Oxford Cambridge and RSA

Higher

GCSE

Chemistry A Gateway Science

J248/04: Paper 4 (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for June 2022

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training*; *OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are available in RM Assessor.
3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the RM Assessor messaging system.

5. Work crossed out:

   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks

   b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response)

   - if there is nothing written at all in the answer space
   - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
   - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question.

   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

   If you have any questions or comments for your Team Leader, use the phone, the RM Assessor messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:

Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.

Once the level is located, award the higher or lower mark:

The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.

The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

In summary:

The skills and science content determines the level.

The communication statement determines the mark within a level.

Level of response question on this paper is **Q22(c)**

11. Annotations available in RM Assessor

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore

12. Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

13. **Subject-specific Marking Instructions**

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

The breakdown of Assessment Objectives for GCSE (9-1) in Chemistry:

	Assessment Objective
AO1	**Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.**
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
AO2	**Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.**
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
AO3	**Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.**
AO3.1	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
AO3.2	Analyse information and ideas to make judgements and draw conclusions.
AO3.2a	Analyse information and ideas to make judgements.
AO3.2b	Analyse information and ideas to draw conclusions.
AO3.3	Analyse information and ideas to develop and improve experimental procedures.
AO3.3a	Analyse information and ideas to develop experimental procedures.
AO3.3b	Analyse information and ideas to improve experimental procedures.

Question			Answer	Marks	AO element	Guidance
1			C ✓	1	2.2	
2			B ✓	1	2.2	
3			B ✓	1	1.1	
4			B ✓	1	1.2	
5			D ✓	1	2.2	
6			D ✓	1	1.1	
7			A ✓	1	1.1	
8			B ✓	1	1.1	
9			C ✓	1	2.2	
10			C ✓	1	1.1	
11			B ✓	1	1.1	
12			B ✓	1	1.1	
13			A ✓	1	1.1	
14			D ✓	1	2.1	
15			D ✓	1	2.1	

For answers to Section A if an answer box is blank ALLOW correct indication of answer e.g. circled or underlined.

Question			Answer	Marks	AO element	Guidance
16	(a)		$2H_2O_2 \rightarrow O_2 + 2H_2O$ Formulae ✓ Balancing ✓	2	2.2	**ALLOW** any correct multiple, including fractions **DO NOT ALLOW** and / & instead of '+' balancing mark is dependent on the correct formulae but **ALLOW** 1 mark for a balanced equation with a minor error in subscripts / formulae e.g. $2H_2o2 \rightarrow O_2 + 2h_2O$ **IGNORE** state symbols
	(b)		All points plotted correctly ✓ Line of best fit drawn ✓	2	2.2 1.2	**ALLOW** ±½ square LOBF should omit the point at (20,16.5) **ALLOW** ECF from plotting for LOBF
	(c)		**Any two from:** Idea that line for catalyst B is steeper ✓ Idea that more gas is produced in a certain time / idea that the reaction finishes in a shorter time ✓ Idea that catalyst B speeds up the reaction <u>more</u> (than catalyst A) ✓	2	2 x 3.2b	 **ALLOW** the reaction with catalyst B is <u>faster</u>
	(d)		Same volume or 50 cm^3 of hydrogen peroxide in each experiment ✓	1	2.2	**ALLOW** same amount of hydrogen peroxide in each experiment **ALLOW** idea that catalysts only affect the rate (but don't change the amount of product made)
	(e)		18.0 (cm^3) ✓	1	2.2	**ALLOW** 18 (cm^3)

Question			Answer	Marks	AO element	Guidance
	(f)		Warm hydrogen peroxide to 30°C / place hydrogen peroxide in a water bath at 30°C ✓ Measure volume of (oxygen) gas every 5 minutes ✓ **AND one from:** Compare results (to results at room temperature) ✓ Idea that <u>gas made quicker</u> at 30°C / <u>reaction finishes quicker</u> at 30°C ✓	**3**	**3 x 3.3a**	**ALLOW** idea of doing the experiment again at 30°C **ALLOW** a different time period other than 5 minutes **ALLOW** idea of measuring the time taken to collect the gas **ALLOW** idea of placing the conical flask on a balance and recording the mass lost every eg 30s **ALLOW** idea that the time taken for hydrogen peroxide to fully decompose will be less at 30°C **MP3 is dependent on an attempt at describing an experiment**

