AstroChallenge 2025

Post-Mortem

“Are you allowed to submit origami as answer?” - AC2025 comm member

QM Team

QM Team

HQMs: Angeline, Wu Xiao

Round ICs: Siva (MCQ), Geron (Team), Mandy (Project), Yong Gin (Observation), Shrinjana (Finals), Kush (Finals)

QMs: Ken Rui, Charles, Choon Hean, Dustin, Mingqian, Aqil, Yu Cheng, Sureyaa, Pranav, Roy, Mingchuan, Kia Yee

Special thanks to:

- Project Directors (Cindy & Charles)
- All external judges for Project and Observation Rounds
- Esteemed judges for Final Round (Dr Leek, Dr Lim, Mr Roy)

General Remarks by HQM

General Remarks

We want everyone who came to AC to take away something.

Different format of questions, but same goal: introduce something in Astronomy

Several important points:

- Science is a way of thinking.
- Mathematics is a language of astronomy (and many other sciences and social sciences in general).
- Analytical skills goes a long way.

Science as a way of thinking

5. What is the motivation behind the theory of general relativity? How did it turn out to be a better encompassing theory about the universe? Are our previous understandings of gravitation still relevant to us today?

15. What are the geocentric and heliocentric models? Why was the geocentric model superseded by the heliocentric model, which was subsequently superseded by newer models?

11. In 1588, Tycho Brahe published the Tychonic system, which is a geoheliocentric model in which the Sun, the Moon and stars revolve around the Earth, and other five planets (Uranus and Neptune were not yet discovered) revolve around the sun.

Back when it was proposed, it was a major competitor, along with the Copernican heliocentric model, as an alternative to the Ptolemy's geocentric model.

However, the scientific community eventually replaced the Tychonic model with the Copernican model. Which one of the following observations could have contributed to the support for Copernicus' heliocentric model **over the Tychonic model**?

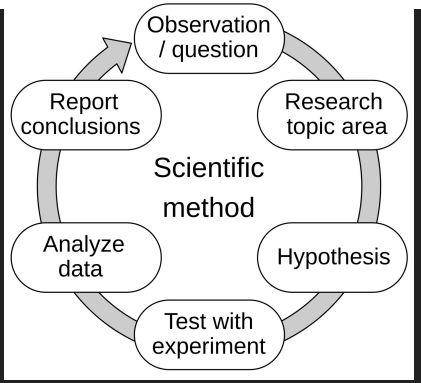
(A) The observed seasonal change of the declination of the Sun on the celestial sphere.

(B) The observation of the retrograde motion of Mars.

(C) The observation of the phases of Venus in 1610.

(D) **The observation of stellar parallax of 61 Cygni in 1838.**

(E) All of the above.



Ongoing process of scientific inquiry

Efbrazil. (2021, March 26). *The Scientific Method* [SVG image]. Wikimedia Commons. https://commons.wikimedia.org/wiki/File:The_Scientific_Method.svg

Mathematics as a language

Assuming that bodies involved in the collision are point mass and there was no other loss of energy, Milo tried to calculate the final mass of the remnant. This is his working:

Since the orbit is circular,

$$e = 0 \tag{2}$$

$$a = 300\,\text{km} \tag{3}$$

Using Equation 1,

$$P_{\text{loss}} = \frac{32G^4 m_1^2 m_2^2 (m_1 + m_2)}{5c^5 a^5 (1-e^2)^{7/2}} \left(1 + \frac{73}{24}e^2 + \frac{37}{96}e^4\right) = \frac{32G^4 m_1^2 m_2^2 (m_1 + m_2)}{5c^5 a^5} \tag{4}$$

$$E_{\text{loss}} = P_{\text{loss}}\, t = \frac{32G^4 m_1^2 m_2^2 (m_1 + m_2) t}{5c^5 a^5} \tag{5}$$

$$E_{\text{remaining}} = \frac{0.975}{0.025} E_{\text{loss}} = \frac{0.975}{0.025} \times \frac{32G^4 m_1^2 m_2^2 (m_1 + m_2) t}{5c^5 a^5} \tag{6}$$

$$M_{\text{remaining}} = \frac{E_{\text{remaining}}}{c^2} = \frac{1}{c^2} \times \frac{0.975}{0.025} \times \frac{32G^4 m_1^2 m_2^2 (m_1 + m_2) t}{5c^5 a^5} = 5.12 \times 10^{27}\,\text{kg} \tag{7}$$

However, it turned out that the actual mass of the remnant is 5.45×10^{30} kg.

(d) One of the key steps above contained a mistake, which resulted in the disparity in the calculation outcome. Which step is it? Explain why it is a mistake. **[1]**

Note that there is no mistake in the numerical calculation. You may use the equation number to refer to the step.

Solution:

Equation 3 contains a mistake. [0.5]

The mistake is that the semi-major axis is constant throughout the merger process.

As the stars collide, the semi-major axis of their orbit, a, decreases from 300 km to 0. So it does not make sense that $a =$ [redacted] ough the entire process. [0.5]

(e) What is one technique that you can use to correct for this mistake? Qualitatively explain how this technique will be helpful. **[1]**

Solution:

We should account for the change of semi-major axis throughout the merger process by seeing $a(t)$ as a function of t. [0.5]

We can then use the technique of integration to account for the change in $a(t)$. [0.5]

Specifically, once we write $a(t)$ as a function of t, now we have $-\left\langle \frac{dE}{dt} \right\rangle$ as a function of t. That is, we have power loss $P_{\text{loss}}(t)$ as a function of t. Then, in step 5, we can find the total energy loss by

$$\int P_{\text{loss}}(t)\, dt$$

Mathematical methods are handy tools in handling tricky situations.

Mathematics as a language

Now, let the time it takes for recombination to happen after the formation of the first acoustic wave be t, and the distance travelled by the wave until recombination be l_r.

Cornelius interjects and gets ahead of himself. "Based on my knowledge of advanced mathematics, we can write l_r as

$$l_r = c_s \int_0^{t_r} \chi(t)\,\mathrm{d}t$$

where $\chi(t)$ account for cosmological expansion of the universe over time."

"Bravo Cornelius! Amazing observation. However, there is one inaccuracy."

(j) What is the inaccuracy here? **[1]**

Hint: Refer to part (g) for hint. I must admit this is more of a mathematical question than a physical one, however we all must respect mathematics, nonetheless.

Solution:

The speed of sound in Cornelius' expression is assumed to be constant. However, from part (g), we know that the speed of sound was decreasing as time passed on due to changing densities. Therefore, c_s must be inside the integral sign in the expression, i.e.,

$$l_r = \int_0^{t_r} c_s(t)\chi(t)\,\mathrm{d}t$$

Analytical Skills goes a long way

(a) By considering how the energies of a satellite of mass m, in a bound orbit around a central point mass of mass M, at its apoapsis and periapsis[7], show that Josh can derive Equation 19. **[1]**

$$\frac{1}{2}v_a^2 - \frac{1}{2}v_p^2 = \frac{GM}{r_a} - \frac{GM}{r_p} \qquad (19)$$

where

- v_a is the velocity of the satellite at apoapsis
- v_p is the velocity of the satellite at periapsis
- r_a is the distance between the satellite and the central point mass at apoapsis
- r_p is the distance between the satellite and the central point mass at periapsis

Solution:

We start off with the expression for the total energy of a satellite in an elliptical orbit at any point as the sum of its KE and GPE: [0.5]

$$E = \frac{1}{2}mv^2 - \frac{GMm}{r}$$

Since the total energy in an elliptical orbit is conserved, we can equate the energies at periapsis and apoapsis, thus forming the equation: [0.5]

$$\frac{1}{2}mv_a^2 - \frac{GMm}{r_a} = \frac{1}{2}mv_p^2 - \frac{GMm}{r_p}$$

which can be simplified to:

$$\frac{1}{2}v_a^2 - \frac{1}{2}v_p^2 = \frac{GM}{r_a} - \frac{GM}{r_p}$$

Sees “considering how the energies…”

Conservation of energy?

Closed system?

$TE_a = TE_p$

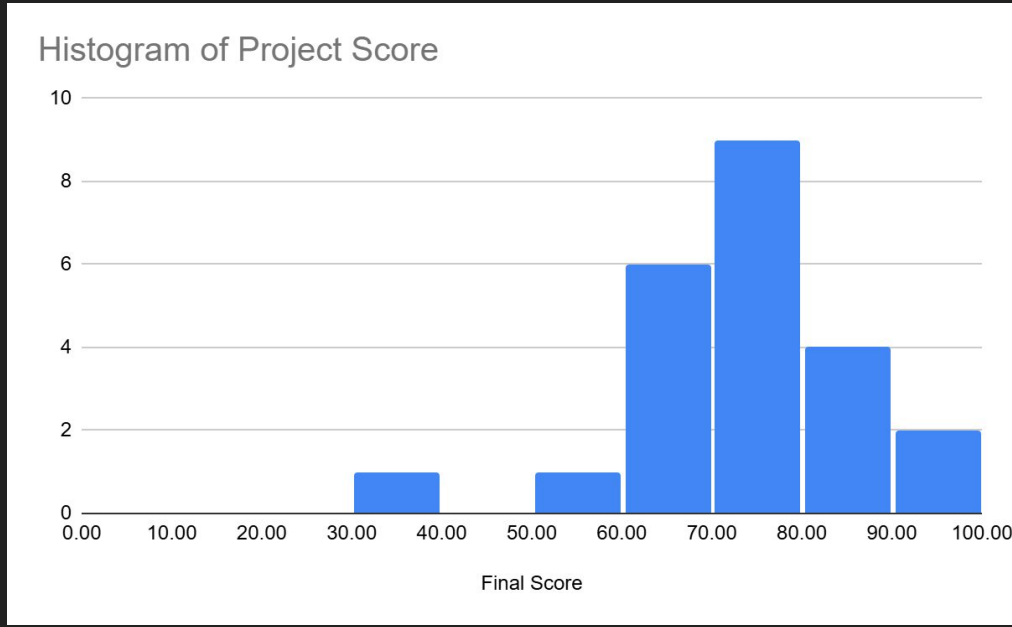
Project Round

Teams who haven't started on Project Round
(There's exactly 24 hours to deadline)

Summary statistics - Junior

Based on question declaration form:

- Most chosen question:
  Q6 Cosmic Distance Ladder
- Least chosen question:
  Q2 Hubble Tension;
  Q7 pitch an Observatory;
  Q10 Observing EM spectrum;
  Q12 Exoplanets



Summary statistics:

- Mean: 73.8
- Median: 74.9

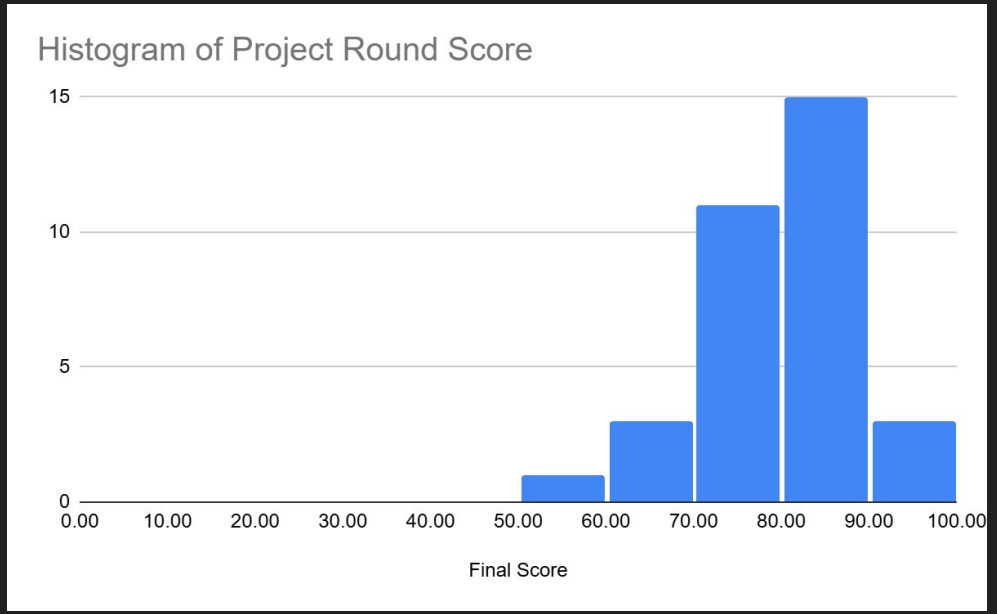
Summary statistics - Senior

Based on question declaration form:

- Most chosen question:
  Q8 What is the Olbers's Paradox
- Least chosen question:
  Q10 Observing on different parts of EM spectrum

Summary statistics:

- Mean: 79.9
- Median: 81.2



VERY IMPORTANTLY

You NEED to recognise others' work (including AI)

- It is never a shame to give credit to others, in fact, it is very noble to do so.
- New intellectual discovery depends on others' previous work. It would be VERY WEIRD if you do not refer to other sources.
- AI is becoming more and more powerful day by day. We follow NTU's guideline on AI usage - you NEED to declare properly if it is used.

Just to make it clear…

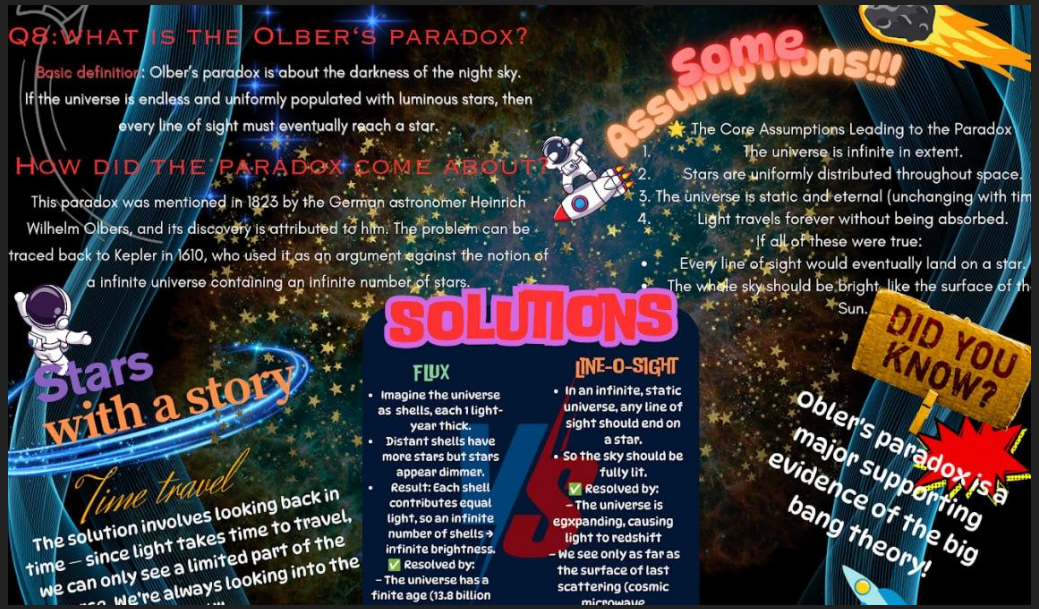
- We DO NOT penalise if you cite sources. There is no maximum amount of source we impose so cite as many as you have referred to!
- We DO NOT penalise on AI usage if you have declared it properly. Use AI when it helps you and do not use it when it hinders you, and declare it!

VERY IMPORTANTLY

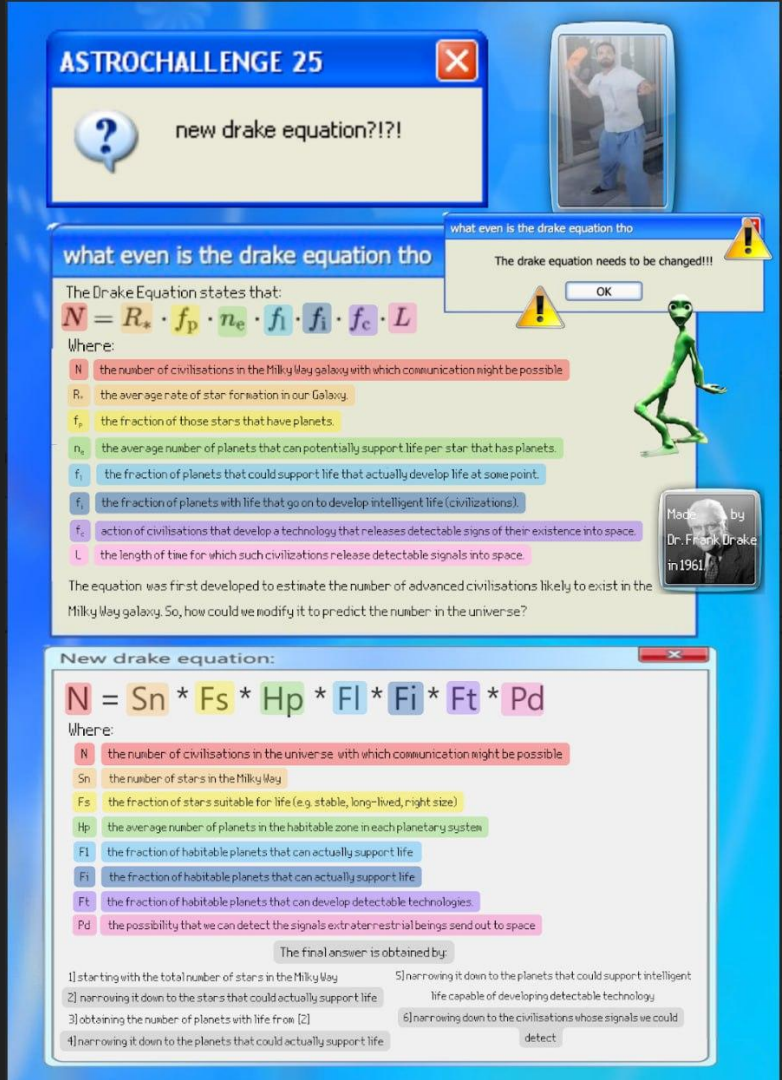
We penalise if

- Citation is improper - we do not require it to be as rigourous as it needs in academic writing. However, there should not be cases where the word description says article A but the link leads to article B.
- AI declaration is improper - you will see some examples.
- The poster you bring is not the same as you submitted electronically.
- Clear signs of plagiarism either from others' work or from AI.

Interesting posters



Q: How many fonts did you use?
A: Y E S



Interesting posters

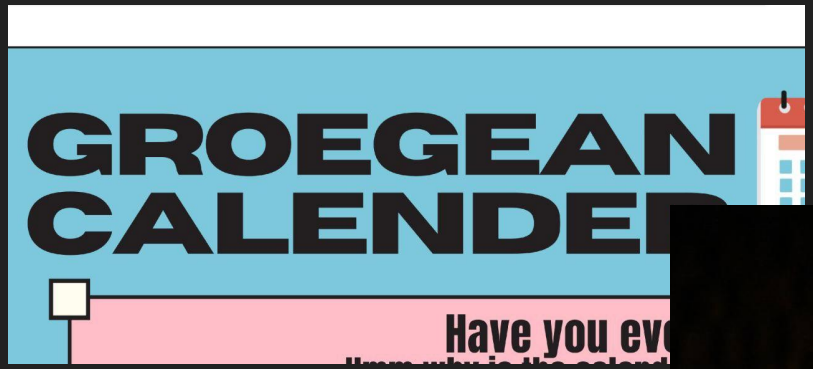
Thank you for setting a new question for AC2025

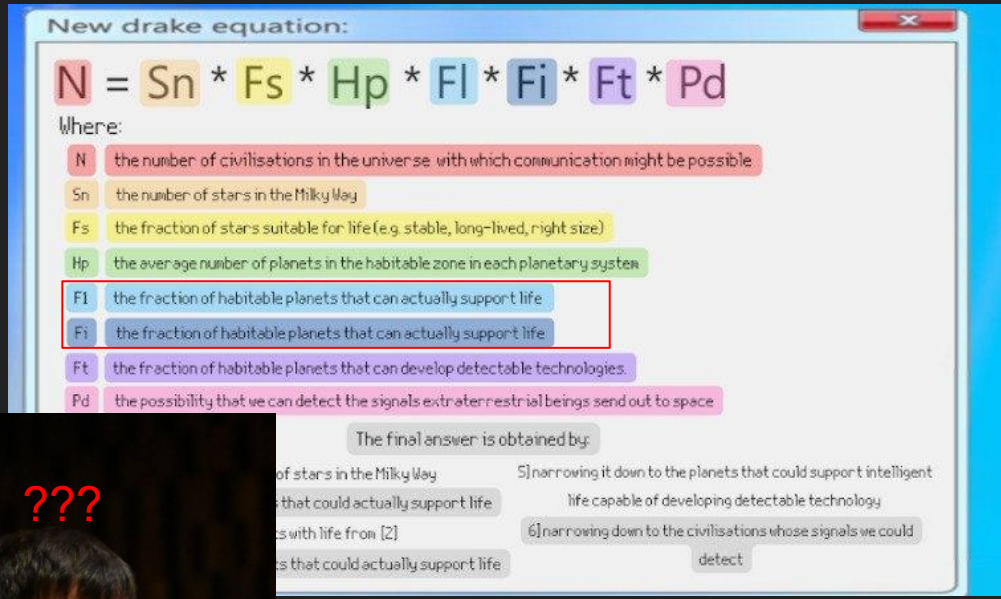
Thanks for the ad…

“I never make the mistake thinking that the Sun rose because I woke up”
-David Neo, 2025

Equation must be so important that it was said three times…

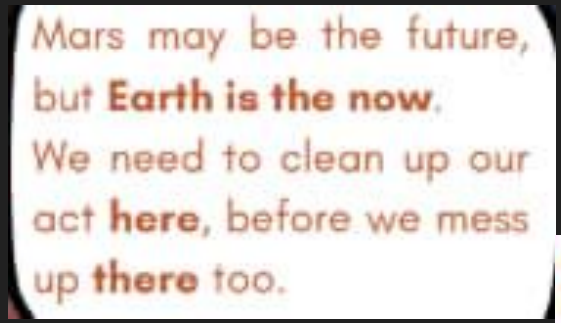
Interesting posters…





Please check your spellings…

Challenge: spot the difference



BUT… Mars has issues

Interesting posters…

- As an object moves towards the observer, the wavelength shortens
  - Hence the light moves towards the infrared end, thus looking more red
  - This is called redshift
- If an object moves away from the observer, the wavelength increases
  - The light moves towards the ultraviolet end, thus looking more blue
  - This is called blueshift

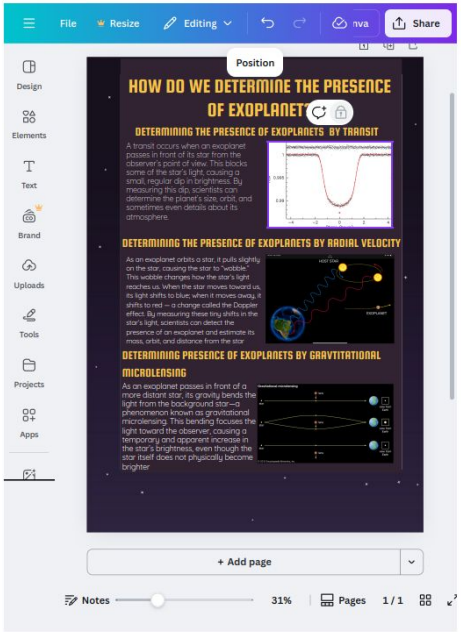
Definitely redshifting from your grades

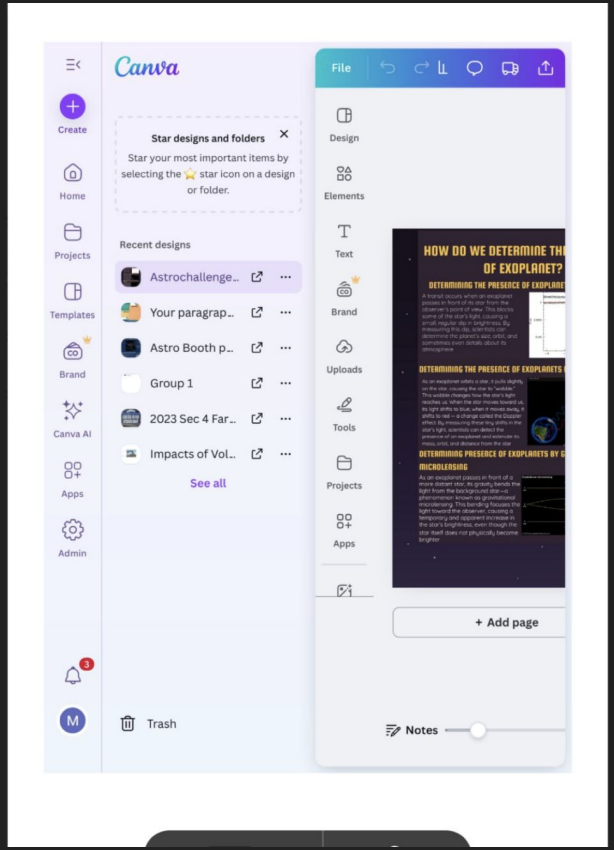
Is the start of starting material

Is the start of is the start of is the start of is the start of….

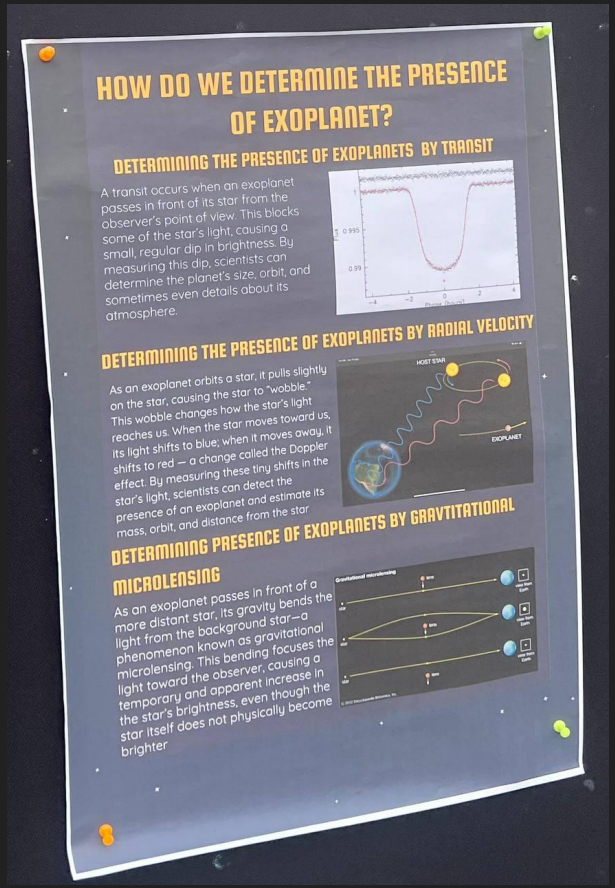
The judges:

The judges were ready to judge with the canva page printed >:(





Digital versions submitted



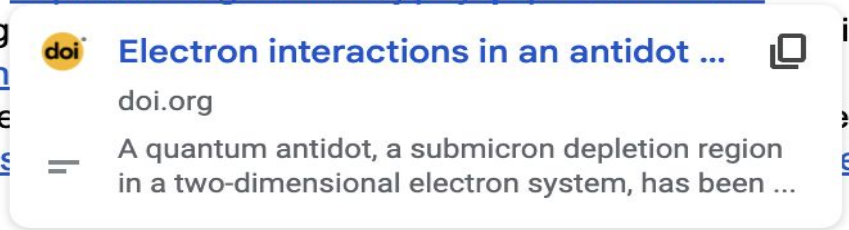
Actual poster printed

Citation / AI Declaration issues

information sourced from Astronomy Textbook and edited by ChatGPT AI

We love your citation ~~so easy to penalise~~

6. Basu, S., & Antia, H. M. (2008). Helioseismology and Solar Abundances. Physics Reports, 457(5), 217–283. https://doi.org/10.1016/j.physrep.2007.11.001
7. Image Source: OrangeDog … ikimedia Commons. https://common…
8. Figure one Source: Orange…]. Wikimedia Commons. https… ectra.png



Helioseismology = electron interactions???

GAI usage declaration…

By listing our names and signing below, we confirm that we have:
(Choose all that applies)

- used Generative Artificial Intelligence (GAI) as permitted to assist in generating key ideas used GAI as permitted to assist in generating a first text
- used GAI to refine syntax and grammar for correct language submission
- not used GAI assistance in any way in the develop assignment

By listing our names and signing below, we confirm that we have:
(Choose all that applies)

- ☑ used Generative Artifical Intelligence (GAI) as permitted to assist in generating key ideas
- ☐ used GAI as permitted to assist in generating a first text
- ☑ used GAI to refine syntax and grammar for correct language submission
- ☑ not used GAI assistance in any way in the development or generation of this assignment

By listing our names and signing below, we confirm th
(Choose all that applies)

- ☒ used Generative Artifical Intelligence (GAI) as permitted to assist in generating key ideas
- ☐ used GAI as permitted to assist in generating a first text
- ☐ used GAI to refine syntax and grammar for correct language submission
- ☒ not used GAI assistance in any way in the development or generation of this assignment

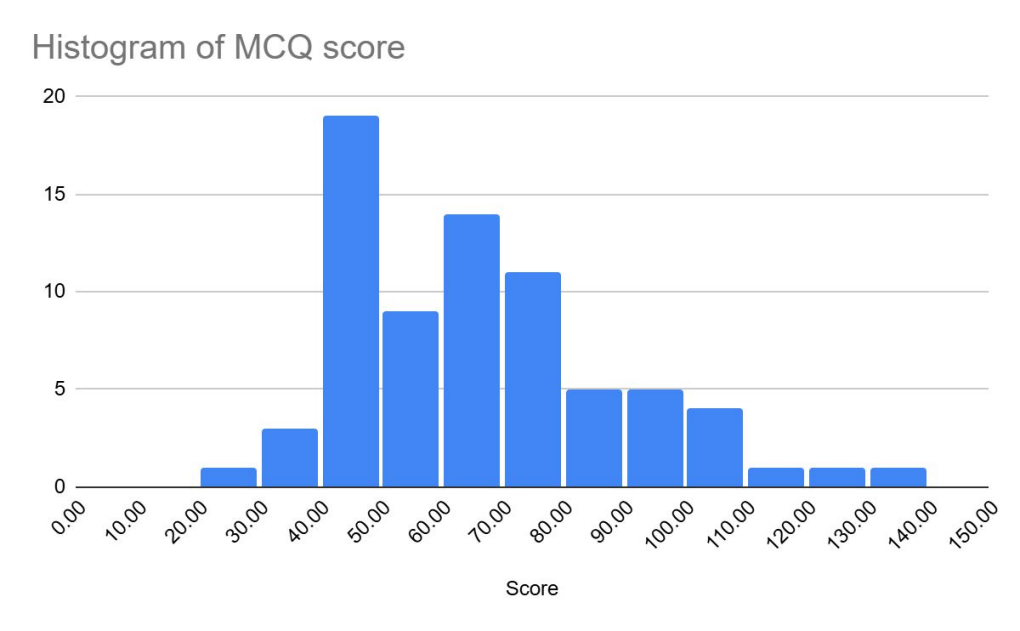
Schrödinger’s AI usage

$$\frac{3}{4}\,|\text{used AI}\rangle + \frac{1}{4}\,|\text{did not use AI}\rangle$$

Juniors

Individual Round

Summary Statistics



A bimodal distribution.

- Sample mean: 65.99
- Sample median: 63
- Sample mode: 49
- Sample largest order statistics: 138
- Sample smallest order statistics: 22
- Expected outcome: 30

Key results

Most correct: Q19

19. On October 14 2024, NASA launched Europa Clipper, to investigate Europa and study the nature of its ice shell, the subsurface ocean, and the moon's geology. Why did NASA choose to study this moon of Jupiter?

(A) Europa shows volcanic activity likely caused by tidal friction with Jupiter, which heats the interior of the moon. Hence, the need to learn the intricacies of this process.

(B) Europa has the largest body of water of any body of the solar system other than Earth, and hence may serve as an additional source of water for humans on earth.

(C) **Europa has a subsurface ocean and may potentially host life. Hence the possibility of signs of life.**

(D) Europa is found to have cryogeysers with traces of iron compounds and hence may turn into a red moon.

(E) Europa is one of the biggest moons in the solar system that still hasn't been explored.

Solution:

Europa has a subsurface ocean that may harbor conditions suitable for life, making it a prime target for astrobiological investigation.

Correct answer: C

Key results

Most correct: Q19

Most wrong: Q31

31. The star Manchun is 8×10^4 times more luminous than the Sun and 25 times more massive than the Sun. What type of star is Manchun most likely to be?

(A) White dwarf

(B) Red giant

(C) Red supergiant

(D) T-Tauri star

(E) **Main sequence**

Solution:

Apply the mass-luminosity relation for main sequence stars:

$$L \propto M^{3.5} \Rightarrow L = 25^{3.5} \approx 8 \times 10^4$$

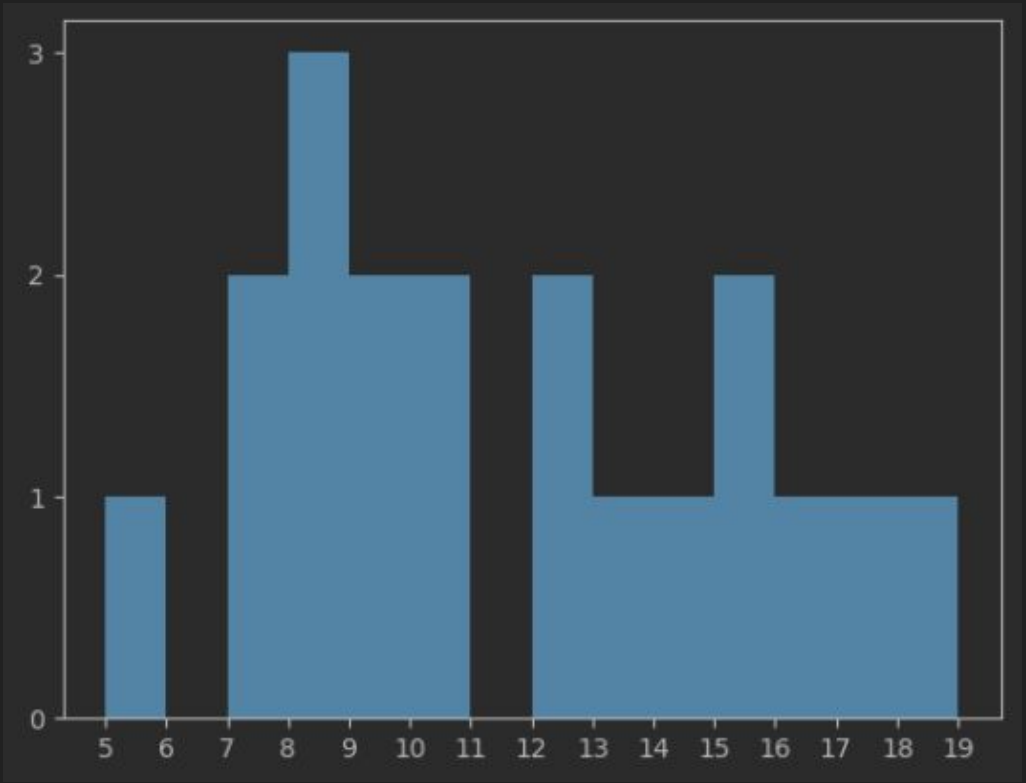
This matches the given luminosity, confirming it's a main sequence star.

