Anglo-Chinese School

(Independent)



Year 3 Integrated Programme Final Examination 2019

CHEMISTRY

PAPER 1

Monday 30th September 2019

TIME 1 hour

Additional material: OTAS answer sheet

INSTRUCTIONS TO CANDIDATES

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

Shade your Candidate Number on the OTAS answer sheet in the spaces provided.

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 OTAS answer sheet.

INFORMATION FOR CANDIDATES

There are **forty** questions in this paper, carrying a total of **40 marks**.

A copy of the Periodic Table is printed on page **2**.

Electronic calculators may be used.

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39.	10	40.08	44.96	47.87	50.94	52.00	54.94	55.85	58.93	58.69	63.55	65.38	69.72	72.63	74.92	78.96	79.90	83.90
ά		38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
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85.	47	87.62	88.91	91.22	92.91	95.96	(98)	101.07	102.91	106.42	107.87	112.41	114.82	118.71	121.76	127.60	126.90	131.29
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Page 2 of 32

- 1 Which of the following will increase the rate of diffusion?
 - A. decrease in polarity of molecules
 - B. decrease in relative molecular mass
 - C. decrease in concentration gradient
 - D. decrease in temperature
- 2 Which of the following statements is **not** true about freezing?
 - A. A pure substance freezes at a constant temperature.
 - B. Particles lose energy to the surrounding during freezing.
 - C. Particles stop moving.
 - D. Freezing is a physical process.
- **3** Which statement is true?
 - A. N^{3-} has the same number of electrons as P^{3-} .
 - B. S^{2-} has the same number of electrons as K^+ .
 - C. Ca^{2+} has more electrons than Ca.
 - D. Na⁺ has more electrons than Mg^{2+} .
- 4 Which particles are isoelectronic with one another? [Q, R, S and T are not the actual chemical symbols.]
 - A. ${}^{14}_{8}\mathbf{Q}^{2-}$ and ${}^{19}_{10}\mathbf{R}$
 - B. ${}^{19}_{10}$ R and ${}^{31}_{15}$ T
 - C. $^{23}_{11}S^{2+}$ and $^{19}_{10}R$
 - D. ${}^{14}_{8}$ **Q**²⁻ and ${}^{23}_{11}$ **S**²⁺
- 5 Which atom has a half-filled *p* sub-shell?
 - A. Ne
 - В. Р
 - C. F
 - D. O

6 The electronic structures of atoms **Q** and **R** are shown.



Q and **R** combine chemically to form an ionic compound.

What is the formula of the compound?

- A. **R**₇**Q**
- B. **R**₄**Q**₂
- C. **RQ**
- D. **RQ**₇
- 7 Which formula represents the empirical formula of a compound?
 - A. C_2H_4O
 - $\mathsf{B}. \quad \mathsf{C}_2\mathsf{H}_4\mathsf{O}_2$
 - C. C₆H₁₂
 - D. H₂O₂
- **8** Which of the following hydroxides contains the smallest percentage of metal in one mole of the compound?
 - A. Fe(OH)₂
 - B. Ni(OH)₂
 - C. Pb(OH)₂
 - D. Mg(OH)₂
- 9 The number of ions produced when 3.45 g of LiNO₃ dissolves completely in water is
 - A. 0.3 x 10²³
 - B. 0.6 x 10²³
 - C. 0.9 x 10²³
 - D. 1.2 x 10²³
- 10 4.00 g of solid sodium hydroxide is added to water to make a solution with a concentration of 0.200 mol dm⁻³.

What is the volume of water used?

- A. 0.5 cm³
- B. 20 cm³
- C. 500 cm³
- D. 2000 cm³

- 11 Which compound contains both ionic and covalent bonds?
 - A. MgCl₂
 - B. HCl
 - C. CH₃COOH
 - D. NH₄Cl
- **12** Three statements on metallic bonding are shown.
 - I. They are electrostatic in nature.
 - II. The metal ions are delocalised.
 - III. Its strength is directly proportional to the magnitude of the charge of the ions.

Which statement(s) is/are correct?

- A. I only B. I and II only
- C. I and III only D. II and III only
- 13 Which statement is correct for magnesium fluoride?
 - A. It has low melting point.
 - B. It can conduct electricity in all states.
 - C. The electronic configuration of both ions in the compound is the same as neon.
 - D. It is soluble in non-polar solvents.
- 14 Three substances have the properties shown.
 - X conducts electricity in solid and molten states.
 - Y is soluble in water and the solution conducts electricity.
 - Z only conducts electricity in molten state.

