Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250
For first teaching in 2016

J250/12 Summer 2019 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper 12 series overview

J250/12 is one of six Papers for the GCSE (9-1) Gateway Science Combined Science A Higher Tier Qualification. It is the second of the two physics papers covering Topics P4 Waves and radioactivity, P5 Energy, P6 Global challenges and CS7 Practical skills. There is assumed knowledge of P1 – P3 and this Paper includes synoptic assessment.

This is the second examination series for J250.

Candidates who used the data sheet and clearly showed calculations on questions where it was needed performed well. For example in Question 8 where it was evident that some candidates had rearranged the equation given to gravitational field strength = potential energy/(mass x height). This can be seen in Exemplar 1.

Exemplar 1

8 An astronaut lifts a 0.3 kg hammer 1.7 m above the surface of the Moon.

The hammer gains 0.82 J of potential energy.

Calculate the gravitational field strength on the Moon.

Use the equation: potential energy = mass × height × gravitational field strength

A 0.0016 N/kg

B 0.22 N/kg

C 0.42 N/kg

D 1.61 N/kg

$GFS = \frac{PE}{m \times h} = \frac{0.82}{0.3 \times 1.7} = 1.61 N/Kg$

Your answer D **[1]**

Section A overview

This section consists of 10 multiple choice questions testing AO1 and AO2.

Questions answered well by candidates	*Questions answered less well by candidates*
• Question 2 about energy transfer • Question 4 about types of errors • Question 6 about isotopes • Question 8 about gravitational field strength	• Question 5 about mains wires and safety • Question 9 about radioactive decay

Question 2

2 A car is accelerated by a constant force on a level road.

Which row of the table describes how energy is transferred as the car accelerates?

	Store that empties	**Stores that fill**
A	chemical	kinetic and elastic
B	chemical	kinetic and thermal
C	gravitational	thermal and kinetic
D	kinetic	thermal and chemical

Your answer [ ] **[1]**

The majority of candidates selected answer B as they understood that the store that empties is chemical and the stores that fill are kinetic and thermal during acceleration. The most common incorrect answer was A.

Question 3

3 A car goes faster.

What effect does this have on thinking distance and braking distance?

	Thinking distance	Braking distance
A	increases	increases
B	increases	no effect
C	no effect	increases
D	no effect	no effect

Your answer ☐ **[1]**

Approximately half the candidates gave the correct answer of A. Many candidates thought that the thinking distance did not change, only the braking distance increases, when a car goes faster.

Question 4

4 A student uses a stopwatch to time water waves. The stopwatch always starts from 0.5 s and does not go back to zero.

What is this type of error called?

A Hypothesis error

B Precision error

C Random error

D Systematic error

Your answer ☐ **[1]**

This question was answered well by most candidates with the few incorrect responses being equally distributed between A, B and C.

Question 5

5 A hairdryer is connected to the mains with only two wires.

Why will this hairdryer operate and be safe to use?

A The wires are earth and neutral and the hairdryer is insulated.

B The wires are earth and neutral and the plug has a fuse.

C The wires are live and earth and the plug has a fuse.

D The wires are live and neutral and the hairdryer is insulated.

Your answer ☐ **[1]**

Only a third of candidates understood that an insulated appliance has only live and neutral wires. The majority of candidates selected option B or option C thinking that an earth wire and a fuse were the important safety features.

Question 6

6 Which statement is **true** for isotopes of the same element?

N_p = number of protons and N_n = number of neutrons.

A $N_p = N_n$

B N_p is the same but N_n is different

C N_p is always greater than N_n

D The total ($N_p + N_n$) is always the same

Your answer ☐ **[1]**

This question was answered well by the majority of candidates (option B where the number of protons is the same but the number of neutrons is different for isotopes of the same element). The most common incorrect response was D where candidates thought that the total number of protons and neutrons were the same.

Question 7

7 For how long can you use a 2 kW electrical heater with 1 kWh of energy?

A 0.0005 hours

B 0.5 hours

C 2 hours

D 2000 hours

Your answer ☐ **[1]**

Half the candidates gave the correct response B (0.5 hours). The most common incorrect response was response C (2 hours).

