

GAN ENG SENG SCHOOL
Preliminary Examination 2024



**CANDIDATE
NAME**

CLASS

**INDEX
NUMBER**

CHEMISTRY

Paper 1 Multiple Choice

6092/01

9 September 2024

1 hour

Additional Materials: OTAS

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name, class and index number on the OTAS. Shade your index number on the OTAS.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

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.

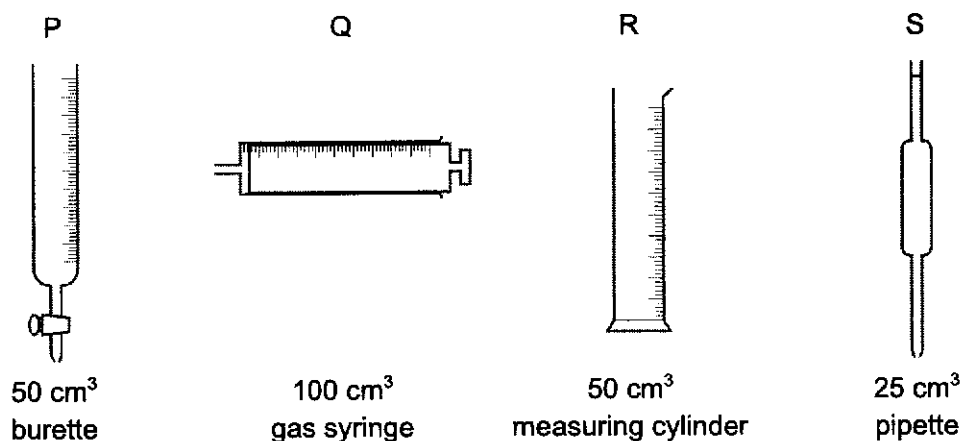
Any rough working should be done in this booklet.

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

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

Total Marks
40

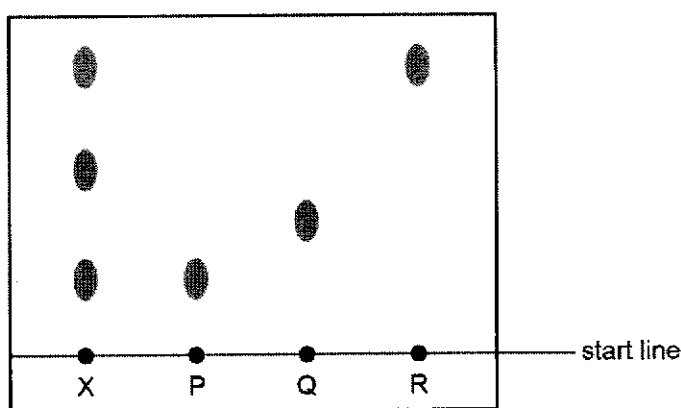
1 P, Q, R and S are pieces of apparatus.



Which row describes the correct apparatus for the measurement made?

	apparatus	measurement made
A	P	the volume of acid added to alkali in a titration
B	Q	0.24 dm ³ of hydrogen gas produced when magnesium reacts with an acid
C	R	75 cm ³ of a gas given off in a rate-determining experiment
D	S	20 cm ³ of alkali for use in a titration

2 X is a mixture of colourless compounds. The diagram shows a chromatogram of X and of three pure compounds, P, Q and R.

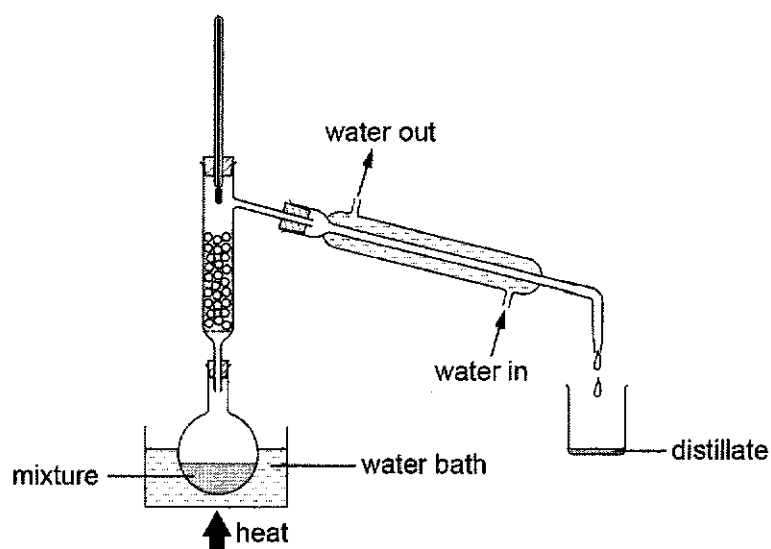


Which statement is **not** correct?

- A** X could contain P and R.
- B** Q has a greater R_f value than R.
- C** P and R have different solubilities in the solvent.
- D** A locating agent was used to develop the chromatogram of X.

3

3 Which substance can be distilled using the apparatus below?



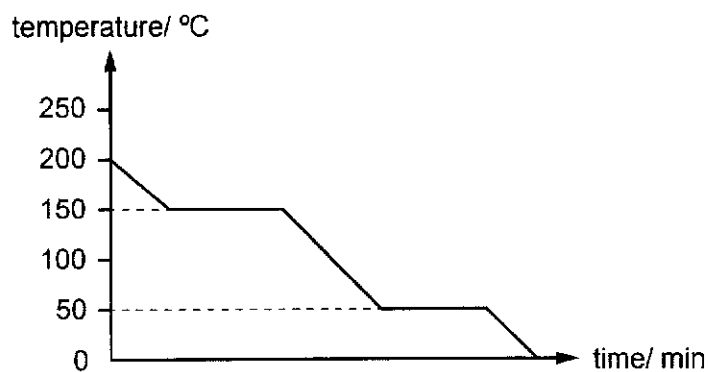
	melting point/ °C	boiling point/ °C
A	-138	0
B	-123	50
C	0	108
D	41	182

4 Which row about a change of state is correct?

	change of state	energy change	process
A	solid → liquid	heat given out	melting
B	gas → liquid	heat taken in	evaporation
C	solid → gas	heat taken in	sublimation
D	liquid → solid	heat given out	condensing

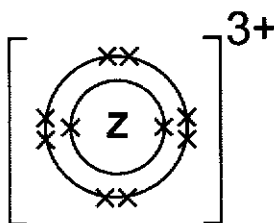
4

- 5 The cooling curve for substance X is shown below.



At which temperature does both solid and liquid exist?

- A 0 °C
 B 50 °C
 C 150 °C
 D 200 °C
- 6 The ion of an element Z is shown below.



In which group and period does element Z belong to in the Periodic Table?

	group	period
A	13	2
B	13	3
C	15	2
D	15	3

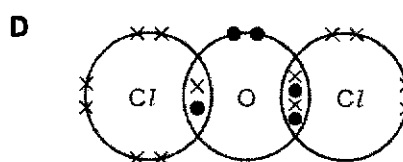
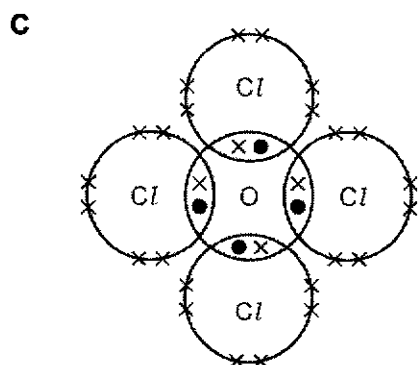
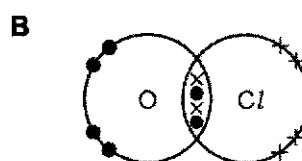
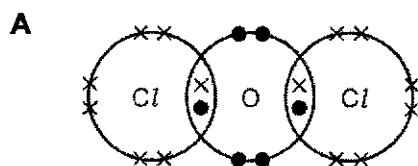
- 7 Which row includes an element, a compound and a mixture?

- A sea water, tap water, pure water
 B sodium chloride, chlorine, pure water
 C sea water, sodium chloride, chlorine
 D sodium chloride, sea water, pure water

- 8 Which row correctly classifies how graphite, aluminium and molten sodium chloride conduct electricity?

	using mobile ions and electrons	using mobile electrons only	using mobile ions only
A	molten sodium chloride	graphite	aluminium
B	molten sodium chloride	aluminium, graphite	none of the above
C	aluminium	graphite	molten sodium chloride
D	none of the above	aluminium, graphite	molten sodium chloride

- 9 Which dot and cross diagram for a compound of oxygen and chlorine is correct?



- 10 Which statement about the structure and properties of silicon(IV) oxide is **not** correct?

- A** It has a giant covalent structure similar to that of diamond.
B There are strong covalent bonds between silicon and oxygen atoms.
C Each silicon atom is bonded to four neighbouring oxygen atoms.
D It has a high melting point due to the strong attractive force between molecules.

11 What is the number of molecules in 500 cm³ of oxygen gas at room temperature and pressure?

- A 1.25×10^{22}
- B 1.34×10^{22}
- C 3.0×10^{22}
- D 3.0×10^{26}

12 The percentage by mass of magnesium in chlorophyll-a ($M_r = 893$) is 2.69%.

How many magnesium atoms are there in one molecule of chlorophyll-a?

- A 1
- B 2
- C 24
- D 100

13 Saline solution is a solution of sodium chloride dissolved in water. It is commonly used in hospitals for cleaning wounds and treating dehydration.

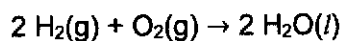
A 0.9% saline solution has 0.9 g of sodium chloride for every 100 cm³ of solution.

What is the concentration of the 0.9% saline solution in mol/dm³?

- A 0.00154 mol/dm³
- B 0.0154 mol/dm³
- C 0.154 mol/dm³
- D 1.54 mol/dm³

14 A mixture containing 8.0 g of hydrogen gas with 8.0 g of oxygen gas is ignited.

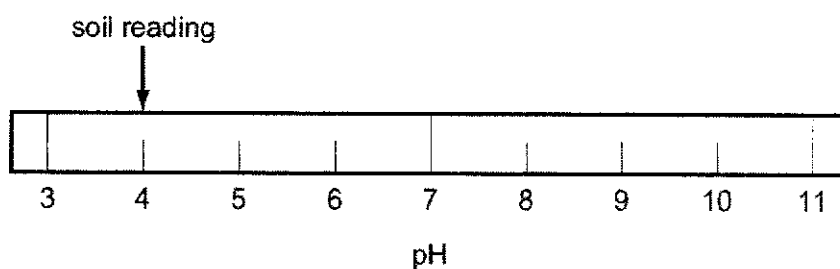
The reaction is represented by the following chemical equation.



What is the mass of water formed?

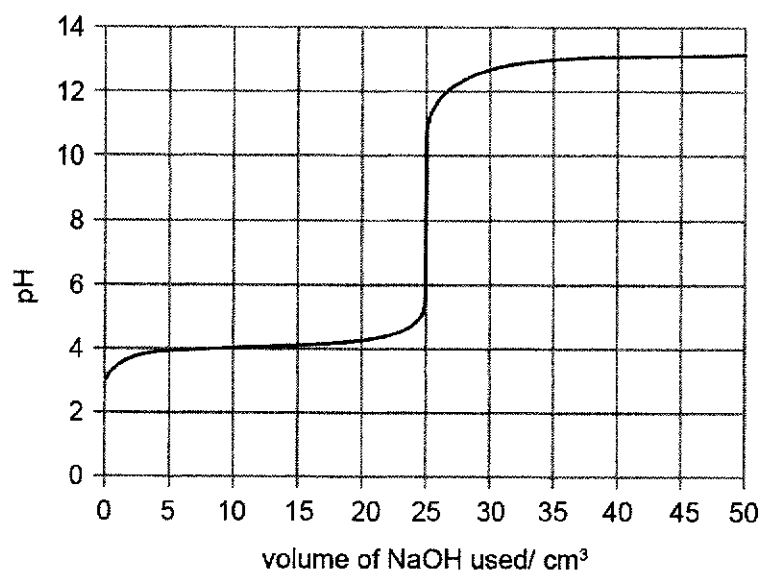
- A 9.0 g
- B 16.0 g
- C 18.0 g
- D 36.0 g

- 15 The diagram shows the results of a pH test on a sample of garden soil.



What could be added to the soil to change its pH to 7?

- A calcium oxide
 B sodium oxide
 C sodium chloride
 D ammonium nitrate
- 16 The graph shows how pH changes as 0.1 mol/dm³ of dilute sodium hydroxide is gradually added to 0.1 mol/dm³ of ethanoic acid.



Which indicator is most suitable to be used in the titration to identify the end-point of neutralisation?

	indicator	colour change	pH at which colour change occurs
A	crystal violet	yellow → violet	0.0 – 2.0
B	methyl orange	red → yellow	3.1 – 4.4
C	phenolphthalein	colourless → pink	8.3 – 10.0
D	indigo carmine	blue → yellow	11.4 – 13.0

- 17 Copper(II) sulfate is made by reacting excess insoluble solid M and solution N.

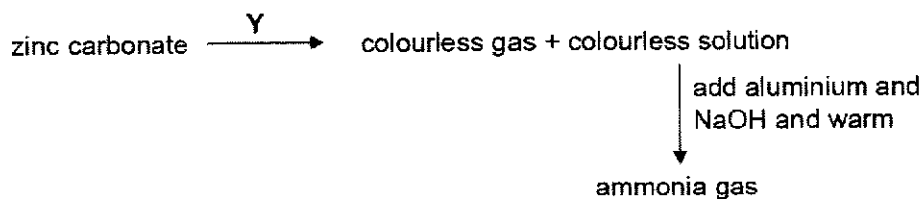
Which row identifies M and N and the method used to extract crystals of copper(II) sulfate from the mixture?

	M	N	method
A	copper	sodium sulfate	filter the mixture to obtain the residue
B	copper	sulfuric acid	filter the mixture and evaporate filtrate until crystals form
C	copper(II) oxide	sulfuric acid	filter the mixture to obtain the residue
D	copper(II) carbonate	sulfuric acid	filter the mixture and evaporate filtrate until crystals form

- 18 Which of the following pairs of gases changes the colour of damp red litmus paper?

- A** ammonia and chlorine
- B** ammonia and carbon dioxide
- C** chlorine and hydrogen
- D** chlorine and sulfur dioxide

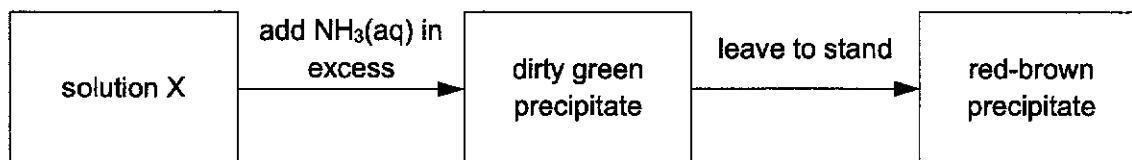
- 19 The diagram shows a reaction scheme.