What could be substance X, Y and Z?

	Х	Y	Z
Α.	Cu	ZnO	КОН
В.	Cu	КОН	ZnO
C.	ZnO	Cu	КОН
D.	ZnO	КОН	Cu

- 15 Which property do all metals have?
 - A. They have high melting point.
 - B. They form amphoteric oxides.
 - C. They react with dilute acids.
 - D. They conduct electricity.

- 16 Which trend is correct down group 1 metals?
 - A. atomic radius decreases
 - B. density decreases
 - C. electronegativity decreases
 - D. melting point increases
- 17 When the species Br, Br⁺ and Br⁻ are arranged in order of increasing size, which is the correct order?
 - A. Br < Br⁺ < Br⁻
 - B. Br⁻ < Br < Br⁺
 - C. Br⁺ < Br⁻ < Br
 - D. Br⁺-< Br < Br⁻
- 18 Aqueous sodium hydroxide and aqueous ammonia each give a white precipitate when added to aqueous zinc sulfate.

What happens when an excess of each of these reagents is added?

	excess NaOH(aq)	excess NH₃(aq)
A.	precipitate dissolves	precipitate dissolves
B.	precipitate dissolves	precipitate does not dissolve
C.	precipitate does not dissolve	precipitate dissolves
D.	precipitate does not dissolve	precipitate does not dissolve

19 One of the tests for anion employs the use of acidified silver nitrate. The positive result is the presence of a white precipitate.

What is the identity of the white precipitate?

- A. Cl-
- B. AgCl
- C. SO4²⁻
- D. Ag₂SO₄
- 20 Which reactants can be used to prepare the highest yield of lead(II) sulfate?
 - A. $Pb + H_2SO_4$
 - B. $PbCl_2 + H_2SO_4$
 - C. $PbO + H_2SO_4$
 - D. $Pb(NO_3)_2 + H_2SO_4$

- 21 The solubility of three substances are shown.
 - **P** is sparingly soluble in water.
 - **Q** is soluble in water.
 - R insoluble in water.

What could be the substances P, Q and R?

	Р	Q	R
Α.	Ca(OH) ₂	FeCl ₂	BaSO ₄
В.	Ca(OH) ₂	FeCO ₃	BaSO ₄
C.	Ba(OH) ₂	FeCO ₃	BaCl ₂
D.	Ba(OH) ₂	FeCl ₂	BaCl ₂

22 The table below shows a series of tests done on substance F.

Test	Observations
Adding excess NH ₃ (aq) to solution	Blue ppt. formed which dissolves in excess
F	NH ₃ (aq) to form a deep blue solution.
Heating solid F	Decomposes to form an acidic brown gas
Adding excess NaOH(aq) and Al	A pungent and colourless gas was evolved,
foil to solution F and warming it	which turns moist red litmus paper blue.

What is substance F?

- A. CuBr₂
- B. Cu(NO₃)₂
- C. FeBr₂
- D. Fe(NO₃)₂
- 23 Which salt is best prepared by titration?
 - A. CuSO₄
 - B. NaNO₃
 - $C. \quad ZnCl_2$
 - D. CaCO₃
- **24** Three positive tests for gases are shown.
 - I. Moist blue litmus turns red.
 - II. White ppt is observed in lime water.
 - III. KMnO₄ changes colour from purple to colourless.

Which will be observed if the gas tested is carbon dioxide?

- A. I only B. II only
- C. I and II only D. II and III only

- 25 Which compound would most commonly be added to soil to reduce its acidity?
 - A. aluminium hydroxide
 - B. calcium hydroxide
 - C. magnesium hydroxide
 - D. sodium hydroxide
- **26** A solution of hydrochloric acid, HCl, has a lower pH than a solution of methanoic acid, HCO_2H , of the same concentration.

Which statement(s) explain(s) this?

- I. HCO₂H molecules dissociate to a greater extent than HCl molecules do.
- II. HCl is monobasic while HCO_2H is dibasic.
- III. Methanoic acid is a weaker acid than hydrochloric acid.
- A. I only B. III only
- C. II only D. II and III only

27 100 cm³ of a solution with pH 3 is mixed with 100 cm³ of a solution with pH 5. What is the final pH of the resulting solution?

