Junior Post Mortem

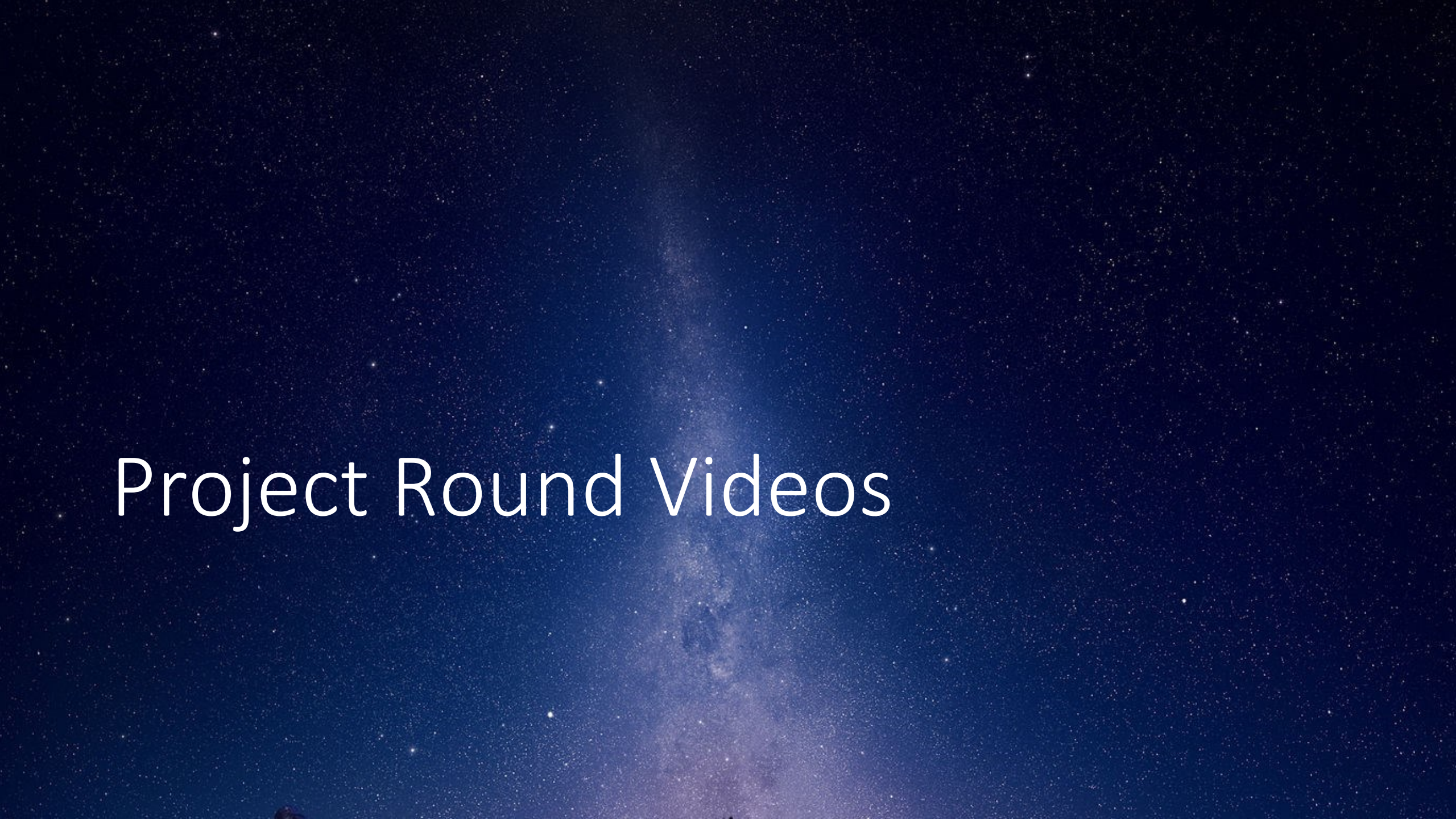
8 June 2019

DO NOT DESECRATE THE AC CHAMPION TROPHY!

Trophy buried under trash!!!

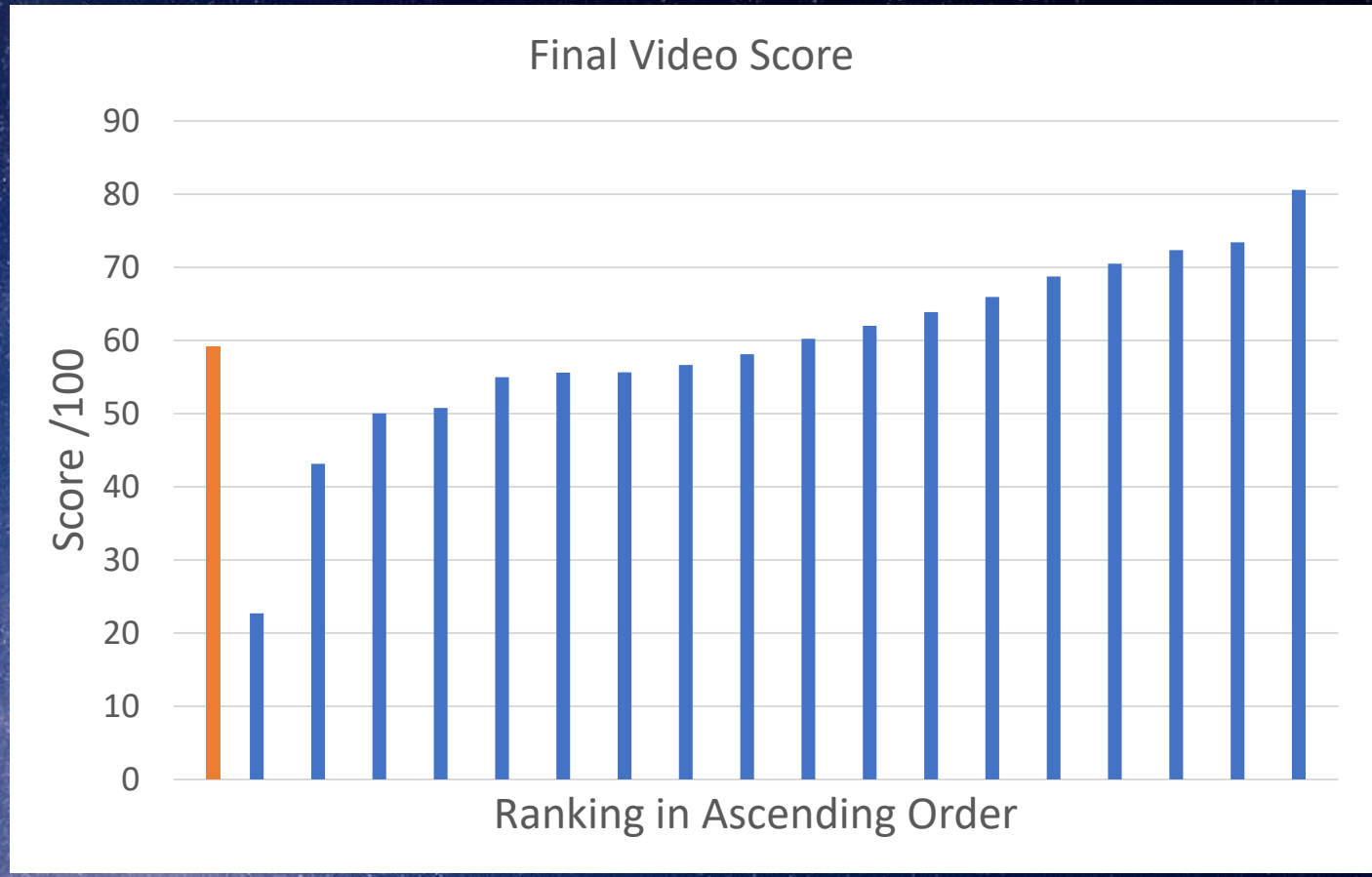
Trophy left lying on grass

Project Round Videos



Summary

- Most teams were on par or around the mean (59/100)
- However, average quality felt generally subpar and last minute
- Performed poorer compared to seniors in quality



Summary

Most popular question: Question 24 (tied with Q18)

- What are some possible ways of colonising Mars?
  - Content was passable, but suffers from poor presentation…
    - Excess use of memes and/or use of irrelevant graphics

Best answered question: Question 18

- What are planetary nebulae and why are they so colourful?
  - Interesting concepts + good vocal clarity, but started to trail off at the end…

Pitfalls and how to avoid them

- Problem: Watermarks, poor quality video editing software
- Solution: Use this list of free video editing software!!!
- **Bold: Recommended**

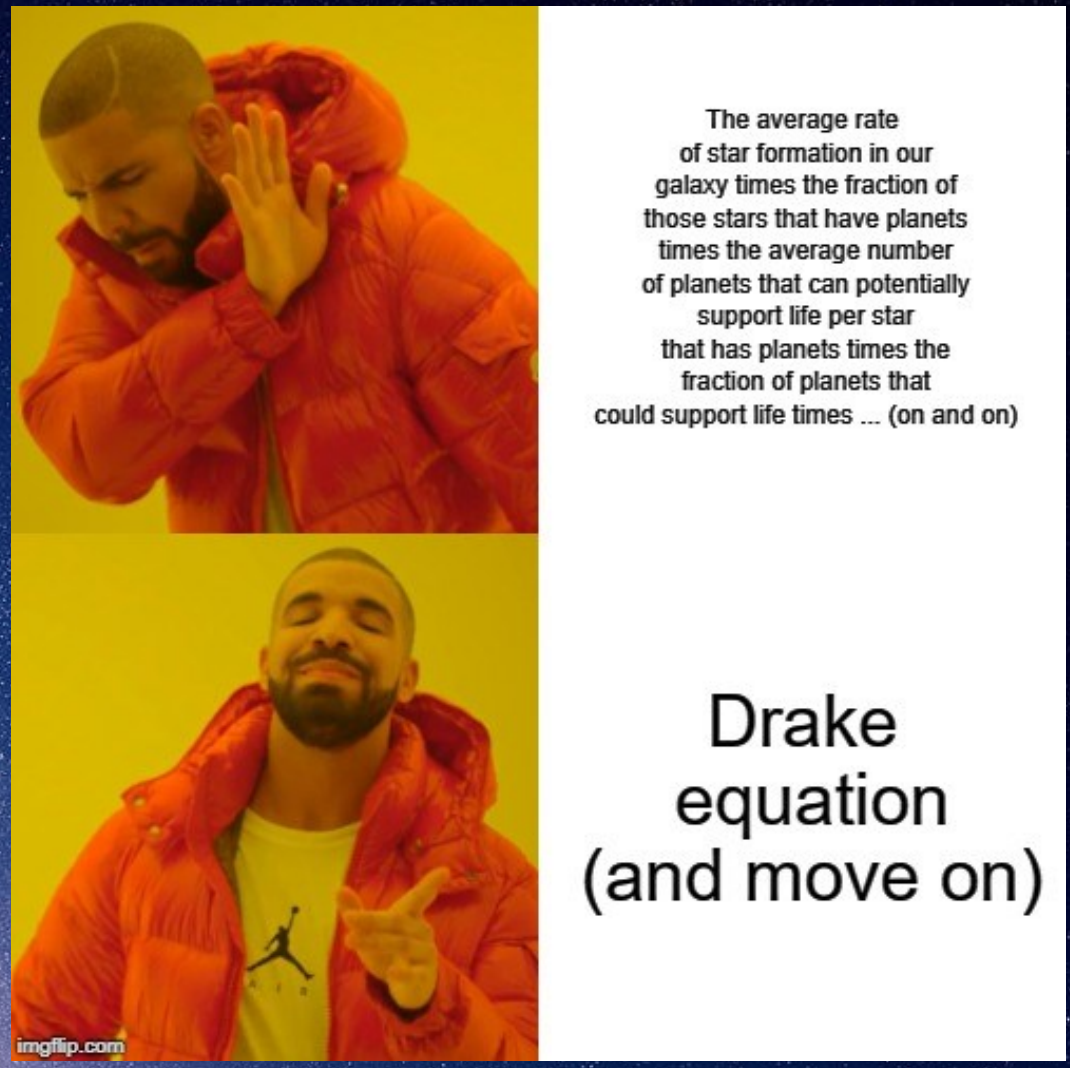
- Problem: Chipmunk voices, speeding up the video, distracting music
- Solution: Make sure your audio is clear and audible; **SUBTITLES**

Windows	***Mac OS***	***Linux***
DaVinci Resolve	**DaVinci Resolve**	**DaVinci Resolve**
Windows Movie Maker	**iMovie**	Kdenlive
ShotCut	LightWorks	avidemux
OpenShot	OpenShot	OpenShot
Kdenlive	ShotCut	ShotCut
avidemux	Blender	Blender
Blender	avidemux	ffmpeg
ffmpeg (command-line)	ffmpeg (command-line)	

Pitfalls and how to avoid them

- Problem: Long and boring, sleep inducing videos
- Solution: Answer the question to the point; NEVER pad runtime by reading out terms of tangentially related equations; research widely and have your own opinion

- Problem: Last minute work
- Solution: All of the above + DO NOT DO LAST MINUTE WORK



Plagiarism

- Asset use warning
  - Create your own assets/ drawings/ material when possible;
  - Credit or reference the original creators, authors and/or artist where applicable; provide links and sources in transcripts & video credits
  - When in doubt, be generous in your credits

- Major incident: Wholesale lifting of content
  - Use at least three different sources of information for research
  - Always include your own opinions after compilation

Plagiarism

Important reminder/ clarification:

- **TIME SPENT ON CREDITS DOES NOT COUNT TOWARDS YOUR TOTAL VIDEO TIME**

- Use this to provide credits for all resources used if possible, in addition to credits for teamwork

Individual Round

This year's "100%"

Q17

- Which of the five pairs cannot possibly be correct?

Object	Deity
Sun	Surya
Mercury	Budha
Mars	Mangala
Saturn	Shani
Neptune	Rahu

- JNR: 27% correct

This year’s “100%” x 2

Q38

- With respect to a hypothetical observer on the Sun, the phases of the Moon as seen by the observer repeat once and only once approximately every ....?