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>17</td><td>(a)</td><td></td><td>Copper chloride ✓</td><td>1</td><td>3.2b</td><td>ALLOW $CuCl_2$</td></tr>
<tr><td></td><td>(b)</td><td></td><td>Carbon dioxide ✓</td><td>1</td><td>3.2b</td><td>ALLOW CO_2</td></tr>
<tr><td></td><td>(c)</td><td></td><td>Chlorine ✓</td><td>1</td><td>3.2b</td><td>ALLOW Cl_2 but NOT Cl
IGNORE chloride</td></tr>
<tr><td></td><td>(d)</td><td></td><td>Green-blue / turquoise / green ✓</td><td>1</td><td>1.2</td><td>ALLOW blue</td></tr>
<tr><td></td><td>(e)</td><td></td><td>Idea that copper is less reactive than carbon / ORA ✓</td><td>1</td><td>1.2</td><td></td></tr>
<tr><td></td><td>(f)</td><td></td><td><table><tr><th>Alloy</th><th>Main metals</th><th>Uses</th></tr><tr><td>duralumin</td><td>copper and aluminium</td><td>aircraft parts</td></tr><tr><td>brass</td><td>copper and zinc</td><td>musical instruments</td></tr><tr><td>bronze</td><td>copper and tin</td><td>bells / propellers for ships / statues</td></tr></table>✓✓</td><td>2</td><td>2 x 1.1</td><td>ALL 3 correct, 2 marks
ANY 2 correct, 1 mark

ALLOW any sensible use for bronze
IGNORE electrical wiring/circuits for bronze
IGNORE ‘parts’ for cars or ‘parts’ for ships for bronze</td></tr>
</table>

Question			Answer	Marks	AO element	Guidance
18	(a)		C_nH_{2n+2} ✓	1	2.1	**ALLOW** $H_{2n+2}C_n$ **NOT** C^nH^{2n+2} / CnH2n+2
	(b)		Alcohols ☐ Alkenes ☐ Carboxylic acids ✓ Esters ☐ ✓	1	2.1	
	(c)		$C_2H_4 + 2O_2 \rightarrow 2CO + 2H_2O$ OR $C_2H_4 + O_2 \rightarrow 2C + 2H_2O$ OR $2C_2H_4 + 3O_2 \rightarrow 2C + 2CO + 4H_2O$ Formulae ✓ Balancing ✓	2	2 x 2.1	**ALLOW** any correct multiple, including fractions **DO NOT ALLOW** and / & instead of '+' balancing mark is dependent on the correct formulae but **ALLOW** 1 mark for a balanced equation with a minor error in subscripts / formulae e.g. $C_2H_4 + 2O2 \rightarrow 2Co + 2h_2O$ **ALLOW** any (balanced) equation that includes H_2O as the only hydrogen containing product and C and/or CO among the carbon containing products. Equation may also produce CO_2 in addition to C and/or CO. **IGNORE** state symbols

Question			Answer	Marks	AO element	Guidance
	(d)		Idea that hydrocarbons have different boiling points ✓ **And any <u>two</u> from:** Larger molecules or longer chains have higher boiling points / ORA ✓ Larger molecules or longer chains have stronger intermolecular forces / ORA ✓ Stronger intermolecular forces result in higher boiling point / ORA ✓	**3**	**3 x 1.1**	**IGNORE** melting points / evaporating points **MP2, 3 & 4 must be comparative** **ALLOW** molecules with higher mass have higher boiling points / ORA **ALLOW** larger molecules or longer chains have more intermolecular forces / ORA **ALLOW** idea that stronger or more intermolecular forces result in more energy needed (to boil or to break the intermolecular forces) / ORA
	(e)		Finite (resource) ✓	**1**	**1.1**	**NOT** non-renewable
	(f)		**NO** Causes acid rain ✓ **CO** poisonous / toxic ✓	**2**	**2 x 1.1**	**ALLOW** an effect of acid rain, eg erosion of stonework / corrosion of metals / kills trees or kills living things in rivers or lakes **ALLOW** causes breathing difficulties (asthma) **IGNORE** references to pollution **ALLOW** an effect of CO, eg can cause difficulty breathing or suffocation / attaches to the haemoglobin (protein) in red blood cells / reduces the amount of oxygen that the blood can carry / can cause drowsiness / can cause death ✓ **IGNORE** harmful / dangerous **IGNORE** contributes to global warming / greenhouse effect

