VCE Physics

Implementation webinar:

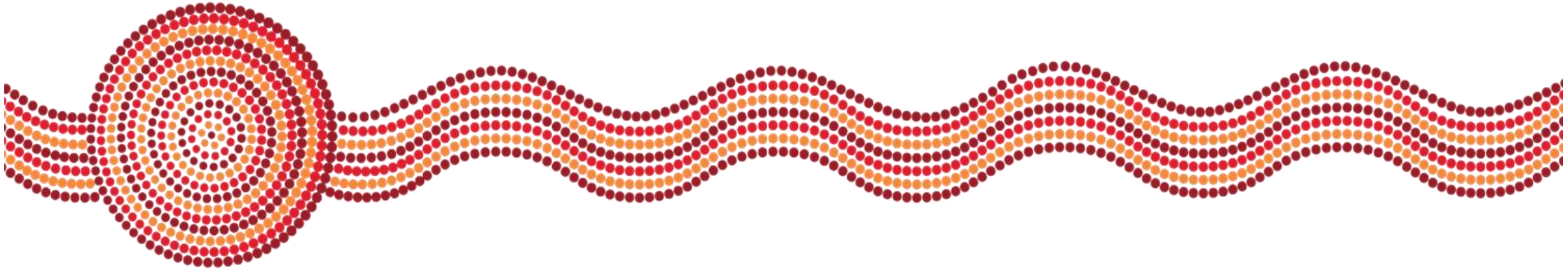
Units 1 and 2 (2023–2027) knowledge, skills and assessment

VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

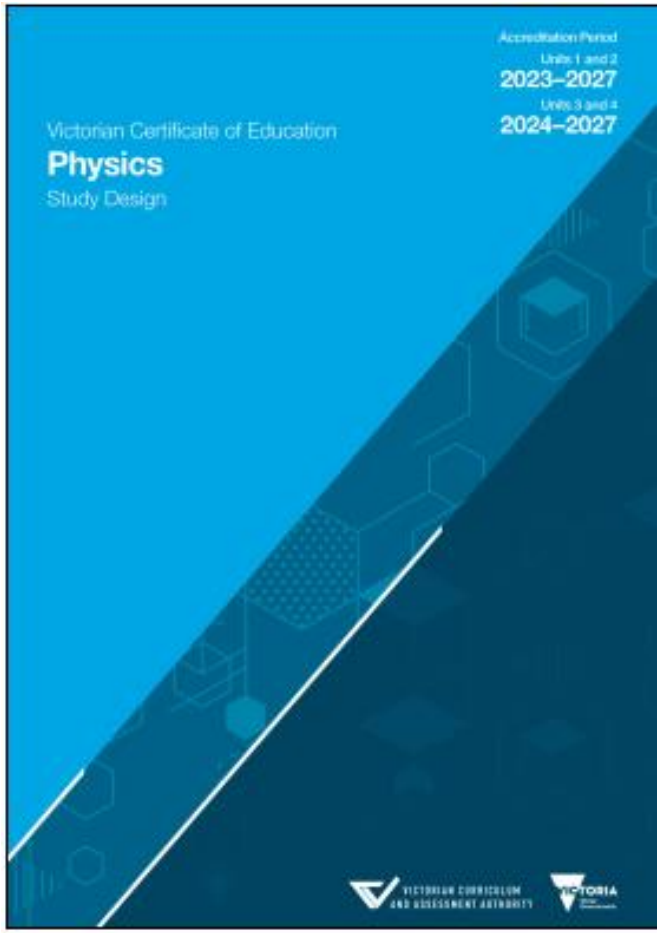
VICTORIA State Government

Acknowledgment of Country

Our event today is being held on the traditional lands of the Wurundjeri people of the Kulin nation, and I wish to acknowledge them as the traditional owners. I'd also like to pay my respects to their elders, past and present and the elders of other communities who may be here today.