Question 8

8 An astronaut lifts a 0.3 kg hammer 1.7 m above the surface of the Moon.

The hammer gains 0.82 J of potential energy.

Calculate the gravitational field strength on the Moon.

Use the equation: potential energy = mass × height × gravitational field strength

A 0.0016 N/kg

B 0.22 N/kg

C 0.42 N/kg

D 1.61 N/kg

Your answer ☐ **[1]**

The majority of candidates were able to rearrange the given equation to calculate the gravitational field strength on the Moon as 1.61 N/kg.

Question 9

9 Beryllium-13 ($^{13}_{4}Be$) is a radioactive isotope.

This is the equation for the decay of beryllium-13.

$^{13}_{4}Be \rightarrow \, ^{12}_{4}Be + \mathbf{X}$

What is **X**?

A An alpha particle

B A beta particle

C A gamma ray

D A neutron

Your answer [ ] **[1]**

Candidates found this question challenging with the most common response being B.

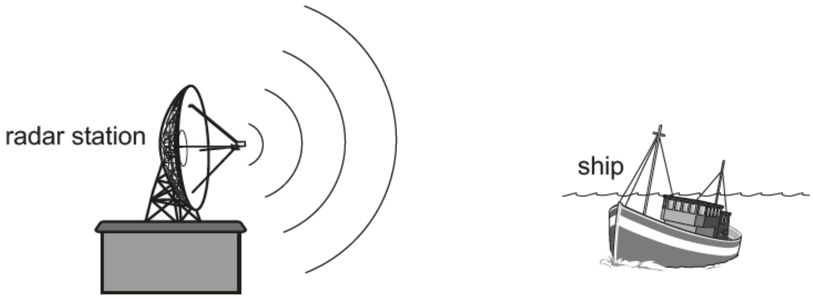
Section B overview

This section consists of six questions testing AO1, AO2 and AO3.

The most successful candidates	*The least successful candidates*
• were able to manipulate equations and apply them to different situations • Question 13 – had experience of identifying the possible types of radiation emitter from a source • Question 15 – had done an experiment to measure angles of incidence and refraction for a glass block • Question 16 – evaluated models in terms of the ways they are a good representation and ways they are a poor representation	• had difficulty interpreting the scales on graphs • had difficulty rearranging equations and performing calculations involving power of ten • appeared to be unfamiliar with practical science activities and How Science Works • Question 16 – were unable to understand what a model was being used for and how to evaluate the model

Question 11 (a) (i)

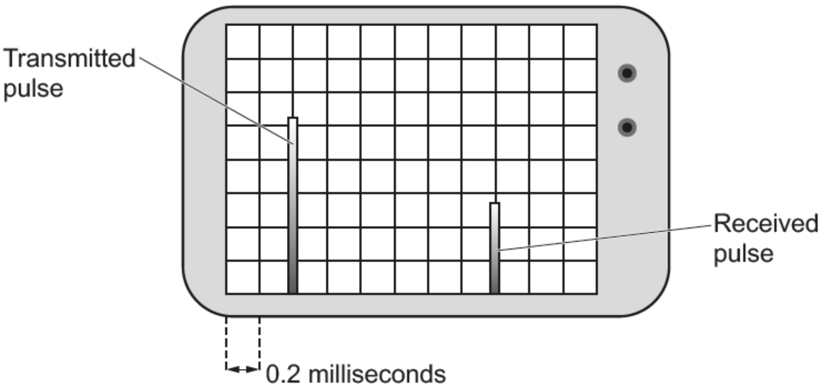
11 Radar stations can be used to find out where ships are.



At a radar station:

- a radar transmitter transmits pulses of microwaves
- the pulses are reflected by the ship
- a radar receiver detects the pulses.

(a) The diagram shows the radar signals on an oscilloscope screen:



(i) Calculate the time taken between the pulse being transmitted and received.

