Examiners Report

Principal Examiner Feedback

Summer 2025

Pearson Edexcel
GCSE Astronomy 1AS0/02
Paper 2: Telescopic Astronomy

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General Comments

Summary

The enthusiasm and commitment which has always characterised those involved with the teaching and learning of GCSE Astronomy continues to be evident in candidates' responses to the examination papers. Centres and their candidates are to be commended for the conspicuous hard work and dedication (often as part of an extra-curricular provision) which clearly went into the preparation of this year's cohort.

This year's candidates demonstrated several impressive qualities, reflecting high quality teaching and learning throughout their courses:

- Many candidates showed competence in handling numerical data particularly in structured calculations, and graphic interpretation, though some struggled to apply this skill when drawing conclusions and identifying relationships from data and images.
- Candidates generally performed well in structured calculations though there were significant errors in unit conversions apparent in some responses
- Graphical skills were a relative strength particularly in plotting points extracting values however many candidates like clarity on the appropriate use of lines of best fit with some incorrectly forcing them as a straight line.

Some candidates appeared unfamiliar with less commonly assessed topics such as variable stars and the details within the Bayer system. This highlights the importance of covering the full specification in preparation for the exam.

Comprehensive Topic Support Guides have been produced to support teaching and learning in several topic areas and these can be downloaded from the GCSE Astronomy pages of the Pearson website. As well as providing detailed subject background they contain worked examples and practice examination questions.

Based on their performance on this paper, candidates should:

- Practice extracting information from figures, graphs and tables as part of an analysis, ensuring that these are referred to specifically within answers
- Improve their understanding of the underlying methods to obtain astronomical data, and refer to these when a question asks for "how" something is achieved
- Practice drawing and labelling diagrams to explain concepts clearly, as these can often be more effective than verbose explanations.
- Practice converting values between different units, e.g. m, km, pc and Mpc or degrees, minutes and seconds.

Please refer and link to the GCSE Astronomy Specification and/or Sample Assessment Materials (SAMs) on the Pearson Edexcel website.

Question requirements

Although it may seem an obvious point, a significant number of candidates are losing marks because they have not fully understood the requirements of the question. Candidates must pay close attention to the command word used at the start of each question as these invariably determine the structure of the mark scheme:

- Questions which ask candidates to 'Explain' will not award any marks for a description. When answering these questions candidates must be clear that they are explaining why something happens and not simply describing what happens. Candidates should ensure that their answer includes causation or justification and does not merely restate or describe a fact.
- Questions which ask candidates to 'Compare…' will require both sides of the argument to be stated for full marks.
- Questions which ask candidates to 'Evaluate…' will require them to come to some kind of judgement or conclusion after having looked at both sides of the information presented.
- Questions including the word 'how' often require a description of a method or process, not an explanation or definition. Many candidates missed marks by misinterpreting this command word.

Diagrams

By the nature of the subject, almost every GCSE Astronomy examination question involves the use of a diagram either in the question, the answer or in the mind of the candidate answering it.

- Clear labelled diagrams were a notable strength in some responses, particularly in questions on observational methods, or when illustrating more complex cosmological concepts. However, rushed or incomplete diagrams, especially those without labels or with unclear layouts, which limited the marks available to some candidates.
- Candidates are advised to use a ruler whenever possible in their diagrams. Diagrams drawn without the use of a ruler can easily descend into becoming rough sketches.

Calculations

Calculations represent a significant number of marks in this paper, and it is important that each candidate shows the full extent of their ability in these questions.

