

Practice Exams for AS OCR Chemistry A

Breadth in Chemistry

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Teacher's Introduction

This resource contains four practice papers for Breadth in Chemistry together with mark schemes. They are designed to assess the learning of candidates sitting OCR A Chemistry AS syllabus. They could also be used to assess learning for Year 2.

The questions are based on the new OCR A Chemistry syllabus specification. They are in line with the new style of testing. There are extended-response questions marked with a * in these papers as there will be in the actual examinations. The papers contain at least 20 % maths skills at level 2.

The Breadth in Chemistry papers each contain 20 multiple-choice questions together with structured questions, problem-solving and extended-response questions.

The questions come with diagrams, but these have been limited to where absolutely necessary to reduce photocopying expenses to a fraction of those involved in copying often very lengthy examination papers. Each set of four papers taken together tries to cover the entire specification.

Students should have access to a calculator and a data sheet when completing these papers.

I hope your students find these papers rewarding and beneficial to use.

Remember!

Always check the exam board website for new information, including changes to the specification and sample assessment material.

Free Updates!

Register your email address to receive any future free updates* made to this resource or other Chemistry resources your school has purchased, and details of any promotions for your subject.

* resulting from minor specification changes, suggestions from teachers and peer reviews, or occasional errors reported by customers

Go to zzed.uk/freeupdates

Specification Cross-reference

	AS Paper 1 (A) Breadth in Chemistry	AS Paper 1 (B) Breadth in Chemistry	AS Paper 1 (C) Breadth in Chemistry	AS Paper 1 (D) Breadth in Chemistry	AS Paper 2 (A) Depth in Chemistry	AS Paper 2 (B) Depth in Chemistry	AS Paper 2 (C) Depth in Chemistry	AS Paper 2 (D) Depth in Chemistry
Module 1								
1.1 Practical skills								
1.1.1 Planning	24bii					7	5, 6b	
1.1.2 Implementing			24ciii				6b	2e,f
1.1.3 Analysis 1.1.4 Evaluation			23c		4dii	6		2biii,iv
Module 2								
2.1 Atoms and reactions								
2.1.1 Atomic structure and isotopes Relative mass	11, 21biii	16, 20, 25a,b	1,5 24bi	5, 22a		4eii		
2.1.2 Compounds, formulae and equations	21bv	20, 23a	22c	21b, 22ciii, 22d, 23b	1b	1ai, 4cii	2bi, 2dii	
2.1.3 Amount of a substance Moles Determination of formulae	26a,b 22a, 22c	11, 23bii, 23di	23a	10		2bv 1aiii,iv		1civ 2ai
Reacting quantities Percentage yield Atom economy	23biii	22d	24ciii	21c 19		5	3bi,ii,iii	2g
2.1.4 Acids Acids, bases and neutralisation Acid-base titrations	8, 9, 20, 24aj,ii,iii	21c 13, 23c	23bi 7, 23bii,iii	21a 22b		2bi,ii	2dii	1a,b,c
2.1.5 Redox Oxidation number Redox reactions	21bvi, 24biii	23bi	3	15, 21cv, vi, 22div	5biii 1ai	4aii 4eiii		

	AS Paper 1 (A) Breadth in Chemistry	AS Paper 1 (B) Breadth in Chemistry	AS Paper 1 (C) Breadth in Chemistry	AS Paper 1 (D) Breadth in Chemistry	AS Paper 2 (A) Depth in Chemistry	AS Paper 2 (B) Depth in Chemistry	AS Paper 2 (C) Depth in Chemistry	AS Paper 2 (D) Depth in Chemistry
2.2 Electrons, bonding and structure								
2.2.1 Electron structure		20				2ai	2a	
2.2.2 Bonding and structure Ionic and covalent bonding Shapes of molecules and ions Electronegativity and bond polarity	21bii 1, 22b 22b	6, 17 25c 7 10, 22eii	21ciii, iv 6, 16 24bii	23a 22ci, ii 23ci, ii	4ei 4eii	2biii, iv, 2ci, 4ci 2cii	2bii, 2di	
Intermolecular forces	25a	19	17, 19, 22a	20, 23ciii	3e		1dii	
Module 3 Periodic table and energy								
3.1 The periodic table								
% marks for quantitative skills Level 2 or above								
Practical skills assessed?								
3.1.1 Periodicity								
Structure of the periodic table Trends in electronic configuration and ionisation energies Trends in structure and melting point	21a, 21bi 4, 7 13		10 17	4	6	4ciii		
3.1.2 Group 2								
Redox reactions and reactivity	5		11			2d, 4ei	3c	
Reactions of group 2	4, 24bii	2		1, 22diii	2aii			1
3.1.3 The halogens								
Characteristic physical properties and redox reactions of the halogens and their compounds	2	14, 22ei	13	14, 24b,c,d		4bi	2ci, 2ciii, 5	
% marks for quantitative skills Level 2 or above	All papers fit this							
Reactions of halide ions	14	3		14, 24a		4ai		

