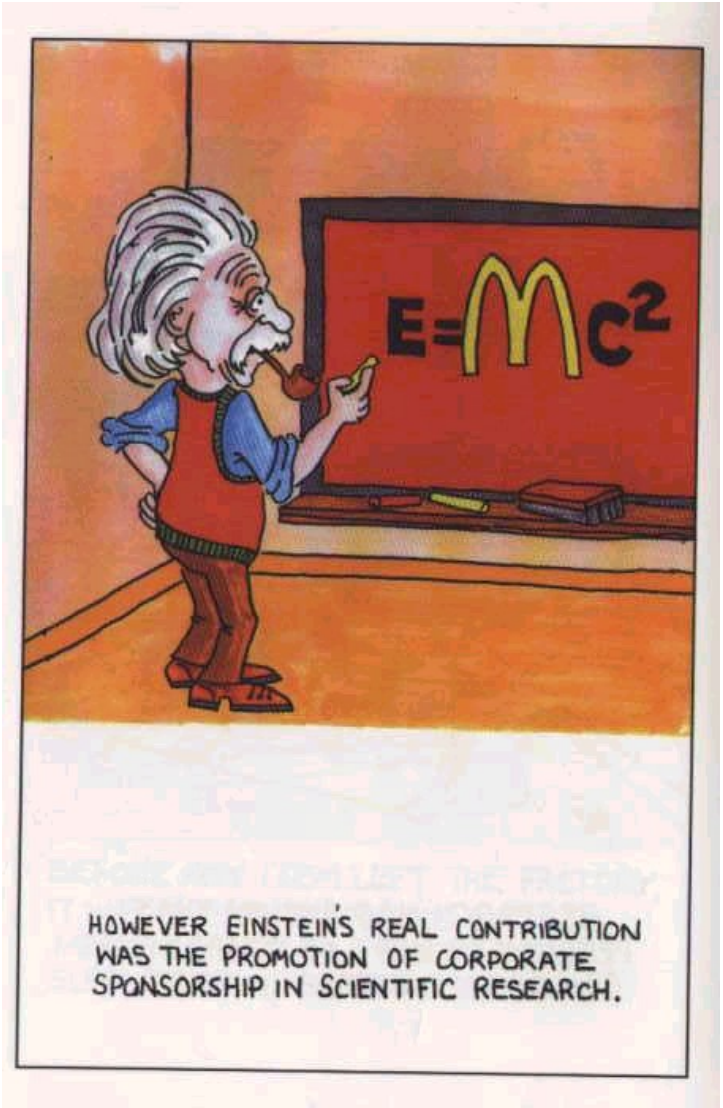
Physics Revision

2023



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for Vicphysics

Revision process

There are two steps to the revision process, firstly you need to master the content, and then master the exam process.

Step 1

Use the attached notes and questions to revise the content that will be examined. If you don't get an example correct, use the table to find some similar questions and work on these until you gain understanding. The questions relate to past exam papers on the current study design, all of which are available on the VCAA website.

Step 2

If you are comfortable with your knowledge of the content, then start attempting exam papers. Initially don't worry about how long it takes to complete a paper (speed will improve with practice), but focus on writing good answers. Correct the paper, and do more questions on the weaknesses that appear.

When correcting the paper, try to avoid marking 'what you meant to say' and mark 'what was written'. If this is too difficult, get someone else to correct the paper for you.

I suggest that you work through any commercial papers that you have in the order of the newest to the oldest. These papers try to reflect what the real paper is doing, so the 2023 version will be better than the 2017 version. I would also be working through the VCAA papers, and I recommend doing them from 2017, 2018, 2019 etc., culminating with the 2022 and the 2023 NHT papers late in the process. See if you can get someone who knows how to mark papers to correct these for you. Respond to any feedback throughout.

Every time you get a question wrong on a VCAA exam, you need to ensure that the next time you do that type of question you can score better. Use the file that shows the relevant examples in the notes and other similar questions. The more often this concept is tested on the exam, the more likely it is to appear this year.

If you are still in doubt as to whether you could do any question on the exam, add an example to your cheat sheet. You can always delete them later on.

There is no limit to how often you can attempt any VCAA paper. As you progress through the VCAA papers, try to keep your times under control. Do at least one paper twice, but try to have some time between the first and second attempt. Hopefully the improvement will be obvious to you.