Correct answer: E

Team Round

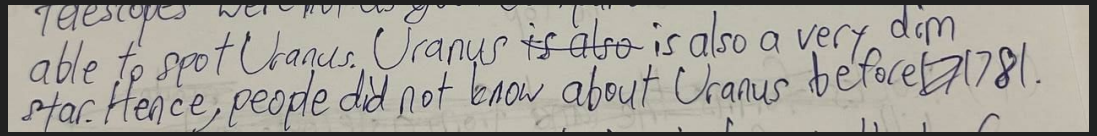
SAQ

Our solar system family



Low: 5
High: 18
Mean: 11.2
Median: 10

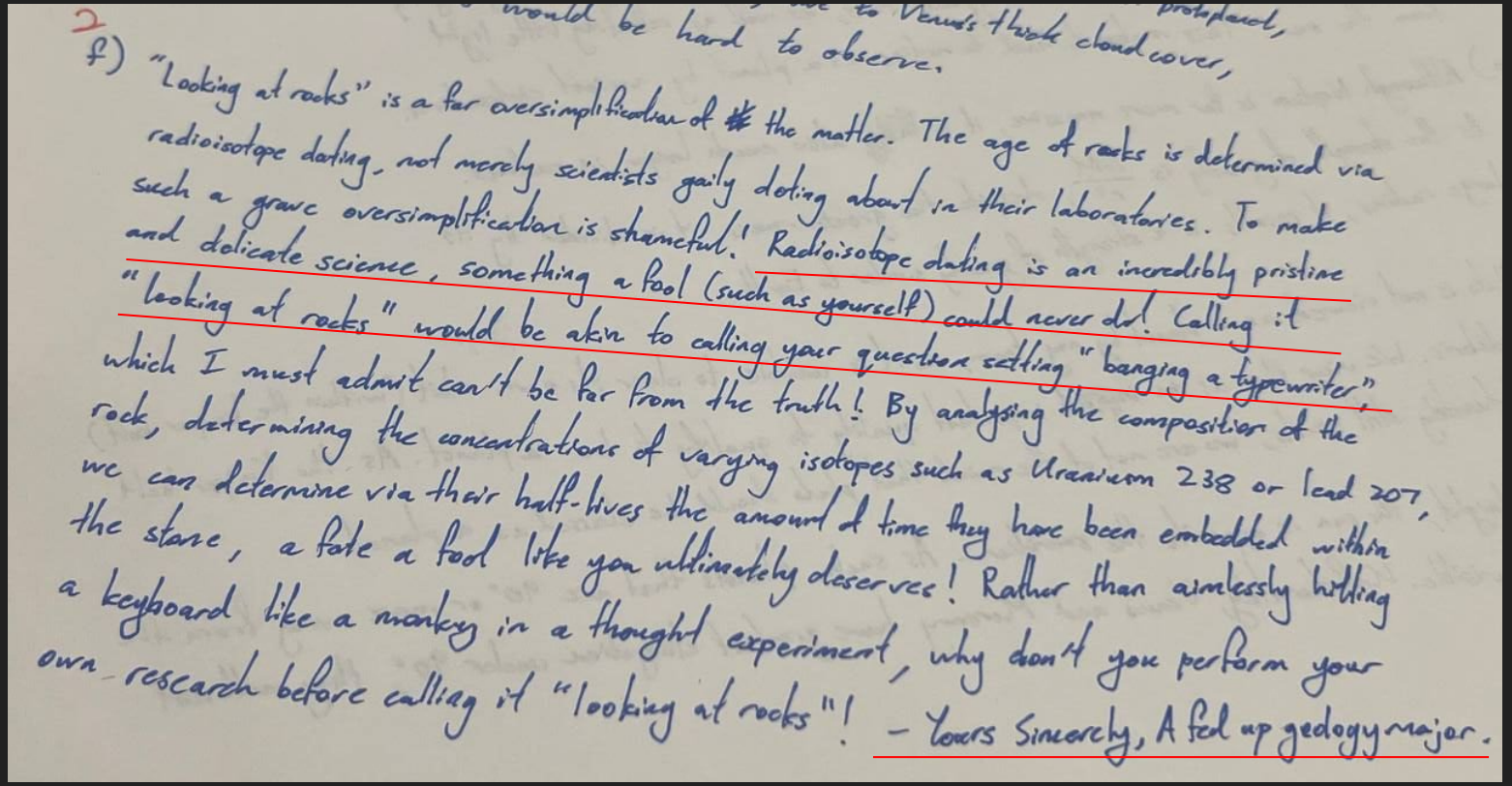
Uranus the star



ing much like rivers on Earth, creating

s a very massive planet, and with great mass, comes great sphere of influence.

The oldest rocks on Earth are estimated to be 4.5 billion years old, and we believe Earth is the same age. Explain why and how we can tell the age of the Earth just by ‘looking at rocks’



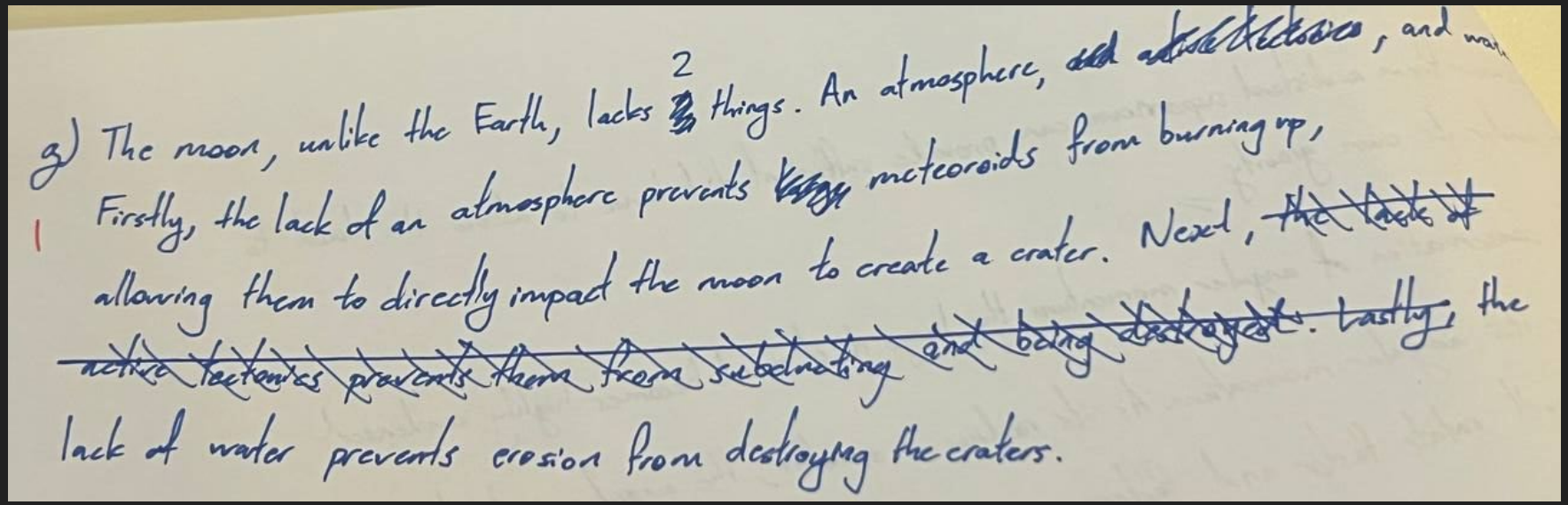
2

would be hard to observe.

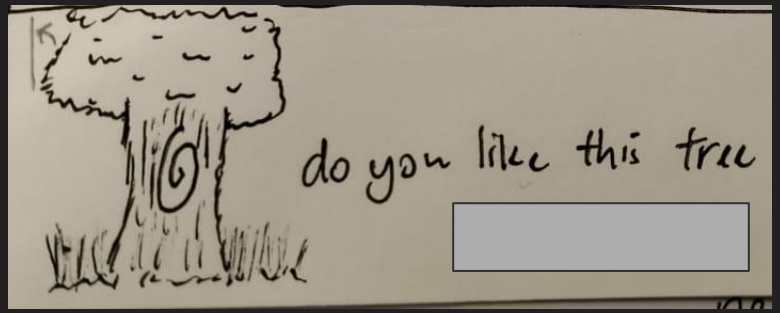
f) "Looking at rocks" is a far oversimplification of the matter. The age of rocks is determined via radioisotope dating, not merely scientists gaily doting about in their laboratories. To make such a grave oversimplification is shameful! Radioisotope dating is an incredibly pristine and delicate science, something a fool (such as yourself) could never do! Calling it "looking at rocks" would be akin to calling your question setting "banging a typewriter", which I must admit can't be far from the truth! By analysing the composition of the rock, determining the concentrations of varying isotopes such as Uranium 238 or lead 207, we can determine via their half-lives the amount of time they have been embedded within the stone, a fate a fool like you ultimately deserves! Rather than aimlessly hitting a keyboard like a monkey in a thought experiment, why don't you perform your own research before calling it "looking at rocks"! - Yours Sincerely, A fed up geology major.

Chill bruh there wouldn’t be a question if we said radiocarbon dating

Although the moon is around the same age as the Earth, its surface is very heavily cratered compared to Earth. Suggest 2 reasons why.



Mr geology major you missed plate tectonics



Democracy (sometimes) works

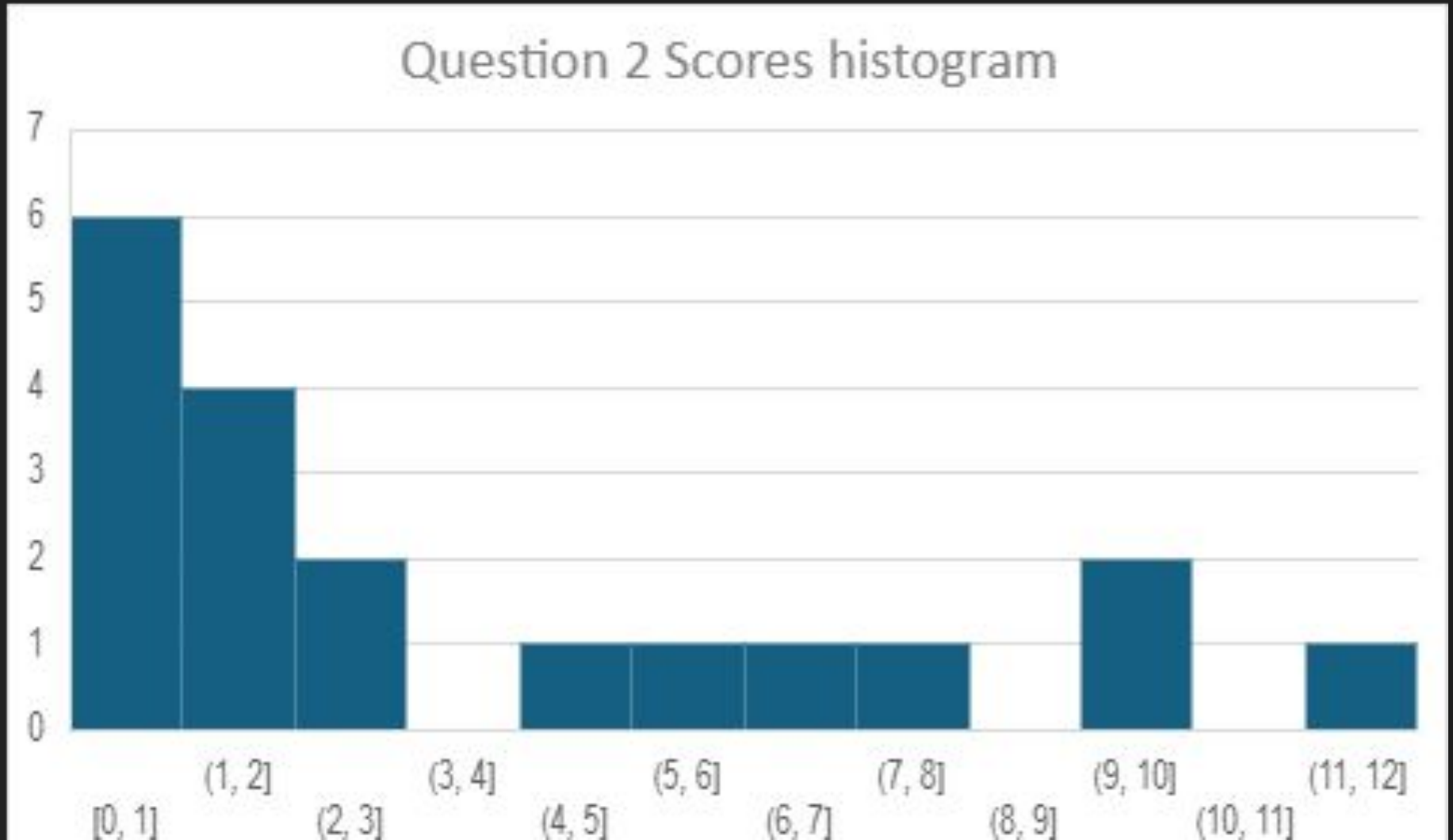
“Not too bad, just the tree’s abit blocky”

- AstroChallenge Art Consultant

Question 2: Exploring Colliding Dead Stars

AC participants doing this question

(ii) We agree with this statement ~~is explanation~~ because we're all stars ☆ XO


Question 2 Scores histogram
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6
5
4
3
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[0, 1]
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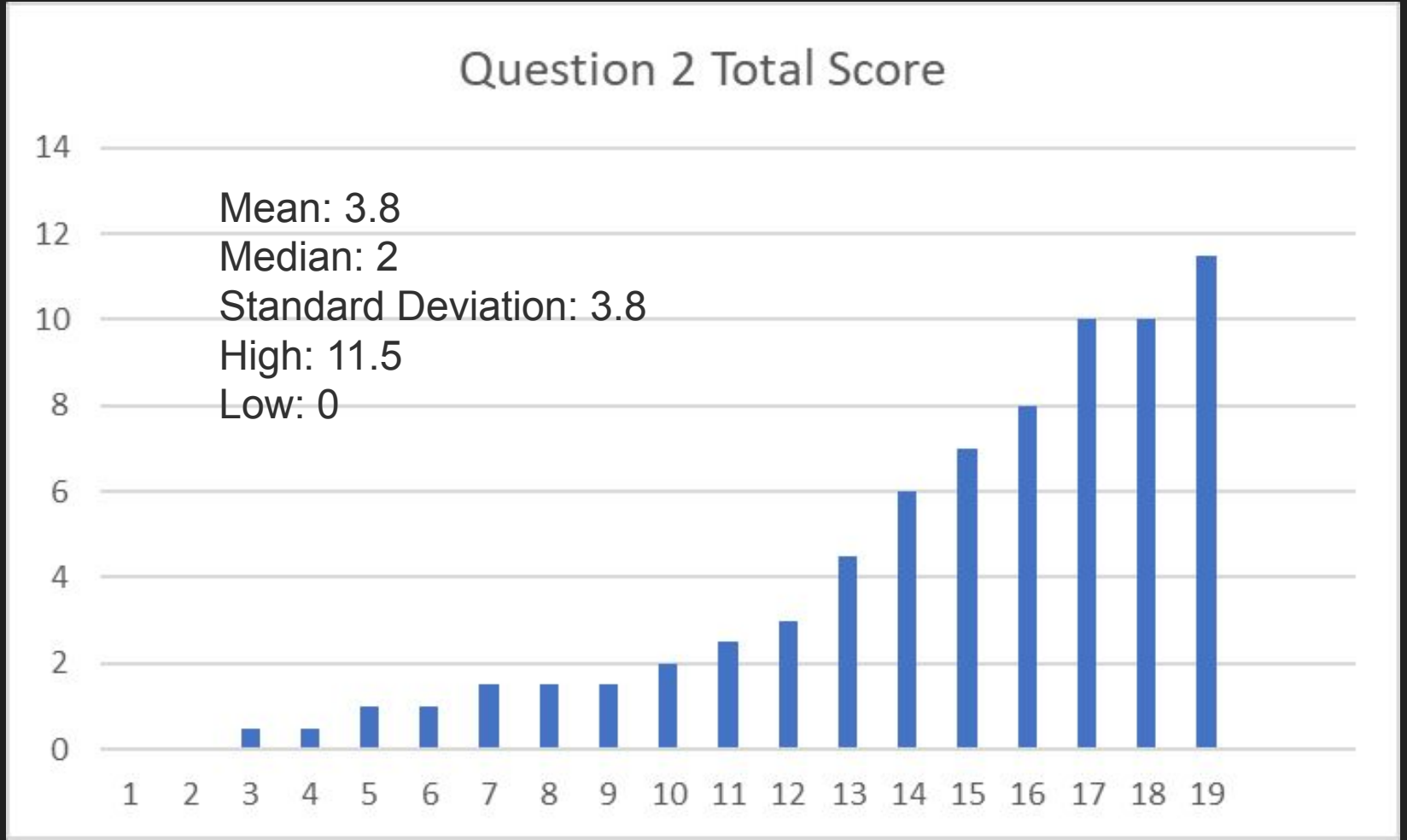
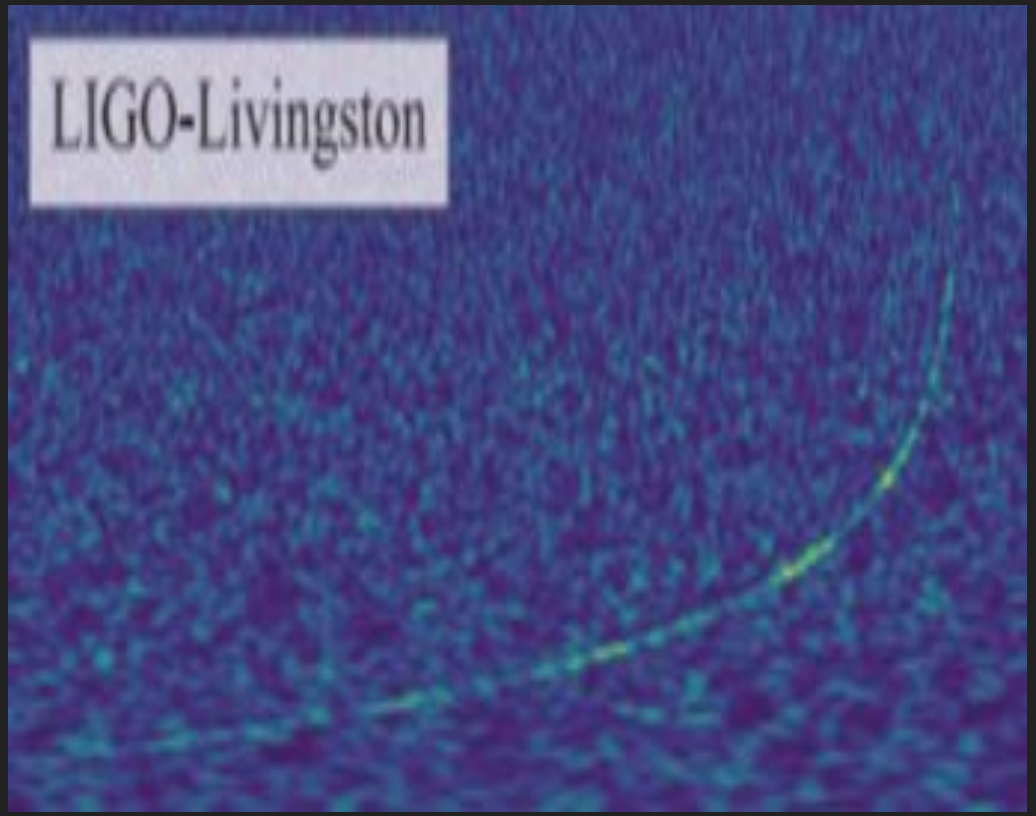
(11, 12]

In another form



In essence…



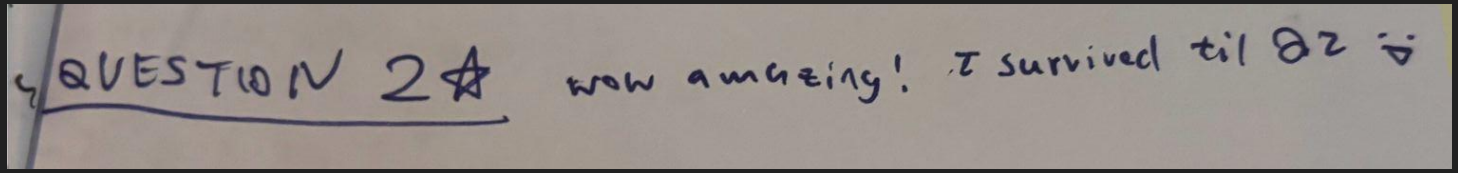
Me

Before marking question

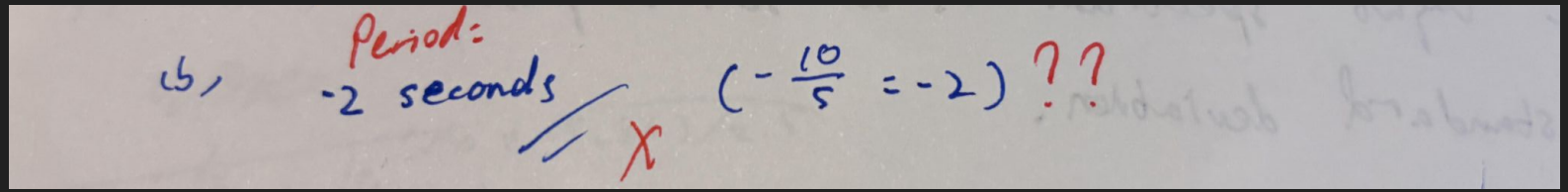
After marking question

Progress throughout question

Start of question…



A single part later…



End of question…

When you don’t know how to answer a question

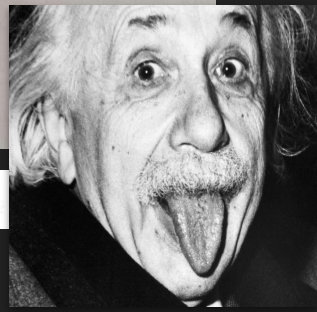
e. BLANK, cuz Einstein can FLY! :/

I suggest void this Question (LOL :)

BTW Einstein Can't FLY

(h) the theory of relativity. Einstine said so and he's smart. X

(f) ~~5[illegible]~~ 52.7°



(h) Explain why the light spectrum looks like a bell-shaped curve instead of sharp emission lines.

(r) A popular astronomer, Carl Sagan, had said "We are made of star-stuff". With our newfound understanding, do you agree with the statement? Explain your answer. **[1]**

(r): The big bang, beginning of everything, yes we agree. XO

"Carl should go get a job" - another team

(n) Given that the heliocentric velocity (receding away from the sun) of NGC 4993, the host galaxy of AT2017gfo, is 2930km/s, find the distance to NGC 4993 in Mpc.

Giveaway question!

$V = H_0 D$

2n) pretty [redacted] far broski [redacted]

Values and Units

When your ruler is a little bit off…

Expected Answer

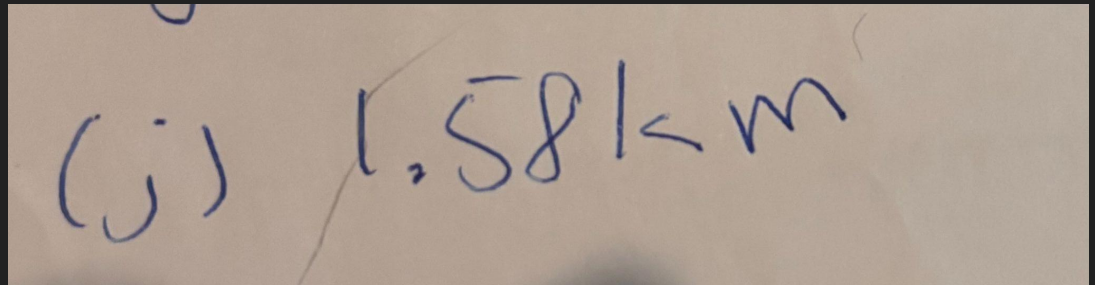
(j) Take the 1.58 μm (micrometer) feature in the +8.4 d graph. Estimate the full width at half maximum intensity (FWHM)[1] of the curve. **[1]**

Solution:

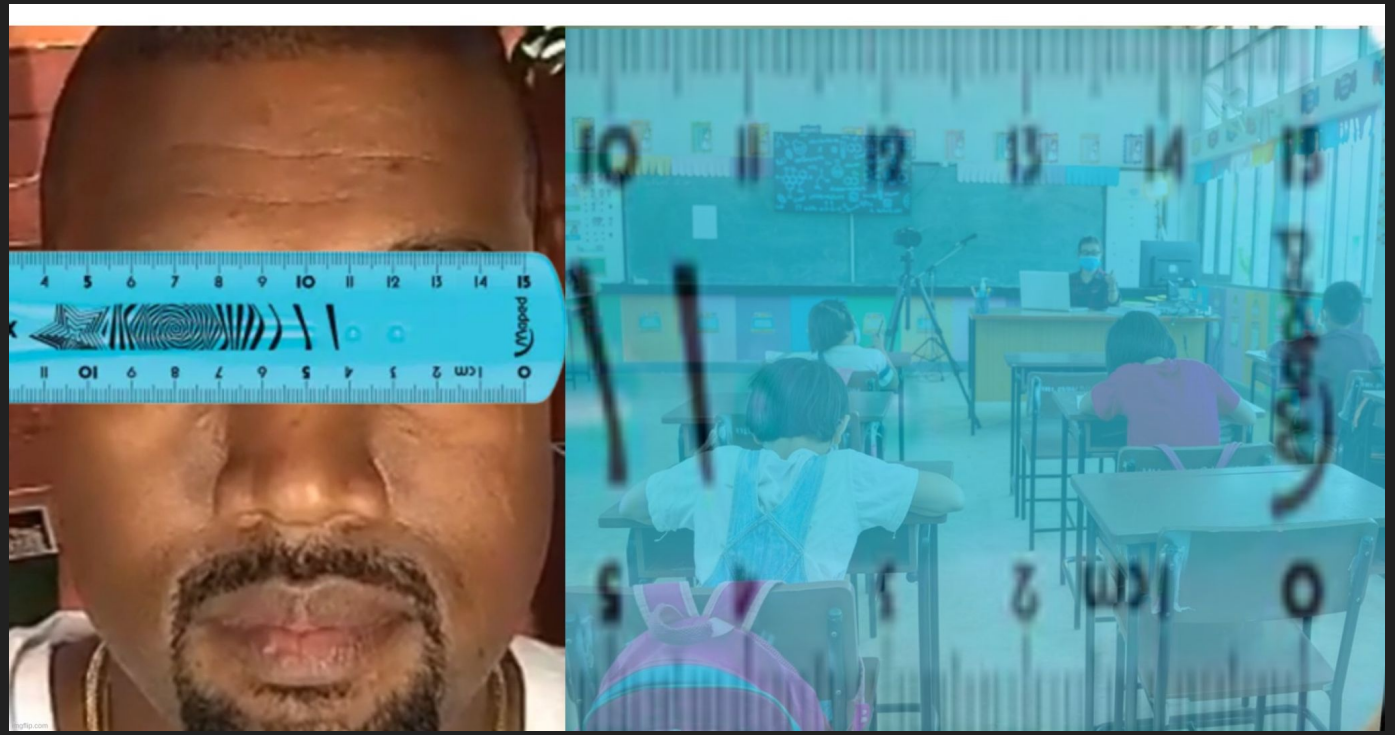
The answer in the range 0.06-0.10 μm is acceptable. [1]

Your answer = 100 000 000 X the answer

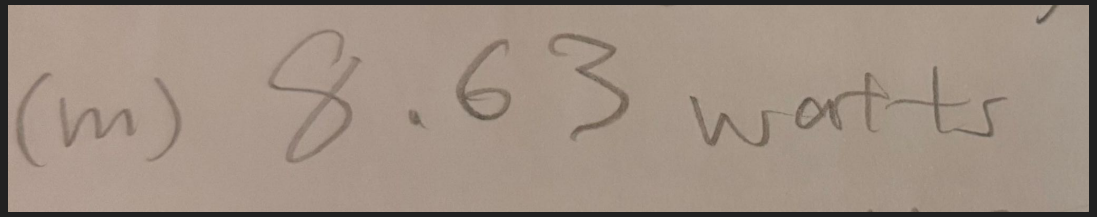
Your Answer



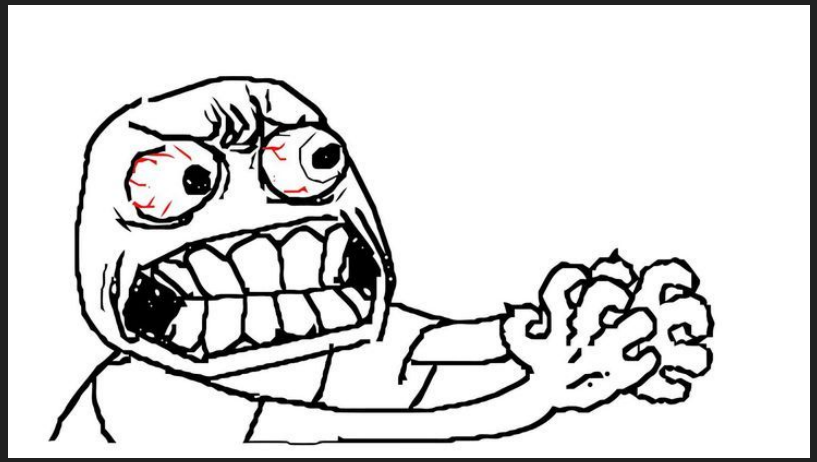
How I think you measure



When I ask for **energy** released from nuclei decay



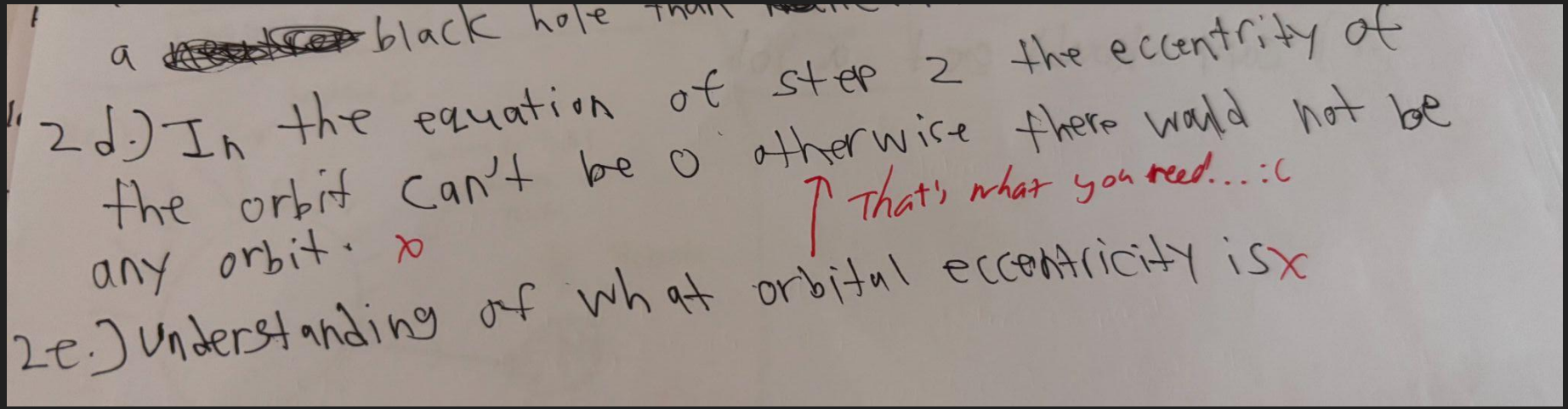
Read the question properly and know your units!



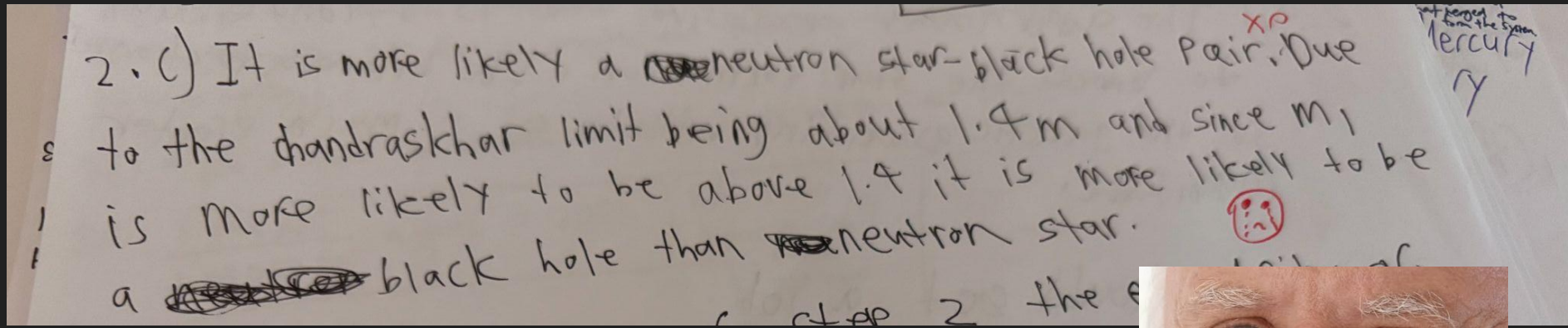
WATT!

Do you understand the terms?

Eccentricity cannot =0???



Too many of you fell for the trick



What I wanted yall to learn from the question

- What we can detect from neutron star mergers →yall somewhat got it
- Nucleosynthesis can occur in neutron star mergers too!
  →no one got it :(

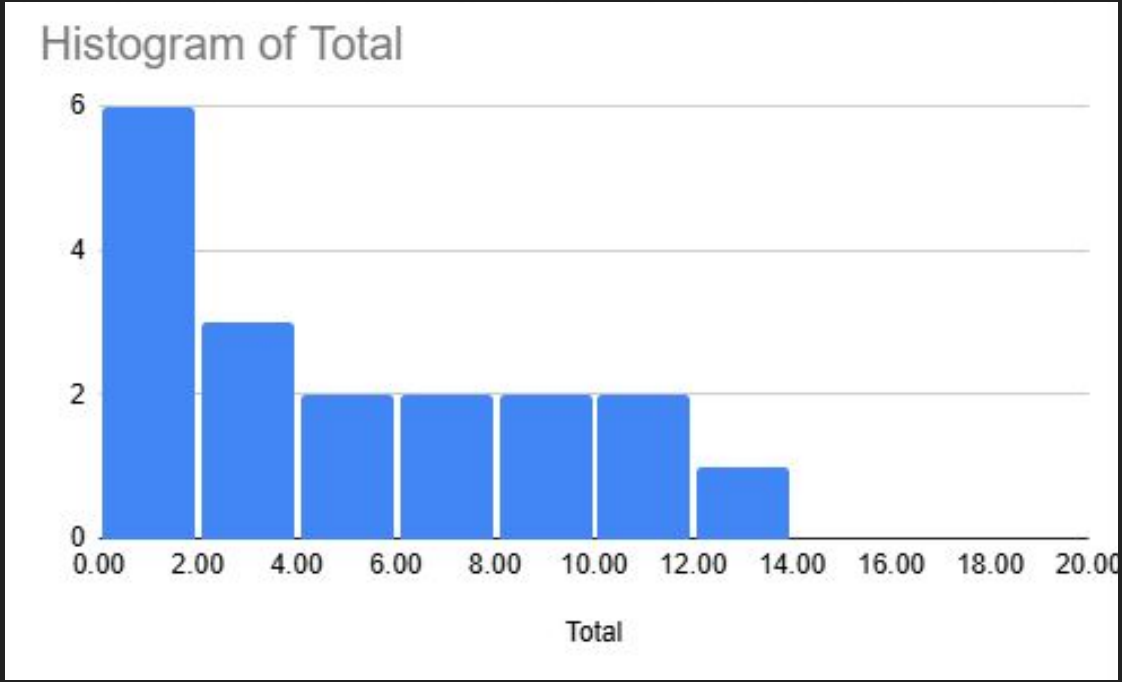
Words of Wisdom

Please try to understand the progression in the question…
It really helps you with the answers

I still hope you did learn something from my question

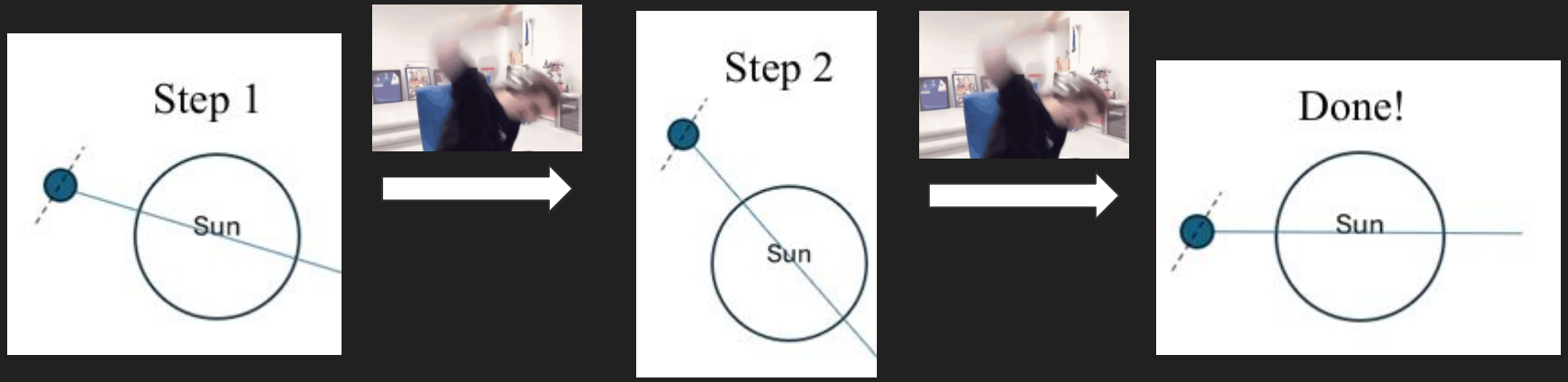
Question 3: Problems Caused By Skill Issues

5 Statistical Numbers



Mean: 4.657
Median: 3
Standard Deviation: 3.967
High: 12
Low: 0

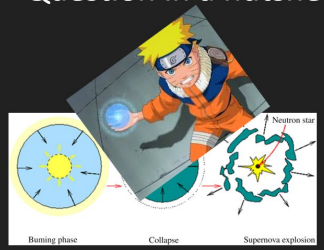
Brief Summary of the Question



What exactly do we expect to see?