	AS Paper 1 (A) Breadth in Chemistry	AS Paper 1 (B) Breadth in Chemistry	AS Paper 1 (C) Breadth in Chemistry	AS Paper 1 (D) Breadth in Chemistry	AS Paper 2 (A) Depth in Chemistry	AS Paper 2 (B) Depth in Chemistry	AS Paper 2 (C) Depth in Chemistry	AS Paper 2 (D) Depth in Chemistry
3.1.4 Qualitative analysis								
Test for ions	20	7, 21a,b,d,e	3		3di,ii			
3.2 Physical chemistry								
3.2.1 Enthalpy changes		5	15		3ci		2diii, 3biv,v 4ai,ii, 4ci,ii,iii	2bi,ii
Definitions			8		1aii, 4ciii	7	4bi	
Bond enthalpies	5, 16		21di	11, 13				
Hess's law and enthalpy cycles					4a,b,ci,ii, 4di			
3.2.2 Reaction rates								
Simple collision theory		24b					3ai,ii	4ai,ii,iii
Catalysts		18, 22c, 24a	18, 21b				4aiii	4b
Boltzmann distribution			21a, 21c					4aiv, 4ci
3.2.3 Chemical equilibrium and Le Chatelier's principle	6	1, 24c		16	3a,	3cii,iii,iv	2cii	
K _c			21dii	12	3bi,ii,iii			
Module 4 Core organic chemistry								
Practical skills assessed?								
4.1 Basic concepts and hydrocarbons								
4.1.1 Naming and formulae								
Functional groups		4	2, 22d	17	1ci			2aii
Isomerism							1di	
Reaction mechanisms	23bii		24a, 24ci		3b			
4.1.2 Alkanes								
Properties of alkanes	25bi,ii		9		1cii			
Reactions of alkanes	14, 15	22ai,ii, 22b	9, 20	2, 6	1ciii	1aii		3a

	AS Paper 1 (A) Breadth in Chemistry	AS Paper 1 (B) Breadth in Chemistry	AS Paper 1 (C) Breadth in Chemistry	AS Paper 1 (D) Breadth in Chemistry	AS Paper 2 (A) Depth in Chemistry	AS Paper 2 (B) Depth in Chemistry	AS Paper 2 (C) Depth in Chemistry	AS Paper 2 (D) Depth in Chemistry
4.1.3 Alkenes								
Stereoisomerism in alkenes	1	8, 23dii	20		2bii			
Addition reactions of alkenes		4		18	2bi			2hi, 3b
Polymers from alkenes						1bii, 4d		
Waste polymers					7			5a
4.2 Alcohols, haloalkanes and analysis								
4.2.1 Alcohols								
Properties of alcohols	3, 17	19	12, 22b	3	5a	6		2c,d
Reactions of alcohols	10, 17, 18	12	6, 14, 24cii	7	5bi,ii, 5cii, 5dii, 5ei,ii		1diii, 6ai,ii,iii, 6b	3b
4.2.2 Haloalkanes								
Substitution reactions	15	15	4		2ai, 3a, 3diii			3a
Environmental concerns	12	22aiii, 24aiii, 24d			2aii–iv	3civ	4bii	4cii, 5b, 5c
Organic synthesis including practical skills and synthetic route	18		14, 24ciii		2biii, 3c, 5ci			
4.2.4 Analytical techniques								
Infrared						1bi	1a,b	2hii
Mass spectrometry	12	9	22ei,ii	9			1ci,ii,iii	
Combined techniques			22eiii				1ci,ii,iii	

AS OCR Chemistry A
Unit H032/01 Breadth in Chemistry

Practice Paper 1 (B)

Name	
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Time allowed

1 hour 30 minutes

Instructions

Answer **all** of the questions in Section A and Section B

Information

- The total marks available for this paper is **70**
The number of marks available for each question is shown in brackets
- Answer all questions and show all working
- Write each answer in the space provided

You must have:

- The Data Sheet for Chemistry A
- A scientific calculator

Question
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Question
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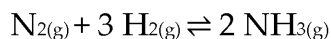
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Section A

Answer **all** the questions

- 1 Which one of the following statements must apply to the reverse reaction when dynamic equilibrium is reached?



- A The concentration of reactants and products are equal.
B The rate of the forward reaction is greater than the rate of the reverse reaction.
C K_c will increase if the percentage of ammonia in the mixture increases when the temperature is increased.
D The reaction must be taking place in an open system.

Your answer is

- 2 Which one of the following statements is true about the group 2 elements?

The group 2 elements...

- A become less chemically reactive down the group.
B lose outer shell s electrons when they form +2 ions.
C normally have an oxidation state of -2 in compounds.
D form oxides which give aqueous solutions with a pH less than 7.

Your answer is

- 3 The addition of silver nitrate solution to an aqueous solution of sodium chloride gives a cream precipitate.

Which of the following is the ionic equation for this reaction?

- A $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$
B $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{g}) \rightarrow \text{AgCl}(\text{s})$
C $\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr}(\text{s})$
D $\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{g}) \rightarrow \text{AgBr}(\text{s})$

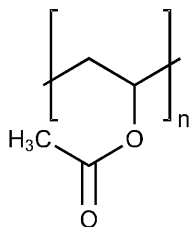
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- 4 The diagram shown below represents the structure of an important acetate commonly used in glues.