What is Y?

- A** dilute nitric acid
- B** dilute hydrochloric acid
- C** aqueous sodium nitrate
- D** aqueous ammonia

20 The flowchart below shows the reactions of solution X.



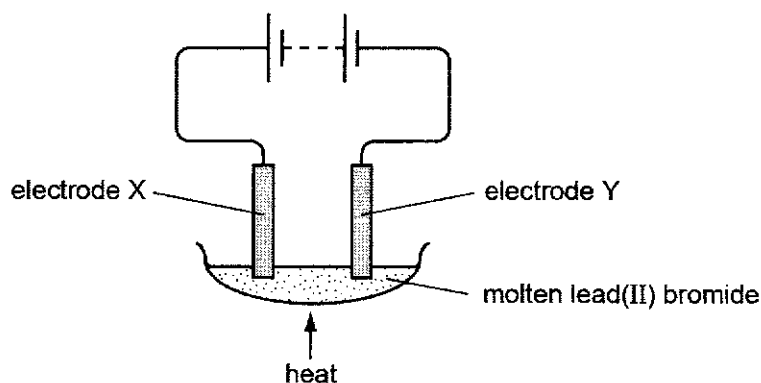
Which row is correct?

	formula of dirty green precipitate	reaction that resulted in red-brown precipitate
A	$\text{Fe}(\text{OH})_2$	reduction
B	$\text{Fe}(\text{NH}_4)_2$	reduction
C	$\text{Fe}(\text{OH})_2$	oxidation
D	$\text{Fe}(\text{NH}_4)_2$	oxidation

21 In which reaction is the underlined substance acting as a reducing agent?

- A** $\underline{2 \text{CuO}} + \text{C} \rightarrow \text{CO}_2 + 2 \text{Cu}$
B $\text{Fe}_2\text{O}_3 + \underline{3 \text{CO}} \rightarrow 2 \text{Fe} + 3 \text{CO}_2$
C $2 \text{Mg} + \underline{\text{O}_2} \rightarrow 2 \text{MgO}$
D $\underline{\text{MnO}_2} + 4 \text{HCl} \rightarrow \text{MnCl}_2 + 2 \text{H}_2\text{O} + \text{Cl}_2$

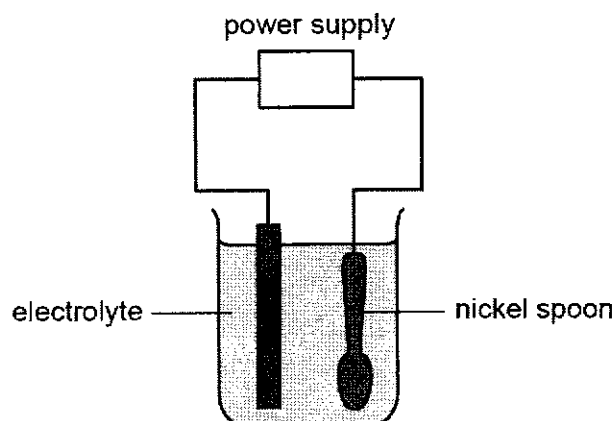
22 The diagram shows the electrolysis of molten lead(II) bromide.



What is seen at each electrode?

	electrode X	electrode Y
A	brown gas	grey metal
B	colourless gas	grey metal
C	grey metal	colourless gas
D	grey metal	brown gas

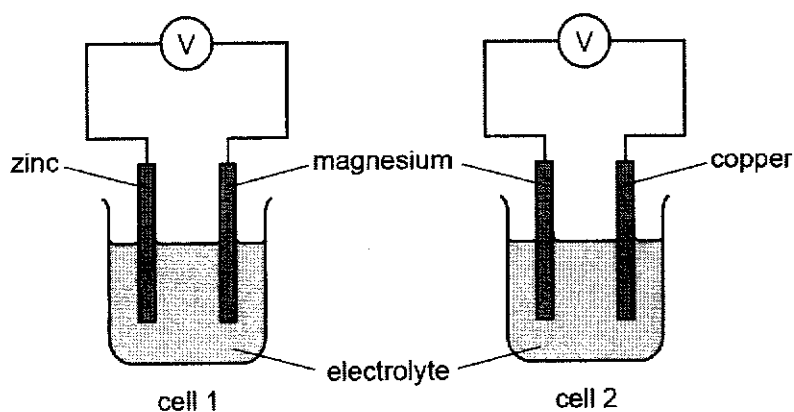
- 23 The diagram shows an experiment to electroplate a nickel spoon with silver.



Which row correctly describes the positive electrode, the negative electrode and the electrolyte?

	positive electrode	negative electrode	electrolyte
A	nickel spoon	pure nickel	silver nitrate solution
B	nickel spoon	pure silver	nickel nitrate solution
C	pure nickel	nickel spoon	silver nitrate solution
D	pure silver	nickel spoon	silver nitrate solution

- 24 The electrical energy, or voltage, of two simple cells is measured.



Which statement correctly describes the results of the experiment?

- A** The voltage of cell 1 is greater than cell 2.
B The electrolyte gradually turns blue in cell 2.
C Electrons flow from zinc to magnesium in cell 1.
D Magnesium loses electrons and undergoes oxidation in both cells.

25 Sodium and rubidium are elements in Group 1 of the Periodic Table.

Which statement is correct?

- A Sodium atoms have more electrons than rubidium atoms.
- B Sodium has a lower density than rubidium.
- C Sodium has a lower melting point than rubidium.
- D Sodium is more reactive than rubidium.

26 Elements X and Y are in Group 17 of the Periodic Table.

X is a liquid at room temperature. Y is a solid at room temperature.

Which statements are correct?

- 1 Atoms of Y have more protons than atoms of X.
- 2 Molecules of Y have more atoms than molecules of X.
- 3 Y displaces X from aqueous solutions of X^- ions.

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

27 The statements refer to a number of elements in the Periodic Table.

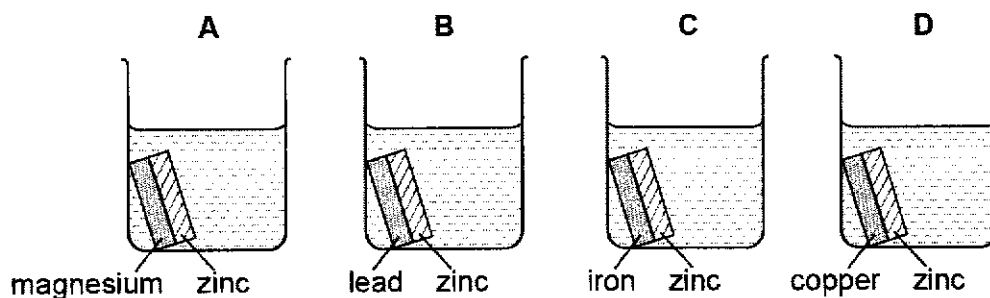
- 1 The elements form coloured compounds.
- 2 The elements have variable oxidation states.

For which pair of elements is each statement correct?

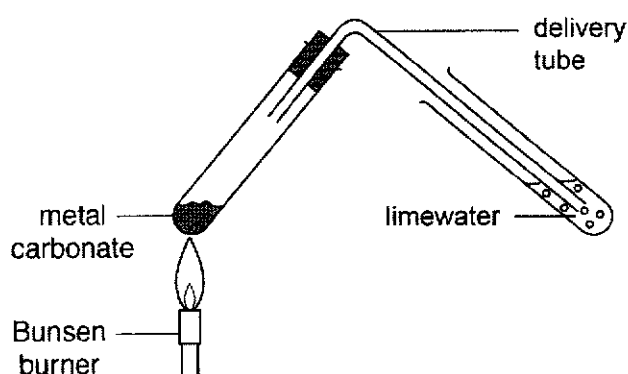
	form coloured compounds	have variable oxidation states
A	Co, Mg	Fe, Al
B	Fe, V	Co, Mn
C	Co, Mn	Mg, Al
D	Mg, Al	Fe, V

- 28 Each beaker contains two strips of metal fastened together and immersed in hydrochloric acid. All the strips are of the same size.

After 5 minutes, which beaker contains the least amount of zinc ions?



- 29 Three metal carbonates were each heated as shown below.

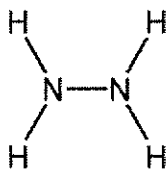


On mild heating of the carbonate of Y, a white precipitate formed in the limewater. Heating more strongly gave the same observation for the carbonate of X but not for the carbonate of Z.

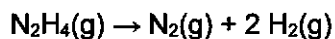
What could X, Y and Z be?

	X	Y	Z
A	Zn	Cu	Na
B	Zn	Na	Cu
C	Na	Zn	Cu
D	Na	Cu	Zn

- 30 The compound hydrazine is used as a rocket fuel. It has the structural formula shown.



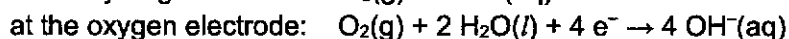
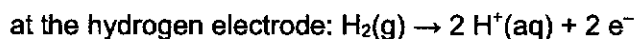
One of the reactions of hydrazine is shown.



	H—H	N—H	N—N	N≡N
bond energy in kJ / mol	436	390	160	945

What is the enthalpy change for this reaction?

- A –339 kJ/mol
 B –97 kJ/mol
 C +97 kJ/mol
 D +339 kJ/mol
- 31 When a hydrogen–oxygen fuel cell is in operation, a different reaction happens at each electrode.



The electrons that are lost at the hydrogen electrode travel through the external circuit to the oxygen electrode, where they are gained by the oxygen and water.

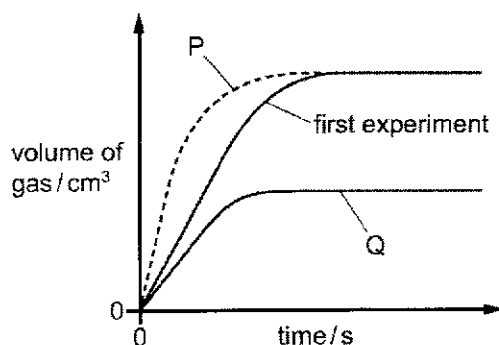
A hydrogen–oxygen fuel cell is operated for a period of time and 4 mol of oxygen molecules are consumed.

Which mass of hydrogen is consumed?

- A 2.0 g
 B 4.0 g
 C 8.0 g
 D 16.0 g

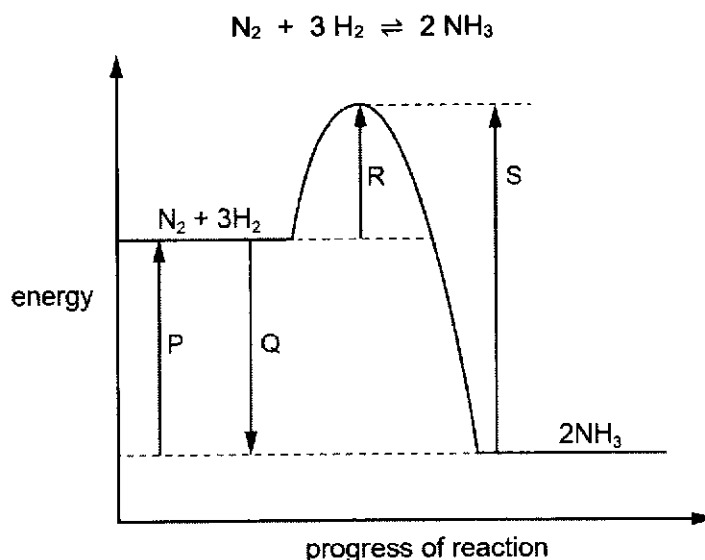
- 32 25 cm³ of 1.0 mol/dm³ hydrochloric acid reacts with excess of a solid to produce a gas.

The graph labelled first experiment shows the volume of gas produced over time. Graphs P and Q show the volume of gas produced under different conditions.



Which changes in conditions produce graphs P and Q, if all other conditions are kept the same?

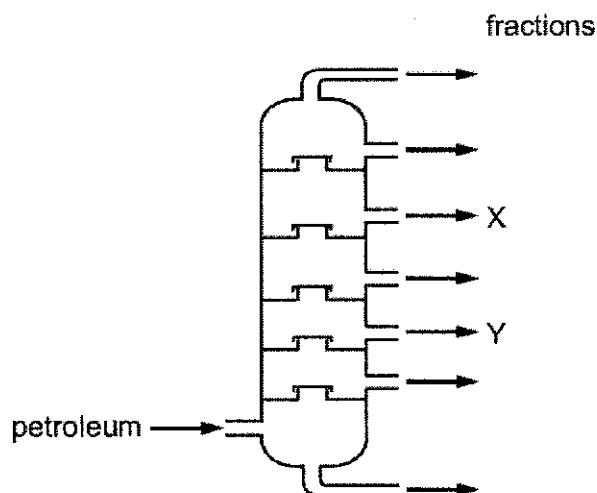
- A P uses a catalyst and Q has a lower temperature.
 B P uses 25 cm³ of more concentrated acid and Q uses smaller pieces of solid.
 C P uses a higher temperature and Q uses 25 cm³ of 0.5 mol/dm³ hydrochloric acid.
 D P uses smaller pieces of solid and Q uses larger pieces of solid.
- 33 The equation and the energy profile diagram for the reversible reaction in the Haber process are shown.



Which statement about the arrows P, Q, R and S is correct?

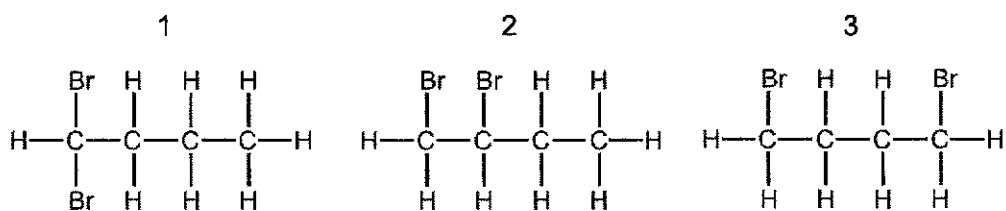
- A P represents the enthalpy change for the forward reaction.
 B Q represents the enthalpy change for both the forward and reverse reaction.
 C R represents the activation energy for both the forward and reverse reaction.
 D S represents the activation energy for the reverse reaction.

- 34 Petroleum (crude oil) is separated into useful fractions by fractional distillation. The positions at which fractions X and Y are collected from the fractionating column are shown.



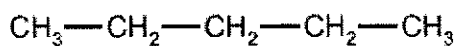
Which statement is correct?

- A The temperature increases up the column.
 B X condenses at a lower temperature than Y.
 C X has a higher boiling point than Y.
 D X has longer chain molecules than Y.
- 35 When butene reacts with bromine in an addition reaction, which compound could be made?