Time taken = ... ms **[1]**

The majority of candidates were able to calculate the time taken to be 1.2 ms by multiplying 0.2 ms by the 6 divisions between the pulses.

Question 11 (a) (ii)

(ii) A radar signal is sent from the radar station. The signal reflects off the ship and is detected 0.0006 s later.

The speed of the microwaves is 3.0×10^8 m/s.

Calculate the distance of the ship from the radar station.

Use the equation: distance travelled = speed × time

Distance = ... m **[2]**

Very few candidates gained both the marks available for this question. The majority of candidates calculated the distance as $3 \times 10^8 \times 0.0006 = 180\,000$ m and so gained 1 mark. They had not taken into account that this distance is the distance from the radar station to the ship and back to the radar station. So this distance needs to be divided by 2 to give 90 000 m.

Question 11 (a) (iii)

(iii) The amplitude of the received pulse is lower than the transmitted pulse.

Suggest why.

....

.... **[1]**

Only a quarter of candidates explained that the amplitude of the received pulse was lower because there was less energy.

Question 11 (b)

(b) Radar stations use microwaves with a frequency of 200 MHz.

The speed of the waves is 3.0×10^8 m/s.

Calculate the wavelength of these waves.

Wavelength = ... m **[4]**

The majority of candidates were able to calculate the wavelength of the waves by rearranging the equation to give wavelength = velocity/frequency but a lower ability candidates rearranged the equation as wavelength = velocity x frequency. Most candidates did not convert or incorrectly converted the frequency of 200 MHz into 2×10^8 Hz before substituting it into the equation. A common incorrect conversion was to state that the frequency was 2×10^5 Hz.

Question 12 (a)

12 This question is about radioactive decay.

A teacher models radioactive decay using 100 dice:

- she shakes a beaker containing 100 dice and empties the dice into a tray
- every time a number "6" lands face up, she removes that dice
- she places the remaining dice in the beaker and repeats the process.

Here are some of the results from this experiment.

Number of throws	Number of dice removed				Number of dice remaining
	Attempt 1	Attempt 2	Attempt 3	Mean	
1	16	18	17	17	83
2	15	14	14	14	69
3	10	12	11	11	58
4	10	9	10	10	48
5	8	9	7	8	40

(a) Describe the difference between **mean**, **mode** and **median**.

In your answer use data from the second throw in the table (shaded in grey).

....

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....

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.... **[3]**

The majority of candidates gained 2 or 3 marks for this question. They were able to communicate clearly the meaning of mean, mode and median. Some candidates did not read the sentence 'In your answer use data from the second throw in the table (shaded) grey.' These candidates did not use the data to calculate the mode and median and to show how the mean was calculated.

Question 12 (b)

(b) Use the table to estimate the half-life of the dice.

Give your answer to the **nearest whole number**.

Half-life = ... throws **[1]**

This question proved challenging for many candidates, with many candidates just writing down any whole number without any calculation.

Question 13 (a)

13 This question is about different types of radiation.

(a) An isotope emits one type of radiation. It could be alpha, beta or gamma.

Describe how a teacher could show the type of radiation emitted using school equipment.

You may include a diagram in your answer.

....

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.... **[4]**

Just over a half of candidates gained one or more marks for this question. Many of these candidates gained marked from carefully labelled diagrams that included an arrow labelled alpha stopping at a sheet of paper, an arrow labelled beta stopping at a sheet of aluminium and an arrow labelled gamma stopping at a thick piece of lead. The use of a Geiger counter to detect the radiation was less well known with most candidates labelling this just as a radiation detector. A significant number of candidates incorrectly interpreted the question as how the teacher could simulate different types of radiation. These candidates explained models of radioactivity using balls of various sizes for alpha and beta and torches for gamma. Some candidates even explained decay in terms of the number of sub atomic particles in alpha and beta but without any experimental procedure.

Question 13 (b) (i)

(b) Sometimes atoms emit radiation even if they are **not** radioactive. This radiation does **not** come from the nucleus.

(i) Describe how these atoms can emit radiation.

....