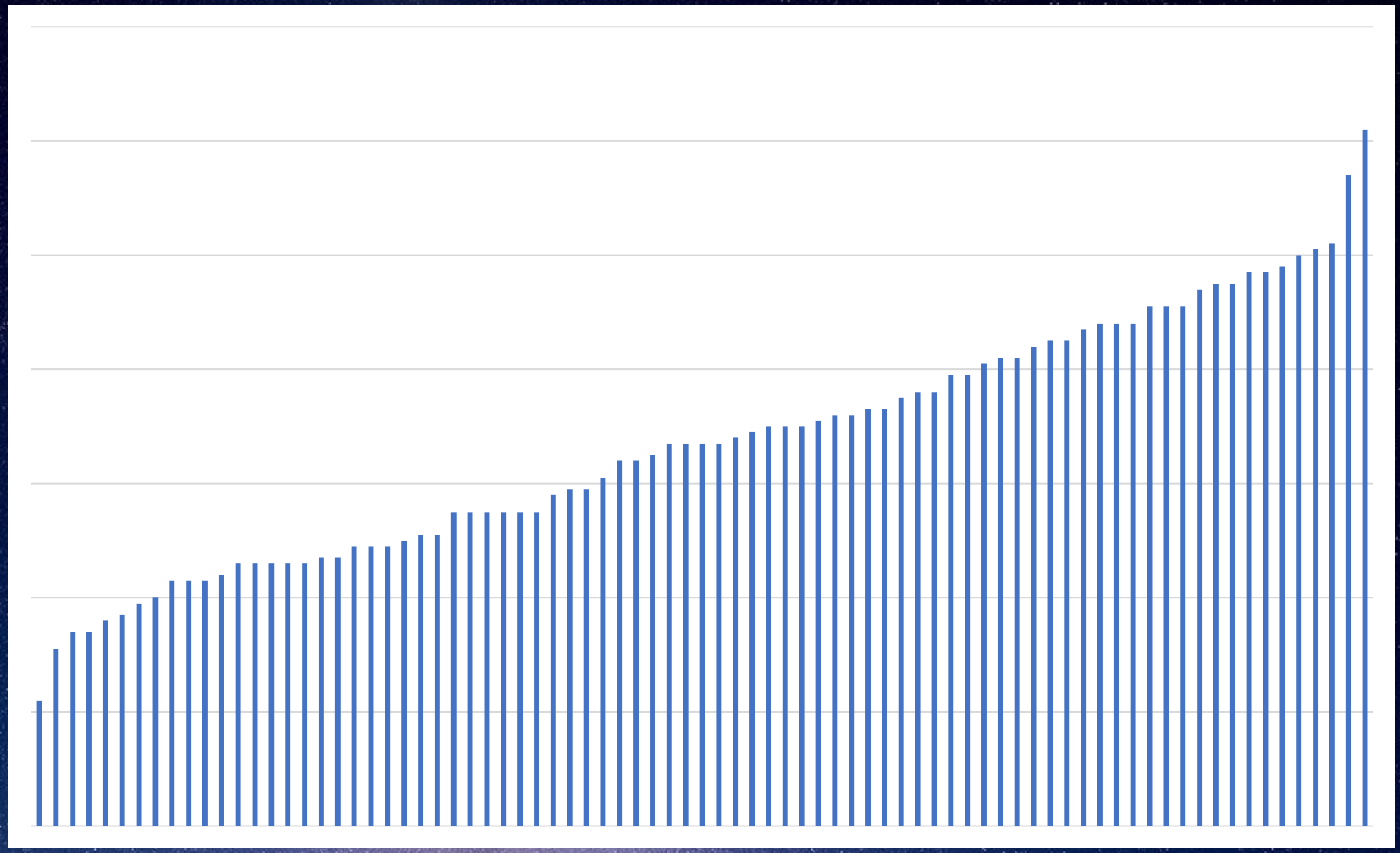
- JNR: 18% correct

JNR Individual Round

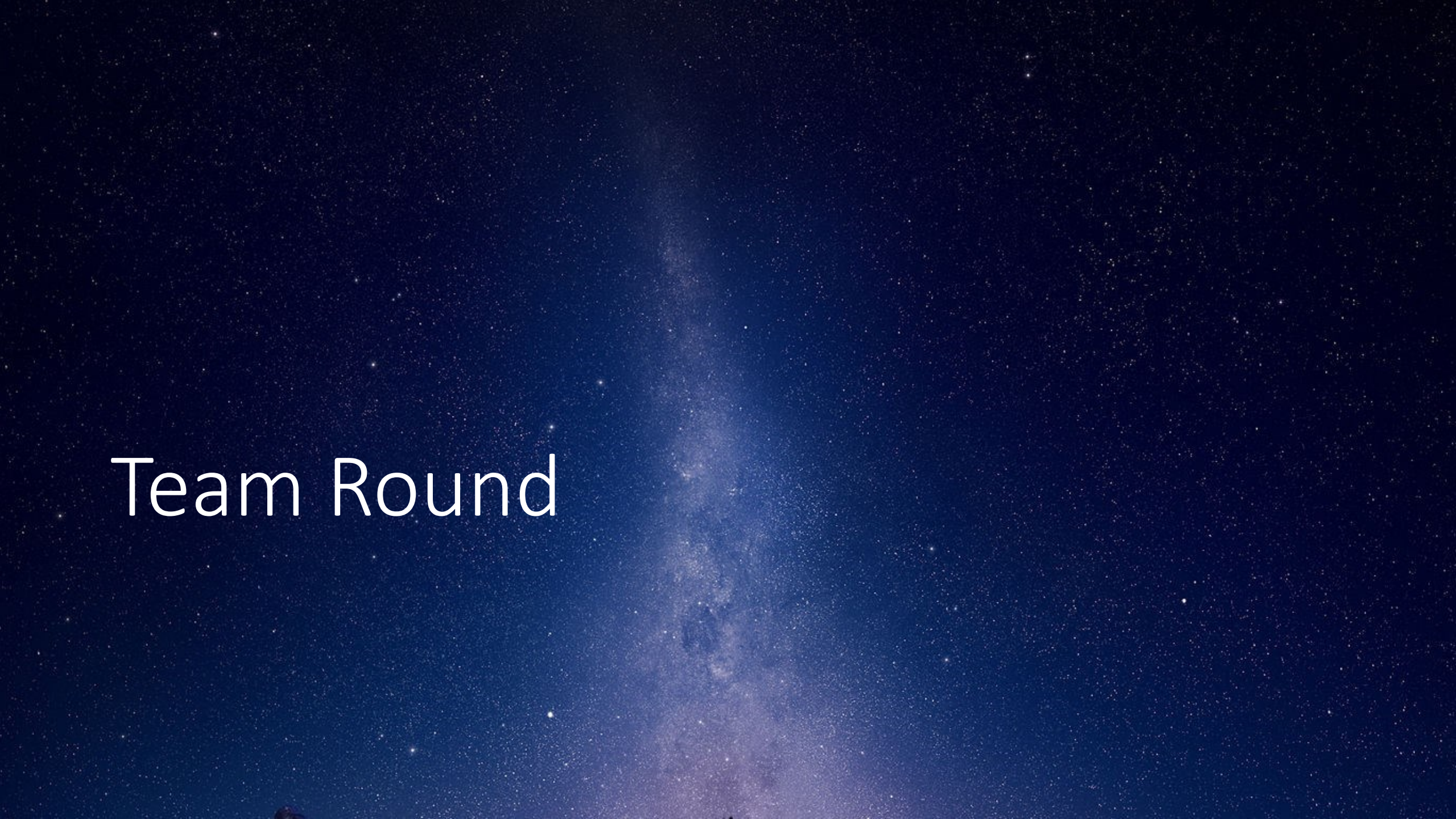
- Easiest Question : Q2 (93% correct)
  - A rule of thumb is that it is best to stargaze during a new moon, rather than during a full moon. Why?
- Most Incorrect : Q39 (7% correct)
  - Which constellation was closest to the zenith at local midnight on 15 March, 44 BCE?
- Most Blanks : Q14
  - $FOV = kt \cos \delta$

JNR Individual Round Score Distribution

Mean = 61
Standard Deviation = 21.4

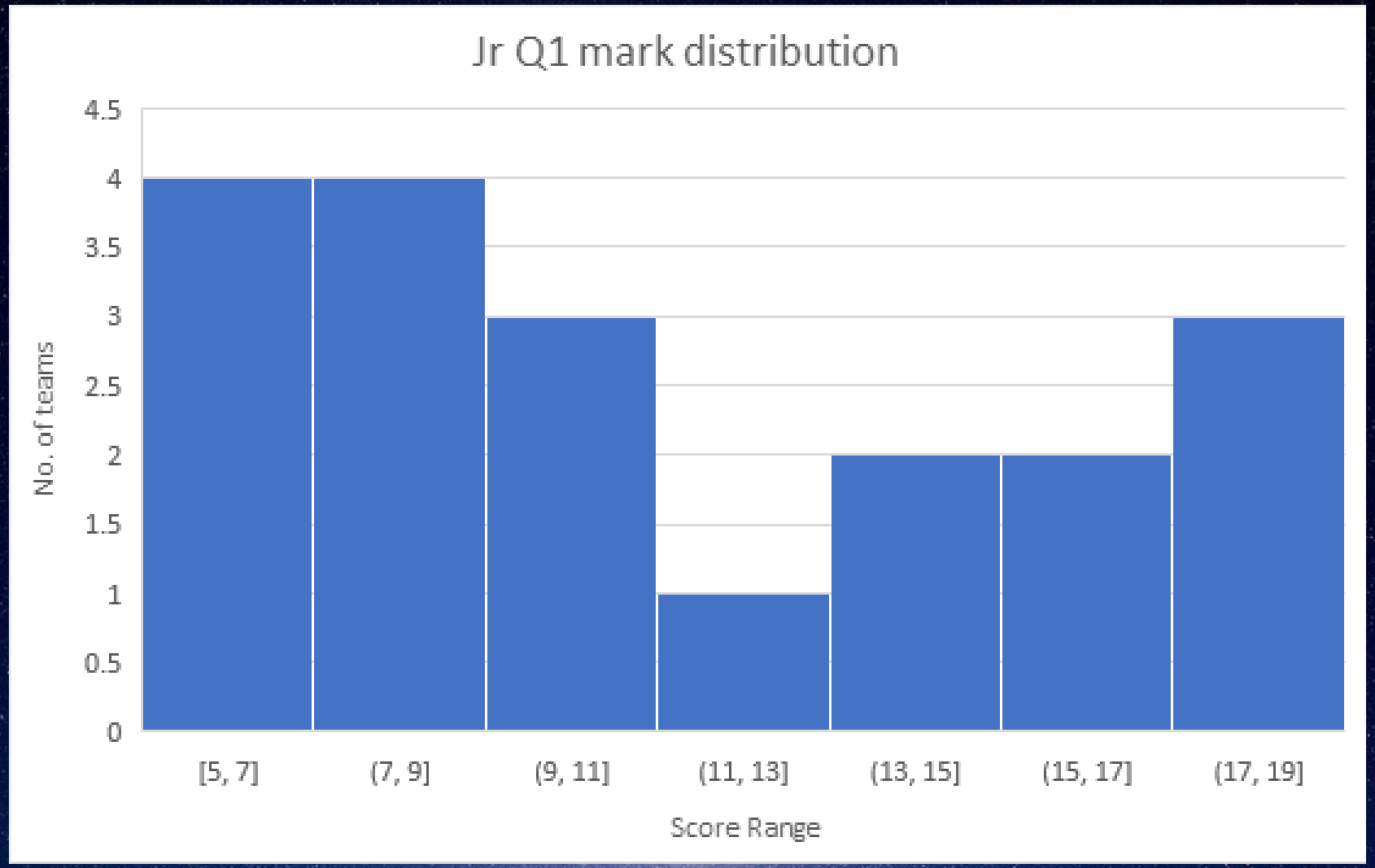


Team Round



Question 1

Geminids, Galaxies and Gear


Jr Q1 mark distribution
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
No. of teams
[5, 7]
(7, 9]
(9, 11]
(11, 13]
(13, 15]
(15, 17]
(17, 19]
Score Range

What went right? ┬──┬*⌒(ˆ◡ˆ⌒)

- 1a (radiant). Most copied over the Gemini correctly [1m].
- 1bi (lower latitude less meteors). Some correctly observed that the Geminids is 32°N [1m].
- 1bii (higher elevation more meteors). Most correctly identified that Earth would block your view if you're lower [2m].
- 1c (spiral vs elliptical). Most correctly identified: shape, structure, central bulge, age/colour of stars.

What went right? ┬─┬*ノ(ˆ◡ˆ)

- 1d (visually observable features of MW). Most correctly identified the Milky Way band.
- 1e (binos). Only some knew where to find the required numbers (it is in the model name).
- 1f (binos > telescope). Majority got it correct.
- 1g (telescope). A few teams provided a third answer which I TIL also: Rayleigh's resolution criterion

What went wrong? ლ (゜Д゜ლ)

- 1a (radiant). Only a handful of teams knew what a radiant is, most drew just 1 arrow or even left it blank
- 1bi (lower latitude less meteors). Majority did not explain why moving South would lower the meteor rate.
- 1bii (higher elevation more meteors). Some actually mixed this up with latitude.
- 1c (spiral vs elliptical). Some tried to 'smoke' by coming up with nonsensical explanations about different orbit patterns between the two.

What went wrong? ლ (゜Д゜ლ)

- 1d (visually observable features of MW). A couple of teams stated spiral arms, but this is not observable from Earth or anywhere within the Milky Way. Most also did not identify MW's central bulge.
- 1e (binos). The answer is in the model's name: 20x80. No calculations needed. The entire rest of the table is unnecessary info to trick you.
- 1g (telescope). Some mentioned either light gathering [1m] or magnifying [1m] but you have to state both points to get the full 2m.

Highlights of Q1

Highlights of Q1

Fig 1. One of the few teams who correctly drew the outward arrows of the radiant.

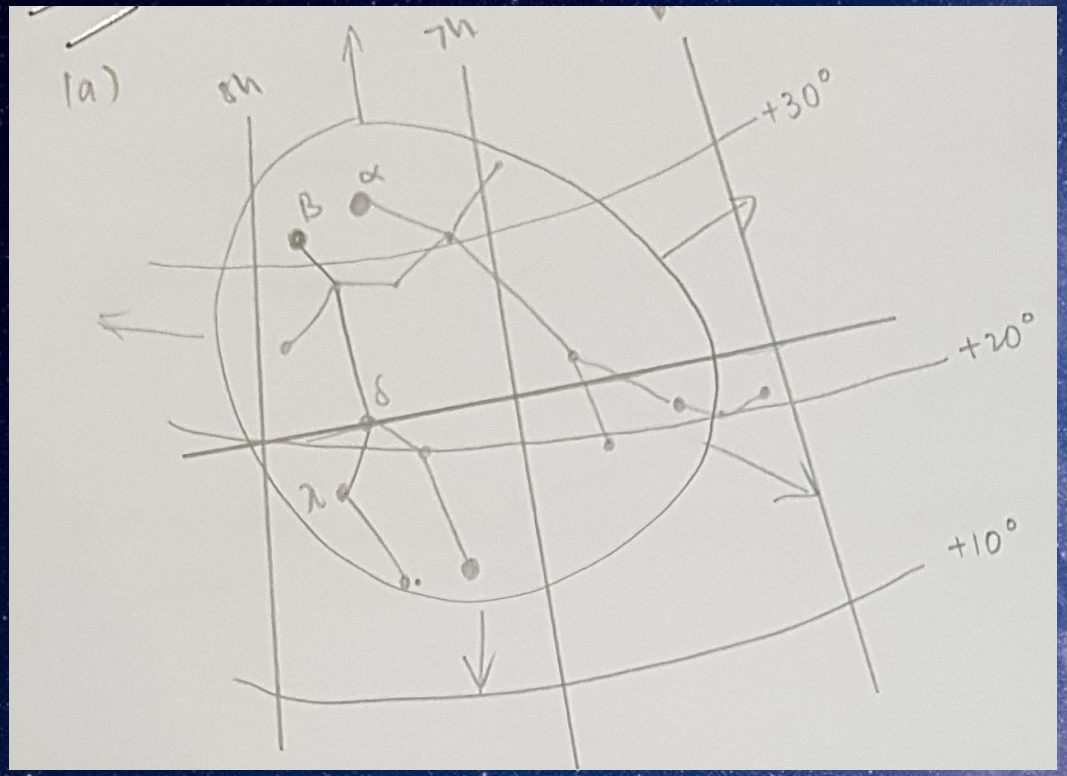
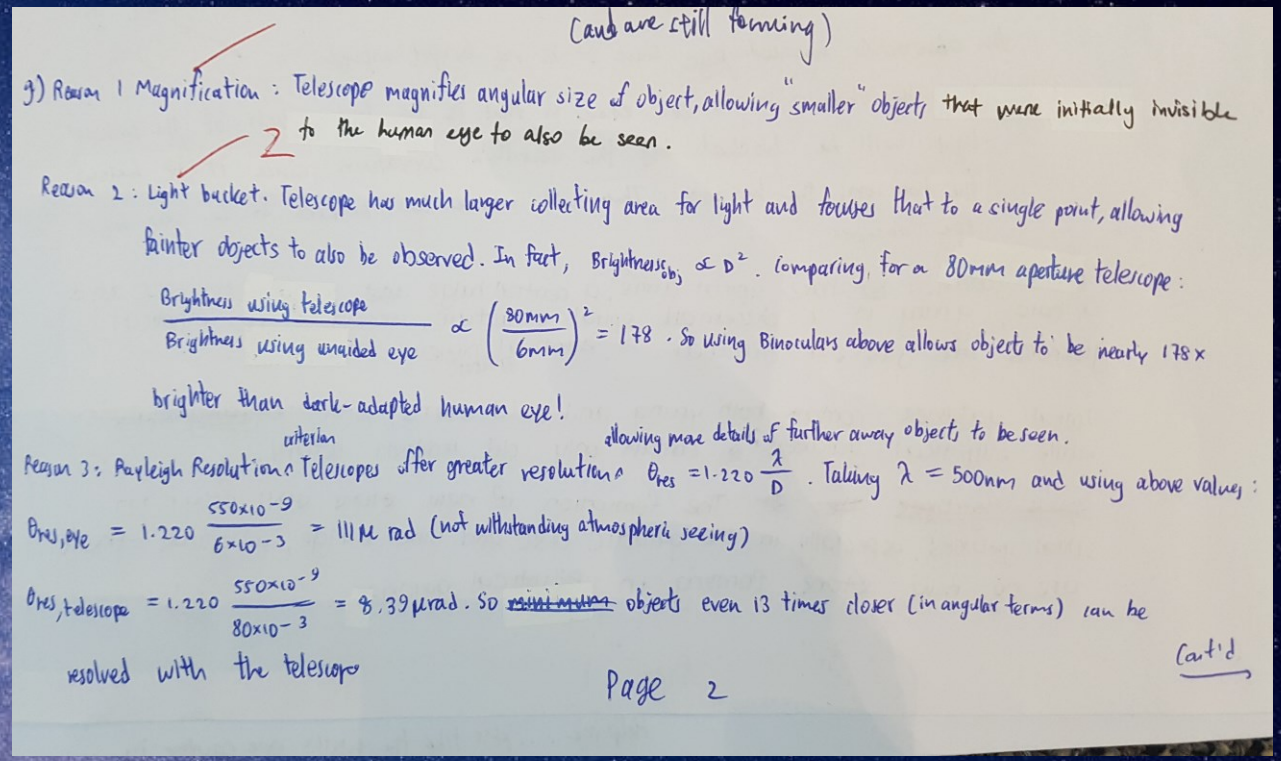


Fig 2. Exemplary elaborate explanations.