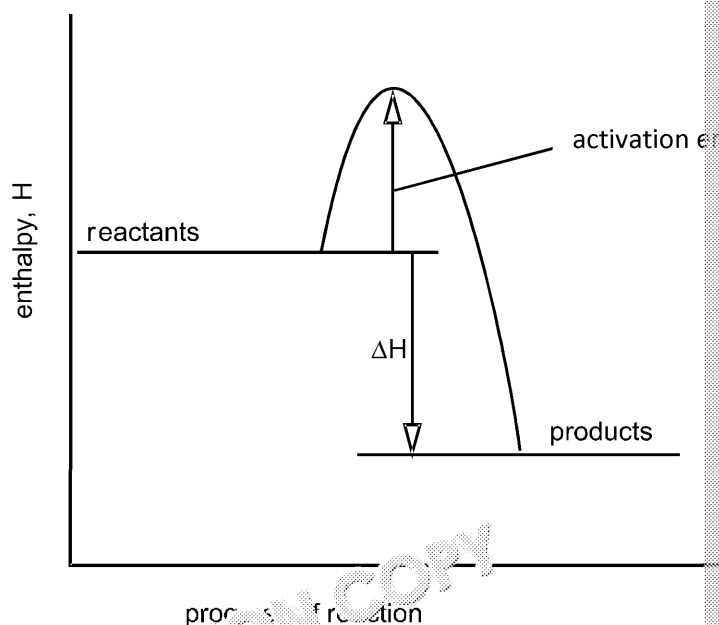
Which one of the following statements is true?

Polyvinyl acetate...

- A contains an ester link.
- B is referred to as an unsaturated compound.
- C has a fixed molecular mass.
- D is manufactured entirely from renewable resources.

Your answer is

- 5 The diagram below represents the enthalpy profile for an uncatalysed reaction.



Which of the following statements about this reaction is correct?

- A The forward reaction is endothermic.
- B ΔH would be the same for both the catalysed and uncatalysed reactions.
- C The activation energies of the forward and back reactions are the same.
- D The enthalpy profile would be the same for the catalysed and uncatalysed reactions.

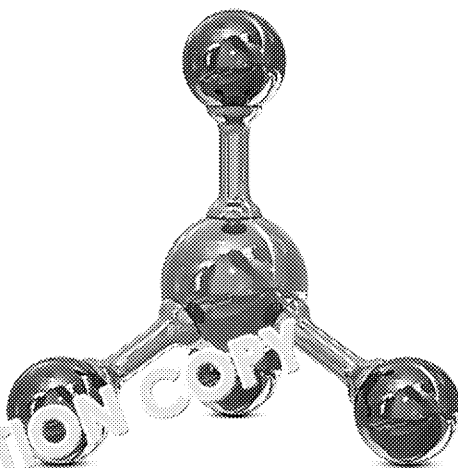
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6 The diagram below shows a molecular model of the 3D structure



Which of the following substances could have this type of structure?

- A SiH_4
- B Diamond
- C SF_4
- D Ice

Your answer is

7 Which one of the following statements involving the ammonium ion is correct?

The ammonium ion...

- A only contains H-N-H bond angles of 109.5° .
- B is present in salts which release ammonia on warming with water.
- C is basic.
- D contains both covalent and dative covalent bonds.

Your answer is

8 Which one of the following statements correctly describes the structure of ethene?

An ethene molecule...

- A is a straight chain.
- B is a branched chain.
- C only contains π -bonds.
- D contains a freely rotating C=C double bond.

Your answer is

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- 9 Chlorine is composed of diatomic molecules and has two isotopes. If a sample of chlorine was analysed in a mass spectrometer and ions then the number of peaks recorded in the mass spectrum would be
- A 2
B 3
C 4
D 5

Your answer is

- 10 Which one of the following substances contains polar molecules?
- A BF₃
B SF₆
C CO₂
D HF

Your answer is

- 11 A piece of magnesium has a mass of 12.15 kg. Which one of the following statements is correct? The ingot contains, correct to one decimal place...
- A 0.5 mol of atoms.
B 2.0×10^{-3} mol of atoms.
C 500.0 mol of atoms.
D 7.3×10^{24} atoms.

Your answer is

- 12 Which one of the following alcohols when treated with a mixture of potassium dichromate solution would **not** bring about a colour change?
- A Butan-1-ol
B Butan-2-ol
C Butanal
D 2-methyl propan-2-ol

Your answer is

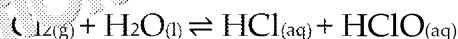
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- 13 Which one of the following statements describes the addition of calcium carbonate and magnesium carbonate, MgCO_3 , separately to hydrochloric acid?
- A Both reactions produce bubbles of gas.
 - B Both reactions involve a species accepting protons.
 - C Only one of the reactions has water as a product.
 - D Both reactions produce the salt MgCl .

Your answer is

- 14 Chlorine gas reacts with water according to the reversible reaction



Which one of the following statements applies to this reaction?