Purpose



- **Respond to submitted webinar questions about Units 1 and 2:**
  - review the major study design changes
  - provide assessment examples
- **Respond to other questions arising during the webinar**

Staged implementation

- **Units 1 & 2: 2023 – 2027**
- **Units 3 & 4: 2024 – 2027**

Questions:

- What has changed in the study design…what is new?...what has been deleted?... what has been shifted?

Key science skills

Key science skill	Major changes for contextualised Physics skills
Develop aims and questions, formulate hypotheses and make predictions	• Formulate hypotheses to focus investigations • Predict possible outcomes of investigations
Plan and conduct investigations	• Determine appropriate investigation methodology…
Comply with safety and ethical guidelines	• Use safety data sheets (if relevant) • Demonstrate ethical conduct
Generate, collate and record data	• Organise and present data in useful and meaningful ways
Analyse and evaluate data and investigation methods	• Use appropriate numbers of significant figures in calculations • Construct linearised graphs… • …repeatability, reproducibility, resolution…
Construct evidence-based arguments and draw conclusions	• Distinguish between opinion and evidence, and between scientific and non-scientific ideas
Analyse, evaluate and communicate scientific ideas	• Analyse and evaluate physics-related societal issues taking into account the influence of social, economic, legal and political factors relevant to the selected issue

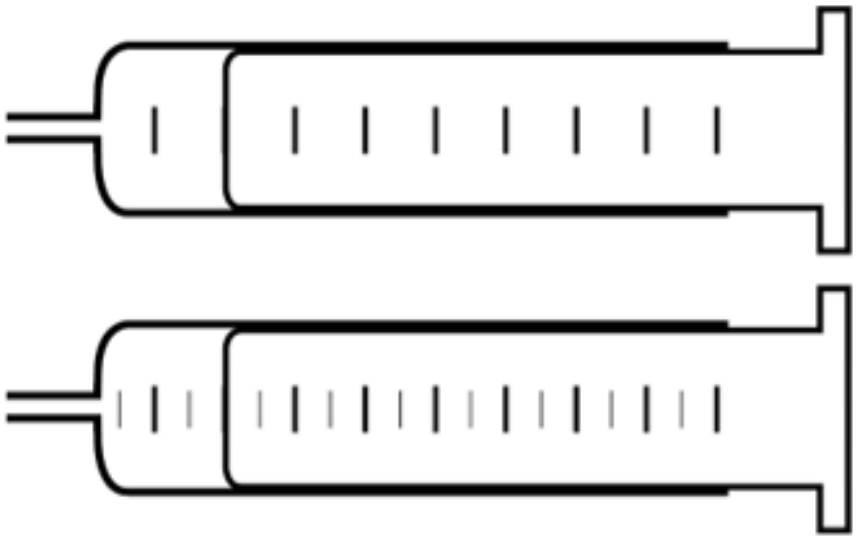
Practical investigations

Question: Are we not expecting independent variables versus dependent variables any more? Can it be a more general exploration?

Answer: We are not confining investigations to controlled experiments involving independent and dependent investigations, so a more general approach is taken, reflecting the nature of contemporary scientific investigations. The eight methodologies are relevant to investigations, although not all of them involve the generation of primary data.

Resolution

This is a new term in the study design that relates to the measurement instruments used in experiments.



The bottom gas syringe has more graduations than the top syringe, so it can measure smaller changes. We can say it has a higher **resolution**.

Precision is used in reference to repeated measurement values, and shouldn't be used instead of **resolution**.

Uncertainty – a qualitative approach

- **Question: If "Determining uncertainty for a set of measurements is beyond the scope of VCE Physics..." how would you recommend students are instructed to estimate the uncertainty of repeated measurements of (say) a dependent variable?**
- **Answer: An estimation of uncertainty is not required. Students would calculate the mean value of the measurements. A discussion as to sources of uncertainty would be expected, thereby taking a qualitative – rather than a quantitative – approach to an understanding of uncertainty.**

Notes:

1. Many teachers use +/- half the range re uncertainty (although this was not supported in consultation with university academics in the consultation process); any quantitative calculation of uncertainty will not be assessed in the end-of-year examination.
2. Students are expected to understand what 25 ± 2 m sec^{-2} means, and how to plot it on a graph as an error bar.