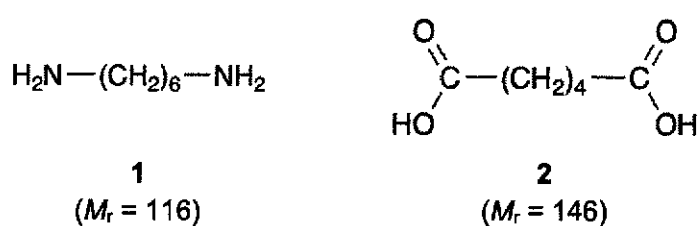
- A 1 only
 B 2 only
 C 2 and 3 only
 D 1, 2 and 3

- 36 Which structure is **not** an isomer of the structure shown?



- A
$$\begin{array}{c} \text{CH}_3\text{---CH}_2\text{---CH---CH}_3 \\ | \\ \text{CH}_3 \end{array}$$
- B
$$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{---C---CH}_3 \\ | \\ \text{CH}_3 \end{array}$$
- C
$$\begin{array}{c} \text{CH}_3\text{---CH}_2\text{---CH}_2\text{---CH}_2 \\ | \\ \text{CH}_3 \end{array}$$
- D
$$\begin{array}{c} \text{CH}_3\text{---CH---CH}_2\text{---CH}_3 \\ | \\ \text{CH}_3 \end{array}$$
- 37 In which chemical reaction does the named product formed have a lower molecular mass than the reactant?
- A the formation of an ester from ethanol
 B the formation of ethanoic acid from ethanol
 C the formation of ethanol from ethene
 D the formation of ethanol from glucose
- 38 Which bond in a molecule of propanoic acid is broken when it reacts with magnesium?
- A C–H bond
 B C–O bond
 C C–C bond
 D O–H bond

- 39 Molecule 1 and molecule 2 react together to make a condensation polymer.



What is the relative molecular mass of the repeating unit of the polymer formed from molecules 1 and 2?

- A 224
B 226
C 244
D 262
- 40 Catalytic converters in car exhausts change polluting gases into non-polluting gases.

Which statement(s) about oxides of nitrogen and car engines is/are correct?

- 1 The nitrogen in oxides of nitrogen comes from compounds in petrol.
- 2 The oxygen in oxides of nitrogen comes from the air in the car engine.
- 3 Catalytic converters convert oxides of nitrogen into nitrogen and other gases.

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

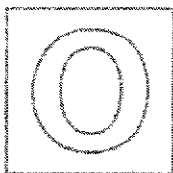
End of paper

The Periodic Table of Elements

Group																																																																													
1	2																17	18																																																											
		<table border="1" style="margin: auto;"> <tr> <td>1</td> <td>H</td> <td>hydrogen</td> <td>1</td> </tr> </table>															1	H	hydrogen	1																																																									
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		<table border="1" style="margin: auto;"> <tr> <th colspan="2">Key</th> <th>proton (atomic) number</th> <th>atomic symbol</th> <th>name</th> <th>relative atomic mass</th> </tr> </table>																Key		proton (atomic) number	atomic symbol	name	relative atomic mass																																																						
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Li lithium 7	Be beryllium 9	B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20	Na sodium 23	Mg magnesium 24	Al aluminium 27	Si silicon 28	P phosphorus 31	S sulfur 32	Cl chlorine 35.5	Ar argon 40																																																														
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36																																																												
K potassium 39	Ca calcium 40	Sc scandium 45	Ti titanium 48	V vanadium 51	Cr chromium 52	Mn manganese 55	Fe iron 56	Co cobalt 59	Ni nickel 59	Cu copper 64	Zn zinc 65	Ga gallium 70	Ge germanium 73	As arsenic 75	Se selenium 79	Br bromine 80	Kr krypton 84																																																												
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54																																																												
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 91	Nb niobium 93	Mo molybdenum 96	Tc technetium -	Ru ruthenium 101	Rh rhodium 103	Pd palladium 106	Ag silver 108	Cd cadmium 112	In indium 115	Sn tin 119	Sb antimony 122	Te tellurium 128	I iodine 127	Xe xenon 131																																																												
55	56	57-71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86																																																												
Cs caesium 133	Ba barium 137	lanthanoids	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195	Au gold 197	Hg mercury 201	Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium -	At astatine -	Rn radon -																																																												
87	88	89-103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118																																																												
Fr francium -	Ra radium -	actinoids	Rf rutherfordium -	Db dubnium -	Sg seaborgium -	Bh bohrium -	Hs hassium -	Mt meitnerium -	Ds darmstadtium -	Rg roentgenium -	Cn copernicium -	Nh nihonium -	Fl flerovium -	Mc moscovium -	Lv livermorium -	Ts tennessine -	Og oganesson -																																																												
		<table border="1" style="margin: auto;"> <tr> <td>57</td> <td>58</td> <td>59</td> <td>60</td> <td>61</td> <td>62</td> <td>63</td> <td>64</td> <td>65</td> <td>66</td> <td>67</td> <td>68</td> <td>69</td> <td>70</td> <td>71</td> </tr> <tr> <td>La lanthanum 139</td> <td>Ce cerium 140</td> <td>Pr praseodymium 141</td> <td>Nd neodymium 144</td> <td>Pm promethium -</td> <td>Sm samarium 150</td> <td>Eu europium 152</td> <td>Gd gadolinium 157</td> <td>Tb terbium 159</td> <td>Dy dysprosium 163</td> <td>Ho holmium 165</td> <td>Er erbium 167</td> <td>Tm thulium 169</td> <td>Yb ytterbium 173</td> <td>Lu lutetium 175</td> </tr> <tr> <td>89</td> <td>90</td> <td>91</td> <td>92</td> <td>93</td> <td>94</td> <td>95</td> <td>96</td> <td>97</td> <td>98</td> <td>99</td> <td>100</td> <td>101</td> <td>102</td> <td>103</td> </tr> <tr> <td>Ac actinium -</td> <td>Th thorium 232</td> <td>Pa protactinium 231</td> <td>U uranium 238</td> <td>Np neptunium -</td> <td>Pu plutonium -</td> <td>Am americium -</td> <td>Cm curium -</td> <td>Bk berkelium -</td> <td>Cf californium -</td> <td>Es einsteinium -</td> <td>Fm fermium -</td> <td>Md mendelevium -</td> <td>No nobelium -</td> <td>Lr lawrencium -</td> </tr> </table>																57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	La lanthanum 139	Ce cerium 140	Pr praseodymium 141	Nd neodymium 144	Pm promethium -	Sm samarium 150	Eu europium 152	Gd gadolinium 157	Tb terbium 159	Dy dysprosium 163	Ho holmium 165	Er erbium 167	Tm thulium 169	Yb ytterbium 173	Lu lutetium 175	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	Ac actinium -	Th thorium 232	Pa protactinium 231	U uranium 238	Np neptunium -	Pu plutonium -	Am americium -	Cm curium -	Bk berkelium -	Cf californium -	Es einsteinium -	Fm fermium -	Md mendelevium -	No nobelium -	Lr lawrencium -
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71																																																															
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The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

The Avogadro constant, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$



GAN ENG SENG SCHOOL
Preliminary Examination 2024



**CANDIDATE
NAME**

CLASS

**INDEX
NUMBER**

CHEMISTRY

Paper 2

6092/02

21 August 2024

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.

Write in dark blue or black pen.

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

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

Section A

Answer **all** questions.

Write your answers in the spaces provided.

Section B

Answer **one** question.

Write your answers in the spaces provided.

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

A copy of the Periodic Table is printed on page 23.

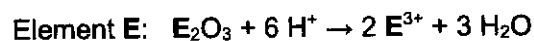
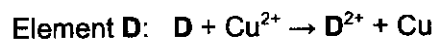
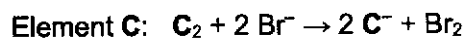
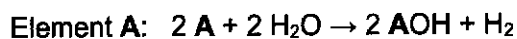
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	70
Section B Q9 Q10 <i>*Circle where appropriate</i>	10
Total	80

Section A

Answer all questions.

- 1 The equations below show reactions involving elements **A** to **E**.



Each letter represents an element found in **Period 3** of the Periodic Table (sodium to argon). The letters do not represent the actual symbols of the elements.

- (a) Identify elements **A** to **E**.

A

B

C

D

E

[5]

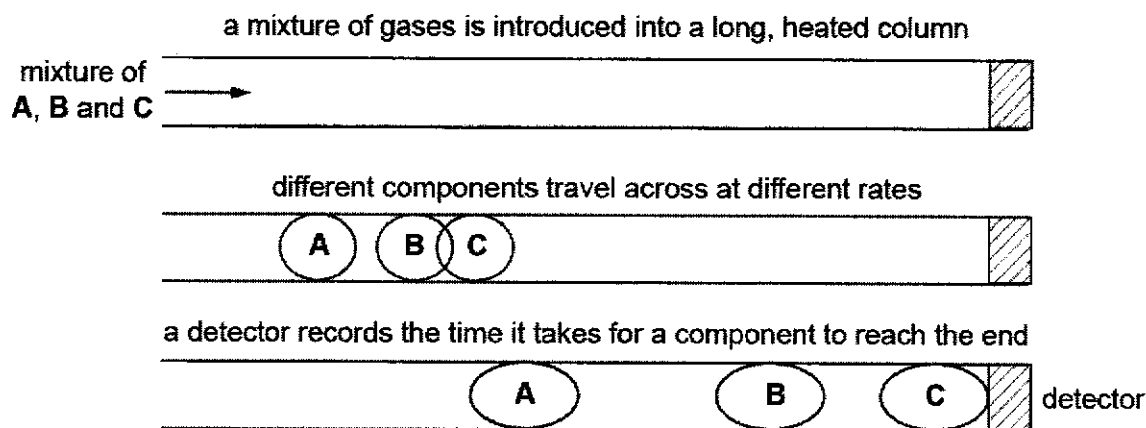
- (b) Classify each element as having undergone oxidation, reduction or neither. Put a tick (✓) in each row.

element	undergone oxidation	undergone reduction	neither oxidised nor reduced
A			
B			
C			
D			
E			

[3]

[Total: 8]

- 2 Gas chromatography can be used to separate a mixture of gases as shown below.



The retention time is the time it takes each component to travel through the column.

- (a) The gases entering the column must be dry to avoid interference from water molecules.

Suggest how the gases may be dried.

..... [1]

- (b) Vegetable oils can be changed into bio-diesel for use in diesel engines.

Gas chromatography is used to identify the methyl esters in a sample of bio-diesel.

The table shows the retention time for three methyl esters.

methyl ester	M_r	retention time / min
lauric	214	1.6
palmitic	270	3.1
stearic	298	3.9

One factor affecting retention time is the rate of diffusion.

- (i) The data in the table suggests a correlation between the relative molecular mass and the retention time.

Describe this correlation.

..... [1]

4

- (ii) The experiment is repeated with the column at a higher temperature.

Suggest and explain how this will affect the retention times.

.....

.....

.....

.....

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.....

.....

[3]

- (c) Unlike gas chromatography, paper chromatography compares R_f values instead of retention times.

Besides temperature, state one factor that affects R_f values.

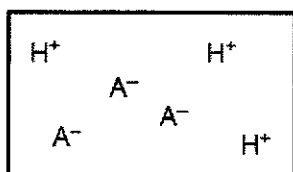
.....

[1]

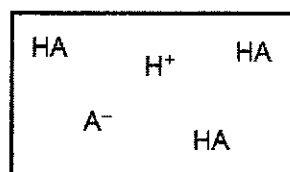
[Total: 6]

5

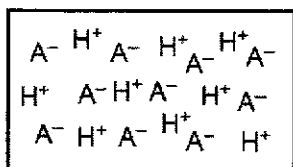
- 3 The diagrams show four different types of acid solutions. The acid molecule is represented as HA. The ions formed in solution are represented as H^+ and A^- .



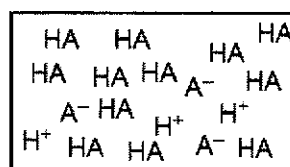
1



2



3



4

- (a) State which diagram represents a dilute solution of a weak acid. Explain your answer.

.....

[3]

- (b) Explain why sulfuric acid is not represented by the diagrams above.

.....

[2]

- (c) Equal volumes of ethanoic acid and hydrochloric acid of the same concentration was allowed to react completely with magnesium.

State, with a reason, whether the volume of hydrogen gas produced will differ.

.....

[1]

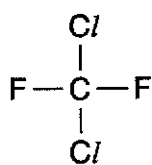
- (d) An unknown bottle is suspected to contain dilute sulfuric acid. Outline a chemical test that can be used to confirm this.

.....

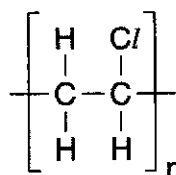
[2]

[Total: 8]

- 4 Two chlorine-containing organic molecules shown below are known to cause harm to the environment.

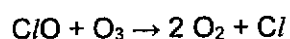
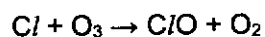


dichlorodifluoromethane (CFC-12)



polyvinyl chloride (PVC)

- (a) In the presence of sunlight, CFC-12 decomposes into chlorine atoms, which deplete the ozone layer by causing the breakdown of ozone in a two-step reaction.



- (i) Explain why the depletion of the ozone layer would be undesirable to humans.

.....

 [2]

- (ii) Use the equations to write an overall equation for the reaction.

..... [2]

- (iii) Explain how the equations show that chlorine atoms act as a catalyst for the breakdown of ozone.

..... [1]

- (iv) Chlorine exists as two stable isotopes, with chlorine-35 (^{35}Cl) reacting faster with ozone than chlorine-37 (^{37}Cl). Studying the ^{37}Cl to ^{35}Cl ratio helps scientists model the rate of ozone depletion more accurately.

Complete Table 4.1 to show the number of subatomic particles in each isotope of chlorine.

Table 4.1

isotope	^{35}Cl	^{37}Cl
number of electrons		
number of neutrons		
number of protons		

[2]

- (b) (i) Draw the structure of the monomer used to make polyvinyl chloride (PVC).

[1]

- (ii) Describe one pollution problem caused by non-biodegradable plastics such as polyvinyl chloride (PVC).

.....

[1]

- (iii) The best way of disposing of plastic waste is recycling to form new plastics. State an advantage of recycling plastics made from petroleum.

.....