- A Chlorine has oxidation numbers of +1 and -1 in the products.
- B The toxicity of chlorine is removed by dissolving it in water.
- C Adding silver nitrate solution to chlorine in water would give a precipitate.
- D Adding chlorine to water would increase the pH of the water.

Your answer is

- 15 Which of the following is the name of the mechanism of the reaction of 1-iodopropane is heated with aqueous sodium hydroxide?

- A Nucleophilic substitution
- B Nucleophilic addition
- C Electrophilic substitution
- D Electrophilic addition

Your answer is

- 16 One form of ordinary water is referred to as heavy water and is deuterium oxide. It contains one ^{16}O atom and two ^2H atoms.

Which one of the following statements about heavy water is true?

- A Heavy water will have different chemical properties to ordinary water.
- B The mass spectra of heavy water and ordinary water will be different.
- C The molecular mass of heavy water is 20.
- D The molecular mass of heavy water is calculated relative to ^{12}C .

Your answer is

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- 17 Which of the following statements regarding elements taken from neon in the periodic table is/are true?

Delocalised electrons are present in

- 1: lithium
- 2: carbon graphite
- 3: liquid nitrogen

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

Your answer is

- 18 Catalysts are used in many chemical reactions.

Which of the following statements about these sorts of reactions

- 1: The formation of esters from carboxylic acids and alcohols is
- 2: The hydrogenation of alkenes is catalysed by phosphoric acid
- 3: The reaction between alkenes and steam is catalysed by iron

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

Your answer is

- 19 Which of the following is/are accounted for by the formation of hydrogen bonds?

- 1: The relatively high melting point of water.
- 2: The density of ice being less than water.
- 3: The ability of many alcohols to mix with water.

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

Your answer is

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20 Nitrogen forms the nitride ion, N^{3-} .

Which of the following statements related to the nitride ion is/are correct?

- 1: The nitride ion contains 10 protons.
- 2: The formula of calcium nitride is Ca_3N_2 .
- 3: The nitride ion would have the same number of electrons as a neon atom.

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

Your answer is



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Section B

Answer **all** the questions

21 A student was given two solutions, **A** and **B**, and asked to confirm dissolved ions. She was told that:

- solution **A** contained halide ions and
- solution **B** contained carbonate and sulfate ions.

Testing solution A

The student decided to test solution A with silver nitrate solution to test the solution for halide ions.

(a) Why should the silver nitrate solution be prepared using distilled water?



.....
.....

(b) The student observed that a white precipitate formed when solution A was added to silver nitrate solution. She concluded that chloride ions were present.

(i) Write the ionic equation for the formation of the white precipitate. Include state symbols.

.....

(ii) What further test could the student have carried out to confirm the presence of the precipitate?

.....
.....

Testing solution B

The student decided to test for carbonate ions first.

(c) She added nitric acid to solution B and noted the formation of bubbles and a white precipitate.



(i) What is the formula of nitric acid?

.....

(ii) Write the essential ionic equation for the formation of the white precipitate.

.....

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The student then added barium chloride solution to test for the presence of carbonate ions. The student observed the formation of a precipitate which confirmed the presence of carbonate ions.

(d) (i) What colour was the precipitate?

.....

(ii) Write the ionic equation for the reaction occurring.

Include state symbols.

.....

(e) Why did the student test for carbonate ions before she tested for sulphate ions?



.....

22 Propane and chlorine react in the presence of ultraviolet radiation to form a mixture of products. The reaction is a free radical substitution reaction.

(a) (i) What is a radical?

.....

(ii) What kind of bond fission results in the formation of radicals?

.....

(iii) State one environmental problem caused by the formation of free radicals.

.....

(b) The partially completed table below shows the stages in the free radical substitution reaction of propane and chlorine to form 1-chloropropane from propane and chlorine.

Complete the table by filling in the empty spaces.

Name of stage	Reaction occurring
Initiation	$\text{Cl}_2 \rightarrow \dots\dots\dots$
Propagation (1 mark)	$\text{C}_3\text{H}_8 + \cdot\text{Cl} \rightarrow \dots\dots\dots$ $\dots\dots\dots + \text{Cl}_2 \rightarrow \dots\dots\dots$
Termination	Possible reactions $\dots\dots\dots$

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- (c) (i) Explain how chlorine radicals are acting as a catalyst in process.

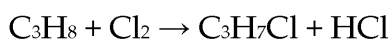
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- (ii) How are catalysts able to speed up chemical reactions?

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



- (d) The overall equation for the formation of 1-chloropropane is



Calculate the percentage atom economy of 1-chloropropane

Give your answer to two significant figures.

Explain in terms of sustainability why it is important to have high atom economies.

Calculation:

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

Reason:

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- (e) This is not a satisfactory method for the preparation of 1-chloroalkanes. Polychlorinated halogenoalkanes are formed. These tend to be liquids. Suggest a method by which a particular halogenoalkane can be separated from the liquid mixture.

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- (ii) The chlorinated products of the reaction often contain polar bonds. Explain why the product molecules are generally polar whereas the molecules from which they were made from was non-polar.

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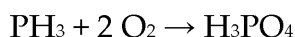
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23 Phosphine, PH_3 , is a colourless, flammable gas. It can be made by the reaction of magnesium phosphide, Mg_3P_2 , and water. In this reaction an alkaline solution is also formed. Write the equation for this reaction.