Doesn’t this question seem…familiar?

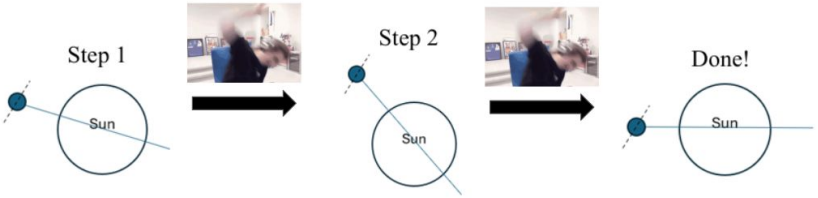
Question in a nutshell…



Intrusive Thought 1 | Intrusive Thought 2 | Intrusive Thought 3

AC2024

Brief Summary of the Question



What exactly do we expect to see?

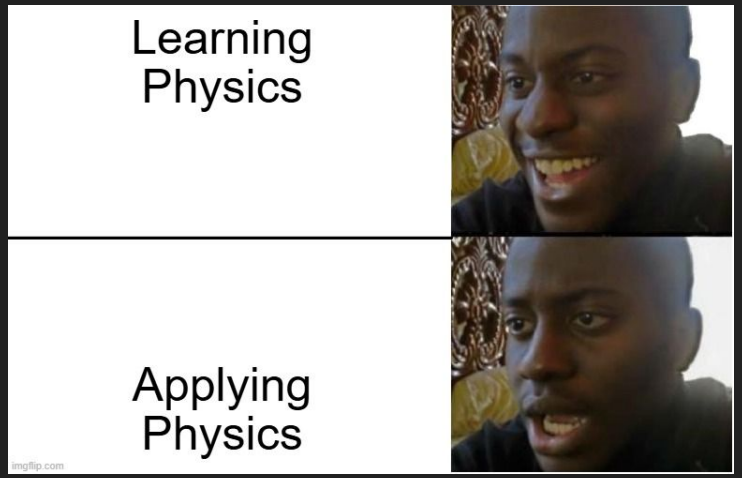
AC2025

Aim of the Question

Remind everyone that to a certain degree, intuition actually helps when it comes to applying Scientific Knowledge!

“If it looks like Science, tastes like Science, and hurts like Science, it’s not just your intuition, it’s probably actually Science!”

- A certain physics teacher (probably)



Aim of the Question

Remind the whole world of…whatever I said back in the paper

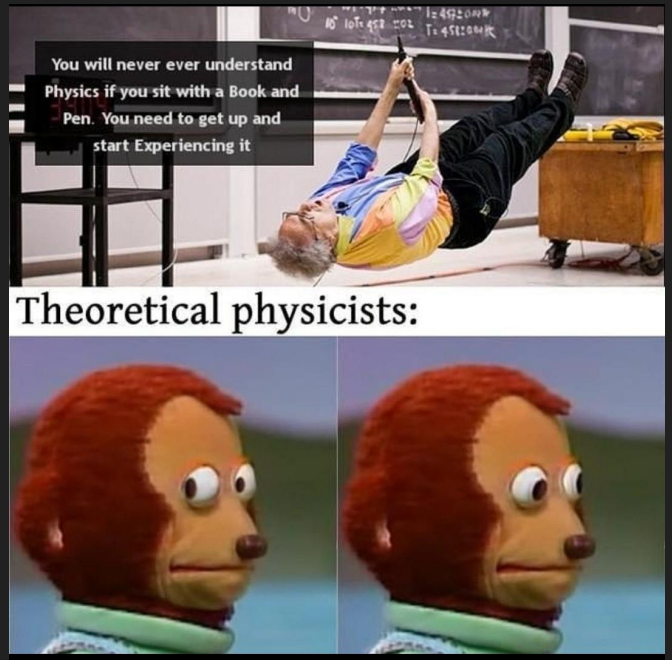
Now that we have figured out the apparent distance the Earth has travelled, now what? One important thing to note is that we are living in a three-dimensional space, not some ideal two-dimensional world where every family consists of a handsome spy, a pretty assassin and a child who is able to read people's minds. Taking that into account, a planetary transit would look like

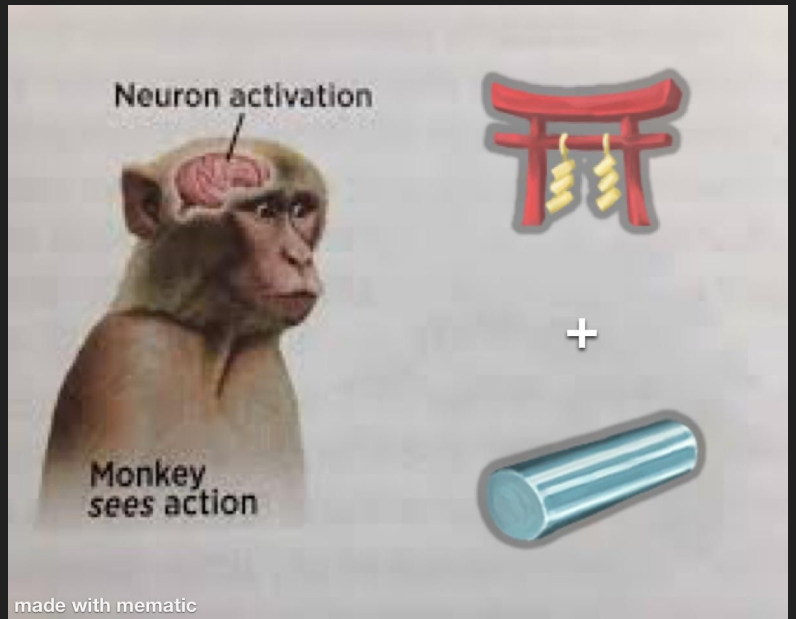
(Trust me, the truth hurts, just like a lot of things)

Aim of the Question

Visualise, Visualise, Visualise!

By visualising the situation, you've won half the fight!





What was expected

“Yayyy not many math”

“Triangles are FUN”

What actually happened

Me when I see words:

Sec 3 and above participants be like:

Here’s some AstroChallenge Top Tips

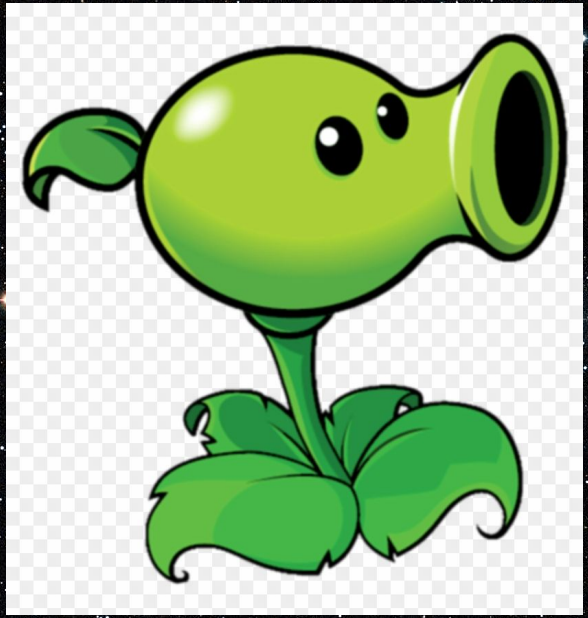
Typo Matters!

(c) What is the reference plane that we, the people on the space station, are using to determine the inclination of Earth? [1]

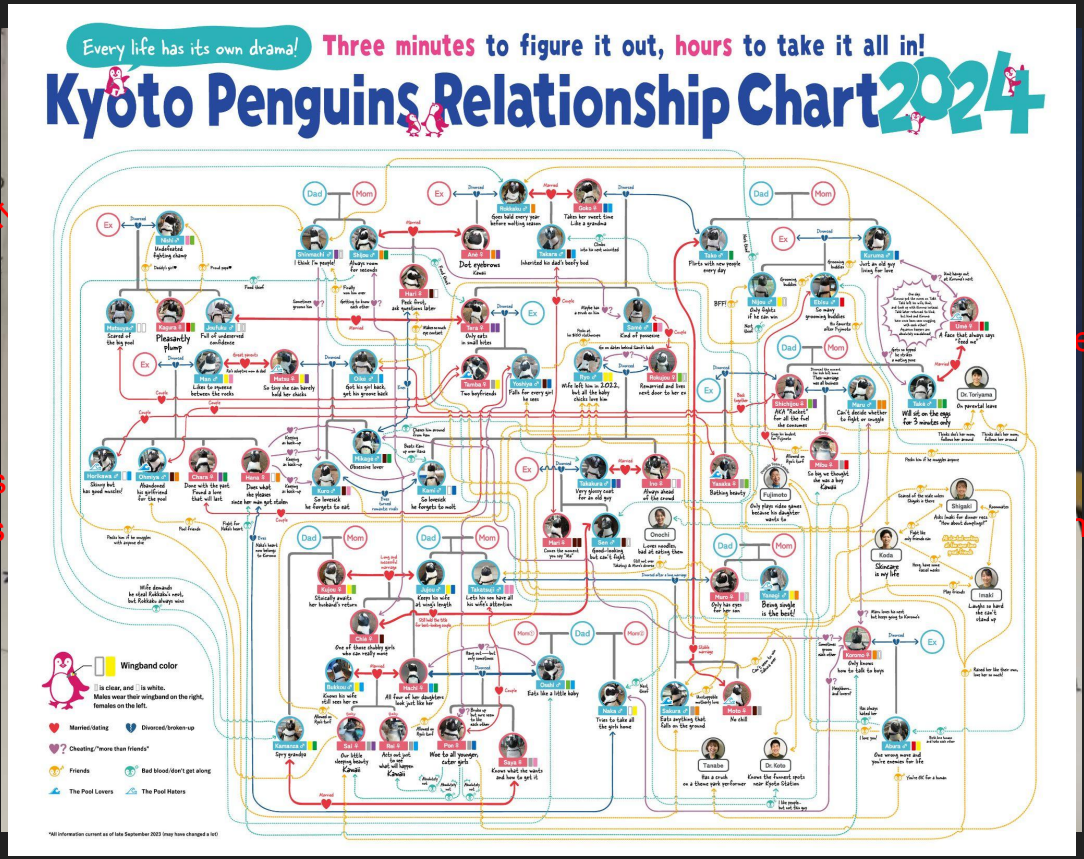
c) The ~~so~~ surrounding plants

?????

c) The ~~so~~ surrounding plants



Presentation of answer is important!



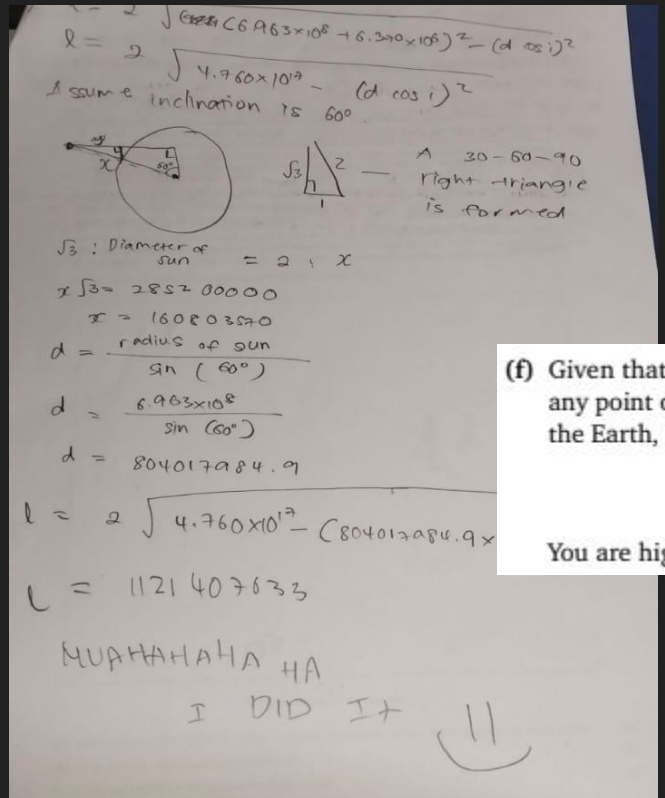
Start

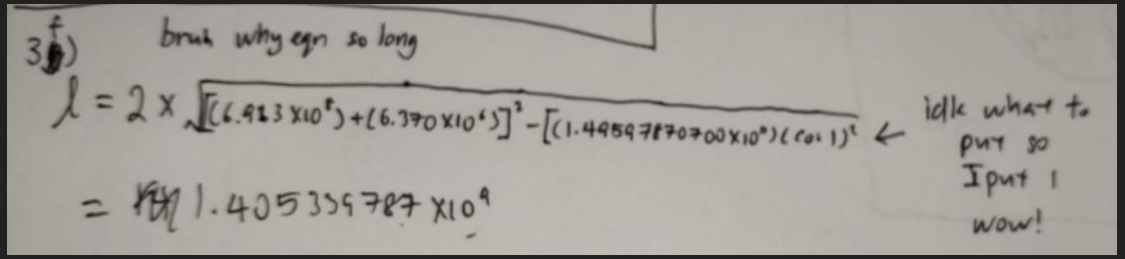
Psych! Here's answer…or is

e

he end of the

Make sure you actually understand the question!





(f) Given that the radius of Earth and Sun are R_E and R_S respectively, the inclination of the Earth's orbit at any point of time is i, and the radius of the Earth's orbit is d, show that the apparent distance travelled by the Earth, l during each transit is given by Equation 9.

$$l = 2\sqrt{(R_S + R_E)^2 - (d\cos i)^2} \qquad (9)$$

You are highly encouraged to use diagrams wherever possible to aid in your derivation and explanation. **[2]**

Yes! Y'all answered the question…just the wrong way

Instructions unclear..?

(f) Given that the radius of Earth and Sun are R_E and R_S respectively, the inclination of the Earth's orbit at any point of time is i, and the radius of the Earth's orbit is d, show that the apparent distance travelled by the Earth, l during each transit is given by Equation 9.

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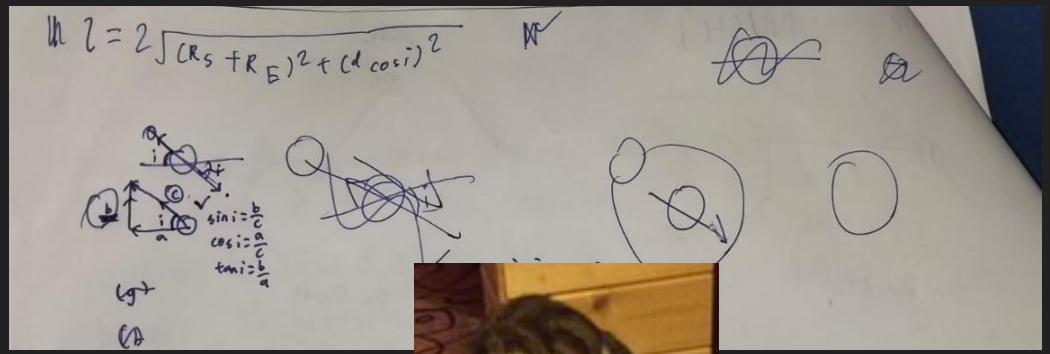
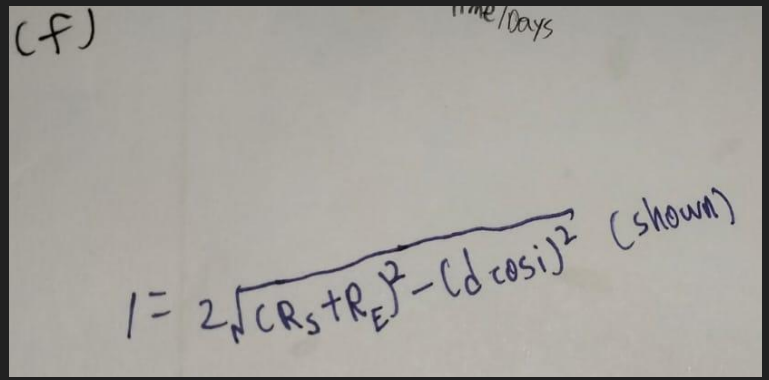
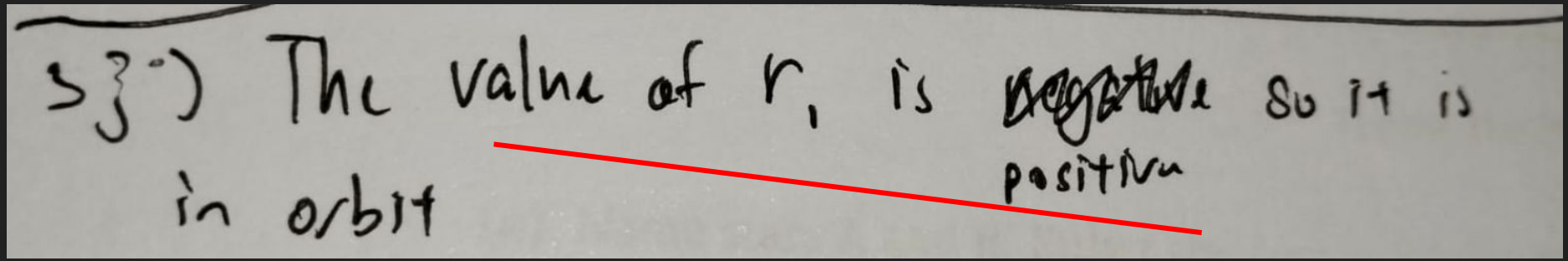


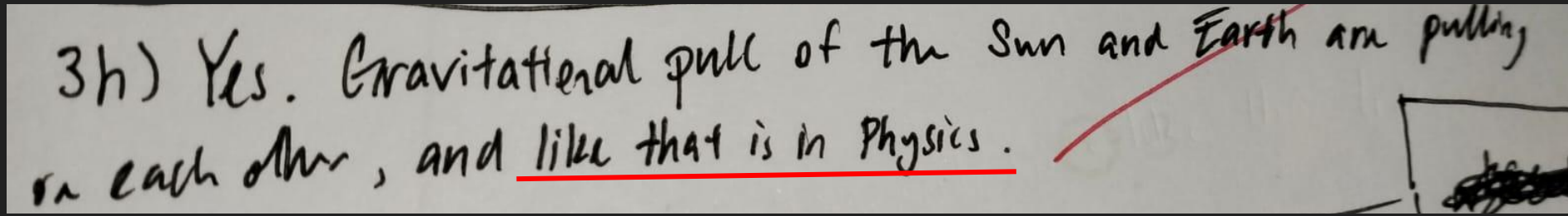


Yes! Y'all…literally showed the equation??

When in doubt, just trust physiks

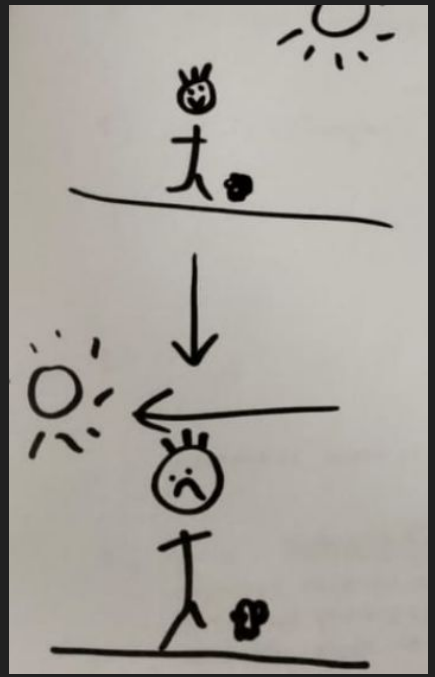
(same team btw)



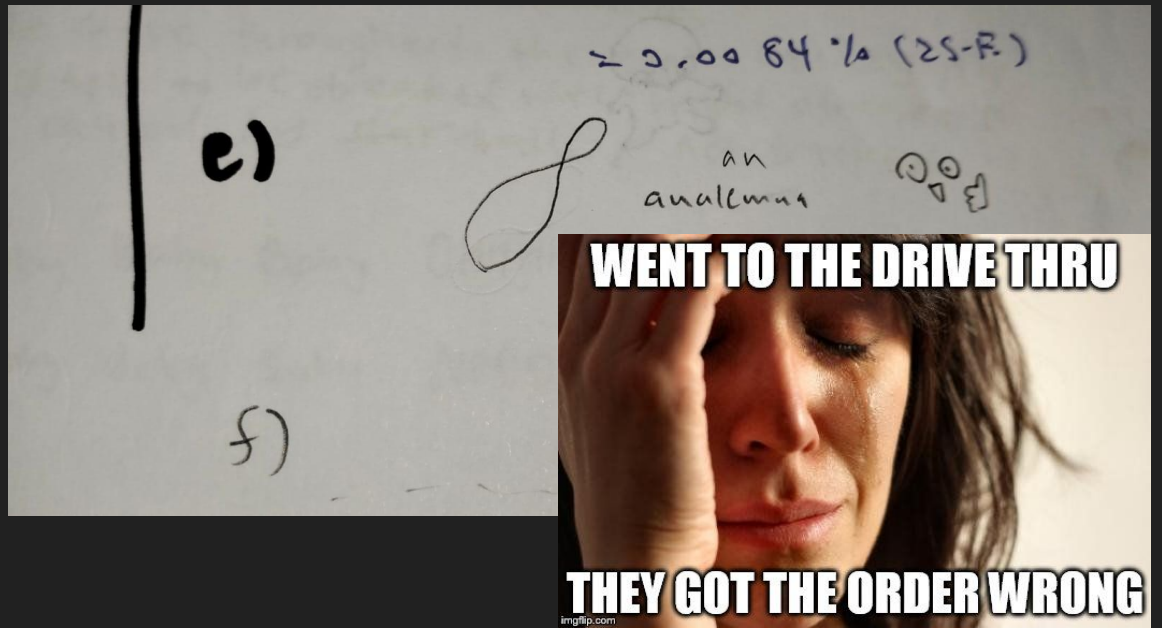


Diagrams helps! (And sometimes doesn't)

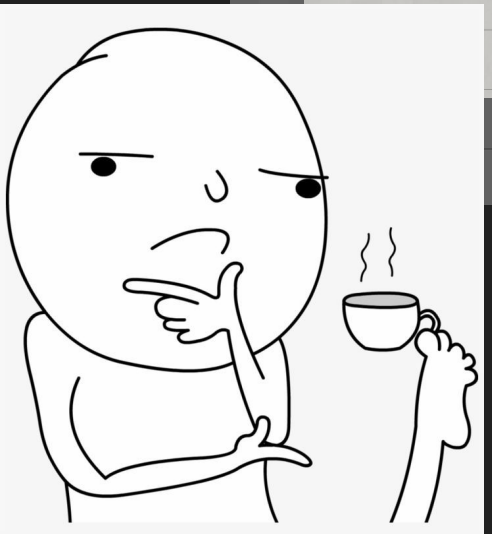
(surprisingly) good diagram

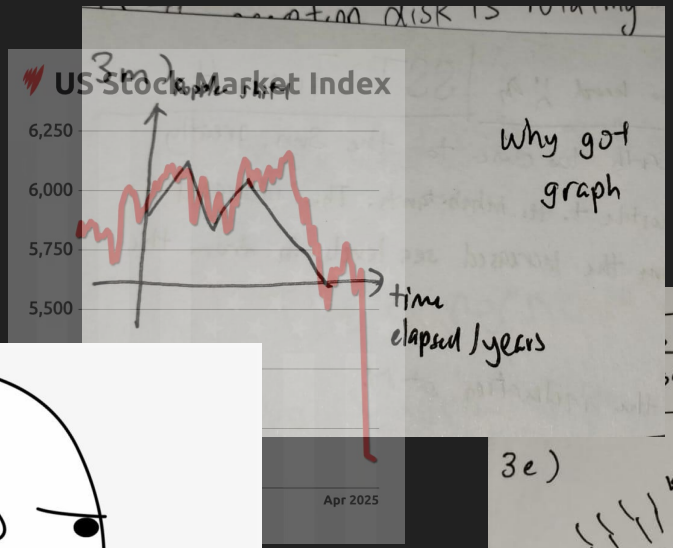


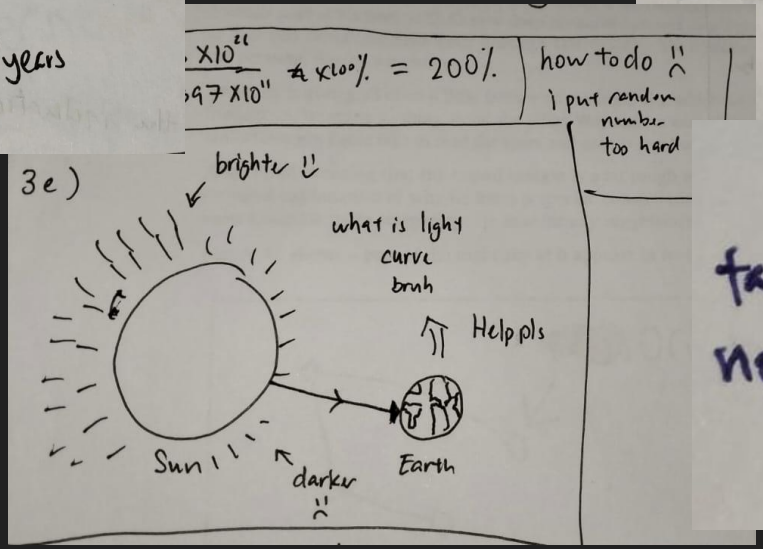
…but you should know what you are supposed to draw too…

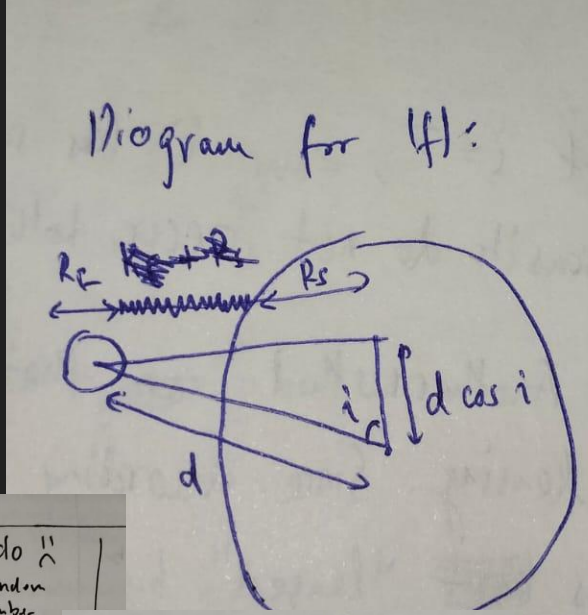


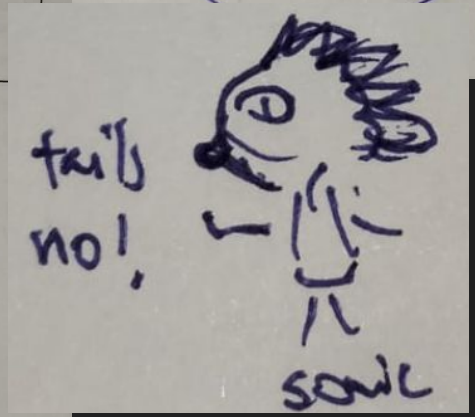
Diagrams helps! (And sometimes doesn't)





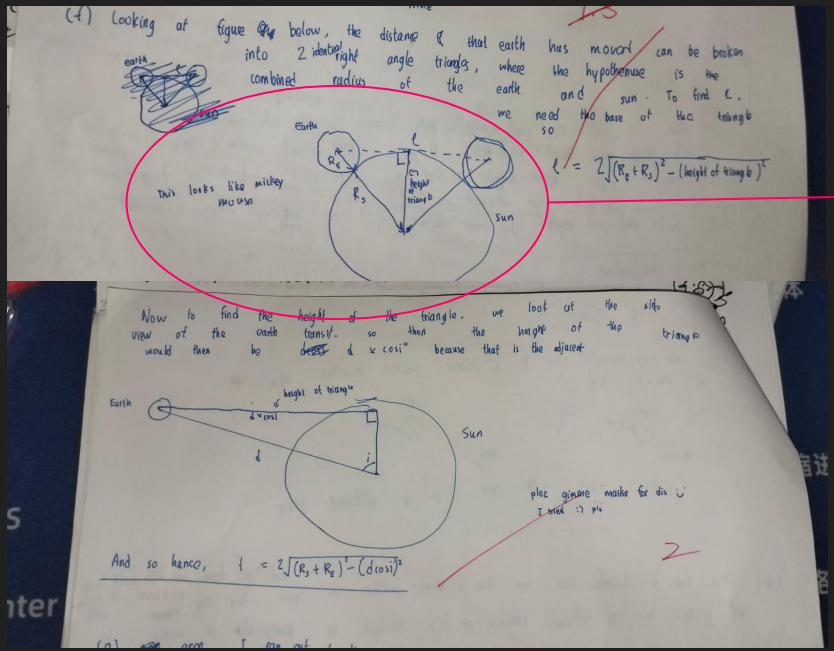






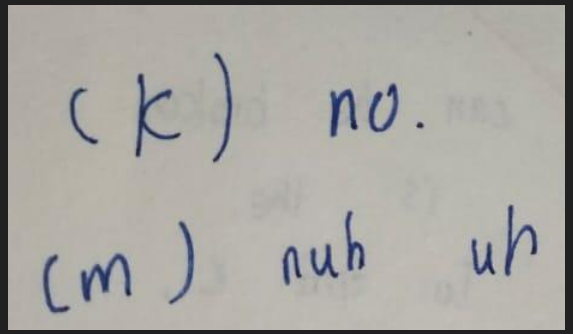
Diagrams helps! (And sometimes doesn't)

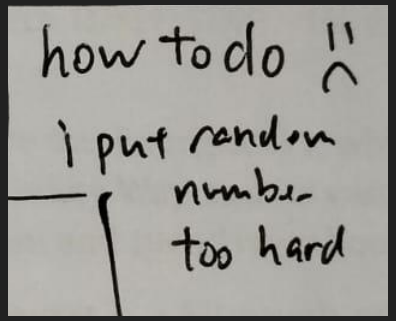
Most of the time the simplest explanations do the best!

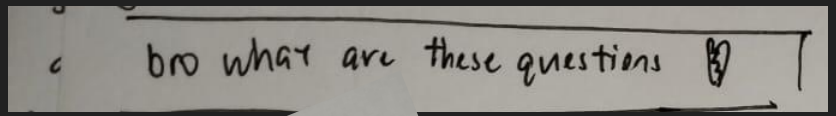


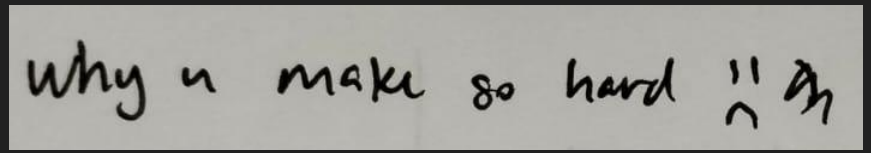
(ngl I didn't think about that)

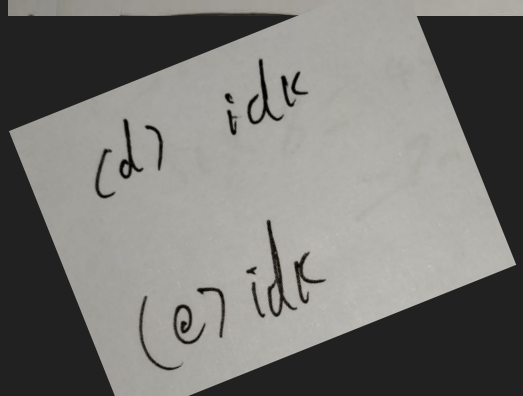
SasstroChallenge: Honesty is the best policy





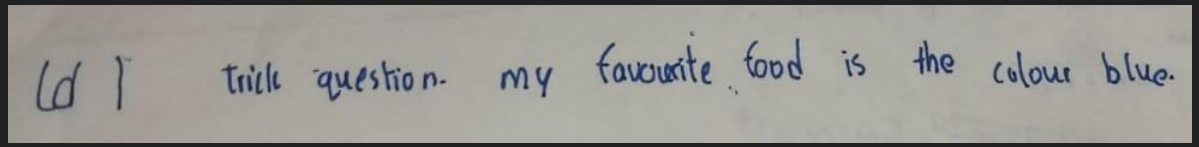






Shout out to this chad

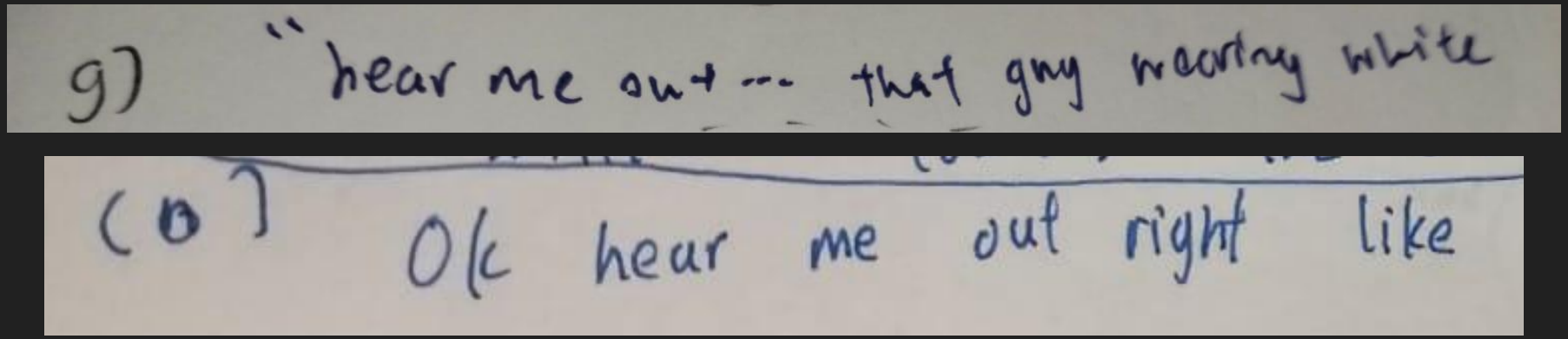
(d) Calculate the maximum percentage change in the brightness of the Sun with respect to the spaceship when the Earth transits the Sun, if possible. State any assumptions made in your calculations, if any. **[2]**



Mine’s the very specific purple that a sunset has btw

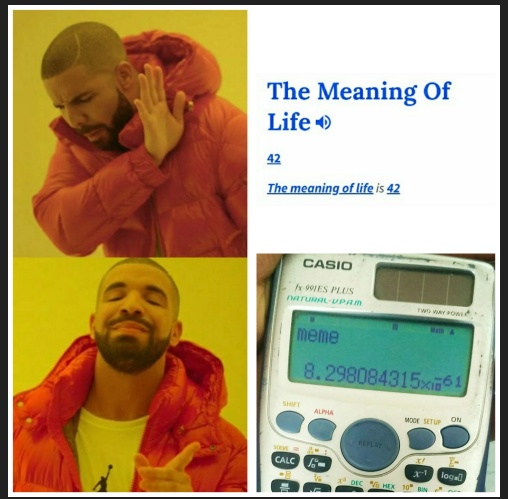
Ayeyo hol’ up, maybe honesty is not always the best policy

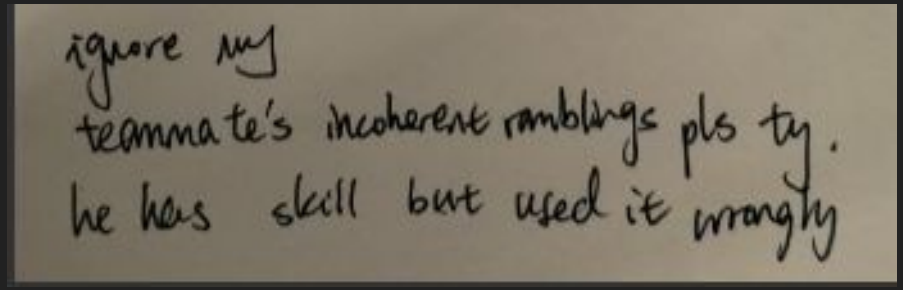
A thir- I mean love story wasn’t in the AstroChallenge Committee’s notebook



Final Messages

p.s.
what is the meaning of life?