- A. 3.3 B. 3.7 C. 4.0 D. 4.3
- 28 Which statement about oxides is correct?
 - A. A solution of magnesium oxide has a pH less than 7.
 - B. Magnesium oxide reacts with nitric acid to make a salt.
 - C. A solution of sulfur dioxide has a pH greater than 7.
 - D. Sulfur dioxide reacts with hydrochloric acid to make a salt.
- 29 Which statement is always correct for an oxidation reaction?
 - A. It involves the gain of oxygen by an element.
 - B. It involves the loss of hydrogen by an element.
 - C. The atom or ion being oxidised will gain electrons.
 - D. The oxidation number of the element being oxidised will increase.

30 Silver chloride decomposes to its elements when it is exposed to light.

Which pair of half-equations is correct?

	half-equation	Type of reaction
Ι.	$Ag^+ + e^- \rightarrow Ag$	oxidation
11.	$Ag^+ + e^- \rightarrow Ag$	reduction
III.	$2Cl^{-} \rightarrow Cl_2 + 2e^{-}$	oxidation
IV.	$2Cl^{-} \rightarrow Cl_{2} + 2e^{-}$	reduction

Α.	I and IV	В.	I and III
~			

- C. II and III D. II and IV
- 31 Hydrogen sulfide can be oxidised to form sulfur dioxide.

 $2H_2S \ + \ 3O_2 \rightarrow \ 2SO_2 \ + \ 2H_2O$

Which statement(s) is/are correct?

- I. The oxidation number of sulfur increases by 6.
- II. The oxidation number of oxygen increases by 2.
- III. The oxidation number of hydrogen decreases.

A. I only B.	I and II only
--------------	---------------

C.	II and III only	D.	I. II. and III
Ο.		υ.	i, ii, and iii

32 When $KClO_3$ is heated, the following reaction occurs.

 $4\text{KClO}_3 \rightarrow 3\text{KClO}_4 + \text{KCl}$

Which statement(s) is/are correct?

- I. The oxidation state of Cl in $KClO_3$ is +5.
- II. The oxidation state of some Cl atoms decreased by 6.
- III. The reaction involves disproportionation.
- A. I only B. I and II only
- C. II and III only D. I, II, and III
- **33** Fluorine and iodine are Group 17 elements. Their melting points are different due to the differing strengths of intermolecular forces between the molecules.

Which of the following is correct?

	melting point	strength of intermolecular forces between molecules
Α.	$F_2 > I_2$	$F_2 > I_2$
В.	$F_2 > I_2$	$F_2 < I_2$
C.	$F_2 < I_2$	$F_2 < I_2$
D.	$F_2 < I_2$	$F_2 > I_2$

34 The diagram shows the structural formula of citric acid.



Which of the following intermolecular forces are present between the molecules?

- I. London dispersion forces
- II. Dipole dipole forces
- III. Hydrogen bonding
- A. I and II only B. III only
- C. II and III only D. I, II, and III
- **35** Methyl isocyanate, CH₃NCO, is a toxic liquid which is used in the manufacture of some pesticides.

What is the **approximate** C–N=C bond angle between the bonds formed by the N atom in a molecule of methyl isocyanate?



Read the following information carefully to answer questions 36, 37, 38, and 39.

Hydrocarbons are covalent molecules made of carbon and hydrogen only. These are commonly used as fuel and they burn in air (assumed to contain 20% oxygen) to have the following unbalanced combustion reaction:

$$C_AH_B(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$$

36 Two hydrocarbons have the formulae C_2H_4 and C_3H_6 .

Which row is correct when comparing the two hydrocarbons?

	empirical formula	molecular formula	relative molecular mass
Α.	different	same	different
В.	different	same	same
C.	same	different	different
D.	same	different	same

37 What are the shapes of the molecules of methane (CH₄) and its combustion products?

	methane	carbon dioxide	water
Α.	trigonal pyramidal	V-shaped (bent)	linear
В.	tetrahedral	linear	V-shaped (bent)
C.	V-shaped (bent)	trigonal pyramidal	tetrahedral
D.	trigonal planar	tetrahedral	trigonal planar

38 Which coefficients would balance the complete combustion equation for propane (C_3H_8) ?

	propane	oxygen	carbon dioxide	water vapour	
Α.	1	10	3	4	
В.	2	5	6	8	
C.	1	5	3	4	
D.	2	10	6	8	