- It is important that candidates bring an adequate calculator to their examinations, so that they can meet all its mathematical demands. As well as basic arithmetical functions, astronomical calculations can often involve more complex operations such as squaring, cubing, taking logarithms etc.
- Candidates should ensure that they are familiar with the operation of their chosen calculator.
- Given that some calculations are worth three or even four marks, the provision of clear structured working is essential in all questions.
- It is recommended that candidates give their final answers to a sensible number of significant figures, taking their cue from the data given in the question, in addition to the precise answer resulting from their calculation. This includes where numbers are required to be entered into tables.
- Questions asking candidates to 'Analyse…' will require them to use the numerical data provided within the question as part of their answer. These data can be provided in a table, graph or other form but must be used in the candidates' calculations if full marks are to be obtained.
- Candidates showed familiarity with key formulae, and many demonstrated strong algebraic substitution. However, confusion with SI prefixes (e.g. kilo-, mega-) and with unit conversions (e.g. km to pc), was common in multi-step calculations.
- Some candidates opted for more complex numerical methods which were valid but were time-consuming. Where simple methods are available these should be prioritised.

Comments on Individual Questions

Q1
The vast majority of candidates were able to identify the objects from the descriptions and diagrams shown the most challenging option being the globular cluster in Q1(b)(ii), and confusion with a globular cluster.

Q2a
Many candidates found this item to be quite accessible.

Q2b
This provided a slightly higher challenge but still was achieved by most candidates.

Q2c
Candidates who correctly answered tended to answer with Seyfert galaxies. The most common error seen was to state the name of a particular galaxy such as the Milky Way or Andromeda, indicating that some candidates may struggle with the difference between the name and type of a galaxy.

Q2di
The majority of candidates gave the correct response here, with the most common incorrect response being "terminal velocity".

Q2dii
A key part of the explanation for this response is the identification that Image B shows the far side of the moon. A candidate who failed to identify what the image therefore gave an incomplete explanation and only was able to score one of the two marks. Another common error was to incorrectly refer to the "dark side" of the moon.

It is important that when explanations are given that candidates produce a statement and then expand upon it within their answer.

Example

because the photo is taken from the far side of the moon, Earth can't see the far side and it has more craters

This response identifies both what the image shows and then explains why this must have been taken from a spacecraft.

Q3a
Many candidates scored well here; however, some candidates forgot the correct name and substituted instead with galaxy names.

Q3b
This had a high proportion of correct answers with the most common being galaxies moving away and that they appear redshifted, although some candidates achieved the other points on the mark scheme. There is clearly a lack of understanding about what redshift means - many candidates saying that the galaxy "appears red".
Most candidates scored marks from their text rather than a diagram: common diagrams included star spectra showing redshift, and a single galaxy moving from Earth – however these were often not labelled clearly (or at all) – as a minimum, we would need the Earth and galaxy labelled, and some words stating what any arrows are showing (e.g. "movement").

Q3c
This response posed some more of a challenge, with many candidates trying to write verbose explanations of what Hubble's constant was, rather than giving the method. "Changing units" was also commonly seen.

When the word "how" appears in the stem of the question, we are often looking for details of a method / process.

Q3d
A wide range of responses were seen here. A common incorrect response was trying to try to incorporate a reference to radiation and that it described "the structure of the universe". There were also many candidates who wrote an answer without reference to the image given. It was clear that this was a weaker topic area, as quite a few candidates clearly could not recall the image, often describing the dots as stars or planets.

When a question refers to data, a figure, or an image, that information should be referenced in the answer.

Example

Lighter areas show more intense microwaves. This shows that there a fluctuations in the temperature of the CMB. These fluctuations are linked to areas with different density. More dense areas act as seeds for structure of universe, have dark matter which collapses to form galaxies. More dense areas accrete matter by gravitational attraction

(Total for Question 3 = 6 marks)

This response scored two marks, for clearly linking the fluctuations in temperature to the differences in density of the Universe.

Q4a
The majority of candidates were able to answer this question accurately.

Q4b
Most candidates were able to select all four correct answers here.

Q4c
Many candidates were successful with these terms however some variation was seen: most success was seen in part 4(c)(ii) (Oort Cloud), with some candidates finding the other two definitions more of a struggle.

Q5a
The Bayer system was not answered well by most – clear that the Greek letter part had been remembered/taught but not the constellation. There were many mostly incorrect responses, often prefixed by the word "Latin".