(and are still forming)

g) Reason 1 Magnification: Telescope magnifies angular size of object, allowing "smaller" objects that were initially invisible to the human eye to also be seen.

Reason 2: Light bucket. Telescope has much larger collecting area for light and focuses that to a single point, allowing fainter objects to also be observed. In fact, $\text{Brightness}_{obj} \propto D^2$. Comparing for a 80mm aperture telescope:

$$\frac{\text{Brightness using telescope}}{\text{Brightness using unaided eye}} \propto \left(\frac{30\text{mm}}{6\text{mm}}\right)^2 = 178$$

. So using Binoculars above allows object to be nearly 178× brighter than dark-adapted human eye!

Reason 3: Rayleigh Resolution criterion: Telescopes offer greater resolution, allowing more details of further away objects to be seen. $\theta_{res} = 1.220\frac{\lambda}{D}$. Taking $\lambda = 500\text{nm}$ and using above values:

$\theta_{res,eye} = 1.220\frac{550\times10^{-9}}{6\times10^{-3}} = 111\,\mu\text{rad}$ (not withstanding atmospheric seeing)

$\theta_{res,telescope} = 1.220\frac{550\times10^{-9}}{80\times10^{-3}} = 8.39\,\mu\text{rad}$. So ~~minimum~~ objects even 13 times closer (in angular terms) can be resolved with the telescope

Page 2

(cont'd)

Highlights of Q1

Fig 3. Are you hungry bro? Do you want my boi Souma to cook you a galactic dish?

shapeless.

(d) Milky Way has arms and a galactic dish and only spiral galaxies have arms and galactic dish. Thus, Milky Way is spiral, not elliptical, galaxy. ✗ 0

(e)(i) Magnification = $\frac{50}{20}$

$= \underline{\times 4}$ ✗ 0

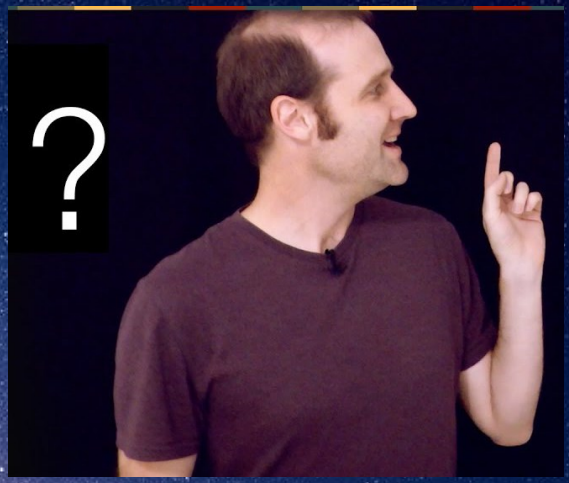
Fig 4. Some concepts from maths do not carry over to the physical world.

will continue to travel in the atmosphere ... Thus some comets can still be observed in the southern hemisphere but not ...

(c) ① Spiral galaxy has one focus in its center while eliptical galaxies have 2 foci. ✗

② Spiral galaxy has one central galactical bulge while the eliptical galaxy does not.

③ spiral galaxy has 4 ~~major~~ major spiral arms while the eliptical gala... has no distinguishible arms. ✗ 0.5



Highlights of Q1

Fig 5. How can a galaxy have no centre and no shape? Be logical!

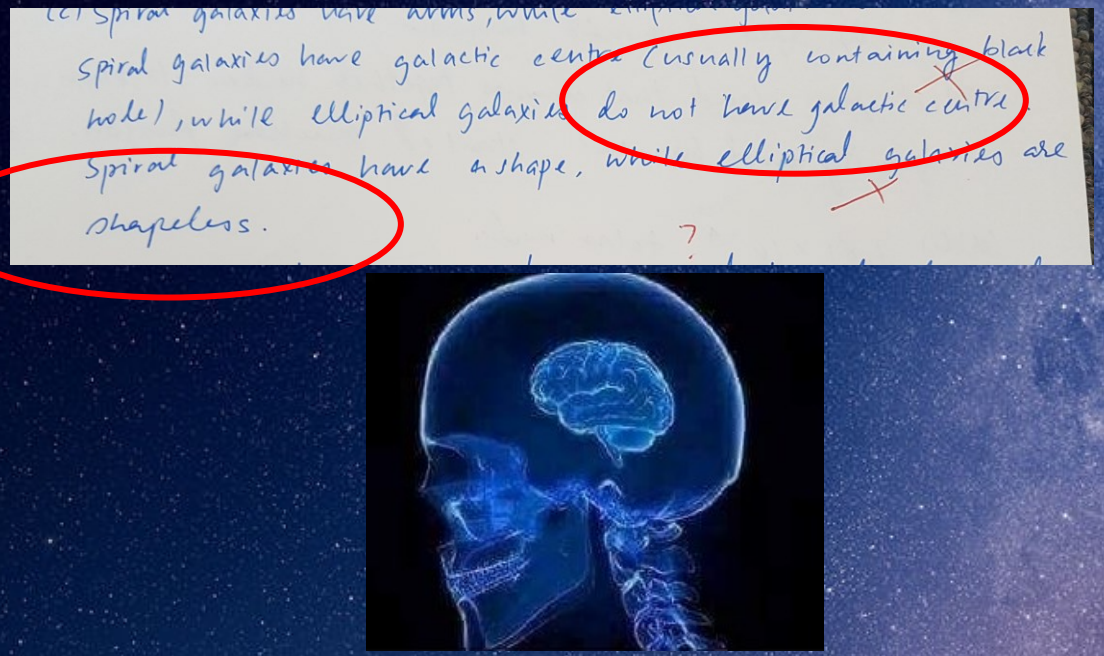
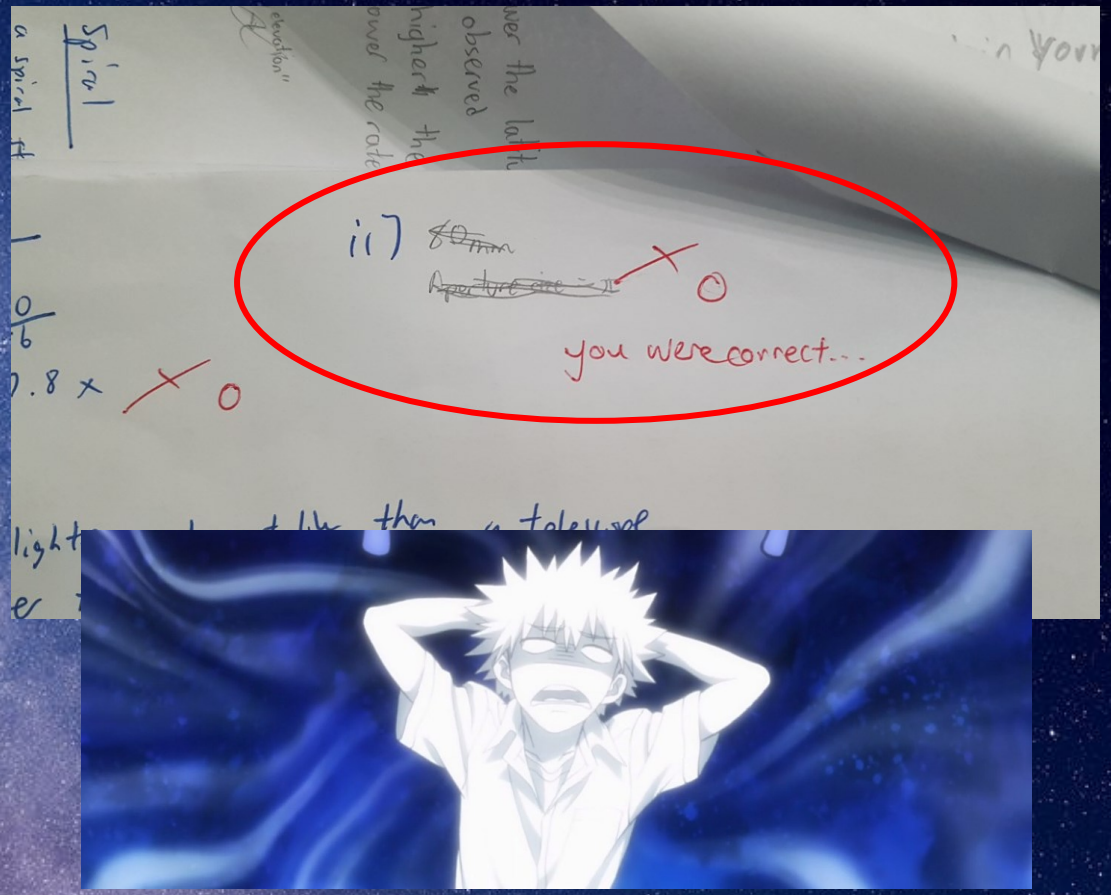
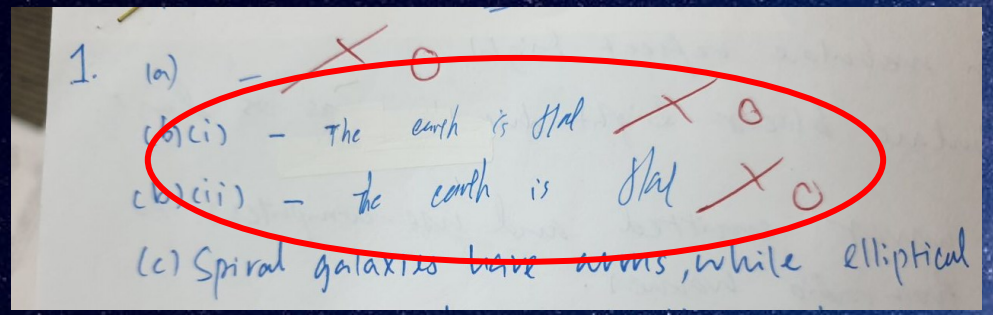


Fig 6. When you cancel your correct answer and submit blank answer instead.



Highlights of Q1

Fig 7. When you give up and can't think of a witty joke.



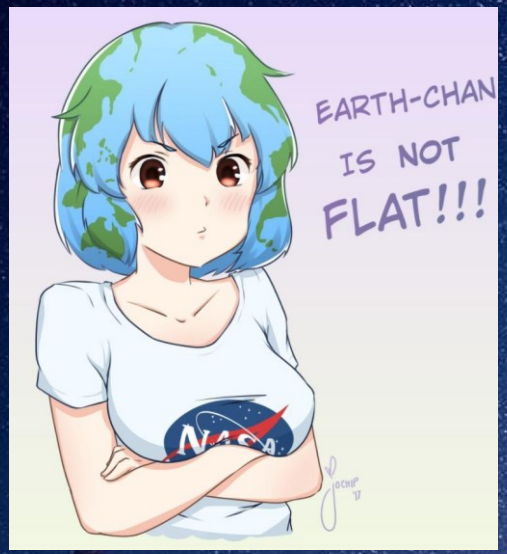
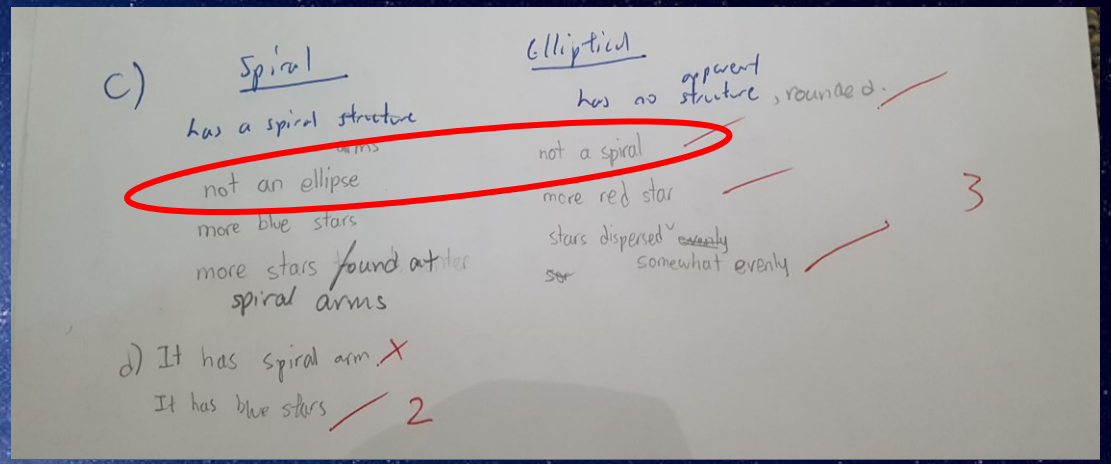
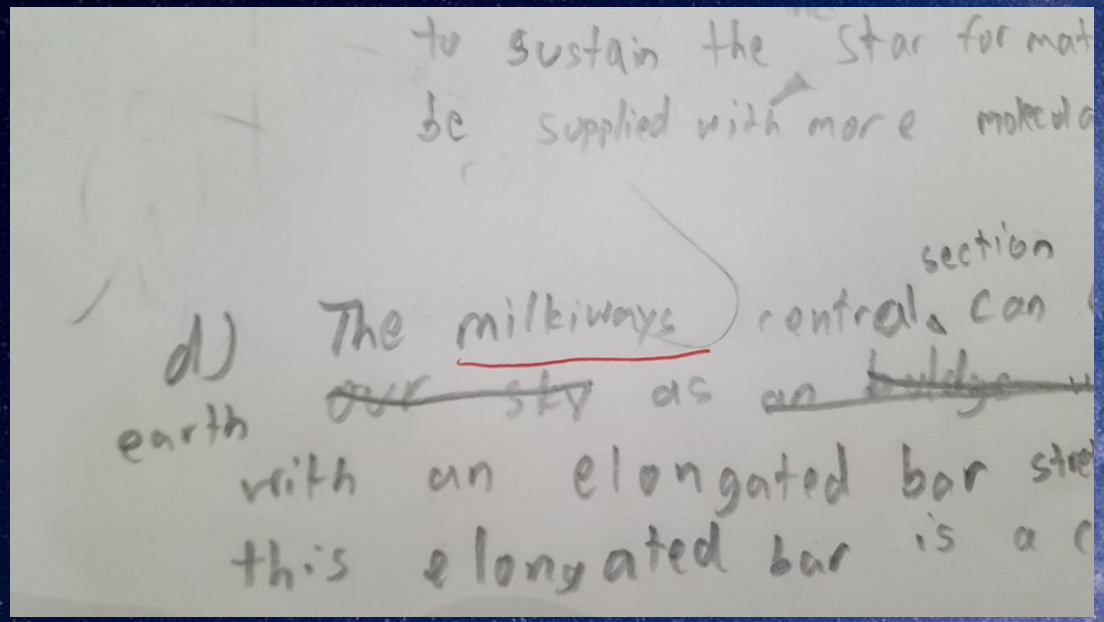


Fig 8. Did you also know that a square is not round, and a circle is not a square?