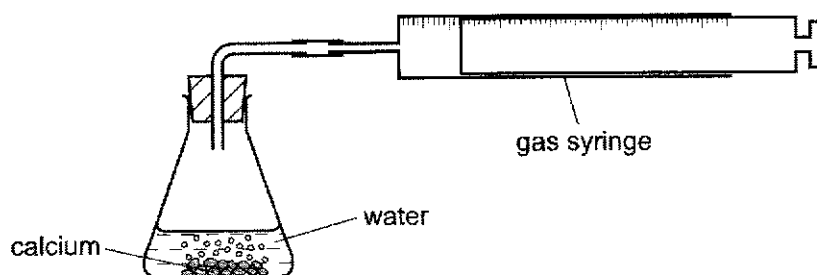
[1]

[Total: 10]

5 The reaction between metals and water can be studied using the apparatus shown.

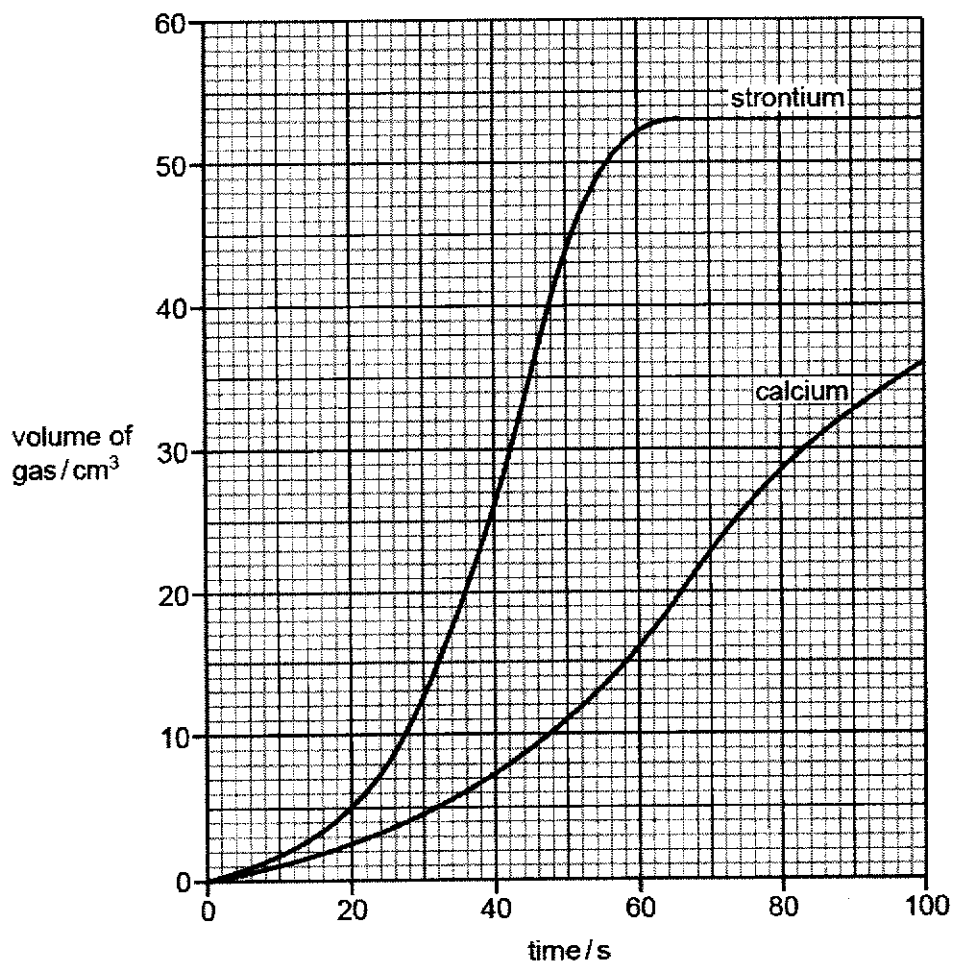
A fixed mass of calcium was allowed to react completely with water.

The volume of gas given off was recorded at fixed time intervals during the reaction.



The experiment was repeated using strontium but keeping all the conditions the same.

The graph obtained from the results is shown below.



(a) Explain how the graph shows that strontium is more reactive than calcium.

.....

.....

[1]

- (i) Calculate the average rate of reaction, in cm^3/s , for the reaction between strontium and water.

average rate of reaction = cm^3/s [1]

- (ii) Explain how the graph shows that the reaction between calcium and water was **not** complete at 100 seconds after the reaction started.

.....
 [1]

- (b) The solution formed at the end of the reaction between strontium and water was tested with Universal Indicator. The indicator turned purple.

Explain this observation with the aid of a chemical equation.

.....

 [3]

- (c) The electrolysis of a molten electrolyte is one method of extracting a metal from its ore. Other methods are the electrolysis of an aqueous solution and the reduction of the oxide by carbon.

Explain why these last two methods cannot be used to extract strontium from strontium oxide.

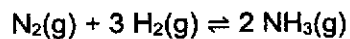
electrolysis of an aqueous solution

reduction of the oxide by carbon

[2]

[Total: 8]

- 6 Ammonia is manufactured by the Haber Process.
The equation for the reaction is shown.



The economics of this process require that as much ammonia as possible is made as quickly as possible.

The percentage yield of ammonia varies with conditions.

pressure / atm	100	200	300	400
% ammonia at 300 °C	45	65	72	78
% ammonia at 500 °C	9	18	25	31

- (a) Describe how hydrogen is obtained for the Haber process.

..... [1]

- (b) Use the electronic structure of nitrogen to explain why the formula of ammonia is NH_3 not NH_4 .

.....

 [2]

- (c) Describe the effect of changing temperature on the percentage yield of ammonia.

..... [1]

- (d) (i) Explain, in terms of particles, what happens to the rate of this reaction when the pressure is increased.

.....

 [3]

(ii) State one other advantage of using a high pressure.

..... [1]

(iii) The conditions actually used are 200 atmospheres, 450 °C and finely divided iron catalyst.

Suggest one reason why a pressure higher than 200 atmospheres is not used in the Haber process.

.....
..... [1]

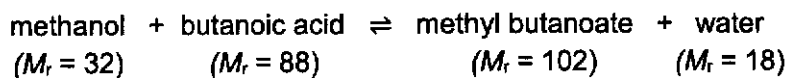
(e) State what happens to the unreacted nitrogen and hydrogen.

..... [1]

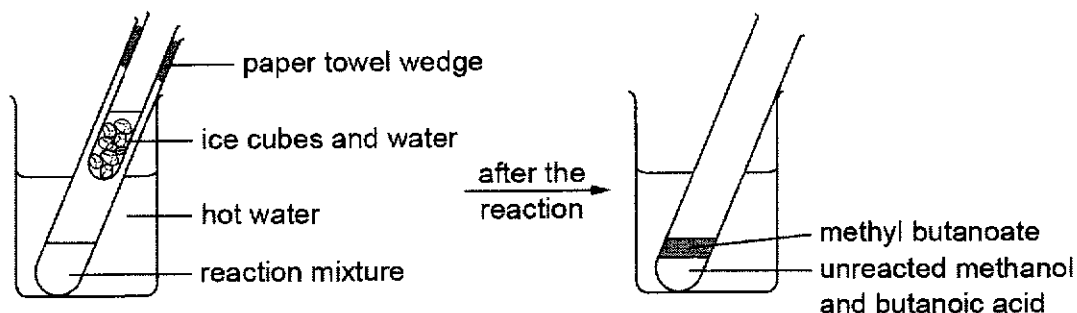
[Total: 10]

- 7 Chemists use esterification reactions to create various pleasant-smelling esters, which are essential components of many artificial and natural flavours.

One such ester, methyl butanoate, is a key contributor to the characteristic aroma of raspberries. It is made by reacting methanol with butanoic acid.



The diagram of the experiment is shown below.



- (a) Draw the full structural formula of methyl butanoate.

[1]

- (b) Suggest the purpose of the test-tube containing ice cubes and water in the set-up.

.....

..... [1]

- (c) Based on the information above, explain why an ester can be separated from the mixture using a separating funnel.

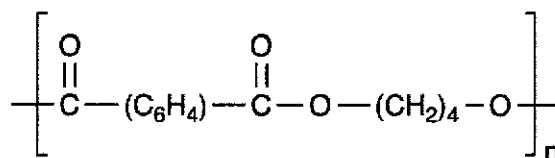
..... [1]

- (d) In an experiment, 2.0 g of methanol was reacted with excess butanoic acid to produce methyl butanoate. However, only 1.0 g of methyl butanoate was isolated after purification.

Calculate the percentage yield of the reaction.

percentage yield = % [3]

- (e) Polyethylene terephthalate is a polyester used in fibres for clothing, containers for liquids and food.



polyethylene terephthalate (PET)

Outline **one** similarity and **one** difference in the formation of methyl butanoate and polyethylene terephthalate from their respective reactant molecules.

.....

.....

.....

..... [2]

[Total: 8]

8 How carbon dioxide affects the oceans

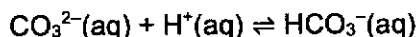
The oceans act as a carbon sink, absorbing much of the CO_2 produced from burning fossil fuels. When CO_2 dissolves in water, carbonic acid, H_2CO_3 is formed.



H_2CO_3 dissociates in water to form bicarbonate ions, HCO_3^- and hydrogen ions, H^+ . When atmospheric CO_2 levels increase, more CO_2 dissolves into ocean waters, decreasing the pH of the oceans.



The ocean naturally contains carbonate ions, CO_3^{2-} , which shell-making marine organisms use to build their calcium carbonate shells. However, when the pH of the ocean decreases, the excess H^+ ions consume the CO_3^{2-} ions available to these organisms.



A Bjerrum plot (Fig 8.1) shows the percentage of each carbon-containing species at different pH.

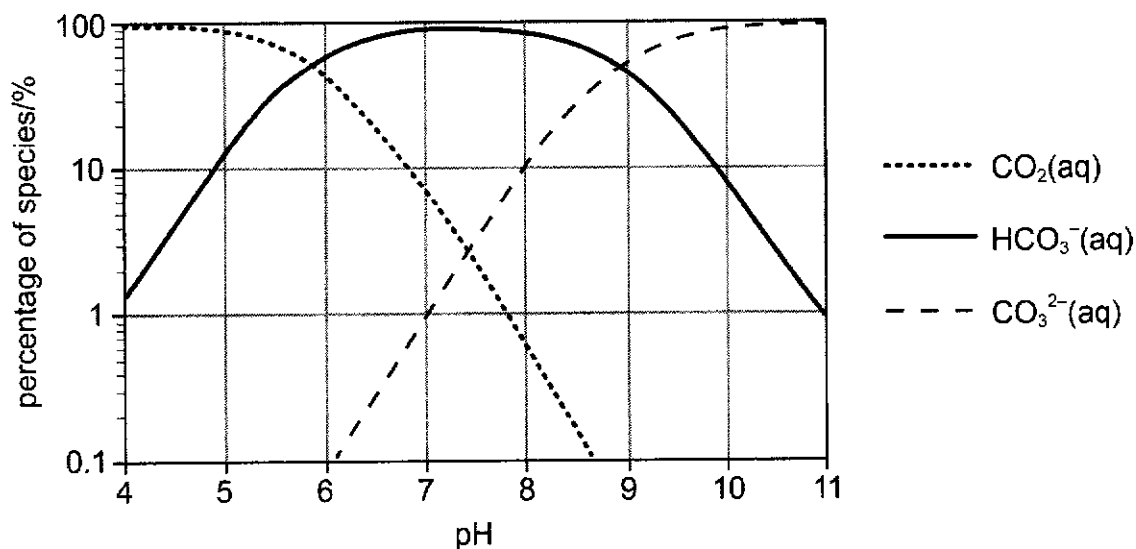


Fig. 8.1: Bjerrum plot

The uptake of CO_2 by seawater has led to the average ocean surface pH falling from 8.2 to 8.1 in the last 200 years. While this change may seem small, it represents an approximate increase of 30% in acidity. Besides far-reaching implications for marine creatures, there is a limit to the capacity of the oceans to absorb CO_2 , unless the CO_2 is simultaneously removed.

Removing CO_2 from oceans

Singapore produces over 50 million tonnes of CO_2 annually. Scientists are exploring the use of electrolytic processes to remove CO_2 from the oceans to expand the ocean's capacity to absorb more CO_2 . By 2025, the world's largest ocean-based CO_2 removal plant, dubbed the Equatic-1, will be built in Singapore. The facility can remove 10 tonnes of CO_2 per day from

seawater and the atmosphere. This will bring Singapore closer towards the target of achieving net zero emissions by 2050.

A scheme of the process used by Equatic-1 is shown in Fig. 8.2.

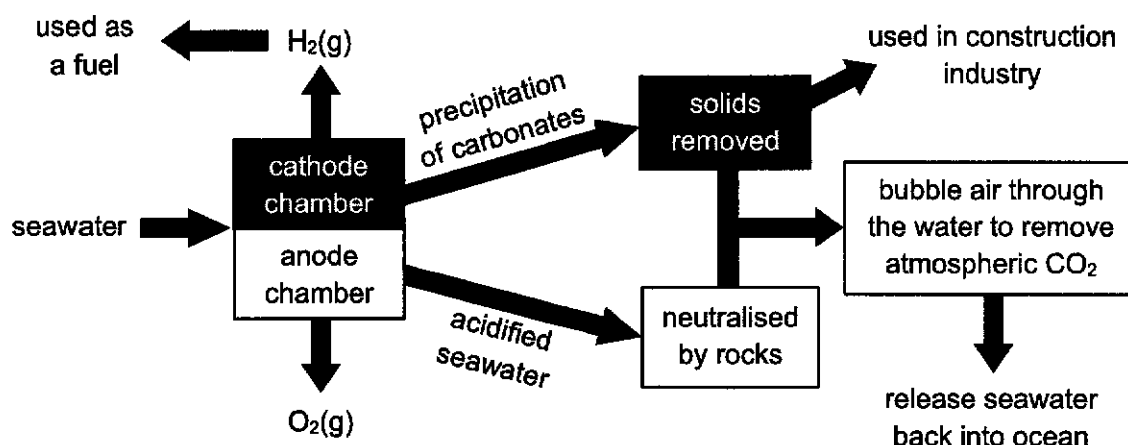


Fig. 8.2

Seawater from the adjacent PUB desalination plants enters the cathode and anode chambers where water is electrolysed and decomposed into oxygen and hydrogen.

In the cathode chamber, the water flows through a porous electrode. The electrode surface is continuously scraped with a blade that dislodges accumulated solids and re-exposes the mesh surface. These metal carbonates could potentially be used in the construction industry for land restoration, cement, or concrete.

The concentration of ions in seawater is shown in Table 8.3.

Table 8.3: Concentration of ions in seawater

cation	concentration (mg/dm ³)	anion	concentration (mg/dm ³)
Na ⁺	10600	Cl ⁻	19000
Mg ²⁺	1260	SO ₄ ²⁻	2650
Ca ²⁺	400	HCO ₃ ⁻	140
K ⁺	380	Br ⁻	65

The anode is covered with an oxygen evolution selective coating to ensure that oxygen gas is produced. As the mixture exiting the anode chamber is acidic, the natural alkalinity and composition of seawater is restored by dissolving alkaline rocks such as Mg₂SiO₄(s) (forsterite) and CaAl₂Si₂O₈(s) (anorthite) before releasing the seawater back into the ocean.

- (a) Based on information in Fig. 8.1, arrange, in increasing order, the percentage of $\text{CO}_2(\text{aq})$, $\text{HCO}_3^-(\text{aq})$ and $\text{CO}_3^{2-}(\text{aq})$ in naturally-occurring seawater.