You should monitor for unforced errors. Typical 'unforced' errors are:

not using the specified/correct number of sig figs.

not using the correct units.

not answering the question being asked due to misreading the question.

calculation errors, eg. not squaring the bottom line.

Identify every mistake you make on a past paper, as either a knowledge shortfall, or an unforced error, and then respond accordingly. Unforced errors are basically a matter of discipline, you need to be aware that you make them and develop some strategies to try to minimise their impact. These strategies and techniques that will improve with repetition, leaving them to the day of the actual exam is fraught with difficulties. You will improve these skills with time, and they should be automatic by the actual exam.

The Exam

70% should be familiar if you have completed enough past papers.

25% for high performance students

5% to sort out the top students.

OR

25% easy, **50%** in the middle, **25%** hard

2017 Exam structure	**2018 Exam structure**	**2019 Exam structure**
48% Calculation	**60%** Calculation	**50%** Calculation
31% Explanation	**28%** Explanation	**39%** Explanation
21% Annotation	**12%** Annotation	**11%** Annotation

2020 Exam structure	**2021 Exam structure**	**2021 Exam structure**
Modified course	**~52%** Calculation	**~ 56%** Calculation
	~38% Explanation	**~ 23%** Explanation
	~10% Annotation	**~ 21%** Annotation

2022 Exam structure

~56% calculations

~23% short answer

~21% annotation graphs.

Know when the exam is.

Thursday 9th November 9:00 am – 11:45 am

Significant figures

“Non-zero digits in data are always considered significant. Leading zeros are never significant whereas **following zeros and zeros between non-zero digits are always significant.** For example, 075.0210 contains six significant figures with the zero at the beginning not considered significant. A whole number may be a counting number, or a measurement and determination of significant figures varies in the literature.

Whole numbers

For the purpose of the *VCE Physics Study Design*, whole numbers will have the same significant figures as number of digits, for example 400 has three significant figures while 400.0 has four.”

VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2022

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER | | | | | | | | | | Letter |

PHYSICS
Written examination

Wednesday 9 November 2022

Reading time: 9.00 am to 9.15 am (15 minutes)
Writing time: 9.15 am to 11.45 am (2 hours 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	17	17	110
			Total 130

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, pre-written notes (one folded A3 sheet or two A4 sheets bound together by tape) and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied
- Question and answer book of 42 pages
- Formula sheet
- Answer sheet for multiple-choice questions

Instructions
- Write your student number in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- All written responses must be in English.

At the end of the examination
- Place the answer sheet for multiple-choice questions inside the front cover of this book.
- You may keep the formula sheet.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

Reading time

In 2022 there were 42 pages to be read in 15 minutes, i.e. 21.4 seconds per page.

This was virtually impossible. You need a plan, and you need to practice it.

One suggestion is:

Go to Section B, short-answer, and read the questions that you haven't seen before.

Skip the questions you are familiar with.

Don't get bogged down reading data, you are going to need to read it again when you do the question, so you are wasting time reading it during reading time.

When you have finished reading section B, go back to Section A, multiple choice, and start doing the questions in your head.

This time you are reading with the intent to complete the question. You will need to remember the answer until you can start writing.

The examination consists of two sections.

All questions must be completed.

A formula sheet will be provided with the examination.

Section A will consist of 20 multiple choice questions worth 1 mark.

A total of 20 marks.

Instructions for Section A

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** or that **best answers** the question.
A correct answer scores 1; an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.
Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
Take the value of g to be 9.8 m s^{-2}.

Instructions for Section B

Section B consists of short-answer and extended answer questions, including questions with multiple parts. The number of questions varies from year to year, worth a total of 110 marks.

Instructions for Section B

Answer **all** questions in the spaces provided.
Where an answer box is provided, write your final answer in the box.
If an answer box has a unit printed in it, give your answer in that unit.
In questions where more than one mark is available, appropriate working **must** be shown.
Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
Take the value of g to be 9.8 m s^{-2}.

Physics Approved materials and equipment

one scientific calculator

one folded A3 sheet or two A4 sheets bound together by tape, single or double-sided. Notes may be typed or handwritten and from any source (including commercially available notes).

Examiner's report

Students still struggle to convert g to kg, and cm and mm to m and m to nm.