.... **[1]**

This was a very challenging question and very few candidates gaining any marks. The expected response was for candidates to appreciate that radiation is emitted when an electron drops energy levels. Many candidates answered in terms of electrons escaping the atom or electrons becoming excited.

Question 13 (b) (ii)

(ii) What type of radiation is emitted?

....

.... **[1]**

This was also a very challenging question and few candidates gaining any marks. Most candidates gave the answer of alpha, beta or gamma.

Question 14 (a)

14 Electricity can be produced in a power station.

(a) Explain the difference between **renewable** and **non-renewable** energy sources.

Give **one** example of each energy source to help explain your answer.

....

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.... **[3]**

This question was well answered with candidates giving clear explanations about the differences between renewable and non-renewable energy sources. Many gave several examples of each type of energy sources, with the most common responses being wind, solar, coal and oil. Some lower ability candidates confused renewable energy sources with reusable and recyclable ideas.

Question 14 (b)

(b) The national grid transfers energy from power stations to consumers.

Explain how the national grid transfers energy in an efficient way.

....

....

....

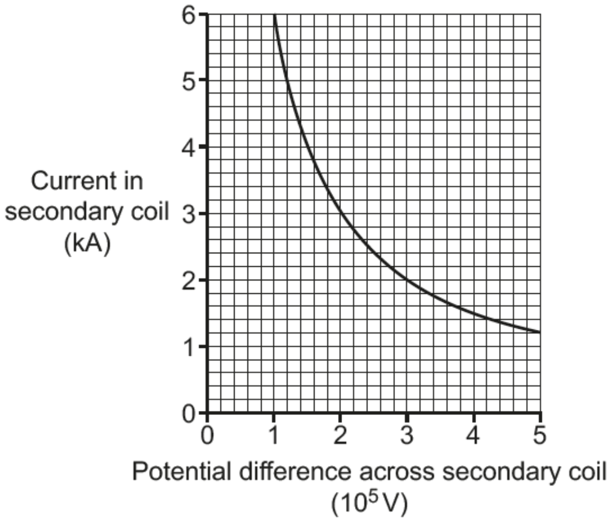
.... **[2]**

The majority of candidates did not gain any marks for this question. Good responses included the use of a step up transformer to increase the voltage and reduce the current to reduce the energy losses. A number of candidates through that the voltage was reduced to increase the power transferred.

?	**Misconception**	The idea that the national grid transfers energy in an efficient way because it makes sure there are **no** energy losses, **no** loss of voltage, **no** loss of power and **no** loss of current.

Question 14 (c)

(c) This graph shows current and potential difference for the secondary coil of a transformer.



The potential difference across the primary coil is 160 000 V.
The current in the secondary coil is 2400 A.

Calculate the current in the primary coil of the transformer.

Use data from the graph in your calculations.

Current in primary coil = ... A **[3]**

Just over half the candidates gained marks for this question. Lower ability candidates either did not use the graph when attempting this question or read the units on the graph incorrectly. They drew a line at 2400 V on the y axis and then drew a vertical line from the curve to the x axis but then read the scale incorrectly often missing the 10^5. Other candidates were unable to rearrange the transformer equation correctly and calculated the current in the primary coil as 2.5 x 10 5 x 2400 x 160 000.

Question 15 (a)

15 A student refracts light with a rectangular glass block.

He looks for a relationship between angle of incidence and angle of refraction.

(a) Suggest how the student completes this experiment and the apparatus he uses.

....

....

....

.... **[2]**

Candidates did show knowledge of this experiment but many were unable to describe the experimental procedure and the apparatus being used. Lower ability candidates often wrote about a reflection experiment using a mirror instead of a refraction experiment using a glass block.

Question 15 (b)

(b) The student needs to write a risk assessment for the experiment.

Complete the table to give **one** risk, the hazard it could cause and a control measure for the risk.