- **39** If 24 cm³ of C₃H₈(g) is burned in 100 cm³ of air, what volume of carbon dioxide will be produced at r.t.p.?
 - A. 72 cm³
 - B. 12 cm³
 - C. 60 cm³
 - D. 24 cm³

- 40 Which statements about the periodic table are correct?
 - I. Elements in period 3 have similar chemical properties.
 - II. Elements in group 17 increase in atomic radii down the group.
 - III. Elements become more electronegative across period 3.
 - A. I and II only
 - B. II only
 - C. II and III only
 - D. I, II and III

Candidate Number

Anglo-Chinese School

(Independent)



Year 3 Integrated Programme Final Examination 2019

CHEMISTRYPAPER 2Monday30th September 2019TIME1 hour 45 minutes

INSTRUCTIONS TO CANDIDATES Do not open this booklet until you are told to do so.

Write your Candidate Number in the space at the top of this page.

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

INFORMATION FOR CANDIDATES

This paper carries a total of **80 marks**.

A detachable copy of the Periodic Table is printed on page **17**.

Electronic calculators may be used.

Marks will be deducted for omission of statements, incorrect number of significant figures and incorrect or missing units in calculation questions.

For Examiners' Use				
G	Question 1	/ 8		
G	uestion 2	/ 8		
Question 3		/ 8		
C	Question 4	/ 7		
Question 5		/ 6		
Question 6		/ 13		
Question 7		⊬6		
Question 8		/ 7		
Question 9		/ 9		
Question 10		/ 8		
ළ Statements				
uctio	Sig. fig.			
Ded	Units			
	Total	/ 80		

1 The diagram below shows the positions of elements T, U, V, W, X, Y and Z (not their actual chemical symbols) in a simplified Periodic Table.



Page 14 of 32	Page	14	of 32
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 \mathbf{ZCl}_{4}^{-}

2 Oxalic acid, H₂C₂O₄, reacts with acidified manganate(VII) ions according to the ionic equation below:

 $2MnO_{4}^{-}(aq) + 16H^{+}(aq) + 5C_{2}O_{4}^{2-}(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_{2}(g) + 8H_{2}O(I)$

(a) Explain, in terms of oxidation state, whether MnO₄[−] is oxidised or reduced. [2] State any colour change you may observe.



(b) State the oxidation state of manganese in each of the following ion/ formula [2] unit.

ion/ formula unit containing manganese	oxidation state of manganese
Mn ²⁺	
MnO ₂	
MnO₄ [−]	
MnO4 ²⁻	

(c) Draw the Lewis diagram for CO₂ and predict its shape and bond angle.

shape

bond angle

[4]

- **3** (a) An important method for the study of long-term climate change involves isotope geochemistry. Oxygen-16, ¹⁶O, and oxygen-18, ¹⁸O, are *isotopes* of oxygen.
 - (i) Define the term *isotopes*.

¹⁶O is the most abundant isotope while ¹⁸O is extremely rare in the Earth's atmosphere. **Table 1** shows the relative abundance of oxygen isotopes.

Isotope	Relative abundance / %
¹⁶ O	99.8
¹⁸ O	0.2

Table 1 Relative abundance of oxygen isotopes

(ii) Calculate the relative atomic mass of oxygen. Give your answer correct to 5 significant figures.

[1]

(b) In the climate change study, scientists would measure the proportion of heavy water (H₂¹⁸O) and light water (H₂¹⁶O) in the oceans and glaciers. Table 2 shows the boiling points of light and heavy water.

Species	Boiling point / °C			
Light water	99.98			
Heavy water	101.4			

Table 2 Boiling points of water

[1]

(i) Describe the relationship between the relative molecular mass and the boiling point of water.

(This question is continued on the following page)

[1]

(ii) Describe, in terms of the Kinetic Particle Theory, the change in the movement of water molecules when evaporation takes place.

.....

(c) The diagram below shows how ice in glaciers originally came from water evaporated from the oceans. Light water evaporates more readily than heavy water. The water vapour condenses to form clouds. At colder temperatures at high altitudes, it snows and the ice compacts to form glaciers.



Predict whether a sample of water from the ocean will have higher or lower [1] relative abundance of ¹⁸O isotopes compared to the figures in **Table 1**.



