

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

GCSE CHEMISTRY

H

Higher Tier Paper 1

Thursday 17 May 2018

Morning

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information

- There are 100 marks available on this paper.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	



J U N 1 8 8 4 6 2 1 H 0 1

0	1
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Soluble salts are formed by reacting metal oxides with acids.

0	1	.	1
---	---	---	---

Give **one** other type of substance that can react with an acid to form a soluble salt.

[1 mark]

0	1	.	2
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Calcium nitrate contains the ions Ca^{2+} and NO_3^-

Give the formula of calcium nitrate.

[1 mark]

0	1	.	3
---	---	---	---

Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid.

[6 marks]



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8

Turn over for the next question

Turn over ►

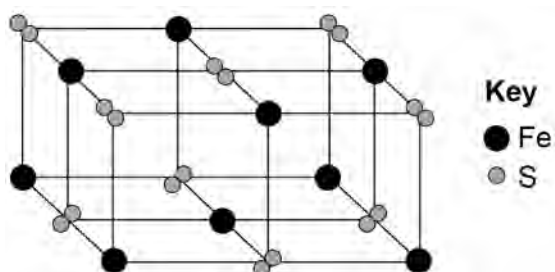


0 2

This question is about metals and metal compounds.

0 2 . 1

Iron pyrites is an ionic compound.

Figure 1 shows a structure for iron pyrites.**Figure 1**

Determine the formula of iron pyrites.

Use **Figure 1**.**[1 mark]**

0 2 . 2

An atom of iron is represented as $^{56}_{26}\text{Fe}$

Give the number of protons, neutrons and electrons in this atom of iron.

[3 marks]

Number of protons _____

Number of neutrons _____

Number of electrons _____

0 2 . 3

Iron is a transition metal.

Sodium is a Group 1 metal.

Give **two** differences between the properties of iron and sodium.**[2 marks]**

1 _____

2 _____



Nickel is extracted from nickel oxide by reduction with carbon.

0 2 . 4

Explain why carbon can be used to extract nickel from nickel oxide.

[2 marks]

0 2 . 5

An equation for the reaction is:



Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses (A_r): C = 12 Ni = 59

Relative formula mass (M_r): NiO = 75

Give your answer to 3 significant figures.

[3 marks]

Percentage atom economy = _____ %



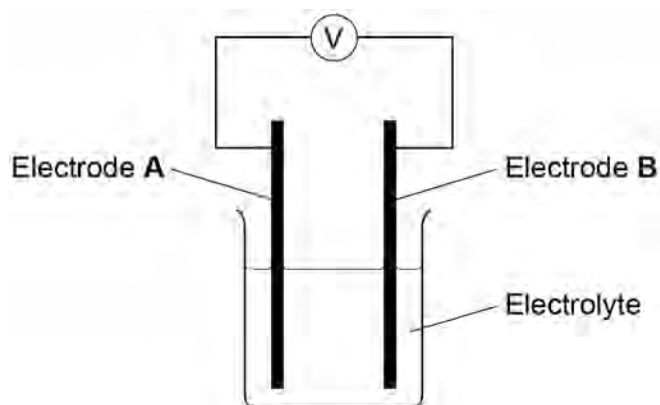
0 3

Chemical reactions can produce electricity.

0 3 . 1

Figure 2 shows a simple cell.

Figure 2



Which of these combinations would **not** give a zero reading on the voltmeter in Figure 2?

[1 mark]

Tick **one** box.

Electrode A	Electrode B	Electrolyte	
Copper	Copper	Sodium chloride solution	☐
Zinc	Zinc	Water	☐
Copper	Zinc	Sodium chloride solution	☐
Copper	Zinc	Water	☐



Alkaline batteries are non-rechargeable.

0 3 . 2 Why do alkaline batteries eventually stop working?

[1 mark]

0 3 . 3 Why can alkaline batteries **not** be recharged?

[1 mark]

Question 3 continues on the next page

Turn over ►



Hydrogen fuel cells and rechargeable lithium-ion batteries can be used to power electric cars.