Students are finding graphing data difficult and interpreting graphical data even more difficult.

Make sure students read the question and check that they have responded specifically.

Use the number of marks as a guide to the level of detail required.

Students are advised **NOT** to write in pencil (it doesn't scan well).

Students are missing out on marks because they are not showing sufficient working (even if their answer is correct).The examination is not about calculating correct answers as much as it is about demonstrating understanding. Students should imagine what they would write if they were explaining their thinking to a teacher or peer.

Students are reminded that numerical answers are expected in simplified standard form rather than fractions or surds. These can often look like intermediate working steps rather than final answers. Unless otherwise stated, the number of decimal places in the student's final answer is not considered. However, students should not be using more decimal places in their answer than there are in the values provided in the question stem.

Students need to be careful when writing indices.

Students are rounding excessively during calculations. Students should carry as many decimal places as is reasonable during their calculations and only round at the end.

There were many examples of students copying text directly from their A3 sheet of pre-written notes. This was particularly obvious when the student's response bore no relation to the question. Students are reminded that copying text from their A3 sheets is unlikely to score highly as the questions require application of knowledge, not recall._Answers MUST relate to the question, need a specific link to the question, not just transposed from the cheat sheet.

For calculation questions worth more than three marks (i.e. questions involving multiple steps), students should take care to plan the layout of their work. Even if the question stem says 'calculate', students can identify their working steps with short written statements.

Many students lose marks due to contradictions in their answer.

It is important to show numbers substituted into formula/equation.

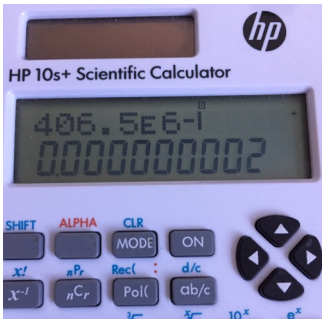
If using $F = \frac{GMm}{r^2}$ then make sure that you substitute in order for M and m.

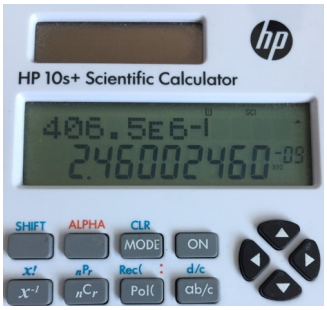
Use of scientific calculators

Be familiar with the operation of the scientific calculator you plan to use in the exam. Ensure that it is in scientific mode, and that it does not truncate answers after one or two decimal places.

Example Personal Location Beacons use EM radiations to transmit information.

What is the period of the EM wave when it is operating at 406.5 MHz?





Marking guide

In general:

1 mark questions:

1 mark for correct answer.

2 mark questions:

1 mark for correct formula and substitution.

1 mark for correct answer.

3 mark questions:

1 mark for initial derivation or conversion of information.

1 mark for final formula and substitution.

1 mark for correct answer.

4 mark questions:

1st mark for calculation or some recognition, i.e. substitution or statement.

2nd and 3rd marks are for process not for outcome, usually attached to a formula and/or substitution that demonstrate the next step in the solution process. Not contingent on the mark before it. If your understanding is correct, you can still get the two middle marks without the first and last marks.

4th mark for correct answer.

Hints

Avoid algebraic rearrangement. Make it easier for markers to award the "formula & substitution" mark(s)

Selected questions

2021 Question 3, 3 marks

To calculate the mass of distant pulsars, physicists use Newton's law of universal gravitation and the equations of circular motion.

The planet Phobetor orbits pulsar PSR B1257+12 at an orbital radius of 6.9×10^{10} m and with a period of 8.47×10^{6} s.

Assuming that Phobetor follows a circular orbit, calculate the mass of the pulsar. Show all your working.

Examiners report

Mark	0	1	2	3	Average
%	28	6	12	55	2.0

$$\frac{GM}{r^2} = \frac{4\pi^2 r}{T^2}$$

$$\therefore M = \frac{4\pi^2 r^3}{GT^2}$$

Equating Newton's law of gravitation with one of the equations for circular motion from the formula sheet demonstrates an understanding of the physics, for the 1st mark.

$$M = \frac{4\pi^2 \left(6.9 \times 10^{10}\right)^3}{6.67 \times 10^{11} \times \left(8.47 \times 10^{6}\right)^2}$$

Substituting correctly, 2nd mark.

$$M = 2.71 \times 10^{30}\, kg$$

Correct answer, 3rd mark.