(d) The ice in glaciers melts to form the surface runoff. State whether energy is [1] given out or taken in during that physical change.

(e) Using the *spdf* notation, write the full electronic configuration of ¹⁸O.

[1]

- 4 Barium carbonate reacts with dilute hydrochloric acid.
 - (a) Write a balanced chemical equation with state symbols for this reaction. [2]
 -
 - (b) 9.85 g of barium carbonate were added to 250 cm³ of 0.100 mol dm⁻³ [3] hydrochloric acid. Calculate the volume, in dm³, of the gas formed at r.t.p..

(c) Explain, in terms of intermolecular forces, why the two simple covalent products formed in (a) exist as different states of matter at r.t.p..

[2]

- 5 A compound **X** contains carbon, hydrogen, and oxygen only.
 - (a) (i) X contains 54.54% of carbon by mass and 9.09% of hydrogen by [2] mass. Calculate the empirical formula of compound X.



(ii) Compound **X** has a relative molecular mass of 88. Deduce the molecular formula of compound **X**.

[2]



(b) The starting compound used to make compound X is ethene, C₂H₄. Ethene [2] reacts with steam to form ethanol in the presence of an acid catalyst.

ethene + steam \rightarrow ethanol



State the H–C–H bond angle in ethene and C–O–H bond angle in ethanol.

H–C–H bond angle in ethene: C–O–H bond angle in ethanol:

6 The diagram shows a series of tests carried out to identify the compounds present in a mixture.



7 The following diagram shows the first ionization energies (1st I.E.) of some Period 3 elements.



- (a) Draw a cross on the diagram to show the first ionization energy of silicon. [1]
- (b) Write an equation to show the process that occurs when the first ionization [1] energy of aluminium is measured.
- (c) State if the first, second or third ionization of sulfur would produce an ion with [1] the electron configuration 1s²-2s²-2p⁶-3s²-3p⁴.
- (d) State and explain the trend in first ionization energies down Group 16 from [3] oxygen to polonium.

8 Metals tend to have high melting and boiling points because of the strength of the metallic bond.



(a) State and explain the difference in melting point between sodium and magnesium.

.....

(b) Metals consist of giant structures of atoms held together by metallic bonds. The metal atoms are *closely packed* - that is, they fit as many atoms as possible into the available volume. The following table describes 2 types of packing in giant metallic structures.

	12-coordination		8-coordination
-	Each atom has 6 other atoms	-	No atoms are touching each
	touching it in each layer.		other within a particular layer
-	3 atoms touching any particular	-	4 atoms touching any particular
	atom in the layer above and		atom in the layer above and
	another 3 in the layer		another 4 in the layer
	underneath.		underneath.
-	Most metals (including magnesium)	-	Group 1 metals

(This question is continued on the following page)

[3]

(i) Suggest the relationship between the packing of atoms and melting [1] point.

(ii) The boiling points of sodium and magnesium are 1156 K and 1364 K [2] respectively. The boiling point of sodium is not unusually low compared to magnesium like their melting points.

Based on your answers in (a) and (b)(i), state, with reason, which factor **does not** contribute to the strength of the metallic bonds of metals in molten state.

.....

(c) State one other physical property of Period 3 metals.

[1]

.....

9 Calcium chlorate(V), Ca(ClO₃)₂, is made by reacting calcium hydroxide with chlorine gas.

$$6Ca(OH)_2 + 6Cl_2 \rightarrow Ca(ClO_3)_2 + 5CaCl_2 + 6H_2O$$

(a) (i) 8.88 g of calcium hydroxide and 7200 cm³ of chlorine gas are mixed [2] together. Determine the limiting reactant. Show your working.

(ii) What is the maximum mass of calcium chlorate(V) that can be made [2] from this mixture?

(iii) The actual mass of calcium chlorate(V) obtained from the reaction in [1](a) is 3.11 g. Calculate the percentage yield.

(This question is continued on the following page)

(b) Chloric acid, HClO₃, is a strong acid. It can be made from calcium chlorate(V). [1] Define what is a *strong acid*.



(c) (i) Define the term acid in terms of proton transfer and complete the [2] equation given to show HClO₃ behaving as an acid in water.

 $HClO_3 + H_2O \rightarrow \dots + \dots$

(ii) Hence, identify the conjugate base.

[1]

.....