Highlights of Q1

Fig 9. *Milky Way has left the chat*

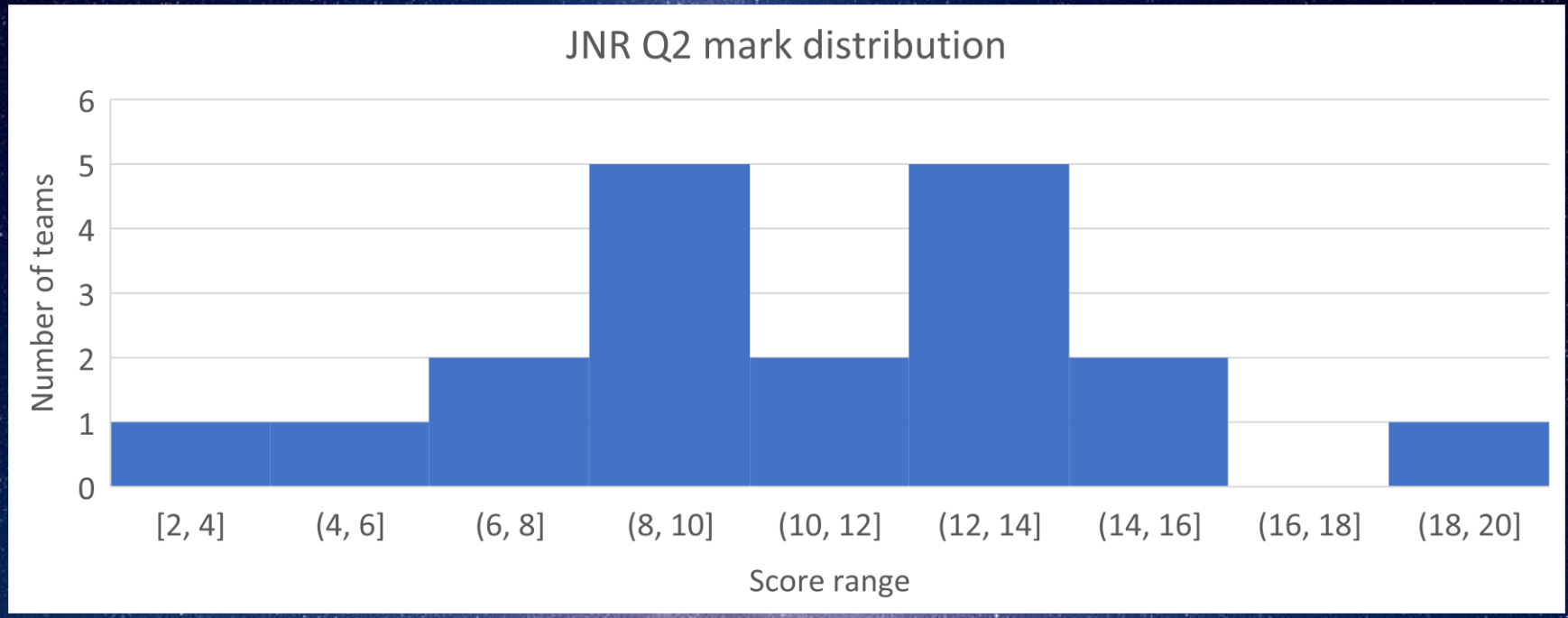


Question 2

Triple trouble in Trifid Nebula

Overall comments

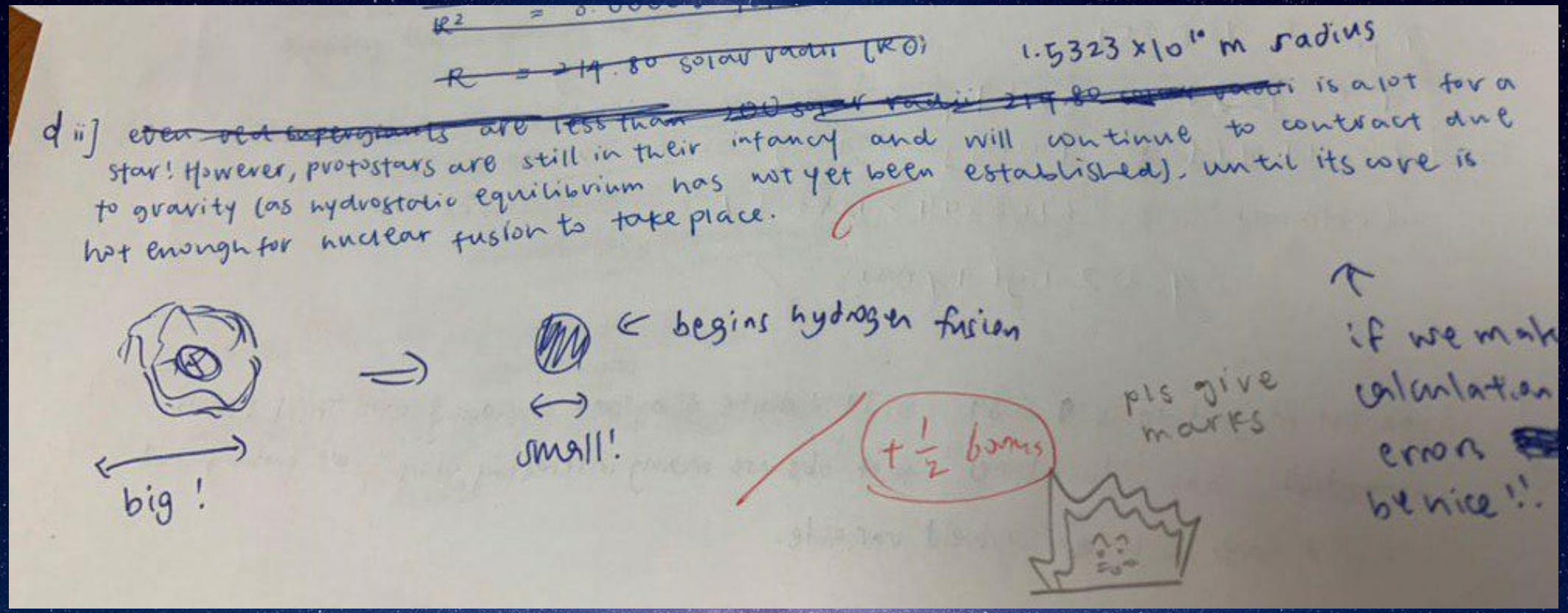
- Generally well done; weaker teams could usually salvage marks, though most strong teams struggle to score well for certain sections
- Data table was generally under-utilized



What went right?

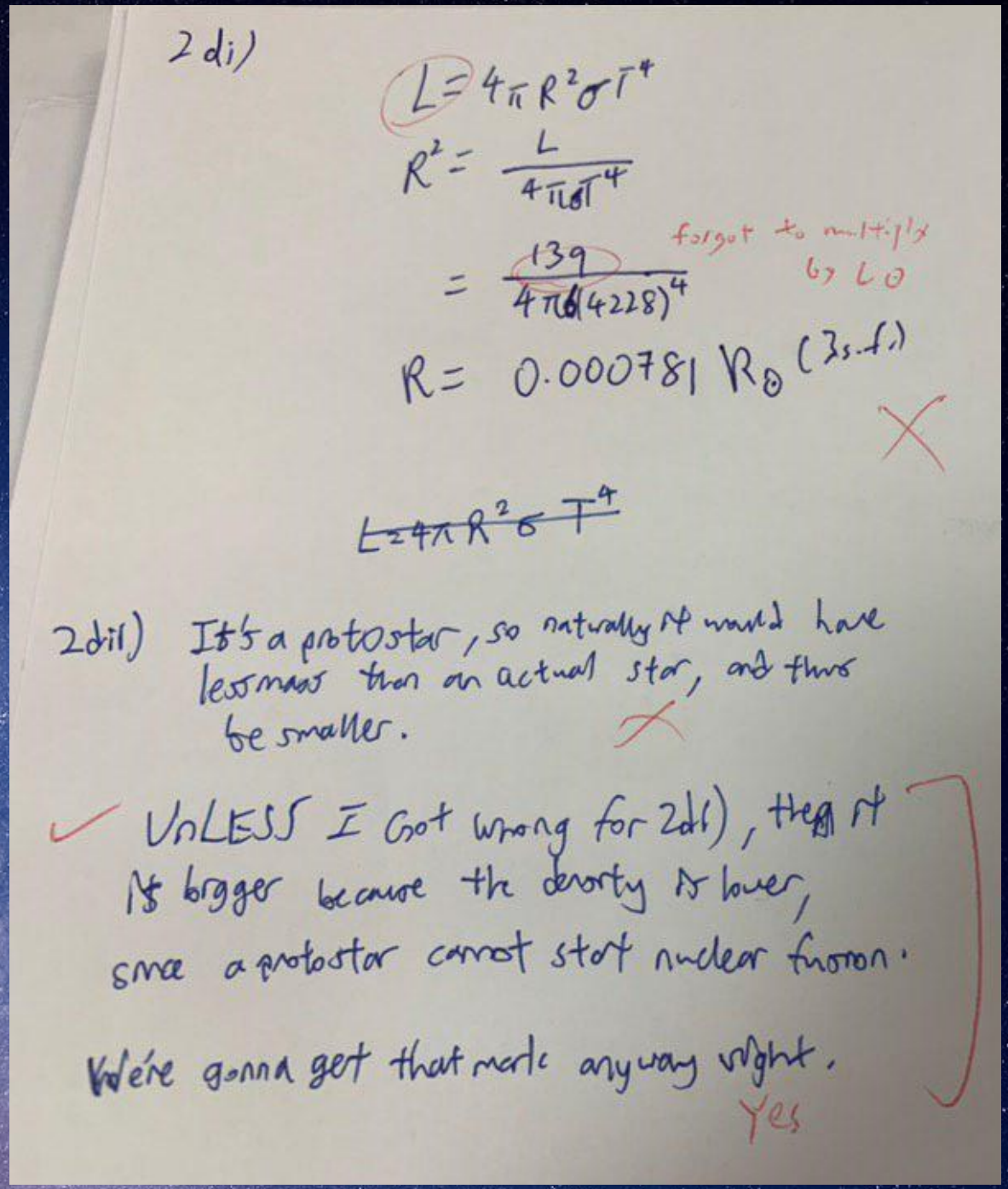
What went right?

- Went the extra mile to explain the question – and you're right, its not a calculation error. Full credit + bonus 0.5 marks!



What went right?

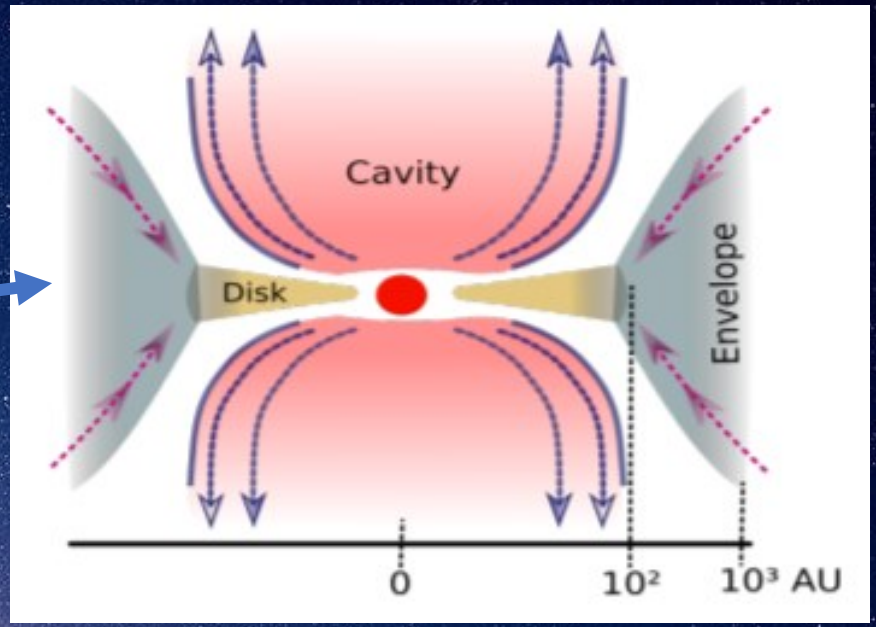
- Careless mistake in first part, but self-aware enough to realise the first answer does not make sense given prior knowledge
- We decided to award full credit for not doubling down on the wrong answer (i.e. you got 2 marks here)



What went right?

- One team was impressive enough to recognise that a flatter accretion disk/ smaller envelope cavity angle is indicative of a more mature protostar (TC2A). This team was the only one that received full credit for the 4 mark question.

Parameters	TC1A	TC2A
Stellar Mass (M_{sun})	4.7	3.1
Stellar Temperature (K)	12000	4228
Envelope Accretion Rate (M_{sun}/yr)	$2.3 \cdot 10^{-3}$	$8.22 \cdot 10^{-4}$
Envelope Cavity Angle (deg)	14	6.8
Disk Mass (M_{sun})	0.11	$1.08 \cdot 10^{-3}$
A_V	59	23
L_{bol} (L_{sun})	308	139

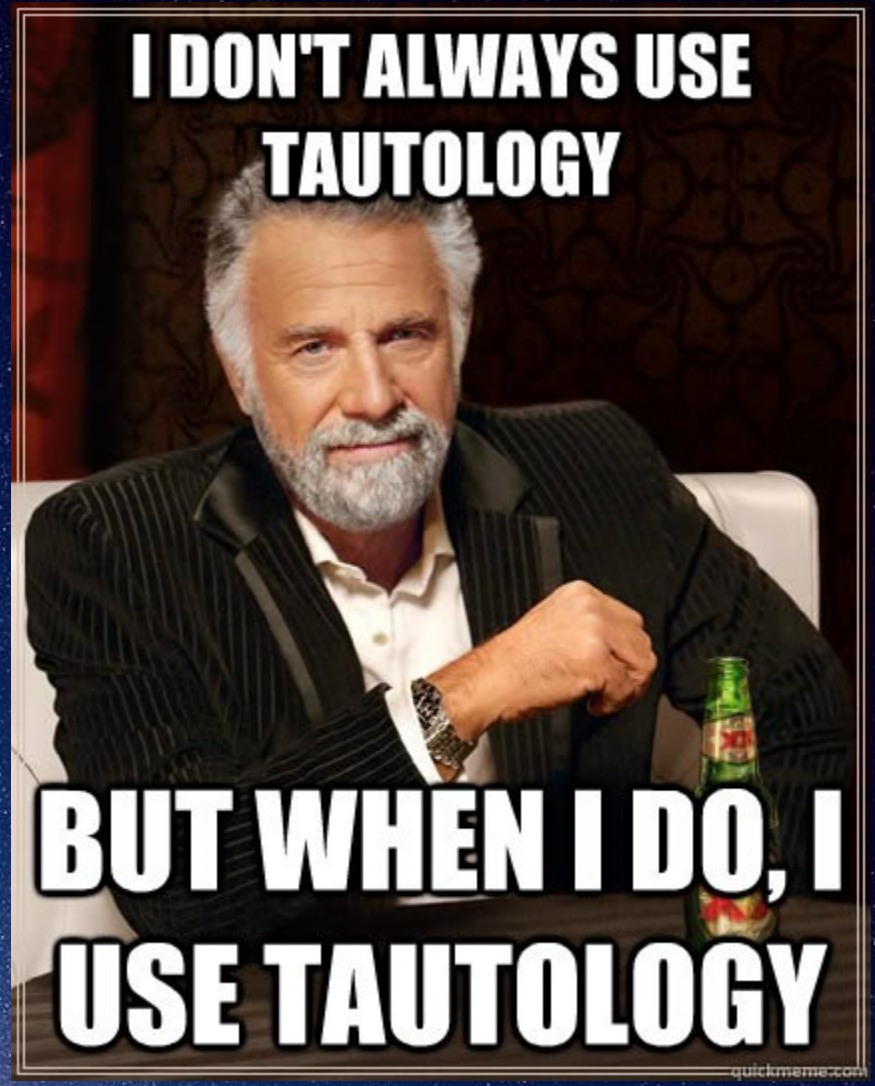


What went wrong?