Q5bi
The majority of candidates were able to successfully identify the most Sun-like star from the provided data.

Q5bii
The most common of the marking points seen was the idea of an increased rate of fuel consumption, alongside that of more massive stars having a larger gravitational force. Several candidates simply compared the data given in Table 2, without any attempt at explanation (i.e. giving reasons for this). Note that the phrase "you may…" means that use of the table was not a requirement.

Many candidates used the stem of the question as part of their answer – this isn't creditworthy and can waste a lot of time.

Example

Greater mass = more gravity pulling everything in. This
means that the hydrogen atoms are more compressed.
This means that fusion is more likely to happen.
This means that the reaction happens quicker. The lifetime
of a star is determined by how long the fusion reaction happens
for. Quicker reaction = shorter lifetime.

This is a good response scoring all three marks – note that for short answer questions, full sentences are not needed within responses.

Q5biii

This calculation was done well - many candidates could substitute values in the correct places in the given equation, with most of these going on to correctly evaluate the result. Candidates had clearly practiced this process, and this has been rewarded.

Q5c

Many candidates referred to the inverse square law however failed to make the link between this and the difference in magnitude, meaning most could not access any of the marks. A small number of candidates used an alternative method, by way of finding the absolute magnitude of the sun first and using the magnitude equation twice. This was often more successful, however very time-consuming.

Examples

10 × distance = 100 × dimmer $\sqrt[5]{100} = 2.5$

-27 $100 = 2.5^5$ factors dimmer

$-27 + 5 = -22$

Apparent magnitude of the Sun = -22

This example shows the expected method and scores 2 marks.

$\cancel{b = \frac{k}{d^2}}$ $\cancel{b = \frac{-27}{10^2}}$ $\cancel{= \frac{-27}{100}}$ $\cancel{= -2.7}$ $\cancel{-0.27}$

$\cancel{-27 = \frac{k}{1^2}}$

$\cancel{k = -27}$

$1\,AU = \frac{1.5 \times 10^8}{3.1 \times 10^{13}}$ pc

$M = -27 + 5 - 5 \log\left(\frac{1.5 \times 10^8}{3.1 \times 10^{13}}\right)$

$= -22 - 5 \log\left(\frac{1.5 \times 10^8}{3.1 \times 10^{13}}\right)$

$= 4.57635\ldots$

$4.57635\ldots = m + 5 - 5 \log\left(\frac{1.5 \times 10^9}{3.1 \times 10^{13}}\right)$ (2)

$-0.4236\ldots = m - 5 \log\left(\frac{1.5 \times 10^9}{3.1 \times 10^{13}}\right)$

$m = -22$

Apparent magnitude of the Sun = -22

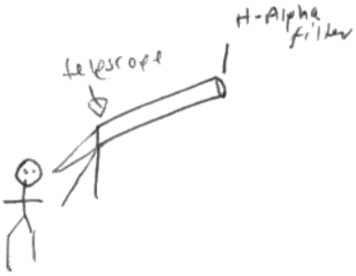
(Total for Question 5 = 9 marks)

This more complex – but equivalent – method was also seen and gains two marks. Candidates should be encouraged to use the most straightforward method available to answer calculation questions.

Q6a

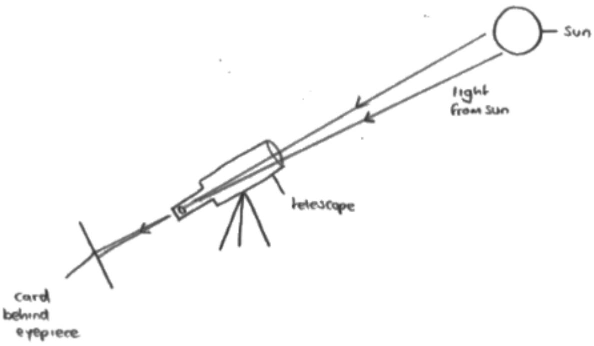
This question is a positive example of the importance of drawing a clear diagram, as many candidates were able to score both marks from their diagram alone. It was, however, noted that some diagrams felt rushed and difficult to decipher – taking additional care when drawing diagrams could be a positive approach to further success. H-alpha filters were by far the most common response seen, but examples of projection methods were also done well.