There were a number of students for whom full marks were not awarded because they did not demonstrate enough working, as shown above.

2021 Question 18a, 1 mark

Scientists are conducting experiments to compare the circular diffraction patterns formed by X-ray photons and electrons when they pass through small circular apertures. The X-ray photons have an energy of 100 eV and pass through an aperture of diameter 1.24 μm. The electrons are moving at 5.0×10^5 m s^{-1}.

a. Show that the de Broglie wavelength of the electrons is equal to 1.46×10^{-9} m.

Examiners report

$$\lambda = \frac{h}{mv}$$

$$\lambda = \frac{6.63 \times 10^{-34}}{9.1 \times 10^{-31} \times 5.0 \times 10^{5}}$$

$$\lambda = 1.46 \times 10^{-9} m$$

45% of students could not make any meaningful start to this question, even though both $\lambda = \frac{h}{p}$ and $p = mv$ are on the formula sheet.

2021 Question 18b, 4 marks

The scientists want an aperture for the electrons that forms diffraction patterns with the same spacing as the diffraction patterns formed by the X-ray photons.

Calculate the diameter of the aperture that the scientists should choose. Show your working.

From the examiners report

Mark	0	1	2	3	4	Average
%	74	6	3	2	16	0.8

If you don't know how to complete the question, at least tell what you know about the question.

The width of the diffraction pattern can be found from the $\frac{\lambda}{w}$ *ratio.* The wavelength of the X-rays is found by: $E = \frac{hc}{\lambda}$

The electrons, with a de Broglie wavelength of 1.46 × 10^{-9} m, will also have to have the same ratio of $\frac{\lambda}{w}$.

If they both have the same wavelength/momentum then the pattern will be the same.

Students are reminded that:

- the number of marks indicates the number of steps they will have to demonstrate.
- the purpose of the question is to allow students to demonstrate the depth of their understanding.

The comments in *italics* would be sufficient to gain the 2 middle marks for this question, because you have demonstrated the physics required.

2017 Question 19, 4 marks (10% were awarded 4 marks)

Roger and Mary are discussing diffraction.

Mary says electrons produce a diffraction pattern.

Roger says this is impossible as diffraction is a wave phenomenon and electrons are particles; diffraction can only be observed with waves, as with electromagnetic waves, such as light and X-rays.

Evaluate Mary's and Roger's statements in light of the current understanding of light and matter. Describe **two** experiments that show the difference between Mary's and Roger's views.

Chief examiner's comment (this was a typical answer)

Diffraction is a wave phenomenon.
The amount a wave diffracts depends on its wavelength.
Electrons demonstrate a wave behaviour based on their de Broglie wavelength.
When electrons are passed through a slit, they show a diffraction pattern.
Electrons produce similar diffraction patterns to X-rays if the de Broglie wavelength of the electron is similar to the wavelength of the X-ray.
If electrons are passed through a pair of slits an interference pattern may be observed.

This is a data dump. It is clear the student does not understand the question.

Examiner's comment

Once again there seemed to be a reliance on prepared responses copied from the student's sheet of notes. Responses such as this did not receive any marks as they did not refer to the question.

2019 Question 9, 3 marks

A proton in an accelerator detector collides head-on with a stationary alpha particle, as shown in Figure 9a and Figure 9b. After the collision, the alpha particle travels at a speed of 4.0×10^6 m s^{-1}. The proton rebounds at 6.0×10^6 m s^{-1}.

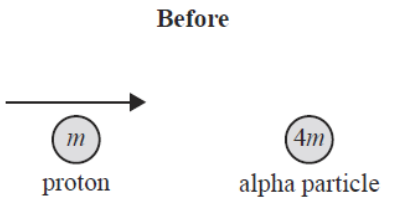


Figure 9a

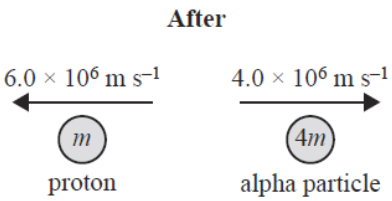


Figure 9b

Find the speed of the proton before the collision, modelling the mass of the alpha particle, $4m$, to be equal to four times the mass of the proton, m. Show your working. Ignore relativistic effects.