0 3 . 4

Complete the balanced equation for the overall reaction in a hydrogen fuel cell.

[2 marks]



0 3 . 5

Table 1 shows data about different ways to power electric cars.

Table 1

	Hydrogen fuel cell	Rechargeable lithium-ion battery
Time taken to refuel or recharge in minutes	5	30
Distance travelled before refuelling or recharging in miles	Up to 415	Up to 240
Distance travelled per unit of energy in km	22	66
Cost of refuelling or recharging in £	50	3
Minimum cost of car in £	60 000	18 000

Evaluate the use of hydrogen fuel cells compared with rechargeable lithium-ion batteries to power electric cars.

Use **Table 1** and your own knowledge.

[6 marks]

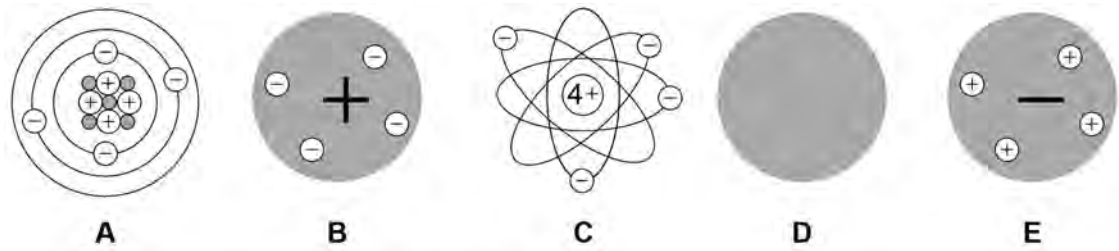


11

0 4

Figure 3 represents different models of the atom.

Figure 3



0 4 . 1

Which diagram shows the plum pudding model of the atom?

[1 mark]

Tick **one** box.

A		B		C		D		E	
---	--	---	--	---	--	---	--	---	--

0 4 . 2

Which diagram shows the model of the atom developed from the alpha particle scattering experiment?

[1 mark]

Tick **one** box.

A		B		C		D		E	
---	--	---	--	---	--	---	--	---	--

0 4 . 3

Which diagram shows the model of the atom resulting from Bohr's work?

[1 mark]

Tick **one** box.

A		B		C		D		E	
---	--	---	--	---	--	---	--	---	--



0 4 . 4

Define the mass number of an atom.

[1 mark]

0 4 . 5

Element **X** has two isotopes. Their mass numbers are 69 and 71

The percentage abundance of each isotope is:

- 60% of ^{69}X
- 40% of ^{71}X

Estimate the relative atomic mass of element **X**.

[1 mark]

Tick **one** box.

< 69.5

☐

Between 69.5 and 70.0

☐

Between 70.0 and 70.5

☐

> 70.5

☐

0 4 . 6

Chadwick's experimental work on the atom led to a better understanding of isotopes.

Explain how his work led to this understanding.

[3 marks]



0 5

A student investigated the temperature change in displacement reactions between metals and copper sulfate solution.

Table 2 shows the student's results.