Examples



A person can use ~~a~~ H-alpha filter on a telescope to filter out certain wavelengths suitable for observing the Sun.

This response is simple and creditworthy for two marks, as it clearly shows where the filter has been placed on the telescope.



Telescopic projection involves pointing a telescope up at the Sun and placing a piece of card ~~next to~~ behind the eyepiece. A projection of the sun is visible on the card and it is important not to look through the eyepiece with the naked eye.

This response shows a telescopic projection method – this very clear labelled diagram shows both marking points.

Q6b
Most candidates achieved this mark.

Q6ci
The scale and plotting were often correct on this graph, but lines of best fit were more variable: some candidates "joined the dots" with rulers, and more commonly tried to make the data linear, even though this was not the case.

It should be remembered that lines of best fit do not need to be linear in Astronomy.

Q6cii
The logarithmic scale proved tricky for some candidates to interpret, however the range of correct answers was set to take this into account. Most candidates successfully gave a value in the given range.

Q6ciii
The majority of candidates extracted this information from the data without issue.

Q6civ
It was not always easy to interpret candidate responses, as there seemed to be some confusion in what was required, with some only commenting on one of the two figures that should have been analysed.
More successful candidates picked up on the shapes of the graphs being similar and highlighted the steep drop in the convective zone. It was relatively common to try to use correlation or (worse) proportionality instead of relationship between the two graphs – this was impossible to conclude as there was no numerical data given on the density graph.

Remember that if you are being asked to determine **if** a relationship exists, then your answer should include a statement as to whether the relationship does or does not exist.
Example

There is a relationship between the suns temperature and its relative density you can see this when you look at the two graphs, its clearly higher at the core both the density and the Temperature and on both Graphs there is a sharp drop ~~out~~ of in the convective zone. and in both graphs the temperature or the density decrease to the right or the further they are from the core.

This response is outstanding and gives all four marking points. Note that the clear initial statement "there is a relationship" sets the tone for the rest of the analysis, which gives the necessary evidence. This is a good structure for this type of response.

Q7ai
Variable stars are a weakness for many candidates, with this question proving challenging for many. Most ruled out the shortest response, however all three other responses were commonly seen.

Q7aii
This response required a simple description, however some candidates gave significant detail, for example reference to the Chandrasekhar Limit. These responses would have better suited an "Explain" question – although extra details were not penalised. A small number of candidates mistakenly thought that 1.2 solar masses would go down the path of a massive star (supernova, black hole / neutron star) or mixed up both evolutionary paths.

Q7aiii
Most candidates realising that Mira would be dimmer but often related this to the stage of its life, rather than the fact that we can't see infrared. Again, many candidates re-stated the stem of the question, with very little credit and can waste a lot of time.

Q7aiv
Various calculations were seen, with most candidates scoring marks on this question. The most successful converted time to seconds before the calculation, however some opted to convert speed into km/year - which was less frequently linked to a correct answer. It was clear many candidates did not know the difference between "kilo-" and "mega-" - more work on SI prefixes could be useful to many. It was also noted that some candidates tried to go from km to pc via light years – often with limited success.

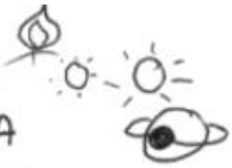
Q7b
Candidates were usually able to correctly link types of stars to the correct graph. It was common for candidates to describe the processes for supernovae and then eclipsing binaries, with analysis of the Cepheid variable being significantly weaker in most responses, with some selecting it by a process of elimination rather than a positive decision. Very few candidates extracted data from the provided graphs, either for time period or magnitude – those doing so tended to be more likely to give Level 3 responses.