What went wrong?

Fail compilation:

- Emission nebula
  - ‘Emits light’
  - ‘Emits spectral lines’
  - ‘Is red because it is Redshifted’
- Reflection nebula
  - ‘Reflects light’
  - ‘Wavelength of light is stretched’
- Dark nebula
  - ‘There are no stars’
  - ‘Contains Dark Matter’



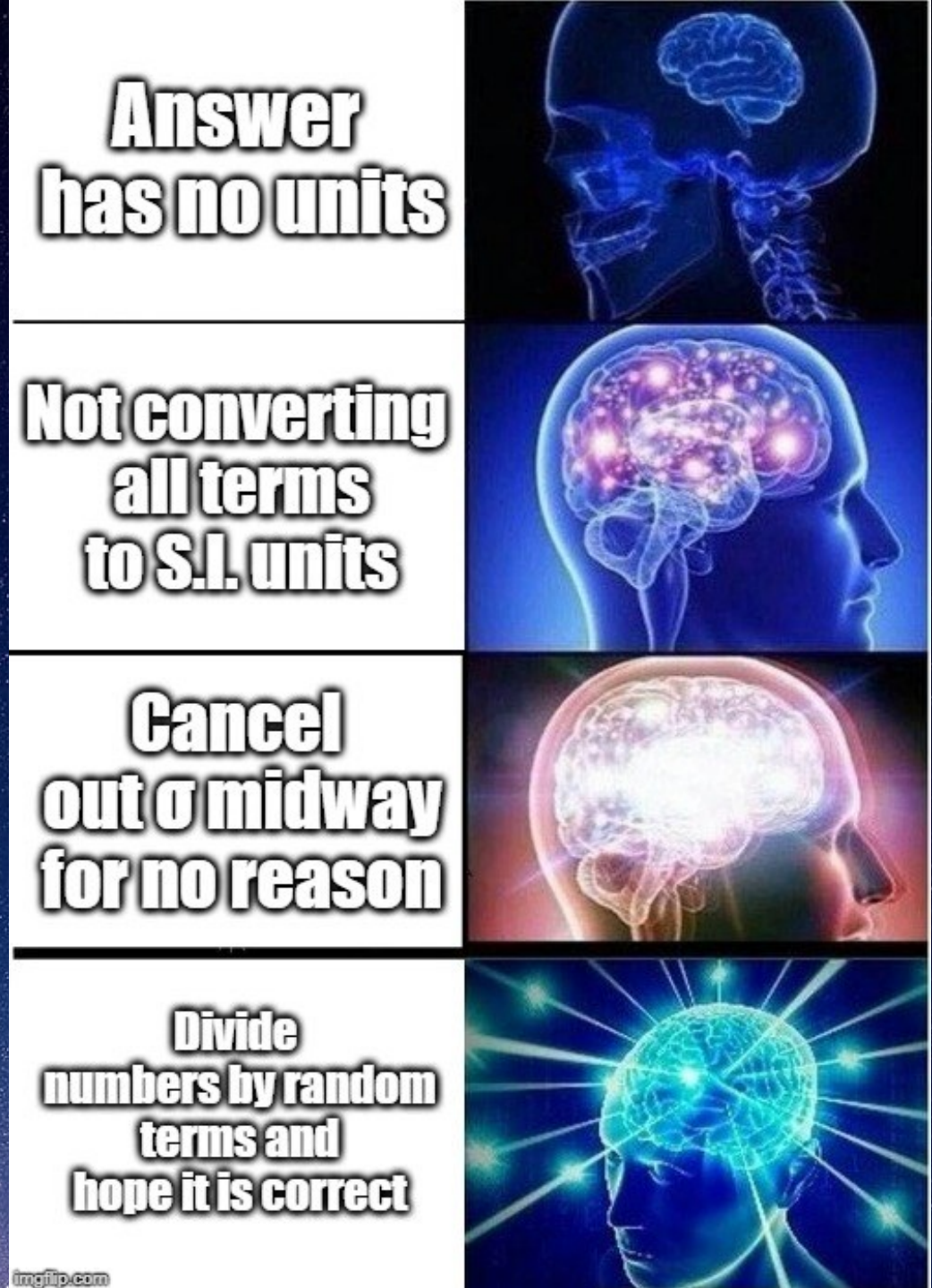
What went wrong?

Fail compilation, calculation qns edition:

The protostar has a radius of…

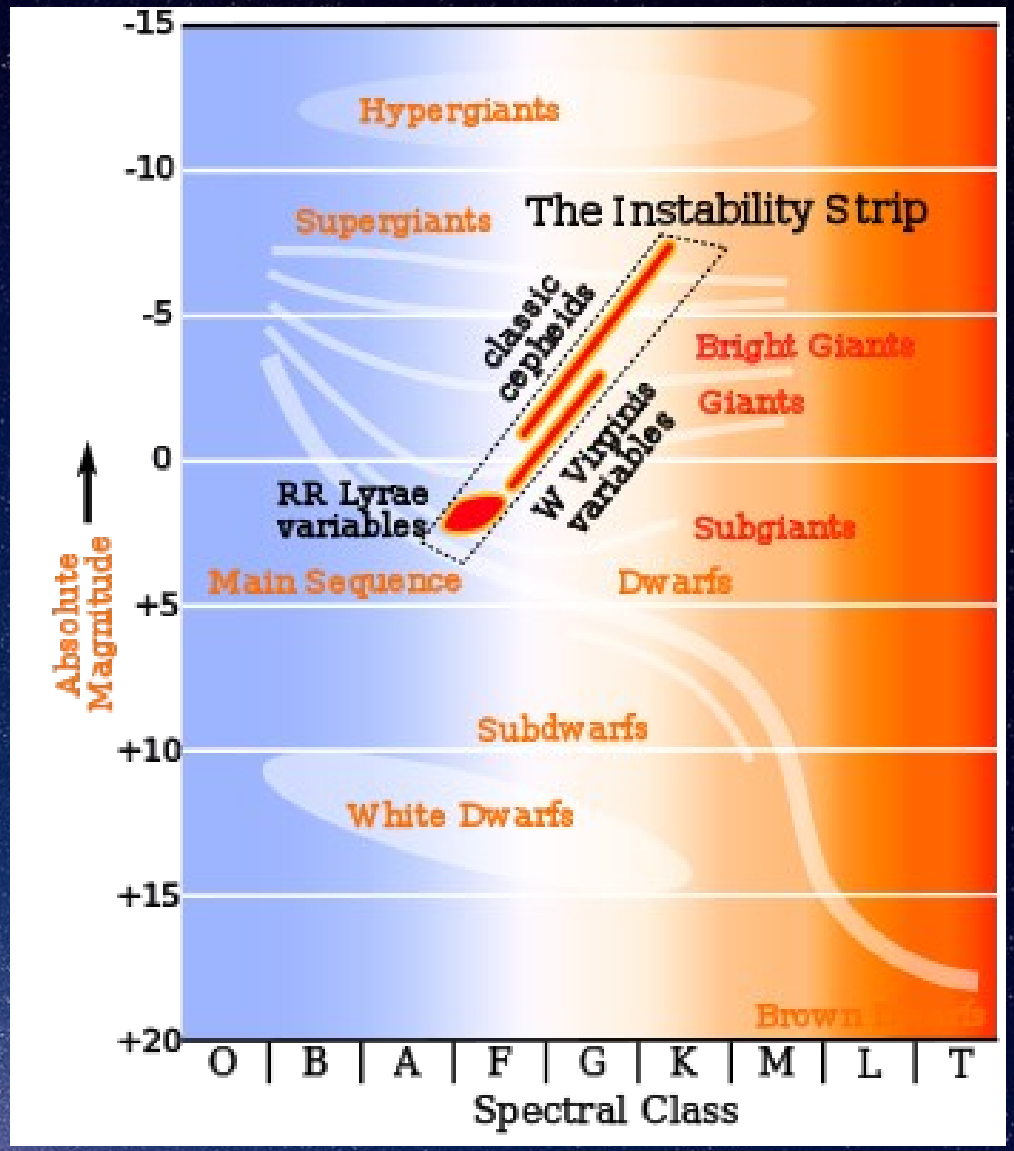
- 215 m
  - This is the typical size of a small asteroid, not a protostar!

- 3.72 × 10^-7 m
  - This is smaller than a typical *E. coli* bacteria!!!



Closing comments

- Why would you not expect to find Cepheid variables in a young star-forming region?
- Cepheid variables are mature stars moving away from main sequence, i.e. they are too old/ Trifid nebula is too young to contain them!
- Other reasonable but not necessary true answers: 0.5 marks



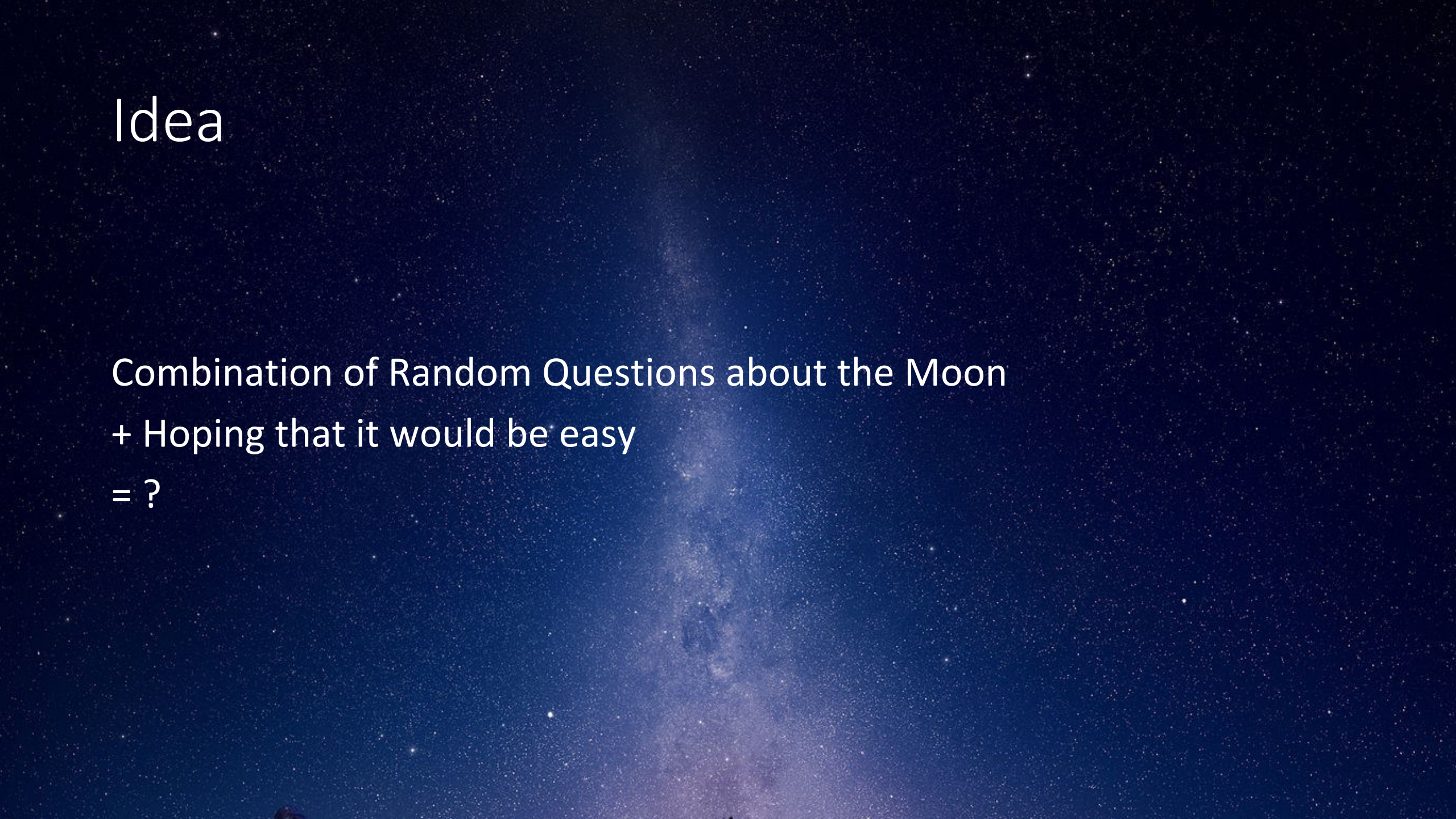
Question 3
Super Blue Blood Moon

Idea

Combination of Random Questions about the Moon

+ Hoping that it would be easy

= ?



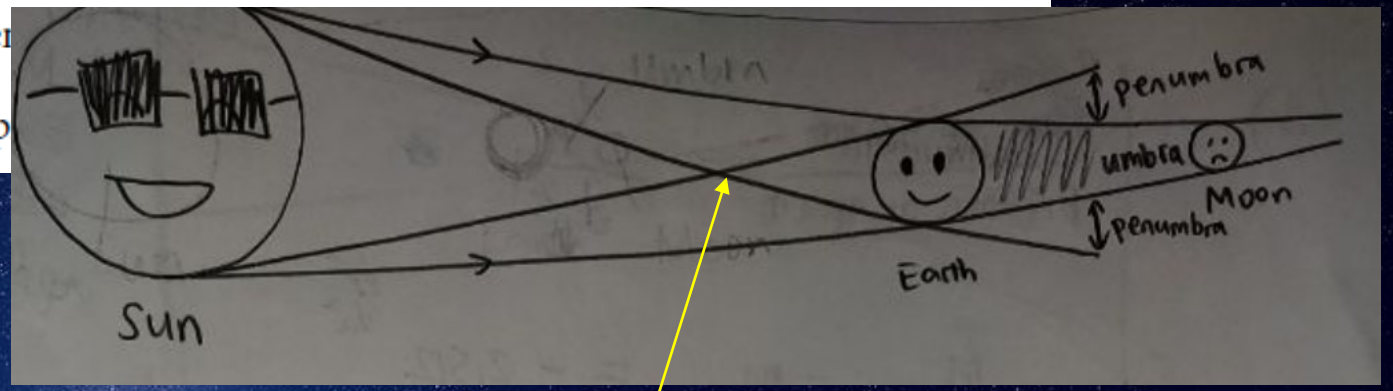
Highlights

(a) In a single diagram,

(i) illustrate the relative position of the Moon, the Sun, and the Earth during a lunar eclipse; [1]

(ii) draw and label the the umbra and the per

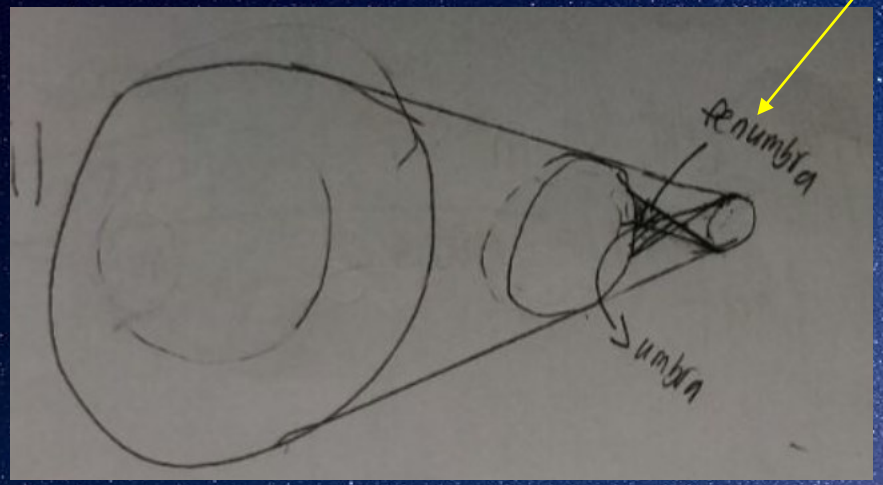
NOTE: You should place the Moon in the app

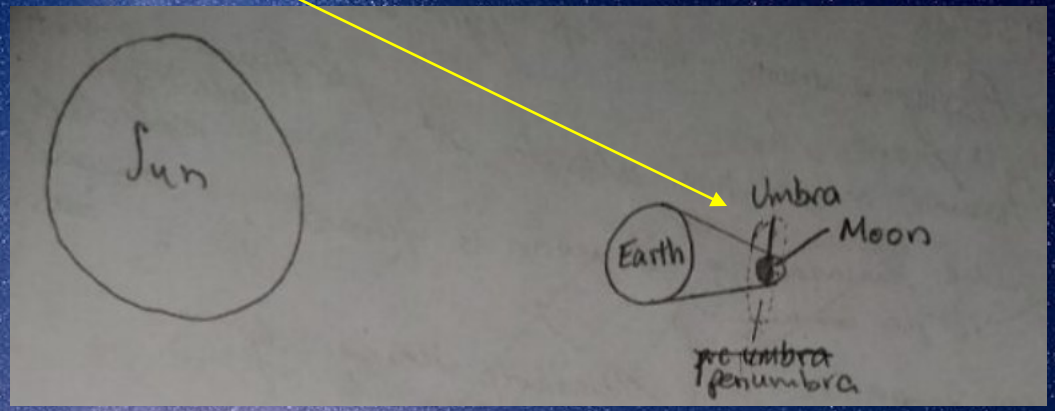


- "Give Away"
- Not many scored 2 points
- Reason:

Umbra drawn at random!