Risk	Hazard	Control measure

[2]

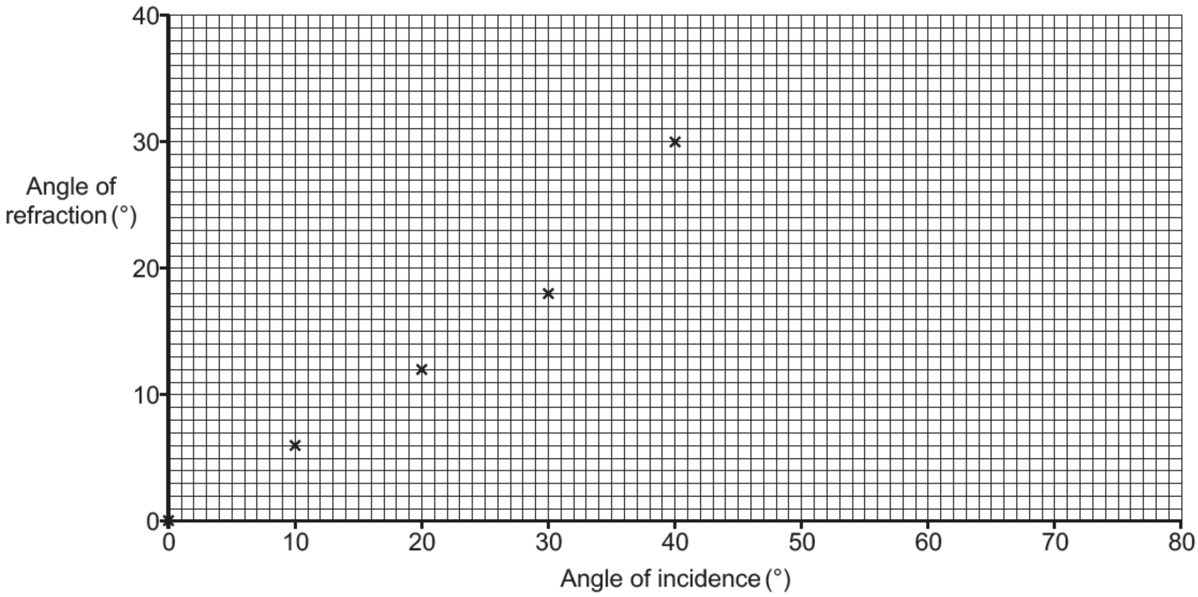
The majority of candidates gained marks for this question but some candidates were very poor at writing sensible risk assessments. Lower ability candidates wrote about general laboratory precautions that could apply to most experiments. These included wearing goggles, using laboratory coats and keeping bags out of the way. The most popular correct response was about the dangers of using a glass block and the least popular correct response was working in low light conditions.

Question 15 (c) (i)

(c) The table shows the results from the experiment.

Angle of incidence (°)	Angle of refraction (°)
0	0
10	6
20	12
30	18
40	30
50	28
60	32
70	35

(i) Plot the results from the table on the axes below and draw a curve of best fit.
The first five points have already been plotted for you.



[2]

This question was answered well with good clear plotting using small crosses. Many candidates then attempted to draw a straight line of best fit even though the question had asked them to draw a curve of best fit.

Question 15 (c) (ii)

(ii) What could the student conclude from the graph?

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....

....

.... **[2]**

Most candidates explained that the angle of incidence increases as the angle of refraction increases or that they are proportional. Fewer candidates then explained that at larger angles this relationship is no longer proportional as the line curves. Many candidates gave explanations about the anomalous result, at an angle of incidence of 40°, as part of their response but this was not answering the question in terms of a conclusion about the experiment.

Question 15 (c) (iii)

(iii) The angle of refraction at 40° is incorrect.

Use the curve of best fit on the graph to estimate the actual angle of refraction at 40°.

.... **[1]**

This question was well answered with most candidates giving an answer between 23° and 24°.

Question 15 (d)

(d) Another student uses red light in the experiment.

She then repeats the experiment with blue light.

Describe and explain the difference in the refraction of the red light and blue light.

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....