Examples

Variable star B is a supernova because the apparent magnitude spikes up aggressively and decreases over 150 days. Variable star C is a Cephead variable because we can see the drop in Apparent magnitude and then the rise in apparent magnitude which happens again so we can assume it is a cycle. Variable star A is an eclypsing binary because we can see one small drop in light from the second star and then a massive drop where the smaller other star passes in front to block of more and then another small dip in apparent magnitude.

This response was given Level 2, 4 marks: the meaning of the text is easily understandable on a single first reading, and details are given related to both apparent magnitude ands period, with some use of data analysis.

- a supernova B
- a Cepheid variable C
- an eclipsing binary. A



Justify your answer in each case.

(6)

A is an eclipsing binary stars as it has one large 'dip' in apparent magnitude and 2 smaller 'dips'. The large dip is caused by a star going in front of /transitting star A which means ~~is~~ some light is blocked by the second star, hence the big dip. The smaller dips are caused when the second star passes behind star A. furthermore, the orbital period of the star orbitting A is ~~jus~~ around 13-14 days which makes sense as the stars are gravitationally bound together and will therefore be close. B is a Supernova as it experiences a huge increase in magnitude shown by the steep gradient. This is caused by a Super Red Giant exploding/collapsing as its gravitational force overcomes the radiative pressure. B's light curve show the explosion and then a ~~lin~~ decreasing magnitude as no more nuclear reactions are occuring as it is now a cloud of matter, prooving that B is a supernova. During an explosion like this a large amount of light is produced. C is a cepheid variable as its light curve shows a regular pattern of increasing then decreasing magnitude which alligns with a Cepid~~s~~ variable's nature of pulsating which makes it brighter then dimmer over and over again.

This is a very detailed Level 3 response, showing clear evidence of analysis of all three graphs, with significant amounts of expansion on most points made.

Q8ai-ii
Many candidates could complete both calculations correctly, however 8(a)(i) was more commonly correct. It was noted that some candidates gave the same answer for both parts, which could indicate a lack of understanding between the factors affecting resolution and light grasp (or indeed the differences between the two concepts).

Q8aiii
Some candidates went down the route of optical improvements which were incorrect (for example better resolution or light grasp – possibly being erroneously directed by the previous questions). Some candidates tried to suggest aperture synthesis, which is also incorrect. Further study is perhaps needed on more complex optical systems within telescopes.

Q8bi
This was answered well, with many candidates getting the link between UV being blocked by the atmosphere. Many weaker responses referenced the weather, the moon or line of sight being issues.

Q8bii
Most responses identified P2 as being above the atmosphere / in orbit, along with reasons why P3 and P4 were unsuitable. A few candidates only discussed the most suitable therefore losing marks – it is important for candidates to remember to discuss all the data which they are being asked to analysis in questions such as this.

Q8ci
Most candidates were able to collect both marks here. It should be noted that data in tables should be maintained to a constant number of significant figures, however this skill was not assessed in this question.

Q8cii
The most common response was increased magnification for advantage and smaller field of view for a disadvantage. It was common to see confusion between advantages and disadvantages, e.g. "higher magnification" being listed for both; or contradictory statements such as an advantage of "higher magnification" and a disadvantage of "lower magnification", clearly highlighting a lack of understanding.

Q9ai
Lots of candidates stated simply that the radio telescope was larger, which is not sufficient detail for this higher demand question, with more precision required within an answer – e.g. what aspect of the telescope is larger. Less successful responses either failed to identify that this question was about the construction of telescopes and gave answers relating to what they could observe using them or gave generic statements such as "radio telescopes use an aerial", which were not creditworthy.

Q9aii
This was generally well answered: main reason for not scoring the mark was not referencing that radio waves interfere with the telescopic observations - many just mentioned that phones emit radio waves. Some erroneous responses discussed the light emitted from the phone and linked to dark eye adaption.

Q9bi
Most candidates gained marks here, with most incorrect responses not relating their comment to radio waves, instead describing what the CCD could detect.