Correctly derived the region of umbra!





(b) Define d_{cutoff} as the cut-off lunar distance for a full or new moon to be a supermoon, whereby $d_{\text{cutoff}} = 0.1d_a + 0.9d_p$. Using any relevant data from the Formula Book, determine the value of d_{cutoff}. [2]

(c) With reference to your working in (b), describe and explain any contradiction, if any, with the data in Figure 6. [2]

(d) Use your answer in (b) to give a difference between the absolute visual magnitude of the Moon when it is at its perigee, and that of the Moon when it is at its apogee.

State any assumptions you have made in your calculations, and explain why they are valid. [3]

(b

(c

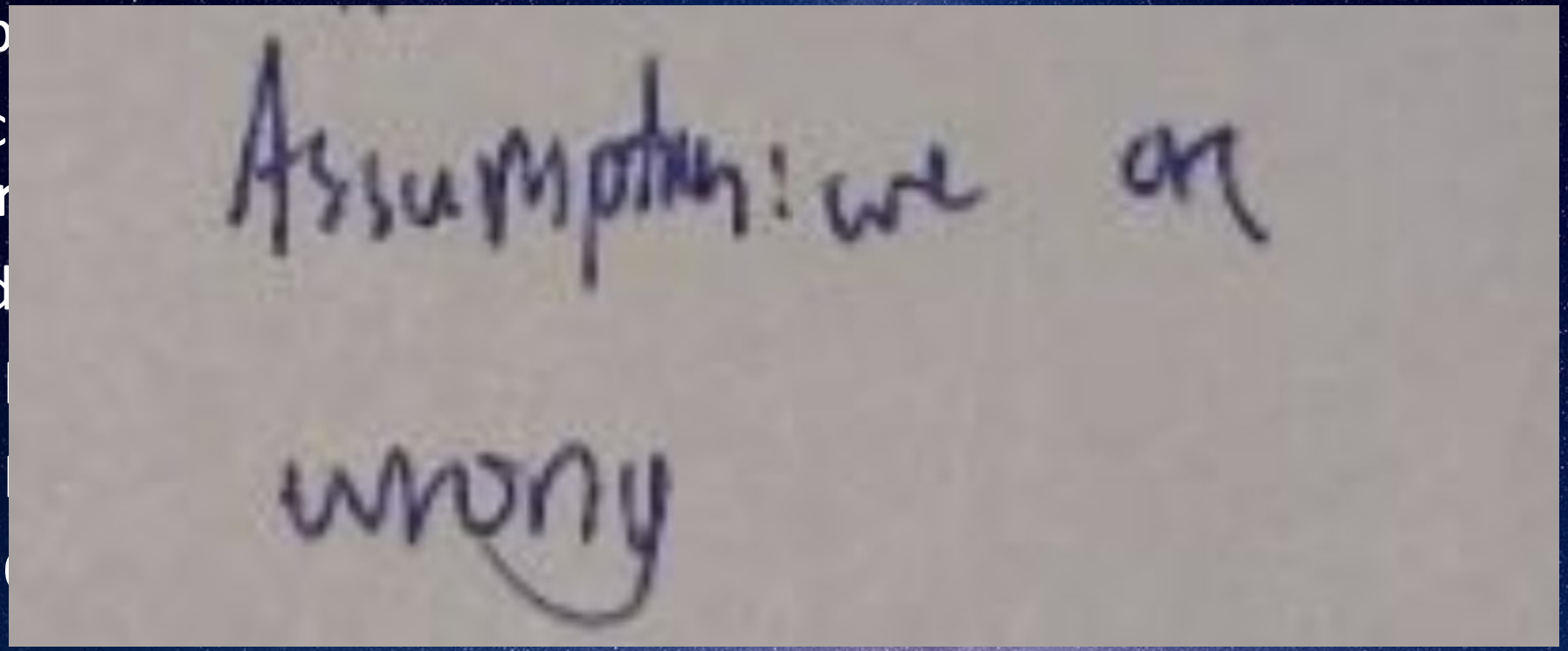
ar

(d

-

-

-



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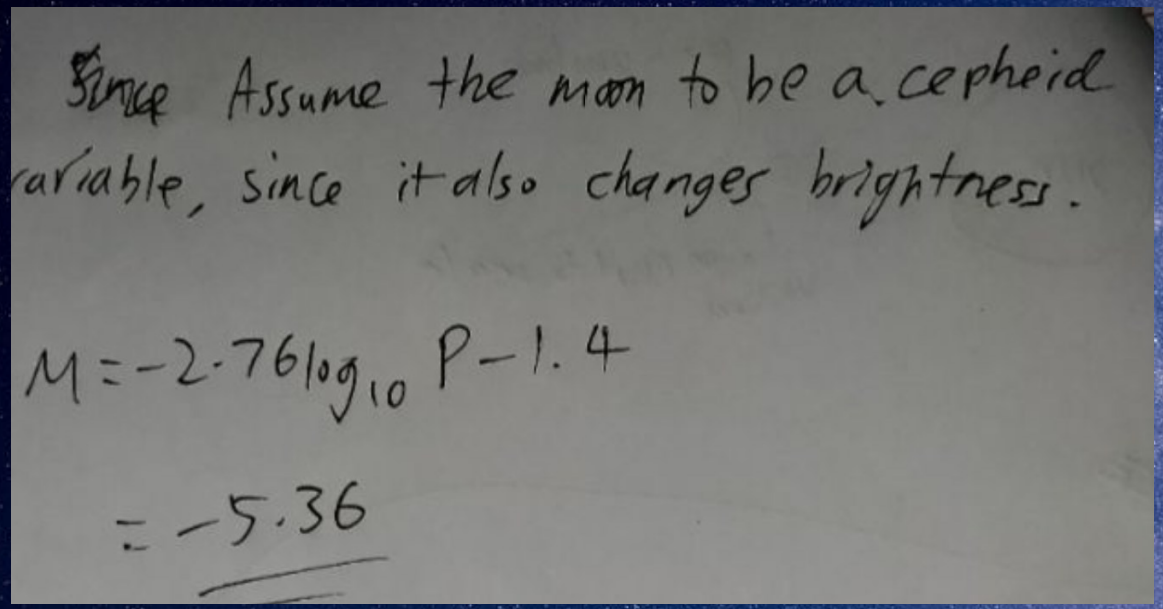
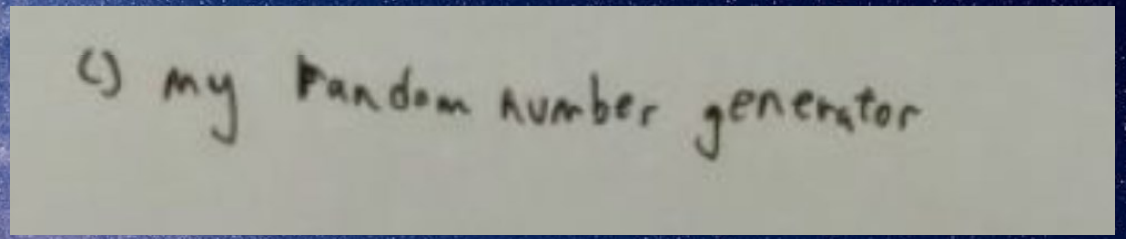
State any assumptions you have made in your calculations, and explain why they are valid. [3]

Time for some fun answers ☺



describe and explain any contradiction.



(e) Give a reason for the colouration of the 'blood moon'. [1]

Use the following information to answer questions (f) and (g).

In 2013, a Japanese research team of astronomers and planetary scientists used the Subaru Telescope's two optical cameras and observed that the super-Earth exoplanet, GJ 1214b, has a water-rich, but less extended atmosphere as compared to Earth.

(f) Now, suppose GJ 1214b has a moon. Given the conditions in (a) and (??) have been met, would it be more or less likely that eclipses would cause its moon to become a 'blood moon'? [1]

(g) Would your answer in (f) change if the atmosphere was hydrogen-rich instead? Explain your answer. [1]

g) If the atmosphere was hydrogen-rich, the red light would be absorbed then released as ~~retracted~~ lower undetectable frequencies. Thus, the red light will never reach the moon and it would never be red. how sad is that. I want to ~~[illegible]~~ die.

(j) According to the Formula Book, the length of a sidereal month is 27.322 days, and the length of a synodic month is 29.531 days.

Use only the length of the sidereal month, and the orbital period of the Earth around the Sun (365.24 days) to derive the length of the sidereal month, as given above. [3]

(k) As an inquisitive astronomer, you want to know the maximum number of blue moons that could occur in a calendar year.

Use the concept of a synodic month to determine the maximum number of blue moons that can happen in a calendar year. Explain your answer.

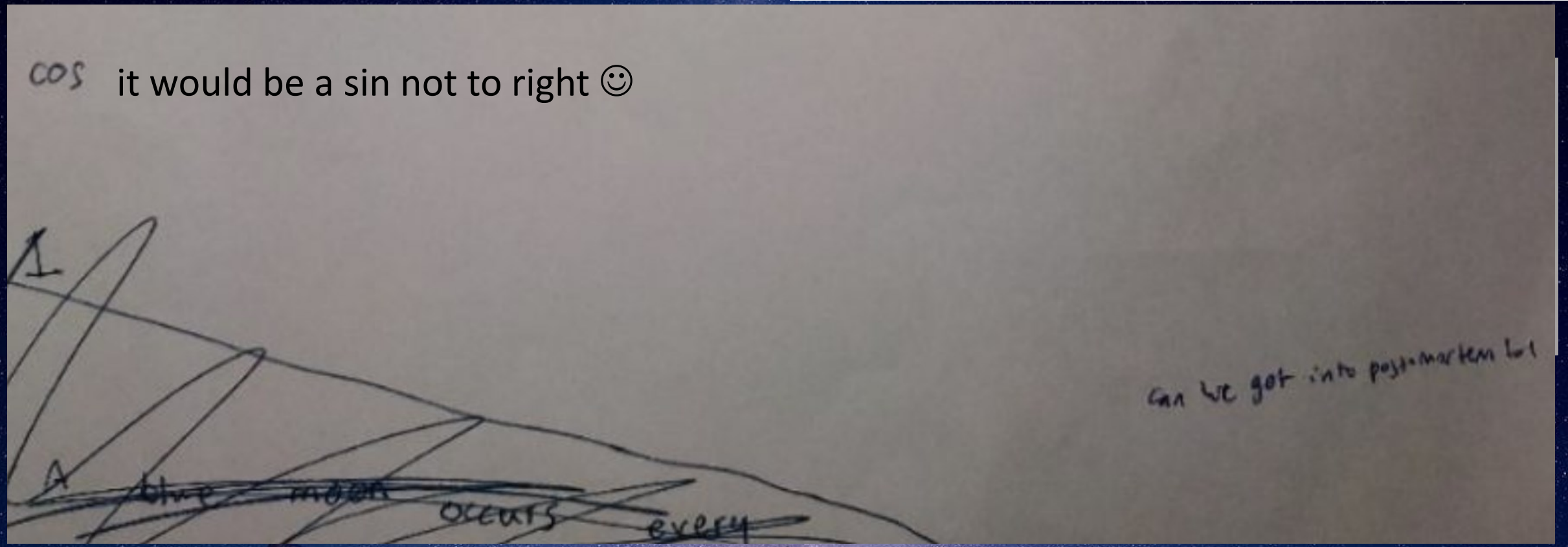
HINT: To determine the maximum number of blue moons, one might begin by assuming that a full moon occurs at midnight on the 1st of January of a given year. [3]

(m) Refer to Table 7 to answer this part.

Year	Date	Time
2020	31 October	14:47
2039	31 October	22:36
2058	31 October	12:51
2077	31 October	10:36
2096	31 October	11:13

Table 7: Occurrences of a blue moon in selected years on the Gregorian calendar

Give a reason for any trends that you might observe in Table 7. [2]



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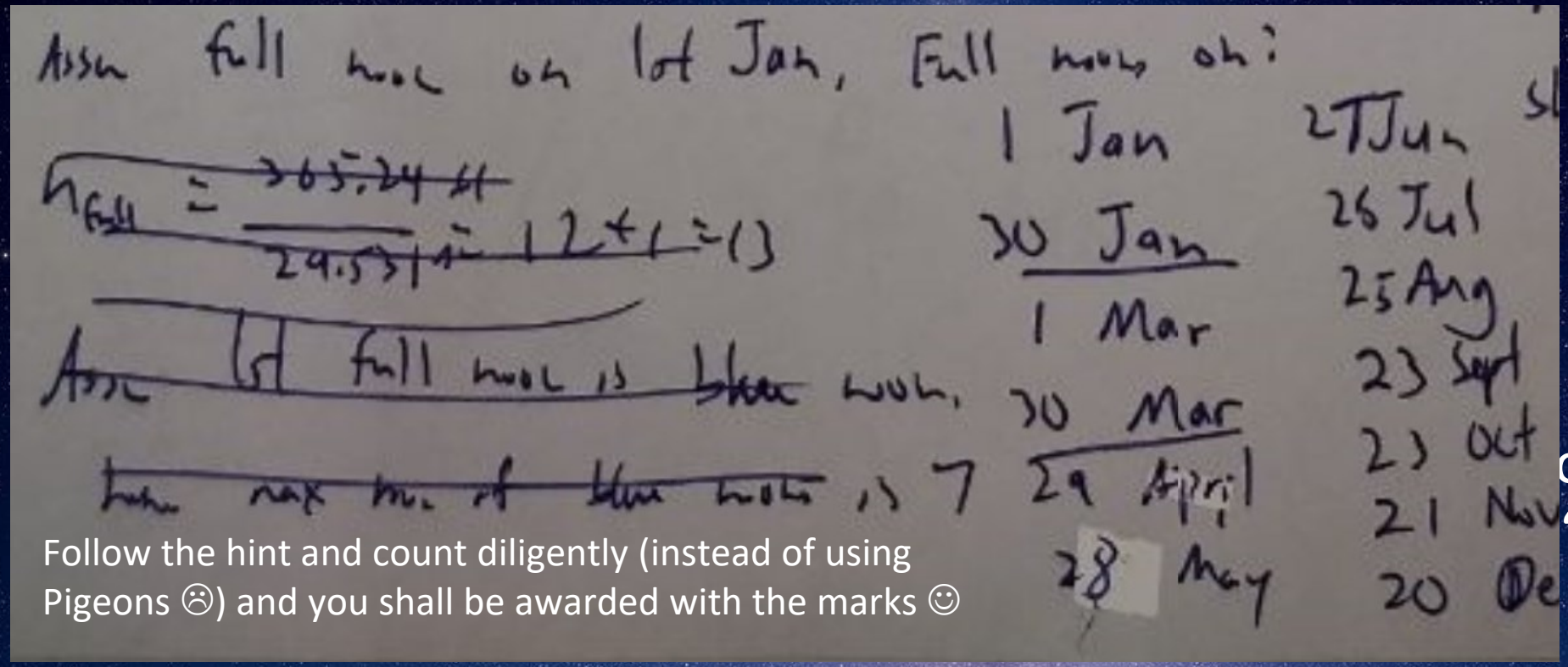


Follow the hint and count diligently (instead of using Pigeons ☹) and you shall be awarded with the marks ☺

ots" to put "items"

(m) Refer to Table 7 to answer this part.