Table 2

Metal	Temperature increase in °C
Copper	0
Iron	13
Magnesium	43
Zinc	17

0 5

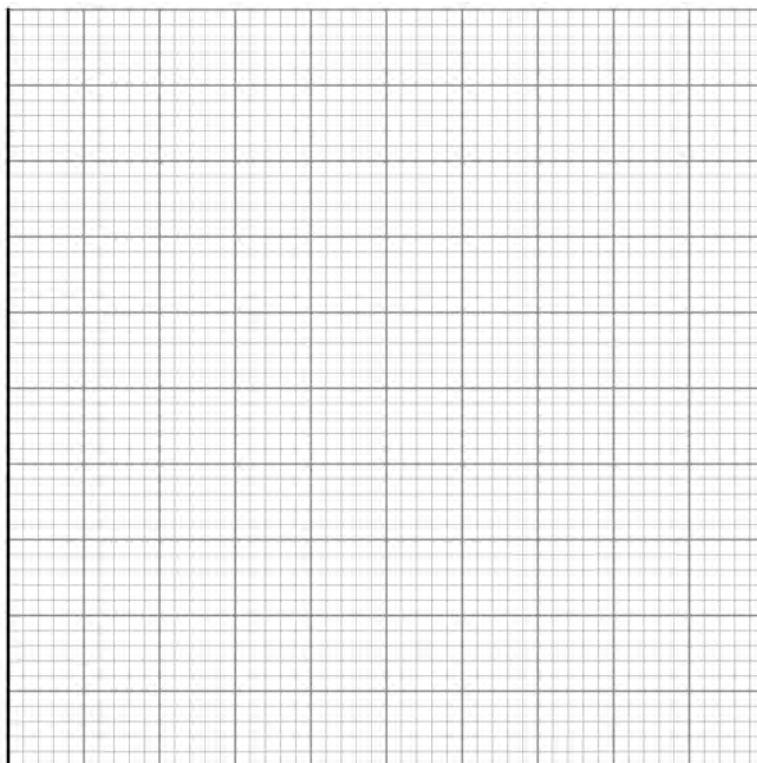
1

Plot the data from **Table 2** on **Figure 4** as a bar chart.

[2 marks]

Figure 4

Temperature
increase
in °C



Metal



0 5 . 2

The student concluded that the reactions between the metals and copper sulfate solution are endothermic.

Give **one** reason why this conclusion is **not** correct.

[1 mark]

0 5 . 3

The temperature change depends on the reactivity of the metal.

The student's results are used to place copper, iron, magnesium and zinc in order of their reactivity.

Describe a method to find the position of an unknown metal in this reactivity series.

Your method should give valid results.

[4 marks]

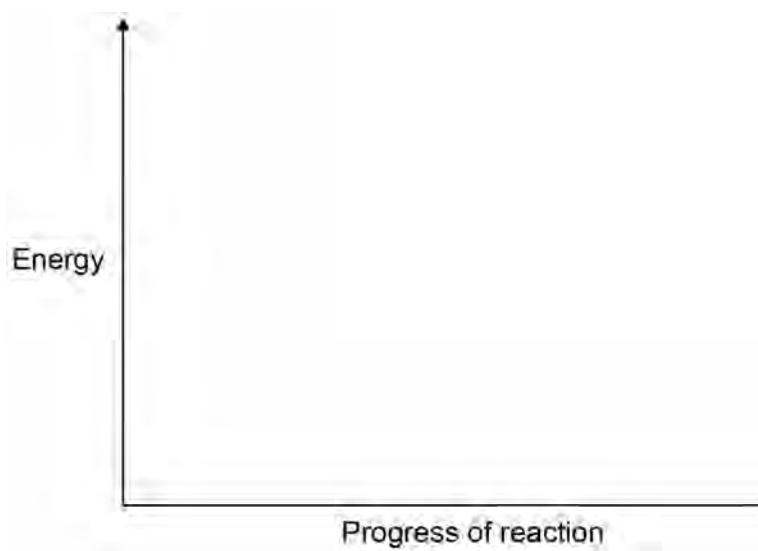
Question 5 continues on the next page

Turn over ►



0 5 . 4

Draw a fully labelled reaction profile for the reaction between zinc and copper sulfate solution on **Figure 5**.

[3 marks]**Figure 5**

10

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ANSWER IN THE SPACES PROVIDED**

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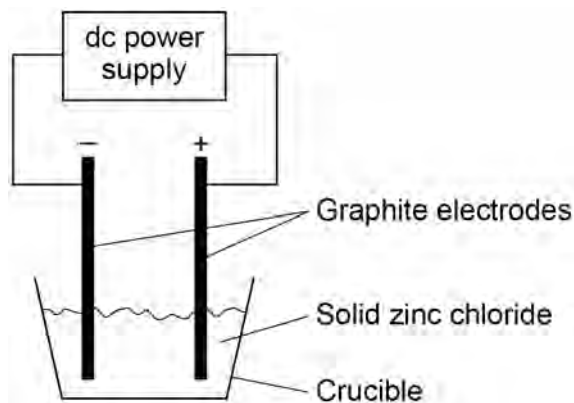


0 6

A student investigated the electrolysis of different substances.

