cool to crystallise the salt out of the solution.
A3(a)(i)	Carbon dioxide / CO_2
(ii)	By passing the gas through calcium hydroxide/ sodium hydroxide/ potassium hydroxide. **Reject: calcium oxide** as answer must be a soluble / slightly soluble base
(b)	Copper will react with the oxygen present in the air to form copper(II) oxide.
(c)(i)	$2NH_3 + 3CuO \rightarrow N_2 + 3Cu + 3H_2O$

(ii)	The nitrogen from the air still contained the noble gases such as argon. Hence it is heavier than the one obtained from ammonia.
A4	All of the elements form two types of oxides
(a)	– one in which the oxidation state of the Group IV is +2 and the other in which the oxidation state is +4 OR oxides with one and two oxygen atoms respectively
(b)	1. Going down the group, the dioxide becomes less stable while the monoxide becomes more stable 2. Going down the group, the dioxides change from acidic to amphoteric OR monoxides change from neutral to amphoteric.
(c)	The metallic character increases down the group.
(d)	Lead(IV) ions accepts electron from chloride ions in hydrochloric acid, thus oxidising chloride ions to chlorine gas.
A5	ic acid is a weak acid with / partially dissociates/ionises in water to form a low concentration of ions that are available to could conduct electricity.
(a)	
(b)	$CH_3COOH\ (aq) + NaOH\ (aq) \rightarrow CH_3COONa\ (aq) + H_2O\ (l)$ [1]: correct formulae and balanced chemical equation [1]: state symbols *Marks for state symbols will only be awarded if all chemical formulae of the substances are correct*
(c)	As NaOH is added to ethanoic acid, the salt / sodium ethanoate / CH_3COONa formed is soluble/fully ionizes in water. After T, ethanoic acid is fully used up and NaOH is in excess. NaOH is a strong alkali /fully ionises, so there is an even much higher concentration of mobile ions present to conduct electricity.
(d)	40 cm^3
A6(a)	$Zn\ (s) + I_2\ (aq) \rightarrow ZnI_2\ (aq)$
(b)(i)	Zinc because the final mass of zinc is greater than 0.
(ii)	Final mass of zinc level higher, gradient less steep 

(c)	on of aqueous ammonia to the sample. White ppt, soluble in excess aq. ammonia and form a colourless solution.
A7 (a)	Element Y It has a much lower density and melting point than other metals and thus Y is most likely a Group I metal which is very reactive.
(b)	X is a transition metal. The three pieces of evidence are : 1. X has variable oxidation states of +1 and +2 / variable valencies. 2. X forms coloured compounds e.g. XCl_2 is a green solid. 3. X has a high density of 8.9 g/cm^3 and high melting point of 1083°C.
A8(a)(i)	An exothermic reaction takes place at night as energy is lost to the surroundings.
(ii)	Initially, in the liquid state, the particles are able to slide past each other and are randomly arranged. As the liquid cools, the particles lose energy and move more slowly. Eventually the particles no longer have enough energy to move freely, only vibrating about fixed positions, and are now regularly/orderly arranged. [1]: change in movement of particles from liquid to solid [1]: change in arrangement of particles from liquid to solid
(b)	
(c)	Mr $CaCl_2.6H_2O$ = 40+(35.5×2)+12+(16×6) = 219 Therefore 219 g of calcium chloride hexahydrate absorbs 37.2 kJ energy 100 kg of calcium chloride hexahydrate thus absorbs [(100×1000)÷219]× 37.2 kJ = 16 986 kJ of energy