This is where the exam is going. Trying to use a well known concept in an obscure scenario. It is also trying to minimise access to those students that can only plug numbers into mathematical equations (hence the use of 'm').

Examiner's comment

Marks	0	1	2	3	Average
%	19	31	4	46	**1.8**

The appropriate approach is to apply conservation of momentum.

$\therefore p_i = p_f$

$\therefore m \times v_{proton} = m \times -6.0 \times 10^6 + 4m \times 4.0 \times 10^6$

$\therefore m \times v_{proton} = = m \times 10 \times 10^6$

$\therefore v_{proton} = 1.0 \times 10^7$ m s^{-1}

As p = mv, is on the formula sheet, there will never be any marks allocated to this, but either $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ or $p_i = p_f$ or the statement that 'momentum is conserved in collisions' is worth the 1st mark.

The most common error was to forget to subtract the momentum of the proton after the collision due to the vector nature of its momentum.

2017 Question 4c, 3 marks (23% were awarded the 3 marks)

Scientists wish to place a spacecraft, of mass 1000 kg, in an orbit of the same radius as Charon. Three students, Rick, Melissa and Nam, are discussing the situation and have different opinions.

Rick says as the spacecraft is lighter, it will have to move at a greater speed than Charon to achieve the same orbit.

Melissa says the spacecraft would need to move at the same speed as Charon.

Nam says the spacecraft would need only to move at a lower speed as it is lighter than Charon.

Evaluate these three opinions. Detailed calculations are **not** necessary.

Examiner's comment

Many students suggested that all three students were correct to some extent. Marks cannot be awarded where it is unclear whether the student has recognised an incorrect argument.

2018 Question 14, 2 marks, 13%

Jani is stationary in a spaceship travelling at constant speed.

Does this mean that the spaceship must be in an inertial frame of reference? Justify your answer.

Examiner's comment

Students were required to identify that constant speed is not the same as constant velocity, and that the ship in question could be travelling in a circular path or it could be in orbit and still be traveling at a constant speed. Therefore, the spaceship may not be in an inertial frame of reference.

2017 Question 11c , (8% of students gained 3 marks)

c. Explain why the scientists would observe more particles at the end of the laboratory measuring range than classical physics would expect.

Examiner's comment

It was clear that the majority of students had no understanding of these phenomena. Many responses simply stated that 'due to time dilation and length contraction the particles last longer and travel a shorter distance'. Many students explained the results by applying both time dilation and length contraction at the same time, which generally resulted in a confused response that indicated the students were not aware of which frame of reference they were referring to.

What does a 'good' answer look like?

Elegance in the answer
- linkages between points
- references to actual question
- appropriate data

Questions require more in-depth understanding, holistic answers forming a coherent argument are essential, facts, by themselves, will not earn marks.

> ***Examiner's comments***
>
> *Factual statements can only be rewarded if they form part of a coherent argument. Factual statements (copied from the A3 sheet) that are not part of a coherent argument do not indicate an understanding of the question.*

The student's response must demonstrate:
- an understanding of the question being asked.
- an understanding of appropriate and relevant physics in response.

therefore
- identify the relevant theory or concept
- describe relevant theory or concept
- apply by relating back to question

Expressing a physical principle linguistically rather than mathematically, is still the same principle, so marks can be awarded, but you must say something that is different to the stem. Repeating what is in the stem never gains marks, so is a waste of time.

Make the pathway through your thinking very clear, by signposting your answer using small statements to show where you are heading.

It is the responsibility of the students to make their understanding known to the assessor, not the job of the assessor to interpret the students response.

If the answer to a graphical question is zero, you must demonstrate this by either marking the point or drawing a line showing zero.

You need to work smarter, not harder.

You need to know what you know, and know what you don't know. Then work on your areas of weakness.

Quality, not quantity, is the secret. Be SMART (specific, measurable, achievable, relevant and timely)

You need to practise the way you intend to perform on the exam.

How to use the revision materials (the remainder of these notes).

Read through the theory section and the worked examples at the start of each set of notes. Try to do some of the past exam questions using the notes, your cheat sheet and the VCAA formula sheet. Correct the questions using the Assessors report.