Year	Date	Time
2020	31 October	14:47
2039	31 October	22:36
2058	31 October	12:51
2077	31 October	10:36
2096	31 October	11:13

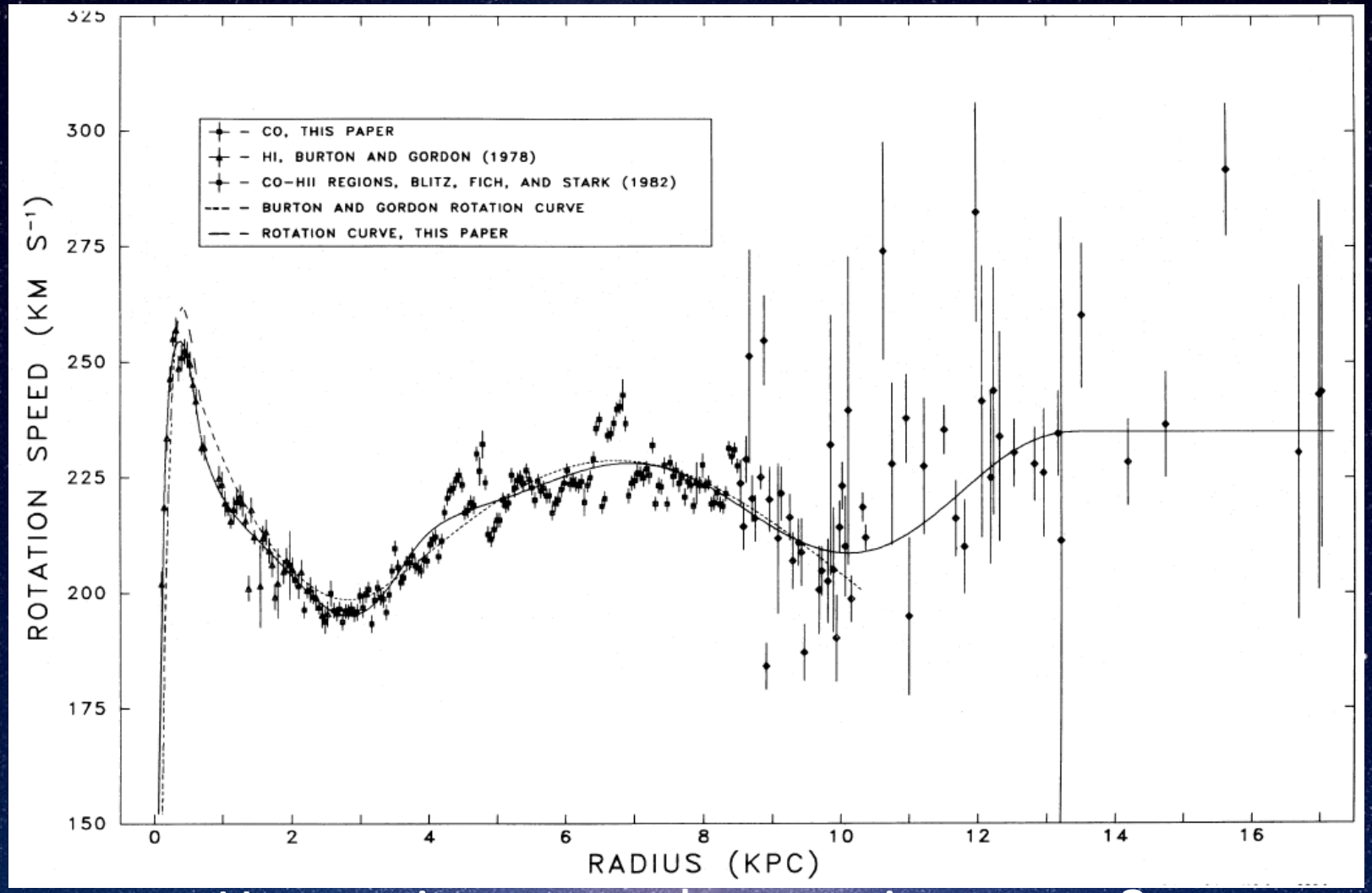
Table 7: Occurrences of a blue moon in selected years on the Gregorian calendar

Give a reason for any trends that you might observe in Table 7. [2]

(m) Not very well done ☹

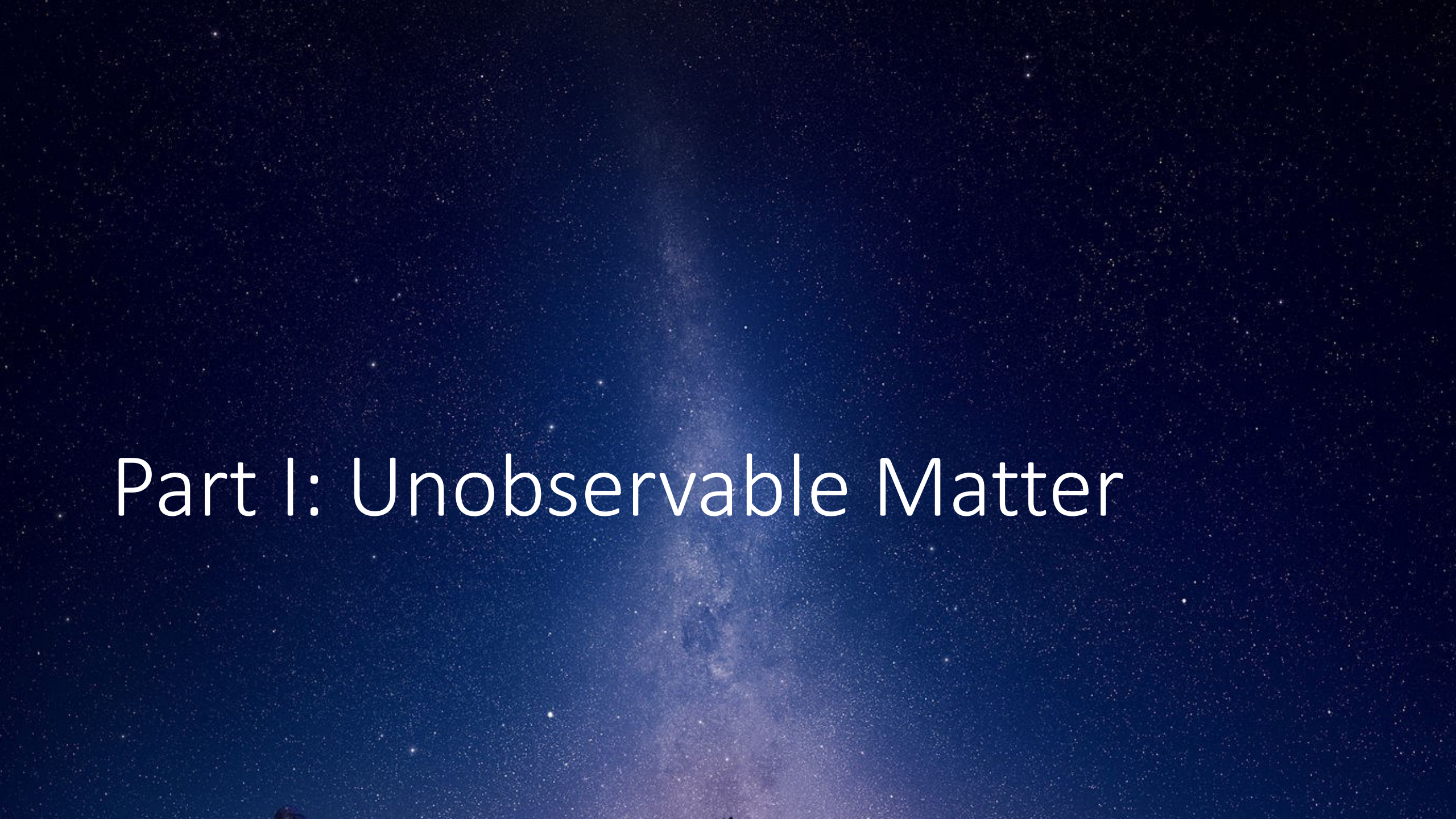
From table 7, it is observed that every 19 years on the same day of 31 October, a blue moon will occur. This implies that the blue moon takes exactly 19 years to orbit around the Earth.

Q4 Cosmology – The Next Decade



How to interpret the rotation curve?

Part I: Unobservable Matter



Q4 Cosmology – The Next Decade

- Average density up to *r* decreases with increasing *r* and as such, one would expect that as a result the orbital velocity of more distant objects should fall off.
- K3L assumes that the gravitational force acting on massive objects act on their overall centre of mass; in this case, the centre of mass is at the centre of the galaxy.
- Instead, what is observed is that the mass distribution does not fall off with *r* but instead new mass was introduced such that the rotation curve comes to roughly ‘plateau’ beyond 8kpc.

Q4 Cosmology – The Next Decade

- CONCEPTUAL MISTAKE 1: Centripetal force is a resultant force.
  - For a free falling object (planets orbiting the Sun, solar systems orbiting the centre of galaxy, MW), the gravitational attraction is the only force contributing to the centripetal force and hence equal in magnitude.
  - They do not cancel out nor are they necessarily equivalent in all physical systems.
- 4(f) was done poorly but understandably so.
  - Understanding of local density function: density at a distance r away from the galactic centre vs average density.

Part II: The Expanding Cosmos

Q4 Cosmology – The Next Decade

- Critical Density as a measure
  - If density is below critical density, massive objects get ‘disintegrated’, separated.
  - If density is above critical density, massive objects are held together by gravitational attraction.
- 4(g): Use of Conservation of Mechanical Energy
  - To derive an expression for the escape velocity

Q5: Chinese Astronomy

- The question is a test of students' night sky familiarity:
  - Summer sky: Scorpius & Sagittarius
  - Winter sky: Orion & Taurus
  - Ursa Major
- The question expects students to recognize these constellations, identify their main features and name some of their common DSOs.
- The standard of the question is based on the level of night sky familiarity an astronomer should have in order to explain the night sky to the general public.
  - It includes the common constellations one can see and recognize easily.

Q5: Chinese Astronomy (General Performance)

- ***Night Sky Familiarity***- Most teams have at least some knowledge of the night sky
  - ***Constellations Identification***- Most could identify the constellations
  - ***Main Features of Constellations***- Half of the teams have at least some knowledge of the features
  - ***Objects in the Constellations***- Mostly unfamiliar with the objects (DSOs, double stars, etc)

- ***Comprehension & Inference Skills***: Good comprehension skills in general
  - Some teams did not read the question thoroughly to be able to answer the inference questions

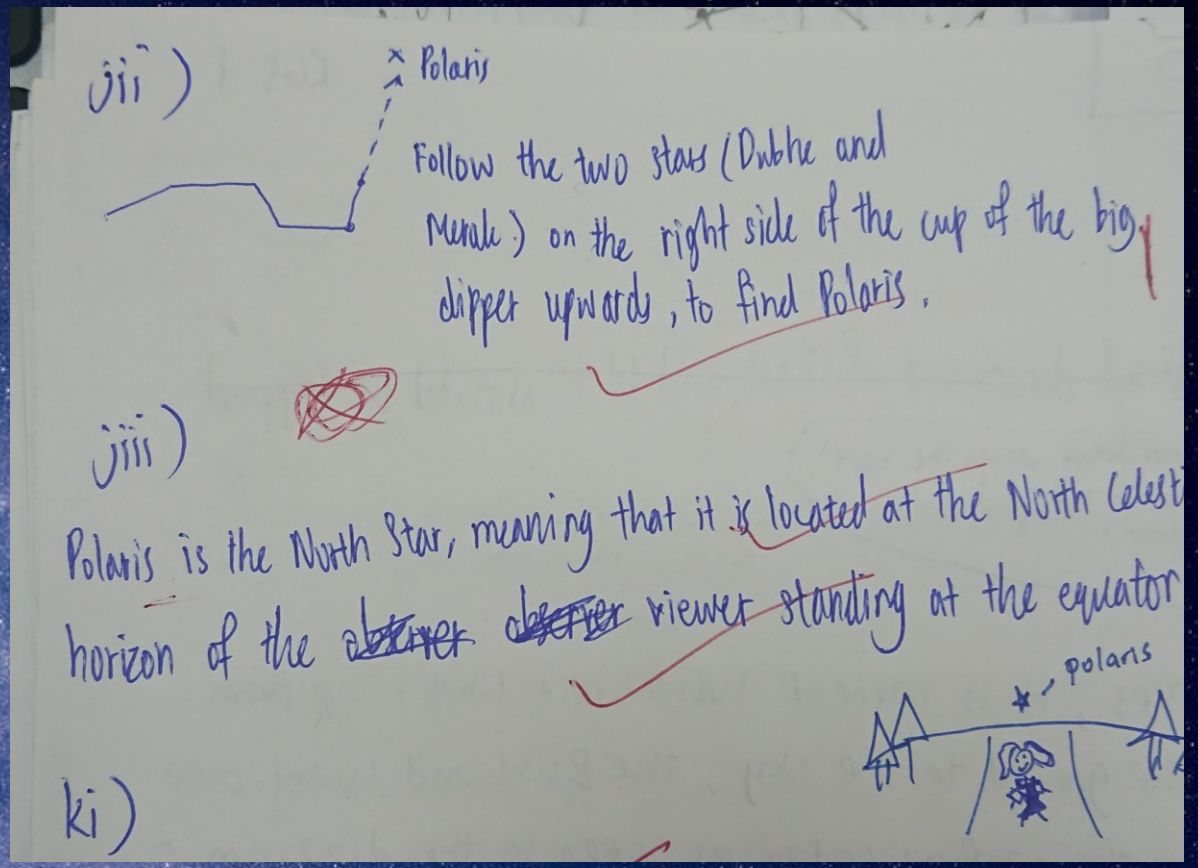
Q5: Chinese Astronomy (What went right)

- Good elaboration of answers and usage of diagrams to substantiate answers from some teams

- Question on finding Polaris from Big Dipper: We are looking for answers that will allow someone who has minimal knowledge of astronomy to be able to understand and follow your answer given to find Polaris.
  - Being able to explain the knowledge you have in an understandable manner is an important skill to master