Sounds like skill issue

Question 4: El Primo

AI Overview

El Primo is a rare brawler in Brawl Stars. He is a tank-type character with a short-range melee attack and a Super that allows him to jump and land on enemies, dealing damage. His abilities make him effective at close combat and disrupting enemy formations.

Here's a more detailed look at El Primo's abilities and how he's used in Brawl Stars:

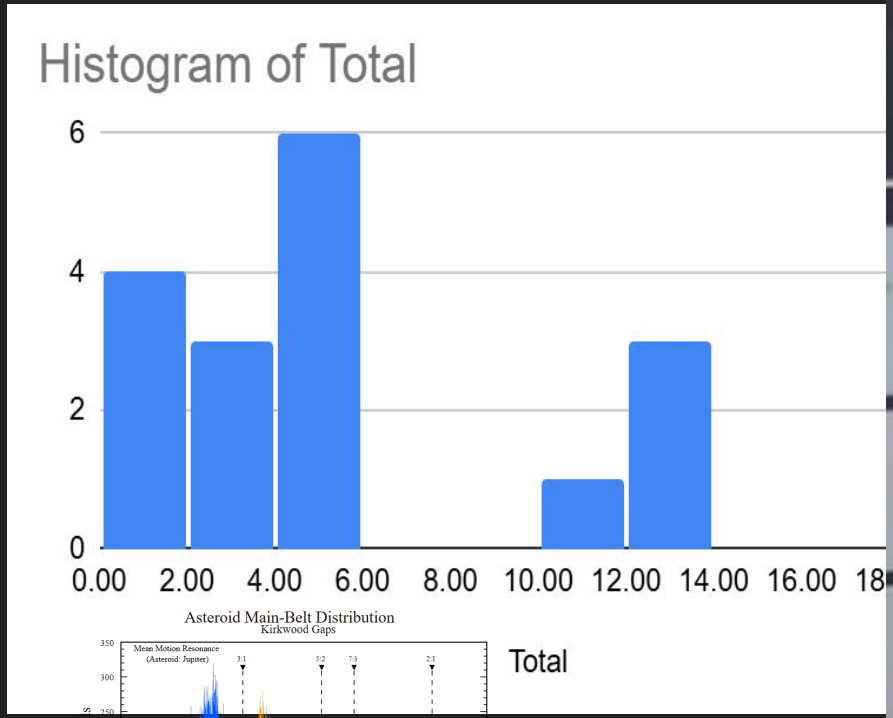
Main Attack:

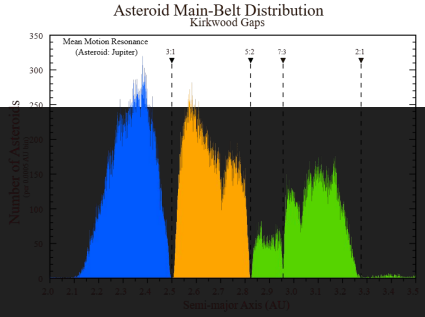
El Primo throws punches that deal damage to enemies within a short range.

Super:

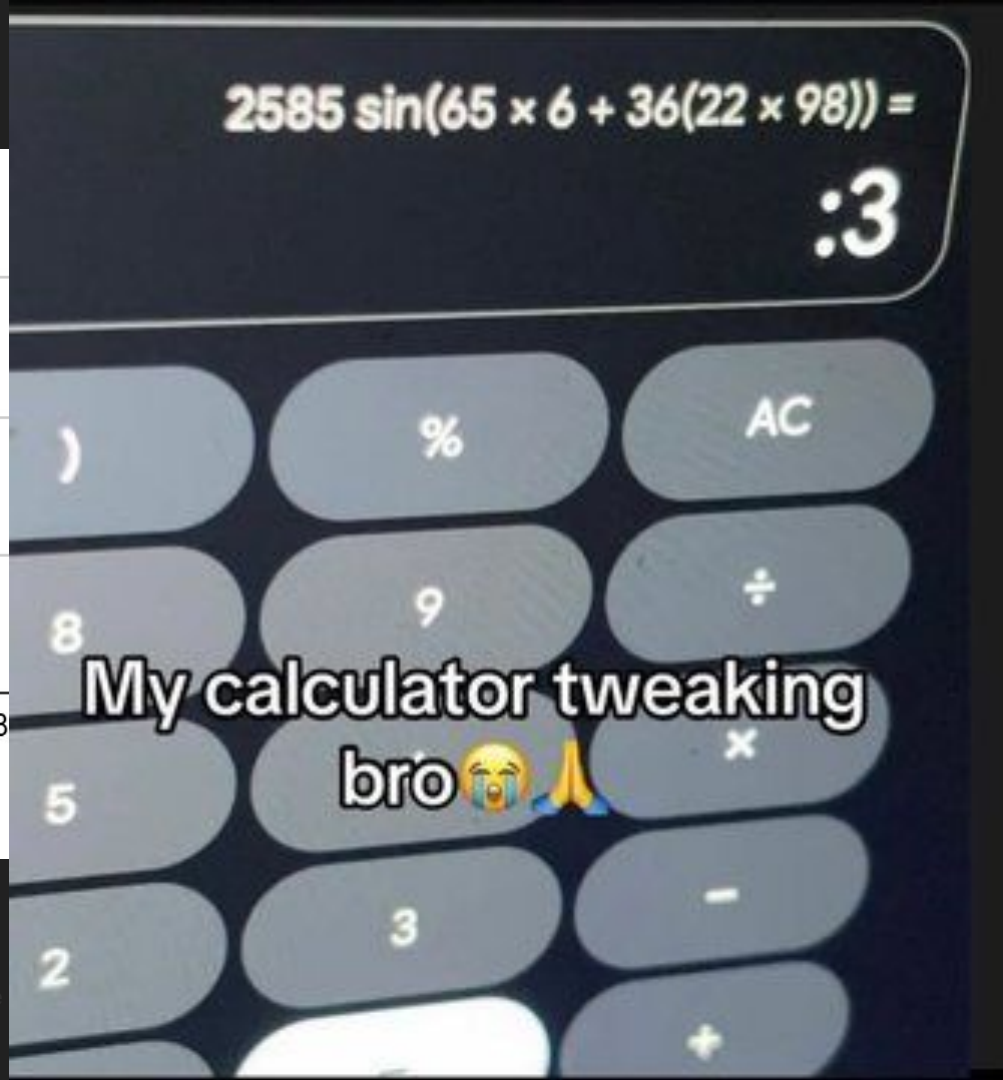
Show more

Marks distribution





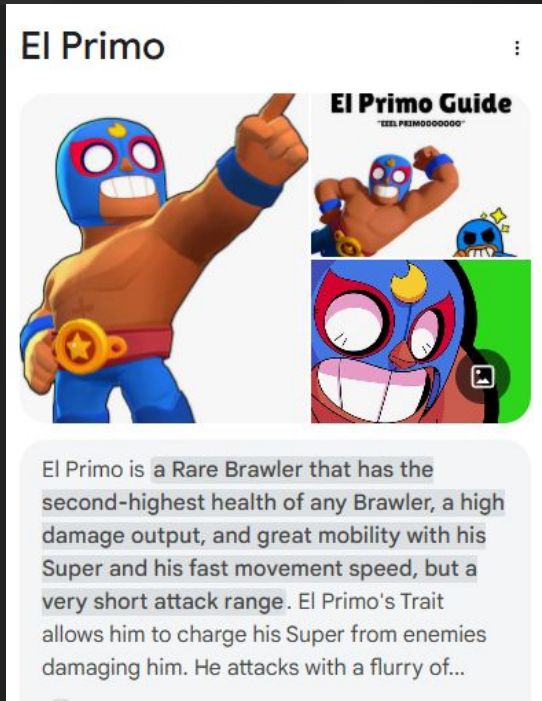
Ok, not really but it did remind me



Why El Primo?

- A more “general” obs question
- Less points put on star charts
- How well do you understand some general knowledge observational terms?

- I am glad some of you actually read the story
- The questions, not so much…

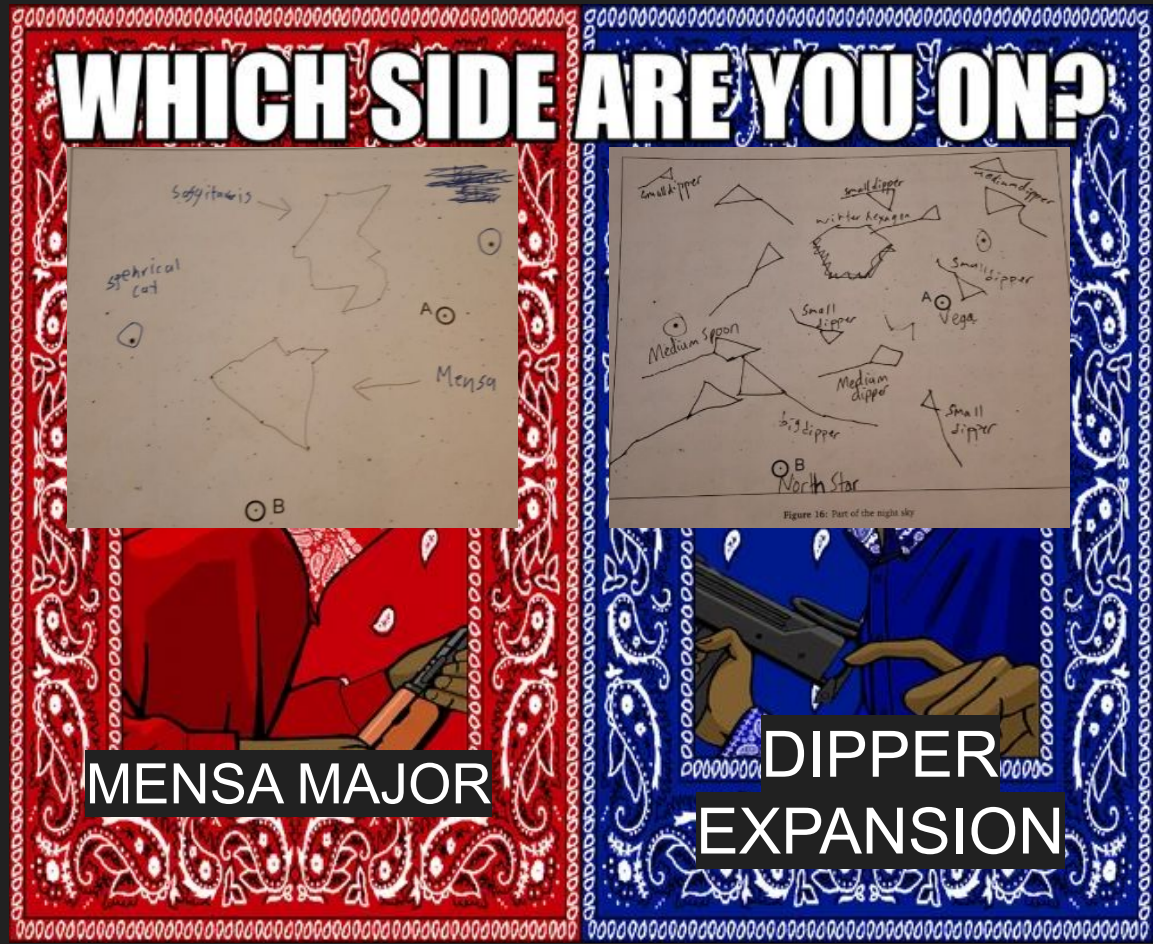


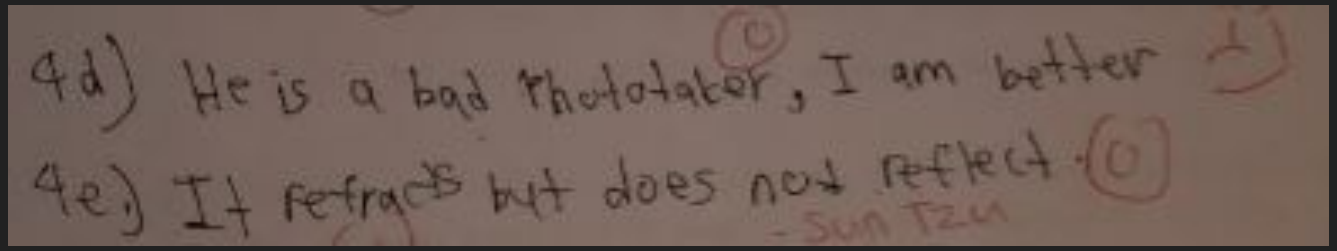
Starboard

(pic unrelated)

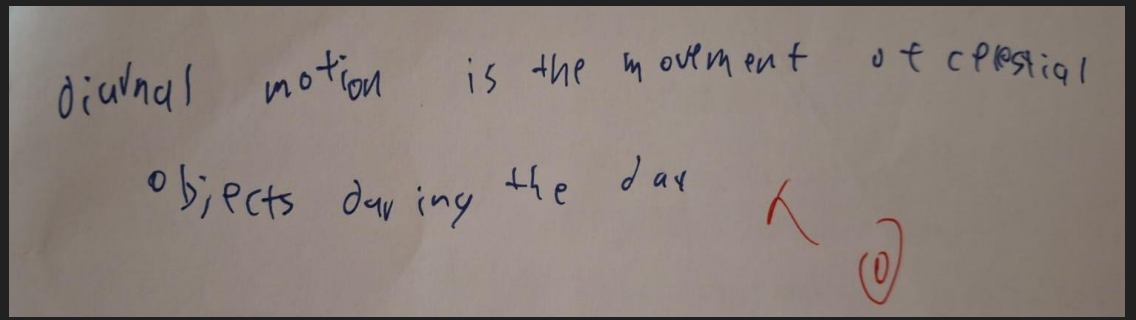
Star Map

- Was always going to be a “either you know or don’t question”
- Less than half the teams got any points here
- As evidenced by the beautiful maps they drew
- No less than 5 teams circled Vega and Capella as the answer to the DSO question (part c)

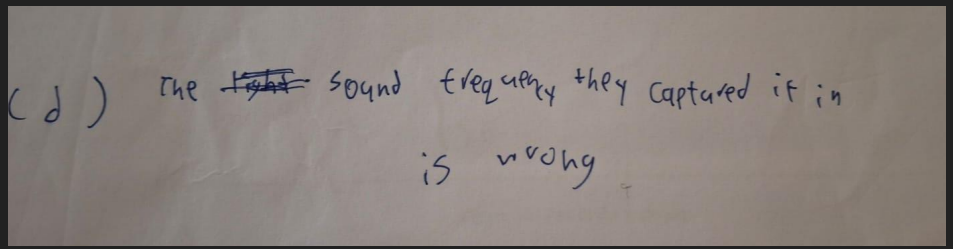




"I did not say that"
- Sun Tzu, Art of War



My fellow geography students



I…what?

Sidereal Time and Figure 18

This figure is supposed to help you visualise the difference between a solar day and a sidereal day.

Which will allow you to answer Qn 4(m).

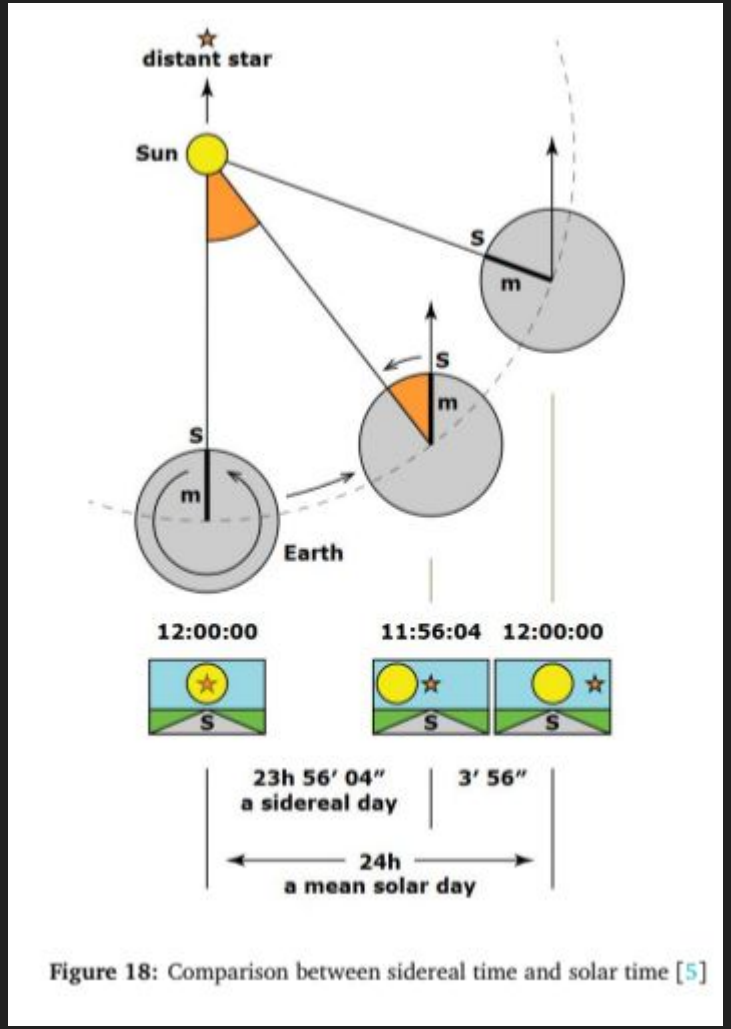


Figure 18: Comparison between sidereal time and solar time [5]

What I expected

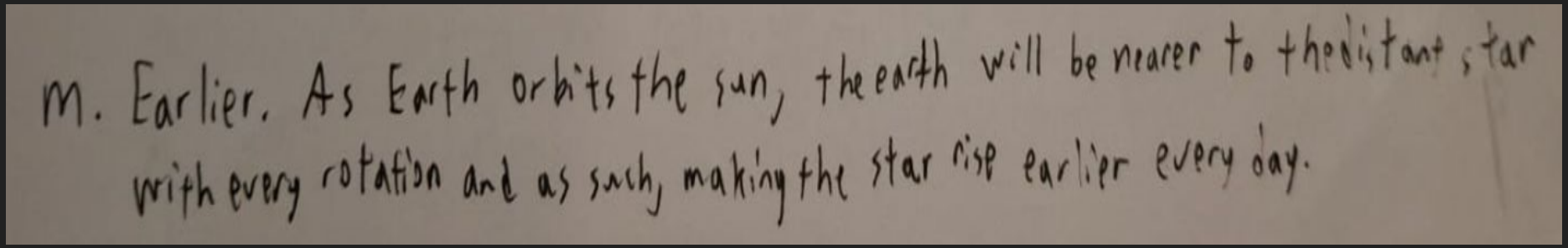
(m) Based on Figure 18, do stars rise earlier, later or at the same time every day? Explain you answer. **[2]**

Solution:

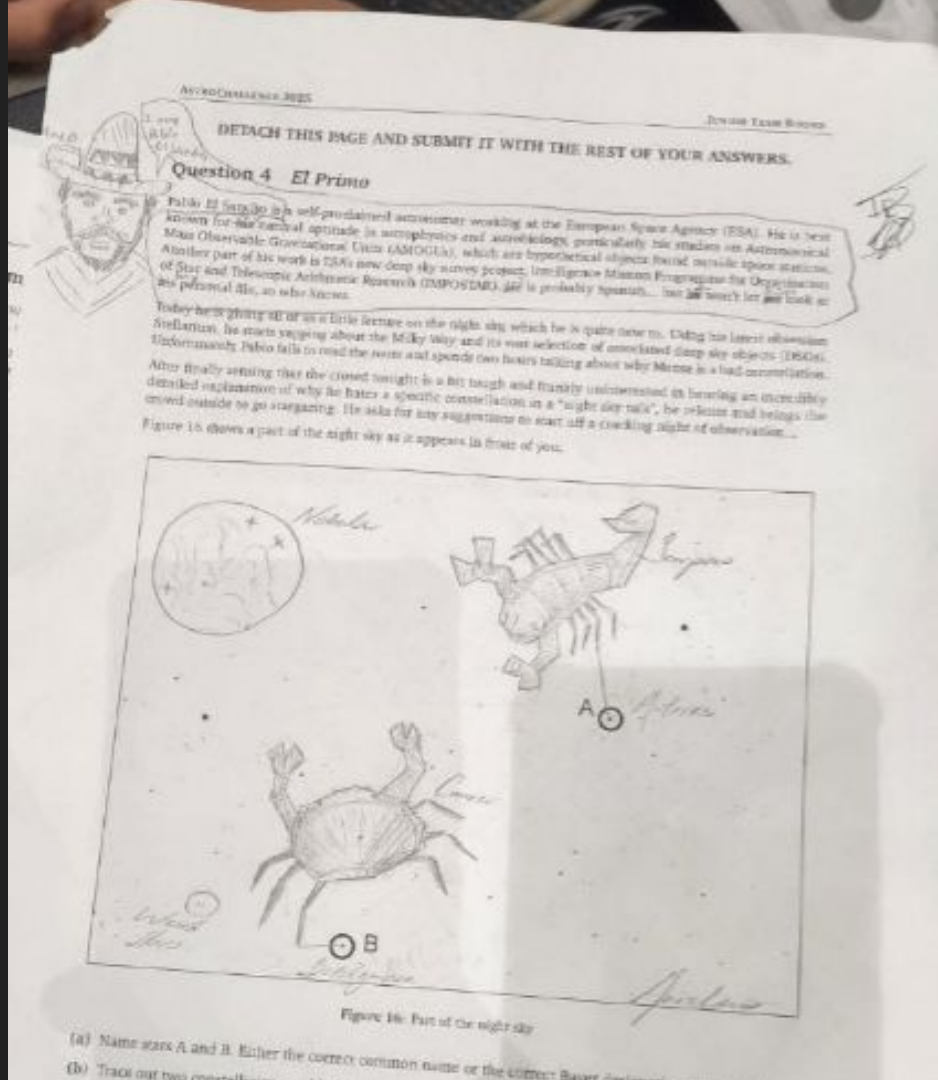
Earlier. A star that is currently rising will be at the same position 23 hours 56 minutes and 4 seconds later. That is, about 4 minutes earlier on the clock of the second day.

To some teams' credit, this question was answered pretty well.

What I got



ArtsoChallenge Winner 2025



DETACH THIS PAGE AND SUBMIT IT WITH THE REST OF YOUR ANSWERS.

Question 4 *El Primo*

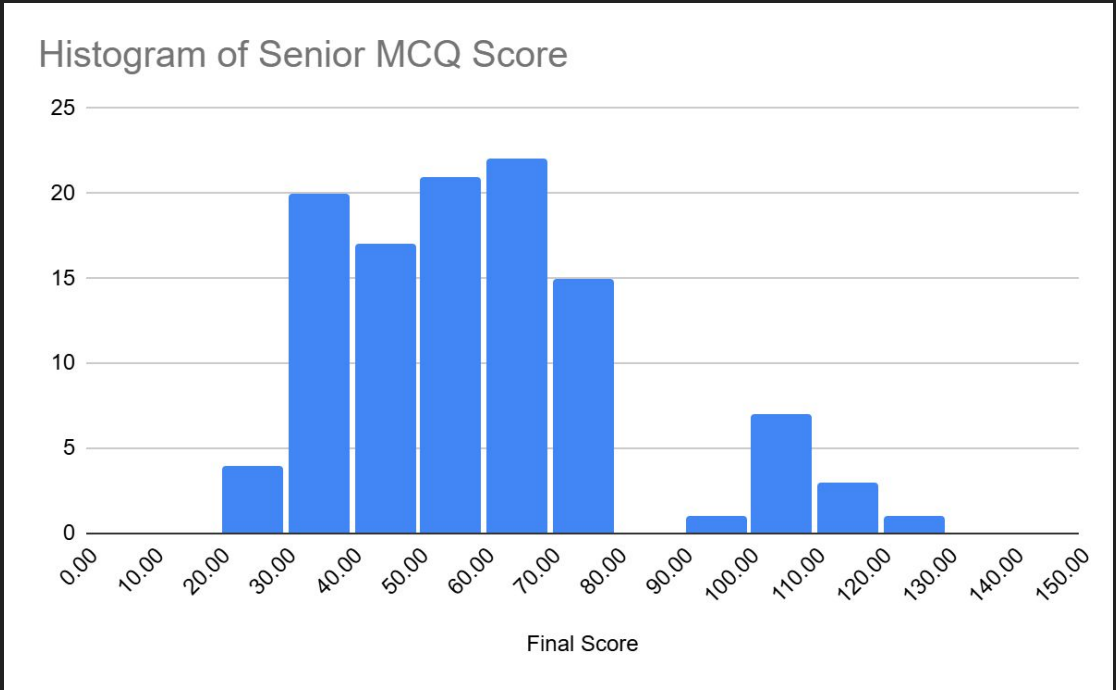
Figure 16: Part of the night sky

(a) Name stars A and B. Either the correct common name or the

Seniors

MCQ

Summary Statistics



A classic bimodal distribution.

- Sample mean: 59.35
- Sample median: 57
- Sample mode: 55
- Sample largest order statistics: 123
- Sample smallest order statistics: 25
- Expected outcome: 34

Key results

Most correct: Q14

SKA - Low is a radio telescope being built in Western Australia and is set to be the biggest radio telescope in the world when it is completed in 2028. It uses 131,072 log-periodic antennas spread between 512 stations at a length around 75km. The antennas are arranged in an interesting shape as shown in Figure 3.

Figure 3: Questions 14 to 15. [5]

14. Which of the following best explains why the antennas are in a Christmas tree shape?

(A) Antennas are stacked vertically on top of each other to filter out unnecessary wavelengths of light for higher sensitivity.

(B) **Antennas of different lengths are able to capture different frequencies - longer antennas for lower frequencies and shorter antennas for higher frequencies. This allows scientists to study the universe in a range of frequencies.**

(C) Some antennae are used for communication between 'trees' while only some are used in observing the night sky.

(D) The Christmas tree shape provides the best structural stability against weather conditions such as sandstorms and rain.

(E) The engineers who designed SKA - Low proposed their plan on Christmas day.

Key results

Most correct: Q14

Most wrong: Q11, Q32

11. In 1588, Tycho Brahe published the Tychonic system, which is a geoheliocentric model in which the Sun, the Moon and stars revolve around the Earth, and other five planets (Uranus and Neptune were not yet discovered) revolve around the sun.

Back when it was proposed, it was a major competitor, along with the Copernican heliocentric model, as an alternative to the Ptolemy's geocentric model.

However, the scientific community eventually replaced the Tychonic model with the Copernican model. Which one of the following observations could have contributed to the support for Copernicus' heliocentric model **over the Tychonic model**?

(A) The observed seasonal change of the declination of the Sun on the celestial sphere.

(B) The observation of the retrograde motion of Mars.

(C) The observation of the phases of Venus in 1610.

(D) **The observation of stellar parallax of 61 Cygni in 1838.**

(E) All of the above.

Solution:

While all observations are true, only D demonstrated a clear reason why the Copernicus heliocentric model should be chosen in favour of the Tychonic geoheliocentric model.

The Tychonic model explains observations A, B and C perfectly well.

Observation A could be modelled by geocentric (and geoheliocentric) models as the Sun moving along the ecliptic on the celestial sphere. In fact, this view is some time still used for convenience today, especially in practical astronomy.

As the Tychonic model involves the planets orbiting the Sun, which in turn, orbits the Earth, it explains why there would be Venus phases (Observation B) and retrograde motion (Observation C) perfectly well.

Since the Tychonic model proposes that Earth is the centre of the universe, there should not be any stellar parallax. After stellar parallax was observed (D), it seems that Copernicus' heliocentric model, which could explain stellar parallax, seemed to be a better model.

Correct answer: D

Key results

Most correct: Q14

Most wrong: Q11, Q32

32. Figure 7 is a graph of the frequency of sunspots seen against time. which of the following observable quantities will reach a maximum during a sunspot minimum (e.g. in 2010, circled below)?

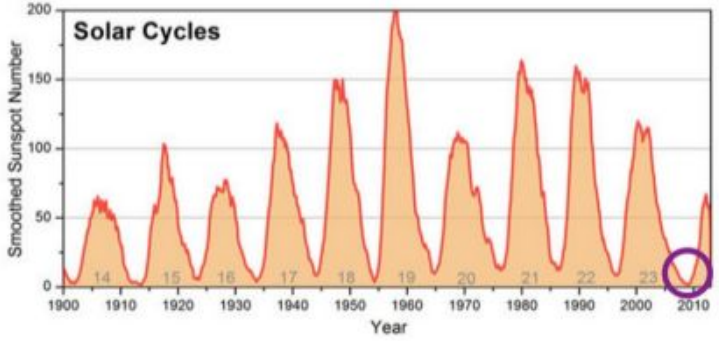


Figure 7: Question 32. [1]

(A) **Galactic Cosmic Ray Flux**

(B) Solar irradiance

(C) Coronal Mass Ejections

(D) Solar eclipses

(E) Solar radio flux

Solution:

The circled point corresponds to solar minimum. At this time, the Galactic Cosmic Ray Flux is highest due to reduced solar magnetic activity and shielding.

Correct answer: A

Funny result

Straight A's?!??!?

Q 1).	Q 26). A
Q 2).	Q 27). A X
Q 3).	Q 28). A X
Q 4).	Q 29). A X
Q 5).	Q 30). A
Q 6).	Q 31). A X
Q 7).	Q 32). A
Q 8). A X	Q 33). A X
Q 9). A X	Q 34). A X
Q 10). A X	Q 35). A X
Q 11). A X	Q 36). A
Q 12). A	Q 37). A X
Q 13). A X	Q 38). A X
Q 14). A X	Q 39). A X
Q 15). A	Q 40). A X
Q 16). A X	Q 41). A
Q 17). A X	Q 42). A X
Q 18). A X	Q 43). A X
Q 19). A X	Q 44). A X
Q 20). A X	Q 45). A X
Q 21). A X	Q 46). A X
Q 22). A X	Q 47). A X
Q 23). A X	Q 48). A X
Q 24). A X	Q 49). A X
Q 25). A X	Q 50). A X

DRQ

Question 1: Astrophotography

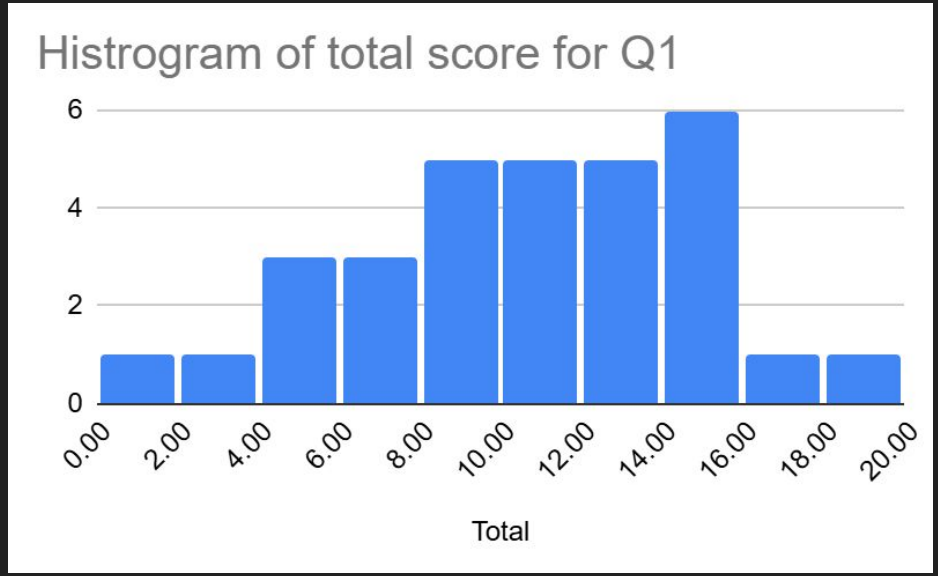
Question 1

Meant to be short-answered question.

Teams generally kept the answer short. Thanks for saving my sanity.

Generally well-done

Rarely in AC do you see this kind of mark distribution…



General comments

Generally well done.

Different parts requires different approach:

- Trivia / Experience
- Background knowledge in photography
- Source reading and analysis

The easiest part is not always at the front.

The preambles provide a surprising amount of information!

Consulting the guide further, he learnt that the images that he takes of the desired field of view are called "light frames". In addition, the same guide highly recommends him to take a bias frame, a dark frame and a flat frame. The techniques as recommended by the book is as stated below:

	Bias Frame	Dark Frame	Flat Frame
Exposure Time	Shortest possible	Same as light frame	Appropriate time such that the signal is of the proper exposure[1], based on the image histogram
Gain (ISO setting)	Same as light frame	Same as light frame	Same as light frame
Ambient temperature	Same as light frame	Same as light frame	Does not matter
Filters	Does not matter	Does not matter	Same as how light frames are taken
Special Pointers	Take with lens cap on (no light signal)	Take with lens cap on (no light signal)	Take with a uniform light source Take at the same camera angle as light frame
Corrects for			

Table 1: Techniques as recommended by the astrophotography guide [10]

(f) Fill up the last row of table 1 with the following keywords:

Dark signal non-uniformity	Difference in gain of each pixel	Noise generated from electronics

[3]

Answer on blank paper. State clearly which column you are putting each keyword under.
For example: "Bias frame: Dark signal non-uniformity".

Part IV A Surprising Find

Suddenly, Wertz was informed that his club's equipment IC has already taken a set of bias frames, dark frames and flat frames for a previous astrophotography session, one month ago. He was also in Singapore, using the same camera and telescope.

Investigating further, Wertz has found that the gain (ISO setting) from the previous session has been consistent with the light frames he has taken today. However, the exposure time of each light frame is different, and that the orientation of the set-up (e.g. orientation of the camera with respect to the telescope) is different as well.