Unit 1 Area of Study 1 changes

- **Name and focus change from ‘How can thermal effects be explained?’ to ‘How are light and heat explained?’**
- **New inclusion: section on ‘Electromagnetic radiation’**
  - Key knowledge points 1, 2, 3, 6, 7 and 8 are derived from the ‘old’ Unit 4 Area of Study 1
  - Key knowledge points 1 and 3 are co-derived from the ‘old’ Unit 2 Option 2.1 ‘What are stars?’
  - New point: compare the wavelength and frequencies of different regions of the electromagnetic spectrum
  - New point: explain the formation of optical phenomena: rainbows; mirages
  - New point: investigate light transmission through optical fibres for communication
- **Edited section: Thermal energy**
  - Edited key knowledge point: describe how an increase in temperature corresponds to an increase in thermal energy (kinetic and potential energy of the atoms) of a system
- **Edited section: Interaction of thermal energy and electromagnetic radiation**
  - New point: apply concepts of energy transfer, energy transformation, temperature change and change of state to climate change and global warming

Unit 1 Area of Study 1 deletions and shifts from ‘old’ study design

- **Shifts**
  - To Option 2.1: ‘Thermodynamics and climate science’ key knowledge points 5, 8 and 10

- **Deletions**
  - Section: ‘Thermodynamics principles’ key knowledge points 2, 4 and 5
  - Section ‘Thermodynamics and climate science’ key knowledge points 6, 7 and 9
  - Section ‘Issues related to thermodynamics’ - all

Unit 1 Area of Study 2 changes: How is energy from the nucleus utilised?

Section: Radiation from the nucleus	Section: Nuclear energy
• **Edited**: explain nuclear stability with reference to the forces in the nucleus including electrostatic forces, the strong nuclear force and the weak nuclear force • **New content**: describe the properties of α, β-, β+ and γ radiation • **Content from 'old' Option 2.7**: explain the effects of α, β and γ radiation on humans (and the three sub-points)	**Edited**: explain, qualitatively, nuclear energy as energy resulting from the conversion of mass **Content from 'old' Option 2.6**: explain fission chain reactions (and two sub-points) **New**: investigate the viability of nuclear energy as an energy source for Australia

Note: Some content from the 'old' Unit 1 Area of Study 3 'What is matter and how is it formed?' now appears in the new Unit 2 options.

Unit 1 Area of Study 3 changes

- **Name and sequence change from Unit 1 AoS 2 ‘How do electric circuits work?’ to Unit 1 AoS3 ‘How can electricity be used to transfer energy?’**
- **Change from ‘explore’ to ‘analyse and evaluate’ re different analogies for electric current and potential difference**
- **Deleted reference to ‘effective’ resistance:**
  - equivalent resistance in arrangements in
  - series: $R_{equivalent} = R_1 + R_2 + ... + R_n$ and
  - parallel: $\frac{1}{R_{equivalent}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}$
- **New: analyse circuits comprising voltage dividers**
- **New: describe energy transfers and transformations with reference to ~~transducers~~ resistors, light bulbs, diodes, thermistors, light dependent resistors (LDRs), light-emitting diodes (LEDs) and potentiometers in common devices**

Unit 2 Area of Study 1 changes

- **Forces and motion section:**
  - change to the formula for changes of momentum from $F_{net} = \frac{\Delta p}{\Delta t}$ to $\Delta p = F_{net}\Delta t$
  - change to the formula for force due to gravity from $F_g = mg$ to $F_{\text{on body by Earth}} = mg$
- **Energy and motion section:**
  - Change to the formula for work done by a constant force from

    work done = constant force × distance moved in direction of force: W = Fs to work done = force × displacement: $W = Fs\cos\theta$
  - Change Hooke's Law formula from $F = -k\Delta x$ to $F = -kx$, where x is extension
  - Change of impulse formula from $I = \Delta p$ to $F\Delta t = m\Delta v$
- **New sub-heading 'Equilibrium'** to include the two key knowledge points relating to torques
- **New key knowledge point:** 'investigate the application of motion concepts through a case study, for example, through motion in sport, vehicle safety, a device or a structure'