..... [1]

- (b) Explain, with the aid of a half equation, why the pH increases at the cathode chamber during electrolysis.

.....

 [2]

- (c) Explain, using information in Fig. 8.1 and Table 8.3, why the increase in pH at the cathode would result in the precipitation of metal carbonates. You should identify the metal carbonates in your answer.

.....

 [2]

- (d) Deduce, using information from Table 8.3, the gas that would be produced in significant quantity in the anode chamber without the oxygen evolution selective coating. Explain your reasoning.

.....

 [2]

- (e) A silicate is a polyatomic anion consisting of silicon and oxygen, with the general formula $[\text{SiO}_{(4-x)}^{(4-2x)-}]_n$ where n is a whole number and $0 \leq x < 2$.

Show, using values of n and x , that forsterite and anorthite are silicates.

.....

 [2]

- (f) Discuss whether the Equatic-1 facility in Singapore would better manage the carbon cycle to result in human lifestyles becoming more environmentally sustainable.

.....

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[3]

[Total: 12]

Section B

Answer one question from this section.

- 9 Calcium nitrate, $\text{Ca}(\text{NO}_3)_2$, and ammonium nitrate, NH_4NO_3 , are ionic compounds which are used to make fertilisers.

Fig. 9.1 shows how the ions are arranged in a solid, ionic compound.

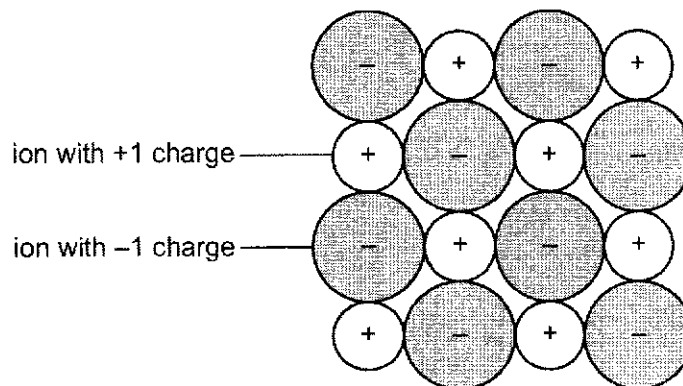


Fig. 9.1

- (a) Give two reasons why Fig. 9.1 is a better representation for the ions in solid ammonium nitrate, NH_4NO_3 , than the ions in solid calcium nitrate, $\text{Ca}(\text{NO}_3)_2$.

.....

.....

.....

.....

[2]

- (b) In Fig. 9.1 the ions are shown far larger than they actually are.

Suggest one other reason why Fig. 9.1 does not accurately represent a solid ionic compound.

.....

.....

[1]

The overall energy changes that happen when solid fertilisers dissolve in water are related to bond breaking and bond forming processes.

Fig. 9.2 shows the process of a solid ionic compound dissolving in water.

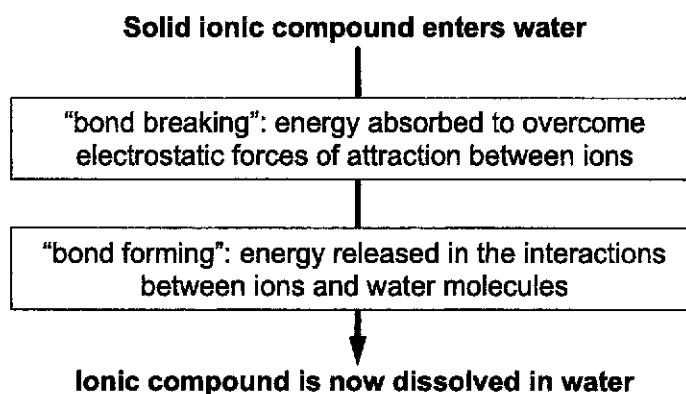


Fig. 9.2

Fig. 9.3 shows the overall energy changes when solid calcium nitrate and solid ammonium nitrate dissolve in water.

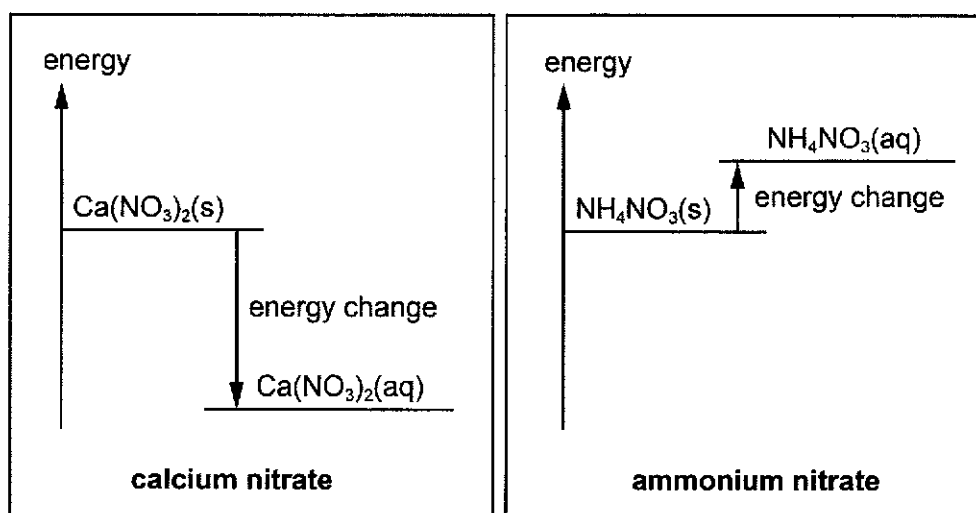


Fig. 9.3

- (c) Using Fig. 9.2 and Fig. 9.3, describe and explain the differences in the overall energy changes when calcium nitrate and ammonium nitrate dissolve in water.

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.....
.....
.....

[4]

- (d) (i) Describe the steps required to prepare a solution of calcium nitrate, starting with powdered calcium carbonate.

.....
.....
.....

[2]

- (ii) Ammonium nitrate can be prepared by the method of titration.

Suggest a suitable pair of reagents that react to produce ammonium nitrate.

.....

[1]

[Total: 10]

10 The table shows information about some alkanes.

alkane	molecular formula	melting point / °C	physical state at 25 °C
methane	CH ₄	-182	gas
propane	C ₃ H ₈	-190	gas
butane	C ₄ H ₁₀	-138	gas
octane	C ₈ H ₁₈	-57	liquid
pentacontane	C ₅₀ H ₁₀₂	93	solid

(a) (i) State the empirical formula of pentacontane.

..... [1]

(ii) The empirical formulae of methane and propane are the same as their molecular formulae.

Explain why.

.....
..... [1]

(b) Explain, in terms of structure and bonding, why the melting points of the alkanes are generally low.

.....
.....
..... [2]

- (c) A textbook has this description of a homologous series.

A homologous series contains compounds with similar structures, the same general formula and similar chemical properties. The compounds show a trend in physical properties down the series.

Use your own knowledge and the information in the table to explain how the alkanes match this description of a homologous series.

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[4]

- (d) Petrol companies 'crack' larger molecules like pentacontane to make smaller molecules such as octane.

Explain why 'cracking' makes the business more profitable and better for the environment.

.....

.....

.....

.....

.....

[2]

[Total: 10]

End of paper

The Periodic Table of Elements

		Group																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
								1 H hydrogen 1									2 He helium 4	
3 Li lithium 7	4 Be beryllium 9																	
11 Na sodium 23	12 Mg magnesium 24																	
19 K potassium 39	20 Ca calcium 40	3 Sc scandium 45	4 Ti titanium 48	5 V vanadium 51	6 Cr chromium 52	7 Mn manganese 55	8 Fe iron 56	9 Co cobalt 59	10 Ni nickel 59	11 Cu copper 64	12 Zn zinc 65	13 B boron 11	14 C carbon 12	15 N nitrogen 14	16 O oxygen 16	17 F fluorine 19	18 Ne neon 20	
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 -	113 Nh nihonium -	114 Fl flerovium -	115 Mc moscovium -	116 Lv livermorium -	117 Ts tennessine -	118 Og oganeson -	

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 dm³ at room temperature and pressure (r.t.p.).

The Avogadro constant, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$

**GESS Sec 4 Chemistry (6092) Preliminary Exams 2024
Suggested Solutions****PAPER 1**

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

Question	Answer	Explanation
1	A	Option A is correct as the burette can measure variable volumes of a liquid in a titration. Option B is incorrect because the 0.24 dm^3 is equivalent to 240 cm^3 which exceeds the capacity of the gas syringe. Option D is incorrect as a pipette can only measure a fixed volume of a liquid depending on its size, in this case 25.0 cm^3 .
2	B	Q has a lower R_f value than R as it travelled a shorter distance from the start line.
3	B	The mixture is heated using a water bath, hence any substance with a boiling point above $100 \text{ }^\circ\text{C}$ (i.e. C & D) cannot be distilled. Substance A is a gas at room temperature.
4	C	The transition from (s) \rightarrow (l) \rightarrow (g) is endothermic as energy is absorbed to overcome forces of attraction between the particles.
5	B	A mixture of solid and liquid exists at the melting point/freezing point, which occurs at $50 \text{ }^\circ\text{C}$.
6	B	Since the ion has a charge of $3+$, it means that Z would have lost 3 electrons, and is therefore in Group 13. Since the ion has 2 electron shells, Z must have had three electron shells in total and is hence in Period 3.
7	C	Sea water is a mixture; sodium chloride is a compound and chlorine is an element.
8	D	In graphite, each carbon atom is only bonded to three other carbon atoms, leaving one electron per carbon atom not involved in bonding. The electrons which are not involved in bonding are delocalised, acting as mobile charged carriers. Metals such as aluminium have a sea of delocalised electrons which act as mobile charged carriers. Ionic compounds conduct electricity due to the presence of mobile ions.
9	A	The electronic structure of oxygen is 2,6. It needs 2 more electrons to have a fully-filled valence shell. Each oxygen atom forms 2 covalent bonds. The electronic structure of chlorine is 2,8,7. It needs 1 more electron to have a fully-filled valence shell. Each chlorine atom forms 1 covalent bond. This results in a structure with the formula Cl_2O .
10	D	Both silicon and carbon are in Group 14, hence SiO_2 and diamond both have a giant covalent structure where the atoms around Si and C are in a tetrahedral arrangement, i.e. each Si and C atom forms 4 covalent bonds. For giant covalent structures, there are no intermolecular forces of attraction as all the atoms are joined via covalent bonds. Melting requires breaking these covalent bonds.
11	A	$n_{\text{O}_2} = 500/24000 = 0.020833 \text{ mol}$ 1 mol contains 6.02×10^{23} molecules. Hence, number of molecules = $0.020833 \times 6.02 \times 10^{23} = 1.254 \times 10^{22}$

12	A	The sum of the relative molecular masses of Mg atoms in a molecule of chlorophyll-a is $\frac{2.69}{100} \times 893 = 24.02$. Since the A_r of a Mg atom is 24, there is only one Mg atom.															
13	C	concentration of saline in $\text{g/dm}^3 = \frac{0.9}{\frac{100}{1000}} = 9 \text{ g/dm}^3$ concentration of saline in $\text{mol/dm}^3 = \frac{9}{23+35.5} = 0.1538 \text{ mol/dm}^3$															
14	A	$n_{\text{H}_2} = \frac{8}{2} = 4 \text{ mol}$ $n_{\text{O}_2} = \frac{8}{32} = 0.25 \text{ mol}$ (limiting reactant) $n_{\text{H}_2\text{O}} \text{ formed} = 0.5 \text{ mol}$ mass of $\text{H}_2\text{O} = 0.5 \times 18 = 9 \text{ g}$															
15	A	Quicklime (CaO) or slaked lime (Ca(OH)_2) are both used by farmers to neutralise the excess acids in the soil, raising the pH.															
16	C	The pH at which the indicator changes colour must fall within the region of drastic pH change in the titration graph. This is where the 'step' occurs, in this case it spans the range of around pH 5 to 11.															
17	D	Copper is an unreactive metal, hence it does not react with acids. To prepare copper(II) sulfate, we add excess copper(II) oxide, copper(II) carbonate or copper(II) hydroxide to ensure all the acid is reacted. We then filter the mixture to remove the excess solid, collect the filtrate and carry out crystallisation on the filtrate.															
18	A	Ammonia turns moist red litmus paper blue, while chlorine bleaches both blue and red litmus papers.															
19	A	Y must be an acid since a gas is produced when reacted with a carbonate. Y also contains nitrate ions as ammonia gas is given off when the solution is warmed with aluminium and sodium hydroxide.															
20	C	In the chapter of Acids and Bases, we learnt that alkalis dissociate in water to give OH^- ions: $\text{NaOH(aq)} \rightarrow \text{Na}^+(\text{aq}) + \text{OH}^-(\text{aq})$ $\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$ We also know that most metal hydroxides are insoluble in water. Hence, the green precipitate is Fe(OH)_2 . The green precipitate slowly turns reddish-brown in air (oxidation). $4 \text{Fe(OH)}_2(\text{s}) + \text{O}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow 4 \text{Fe(OH)}_3(\text{s})$															
21	B	CO acts as a reducing agent as it causes Fe_2O_3 to be reduced to Fe . This is seen in the oxidation state of iron decreasing from +3 in Fe_2O_3 to 0 in Fe .															
22	A	<table border="1"> <thead> <tr> <th></th> <th>positive (+) electrode X</th> <th>negative (-) electrode Y</th> </tr> </thead> <tbody> <tr> <td>Ions attracted</td> <td>Br^-</td> <td>Pb^{2+}</td> </tr> <tr> <td>Half equation</td> <td>$2\text{Br}^-(\text{l}) \rightarrow \text{Br}_2(\text{g}) + 2\text{e}^-$</td> <td>$\text{Pb}^{2+}(\text{l}) + 2\text{e}^- \rightarrow \text{Pb}(\text{l})$</td> </tr> <tr> <td>Nature of reaction</td> <td>Oxidation</td> <td>Reduction</td> </tr> <tr> <td>Anode or cathode?</td> <td>Anode</td> <td>Cathode</td> </tr> </tbody> </table>		positive (+) electrode X	negative (-) electrode Y	Ions attracted	Br^-	Pb^{2+}	Half equation	$2\text{Br}^-(\text{l}) \rightarrow \text{Br}_2(\text{g}) + 2\text{e}^-$	$\text{Pb}^{2+}(\text{l}) + 2\text{e}^- \rightarrow \text{Pb}(\text{l})$	Nature of reaction	Oxidation	Reduction	Anode or cathode?	Anode	Cathode
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Overall reaction	$\text{PbBr}_2(l) \rightarrow \text{Pb}(l) + \text{Br}_2(g)$							
23	D	<p>In electroplating, the object to be electroplated is always placed at the cathode (negative electrode), so that reduction of cations at the cathode will result in a solid deposit/coating around the object. The anode (positive electrode) is the metal used for electroplating. Oxidation at the anode replenishes the electrolyte with the cations.</p> <p>anode: $\text{Ag}(s) \rightarrow \text{Ag}^+(aq) + e^-$ cathode: $\text{Ag}^+(aq) + e^- \rightarrow \text{Ag}(s)$</p>						
24	D	<p>In a simple cell, the larger the difference in reactivity of the two metal electrodes, the greater the voltage. Hence the voltage of cell 1 < cell 2.</p> <p>In both cells, magnesium is the more reactive metal and hence undergoes oxidation: $\text{Mg}(s) \rightarrow \text{Mg}^{2+}(aq) + 2e^-$. Mg^{2+} ions enter the electrolyte, which does not result in a colour change. Electrons flow from the more reactive metal (magnesium) to the other electrode.</p>						
25	B	<p>Trends going down Group 1:</p> <ul style="list-style-type: none"> • Melting and boiling points decrease • Density increases • Reactivity increases 						
26	A	<p>Statement 1 is true. Melting and boiling points increases down the group. Since X is a liquid, it must be Br_2. Y, being a solid, must be below X in the Periodic Table.</p> <p>Statement 2 is false. All Group 17 elements are diatomic, meaning they are diatomic molecules which consist of two atoms covalently bonded.</p> <p>Statement 3 is false. Reactivity decreases down the group. Y is less reactive than X. Hence Y cannot displace X from its solution.</p>						
27	B	The two properties are characteristic of transition metals. Option B is the only one where all examples are transition metals.						
28	A	<p>This is a question on sacrificial protection. In the presence of an acid, the more reactive metal is preferentially oxidised:</p> $\text{M}(s) + 2\text{H}^+(aq) \rightarrow \text{M}^{2+}(aq) + \text{H}_2(g)$ <p>Given that all beakers contain zinc, the beaker where Zn is least likely to be oxidised is where there is a more reactive metal present, i.e. Mg.</p>						
29	A	The more reactive the metal, the more thermally stable the compound and the harder it is to decompose the carbonate. Z is the most stable carbonate (Na_2CO_3) while Y is the least stable carbonate (CuCO_3).						
30	B	<p>Energy absorbed during bond breaking $= 4\text{BE}(\text{H}-\text{H}) + \text{BE}(\text{N}-\text{N}) = 4(390) + 160 = 1720 \text{ kJ/mol}$</p> <p>Energy released during bond forming $= \text{BE}(\text{N}\equiv\text{N}) + 2\text{BE}(\text{H}-\text{H}) = 945 + 2(436) = 1817 \text{ kJ/mol}$</p>						