(g) Can bias frame be reused? Why or why not? **[2]**

(h) Can dark frame be reused? Why or why not? **[2]**

(j) Can flat frame be reused? Why or why not? **[2]**

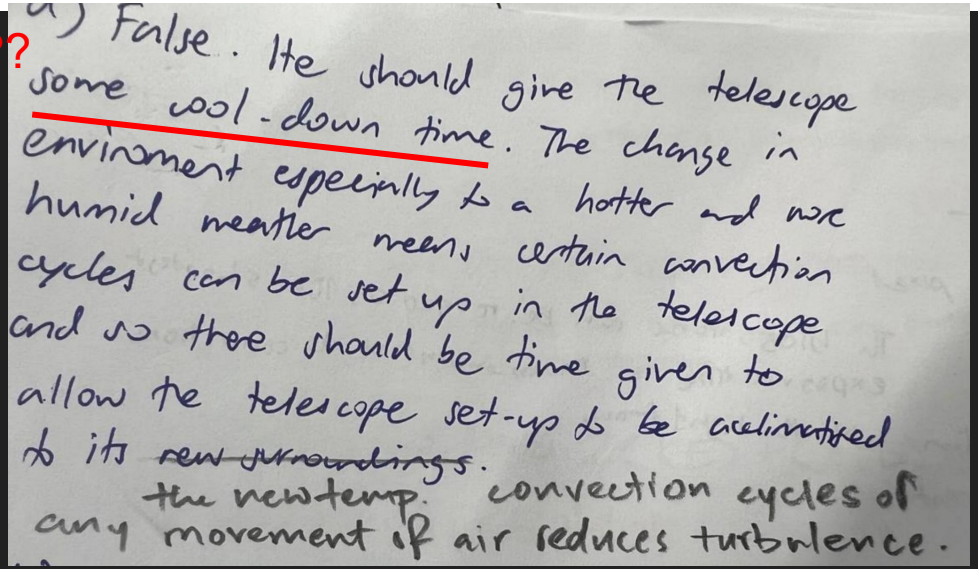
[1] "proper exposure" here refers to a suitable length of exposure such that the histogram of the picture, which indicate the distribution of pixels with certain brightness, peaks around the middle. In addition, close to all (ideally all) pixels should not be too bright (overexposed) or too dark (underexposed).

Some interesting answers…

It is a rare clear night in Singapore, and Wertz intends to use his school's astronomy club equipment to do deep sky photography. His school has a climate-controlled room that stores all of the club's equipment.

(a) Upon taking out the telescope from the climate-controlled room to the hot and humid observation site, he should start his observation as soon as possible to make full use of the clear night. Is this true or false? Elaborate and explain your answer. **[2]**

??



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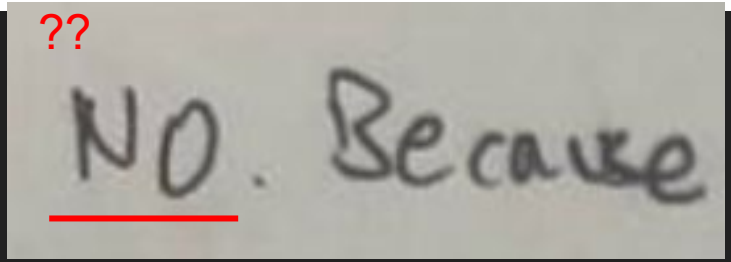
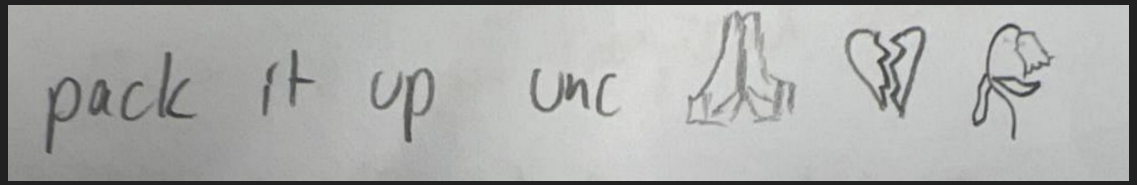
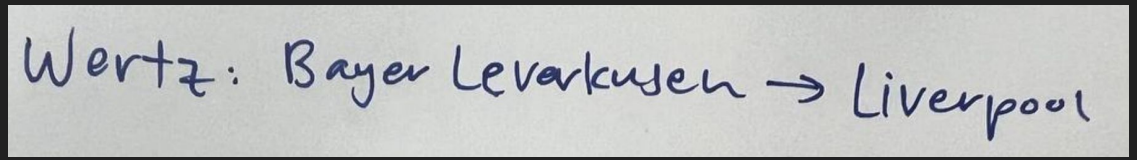


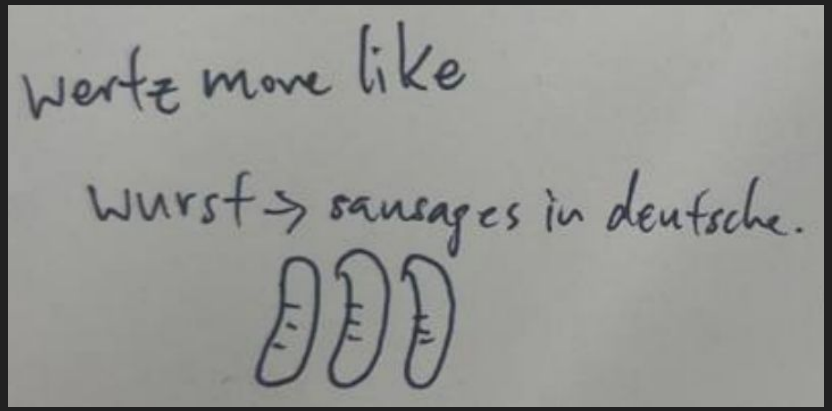
Some REALLY interesting answers…



Don’t give up!



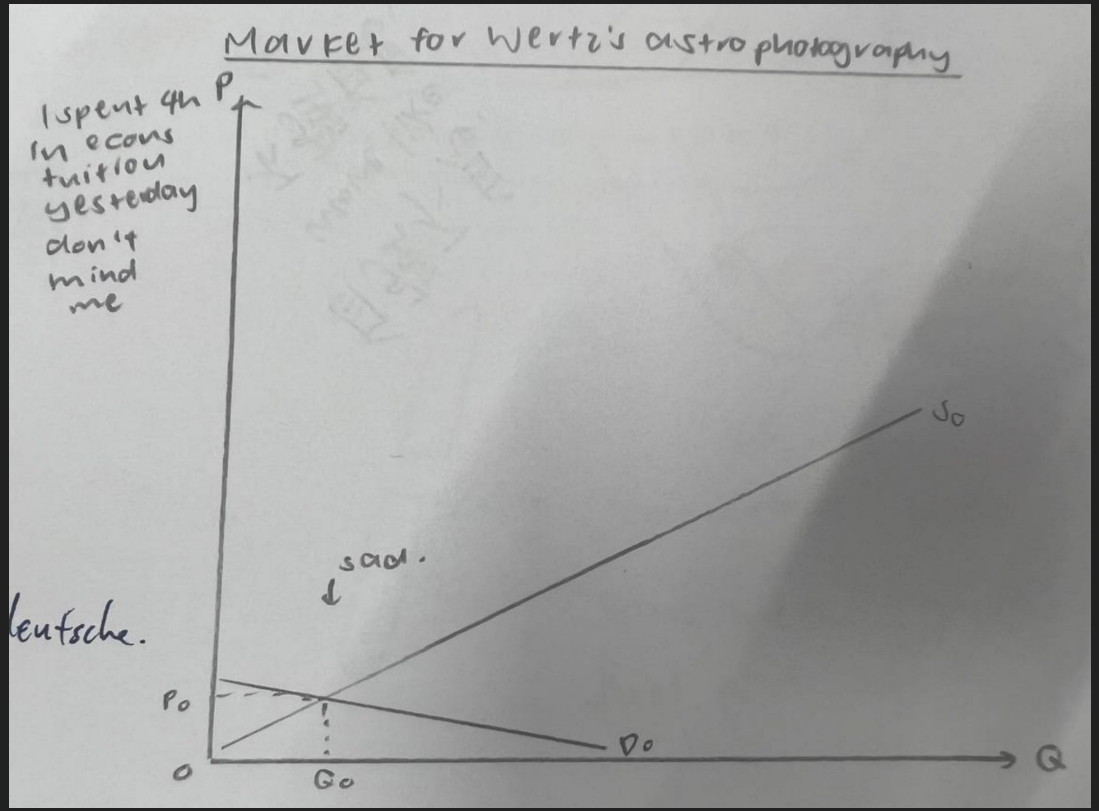
f: G→H



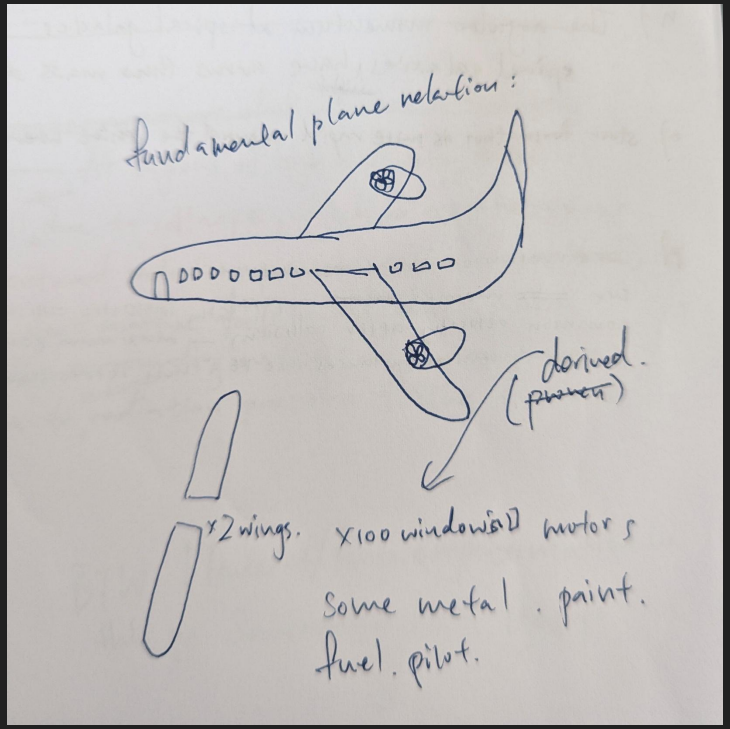
It’s the name of my professor…

And of course…

I don't mind econs stuff…



But to a single firm it is perhaps better to draw the cost-benefit diagram… (MR vs MC)



Q2 Fuzzy Moments

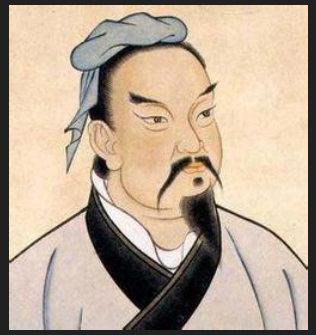
Question Setting Philosophy

- Test concepts and physical understanding rather than algebra and calculus

"Math is not Physics. You cannot math your way out of the physics."

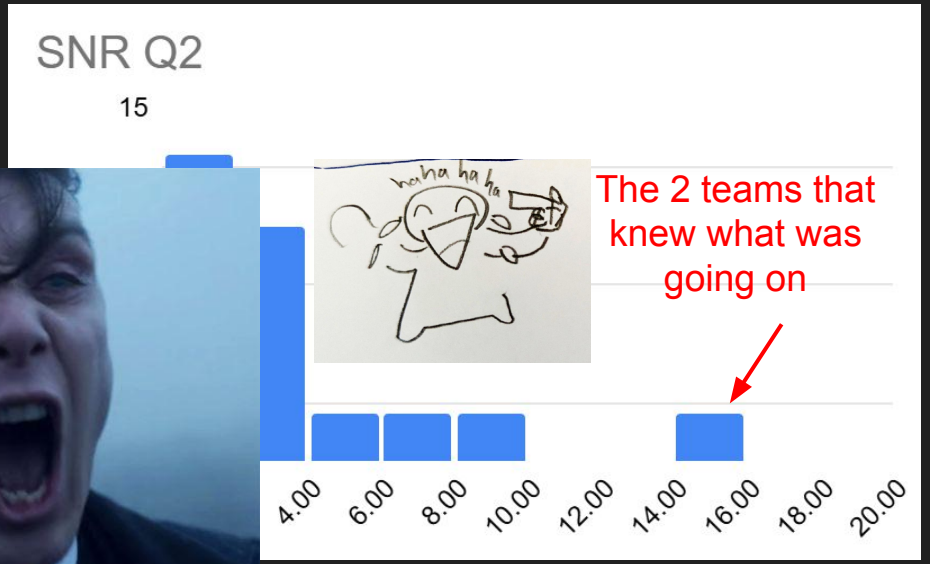
- Sun Tzu, Art of War (probably)

- Focus on galaxies & observational astronomy



How did everyone perform?

- Very Badly
- Mean: 3.1935
- Median:
- Mode: 0
- High: 15
- Low: 0

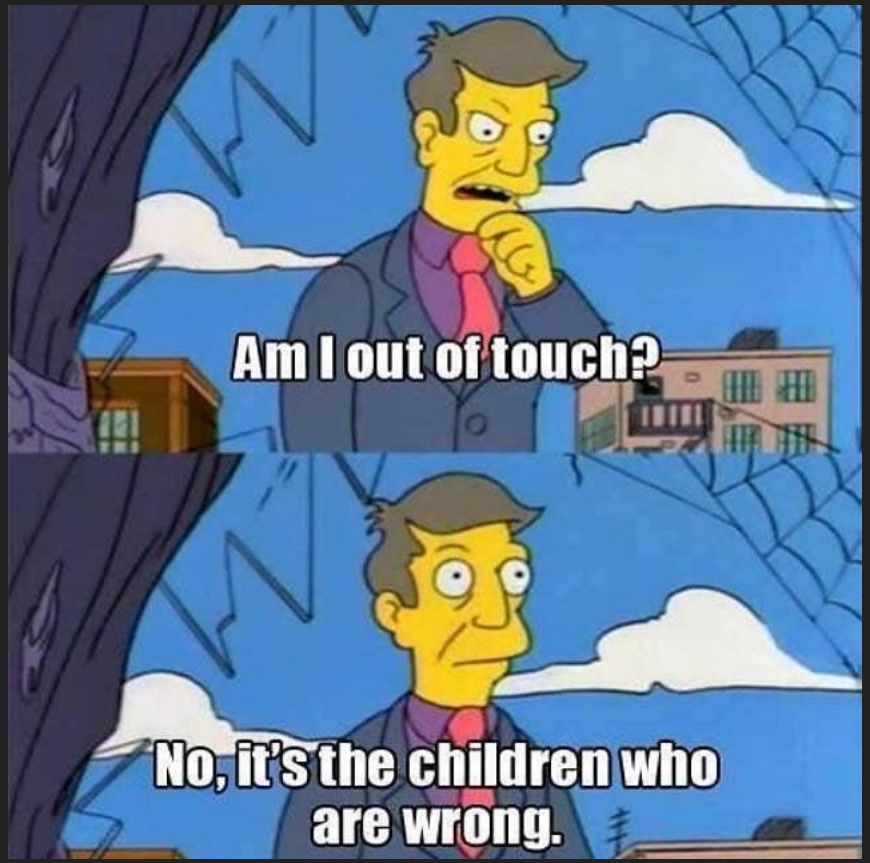


What went wrong???

My guess: teams have a huge blind spot in what they read up on

- Q2 demanded a decent grasp of certain fundamentals:
  - Various spectroscopic techniques and what they can be used for
  - Have some picture of how stars move within galaxies (both spiral & elliptical)
  - Be aware that there are such things as galaxy clusters and the intra-cluster medium (ICM)
- Many teams seem to have *very minimal* awareness of the above!
- Difficult questions expect you to make further *inferences* given the text & your existing knowledge
  - E.g. you are not expected to know what galactic quenching is; there are explanations in the footnotes!

Some examples of what I thought were giveaway questions but were not giveaway questions after all



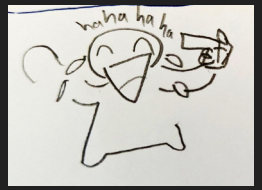
(a) Suggest a method for observationally measuring the velocity dispersion σ of an elliptical galaxy. **[1]**

Hint: Consider how spectroscopy can be used to measure velocity.

Answers fell into 5 cases:

- C1: Explains how the motion of stars causes doppler broadening
- C2: Measure doppler shift throughout galaxy and compute standard deviation
- C3: Measure doppler shift+ no elaboration (clearly regurgitating the hint)
- C4: ‘Creative’ answers
- C5: Blank

C5 was the plurality of answers



my mood while marking

9) On different nights, take photos of the galaxy and look for changes between photos, which will correspond to the velocity dispersion σ of an elliptical galaxy. wow.

Waiting for the stars to move in M87

spectroscopy, obtain a star's spectrum through its charcteristic lin
the star on a H-R diagram to obtain and find its absolute ma
asure apparent magnitude using $m - M = 5\lg(d) - 5$
ter which apply the formula $\frac{L_1}{L_2} = 10^{(M_2 - M_1)/2.5}$ Huh
o find L, since $L = k V^{\alpha}$

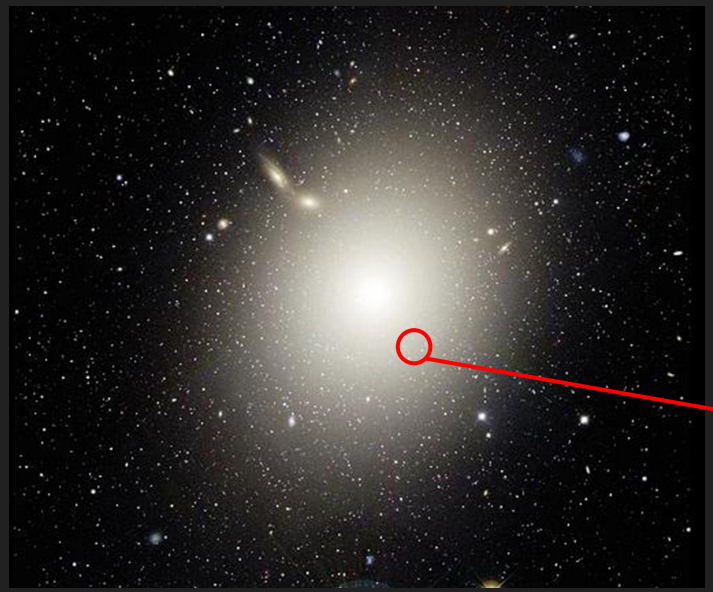
$$\frac{L_1}{L_2} = \frac{V_1^{\alpha}}{V_2^{\alpha}} = 10^{M_2 - M_1/2.5}$$, rearrange to find V.

$$2\langle KE \rangle + \langle GPE \rangle = 0$$

$$\langle GPE \rangle = -2\langle KE \rangle$$

We want to measure dispersion σ in order to find the absolute magnitude M, not the other way round!!!

The curious case of C2



Your logic:

- Velocity dispersion is a standard deviation
- Measure the recessional velocity across the ‘face’ of the galaxy and compute the sample standard deviation

The good:

- You guys are reading the text

The questionable:

- Are you sure that all the stars in your line of sight have a similar velocity?

Hint: How do stars move in an elliptical galaxy? How is it different from a spiral galaxy?

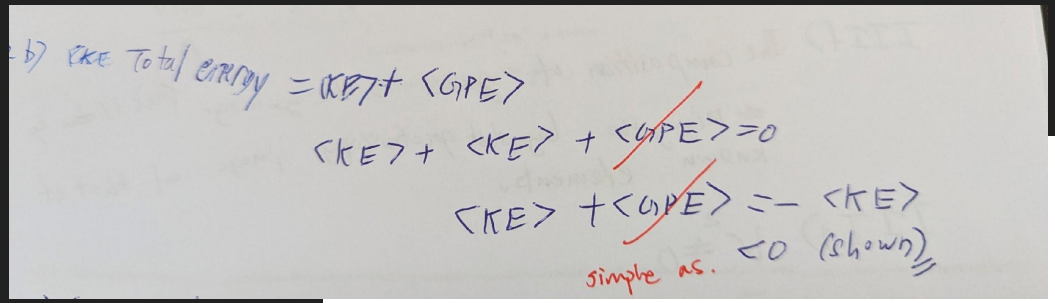
$$2\langle KE \rangle + \langle GPE \rangle = 0$$

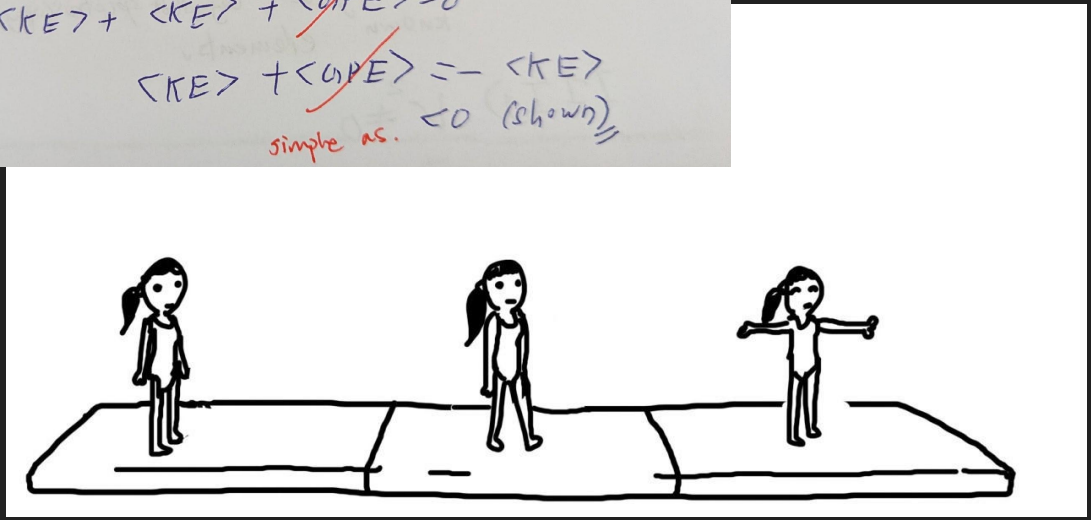
(b) Show that the average total energy of a system obeying Equation 3 is negative, and explain the physical implication. **[1]**

Expectation

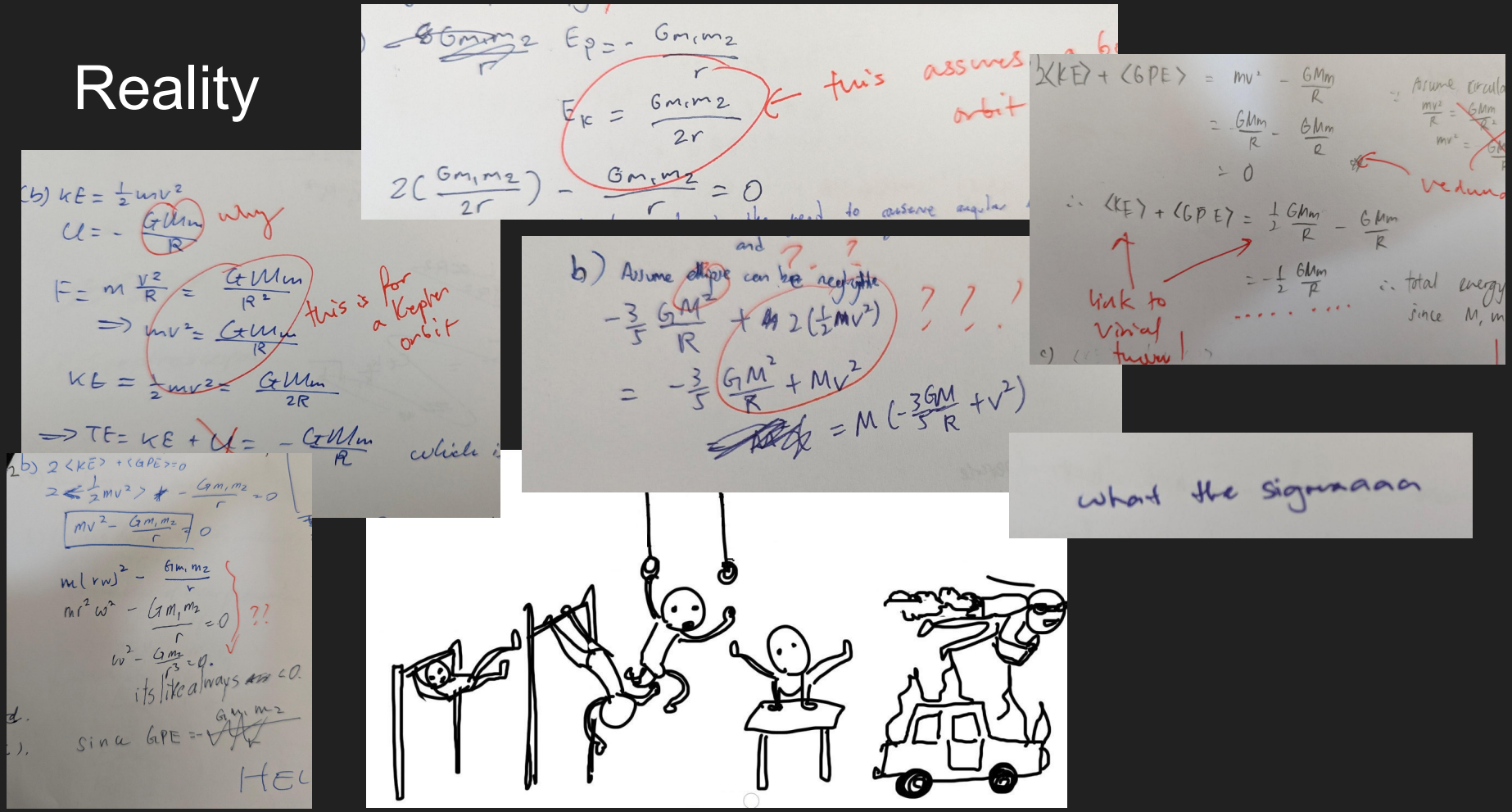
1) Recall the definition of total energy

2) Substitute into Virial Theorem equation





Reality



this assumes a b
orbit
why
this is for a Kepler orbit
b) Assume ellipse can be neglected
? ? ?
link to virial theorem!
veduna
what the sigmaaaa

Not only you are shooting your own foot by overcomplicating things, your argument is also incorrect fundamentally!

$$2\langle KE\rangle + \langle GPE\rangle = 0$$

This little equation is fully general and applies to all gravitationally-bound many-body systems!

(j) What are some other likely differences between 'red sequence' and 'blue cloud' galaxies? State two reasons. [2]

IV) Red sequence → ~~Red~~ shift

Blue cloud → Blue shift

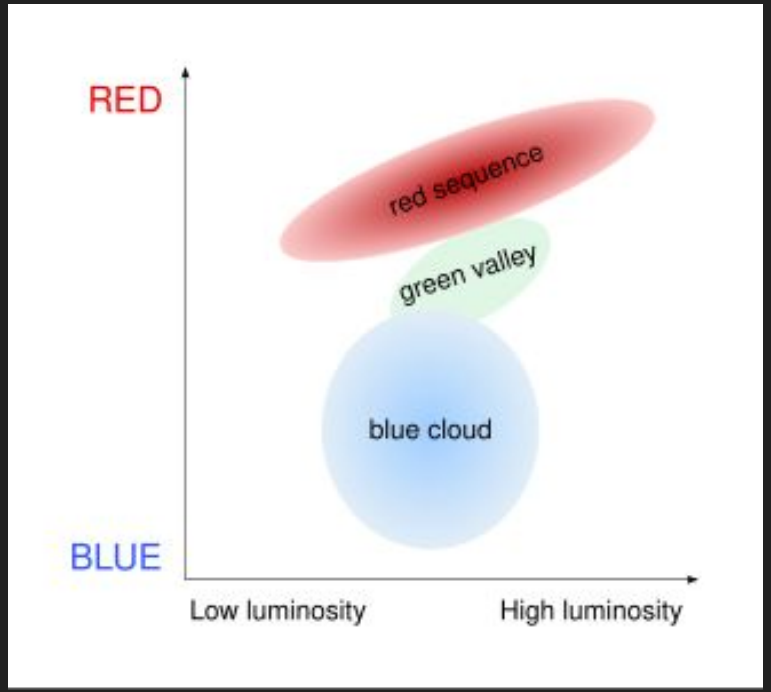
huh.

$\left(\frac{M}{L}\right)^{-2}$

i) One is spiral and one is lenticular. Thank you captain obvious

The spiral galaxy is older than the lenticular.

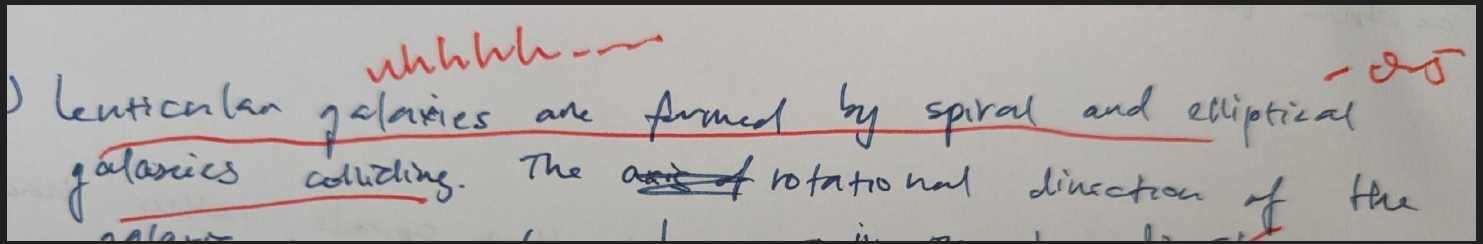
Just rehash your answers for spirals vs ellipticals!



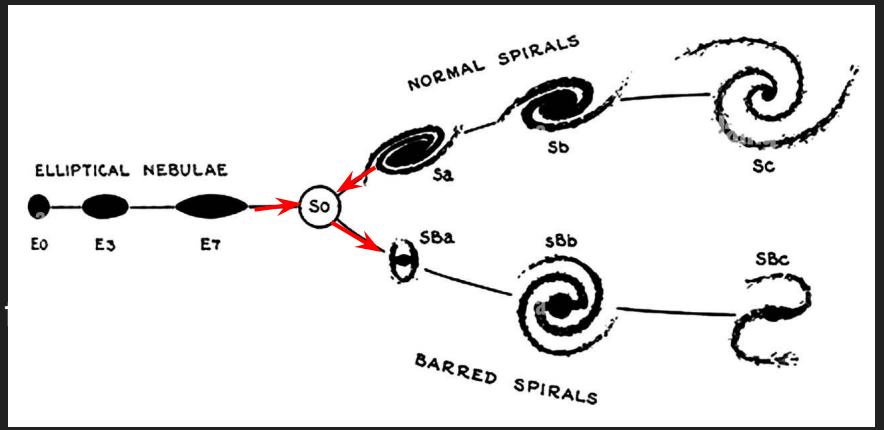
- No active star formation
- Stars are older and thus redder
- No cold gas reserves

- Active star formation
- Stars are younger and thus bluer
- Have cold gas reserves

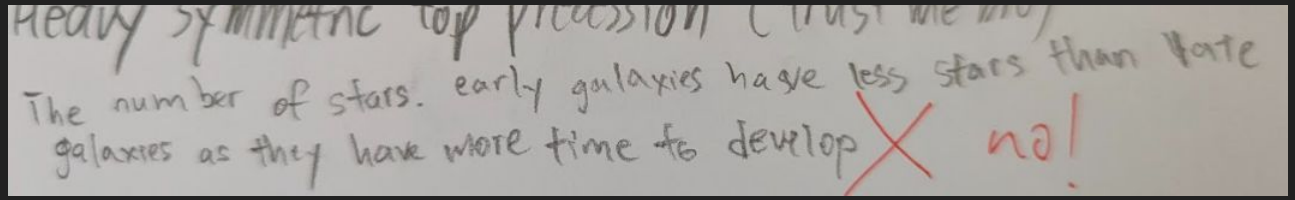
Do AC teams know what a lenticular galaxy is?

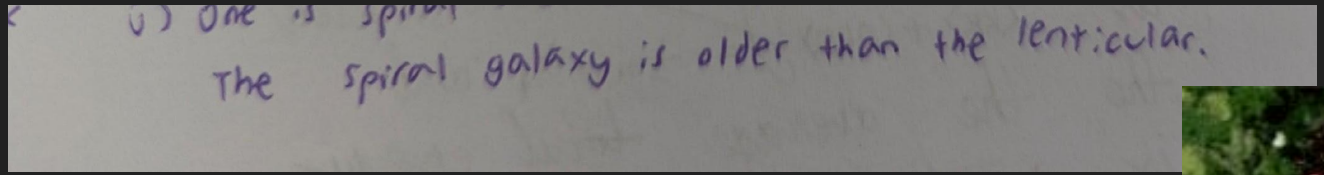


Is the Hubble tuning
tree?



Did early-type galaxies form ‘earlier’?





c) All the info is given to you; just piece it together

We can write a familiar-looking expression for rotational kinetic energy $\langle KE \rangle = \frac{1}{2} M \langle v^2 \rangle$ assuming identical masses of individual stars[3]. But beware! v here should be thought of as a probability distribution describing the individual rotational velocities of individual stars in the overall population, and the angled brackets $\langle\rangle$[4] represents an averaging operation. M here refers to the total mass of the entire system, and $\langle v^2 \rangle$ is actually the mean-square velocities of all particles in the system. This is a quantity called the second (statistical) moment $\mathrm{E}[v^2]$, which can be related to the more familiar variance $\mathrm{Var}(v)$ by the following formula:

$$\mathrm{Var}(X) = \mathrm{E}[X^2] - \mathrm{E}[X]^2 \tag{4}$$

As for the gravitational binding energy term, we let $GPE = -\frac{GM^2}{R}$, where M again is the total mass, G is the gravitational constant, and R is the radii of the system.

(c) Show that:

$$V^2 + \sigma^2 = \frac{GM}{R} \tag{5}$$

where V is the rotational velocity and σ is the velocity dispersion. State any other assumptions made. Hint: Think carefully about the physical meaning of the terms, and do not expect to arrive at the answer by only algebraic substitutions. **[2]**

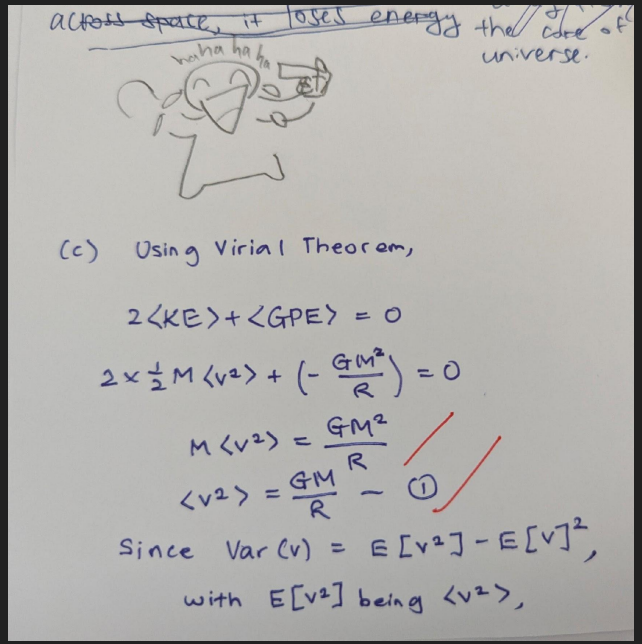
Just explain to me why velocity dispersion is sqrt(Var(v)) and rotation speed is E[V]

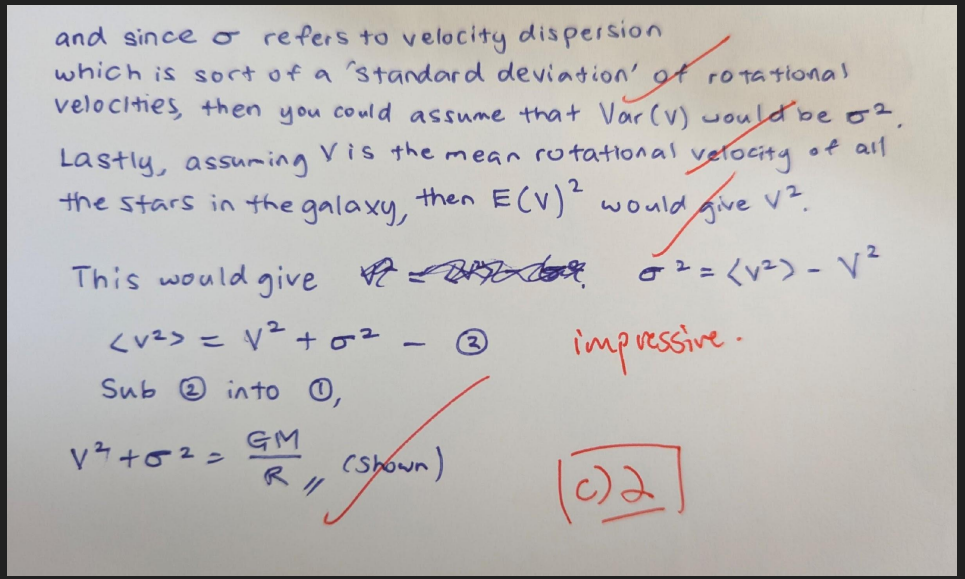
In fact, I gave you the explanation for this in the text!