Unit 2 Area of Study 3 changes

New	Modified

• Sub-heading sections:
  - Investigation design
  - Scientific evidence
  - Science communication
• Inclusion of verbs to indicate cognitive expectations
• Logbook as authentication of primary data
• Primary data characteristics
• Distinction between an aim, a hypothesis, a model, a theory and a law
• ‘resolution’
	• Distinction between ‘methodology’ and ‘method’
	• ‘reliability’ replaced with ‘repeatability’ and ‘reproducibility’
	• ‘identification of uncertainty’ replaced with ‘causes of uncertainty’ (qualitative)

Question:

- What is the VCAA expectation for Unit 2 Area of Study 2?

Flexibility in meeting the outcome

Unit 2 Outcome 2: "…the student should be able to **investigate and apply physics knowledge** to **develop and communicate** an **informed response** to a contemporary societal issue or application related to a selected option."

- Almost all schools offer multiple options
- Many schools organise students to vote for a set number of options
- Some schools work out the options that can be delivered, and then students select from the list
- Some schools offer all options: use 'flipped classroom' and 'Socratic seminar' delivery modes
- Options are often introduced to students through:
  - a provided list early in the year for students to consider
  - 'tasters' by embedding some key knowledge points from options into the 'core'

Changes to options

- **Reduction in key knowledge – 5 to 6 key knowledge points: “The physics of…”**
- **Common set of 5 ‘Communicating physics’ points**

New options	Modified options (including some titles)
• 2.1 How does physics explain climate change? • 2.4 How do forces act on structures and materials? • 2.9 How is physics used in photography? • 2.15 How can physics explain traditional artefacts, knowledge and techniques? • 2.17 How does physics explain the origins of matter? • 2.18 How is contemporary physics research being conducted in our region?	• 2.2 How do fusion and fission compare as viable nuclear power sources? • 2.3 How do heavy things fly? • 2.5 How do forces act on the human body? • 2.6 How is radiation used to maintain human health? • 2.7 How does the body use electricity? • 2.8 How can human vision be enhanced? • 2.10 How do instruments make music? • 2.11 How can performance in ball sports be improved? • 2.12 How can AC electricity charge a DC device? • 2.13 How do astrophysicists investigate stars and black holes? • 2.14 How can we detect possible life beyond Earth’s Solar System? • 2.16 How do particle accelerators work?

Unit 2 options: Communicating physics

All 18 options in Unit 2 Area of Study 2 have a common set of key knowledge points related to communication of physics:

- evaluate validity of sources of information
- apply physics concepts specific to the investigation: definitions of key terms; and use of appropriate scientific terminology, conventions and representations
- apply the use of data representations, models and theories in organising and explaining observed phenomena and physics concepts, and discuss the limitations of the explanations
- discuss the influence of sociocultural, economic, legal and political factors relevant to the selected issue or application
- apply physics understanding to justify a stance, opinion or solution to the selected issue or application

These key knowledge points can be used as the basis of assessment, for equity, regardless of the topic selected by students

Questions:

- How do the Units 1 and 2 assessment tasks link to the Units 3 and 4 assessment tasks?
- What are some examples of the new assessment tasks?

Links in assessment tasks across Units 1 – 4

2023-2027 Units 1 & 2 tasks	2024-2027 Units 3 & 4 task
• a report of the design, building, testing and evaluation of a device • an explanation of a selected physics device, design or innovation • a report of a selected physics phenomenon • a physics-referenced response to an issue • a modelling or simulation activity • a media analysis/response • an infographic (presentation mode) • a scientific poster (presentation mode)	application of physics concepts to **explain a model, theory, device, design or innovation**