Q9bii
Most candidates were able to analyse this graph successfully to obtain valid conclusions. There were a few candidates who tried to explain using energy or were so focussed on the range of wavelengths that they forgot to utilise the information on the proportion of light.

Q9c
Most candidates could state problems and how to overcome them but not go any further with their responses: these often ended up as a brief list which limited access to higher marks, where more expansions were required, for example explaining why moving the position of the camera would help to find the radiant, or why light pollution would be a problem. A small number of candidates confused the star trails and the meteors, and a few references to "comets" were seen.

When evaluating an observational procedure, remember to explain why an issue is problematic as well as simply stating the issue.

Examples

(6)

One way to improve the ~~radiant point~~ photo is to move away from urban areas to the countryside. This is where there is much less light pollution from cars and streetlights and homes etc. in the city which interfere with the photo as it makes the sky seem lighter and so makes the stars appear dimmer and more difficult to observe. This would allow them to take a longer exposure photograph as there is less light pollution hitting the sensor so there will be longer meteor trails making it easier to extend them back to the radiant point accurately. However, they also need to use a camera with a wider field of view to make it suitable, just moving out of light polluted areas won't do this. For this they need to zoom out with their camera, reducing magnification by shortening the focal lengths. This will produce a larger field of view of the night sky so they will detect more meteors and include the radiant point in the image which they can connect the trails back too. This picture doesn't have a wide enough field of view, they need to increase the field of view and direct the camera more to the top left in order to include the radiant point in the image.

(Total for Question 9 = 12 marks)

This is a detailed response that scores 5 marks. Looking at the start of the response, there is a clear suggestion, followed by a justification for that proposal, and saying why the identified problem causes a negative effect on the image.

• The student should find an area with less light pollution to take the photograph as it can interfere with locating the radiant point (makes ~~t~~ fainter stars less visible)
• The student should ensure that the camera is facing Polaris in order to be able to see the middle of the circles
• The student should increase their exposure time in ~~od~~ order to make some of the stars ~~brigt~~ more visible
• The student should leave the camera on for the entirety of the meteor shower in order to capture everything.

The meaning of the text is easily understandable on a single first reading and hence is a Level 2 response. The list-based structure lacks additional detail on each point, and so does not fully answer the question set, scoring 3 marks.

Q10ai
Most candidates were successful here – the main error being to state “spiral” rather than “barred spiral”.

Q10aii
Many candidates failed to be specific enough about the viewing angle for this question simply stating, “at an angle”, which lacks precision. Several candidates listed types of classification that is could be and didn't state why it was challenging to differentiate between them.

10bi
Most candidates gave the correct answer here, however some simply re-stated the question, and others tried erroneously to discuss redshift and the principles involved (possibly coming back to this after attempting part (c).

10bii
A lot of correct answers were seen here. Many candidates missed the first conversion, however, were able to follow the other steps through using either 40 or a different (calculated) number. Quite a few errors in completing the pc to Mpc calculation – like those errors seen in Q7(a)(iv).

10ci
In a similar way to Q3(c), this question used the word “how” in the command sentence to indicate to candidates that a method was required, rather than simply describing or explaining spectroscopy or spectral lines. Many candidates did not pick up on this, and therefore a wide range of answers were seen, including a wide variety of diagrams – mostly unlabelled – which gained little credit. The first mark was more commonly scored than the second as candidates often delved into redshift instead of answering the question.

10cii

Candidates were often good at explaining that the spectra needed to be compared but neglected the detail required in the comparison (i.e. wavelengths being measured). The best responses linked their answers to the redshift equation. A few candidates seemed to misunderstand how redshift and velocity were related and tried to link it to a measure of the wavelengths over time.

10ciii

Some excellent graphs were seen, most of which were straight lines through the origin. Some candidates instead chose to draw a scatter graph without a line of best fit. The most common error was not explaining that the gradient was needed. A few sketches of HR diagrams were also seen from weaker candidates.

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