		Enthalpy change = +1720 – 1817 = –97 kJ/mol
31	D	$n_{\text{O}_2} = 4 \text{ mol}$ mole ratio of $\text{O}_2 : e^- = 1:4$ $ne^- = 16 \text{ mol}$ mole ratio of $e^- : \text{H}_2 = 2:1$ $n_{\text{H}_2} = 8 \text{ mol}$ Mass of $\text{H}_2 = 8 \times 2 = 16 \text{ g}$
32	C	Option A, B and D are incorrect as a lower temperature or different particle size will not change the yield. HCl is the limiting reactant. Hence to produce curve Q, a lower number of moles of HCl is used.
33	D	P represents the enthalpy change for the <i>backward</i> reaction. Q represents the enthalpy change for the <i>forward</i> reaction. R represents the activation energy for the <i>forward</i> reaction.
34	B	The temperature at the top of the column is lower. Smaller molecules with lower boiling points condense higher up the column. Hence, X has a lower boiling point range and consists of short chain hydrocarbons than Y.
35	B	In an addition reaction, the two bromine atoms are added across the double bond. They must be on <u>adjacent</u> carbon atoms.
36	C	Option C is the same molecule as it consists of a continuous chain of 5 carbon atoms.
37	D	A: Since the formation of an ester involves condensation of a carboxylic acid with ethanol, the M_r increases. B: The M_r of ethanoic acid is 60 while the M_r of ethanol is 46. C: The M_r of ethanol is 46 while the M_r of ethene is 28. D: The M_r of ethanol is 46 while the M_r of glucose is 180.
38	D	When a carboxylic acid dissociates, the O–H bond of the –COOH functional group is broken. The example shown below is for ethanoic acid. <div style="text-align: center;"> </div>
39	B	The structure of the repeating unit is: <div style="text-align: center;"> </div> Subtract the atoms that are lost in the condensation reaction. Therefore, the M_r is $116 + 146 - [1 + 1 + 16 + 1 + 16 + 1]$
40	D	Under high temperature conditions in the car engine, nitrogen and oxygen in the air react to form oxides of nitrogen. In the catalytic converter, carbon monoxide is oxidised to carbon dioxide, oxides of nitrogen are reduced to nitrogen. $2 \text{NO(g)} + 2 \text{CO(g)} \rightarrow \text{N}_2\text{(g)} + 2 \text{CO}_2\text{(g)}$

PAPER 2

- 1 (a) A sodium
 B sulfur / silicon
 C chlorine
 D magnesium
 E aluminium [5]

ALLOW symbol of element

(b)

element	undergone oxidation	undergone reduction	neither oxidised nor reduced
A	✓		
B			✓
C		✓	
D	✓		
E			✓

Any 2 correct = 1 m; all 5 correct = 3 m

[3]

[Total: 8]

- 2 (a) the gases may be passed through anhydrous/fused calcium chloride / quicklime / bubbled into/passed through concentrated sulfuric acid

Note: Question asks 'how' therefore stating the chemical alone is not sufficient [1]

- (b) (i) higher M_r , longer retention time / longer time taken for component to travel through the column [1]

(ii) shorter retention time [1]
 (kinetic) energy of particles increase [1]
 rate of diffusion increases [1] [3]

- (c) solubility of solute in solvent / type of solvent / type of solute / type of paper [1]

[Total: 6]

- 3 (a) 2 [1]
 weak acid undergoes partial dissociation / presence of undissociated HA [1]
 low concentration of H^+ [1] [3]

(b) dibasic [1]
 Should be represented as H_2A / H_2SO_4 dissociates to produce 2 H^+ ions for every A^{2-} [1] [2]

(c) No.
 same moles of acid / H^+ ions [1] [1]

(d) add dilute nitric acid, then aqueous barium nitrate [1] [2]

white precipitate [1]

Note: not necessary to acidify since the unknown is sulfuric acid which does not contain carbonate ions.

[Total: 8]

- 4 (a) (i) ozone blocks UV / destruction leads to more UV radiation [1]
sunburns / skin cancer / premature aging / cataracts [1] [2]
- (ii) $2 \text{O}_3 \rightarrow 3 \text{O}_2$ 1 m – formulae, 1 m – balanced [2]
- (iii) remains chemically unchanged [1] [1]

(iv)

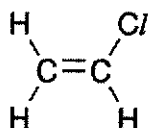
Table 4.1

isotope	^{35}Cl	^{37}Cl
number of electrons	17	17
number of neutrons	18	20
number of protons	17	17

Any 3 = 1 m

[2]

(b) (i)



[1]

(ii)

	Any one from:
Land pollution	filling landfill sites / shortage of landfill sites / visual pollution
Water pollution	gets stuck in animals digestive system / animals get stuck in the plastic / mistake plastic items for food / stops light getting to organisms in sea (must mention an effect on animals)
Air pollution	release poisonous gases when <u>burnt</u> NOT carbon monoxide, sulfur dioxide. If gas named has to be a correct one i.e. HC_l

[1]

- (iii) conserving crude oil / saving energy / reduce carbon emissions [1]
REJECT: cheaper [1]

[Total: 10]

- 5 (a) gradient steeper for graph for strontium therefore a greater volume of gas produced per unit time [1] **Note:** steeper graph alone is insufficient to earn full credit as students need to explain what is understood by 'steeper'. [1]
- (i) Total volume = 53 cm³
Time taken for reaction to be complete = 65 s (allow ±1)
Average rate = total volume / total time = 53/65 = **0.815 cm³/s** (OR 0.828, 0.803) [1] [1]
- (ii) the line was still going up / the line was still rising / not horizontal / gradient not zero / gradient still positive
REJECT: not constant [1]
- (b) $\text{Sr} + 2 \text{H}_2\text{O} \rightarrow \text{Sr}(\text{OH})_2 + \text{H}_2$ [2] 1 m – formulae, 1 m – balanced
strontium hydroxide is an alkali / alkaline / base / contains OH⁻ [1] [3]
- (c) **electrolysis of an aqueous solution:**
Answer must compare reactivity + state what is discharged + what is formed [1]
e.g. hydrogen below strontium in reactivity, H⁺ preferentially discharged to form H₂
reduction of the oxide by carbon:
Answer must compare reactivity + state the outcome [1]
e.g. Sr more reactive than carbon therefore carbon cannot reduce strontium oxide/
carbon doesn't displace strontium [1] [2]
[Total: 8]

- 6 (a) **Any one of**
- cracking of alkanes / hydrocarbon (using heat / catalyst)
ALLOW: cracking of crude oil
 - electrolysis of water (H₂ obtained at cathode)
 - steam reforming / reacting alkane with steam using heat / catalyst (not in syllabus) [1]
- (b) electronic structure is 2.5 / 5 valence electrons [1]
needs three electrons for fully-filled/complete valence shell [1] (therefore shares three electrons, one to each hydrogen atom) [2]
- (c) as temperature increases, yield decreases ORA [1] [1]
- (d) (i)
- increases rate of reaction [1]
 - molecules closer together / more reacting particles per unit volume [1]
 - frequency of effective collisions increases [1] [3]
- (ii) **Any one of**
- increases yield of NH₃ / produces higher % of NH₃ [1] [1]

- lower temperature can be used to achieve comparable rate thus saving energy [1]

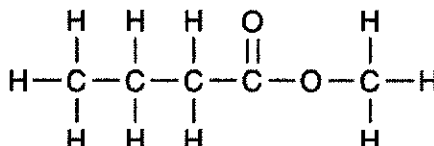
(iii) **Any one of**

- safety risk / risk of explosion [1]
- high cost, with link to construction / materials to withstand pressure [1]

(e) recycled / sent over catalyst again [1] ALLOW used again

[1]
[Total: 10]

7 (a)



[1]

(b) to cool and condense vapours / minimise loss of volatile chemicals during heating
ALLOW: prevent vapours from escaping

[1]

(c) immiscible (ALLOW: insoluble / do not mix)

[1]

(d)

M1	no. of moles of methanol = $2/32 = 0.0625 \text{ mol}$ [1]
M2	In an esterification reaction, the stoichiometry is 1:1:1:1 actual yield of methyl butanoate (in mol) = 0.009804 mol theoretical yield of methyl butanoate (in moles) = 0.0625 mol [1] OR actual yield of methyl butanoate (in g) = 1.0 g theoretical yield of methyl butanoate (in g) = 6.375 g [1]
M3	percentage yield = $\frac{1.0}{6.375} \times 100\% = 15.686\% \approx \mathbf{15.7\% (3 \text{ s.f.})}$ [1] OR percentage yield = $\frac{0.009804}{0.0625} \times 100\% \approx \mathbf{15.7\% (3 \text{ s.f.})}$ [1]

[3]

(e) **similarity (any one)** [1]

- both involve formation of ester linkage
- both involve loss of water
- both undergo condensation polymerisation between a hydroxyl and carboxyl group (REJECT alcohol and carboxylic acid)
- both require heat / catalyst for formation

difference (any one) [1]

methyl butanoate	polyethylene terephthalate
joining two molecules	joining many molecules (monomers)
between alcohol and carboxylic acid	between diol and dicarboxylic acid
no repeating unit	has repeating units

[2]

loss of one water molecule	loss of many water molecules
----------------------------	------------------------------

[Total: 8]

8 (a) At pH 8.2, $\text{CO}_2(\text{aq}) < \text{CO}_3^{2-}(\text{aq}) < \text{HCO}_3^-(\text{aq})$ (ignore if state symbols are not written) [1]

(b) $2 \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow \text{H}_2(\text{g})$ [1] (ignore if state symbols are not written)

H^+ preferentially discharged (to form H_2) AND $[\text{H}^+]$ decreases / $[\text{OH}^-]$ increases [1]

ALLOW: 'selectively' in place of 'preferentially'

ALLOW: 'reduced' in place of 'discharged'

[2]

(c) When pH increases, concentration of CO_3^{2-} increases / $\text{CO}_2(\text{aq})$ and/or HCO_3^- converted to CO_3^{2-} / more CO_3^{2-} formed [1]

Ca^{2+} and Mg^{2+} react with CO_3^{2-} to form CaCO_3 and MgCO_3 [1]

Allow if expressed in the form of ionic equations.