- (a) Write the equation for this reaction.

.....

- (b) Phosphine burns readily in oxygen according to the reaction



- (i) State the increase in the oxidation number of phosphorus in this reaction.

.....

- (ii) Calculate the maximum mass of phosphoric acid that can be formed from 10 g of phosphine.

.....

.....

.....

- (c) Phosphine dissolves in strongly acidic solutions where it acts as a base. Write the structure of the phosphorus containing ion formed in these solutions.

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Another phosphorus hydride exists called diphosphene, P_2H_2 .

(d) (i) Calculate the percentage by mass of phosphorus in diphosphene.

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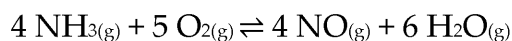
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(ii) Diphosphene exists in two allotropic forms. What does the structure of a molecule of diphosphene present in a molecule of diphosphene?



24 The production of nitric acid from ammonia involves the catalytic reaction shown below. The reaction is carried out at relatively high temperatures in the presence of a platinum/rhodium gauze catalyst.



(a) (i) The catalyst used is in a different physical state to the reactants. What general name is given to this type of catalyst?

.....

(ii) How could the platinum/rhodium catalyst be made more effective?

.....

.....

(iii) Explain how the reaction could become more sustainable by using a more effective catalyst.



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(b) Explain, in terms of particles, how any increase in pressure of result in an increase in the rate of both the forward and back

.....

.....

.....

.....

(c) Oxygen is normally present in exhaled air. Why is this done?

.....

.....



(d) If the NO escaped into the atmosphere it would slightly increase the amount of NO already present.

What is the major cause of atmospheric NO pollution?

.....

.....

25 This question is about the chlorides of potassium and titanium (KCl and TiCl₄).

Potassium and titanium are metals in the same period of the periodic table.

(a) A particular sample of potassium chloride was formed from potassium that contained two isotopes of potassium. Mass spectrometry of the results shown in the table below.

isotope	relative isotopic mass	abundance
³⁹ K	39.0	88
⁴¹ K	41.0	11

Using the table, calculate the relative atomic mass of the potassium in the sample.

Give your answer to **three** significant figures.

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AS OCR Chemistry A
Unit H032/01 Breadth in Chemistry

Practice Paper 1 (B)

Name	
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Time allowed

1 hour 30 minutes

Instructions

Answer **all** of the questions in Section A and Section B

Information

- The total marks available for this paper is **70**
The number of marks available for each question is shown in brackets
- Answer all questions and show all working
- Write each answer in the space provided

You must have:

- The Data Sheet for Chemistry A
- A scientific calculator

Question
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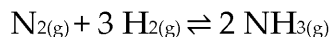
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Section A

Answer **all** the questions

- 1 Which one of the following statements must apply to the reverse reaction when dynamic equilibrium is reached?



- A The concentration of reactants and products are equal.
B The rate of the forward reaction is greater than the rate of the reverse reaction.
C K_c will increase if the percentage of ammonia in the mixture increases and the temperature is constant.
D The reaction must be taking place in an open system.

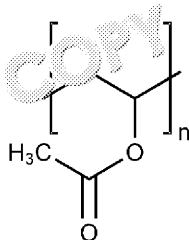
- 2 Which one of the following statements is true about the group 2 elements...
The group 2 elements...

- A become less chemically reactive down the group.
B lose outer shell s electrons when they form +2 ions.
C normally have an oxidation state of -2 in compounds.
D form oxides which give aqueous solutions with a pH less than 7.

- 3 The addition of silver nitrate solution to an aqueous solution of calcium chloride gives a white precipitate.

Which of the following is the ionic equation for this reaction?

- A $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$
B $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{g}) \rightarrow \text{AgCl}(\text{s})$
C $\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr}(\text{s})$
D $\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{g}) \rightarrow \text{AgBr}(\text{s})$
- 4 The diagram shown below represents the structure of an important polymer commonly used in glues.



Which one of the following statements is true?

Polyvinyl acetate...

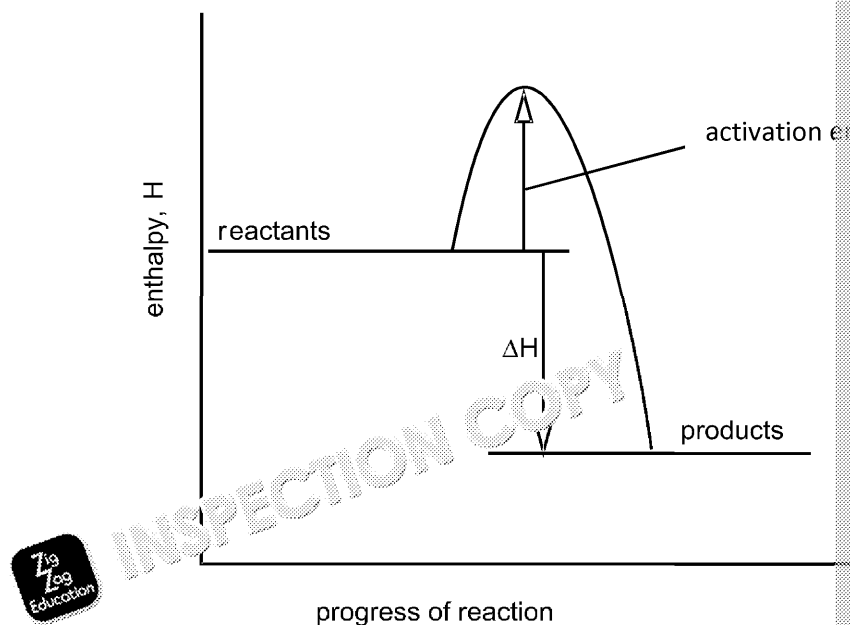
- A contains an ester link.
B is referred to as an unsaturated compound.
C has a fixed molecular mass.
D is manufactured entirely from renewable resources.