VCAA physics exams and exam reports

These papers are all available on the VCAA website.

https://www.vcaa.vic.edu.au/assessment/vce-assessment/past-examinations/Pages/physics.aspx

The NHT papers can be found here:

https://www.vcaa.vic.edu.au/assessment/vce-assessment/past-examinations/nht-past-exams/Pages/nht-past-exams.aspx
You need to scroll down the page to find the Physics exams.

Every time you don't score full marks on a question, look back at the underlying concepts and try some more similar type questions.

Understand the difficulty levels of different questions, strive for perfection, **close enough** is really not good enough at this stage of the year.

Exam preparation

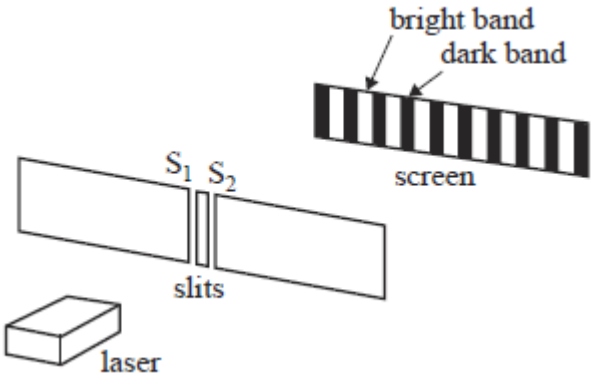
Learning theory suggests something along the following lines.

In general you remember ~ 10% of what you hear
~ 25% of what you read
~ 40% of what you write
~ 70% of what you do
~ 85% of what you teach

What to do from here on.

Practice explaining the problems and solutions, by using words, calculations and diagrams.
Develop an inner monologue, rehearse it when answering questions.
Annotate solutions to numerical problems. Tell the assessor what you are doing and what the next step is.

Do past papers, questions often repeat.



This diagram or some minor variation of it has been on the following papers.

2022
2021
2021 NHT
2020
2018
Use the notes to find the questions that the examiners seem to like asking, and prepare accordingly.

How many past papers do you need to do?

This is the same as asking how long is a piece of string? It is a question that doesn't have one answer. It depends on what you want to get out of this process. In general 'the more you put in, the more you get out' applies here.

On the day

Thursday 9th November 9:00 am – 11:45 am

Have a good breakfast, your brain needs food for energy. Sharpen your pencils. Check your calculator, pens and ruler.
Find and re-read your cheat sheet, make any last minute additions.

How to tackle the paper

Reading

During reading time I suggest that you start reading at section B. Look for the questions that you have not seen before and read them carefully but quickly.

Skim over the data in the stem, and work out what is required of you to answer the question.

2020 Question 11a

An astronaut has left Earth and is travelling on a spaceship at $0.800c$ ($\gamma = 1.67$) directly towards the star known as Sirius, which is located 8.61 light-years away from Earth, as measured by observers on Earth.

a. How long will the trip take according to a clock that the astronaut is carrying on his spaceship? Show your working.

During reading time, you are wasting your time trying to process the information that the speed is 0.800*c*, γ = 1.67, and the distance is 8.61 light-years.

You are not going to remember these numbers and you are going to have to read them again when you do the actual question, so reading them during reading time is wasting time.

All you need to know is that you need to calculate a time as measured by the astronaut on the spaceship.

Writing

As soon as you are allowed to begin writing complete all Section A questions in pencil.

Then **swap to a pen** and move to Section B and do all the questions that you know how to answer, don't worry about the others too much at the moment.

Make sure you allow plenty of time to complete the Investigations question. (See below)

The Investigations has been either the last question on the paper, or one of the last.

Year	*Question*	*Marks*	*Average score*
2022	*10 of 17*	*16*	*76%*
2021	*20 of 20*	*17*	*33%*
2020	*18 of 18*	*16*	*66%*
2019	*19 of 19*	*18*	*39%*
2018	*20 of 20*	*10*	*66%*
2017	*9 of 19*	*14*	*61%*

Overall the performance has not been that good, and I suspect that some of this is due to students leaving this until the end of the exam to attempt. Often a significant proportion of the marks are allocated for completing simple calculations and plotting the graph. These are easy marks.

I recommend that students do not leave this to the last, as it appears that some students have either run out of time or energy, to complete this question.

Then move back to the questions that you have left, and complete section B.