Underlying lesson: KE of a many-body system can be separated into rotation and dispersion contributions!

Model answer for c)

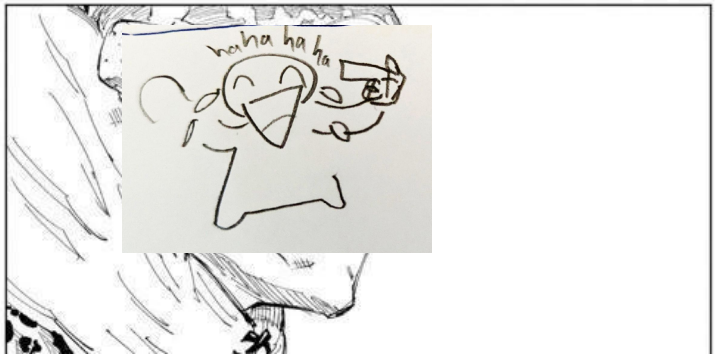
- Neat presentation
- Clearly explained line of reasoning
- No 'magic' and handwaving





YOU'RE STRONG.
STAND PROUD.

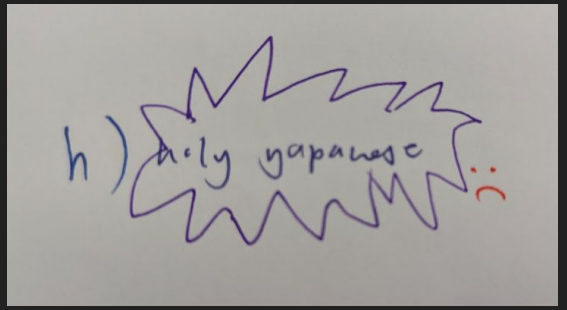
WHAT... IS THIS?



What is the point of the question?

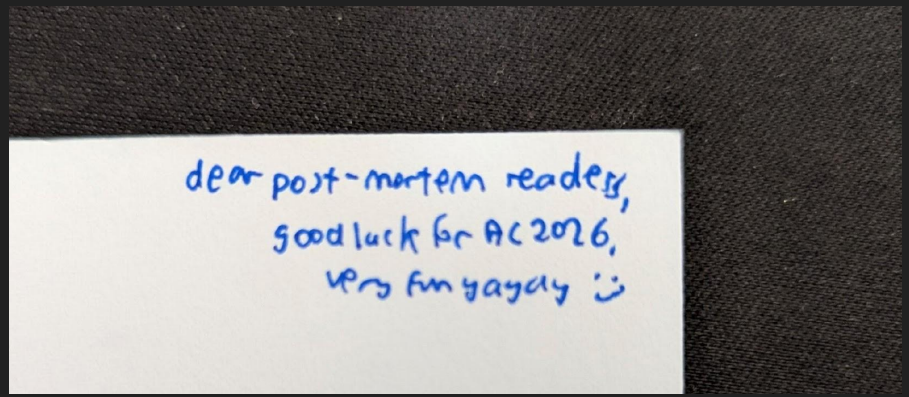
The ‘story’ I was hoping to tell:

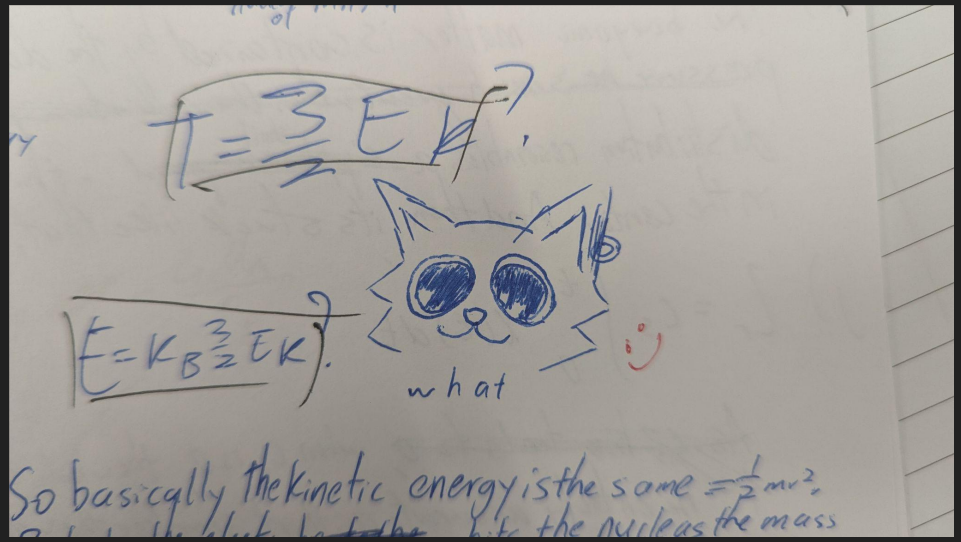
1. We think of (and model) spirals vs. ellipticals as rotation vs. dispersion-dominated systems
2. These kinds of models oversimplify the diversity of ellipticals (more generally early-type galaxies)
3. There are such things as fast-rotating and slow-rotating ETGs; slow rotators are more massive than fast rotators
4. Our current best theory for this dichotomy is the hierarchical merger of galaxy clusters



I don’t expect you guys to understand every little detail; just the broad outline of the argument!

Lastly, a message from one of your peers with Stockholm syndrome





Question 3: The Sound Game

How did the question go?

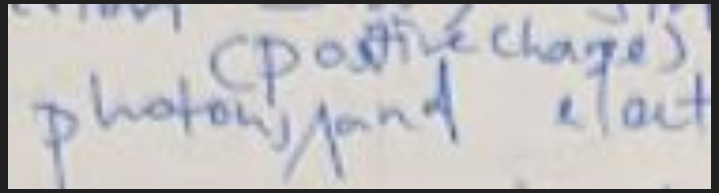
Generally VERY WELL DONE! YAY.

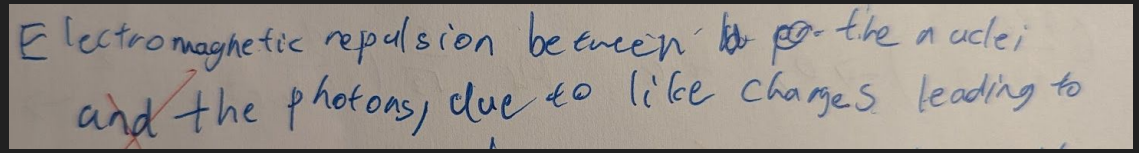
Mean: 8.532258065
Median: 8.5
Mode: 9
Highest: 18.5
Lowest: **1**

Reminds me of NYC skyline but ok

But before the good stuff…

But before the good stuff…





PHOTONS. ARE. NOT. POSITIVE

After the crashout, question by question breakdown:

Subpart **(a)**

(a) Why does sound not travel in space? Answer strictly in one sentence.

If anyone of you got it wrong, I would've emailed your school's physics department to request an explanation.

After the crashout, question by question breakdown:

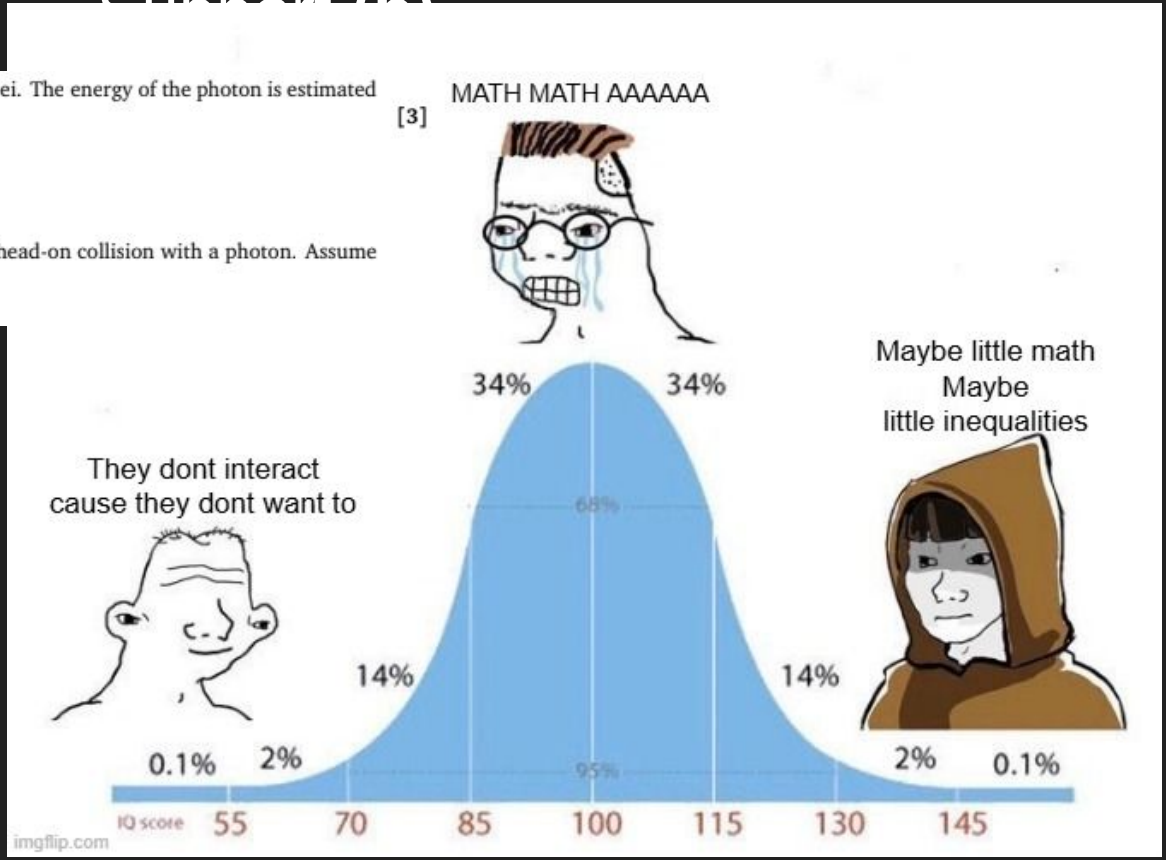
Subpart (b)

(b) Explain why the photos did not interact significantly with the nuclei. The energy of the photon is estimated by $E = k_B T$ where k_B is the Boltzmann constant. **[3]**

Hints:

1. Use a conservation law.
2. Consider the particles as classical balls.
3. Calculate the final speed of an electron and nuclei after their head-on collision with a photon. Assume the photon transfers all its energy to the other particle.
4. Think about the correct use of $E^2 = p^2c^2 + m^2c^4$.

You all need to calm down and read it properly



After the crashout, question by question breakdown:

Subpart **(b)**

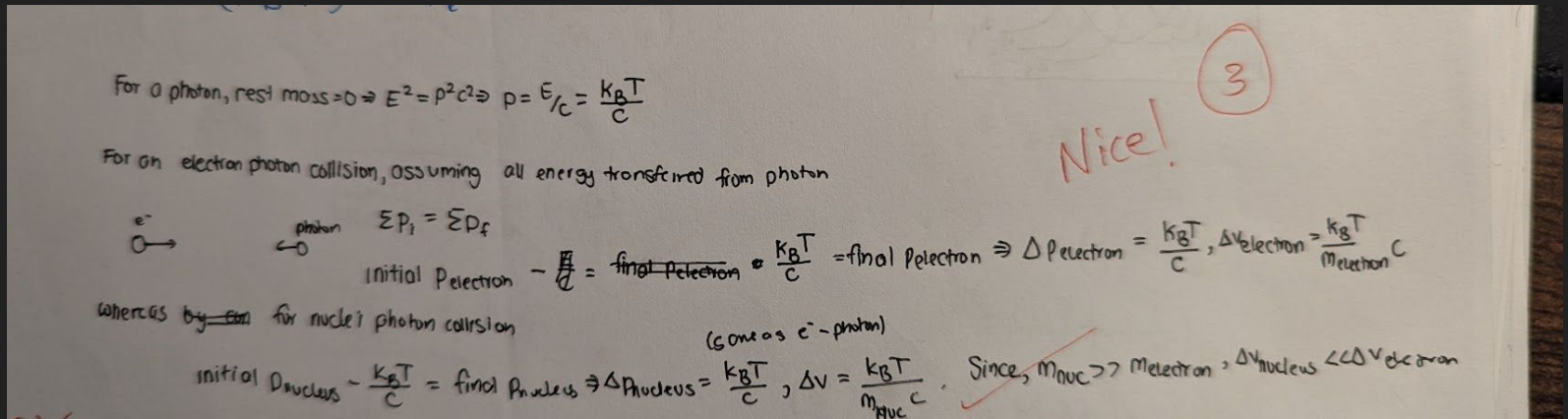
I expected:

1. Conservation of linear momentum

or

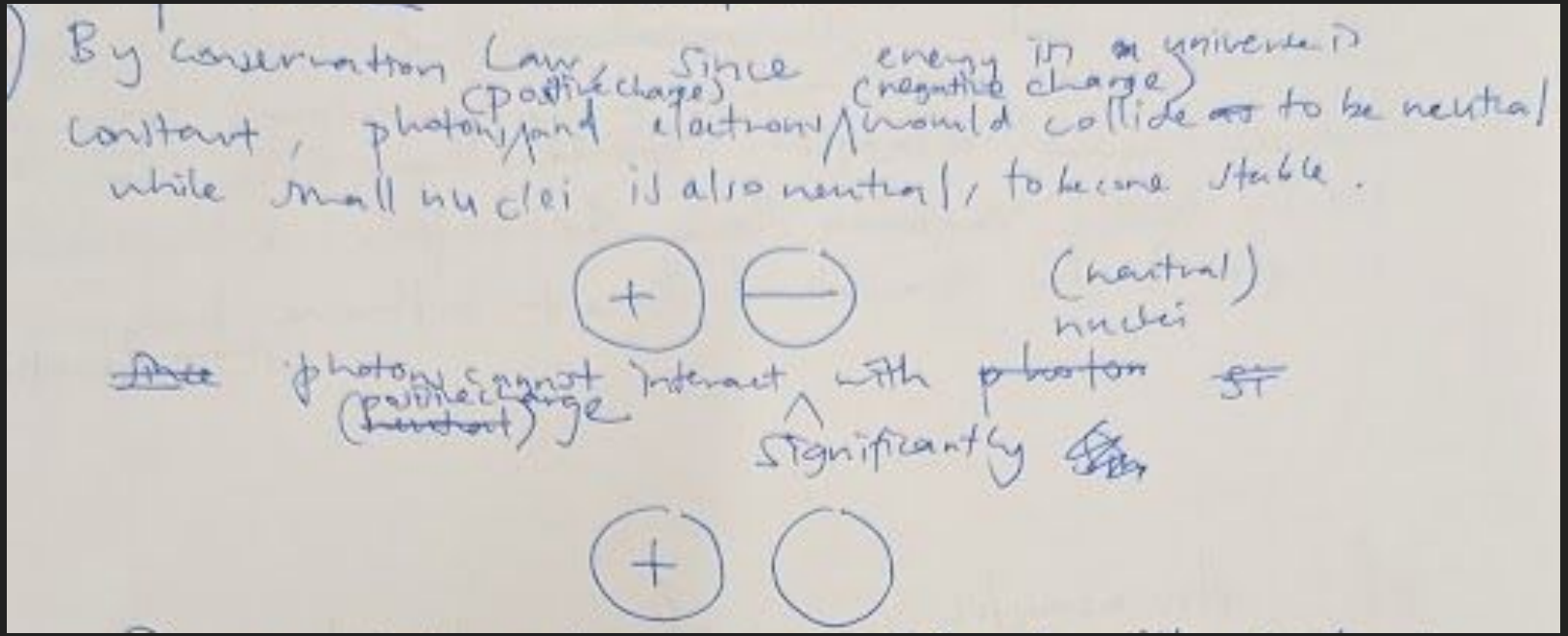
2. Conversation of energy [MUST BE CAREFUL]

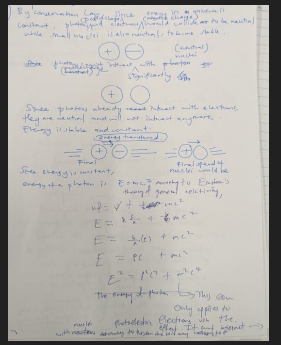
A good example without calculations…



After the crashout, question by question breakdown:

Subpart **(b)** However, what is this blasphemy

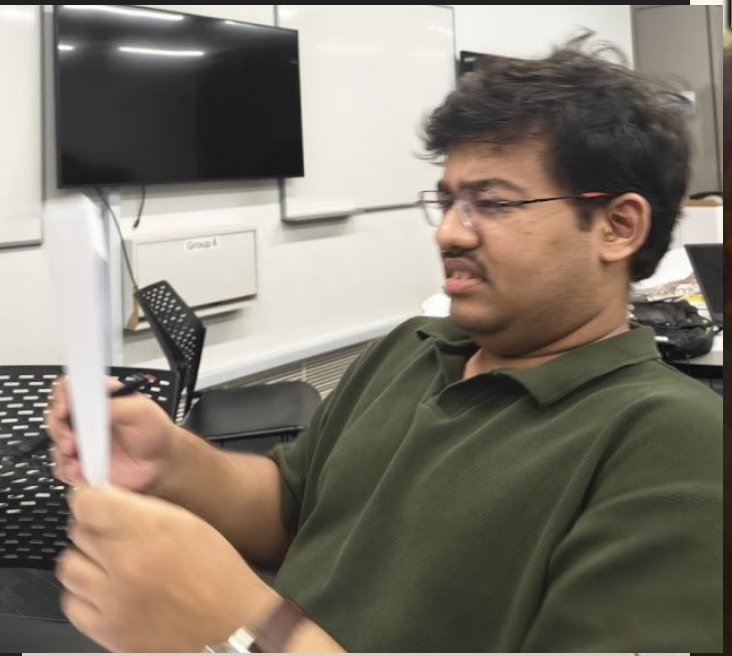


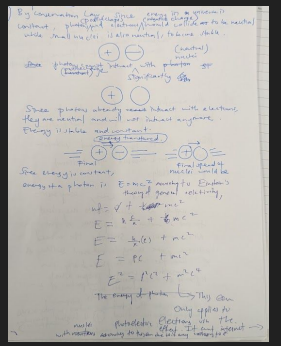


After the crashout, question by question breakdown:

Subpart **(b)** However, what is this blasphemy

Genuine realtime reaction captured

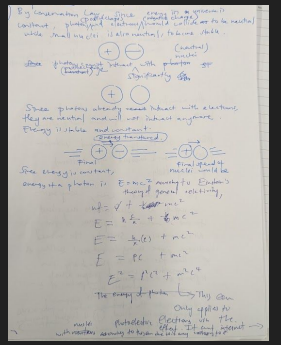




After the crashout, question by question breakdown:

Subpart **(b)** However, what is this blasphemy

It did not stop there



Since photons already ~~react~~ interact with electrons, they are neutral and will not interact anymore. Energy is stable and constant.

energy transferred.

Since energy is constant

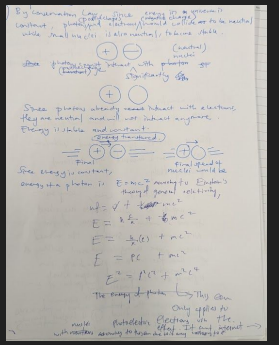
energy of a photon is

$E = mc^2$ according to Einstein's theory of general relativity,

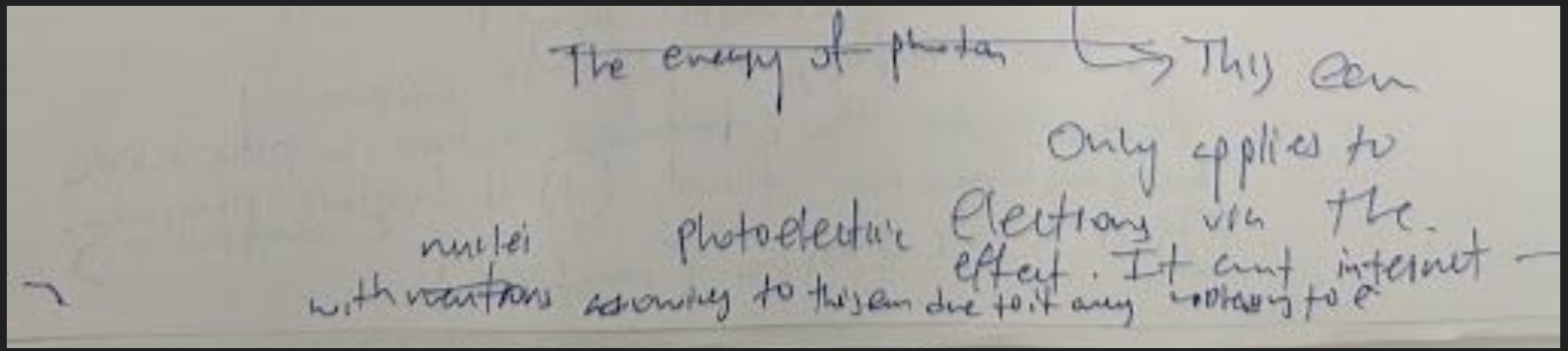
Guys what…

After the crashout, question by question breakdown:

Subpart **(b)** However, what is this blasphemy

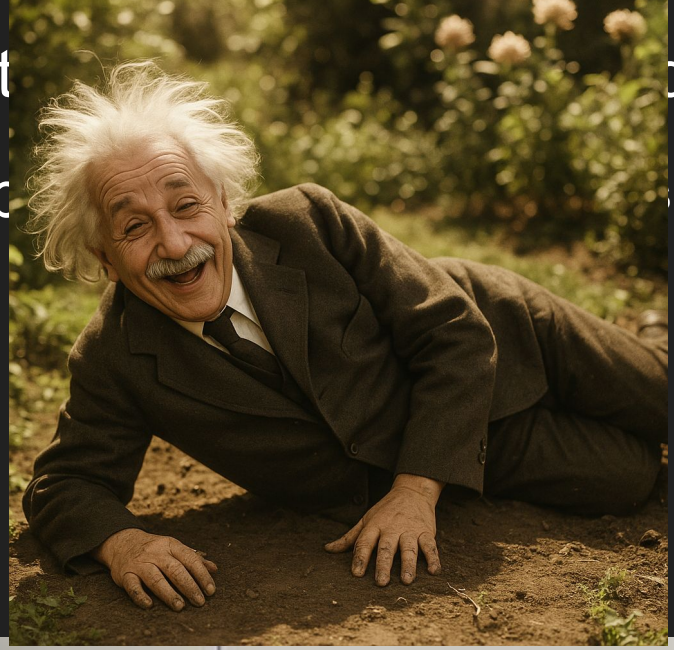


HOW DID. WE. REACH.
PHOTOELECTRIC EFFECT??



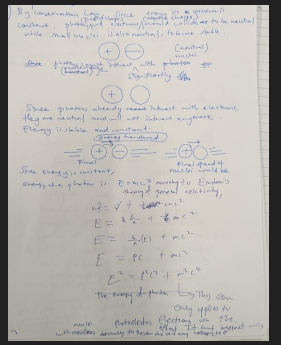
After the crashout, quest down:

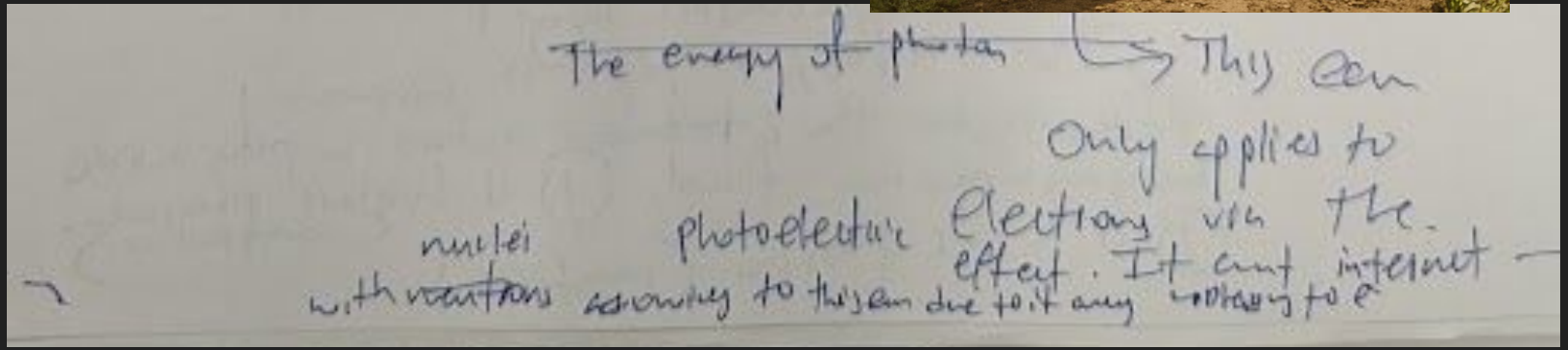
Sub this blasphemy



Einstein ROLLING in his grave:
(**einstein was not buried but rather cremated and his ashes were disposed off at an undisclosed location**)

HOW DID. WE. REACH. PHOTOELECTRIC EFFECT??





After the

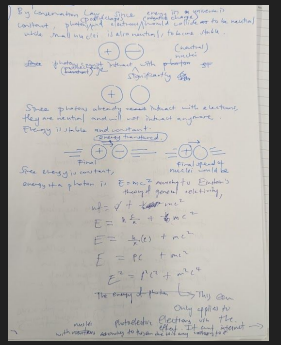
STOP DOING Traumatic Bullshittery

- Photoelectric effect was not supposed to be treated like this
- YEARS OF patience yet NO REAL-WORLD USE FOUND for Using common sense
- Wanted to bullshit? ? We had a tool for that: It was called Brain. USE IT.
- "Yes please give me 1 photoelectric of something. Please give me effect of it" - Statements dreamed up by evil wizards

General relativity

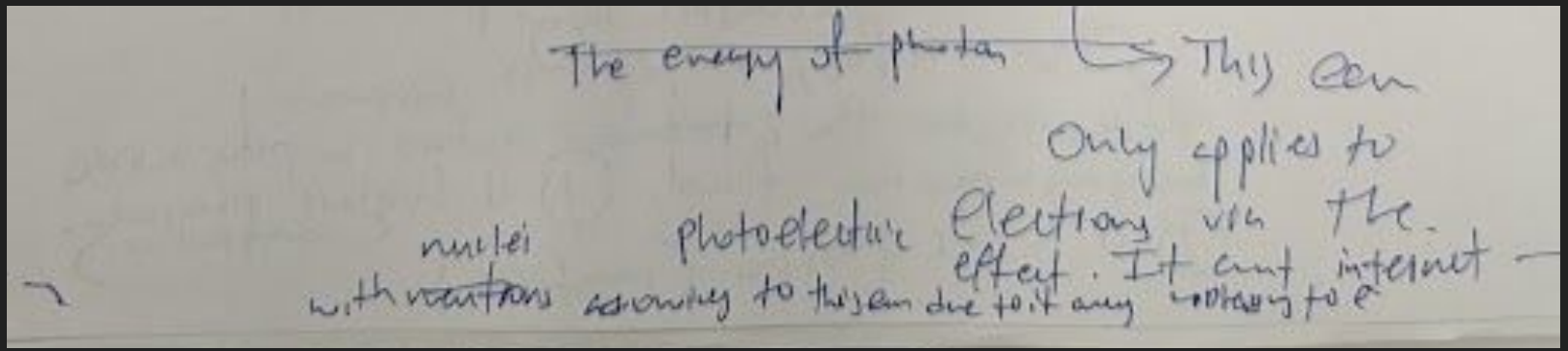
reakdown:

what is this blasphemy



HOW DID. W

PHOTOELECTRIC EFFECT??



er the crashout, question by question breakdown:

Subpart **(b)**

Your argument cannot be:

1. I calculate speed greater than speed of light
2. Your question must be wrong
3. Therefore, they do not interact

$$= 299794681.1$$

$$= 2.99794681 \times 10^{8}$$

$$\sqrt{\frac{(1.380648 \times 10^{-23}) + (1.672622 \times 10^{-27}}{2.99792458 \times 10^{8}}}$$

$$= 2.999245801 \times 10^{8}$$

After the crashout, question by question breakdown:

Subpart **(c), (d), (e)**

The fundamental forces. Electromagnetic, gravitational, and Dark matter interaction

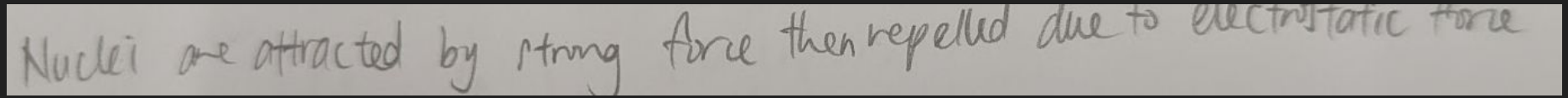
Most of you got all 3. However, what is up with …

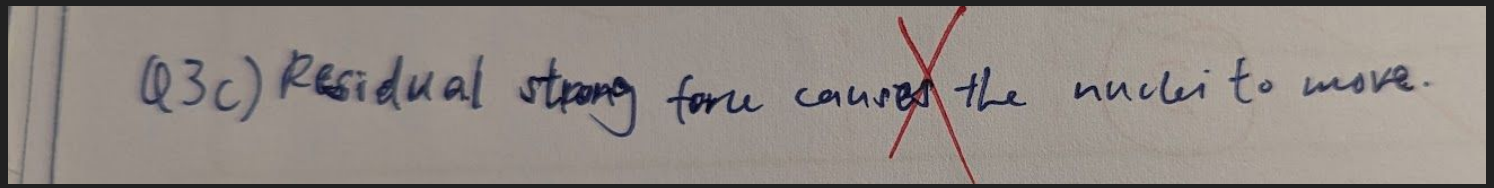
After the crashout, question by question breakdown:

Subpart **(c), (d), (e)**

The fundamental forces. Electromagnetic, gravitational, and Dark matter interaction

Most of you got all 3. However, what is up with so many answers talking about STRONG FORCE



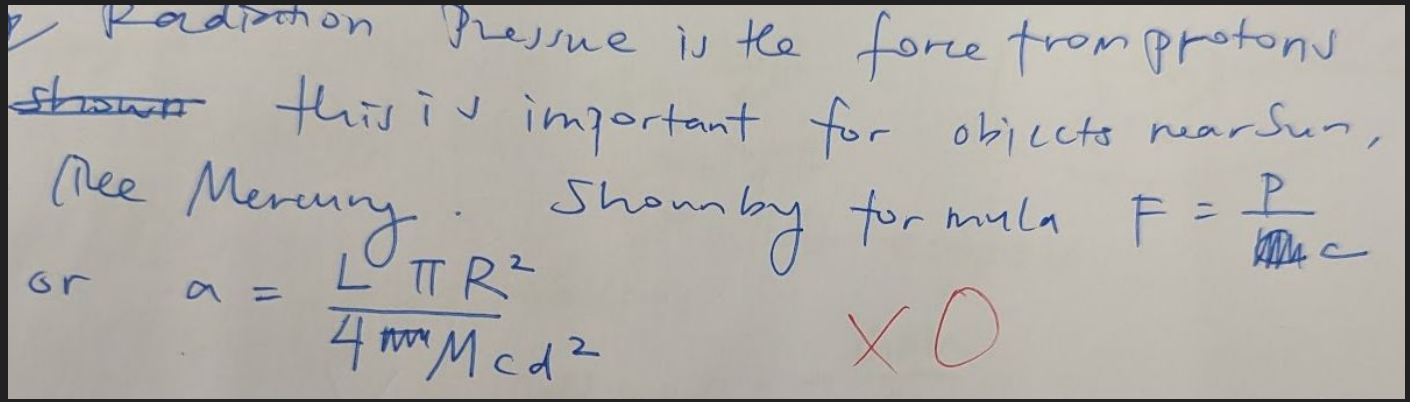


After the crashout, question by question breakdown:

Subpart **(c), (d), (e)**

The fundamental forces. Electromagnetic, gravitational, and Dark matter interaction

Also, what the…??????????????????????



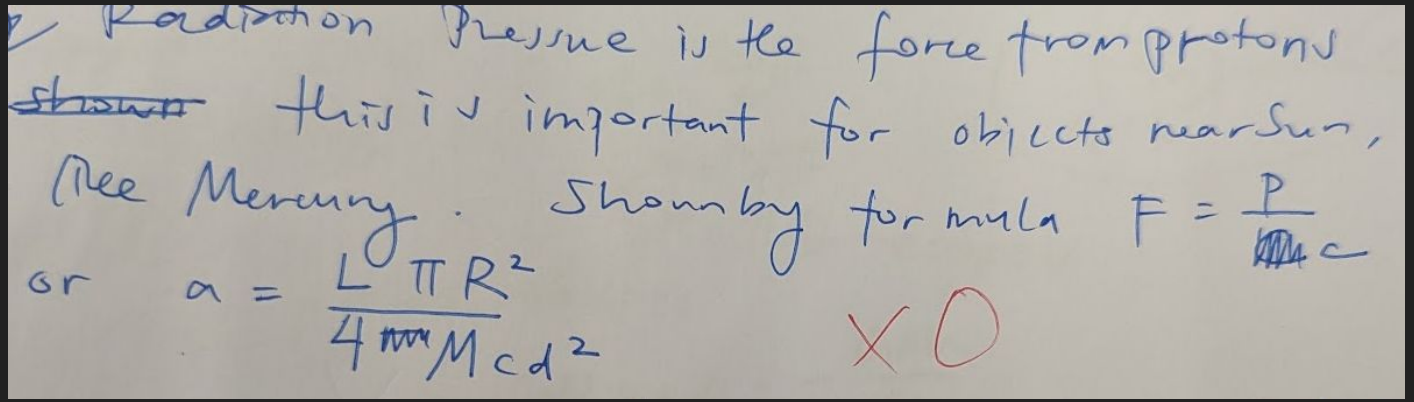
Where did mercury come from??

THE STRAITS TIMES SINGAPORE

Interdisciplinary education key to developing green economy skills

The fundamental forces: Electromagnetic, gravitational, and Dark matter interaction

Also, what the…??????????????????????



Where did mercury come from??

After the crashout, question by question breakdown:

Subpart **(f)**

How does sound work?

(f) Explain how does an acoustic wave form inside the baryon-photon fluid with reference to compressions and rarefactions. Use sound as analogy if required **[2]**

My mood after looking at good answer!

After the crashout, question by question breakdown:

Subpart **(g) and (j)**

Mathematical manipulation

(g) Explain what happens to the speed of the acoustic wave at recombination using the formula above. **[2]**

Hint: The mathematical tool of limits might be helpful here, but non-mathematical arguments are fine as well. Do NOT overthink.

Solution:

At recombination, the radiation is freely able to move in the universe. This means, suddenly,

$$\rho_\gamma \ll \rho_b$$

Algebraically manipulating the equation, we notice,

$$c_s = \frac{c}{\sqrt{3}}\left(\frac{1}{1+\frac{3\rho_b}{4\rho_\gamma}}\right)^{\frac{1}{2}}$$

As $\rho_\gamma \ll \rho_b$,

$$\frac{\rho_b}{\rho_\gamma} \gg 1 \implies \frac{1}{1+\frac{3\rho_b}{4\rho_\gamma}} \approx 0 \implies c_s \approx 0\,\mathrm{m\,s^{-1}}$$

This implies that the wave stopped immediately at recombination.

(j) What is the inaccuracy here? **[1]**

Hint: Refer to part (g) for hint. I must admit this is more of a mathematical question than a physical one, however we all must respect mathematics, nonetheless.