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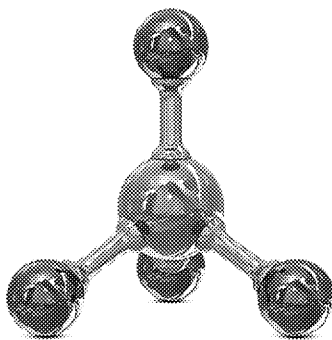


- 5 The diagram below represents the enthalpy profile for an uncatalysed reaction.



Which of the following statements about this reaction is correct?

- A The forward reaction is endothermic.
 - B ΔH would be the same for both the catalysed and uncatalysed reactions.
 - C The activation energies of the forward and back reactions are the same.
 - D The enthalpy profile would be the same for the catalysed and uncatalysed reactions.
- 6 The diagram below shows a molecular model of the 3D structure of a substance.



Which one of the following substances could have this type of structure?

- A SiH_4
 - B Diamond
 - C SF_4
 - D ICl_4
- 7 Which one of the following statements involving the ammonium ion is correct?

The ammonium ion...

- A only contains H-N-H bond angles of 109.5° .
- B is present in salts which release ammonia on warming with water.
- C is basic.
- D contains both covalent and dative covalent bonds.

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- 8 Which one of the following statements correctly describes the structure of an ethene molecule...
- An ethene molecule...
- A is very stable.
 - B is planar.
 - C only contains π -bonds.
 - D contains a freely rotating C=C double bond.
- 9 Chlorine is composed of diatomic molecules and has two isotopes. If a sample of chlorine was analysed in a mass spectrometer and ions then the number of peaks recorded in the mass spectrum would be...
- A 2
 - B 3
 - C 4
 - D 5
- 10 Which one of the following substances contains polar molecules?
- A BF_3
 - B SF_6
 - C CO_2
 - D HF
- 11 A piece of magnesium has a mass of 12.15 kg. Which one of the following statements is correct? The ingot contains, correct to one decimal place...
- A 0.5 mol of atoms.
 - B 2.0×10^{-3} mol of atoms.
 - C 500.0 mol of atoms.
 - D 7.3×10^{24} atoms.
- 12 Which one of the following alcohols when heated with a mixture of potassium dichromate solution would react to form about a colour change from orange to green?
- A Butan-1-ol
 - B Butan-2-ol
 - C 2-methylpropan-1-ol
 - D 2-methylpropan-2-ol

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- 13 Which one of the following statements describes the addition of calcium carbonate and magnesium carbonate, MgCO_3 , separately to hydrochloric acid?
- A Both reactions produce bubbles of gas.
 B Both reactions involve a species accepting protons.
 C Only one of the reactions has water as a product.
 D Both reactions produce the salt MgCl_2 .

- 14 Chlorine gas reacts with water according to the reversible reaction



Which one of the following statements applies to this reaction?

- A Chlorine has oxidation numbers of +1 and -1 in the products.
 B The toxicity of chlorine is removed by dissolving it in water.
 C Adding silver nitrate solution to chlorine in water would give a precipitate.
 D Adding chlorine to water would increase the pH of the water.
- 15 Which of the following is the name of the mechanism of the reaction of 1-iodopropane with aqueous sodium hydroxide?
- A Nucleophilic substitution
 B Nucleophilic addition
 C Electrophilic substitution
 D Electrophilic addition

- 16 One form of ordinary water is referred to as heavy water and is D_2O . It contains one ^{16}O atom and two ^2H atoms.

Which one of the following statements about heavy water is true?

- A Heavy water will have different chemical properties to ordinary water.
 B The mass spectra of heavy water and ordinary water will be different.
 C The molecular mass of heavy water is 20.
 D The molecular mass of heavy water is calculated relative to ^{16}O .
- 17 Which of the following statements regarding elements taken from neon in the periodic table is/are correct?

Delocalised electrons are present in

- 1: lithium
 2: carbon in graphite
 3: liquid nitrogen

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

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18 Catalysts are used in many chemical reactions.

Which of the following statements about these sorts of reactions is/are correct?

- 1: The formation of esters from carboxylic acids and alcohols is catalysed by concentrated sulphuric acid.
- 2: The hydrogenation of alkenes is catalysed by phosphoric acid.
- 3: The reaction between alkenes and steam is catalysed by iron(III) oxide.