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.... **[2]**

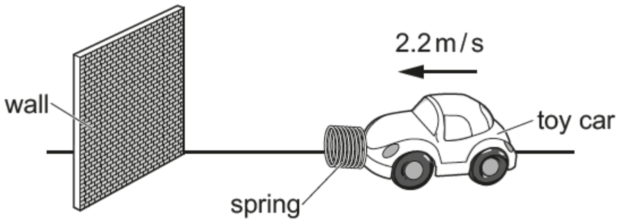
Only a quarter of candidates gained marks for this question. Good responses included a comparison of the amount of refraction and a comparison of the speed of the different colours of light. Lower ability candidates thought that the red light and blue light refracted in different directions or that red light has the highest frequency.

?	**Misconception**	The idea that red light and blue light are made up of light of many colours. So when the red light or blue light is refracted it splits into the colours of the spectrum.

Question 16 (a)

16 This question is about modelling crumple zones in cars.

A student models a crumple zone by adding a spring to the front of a toy car.
The spring compresses when the toy car hits a wall.



(a) Before the toy car hits the wall, its speed is 2.2 m/s.
The total mass of the toy car and spring is 500 g.

Show that the kinetic energy of the toy car and spring is about 1.2 J.

[3]

Most candidates were able to state the equation kinetic energy = ½ mv^2. However, fewer were able to convert the 500 g mass of the toy car into kg before substituting this into the equation. Many candidates used ½ x 500 x 2.2^2 giving an answer of 1210 J. They then divided by 1000 to get 1.21 J but did not explain why they were dividing by 1000. Some candidates stated the correct kinetic energy equation but then substituted it as ½ x 500 x 2.2 giving an answer of 550. They then tried various different mathematical manipulations to get an answer of 1.2 J.

Exemplar 2

$KE = \frac{1}{2} m \times v^2$

$KE = \frac{1}{2} 0.5 \times 2.2^2$

$KE = 0.25 \times 2.2^2$

$KE = 1.21 J$

This candidate response shows an example of clearly set out workings with a logical structure that was easy to follow and was given all three marks.

Question 16 (b)

(b) The spring constant of the spring is 4200 N/m.

Calculate the change in the length of the spring when the toy car hits the wall.

Give your answer to **2** significant figures.

Change in length = ... m **[4]**

This question was challenging with less than half the candidates gaining any marks. The majority of candidates were unable to rearrange the equation and often forgot about the x^2, giving the equation as x = 2 x E/k rather than x^2= 2 x E/k. Higher ability candidates who correctly used the equation were usually able to give their answer to 2 significant figures.

Question 16 (c)

(c)* Evaluate the student's model of the crumple zone.

Include ideas about how crumple zones make cars safer in your answer.

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....

....

.... **[6]**

This is the level of response question. This question was attempted by the majority of candidates and the full range of marks available were given. Many candidates gained credit for AO1.1 for describing the reasons for having a crumple zone on a car. Answers here tended to concentrate on the reduction of force on the people inside the car so they were not so badly injured or that the crumple zone absorbs the energy of the crash. Fewer candidates were able to evaluate the student's model of the crumple zone, AO3.1b. Lower ability candidates just pointed out that it was not practical to have springs on real cars but did not explain why the model was good or poor. Higher ability candidates usually gave the evaluation in terms of the model being good because the spring and the crumple zone both absorb energy and the model being poor because the spring compresses and then bounces back causing further injury.

Exemplar 3

The effect of the spring on the wall is similar to the effect of crumple zones as both increase the time taken for the change in momentum of the car, hence decreasing the force of the collision, making it safer. However, a spring to show the effect of the ~~toy car~~ ~~to~~ crumple zone better, the student should have first used a model of ~~th~~ a collision without the spring as a comparison point. Furthermore, the addition of the spring also increases the distance between the car and the wall, whereas crumple zones only increase the time taken for the change in momentum by decreasing speed gradually and absorbing ~~force~~. Some force **[6]**

This candidate has given a detailed description of a crumple zone, AO1. The candidate has also compared the good and poor points of the model, AO3. They have stated that the spring increase the distance between the car and the wall but that crumple zones only increase the time which is slightly muddled, hence the award of Level 3 and 5 marks.

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