Question			Answer	Marks	AO element	Guidance
	(g)	(i)	(Catalyst) provides an alternative reaction pathway ✓ with a lower activation energy ✓	2	2 x 1.1	**ALLOW** idea that reactants adsorb onto the surface of the catalyst to allow the molecules to react for 1 mark **ALLOW** idea that adsorption (onto catalyst surface) weakens bonds **IGNORE** references to larger surface area
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 102 (dm^3) award 4 marks** Moles of CO_2 = $\frac{187}{44.0}$ / 4.25 ✓ Moles of CO = moles of CO_2 / 4.25 ✓ Volume of CO = moles x 24 / 4.25 x 24 ✓ = 102 dm^3 ✓ **OR** 187g of CO_2 produced from 187 x $\frac{28}{44}$ = 119g CO ✓ 119g CO = $\frac{119}{28}$ = 4.25 moles CO ✓ Volume of 4.25 mol CO = 4.25 x 24 dm^3 ✓ = 102 dm^3 ✓	4	1 x 1.2 3 x 2.2	**ALLOW** ECF from incorrect moles of CO_2 **ALLOW** ECF from incorrect moles of CO **ALLOW** ECF from incorrect mass of CO **ALLOW** ECF from incorrect moles of CO

Question			Answer	Marks	AO element	Guidance
19	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3.92 (g) award 5 marks** M_r of H_2SO_4 = 98.1 **AND** $(NH_4)_2SO_4$ = 132.1 ✓ Theoretical yield of $(NH_4)_2SO_4$ = 4.22 x 100 / 5.275 /5.28✓ 80 Mass of H_2SO_4 = 5.275 x 98.1 / 5.28 x 98.1 ✓ 132.1 132.1 = 3.917 / 3.921 ✓ **BUT** 3.917 / 3.921 without working out ✓✓ To 3 **sig figs** = 3.92 (g) ✓	**5**	**4 x 2.2** **1 x 1.2**	**ALLOW** ECF from incorrect M_r **ALLOW** ECF from incorrect theoretical yield eg Mass of H_2SO_4 = 4.22 x 98.1 ✓ 132.1 = 3.13385 ✓ **BUT** 3.13385 without working out ✓✓ **ALLOW** ECF for sig fig mark
	(b)		(Industry method is more suitable because) Any **three** from: Continuous process / operates 24/7 / AW ✓ Large scale / AW ✓ Quick process ✓ Ammonium sulfate can be made from by-products of other processes ✓	**3**	**3 x 3.1b**	**No mark for industry method – marks are for explanation** **ALLOW** ORA for laboratory process **IGNORE** produces large amounts (stem of question)
	(c)		(Nitrogen is needed) to prevent poor (plant) growth / to prevent yellow leaves / to make proteins / amino acids ✓	**1**	**1.1**	**ALLOW** ORA **ALLOW** to help with growth **IGNORE** just to allow growth **ALLOW** to ensure green leaves **ALLOW** to make chlorophyll **IGNORE** to increase crop yield

Question			Answer	Marks	AO element	Guidance
20*			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** **Applies knowledge and understanding to calculate the atom economy for methods 1 and 2** **AND** **Analyses the information to comprehensively explain why the company should use method 2.** *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** **Applies knowledge and understanding to calculate the atom economy for method 1 and 2** **OR** **Analyses the information to comprehensively explain why the company should use method 2.** *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** **Applies knowledge and understanding to attempt to calculate the atom economy for method 1 or 2** **OR** **Analyses the equations and appreciates the problem of CO_2 production in method 1.** *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	**6**	**4 x 2.1** **2 x 3.2b**	**AO2.1 Apply knowledge and understanding of scientific ideas** **Method 1** M_r of $MgSO_4$ = 120.4 Atom economy = $\frac{\text{sum of } M_r \text{ of desired product}}{\text{sum of } M_r \text{ of all products}} \times 100$ Atom economy = $\frac{120.4}{182.4} \times 100 = 66\%$ **Method 2** M_r of $MgSO_4$ = 120.4 Atom economy = $\frac{\text{sum of } M_r \text{ of desired product}}{\text{sum of } M_r \text{ of all products}} \times 100$ Atom economy = $\frac{120.4}{138.4} \times 100 = 87\%$ / 86.99% **AO3.2b Analyse information to make judgements and draw conclusions** Company should use **Method 2** as • Atom economy is greater / process is more sustainable • CO_2 is not a waste product • CO_2 contributes to the Greenhouse Effect / global warming

Question			Answer	Marks	AO element	Guidance
21	(a)		**Any two from:** Idea that the rates of the forward and backward reactions are equal (so it is an equilibrium) ✓ Idea that the forward and backward reactions still happen (so it is dynamic) ✓ Idea that the <u>concentrations</u> of the reactants and products do not change ✓	**2**	**2 x1.1**	 **IGNORE** both reactions happening at a constant rate **IGNORE** the <u>concentrations</u> of the reactants and products are equal
	(b)	**(i)**	(Position of equilibrium) moves to the right ✓ Idea that (when the temperature is increased) the equilibrium moves in the direction of the endothermic change ✓	**2**	**2 x 2.1**	**ALLOW** idea that forward reaction is favoured **Marking points are independent**
		(ii)	Idea that the reaction is too slow at low pressure ✓	**1**	**3.2b**	**ALLOW** to increase the rate of reaction
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 91 (%) award 4 marks** Theoretical yield = $\frac{6}{16}$ x 200 ✓ = 75 tonnes ✓ % yield = $\frac{68.4}{75}$ x 100 / 91.2 (%) ✓ To 2 **sig figs** = 91 (%) ✓	**4**	**3 x 2.2** **1 x 1.2**	 **ALLOW** ECF **ALLOW** ECF from incorrect theoretical yield **ALLOW** % yield = (am ÷ pm) x 100 for 1 mark if no other mark awarded from first 3 MPs **ALLOW** ECF for sig fig mark