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

19 Which of the following properties are accounted for by the formation of hydrogen bonds in water?

- 1: The relatively high melting point of water.
- 2: The density of ice being greater than water.
- 3: The ability of many alcohols to mix with water.

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

20 Nitrogen forms the nitride ion, N^{3-} .

Which of the following statements related to the nitride ion is/are correct?

- 1: The nitride ion contains 10 protons.
- 2: The formula of calcium nitride is Ca_3N_2 .
- 3: The nitride ion would have the same number of electrons as a neon atom.

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

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Section B

Answer **all** the questions

21 A student was given two solutions, **A** and **B**, and asked to confirm dissolved ions. She was told that:

- solution **A** contained halide ions and
- solution **B** contained carbonate and sulfate ions.

Testing solution A

The student decided to use silver nitrate solution to test the solution.

(a) Why should the silver nitrate solution be prepared using distilled water?

(b) The student observed that a white precipitate formed when solution A was added to silver nitrate solution. She concluded that chloride ions were present.

- Write the ionic equation for the formation of the white precipitate. Include state symbols.
- What further test could the student have carried out to confirm the presence of chloride ions in the precipitate?

Testing solution B

The student decided to test for dissolved carbonate ions first.

(c) She added nitric acid and noted the formation of bubbles and a precipitate. Carbonate ions were present.

- What is the formula of nitric acid?
- Write the essential ionic equation for the formation of the precipitate.

The student then added barium chloride solution to test for the presence of sulfate ions. She observed the formation of a precipitate which confirmed the presence of sulfate ions.

- What colour was the precipitate?
- Write the ionic equation for the reaction occurring. Include state symbols.

(e) Why did the student test for carbonate ions before she tested for sulfate ions?

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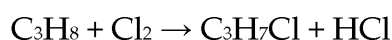
22 Propane and chlorine react in the presence of ultraviolet radiation to form a mixture of radicals.

- (a) (i) What is a radical?
 (ii) What kind of bond fission results in the formation of radicals?
 (iii) State one environmental problem caused by the formation of radicals.
- (b) The partially completed table below shows the stages in the formation of 1-chloropropane from propane and chlorine.

Copy and complete the table by filling in the empty spaces.

Name of stage	Reaction occurring
Initiation	$\text{Cl}_2 \rightarrow \dots\dots\dots$
Propagation	$\text{C}_3\text{H}_8 + \cdot\text{Cl} \rightarrow \dots\dots\dots$ $\dots\dots\dots + \text{Cl}_2 \rightarrow \dots\dots\dots$
Termination	Possible reactions $\dots\dots\dots$

- (c) (i) Explain how chlorine radicals are acting as a catalyst in the reaction.
 (ii) How are catalysts able to speed up chemical reactions?
- (d) The overall equation for the formation of 1-chloropropane is



Calculate the percentage atom economy of 1-chloropropane.

Give your answer to two significant figures.

Explain in terms of sustainability why it is important to have high atom economies.

- (e) This is not a satisfactory method for the preparation of 1-chloropropane because polychlorinated propanealkanes are formed. These tend to be difficult to separate from the liquid mixture.
- (i) Suggest the name of a method by which a particular halogenoalkane can be separated from the liquid mixture.

- (ii) The chlorinated products of the reaction often contain polar bonds.
 Explain why the product molecules are generally polar whereas the reactant molecules were non-polar.

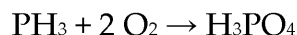
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23 Phosphine, PH_3 , is a colourless, flammable gas. It can be made by reacting magnesium phosphide, Mg_3P_2 , and water. In this reaction an alkane and another product.

(a) Write the equation for this reaction.

(b) Phosphine burns readily in oxygen according to the reaction



(i) State the increase in the oxidation number of phosphorus.

(ii) Calculate the maximum mass of phosphoric acid that could be formed from 10 g of phosphine.

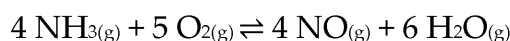
(c) Phosphine dissolves in strongly acidic solutions where it acts as a base. Draw the structure of the phosphorus containing ion formed in these solutions.

Another phosphorus hydride exists called diphosphene, P_2H_2 .

(d) (i) Calculate the percentage by mass of phosphorus in diphosphene.

(ii) Diphosphene exists in the E and Z forms. What does the E form look like? Draw it present in a molecule of diphosphene?

24 The production of nitric acid from ammonia involves the catalytic reaction shown below. The reaction is carried out at relatively high temperature in the presence of a platinum/rhodium gauze catalyst.



(a) (i) The catalyst used is in a different physical state to the reactants. What general name is given to this type of catalyst?

(ii) How could the platinum/rhodium catalyst be made more effective?

(iii) Explain how the reaction could become more sustainable by using a more effective catalyst.

(b) Explain, in terms of particles, how any increase in pressure of the reactants would result in an increase in the rate of both the forward and backward reactions.

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- (c) Oxygen is normally present in excess. Why is this done?
- (d) If the NO escaped into the atmosphere it would slightly increase the amount of NO already present.

What is the major cause of atmospheric NO pollution?