[2]

(d) Cl_2 / chlorine [1]

High concentration of Cl^- relative to other anions AND Cl^- preferentially oxidised / selectively discharged compared to OH^- [1]

[2]

(e) In forsterite, the formula of the anion is SiO_4^{4-} . $n = 1$ and $x = 0$

In anorthite, the formula of the anion is $\text{Si}_2\text{O}_8^{8-}$. $n = 2$ and $x = 0$

[2]

(f)

	Feature of Equatic-1	Impact on environmental sustainability
Positive	H_2 when burnt/used as fuel, <u>water</u> is the <u>only</u> product;	eliminating any further CO_2 emissions / reduce reliance on fossil fuels / relate to competing uses of crude oil / renewable
	CO_2 removed from seawater by precipitation in the form of solid metal carbonates	Re-establish levels / reduce carbon content in ocean / counteracts ocean acidification / restore capacity of ocean to take up CO_2 / increase pH of water / reduces the overall rate at which humans are adding CO_2 to the atmosphere
	CO_2 removed from environment by bubbling air through (immobilised in the form of dissolved HCO_3^-)	
	carbonates used for construction	conserving (finite) resources
Negative	electrolysis is energy intensive	may require fossil fuels / add more CO_2 to the environment / however it is possible to use solar energy
	negligible amount of CO_2 removed compared to annual emissions	One plant is not enough / many plants need to be built to remove enough CO_2 to achieve net zero

[3]

	may not be feasible in terms of construction cost and land use
--	--

Any 2 boxes = 1 m (max 3 m)

[Total: 12]

9 (a) Any two

- NH_4^+ (& NO_3^-) ions have single positive and negative charges
- Calcium ion has a +2 charge which is not represented in the diagram
- There is a 1:1 ratio for ammonium nitrate
- There needs to be a 1:2 ratio for calcium nitrate

[2]

(b) Any one

- nitrate / polyatomic ions contain multiple atoms
- ions are not spherical
- vibration / movement of ions is not shown
- there are many more ions in a real ionic compound
- only 2D shown but ions in an ionic compound are arranged in 3D

[1]

(c)

	Each marking point worth 1 m (max 1 per row)
M1 (magnitude)	<ul style="list-style-type: none"> • ΔH larger <u>magnitude</u> / <u>value</u> for calcium nitrate / larger difference in energy between reactant and products ORA (BOD: larger energy change)
M2 (ΔH)	<ul style="list-style-type: none"> • $\Delta H < 0$ / exothermic for $\text{Ca}(\text{NO}_3)_2$ but $\Delta H > 0$ / endothermic for NH_4NO_3
M3 (explanation for ΔH)	overall exothermic for $\text{Ca}(\text{NO}_3)_2$ because more energy released than absorbed AND overall endothermic for NH_4NO_3 because more energy because more energy absorbed than released ALLOW heat energy, but NOT heat REJECT: used / required / needed
M4 (explanation for difference in magnitude)	Bigger <u>difference</u> in amount of <u>energy absorbed</u> for bond breaking and amount of <u>energy released</u> in bond forming for $\text{Ca}(\text{NO}_3)_2$, compared to NH_4NO_3

[4]

(d) (i) add excess CaCO_3 to nitric acid [1]

stir until no more effervescence

filter to remove residue / obtain filtrate [1]

[2]

(ii) aqueous ammonia / ammonium carbonate + nitric acid [1]

[1]

[Total: 10]

10 (a) (i) $C_{25}H_{51}$ [1] [1]

(ii) The (C and H) atoms are already in the simplest ratio [1]
 ALLOW they have odd numbers of carbon atoms / prime numbers of carbon atoms / can't divide by 2
 ALLOW formula cannot be simplified / cannot cancel down [1]

(b) simple molecular structure[1]

little energy needed to overcome weak intermolecular forces of attraction [1] [2]

(c)

	Each marking point worth 1 m (max 1 per row)
M1 (similar structure)	<ul style="list-style-type: none"> are hydrocarbons / only contain carbon and hydrogen are saturated/contain all single bonds/do not have any functional groups covalent bonds / have (weak) intermolecular forces between molecules each molecule differs from the last by CH_2
M2 (same general formula)	<ul style="list-style-type: none"> C_nH_{2n+2}
M3 (similar chemical properties)	<ul style="list-style-type: none"> similar (REJECT: same) chemical property / give e.g. undergo combustion/flammable/are generally unreactive/undergo substitution reaction
M4 (trend in physical properties)	<ul style="list-style-type: none"> example of physical property which changes down the series (e.g. m.p./b.p. increase, less volatile/more dense/less flammable) states show a trend in their change from gas (to liquid) to solid

[4]

(d)

	Each marking point worth 1 m (max 1 per row)
M1 (profitability)	<ul style="list-style-type: none"> <u>higher demand</u> / <u>meet demand</u> for smaller molecules ALLOW: more valuable <i>no marks for stating the use of small molecules without idea of matching demand</i>
M2 (environment)	<ul style="list-style-type: none"> <u>reduce waste</u> / fully utilise crude oil by converting excess of large molecules to smaller, more useful ones <u>reduce pollution</u> as smaller molecules burn more efficiently / cleanly as fuels

[2]

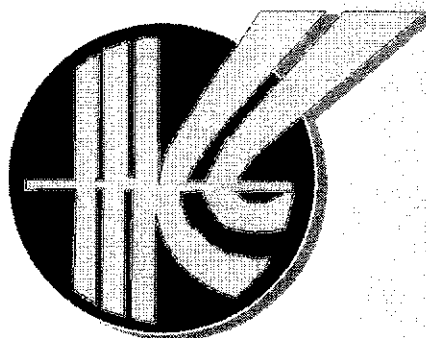
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4E
Session 2

Candidate Name: _____ () Class: _____

KRANJI SECONDARY SCHOOL
Preliminary Examination
Secondary 4 Express

CHEMISTRY
Paper 1 Multiple Choice



6092/01

Wednesday

28 August 2024

1 hour

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Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

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 to be correct and record your choice in **soft pencil** on the separate Answer Sheet.

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

Any rough working should be done in this booklet.

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

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

Set by: Mrs Toh-Chong Keting

This Question Paper consists of **18** printed pages.

[Turn over

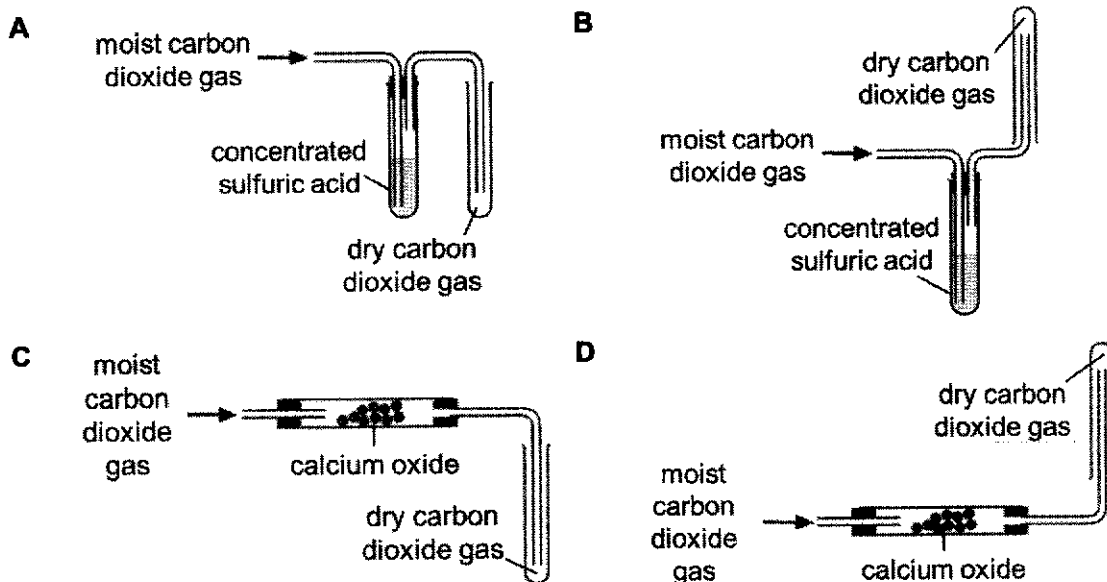
2

- 1 Which piece of apparatus could be used to determine the end-point of the reaction between hydrochloric acid and potassium hydroxide?

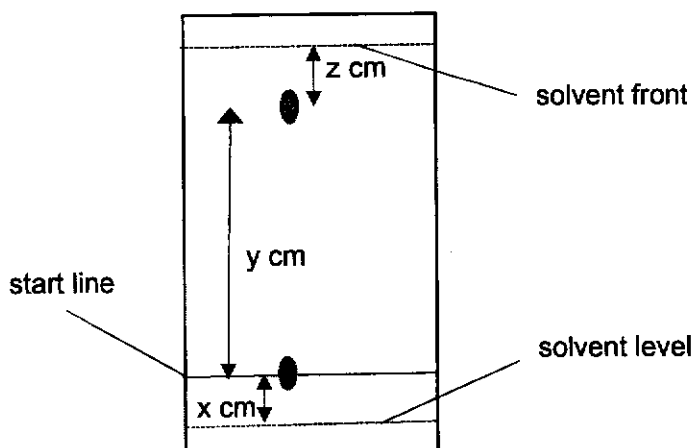
A electronic balance
 B gas syringe
 C stopwatch
 D thermometer

- 2 A student is provided with two drying agents: concentrated sulfuric acid and calcium oxide.

Which method should he use to collect a sample of dry carbon dioxide gas?



- 3 The diagram shows the chromatogram obtained by analysis of a single dye. Three measurements are shown in the diagram below.



How is the R_f value of the dye calculated?

A $x/(x+y)$ B $y/(y+z)$ C $y/(x+y+z)$ D $z/(x+y+z)$

3

- 4 The labels fell off two bottles each containing a colourless solution, one of which was sodium carbonate solution and the other was sodium chloride solution.

Which of the following tests would allow for the identification of the solutions?

- A addition of aqueous ammonia
 B addition of dilute nitric acid
 C addition of lead(II) nitrate solution
 D addition of sodium hydroxide solution
- 5 Two solutions, W and X, were tested as shown.

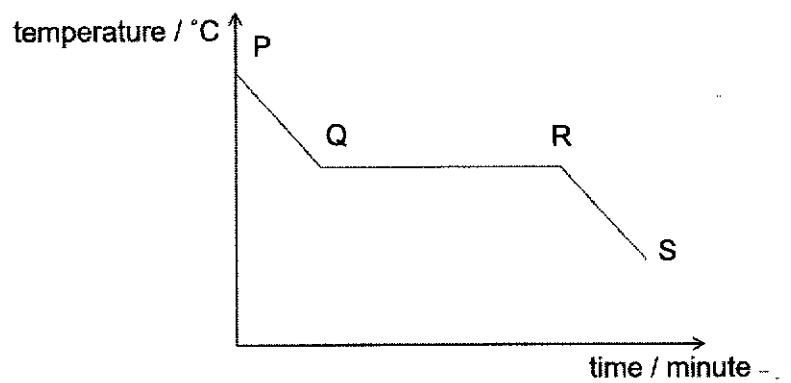
	W	X
dilute sulfuric acid	no visible reaction	no visible reaction
dilute nitric acid added, then aqueous barium nitrate	white precipitate	white precipitate
aqueous ammonia added	no precipitate seen	white precipitate, soluble in excess, forming a colourless solution
aqueous sodium hydroxide and aluminium foil added, then warmed	gas given off which turns red litmus paper blue	no gas given off

What are solutions W and X?

	W	X
A	sodium carbonate	zinc sulfate
B	lead(II) nitrate	ammonium carbonate
C	sodium nitrate	ammonium carbonate
D	ammonium sulfate	zinc sulfate

[Turn over

- 6 A sample of solid X is heated strongly until it has completely melted. The graph shows how its temperature varies with time as molten X is cooled.



Which of the following statements are true about the particles in X?

- 1 The arrangement is more orderly at stage RS than at stage PQ.
- 2 The forces of attraction are stronger at stage P than at stage S.
- 3 Their total energy content at stage QR is lower than at stage RS.
- 4 They are closer to each other at stage RS than at stage PQ.

- A 1 and 3 only
 B 1 and 4 only
 C 1, 2 and 3 only
 D 1, 3 and 4 only
- 7 The table shows the boiling points of the elements found in a sample of liquid air.

element	argon	helium	neon	nitrogen	oxygen
boiling point / °C	-186	-269	-246	-196	-183

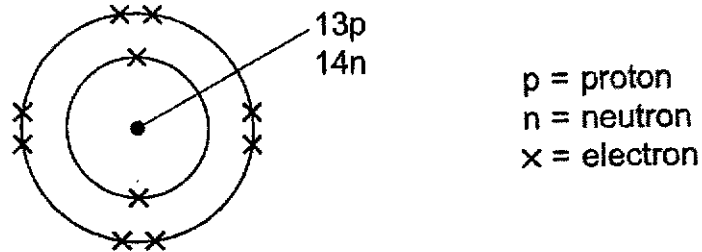
Which elements would be gaseous at $-190\text{ }^{\circ}\text{C}$?

- A argon, helium and nitrogen
 B argon, nitrogen and oxygen
 C helium, neon and nitrogen
 D helium, neon and oxygen

11 Which of the following substances contains both ionic and covalent bonds?

- A** aluminium carbonate **B** hydrogen chloride
C silicon dioxide **D** sodium

12 The diagram shows a structure of an ion.



What is the correct position in the Periodic Table of the element from which this ion was formed?

	period	group
A	2	13
B	2	18
C	3	13
D	3	18

13 A cartoon hero was famous for his shiny armour, a gold-titanium alloy, which allowed him to fly to Mars and back to Earth without melting.

Which of the following best describes the chemical bonds that exist within the structure of his armour?

- A** Ions and atoms of gold and titanium are held by strong ionic forces.
B Ions and atoms of gold and titanium are held by strong electrostatic forces.
C Ions and electrons of gold and titanium are held by strong ionic forces.
D Ions and electrons of gold and titanium are held by strong electrostatic forces.

14 Which quantity is the same for one mole of ethanol and one mole of ethane?

- A** mass
B number of atoms
C number of molecules
D volume at room temperature and pressure

18 What does the term strong acid mean in relation to hydrochloric acid, HCl ?

- A** Each molecule can produce a maximum of one hydrogen ion.
- B** It forms an insoluble salt, silver chloride.
- C** It is completely dissociated in aqueous solution.
- D** Its aqueous solution has a pH above 7.

19 Elements H, J, L are in the same period in the Periodic Table.

The oxide of H dissolves in water to form a solution with a pH 12.5. The oxide of J forms a solution with a pH less than 4.5. The oxide of L is soluble in both aqueous potassium hydroxide and dilute nitric acid.

Which option shows the position of the elements in order of increasing atomic number?

- A** H, J, L
- B** H, L, J
- C** J, L, H
- D** L, J, H

20 Which pair of compounds could be used in the preparation of calcium sulfate?

- A** calcium and sulfuric acid
- B** calcium carbonate and sodium sulfate
- C** calcium chloride and ammonium sulfate
- D** calcium nitrate and lead(II) sulfate

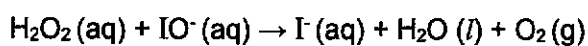
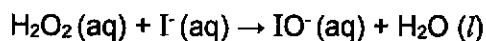
21 A method used to make copper(II) sulfate crystals is shown.

- 1 Place dilute sulfuric acid in a beaker.
- 2 Warm the acid.
- 3 Add copper(II) oxide until it is in excess.
- 4 Filter the mixture.
- 5 Evaporate the filtrate until it is saturated.
- 6 Leave the filtrate to cool.

What are the purposes of carrying out step 3 and step 4?

	step 3	step 4
A	to ensure all of the acid has reacted	to obtain solid copper(II) sulfate
B	to ensure all of the acid has reacted	to remove excess copper(II) oxide
C	to speed up the reaction	to obtain solid copper(II) sulfate
D	to speed up the reaction	to remove excess copper(II) oxide

22 When aqueous potassium iodide is added to hydrogen peroxide, the following reactions are observed.



There is a vigorous reaction and energy is liberated very rapidly, leading to a rise in temperature of the reaction mixture.