Solution:

The speed of sound in Cornelius' expression is assumed to be constant. However, from part (g), we know that the speed of sound was decreasing as time passed on due to changing densities. Therefore, c_s must be inside the integral sign in the expression, i.e.,

$$l_r = \int_0^{t_r} c_s(t)\chi(t)\,\mathrm{d}t$$

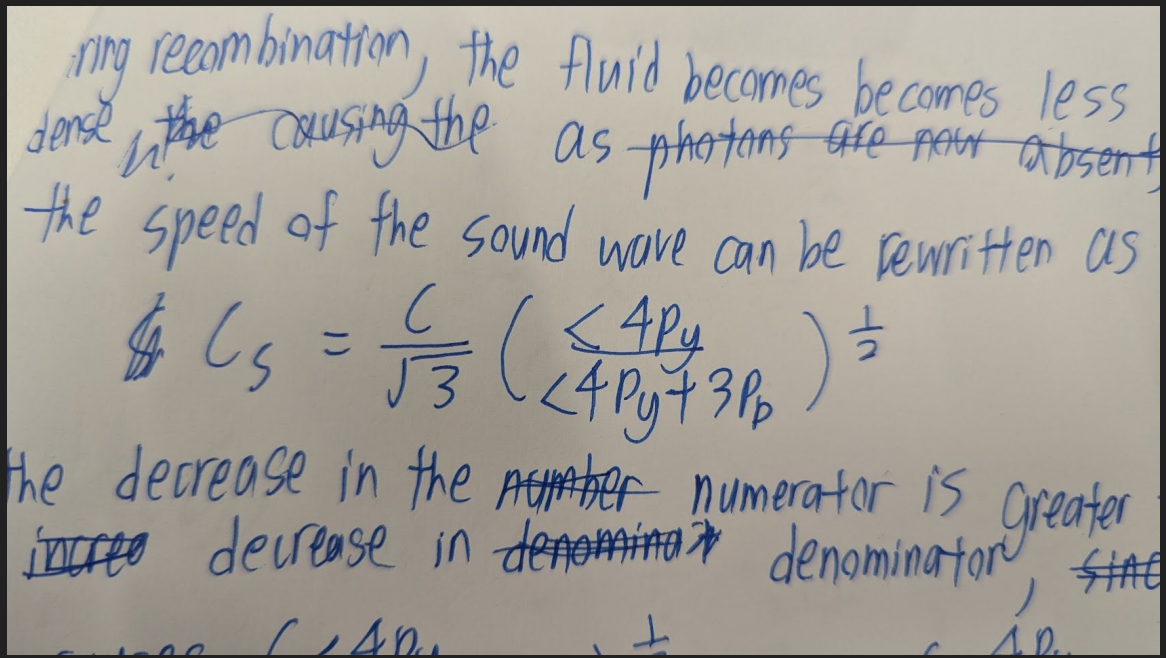
Another happy question moment. Most of you understood this. but…

After the crashout, question by question breakdown:

Subpart **(g) and (j)**

Mathematical manipulation

WHEN IN DOUBT, CREATE YOUR OWN NOTATION



After the crashout, question by que

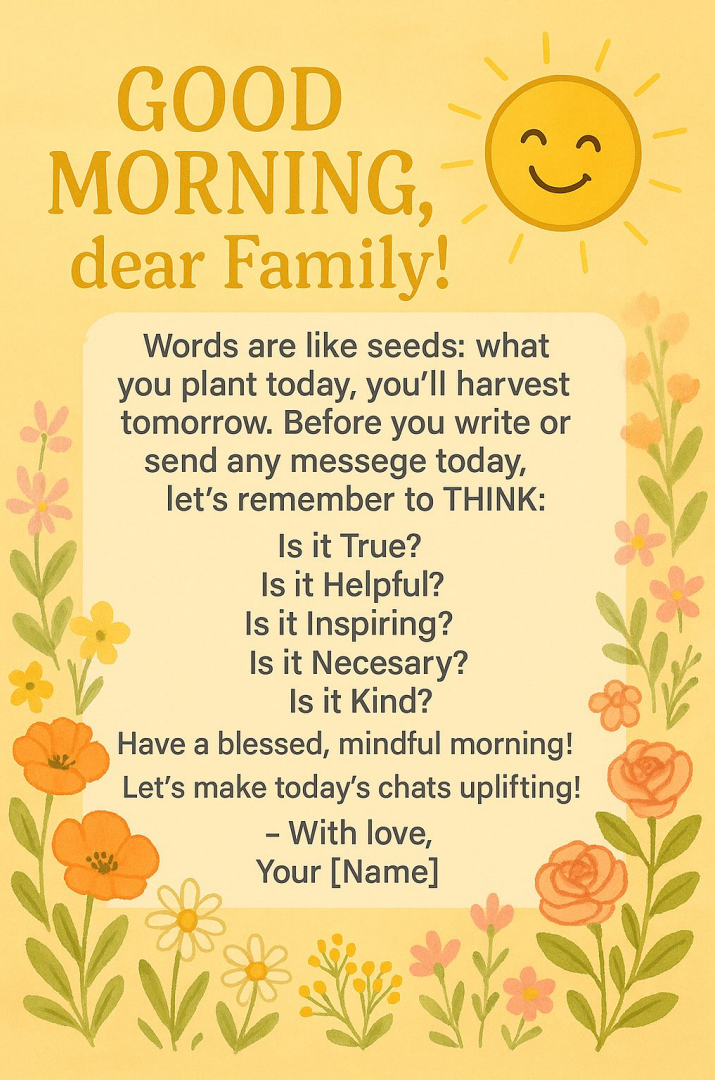
Subpart **(g) and (**

Mathematical manipulat

g) Increase because the density of radiation and baryon

and $c_s \propto \frac{1}{v}$, where v is the tota

Infinite speed!



After the crashout, question by question breakdown:

Subpart **(h)**

Disappointment

(h) What does part (g) imply about the baryonic and dark matter distribution at recombination? Think about a three-dimensional wave propagating through space, with a higher dark matter concentration at the location where the wave started. **[1]**

After the crashout, question by question breakdown:

Subpart **(h)**

Disappointment

(h) What does part (g) imply about the baryonic and dark matter distribution at recombination? Think about a three-dimensional wave propagating through space, with a higher dark matter concentration at the location where the wave started. [1]

Page 16

Hint to the question, also on Page 16

Hint: Maybe reading the rest of the question will give you inspiration for an answer.

After the crashout, question by question breakdown:

Subpart **(h)**

Disappointment

(h) What does part (g) imply about the baryonic and dark matter distribution at recombination? Think about a three-dimensional wave propagating through space, with a higher dark matter concentration at the location where the wave started. [1]

Page 16

Hint to the question, also on Page 16

Hint: Maybe reading the rest of the question will give you inspiration for an answer.

ANSWER LITERALLY ON PAGE 17

Samantha continues, "The evidence is galaxies. As I mentioned before, at recombination you are left with a central dark matter region and a spherical shell with a radius of 150 Mpc (in comoving coordinates) with slightly higher matter density."

After the crashout, question by question breakdown:

Subpart **(k), (m), (n), (o)**

You all simply collapsed at this point

After the crashout, question by question breakdown:

Subpart **(k), (m), (n), (o)**

K wanted → understanding of interference
M wanted → understand of comoving coordinates
N wanted → understanding of sampling
O wanted → understand of the two point correlation function

Very few correct; maybe you guys were too tired

After the crashout, question by question breakdown:

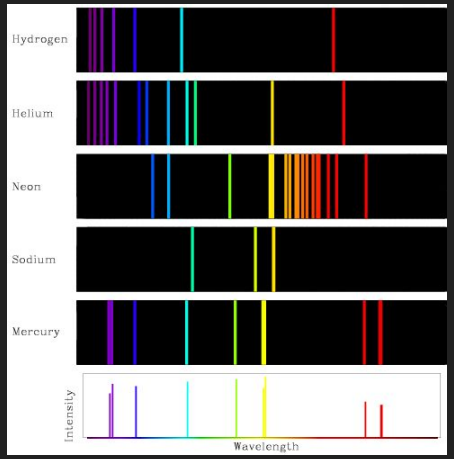
Subpart **(k), (m), (n), (o)**

You have heard of…

After the crashout, question by question breakdown:

Subpart **(k), (m), (n), (o)**

You have heard of…



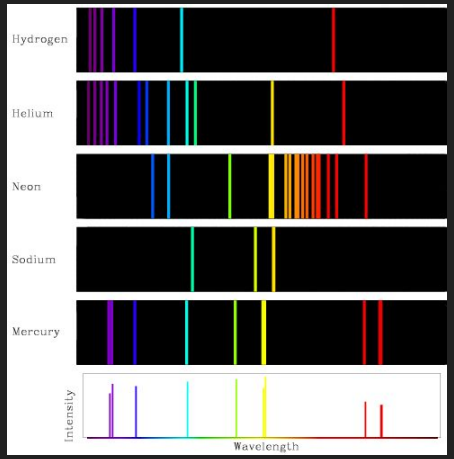
Emission spectra

After the crashout, question by question breakdown:

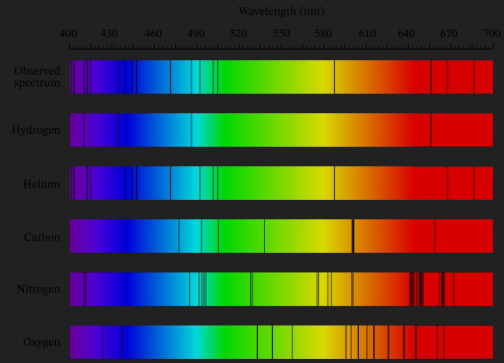
Subpart **(k), (m), (n), (o)**

You have heard of…

Please welcome…



Emission spectra



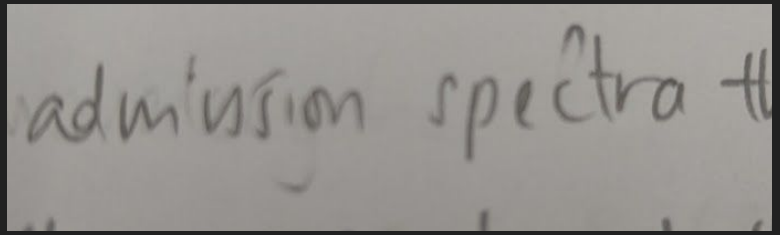
Absorption spectra

After the crashout, question by question breakdown:

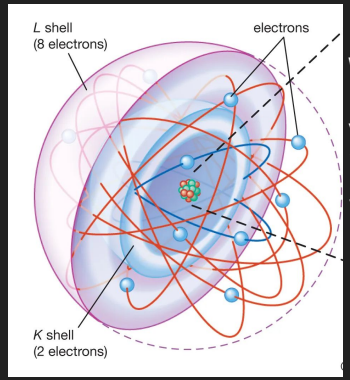
Subpart **(k), (m), (n), (o)**

You have heard of…

Please welcome…



Admission spectra



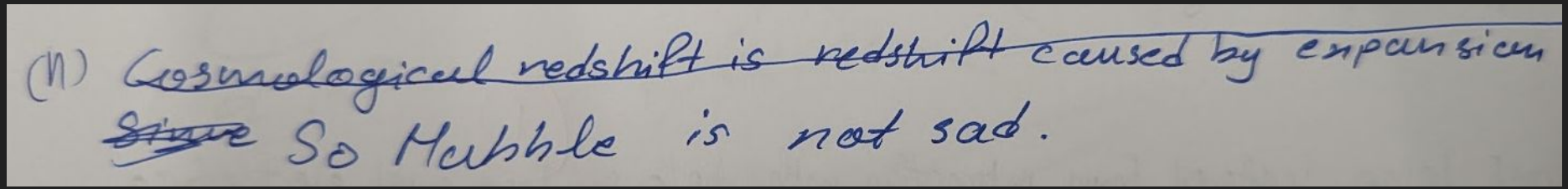
What was your PSLE score?

Cannot come here then

Not good eh

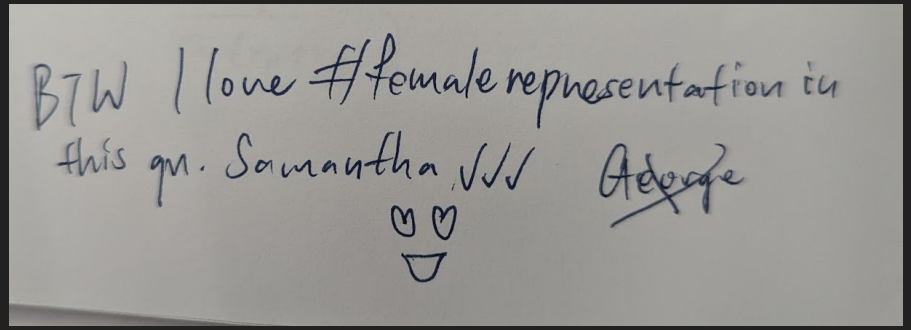
After the crashout, question by question breakdown:

Subpart **(k), (m), (n), (o)**



Valid enough

Final comments



Question wanted to test:
> how good you understand J1/J2 physics
> agreed, majority of the question was on “analysing and synthesizing your existing knowledge”
> when in doubt, please go back to physics fundamentals. People who stuck with basic physics fundamentals did very well.

Short story:
How Trump potentially affected my question's experience?

I wanted a plate…

Wondering if I can get the "plates" for an astronomy event in Singapore

Kushagra Shrivastava

To: outreach@sdss.org

Cc: sdss5-director@sdss.org; astrochallenge@gmail.com

Reply | Reply all | Forward

Wed 12/18/2024 2:27 AM

Greetings of the day,

I am Kush, a Y2 Physics undergraduate and, the President of the National University of Singapore's Astronomical Society (NUSAS). NUSAS (along with our counterpart, NTU Astronomical Society) organises AstroChallenge every year — an astronomy event for pre-university students. 2025 marks its 21st iteration, and I would like to do something funny.

For the upcoming AstroChallenge, I am creating a question on Baryonic Acoustic Oscillations. During my research, I came across Dr Daniel Eisenstein's lecture at Harvard a decade ago on the same topic. During the lecture, he passed around the plates in which the fibers are connected for data collection. He mentioned how each plate was used once and then stored, probably for no further use.

I would like to ask if it's possible to get any one of those plates, from any SDSS survey, parceled to Singapore.

I understand it is a rather unusual request asking for a 10-pound aluminum plate parceled around half the globe, but it would make for an amazing story! Storied and experiences are extremely inspiring.

I was a participant in AstroChallenge from 2019-2022, and it was the reason why I choose astrophysics as my career path. For its 21st edition, I want to give back to my juniors and provide them this weird, but rather remarkable piece of aluminum to have a look at (and also significant to the question I am creating).

AstroChallenge 2025 takes place from 6th to 11th of June, 2025.

Any form of help with this *creative endeavor* would be greatly appreciated.

Thanks and regards,
Kushagra Shrivastava (FRAS)
President, 27th NUSAS Executive Committee

They AGREED???

Dear Kushagra,
I'm [redacted], the Education and Public Outreach Coordinator for SDSS-V. We should be able to ship a plate to you. For universities we typically ask the university to pay for and arrange a shipping label. You then send it to the University of Washington where some of the plates are stored and they ship the plate to you. Would your institution be able to arrange and pay for shipping?

Thanks
[redacted]

But they wanted money 😭😭😭😭😭😭😭😭😭😭

I begged AstroChallenge got no money

Hi [redacted]

Thank you for the reply. [redacted] is an independent student-run organization, and we do not receive any funding from [redacted] directly.

Thus, is there any chance you could sponsor the shipping as well?

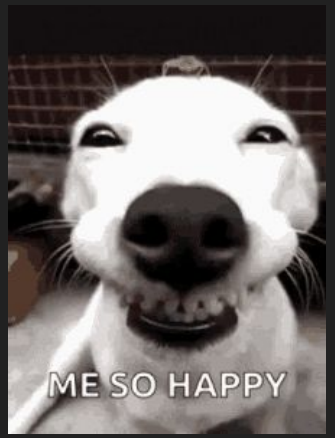
HORRAY THEY AGREED FOR COMPLETELY FREE

Dear Kushagra,
I'm pleased to tell you that our director has approved paying for the shipment of the plate. This is on condition that you only use the plate for education and outreach & don't sell it. Also that you send us lots of pictures of the event so we can publicise it on our social media. I've been asked by [redacted] (in cc) to ask you for the following information. Note that the postal code and phone number here are placeholders and you will need to replace them.

Thanks
[redacted]

I was so happy omgomgomgomgomgomgomgomg

Me fr



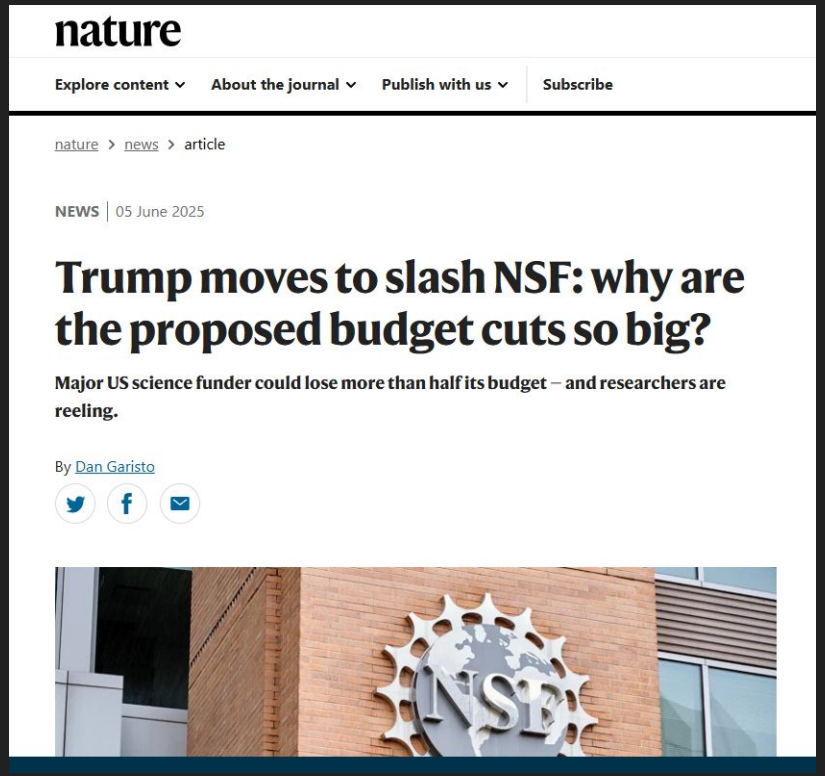
Then that trump happened…

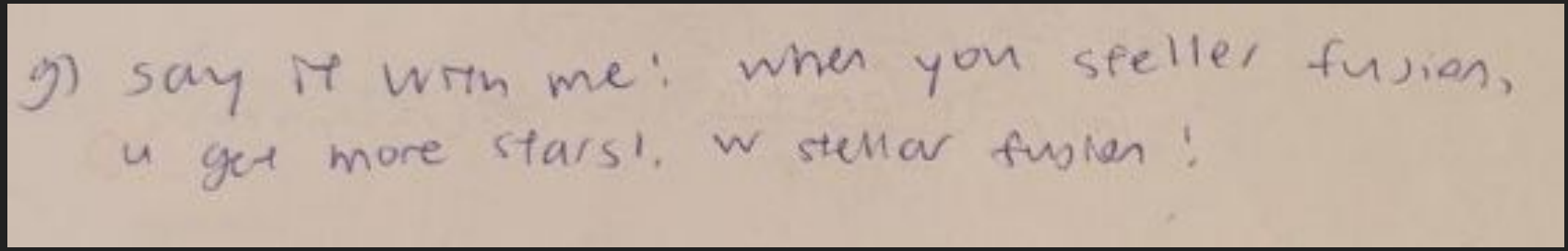
The Sloan Digital Sky Survey (SDSS) has been funded by a combination of private and public sources, including the Alfred P. Sloan Foundation, the participating institutions, the National Science Foundation, the U.S. Department of Energy, the National Aeronautics and Space Administration, the Japanese Monbukagakusho, the Max Planck Society, and the Higher Education Funding Council for England. SDSS-IV, for example, also received support from the Sloan Foundation, participating institutions, and national funding agencies.

My follow up emails were never replied :(… at least i tried

Just checking if there's any update on this?

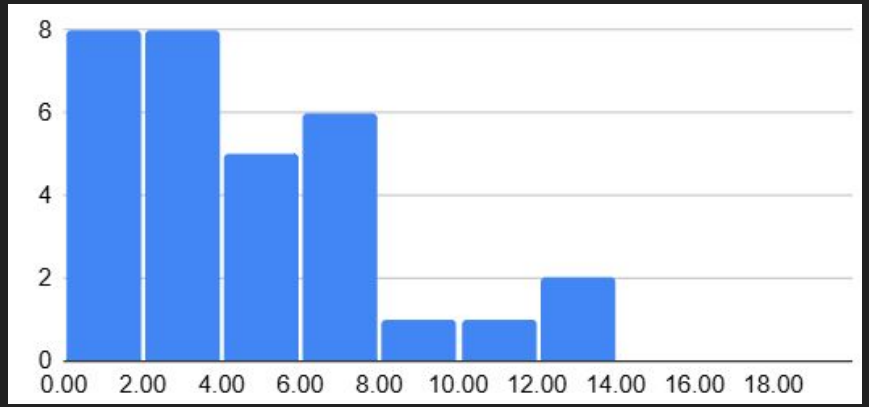
Thanks and regards,
Kushagra Shrivastava




9) say it with me: when you stellar fusion,
u get more stars!. w stellar fusion!

Question 4

Generally went… as expected



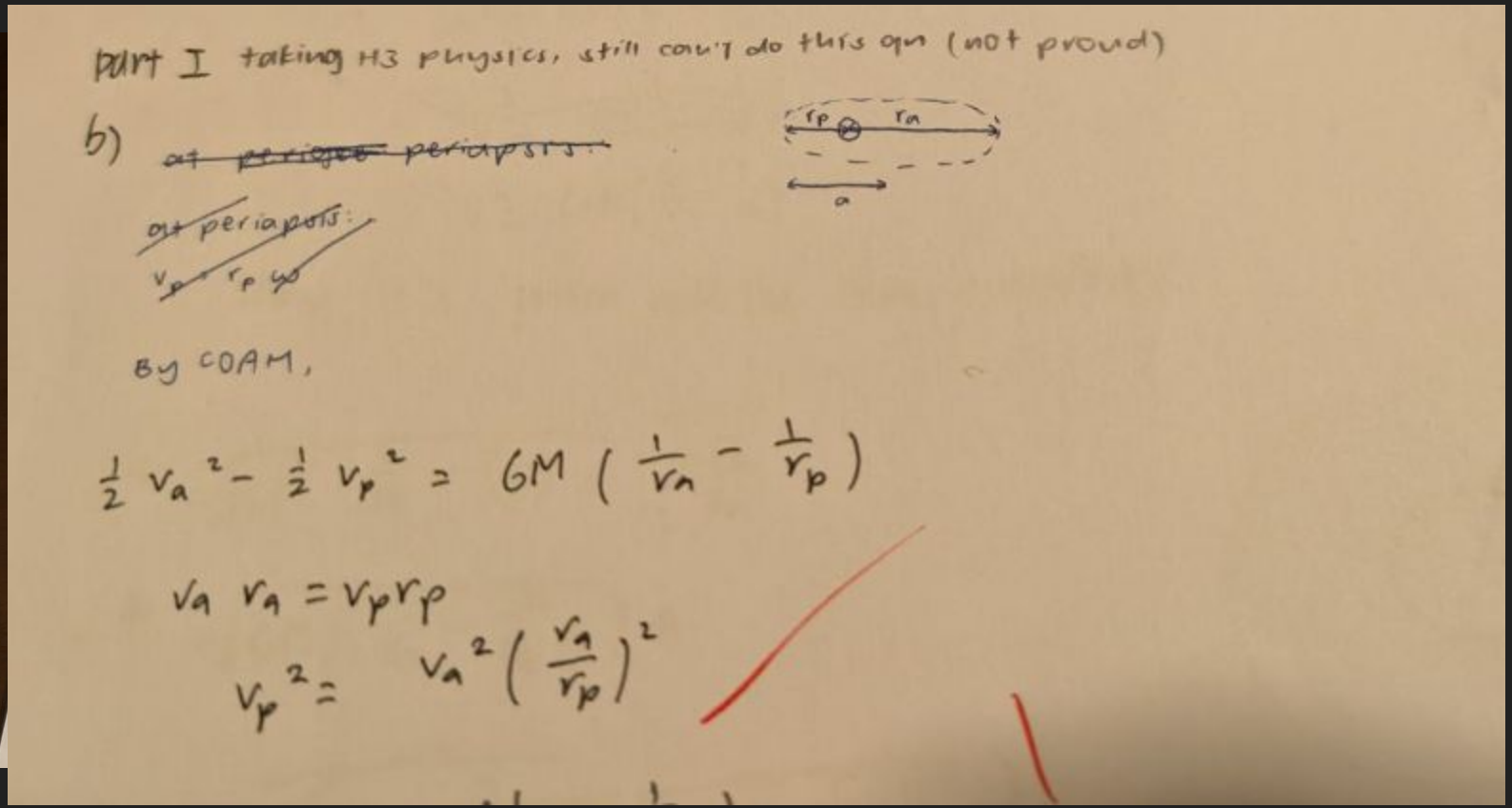
Aim of the question

- 2 Pronged
- 1: Get a better understanding of the calculations and the physics behind orbital mechanics, especially hohmann transfers
- 2: Better understand the physics of moons and satellites and effects caused by tidal forces.

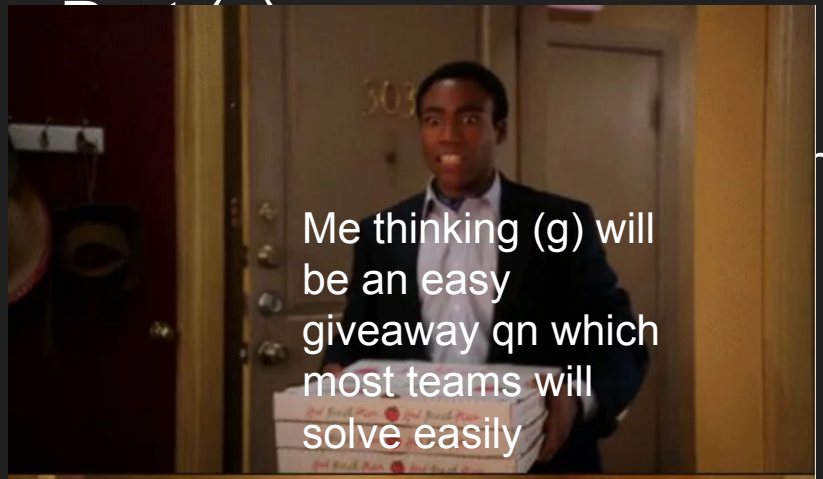
What actually happened

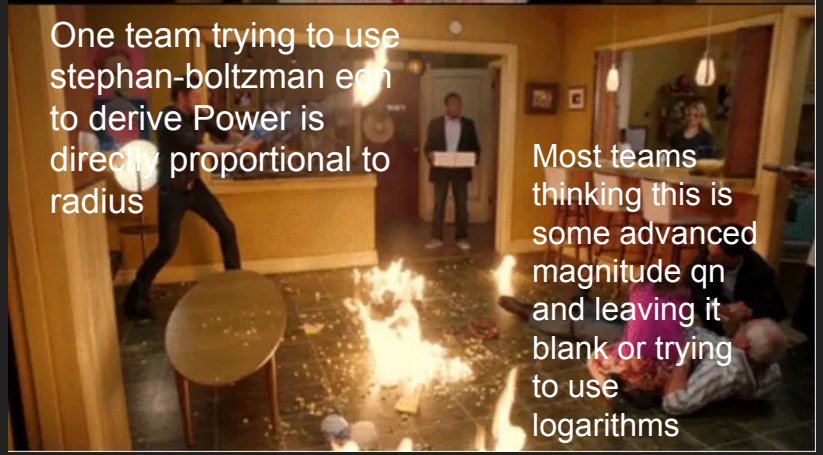
- Most attempted (a), (b), (c) and (d) and got it partially right
- (e) was attempted by many but….
- (f) and surprisingly (g) were left completely blank by most
- The rest of the subparts had varying degrees of attempts but very few teams got any correct
- No team got (m) or (n) correct

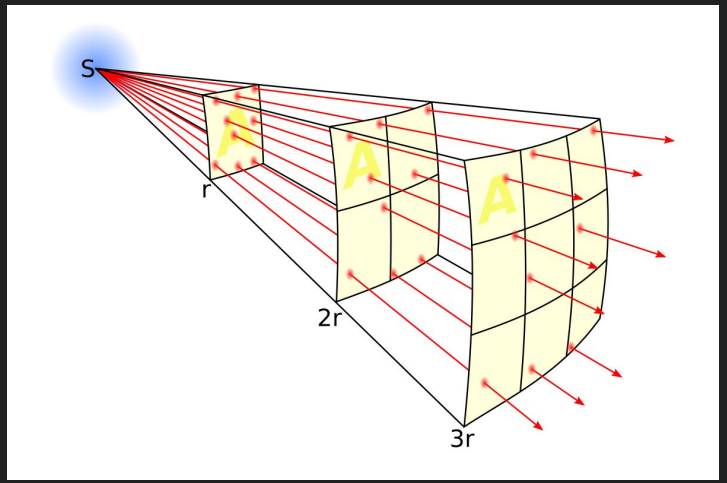
Parts (a) to (e): generally well done



n based on H2 Physics

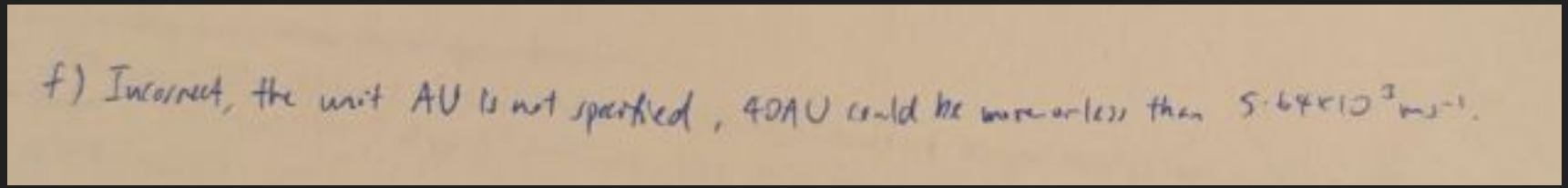






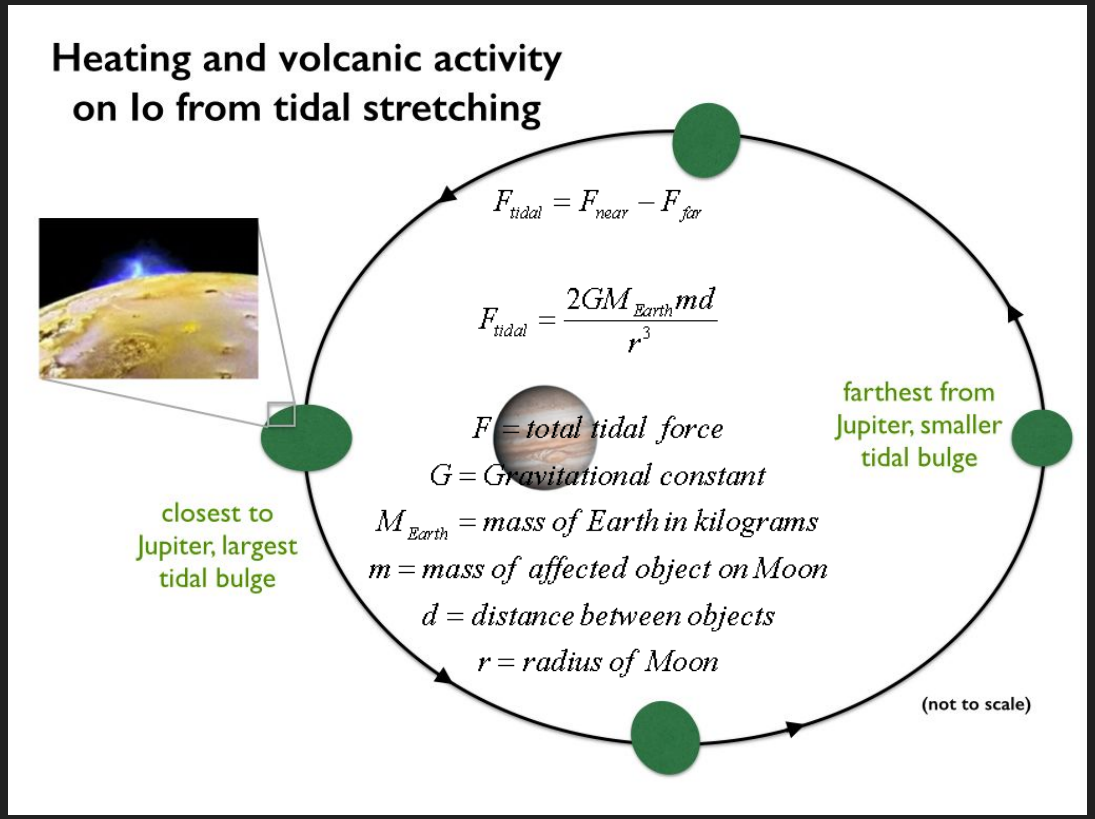
Parts (f) , (m) and (n)

Only 1 team got (f) correct, none got (m) and (n) correct



Nothing else to show here because everything else was blank

How to do (m): No one knew how to even start



Work Done

Work done is the amount of energy transferred.
Work done = force x distance moved in the direction of the force.

$$W = \Delta E$$

$$W = F \times d$$

W = work done (J)
ΔE = energy transferred (J)
F = force (N)
d = distance moved in the direction of the force (m)

PART (n) WHY DOES NO ONE KNOW HOW TO USE CALCULATOR

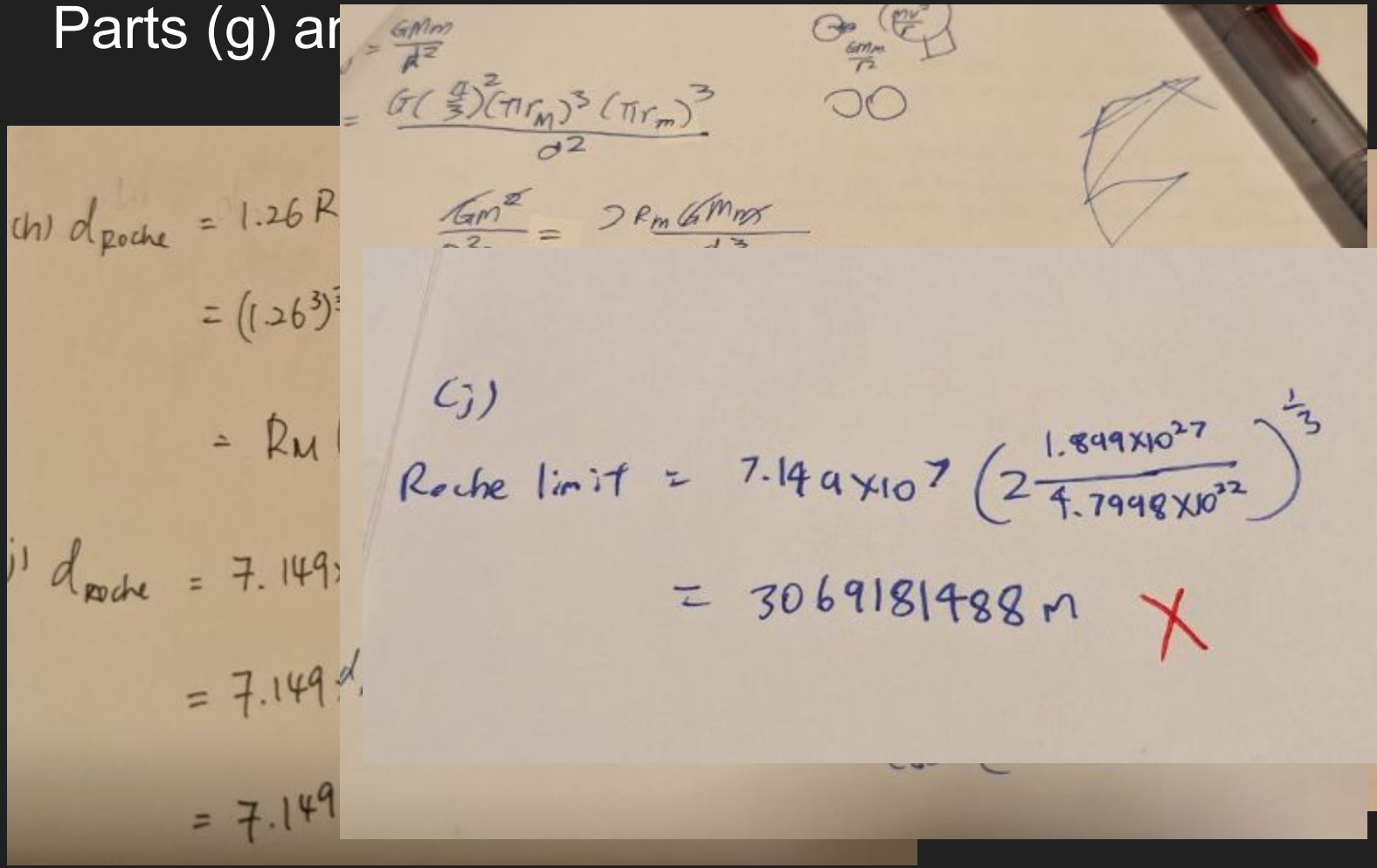
$$\frac{dE_{Tidal}}{dt} = -\text{Im}\{k_2\}\frac{21}{2}\frac{GM^2R^5ne^2}{a^6} \tag{26}$$

where

- $-\text{Im}\{k_2\}$ is the imaginary part of the second order love number, with a value of 0.02. That is, $-\text{Im}\{k_2\} = 0.02$
- R is the radius of the moon
- M is the central larger body's mass
- n is the mean orbital motion, which is the angular velocity required for the satellite to complete one full perfectly circular orbit in the same time as its elliptical orbit period
- e is the eccentricity of the satellite's orbit.