Figure 6 shows the apparatus.

Figure 6

**0 6 . 1**

Explain why electrolysis would **not** take place in the apparatus shown in **Figure 6**.

[2 marks]

0 6 . 2

Explain why graphite conducts electricity.

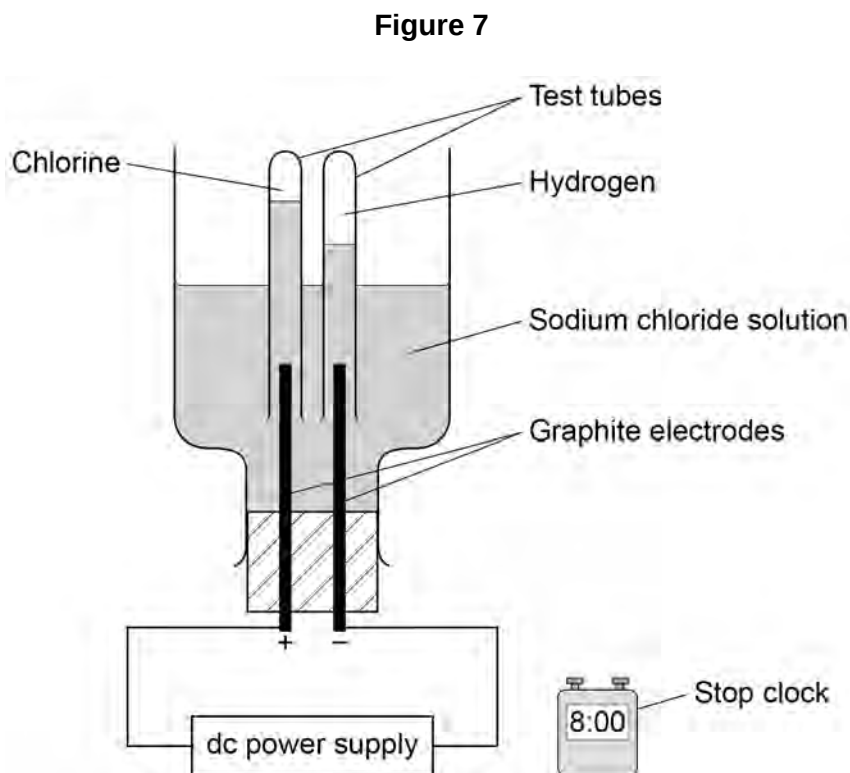
Answer in terms of the structure and bonding in graphite.

[3 marks]



The student investigated how the volume of gases produced changes with time in the electrolysis of sodium chloride solution.

Figure 7 shows the apparatus.



0 6 . 3 The student made an error in selecting the apparatus for this investigation.

How should the apparatus be changed?

Give **one** reason for your answer.

[2 marks]