10 When thionyl chloride SOCl₂, is reacted with a carboxylic acid C_nH_{2n+1}COOH, where n is a whole number an acyl chloride, C_nH_{2n+1}COCl and two acidic gases are formed.

 $SOCl_2 + C_nH_{2n+1}CO_2H \rightarrow C_nH_{2n+1}COCl + SO_2 + HCl$

- (a) A 1.00 g sample of a carboxylic acid underwent the above reaction and the [1] gases produced were absorbed in 60.0 cm³ of 0.500 mol dm⁻³ NaOH(aq).
 - (i) Calculate the number of moles of NaOH at the start of the reaction.



(This question is continued on the following page)

(v)	Hence, calculate the number of moles of NaOH that reacted with the	[1]
	gases using answers from (a) (i) and (a) (ii)	

(b) (i) If the number of moles of $C_nH_{2n+1}COOH = 0.01136$ mol, calculate the M_r [1] of the carboxylic acid.

-
- (ii) Hence determine the value of n in $C_nH_{2n+1}COOH$.

[1]

.....

Anglo-Chinese School (Independent) Year 3 IP Chemistry Final Exam 2019 Answers

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

Paper 1

Paper 2

1	(a)	W ₂ V ₃				[1]	
		The white solid will dissolve.					
		It is an amphoteric oxide.					
	(b)	ZO					
		Z ₂ O ₃					
		Both are insoluble				[1]	
			complex	oxidation state of Z			
			[Z (H ₂ O) ₆] ²⁺	+2		[1]	
			ZCl4 ⁻	+3		[1]	
2	(a)	MnO ₄ - is re in Mn ²⁺ .	D_4^- is reduced as the oxidation state of Mn decreases from +7 in MnO ₄ ⁻ to +2 ln ²⁺ .				
		Solution ch	changes colour from purple to colourless.				
	(b)	[1m: 2 – 3	m: 2 – 3 correct] ; [2m: all correct]				
			ion/ formula unit oxidation state of containing manganese manganese				
			Mn ²⁺	+2			
			MnO ₂	+4			
			MnO4 ⁻	+7			
			MnO4 ²⁻	+6			

	(c)	$\ddot{O} = C = \ddot{O}$		
		Correct structural formula		
		2 lone pairs on each C atom		
		shape: linear		
		bond angle: 180°	[1]	
3	(a)	(i) Isotopes are different atoms of the same element that have the same atomic number (number of protons) but different mass numbers (number of neutrons).		
		(ii) 16.004	[1]	
	(b)	(i) Higher the molecular mass, higher the boiling point.		
		(ii) The particles in a liquid slide over one another		
		but the particles in gas will move randomly and rapidly.	[1]	
	(c)	higher	[1]	
	(d)	Taken in	[1]	
	(e)	1s ² 2s ² 2p ⁴	[1]	
4	(a)	$BaCO_{3}(s) + 2HCI(aq) \rightarrow BaCI_{2}(aq) + CO_{2}(g) + H_{2}O(I)$		
		Balanced chemical equation;	[1]	
		state symbols	[1]	
	(b)	M_r of BaCO ₃ = 197		
		nBaCO ₃ = 9.85/197 = 0.0500 mol	[1]	
		nHCl = 0.100 x 0.25 = 0.0250 mol	[1]	
		HCI : CO ₂ is 2:1		
		$nCO_2 = 24.0 \times 0.0125 = 0.300 \text{ dm}^3$	[1]	
		ECF given if: method correct even though value used is wrong.		
	(c)	Carbon dioxide has weak London (dispersion) forces between its molecules. However water has stronger hydrogen bonding between its molecules. Thus, a larger amount of energy is needed to overcome the stronger intermolecular forces in water and it has a higher boiling point.	[1] [1]	
		bonding; hydrogen bonding in molecules; uses hydrogen bonding; break the bonds; joined together		