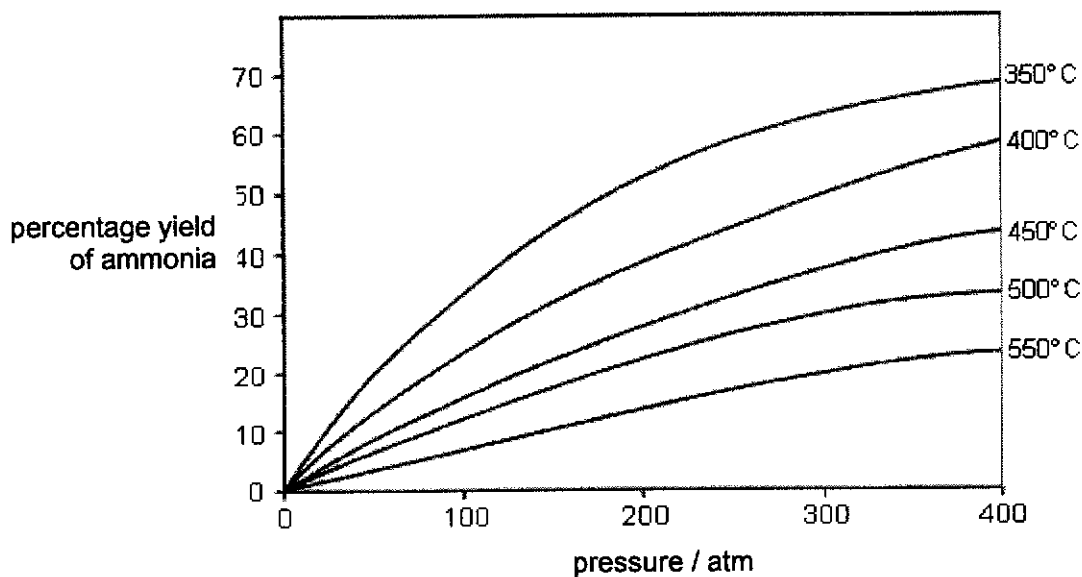
What is one of the roles of aqueous potassium iodide during any of the reactions?

- A** as a base
- B** as a dehydrating agent
- C** as a reducing agent
- D** as an oxidising agent

[Turn over

- 23 Ammonia is a very important intermediate in the manufacture of fertilisers. Ammonia is made in the Haber process by the reversible reaction between nitrogen and hydrogen at 450 °C.

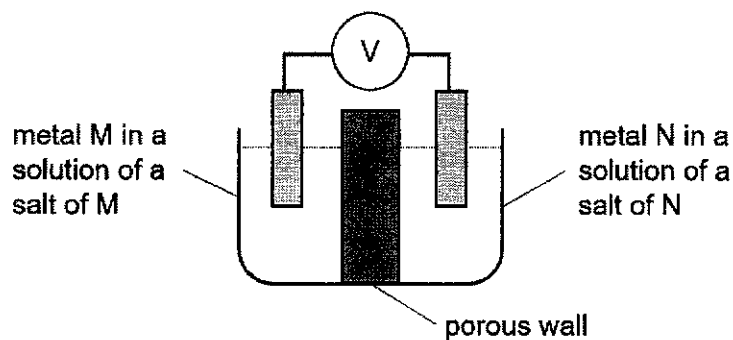
The graph gives the percentage yield of ammonia gas under different conditions of temperature and pressure.



Which of the following statements is true of the process above?

- A The process is usually carried out at 450 °C rather than 200 °C as the speed of reaction would be faster.
- B The yield of ammonia increases at higher temperature.
- C The yield of ammonia increases at lower pressure.
- D The yield of ammonia increases when a catalyst is added.

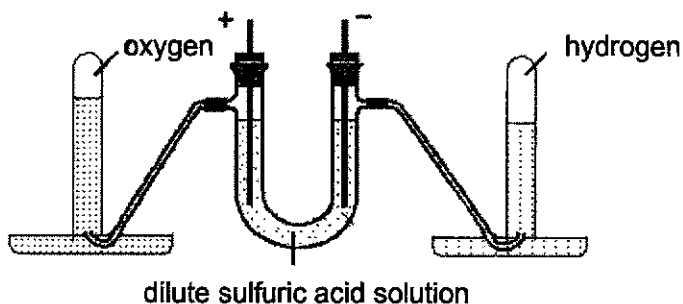
- 24 The diagram shows a simple cell with electrodes M and N.



Which pair of metals, M and N, will produce the highest voltage?

	M	N
A	copper	magnesium
B	magnesium	silver
C	silver	zinc
D	zinc	copper

- 25 The diagram shows the electrolysis of dilute sulfuric acid solution using inert electrodes.



Given that, at room temperature and pressure, x moles of electrons were passed in the circuit, which of the following statement is correct?

- A $6x \text{ dm}^3$ of oxygen was collected at the anode.
- B $6x \text{ dm}^3$ of hydrogen was collected at the cathode.
- C $12x \text{ dm}^3$ of oxygen was collected at the cathode.
- D $12x \text{ dm}^3$ of hydrogen was collected at the anode.

[Turn over

- 26 Four different conditions under which sodium chloride is electrolysed using inert electrodes are listed.

- 1 concentrated aqueous sodium chloride
- 2 dilute aqueous sodium chloride
- 3 molten sodium chloride
- 4 solid sodium chloride

Under which conditions is a yellowish green gas formed?

- A** 1 and 2 **B** 1 and 3 **C** 3 and 4 **D** 3 only

- 27 The positions of four elements are shown in the outline of part of the Periodic Table.

Element X has a high melting point and is a good conductor of electricity.
It forms chlorides $XC\ell$ and $XC\ell_2$.

Which element is X?

A											D					
	B										C					

- 28 Which of the following statements regarding the element caesium are correct?

- 1 It is more reactive than potassium.
- 2 It reacts with chlorine to form an ionic compound.
- 3 It has a higher density than sodium.
- 4 It has a higher melting point than lithium.

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

- 29 The table below refers to four metals and some of their compounds.

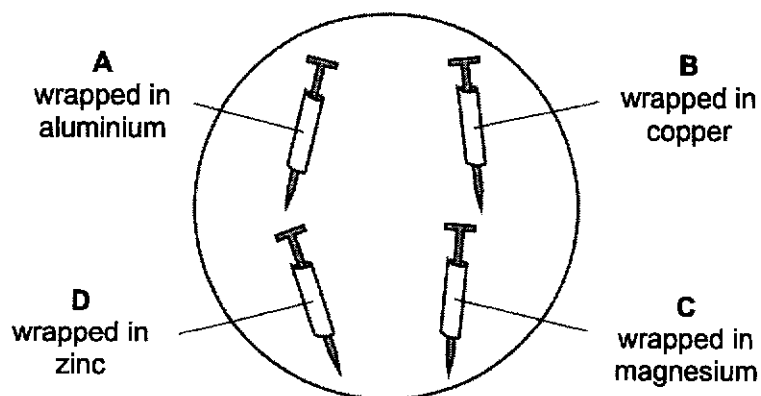
metal	action of dilute acid on metal	effect of hydrogen on heated oxide	action of metal on a solution of sulfate of J
G	hydrogen evolved	reduced	no reaction
H	no reaction	reduced	no reaction
I	hydrogen evolved	no reaction	J formed
J	hydrogen evolved	no reaction	no reaction

What is the correct order of reactivity of the metals?

	least reactive	—————>			most reactive
A	H	G	J	I	
B	H	J	G	I	
C	I	J	G	H	
D	I	G	J	H	

- 30 Four iron nails had different metals wrapped around them. The nails were placed in an open dish filled with water and left for a week.

Which iron nail has no protection against rusting?

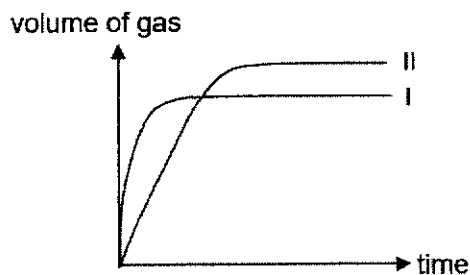


- 31 Which change is endothermic?

- A** $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$
B $\text{H}(\text{g}) + \text{Cl}(\text{g}) \rightarrow \text{HCl}(\text{g})$
C $\text{H}_2\text{O}(\text{g}) \rightarrow 2\text{H}(\text{g}) + \text{O}(\text{g})$
D $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{s})$

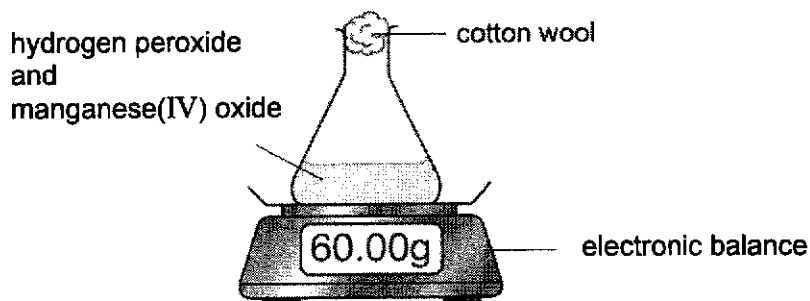
[Turn over

- 32 In the graph, curve I represents the result of a reaction between 1.0 g of calcium granules and excess water at 25 °C.



Which conditions would produce curve II?

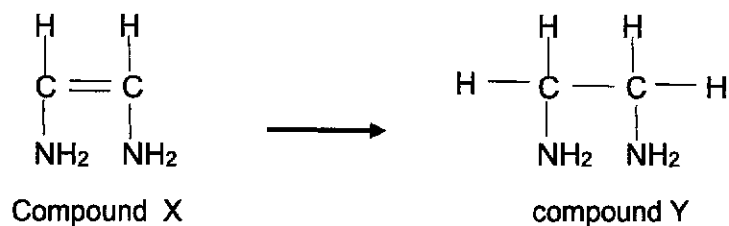
- A 1.0 g of calcium granules with excess water at 15 °C
 B 1.0 g of calcium powder with excess water at 25 °C
 C 1.15 g of calcium granules with excess water at 15 °C
 D 1.15 g of calcium granules with excess water at 50 °C
- 33 A small amount of manganese(IV) oxide powder is used as a catalyst in the decomposition of hydrogen peroxide to form oxygen gas and water.



Which of the following is **not** true about the reaction?

- A The manganese(IV) oxide can be recovered by filtration.
 B The mass of the flask and its contents decreases.
 C The reaction becomes slower as the reaction proceeds.
 D The reaction stops when all the manganese(IV) oxide is used up.
- 34 Which statement correctly describes the members of any homologous series?
- A They have the same empirical formula.
 B They have the same physical properties.
 C They undergo similar chemical reactions.
 D The relative molecular masses of consecutive members differ by 12.

- 35 Compound X can be converted into compound Y as shown.



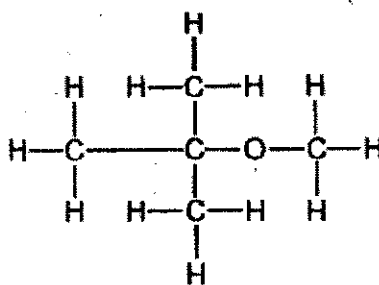
Which correctly shows the reagents and conditions needed for the conversion?

	reagent	conditions
A	concentrated sulfuric acid	heat
B	hydrogen	high temperature, nickel catalyst
C	monomer	high temperature, iron catalyst
D	steam	high temperature and high pressure, phosphoric acid

- 36 What process/reaction is occurring when ethene and octane are obtained from decane, $\text{C}_{10}\text{H}_{22}$?
- A** combustion
 - B** cracking
 - C** fractional distillation
 - D** polymerisation

[Turn over

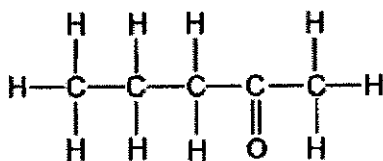
37 The structural formula of compound Z is shown.



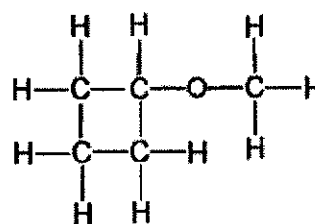
Compound Z

Which of the following compound is an isomer of compound Z?

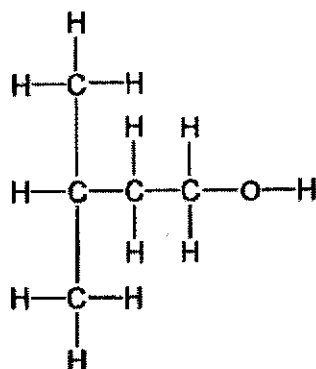
A



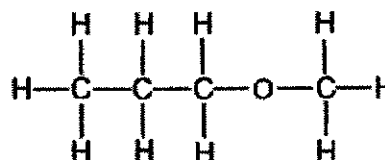
B



C



D



38 Which statement about alcohols are correct?

- 1 All alcohols contain the hydroxide ion, OH^- .
- 2 Ethanol can be formed from ethene using a reaction catalysed by yeast.
- 3 Ethanol can undergo neutralisation with aqueous sodium hydroxide.
- 4 Methanol can be oxidised to methanoic acid.

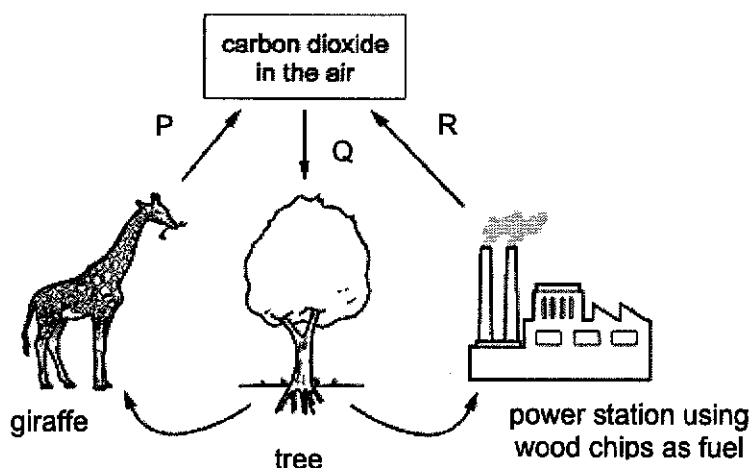
A 1 and 4

B 2 and 3

C 2 and 4

D 4 only

- 39 The diagram shows part of the carbon cycle. P, Q and R refer to specific processes of the carbon cycle.



Which row correctly describe the energy changes of these processes?

	P	Q	R
A	endothermic	endothermic	exothermic
B	endothermic	exothermic	endothermic
C	exothermic	endothermic	exothermic
D	exothermic	exothermic	endothermic

- 40 Methane, chlorofluorocarbons (CFCs) and carbon dioxide are all gases which affect the atmosphere and the environment.

In what way do these gases affect the environment?

	methane	chlorofluorocarbons (CFCs)	carbon dioxide
A	acid rain	global warming	photochemical smog
B	depletion of ozone layer	photochemical smog	global warming
C	global warming	depletion of ozone layer	global warming
D	global warming	depletion of ozone layer	acid rain

[Turn over

The Periodic Table of Elements

		Group																					
		13																18					
		14																17		18			
		15																16		17		18	
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		71																					
1	2																	17	18				
3	4																	9	10				
7	12																	17	18				
11	19																	35.5	40				
19	23																	35	36				
39	40																	79	84				
37	38																	52	54				
55	88																	85	86				
56	88																	85	86				
87	88																	117	118				
89-103	103																	117	118				
57	58																	71					
59	60																	71					
89	90																	103					
89	90																	103					

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
 The Avogadro constant, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$.