Question			Answer	Marks	AO element	Guidance
22	(a)	(i)	21.50 (cm^3) ✓	1	2.2	**ALLOW** 21.5 (cm^3)
		(ii)	Methyl orange gives a sudden (colour) change / Universal indicator gives a range of colours ✓	1	1.2	**Assume unqualified answer refers to universal indicator** **ALLOW** ORA for universal indicator eg universal indicator gives a gradual colour change **IGNORE** methyl orange is a single indicator / universal indicator is a mixed indicator
		(iii)	Titrations 2 and 4 are consistent or concordant / only consistently close readings should be included / the volumes are close to one another / the volumes are within 0.1 (cm^3) ✓	1	3.2b	**ALLOW** volumes are similar **ALLOW** titrations 1 and 3 are inaccurate or anomalous / idea that titrations 1 and 3 show a wider range / idea that titration 1 is a rough titration and titration 3 is an outlier

Question	Answer	Marks	AO element	Guidance
(iv)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.049 award 5 marks** average titre = (20.51 + 20.41) ÷ 2 = 20.46 (cm^3) / 0.02046 (dm^3) ✓ moles of acid = $\frac{0.12 \times 20.46}{1000}$ / 0.12 x 0.02046 / 0.0024552 / 2.4552 $x10^{-3}$ ✓ idea that moles of alkali = ½ x moles acid or moles of alkali =½ x $\frac{0.12 \times 20.46}{1000}$ / 0.12 x 0.02046 / 0.00123 / 1.23 $x10^{-3}$ ✓ concentration of alkali = $\frac{0.00123}{0.025}$ / $\frac{0.00123 \times 1000}{25}$ / $\frac{1.23 \times 10^{-3}}{0.025}$ / $\frac{1.23 \times 10^{-3} \times 1000}{25}$ / 0.0492 (mol/dm^3) ✓ **2 Sig figs:** concentration = 0.049 (mol/dm^3) ✓	**5**	**4 x 2.2** **1 x 1.2**	**ALLOW** ECF from average titre **ALLOW** ECF from moles of acid **ALLOW** ECF from moles of alkali i.e. conc = $\frac{\text{moles}}{0.025}$ / $\frac{\text{moles} \times 1000}{25}$ **ALLOW** ECF for sig fig mark

Question			Answer	Marks	AO element	Guidance
	(b)	(i)	**Cation Na^+** **Test** – Flame test ✓ **Result** – Yellow or orange (flame) ✓	**2**	**2 x 1.2**	**ALLOW** correct description of a flame test **Mark for result is dependent on correct test**
		(ii)	**Anion Cl^-** **Test** – Add (a few drops of) silver nitrate solution ✓ **Result** – White precipitate ✓	**2**	**2 x 1.2**	**IGNORE** add dilute nitric acid **DO NOT ALLOW** add dilute hydrochloric acid **Mark for result is dependent on correct test**

Question			Answer	Marks	AO element	Guidance
23	(a)		Idea of working out the potential environmental impact at each stage of the life of the car ✓	1	1.1	**IGNORE** just the impact of manufacturing a car on the environment
	(b)	(i)	% = $\frac{0.7}{4.9}$ x 100 = 14.3 / 14% ✓	1	3.1a	**ALLOW** answer in range 12 to 15%
		(ii)	Coal is a hydrocarbon ✓ When hydrocarbons burn, they produce carbon dioxide ✓	2	2 x 3.2b	**ALLOW** coal is a fossil fuel **ALLOW** renewable energy emits less CO_2 **ALLOW** burning coal or fossil fuels produces CO_2 **IGNORE** just fossil fuel increase CO_2 emissions, without reference to burning
	(c)		Petrol has weaker intermolecular forces (than diesel) / ORA ✓	1	1.1	**Assume unqualified answer refers to petrol** **ALLOW** petrol has less or smaller intermolecular forces (than diesel) / ORA **ALLOW** less energy is required to break the intermolecular forces in petrol / ORA **IGNORE** references to breaking bonds

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