Turn over ►

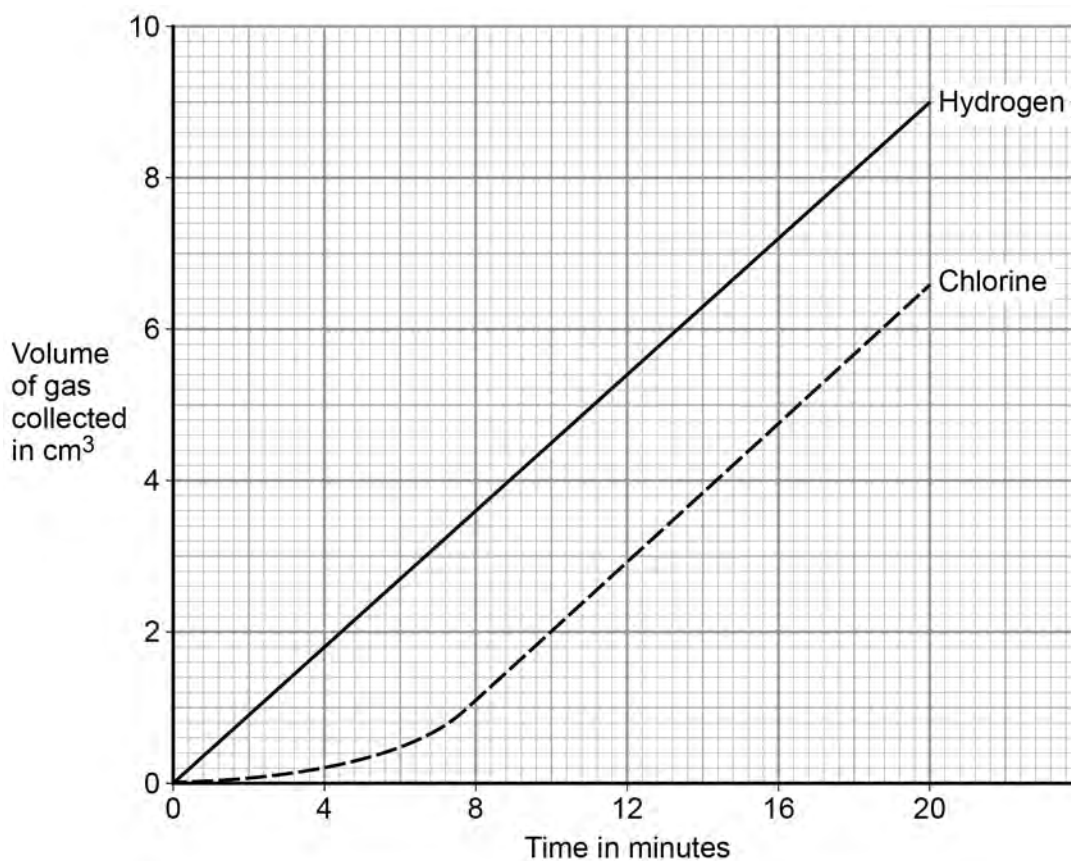


Another student used the correct apparatus.

This student measured the volumes of gases collected every minute for 20 minutes.

Figure 8 shows the student's results.

Figure 8



0 6 . 4 Describe the trends shown in the results.

Use values from **Figure 8**.

[3 marks]



0 6 . 5

The number of moles of each gas produced at the electrodes is the same.

No gas escapes from the apparatus.

Suggest **one** reason for the difference in volume of each gas collected.

[1 mark]

0 6 . 6

Calculate the amount in moles of chlorine collected after 20 minutes.

Use **Figure 8**.

The volume of one mole of any gas at room temperature and pressure is 24.0 dm^3

Give your answer in standard form.

[3 marks]

Moles of chlorine = _____ mol

Turn over for the next question

14

Turn over ►



0 7

This question is about Group 7 elements.

Chlorine is more reactive than iodine.

0 7 . 1

Name the products formed when chlorine solution reacts with potassium iodide solution.

[1 mark]

0 7 . 2

Explain why chlorine is more reactive than iodine.

[3 marks]

0 7 . 3

Chlorine reacts with hydrogen to form hydrogen chloride.

Explain why hydrogen chloride is a gas at room temperature.

Answer in terms of structure and bonding.

[3 marks]



0 7 . 4 Bromine reacts with methane in sunlight.

Figure 9 shows the displayed formulae for the reaction of bromine with methane.

Figure 9

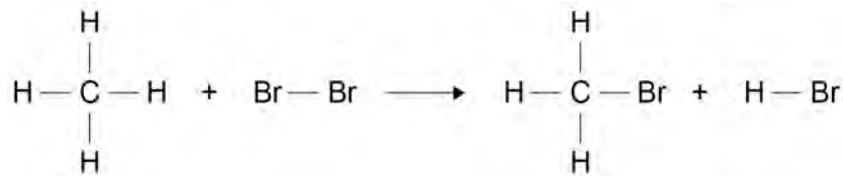


Table 3 shows the bond energies and the overall energy change in the reaction.