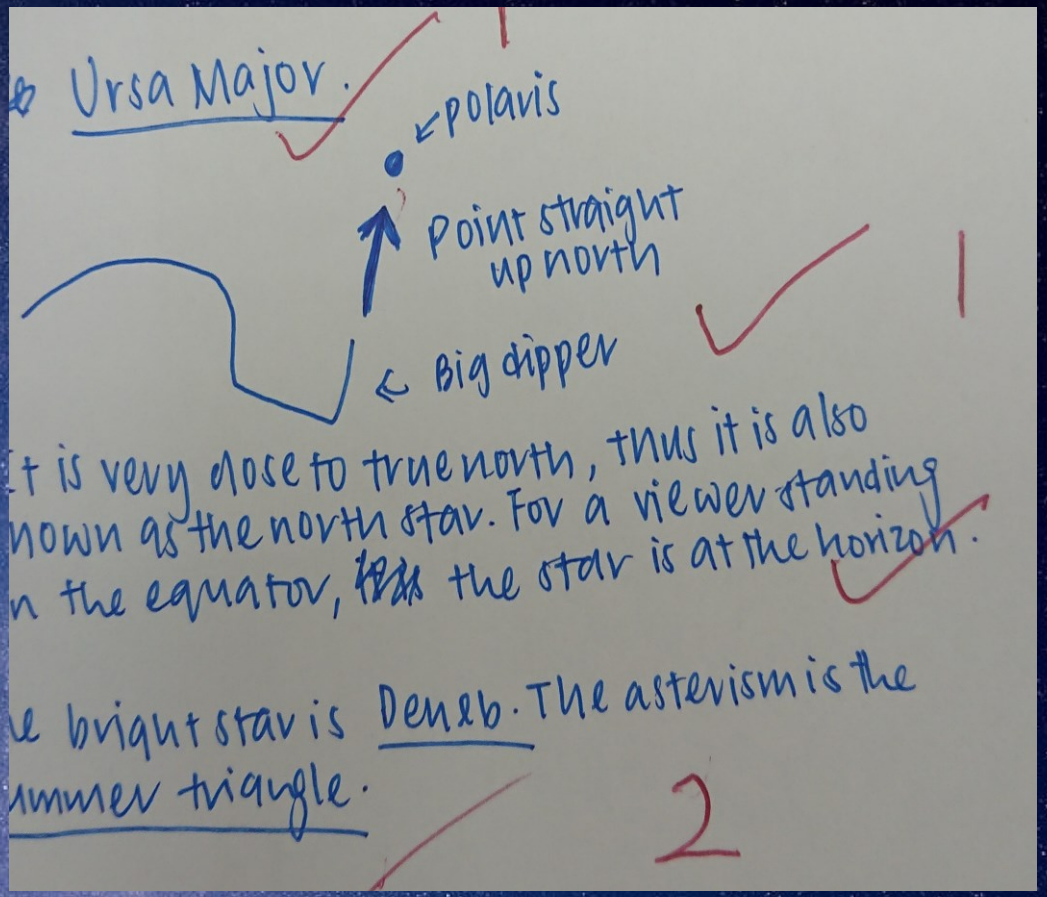
Q5: Chinese Astronomy (Good example)

- Clear directions given (with names of stars stated) with a simple diagram
- One can easily know which stars to look for and how to find Polaris with the aid of the diagram

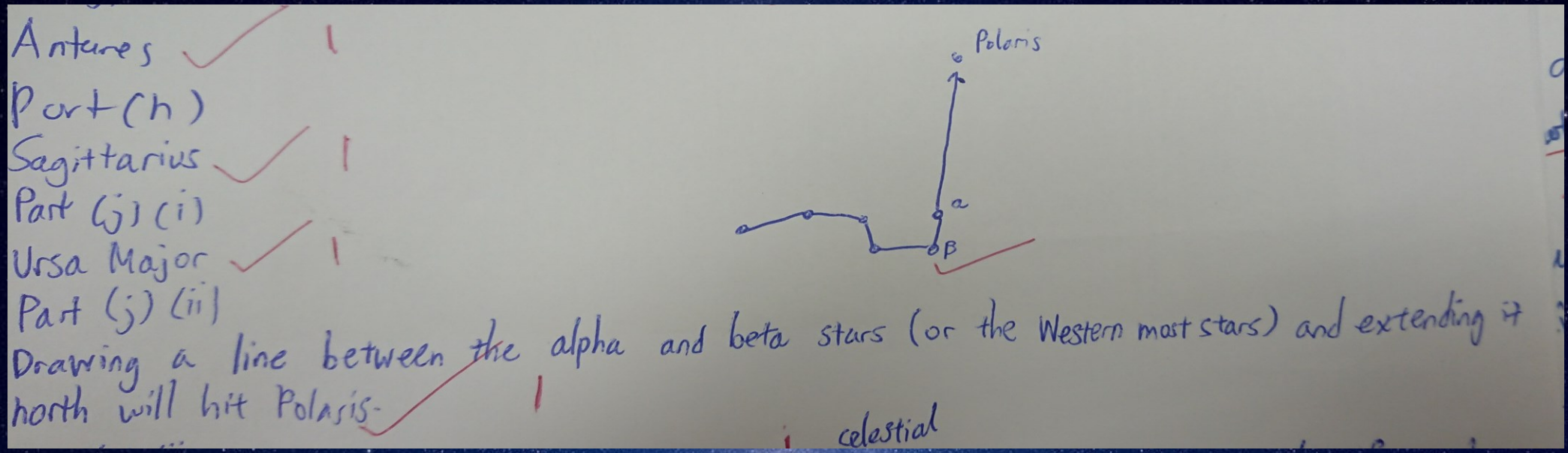


Q5: Chinese Astronomy (Good example)

- A simple diagram with clear and concise annotations
- Also acceptable. Question did not state that you must explain your answer in words only.



Q5: Chinese Astronomy (Good example)



- Clear labelling of stars and a simple diagram to help the reader to comprehend the text

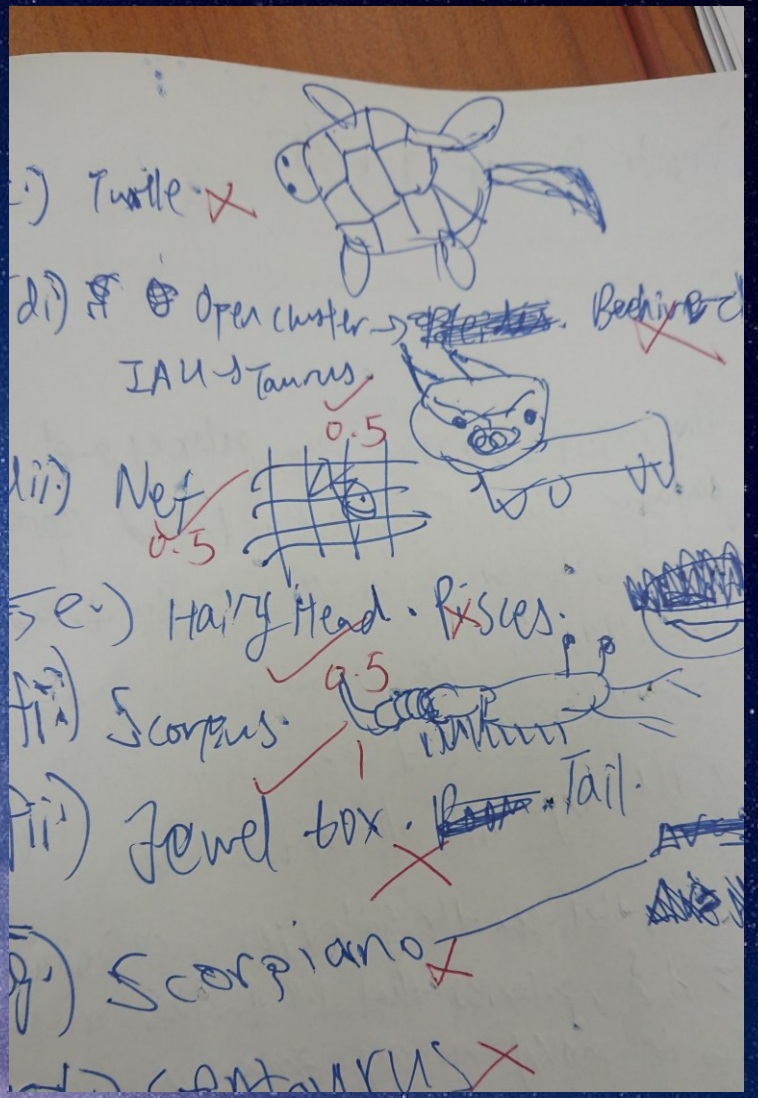
Q5: Chinese Astronomy (What went wrong)

- Common misconceptions:
  - Sagittarius and Centaurus are NOT the same
  - Big Dipper is NOT part of Canis Major but Ursa Major
  - The Jewel Box cluster is NOT in Scorpius but in Crux
  - Horsehead Nebula is NOT in Scorpius but in Orion
  - “Scorpio”, “Scorpion” are NOT constellations. Scorpius is a constellation.
  - Spelling of Pleiades

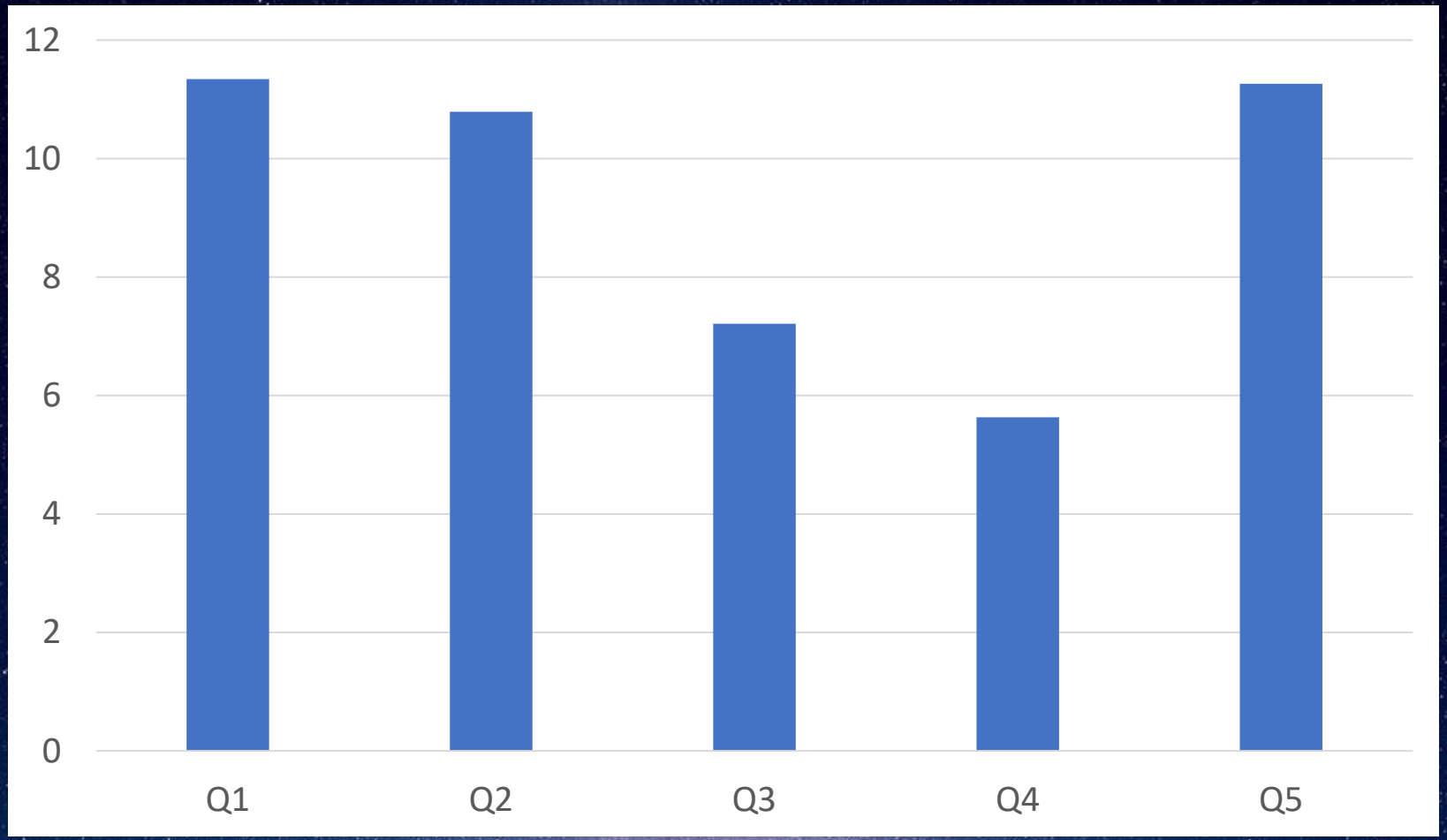
- ***Definition of Double star:*** a pair of relatively close stars that usually appear as a single star with naked eye. A true double star is called a binary star that consists of two stars that lie relatively close together in space and revolve around one another because of the gravitational attraction each exerts on the other. (adapted from HowStuffWorks)

Q5: Chinese Astronomy (What went wrong)

- Poor Presentation (and handwriting) from some teams
  - Although random drawings made our marking process more fun, please make an effort to present your answers in a readable format



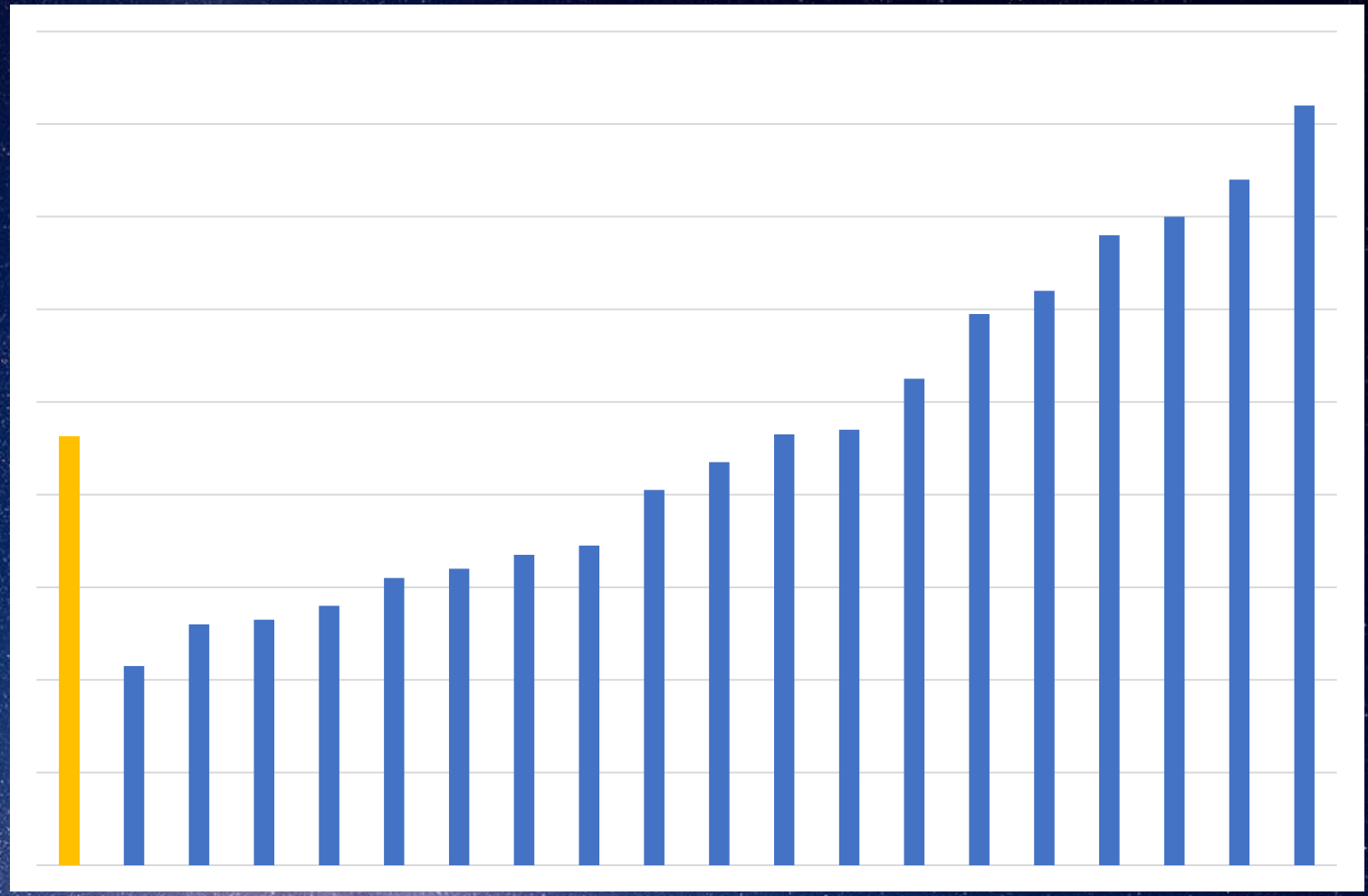
JNR Team Round Average Scores, by Question



JNR Team Round Score Distribution

Mean = 46.2

Standard Deviation = 17.9



NOTE: TEAM ROUND SCRIPTS

- We will allow you to take a look at your scripts after the Finals
- Note that SNR Q1/Q2 + JNR Q3 were scanned, and so no annotations were made on your script
- You may take photos of your scripts, but for recordkeeping purposes we cannot let you take the scripts home.
- Feel free to clarify with the QMS about where you went wrong, but scores awarded are **FINAL**

End of JNR Post Mortem