Sample task: Explanation of a device, design or innovation

Unit 1 AoS1	U1 AoS2	U1 AoS3	U2 AoS1
Animal vision Bifocals Central heating Cooking Diamond designs Human eye Magnifying glass Microscope Refrigeration Split system air conditioning Telescope	Artificial radioactivity Breeder reactor Geiger counter Iodine 131 therapy Laser fusion PET scan Radioactive tracers Smoke detectors Sterilisation of medical equipment	Automobile electric circuit Diode Earth leakage protection Electric blanket Electric hair dryer/ iron/ toaster Fuse LED Piezoelectric sensor	Aerofoil Airbags Arch Bridge Bumper bars Cantilever Crash helmets Crumple zone Diving board Parachute Pendulum Seat belts

Links in assessment tasks across Units 1 – 4

2023-2027 Units 1 & 2 tasks	2024-2027 Units 3 & 4 task
• an analysis and evaluation of generated primary and/or collated secondary data • a report of a laboratory or fieldwork activity including the generation of primary data • a modelling or simulation activity (must include data) • an infographic (presentation mode) • a scientific poster (presentation mode)	analysis and evaluation of **primary and/or secondary data**, including data plotting, identified assumptions or data limitations, and conclusions

Scope of an ‘analysis of primary and/or secondary data’ task

Primary and/or secondary data may be used in data analysis tasks. It is expected that students will **plot data** on a graph as part of the assessment task. The **focus of this task is on assessing students’ skills in constructing graphs, including scaling, use of units, plotting lines of best fit and use of appropriate labels**. Students should also be able to discuss the **significance of trend lines and patterns and relationships in data**, including identifying and accounting for outliers.

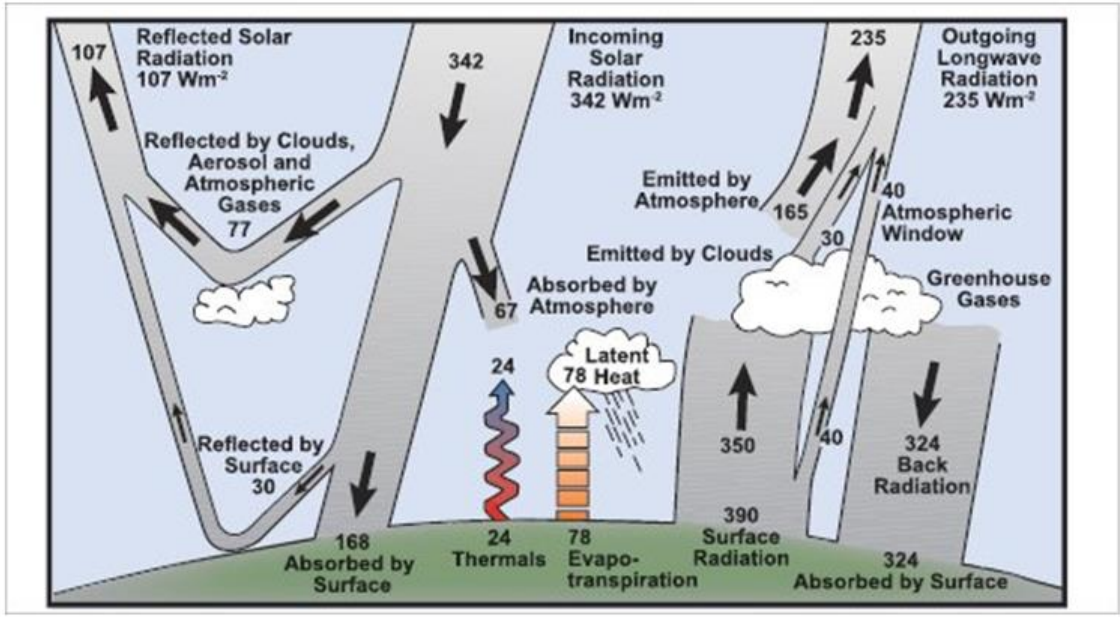
Teachers may refer to student-generated data from scientific investigations or collated primary data from a class, across different classes within a school, or across different schools or settings in setting assessment tasks. Secondary data may be accessed through a variety of different print and electronic resources or may include data generated by VCE Physics students in prior years. If data previously generated by students is used, then permission should be obtained from the students and the data de-identified. This task may also involve students analysing the data and methodology and methods used to generate the data as well as constructing evidence-based arguments and drawing conclusions based on the data available.