Table 3

	C—H	Br—Br	C—Br	H—Br	Overall energy change
Energy in kJ/mol	412	193	X	366	– 51

Calculate the bond energy **X** for the C—Br bond.

Use **Figure 9** and **Table 3**.

[4 marks]

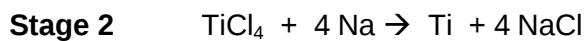
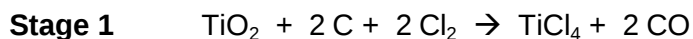
Bond energy **X** = _____ kJ/mol



0	8
---	---

Titanium is a transition metal.

Titanium is extracted from titanium dioxide in a two stage industrial process.



0	8	.	1
---	---	---	---

Suggest **one** hazard associated with **Stage 1**.

[1 mark]

0	8	.	2
---	---	---	---

Water must be kept away from the reaction in **Stage 2**.

Give **one** reason why it would be hazardous if water came into contact with sodium.

[1 mark]

0	8	.	3
---	---	---	---

Suggest why the reaction in **Stage 2** is carried out in an atmosphere of argon and **not** in air.

[2 marks]



0 8 . 4

Titanium chloride is a liquid at room temperature.

Explain why you would **not** expect titanium chloride to be a liquid at room temperature.

[3 marks]

In **Stage 2**, sodium displaces titanium from titanium chloride.

0 8 . 5

Sodium atoms are oxidised to sodium ions in this reaction.

Why is this an oxidation reaction?

[1 mark]

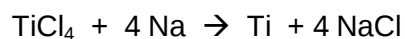
0 8 . 6

Complete the half equation for the oxidation reaction.

[1 mark]**Turn over ►**

0 8 . 7 In **Stage 2**, 40 kg of titanium chloride was added to 20 kg of sodium.

The equation for the reaction is:



Relative atomic masses (A_r): Na = 23 Cl = 35.5 Ti = 48

Explain why titanium chloride is the limiting reactant.

You **must** show your working.

[4 marks]

0 8 . 8 For a **Stage 2** reaction the percentage yield was 92.3%

The theoretical maximum mass of titanium produced in this batch was 13.5 kg.

Calculate the actual mass of titanium produced.

[2 marks]

Mass of titanium = _____ kg



0 9

This question is about acids and alkalis.

0 9 . 1

Dilute hydrochloric acid is a strong acid.

Explain why an acid can be described as both strong and dilute.

[2 marks]

0 9 . 2A $1.0 \times 10^{-3} \text{ mol/dm}^3$ solution of hydrochloric acid has a pH of 3.0What is the pH of a $1.0 \times 10^{-5} \text{ mol/dm}^3$ solution of hydrochloric acid?**[1 mark]**

pH = _____

Question 9 continues on the next page**Turn over ►**

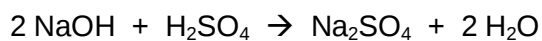
A student titrated 25.0 cm³ portions of dilute sulfuric acid with a 0.105 mol/dm³ sodium hydroxide solution.

0 9 . 3 Table 4 shows the student's results.

Table 4

	Titration 1	Titration 2	Titration 3	Titration 4	Titration 5
Volume of sodium hydroxide solution in cm ³	23.50	21.10	22.10	22.15	22.15

The equation for the reaction is:



Calculate the concentration of the sulfuric acid in mol/dm³

Use only the student's concordant results.

Concordant results are those within 0.10 cm³ of each other.

[5 marks]

Concentration of sulfuric acid = _____ mol/dm³



0 9 . 4

Explain why the student should use a pipette to measure the dilute sulfuric acid and a burette to measure the sodium hydroxide solution.

[2 marks]

0 9 . 5

Calculate the mass of sodium hydroxide in 30.0 cm^3 of a 0.105 mol/dm^3 solution.

Relative formula mass (M_r): $\text{NaOH} = 40$

[2 marks]

Mass of sodium hydroxide = _____ g

END OF QUESTIONS

12



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