A9(a)	Carbon/soot
(b)	The high temperature in the car engine causes nitrogen **in the air** to react with oxygen **in the air** producing oxides of nitrogen.
(c)	Installing a catalytic converter decreases the emissions of nitrogen oxides, carbon monoxide, hydrocarbons and particulates but increases the emission of carbon dioxide.
B10 (a)	Comparing Expts 1, 2 and 6 – As the concentration of ClO_2 increases while concentration of OH^- is kept constant, rate of reaction increases. Comparing Expts 2, 4 and 5 – an increase in the concentration of OH^- increases the rate of reaction. Hence the rate of reaction increases as the concentrations of reactants increase.
(b)	The higher the concentration, the greater the number of particles for the same volume / per unit volume. Hence, the particles are closer together and frequency of effective collisions increases, leading to an increase in the rate of reaction.
(c)	Comparing Expts 1 and 2, doubling the concentration of ClO_2 increases the rate of reaction by 4 times $\left[\frac{0.01104}{0.00276} = 4\right]$. Comparing Expts 2 and 4 (or 1 and 3), doubling the concentration of OH^- increases the rate of reaction by 2 times $\left[\frac{0.02208}{0.01104} = 2\right]$. Hence the rate is more dependent on the concentration of ClO_2.
(d)	0.04416 mol dm^{-3} s^{-1}
(e)	Oxidation state of chlorine increases from +4 in ClO_2 to +5 in ClO_3^-, hence chlorine in ClO_2 is oxidised. Oxidation state of chlorine decreases from +4 in ClO_2 to +3 in ClO_2^- hence chlorine in ClO_2 is reduced.
B11(a)	$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
(b)	It is used in the extraction of iron to remove acidic impurities such as sand / silicon dioxide from molten iron in the form of molten slag. It is used in flue gas desulfurisation to remove sulfur dioxide from the waste gases when fossil fuels undergo combustion.
(c)(i)	White precipitate is formed in limewater.
(ii)	Same mass of carbonate contains different number of moles of carbonate due to different relative molecular mass of the metal carbonate. Since the amount of carbonate ions affect the volume of carbon dioxide gas produced, the same number of moles of carbonate had to be used in order to ensure that the only changing variable is due to the different stability of the carbonates that causes the different volumes of gas produced per unit time.
(iii)	Magnesium carbonate should take a shorter time to decompose and form white precipitate in limewater. Magnesium is less reactive than calcium and hence form a less stable metal carbonate than calcium carbonate.

Either B12 (a)(i)	The mixture can be cooled to about 50°C (or below 78°C). Water and ethanol will condense as a mixture of liquids. Ethanol can then be separated from the mixture by fractional distillation.
(ii)	Using octane as a typical alkane in petrol, $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ Mr C8H18 = (8×12)+18 = 114 ⇒ (114×2) = 228 g C_8H_{18} requires 25 mol oxygen ⇒ 1g C_8H_{18} requires (1/228)×25 = 0.110 mol oxygen (to 3sf) $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ M_r C_2H_5OH = 24+6+16 = 46 ⇒ 46 g C_2H_5OH requires 3 mol oxygen ⇒1 g C_2H_5OH requires (1/46)×3 = 0.0652 mol oxygen (to 3 sf)
(iii)	Unlike octane, ethanol contains oxygen atoms in its molecules, hence it requires less oxygen from the air per gram compared to octane. OR Octane has higher carbon content, hence it requires more oxygen from the air per gram compared to ethanol.
(b)(i)	Bombykol should be slightly soluble in water .As it is an alcohol/ as it has a hydroxyl group, bombykol should be soluble in water but because of the relatively long carbon chain it became only be slightly soluble.
(ii)	Reddish-brown/Orange-red aqueous bromine will decolourise/turn colourless because of the presence of carbon-carbon double bond/ C=C bonds / as the molecule is unsaturated.
OR B12a	 Key X electron of H O electron of C ● electron of Cl
b(i)	C_3H_8 or $CH_3CH_2CH_3$

(ii)	Addition
(iii)	 Ethyl propanoate
(iv)	CH_4
(c)(i)	$C_nH_{2n+1}CHO$ or $C_{n-1}H_{2n-1}CHO$
(ii)	Yes. A pentanal molecule has more atoms and hence **size of molecules increases**. The **intermolecular forces are stronger** and **more energy is required to overcome these stronger intermolecular forces**.
(d)	 OR  OR