This task type is **useful for students to undertake early in their study of VCE Physics** so that formative advice about data analysis can be provided by teachers, prior to students undertaking further learning activities and assessments that include data analysis. The task may be shorter (e.g., 20 minutes) compared with other assessment task types.

Links in assessment tasks across Units 1 – 4

2023-2027 Units 1 & 2 tasks	2024-2027 Units 3 & 4 task
• problem-solving involving physics concepts and/or skills • a report of an application of physics concepts to a real-world context (qualitative) • an analysis, including calculations, of physics concepts applied to real-world contexts (quantitative) • a physics-referenced response to an issue • a critique of an experimental design, process or apparatus	problem-solving, **applying physics concepts and skills to real-world contexts**

Sample task: Real-world physics applications (including calculations)



The infographic summarises the results of measurements taken from satellites of the amount of energy coming into and going out of Earth's climate system. Representations such as this enable students to see that our scientific understanding of phenomena such as the greenhouse effect is dependent on the generation and interpretation of real-world measurements.

A set of structured questions could be used to scaffold students' quantitative analysis of this real-world context related to climate change, for example:

The energy coming from the Sun is 342 W m^{-2}. This means that, on average over Earth, in every second 342 joules of energy enter an area of 1 square metre at the top of the atmosphere.

The distance from the centre of Earth to the top of the atmosphere* is approximately 6400 km or 6,400,000 metres.

The radius of Earth's surface is 6371 km on average (ranging from 6378 to 6357 km). The troposphere has a height of 12 km and includes 80% of the mass of the atmosphere.

1. **Calculate the area of the surface of Earth in square metres.**
2. **Determine how much energy from the Sun enters Earth's atmosphere every second.**
3. **Using the figure above (Figure 1):**
   a. Which terms represent energy being radiated out into space?
   b. Add up the energy values for these terms. (The answer should equal 342 Wm^{-2})

(Note: this is an extract from a sample assessment task available in the 'Assessment' section of the VCE Physics study page on the VCAA website.

Links in assessment tasks across Units 1 – 4

2023-2027 Units 1 & 2 tasks	2024-2027 Units 3 & 4 task
• comparison and evaluation of two solutions to a problem, two explanations of a physics phenomenon or concept, or two methods and/or findings from practical activities • reflective annotations related to one or more practical activities from a logbook • a media analysis/response • an infographic (presentation mode) • a scientific poster (presentation mode)	**comparison and evaluation** of two solutions to a problem, two explanations of a physics phenomenon or concept, or two methods and/or findings from practical activities

Sample task: Comparison of two solutions to a technological problem

Examples of different solutions to technical problems:

- Nuclear fission vs nuclear fusion
- Energy from nuclear fission: thorium vs uranium
- Energy from nuclear fusion: tokamak vs laser confinement
- Geothermal vs nuclear energy as energy sources for society
- Evaporative cooling vs refrigeration
- Truss bridges vs arch bridges for stability or supporting the greatest mass

Task requirements

For the assessment task, students should:

- **precisely state the nature of the technological problem**
- **summarise the physics of each solution as it relates to the problem and to a depth consistent with the study design**
- **identify criteria to be used in the comparison and then compare the two solutions**
- **provide a reasoned argument in support of a preferred solution**

Links in assessment tasks across Units 1 – 4

2023-2027 Units 1 & 2 tasks	2024-2027 Units 3 & 4 task
• a report of a laboratory or fieldwork activity including the generation of primary • a scientific poster (presentation mode) • an infographic (presentation mode) • (for Unit 2 Area Outcome 3) a report of a practical investigation (student-designed or adapted) using an appropriate format, for example a scientific poster, practical report, oral communication or digital presentation	application of the design, analysis and findings of a **student-designed** and **student-conducted investigation** through a structured scientific poster and logbook entries

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