25 This question is about the chlorides of potassium and titanium (KCl and TiCl₄). Potassium and titanium are metals in the same period of the periodic table.

- (a) A particular sample of potassium chloride was formed from potassium containing two isotopes of potassium. Mass spectrometry of this sample gave the following results shown in the table below.

isotope	relative isotopic mass	abundance (%)
³⁹ K	39.0	88.4
⁴¹ K	41.0	11.6

Using the table, calculate the relative atomic mass of the potassium in this sample. Give your answer to **three** significant figures.

- (b) To which blocks in the periodic table do potassium and titanium belong?
- (c) The melting points and boiling points of potassium chloride and titanium tetrachloride are given in the table below.

compound	melting point / °C	boiling point / °C
KCl	770	1412
TiCl ₄	-24	174

Account for the differences in melting point and boiling point between potassium chloride and titanium tetrachloride by predicting the structure and bonding in these two chlorides.

In your answer, you should use appropriate technical terms.

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END OF QUESTION PAPER

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Mark Scheme

Practice Paper 1 (A)

Section A

- 1 C
- 2 D
- 3 A
- 4 A
- 5 C
- 6 D
- 7 B
- 8 C
- 9 B
- 10 B
- 11 C
- 12 B
- 13 B
- 14 A
- 15 C
- 16 D
- 17 D
- 18 C
- 19 B
- 20 A

Section B

- 21 (a) The highest filled orbital is an s orbital / furthestmost electron is in an s orbital
- (b) (i) All have one electron / same number of electrons in the outer shell.
(ii) $(1s^2) 2s^2 2p^6$. Accept in either order / capitals.
(iii) $10 \times 6.02 \times 10^{23}$
 6.02×10^{24}
(iv) $2\text{Na} + 2\text{NH}_3 \rightarrow 2\text{NaNH}_2 + \text{H}_2$
(v) Sodium changes from 0 to +1.
Hydrogen changes from +1 to 0.
Sodium is oxidised and hydrogen is reduced.
If nitrogen changes maximum 1 mark.
- 22 (a) Moles Al = $1.08/27 = 0.04$ and moles Cl = $4.26/35.5 = 0.12$
Evidence of $0.04/0.04$ and $0.12/0.04 = 1:3$
- (b) Shape: Trigonal planar.
Explanation: Chlorine is more electronegative than aluminium / (aluminium and chlorine are polar / correct polarity from diagram.
Dipole moment is zero because molecule is symmetrical.
- (c) All AlCl₃ are rejected
Reject 2 AlCl₃
- (d) Dative covalent/coordinate.
- (e) (i) Reagent: (Aqueous) silver nitrate.
Result: White precipitate/solid.
- (f) It provides an alternative route of lower activation energy.

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- 23 (a) Any two from:
 same general formula
 same functional group / similar chemistry
 differ by CH_2
 melting points / boiling points increase down the group
- (b) (i) Name: 2-methyl pent-1-ene.
 Use: To make polymers/alcohols.
- (ii) Mechanism: Electrophilic addition.
 Type of bond fission: Heterolytic.
- (iii) $pV = nRT$
 $V = nRT/p$
 $n = (4.30/84.0) = 0.0512$
 $V = 0.0512 \times 8.314 \times 500/100 = 2.13 \text{ dm}^3$
 $V = 2.13 \times 10^3 \text{ cm}^3$
 Allow ecf M3 to M4 and M4 to M5.
 Maximum 2 sf for incorrect formula / incorrect arrangement.
- 24 (a) (i) Hydrogen ions have been replaced by metal ions / Cu^{2+} ions.
 (ii) Observation 1: Solid dissolves/disappears.
 Observation 2: Bubbles/effervescence seen.
 Accept colourless solution goes blue/green.
 (iii) It is donating protons / H^+ ions (to carbonate ions).
- (b) (i) No further mass change occurs
 (ii) Thermal decomposition
 (iii) Type of reaction: Disproportionation
 Chemical equation: $2 \text{NO}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_3 + \text{HNO}_2$
 Correct balancing
- 25 (a) Accept any more branched isomer, e.g. 2,3-dimethyl hexane.
- (b) (i) $\text{C}_8\text{H}_{18} + 12.5 \text{O}_2 \rightarrow 8 \text{CO}_2 + 9 \text{H}_2\text{O}$
 Correct formulae.
 Correct balancing. Accept multiples.
- (ii) Insufficient oxygen/air.
- 26 (a) $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$
 Ignore state symbols.
- (b) Moles $\text{HCl} = (23.2/1000) \times 0.18 = 4.176 \times 10^{-3}$
 (Moles NaOH in $25.0 \text{ cm}^3 = 4.176 \times 10^{-3}$)
 Moles NaOH in $250 \text{ cm}^3 = 4.176 \times 10^{-2}$
 $M_r \text{ NaOH} = 40$
 $M_r \text{ CaCO}_3 = 100$
 $\text{Mass CaCO}_3 = 4.176 \times 10^{-2} \times 40 = 1.67(04)$
 $\% = (1.6704/2.42) \times 100 = 69\%$. Must be to 2sf.
 Allow ecf for each step.

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