You may wish to use any necessary values of the Europa system from part (m).

Parts (g) ar



(j)

Roche limit $= 7.149 \times 10^7 \left(2 \frac{1.899 \times 10^{27}}{4.7998 \times 10^{22}}\right)^{\frac{1}{3}}$

$= 3069181488$ m

Overall:

Definitely a harder qn

Expected most to be able to get parts (a), (c), (g) and (n)

Reality was a little more disappointing.

Overestimated the ability of seniors to do delta-v calculations

Observation (Theory + Practical)

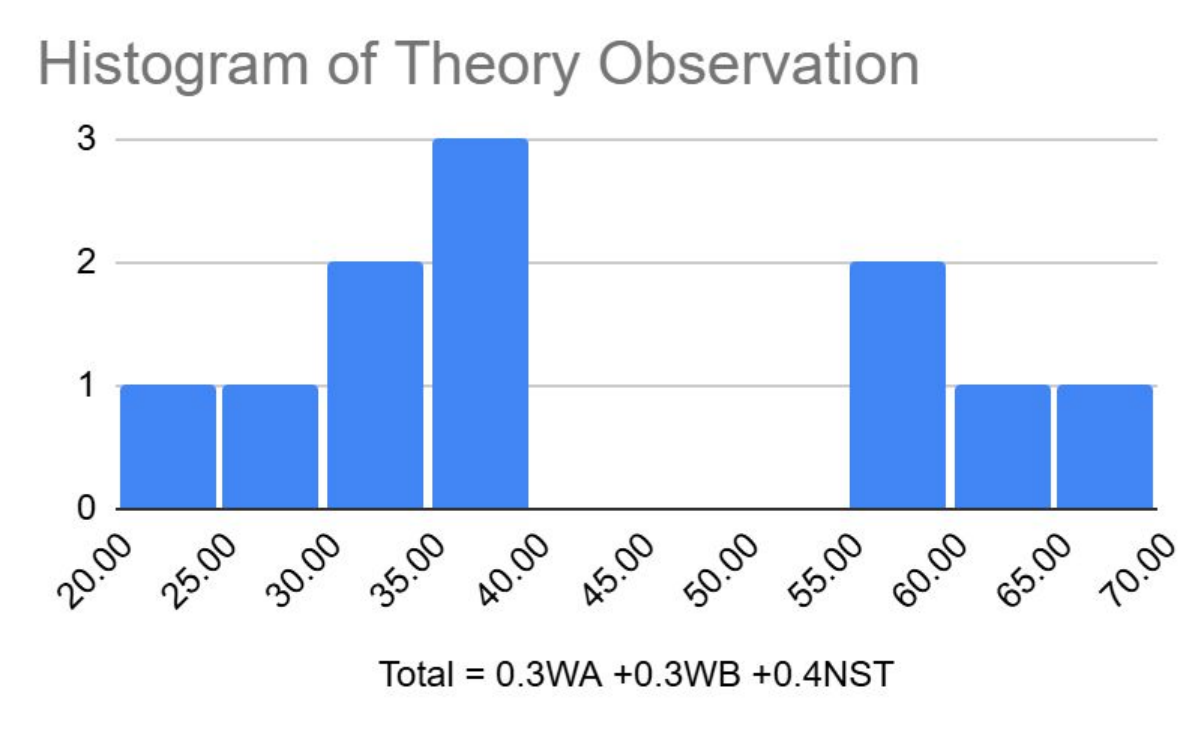
Day 1 (Theory and NST)

Mean: 42.08693131

Median: 36.28350501

Highest: 67.99107424

Lowest: 23.48177318



Day 1 (Theory and NST)

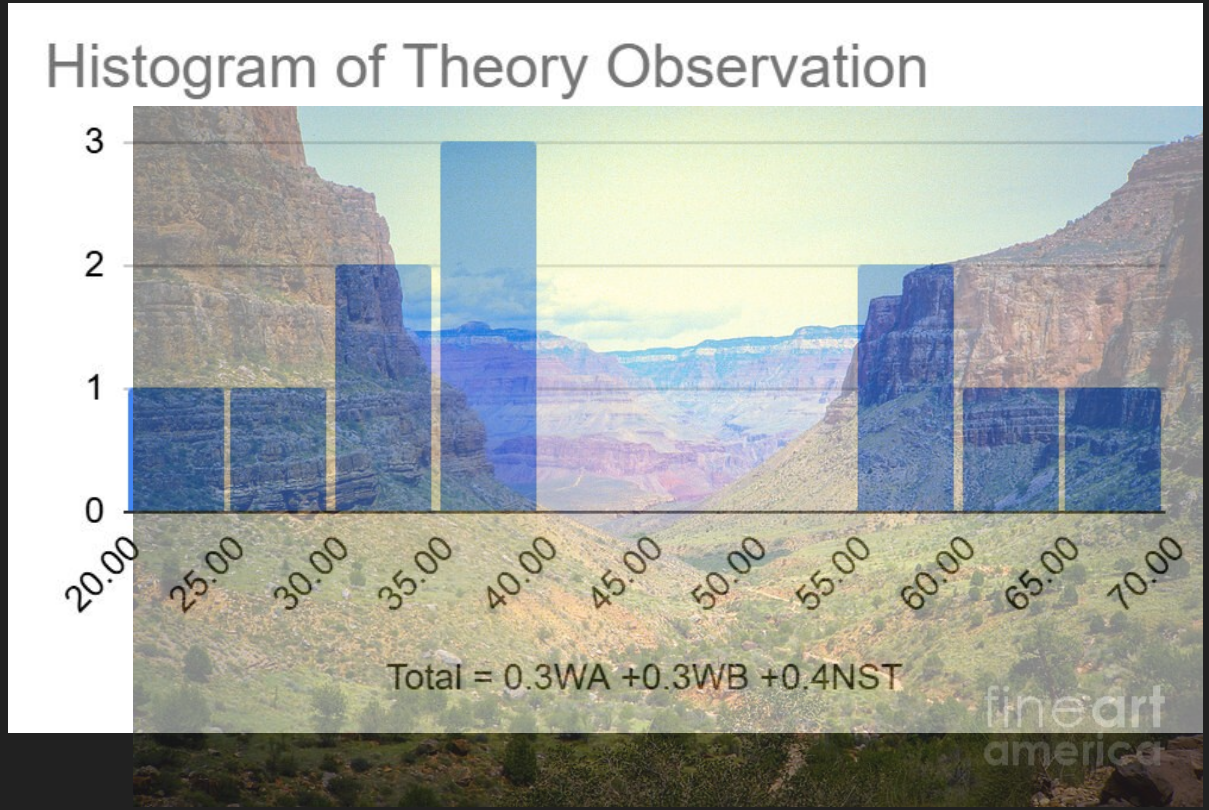
Mean: 42.08693131

Median: 36.28350501

Highest: 67.99107424

Lowest: 23.48177318

Grand Canyon?!?!?



Question 1: Harmonic Mount

Some statistics

Mean: 6.272727273

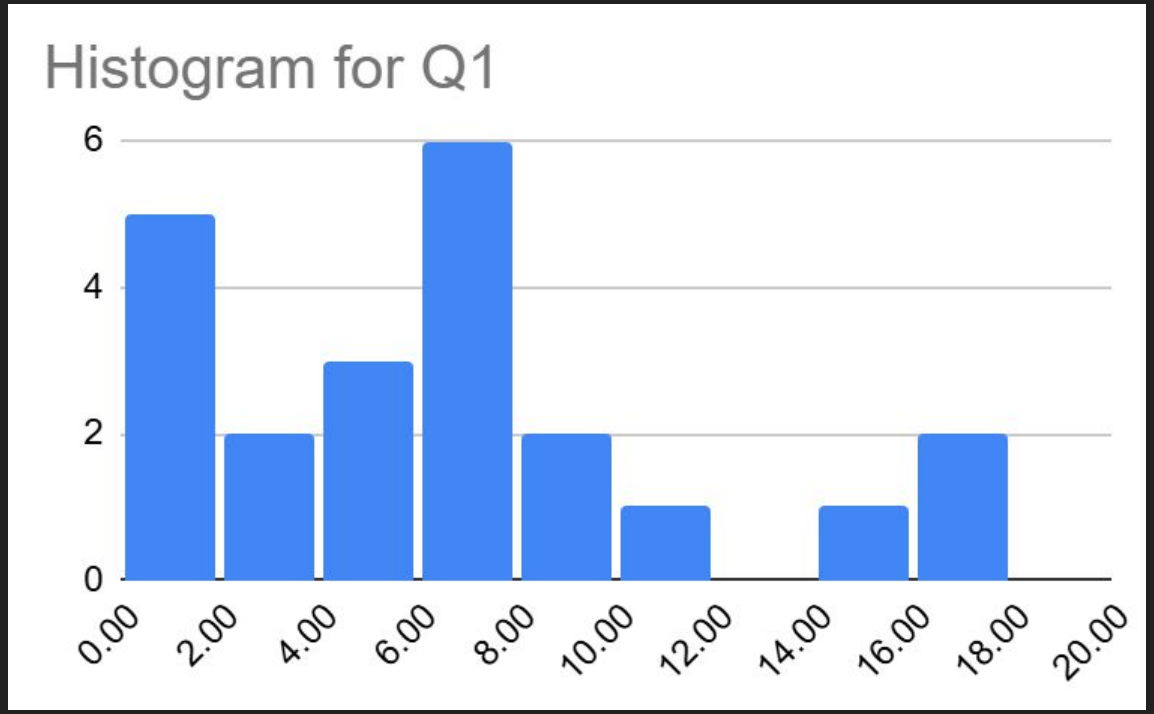
Median: 6.25

Mode: 1

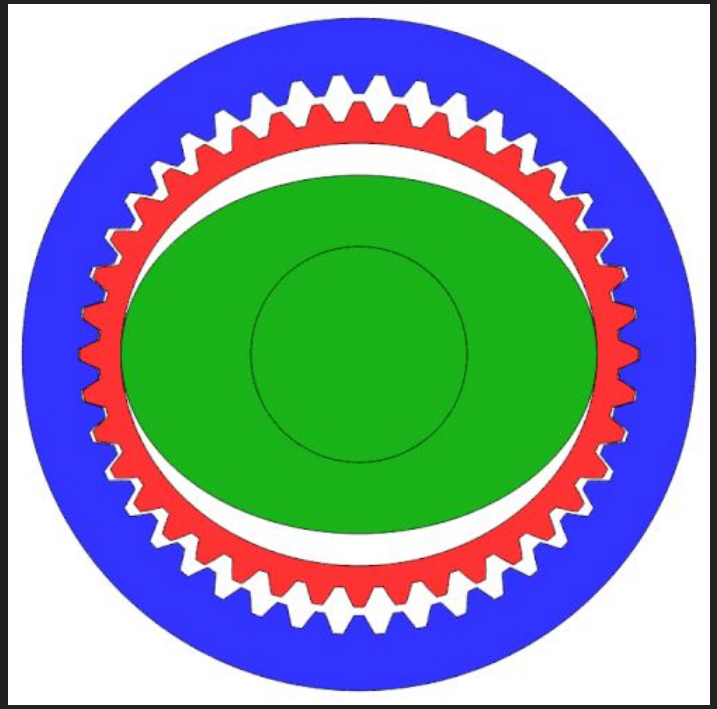
Highest: 17

Lowest: 0.5

Total score: out of 20

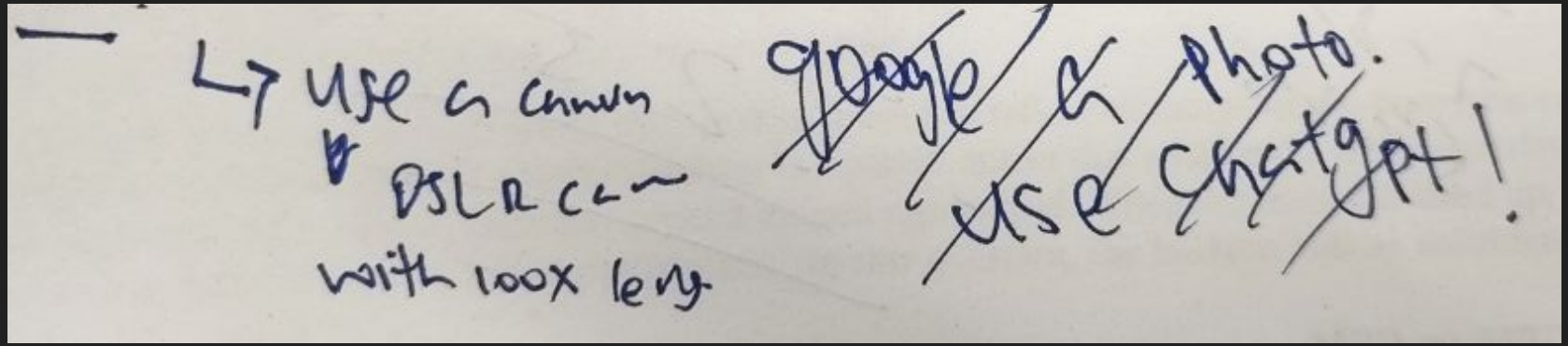


Hypnotising… I mean Harmonic reducer



Mounts can feel like ✨magic✨ sometimes, but this question was there to help you explore how such equipment works.

The 3D model was there to help you do the question, not to be a fidget toy to fiddle with when you know you're cooked for the paper (although I must admit it is very fun to play with).



↳ use a canon
DSLR cam
with 100x lens

~~google a photo.~~
~~use chatgpt!~~

Question 2: Geo Guesser

Some statistics

Mean: 8.863636364

Median: 8.25

Mode: 2 and 19 (?!?!?!!?)

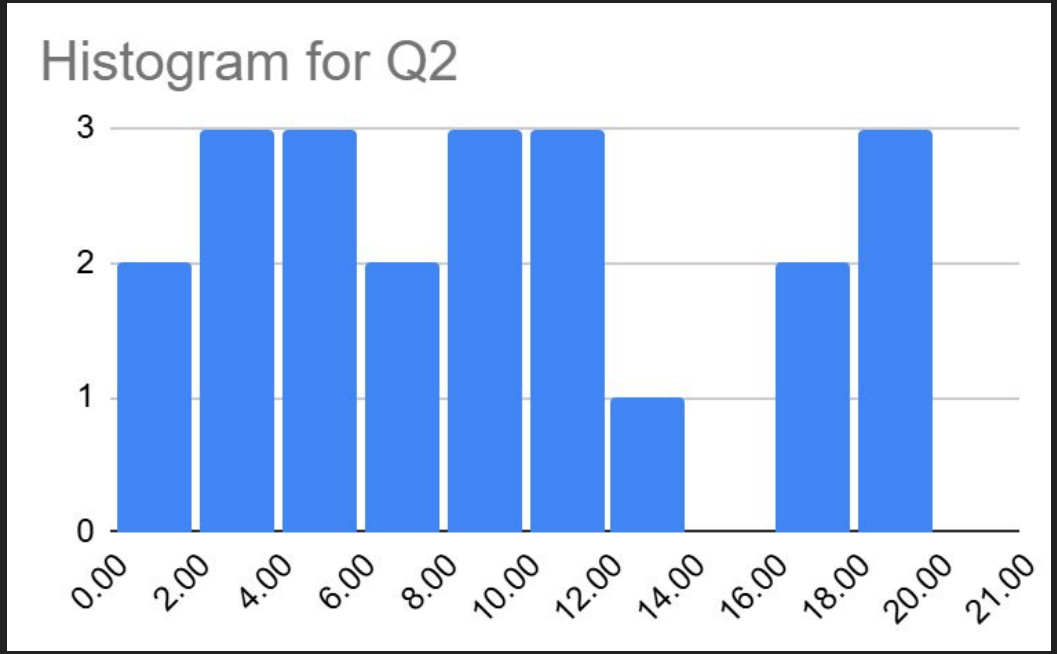
(two teams each)

Standard Deviation: 6.081161031

Highest: 19

Lowest: 0

Total score: out of 21



Why this question?

This was Stellar Vista in Jan 2025

The index mirror is a fully reflective mirror that is used to reflect an image of the body you are measuring towards the horizon mirror. The horizon mirror is a partial mirror that enables the user to overlay the reflected image from the index mirror, with the horizon viewed right ahead. When the sextant is lined up, the rays from the object appear to be parallel to the horizon. In this question, the horizon will be considered to have an altitude of 0 degrees.

"I've been staring at the edge of the water"

To trick people into thinking this is a history of astronomy question before scaring them away with spherical trigo

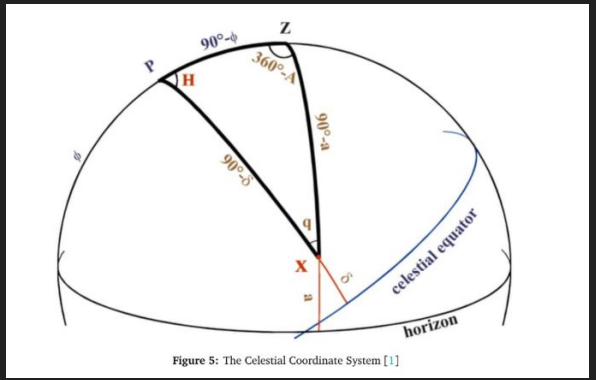
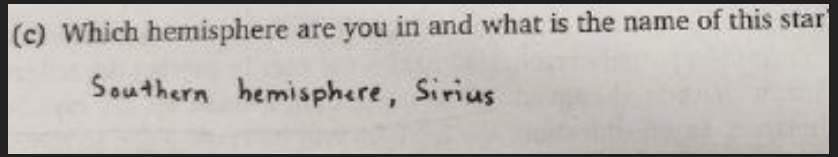


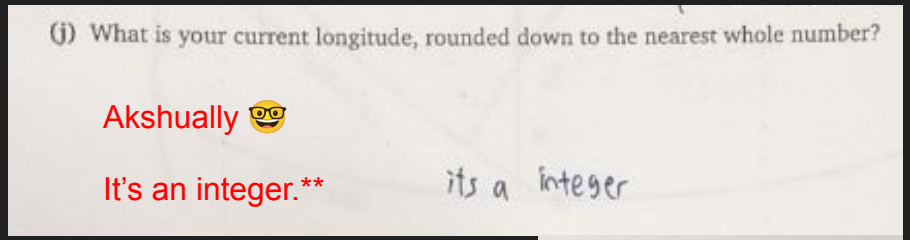
Figure 5: The Celestial Coordinate System [1]

Some funny answers

Ah yes, Sirius the pole star.


(c) Which hemisphere are you in and what is the name of this star

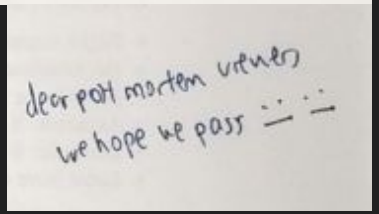
Southern hemisphere, Sirius

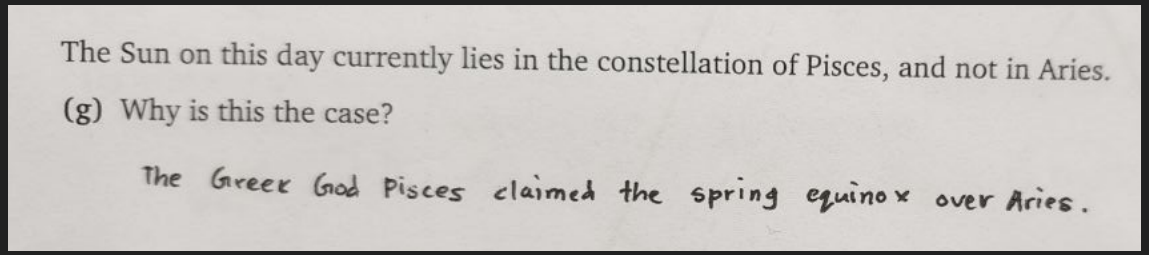

(j) What is your current longitude, rounded down to the nearest whole number?

Akshually 🤓

It's an integer.**

its a integer

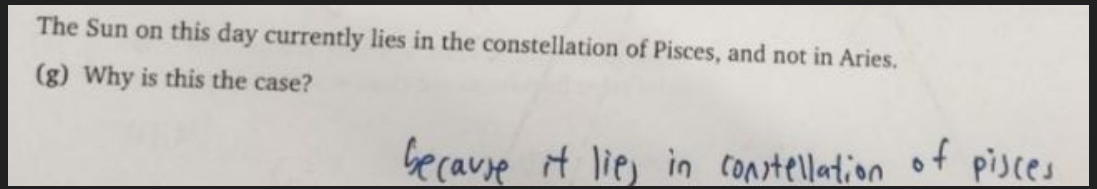

dear post mortem viewer
we hope we pass


The Sun on this day currently lies in the constellation of Pisces, and not in Aries.

(g) Why is this the case?

The Greek God Pisces claimed the spring equinox over Aries.

Ah yes, the floor is made of floor.


The Sun on this day currently lies in the constellation of Pisces, and not in Aries.

(g) Why is this the case?

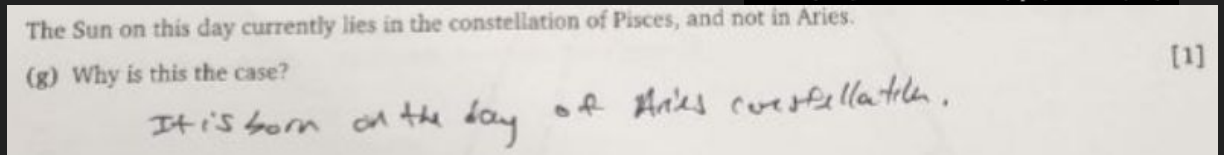
because it lies in constellation of pisces

Prove the sunrise equation [5]

Some actual trigo. Gives up.

GYATT

Therefore, $\cos(H) = -\tan(\phi)\tan(\delta)$

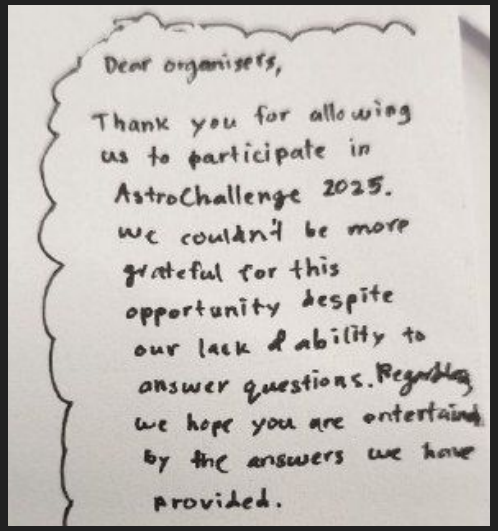

The Sun on this day currently lies in the constellation of Pisces, and not in Aries.

[1]

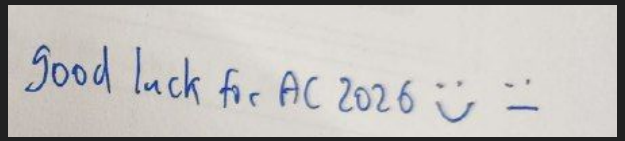
(g) Why is this the case?

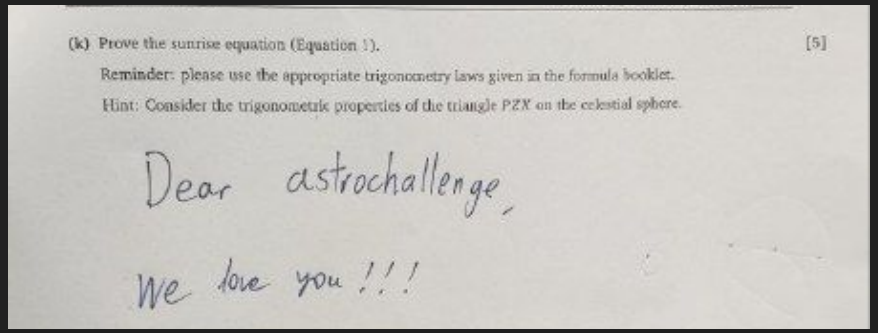
It is born on the day of Aries constellation.

Breaking the Fourth Wall


Dear organisers,

Thank you for allowing us to participate in AstroChallenge 2025. We couldn't be more grateful for this opportunity despite our lack of ability to answer questions. Regardless we hope you are entertained by the answers we have provided.


Good luck for AC 2026 ☺


(k) Prove the sunrise equation (Equation 1). [5]

Reminder: please use the appropriate trigonometry laws given in the formula booklet.

Hint: Consider the trigonometric properties of the triangle PZX on the celestial sphere.

Dear astrochallenge,

We love you !!!

Grand Reveal

(m) Just for fun, suggest what island you are on.

Antartica

Page 11 of 1

Part II Look up!

You come ashore to an island with a very clear horizon on a
or hills, just beautiful beaches.

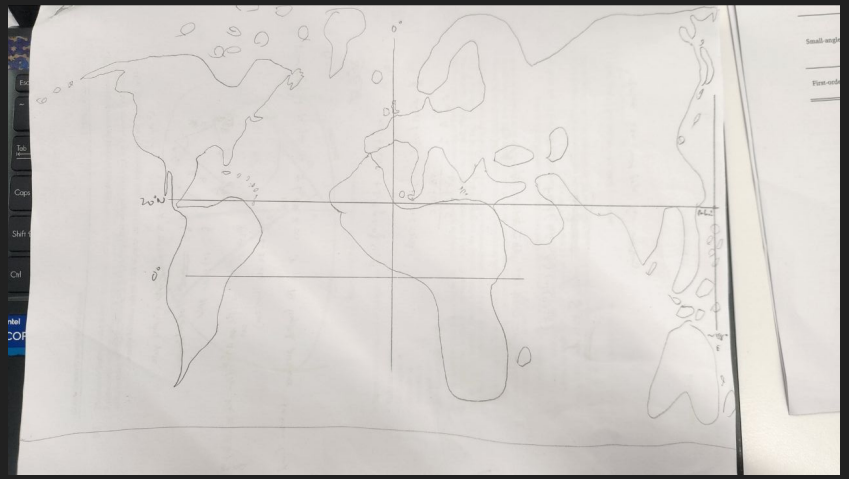
At night, since you are stranded on the island, you look up t
anti-clockwise about a single point, which is very close to a c
seem to move at all over the course of the night, and all oth

(c) Which hemisphere are you in and what is the name of t

Northern hemisphere

(m) Just for fun, suggest what island you are on.

Polar. See next page for working



HAWAII!

Quite a few teams got this right.

Latitude = altitude of polaris = 2*index mirror inclination = 2*10deg = 20 deg North

Longitude can be found using ratios 1634h UTC at 0600hrs LST -> 158 deg West.

ALOHAAAAAAA

Night Sky Talk

Rationale for Night Sky Talk

- Tests your knowledge about the night sky
- Test your presentation skills

Some memorable moments:

- “This is the star Capella, and now we will perform A-capella”
- “This is the moon” (looks at Jupiter)

Some comments

Some tips:

- Purely spamming objects are not engaging
- During preparation, please orientate yourselves and verify any objects that are very very prominent

Most importantly, we hope you have learnt something and please try to practice night sky talk back in school!

It helps with engaging the public when there’s an event too!

Day 2: Prac Obs

Governor Larry Hogan @GovLarryHogan · 10h

Last night, beginning at around 9:45 pm, I personally witnessed (and videoed) what appeared to be dozens of large drones in the sky above my residence in Davidsonville, Maryland (25 miles from our nation's capital). I observed the activity for approximately 45 minutes.

...

Show more

Preface

- Owing to the less than ideal weather, the Cloudy Weather plan was used for the first time in a while
- We actually ended pretty much on time (a first), thanks for cooperating!
- Teams were generally quite prepared and adapted well to the plan

Section A: Set-up

- Most teams breezed through this section with full, or almost full marks
- Mistakes made were either careless or very minor
- HOWEVER… There was a serious safety infraction during the round

Lessons learnt: Safety Incident on 6/6/25

Summary: A team was unfamiliar with their scope, leading to a lack of procedural knowledge on how to set it up. Several unsafe procedures were made, the most serious being when the scope almost fell off the tripod during the round.

Comments:

1) We aren’t going to crucify you if you’re not sure about something. We are here to help you, not to kill you.
2) You want to be safe, we want you to be safe. Injuries are painful and make us sad.
3) Marks are important, but are they more important than your non-broken foot?
4) Familiarise yourself with your scope! Remember that unsafe setup is a disqualification!
5) I think five is a nice number. This isn’t an actual point.

Section B: Boresighting

Mean: 76.36
Median: ???
Mode: ??

- Two teams got maximum points, well done!
- We unfortunately do not give credit for boresighting a moving plane (you know who you are)
- We may be considering a different boresighting test next year for cloudy weather (this may or may not involve a moving human)

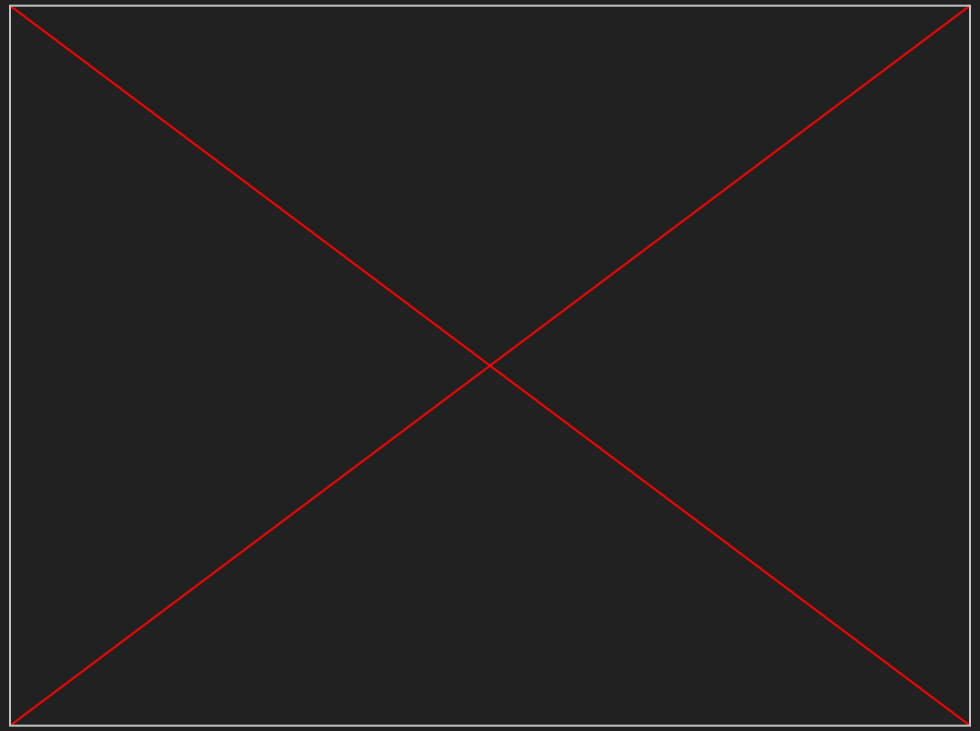
Section C: Marathon

- Most teams managed to really score in this section
- 3 teams managed to get above 200
- 8 teams (73%) managed to get above 100
- Several strategies were employed with varying success
  - Open cluster spam was used by most higher-scoring teams
  - However, the top 4 all found several galaxies boosting their scores even further
  - Finding stars is relatively easier but has less point weightage

Mean: 161.32
Median: 175
Mode: everyone got a different score so there isn’t one

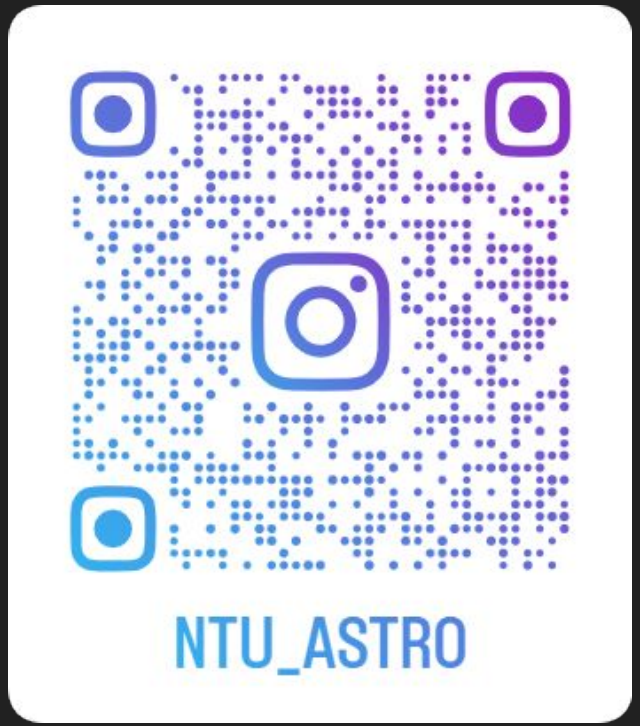
Finals (finally!)

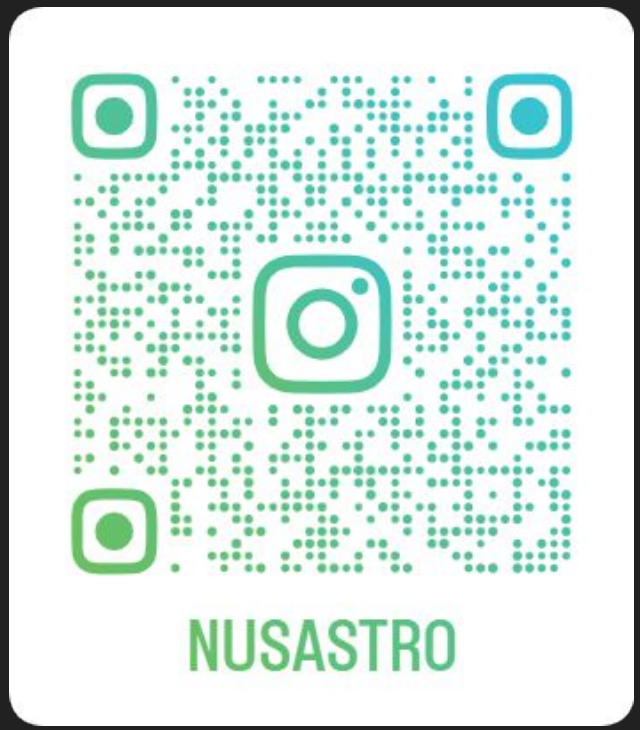
Released video:



the judges hearing random nonsense coming out during buzzer round

Alright so if you've liked this video remember to like, share and follow!





Closing