5	(0)	(i)					
5	(a)		С	Н	0	1	
		%	54.54	9.09	36.37		
		Mr	12.01	1.01	16		
		mole	4.54	9	2.27	-	[1]
		ratio	2	4	1	-	[]
		Empirical fo	rmula C ₂ H ₄ O			-	[']
		(ii) M _r of C ₂ H ₄ C	9 = 44				[4]
		n = 88/44 =	2				[1]
		molecular formula = $C_4H_8O_2$					[1]
		ECF given if method correct from wrong answer in (i)					1.1
	(b)	Bond angle in ethene: 120°				[1]	
		Bond angle in ethanol: <<109.5° (Accept 104° - 105°)					[1]
-							
6	(a)	A: Ca(NO ₃) ₂			E: HCI		Н
		B : FeO			F: FeCl ₂		
		C: Ca(OH) ₂			G: AgCl		
		<mark>Ð: NH</mark> ₃			[1] each; Not a	ccepted: chemical name	
	(b)	(i) $Ee^{2+}(2a) + 2OH^{-1}$		ا)^(د)			
	(9)	$\frac{(I)}{F}e^{2\tau}(aq) + 2OH^{-}(aq) \rightarrow Fe(OH)_{2}(S)$					547
		palanced lonic equi	ation;				[1]
		state symbols					[1]
		(ii) Fe(OH) ₂ is oxidised to Fe(OH) ₃ . OWTTE				[1]	
	(c)	Add excess Ag ₂ O to a fixed volume of HNO ₃ . Stir.					[1]
		Filter reaction mixture to obtain the filtrate.					[1]
		Heat filtrate until saturation and leave it to cool/crystallize. Then wash crystals					[1]
		with little cold distilled water.					ניז
7	(2)						[1]
+	(a)	1400				×	[י]
		1200			×		
		ionization	×				
		energy / 600	×				
		kJ mol ⁻¹ 400					
		200					
		0					
		N	Mg Al	Si	P S	С	
						I	
	(b)	A l(g) -> -Al⁺ (g) + e ⁻					[1]
	(c)	Third ionisation					[1]

	(d)	First I.E. decreases down the group.					
		The number of shells increase.					
		Attraction between the valence electron and the nucleus decrease.					
8	(a)	Magnesium has a higher melting point than sodium as its metallic bonding is stronger.					
		Increasing number of delocalised electrons per atom					
		Increasing cation charge					
	(b)	(i) The higher the packing efficiency, the higher the melting point.					
		(ii) When the solid melt, the rigid structure/lattice is broken. Packing efficiency of group 1 metals will not affect the boiling point.	[1] [1]				
	(c)	Malleable/ ductile/ high thermal condictivity/ high electrical conductivity					
9	(a)	(i) $nCa(OH)_2 = 8.88/74.10 = 0.120 \text{ mol}$ $nCl_2 = 7.200/24.0 = 0.300 \text{ mol}$ Calcium hydroxide is limiting reactant.					
		$Ca(OH)_2$: $Ca(CIO_3)_2 = 6$: 1 nCa(CIO_2)_2 = 0.0200 mol					
		(ii) mass of $Ca(CIO_3)_2 = 0.0200 \text{ x } 206.98 = 4.14 \text{ g } (accept 4.13 \text{ g } (3 \text{ s.f.}) \text{ if more s.f. given earlier})$					
		(iii) $(3.11/4.14) \times 100 = 75.1\%$ (accept 75.2 % (3 s.f.) if more s.f. given earlier)					
	(b)	A strong acid is a substance which dissociates completely in water to produce (high concentration of) H ⁺ ions.					
	(c)	(i) $HCIO_3 + H_2O \rightarrow CIO_3^- + H_3O^+$. Acid is a proton donor.					
		(ii) CIO ₃ -					
10	(a)	(i) n_{NaOH} (at start) = 0.500 x (60.0/1000) = 3.00 x 10 ⁻² mol or 0.0300 mol	[1]				
		n_{NaOH} (at end) = 0.500 x (10.8/1000) = 5.40 x 10 ⁻³ mol or 0.000540 mol	[1]				
		(iii) Methyl orange / screened methyl orange / bromothymol blue / thymolphthalein	[1]				
		(iv) 7 + end - point	[2]				
		10 • 8 Shape [1]; labelling of pH and volume of HNO ₃ used at endpoint [1]					
		(v) n_{NaOH} reacted = 0.0246 mol = 2.46 x 10 ⁻² mol	[1]				
	(b)	(i) $M_r = 1.00/(0.01136) = 88.03 (2 d.p.)$	[1]				
		(ii) $12.01n + (2n + 1) (1.01) + 12.01 + 16.00 \times 2 + 1.01 = 88.03$ 14.03n + 1.01 = 43.01 n = 3 (nearest whole number)	[1]				