OBSERVATION ROUND

THEORY PAPER

Instructions to Candidates

1) The duration of this round is 3 hours, and consists of 4 sections with a total of 100 marks.

The breakdown of marks is as follows:

1.	Finder Chart Construction	[30m] – **20 minutes**
2.	Astronomy Cloze Passages	[20m] **- 20 minutes**
3.	Equipment OEQ: Mounts and Setup	[25m] **- 55 minutes**
4.	Night Sky OEQ: An Unfamiliar Ceiling	[25m] - **55 minutes**

Instructions to Candidates

2) For each section, you are only allowed to move on to the next section once you have finished the current section and submitted all the deliverables. You will not be allowed to return to the section afterwards.

3) Within a section, you are allowed to move forwards and backwards. As such, you may skip a question and return to it later if you wish.

4) The submission time is included within the time limit. If the time limit is up, whatever submission we have received (or lack thereof) will be deemed to be your final answer. You may alter previous submission to questions by informing your invigilator before the time is up, or before moving on to the next section.

Instructions to Candidates

5) Each individual question parts may require you to answer the question in a different manner. Specific instructions on answer submission are appended to each question.

6) For some questions, you will be required to draw diagrams on a blank paper, and to submit the diagram to the invigilator. For such submissions, you are required to write the name of your school on the upper-right corner of the paper.

7) For some questions, you may be required to make use of Zoom functions, such as the chatroom, or annotation tools such as lines, symbols, stamps or text input. Please do familiarize yourself with these functions, and feel free to approach your invigilator if you have any doubts. Further instructions will be provided in the questions.


Are You Ready?
Press ‘F’ in the chat to start
Press ‘B’ to go back to [Instructions to Candidates]

Section 1: Finder Chart Construction

30 marks - 20 minutes

Section 1: Instructions

For this question, your team will be randomly split into two groups: Group A and Group B.

Group A is tasked with drawing a finder chart for a given start and end location. Group B will then use the finder chart to navigate from the start to the end location in Stellarium. The flow of events is as follows:

1. Group A will be allocated to a breakout room with an Invigilator.

2. Group A will be shown a star chart with start and end locations labelled. They will be given 15 minutes to draw a finder chart.

3. Group A will be required to take a photo of the drawing and submit it to the invigilator via Telegram PRIVATELY BEFORE the time is up.

Section 1: Instructions

4. If you have not submitted within the 15 minutes, it will be deemed as a non-submission and both Group A and B will be awarded zero marks.

5. After submission, Group B will be invited into the room and Group A is allowed to watch. However, Group A will not be allowed to communicate with Group B in any way.

6. Group B will be given Group A's star chart for reference, and 5 minutes to navigate from the start point to the end point.

Section 1: Instructions

The score weightage is split 50-50 between drawing and finding.
Do also take note of the rubrics for marking of the finder chart as shown below.

Component	Percentage (%)
Indication of Start and End Points	10
FOV Calculations	20
Instructions on Slew	30
Use of Finderscope	20
Accuracy of Drawing	20

Drawing Segment:

Group A will proceed to the breakout room.
Group B will remain here.

Time Limit: 15 minutes

Drawing Segment:

Group A in the Breakout Room

Time Limit: 15 minutes

Drawing Instructions

Time limit: 15 minutes

Starting Location: Aldebaran

Ending Location: Hamal

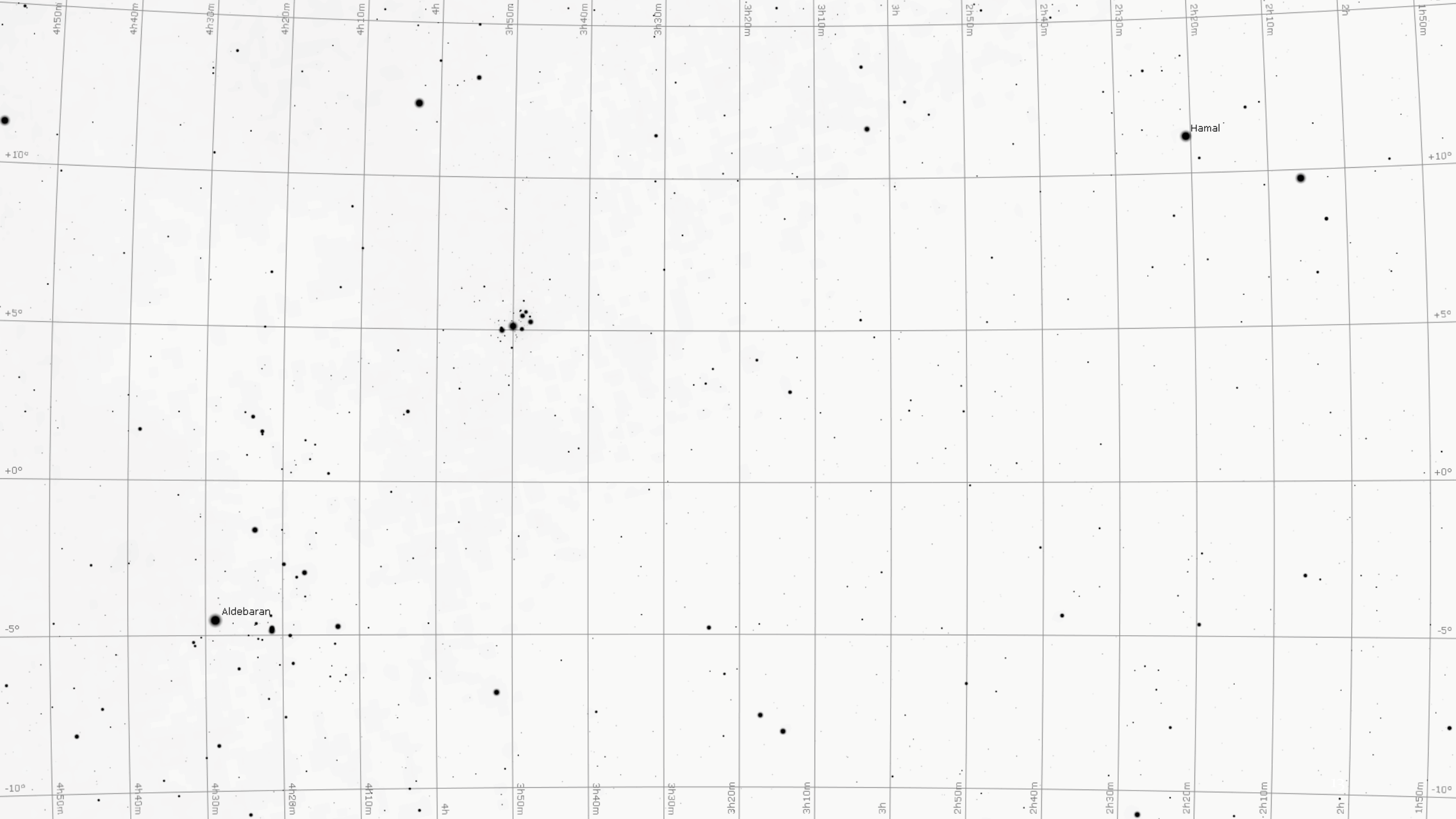
Equipment list:

- 50mm finder (7° FOV, 2x magnification)
- 60mm Diameter, 1000mm Focal Length telescope on an altitude-azimuth mount
- Eyepieces 40mm (43 °), 26mm (52 °), 14mm (50 °),.

Deliverables to be included with star chart:

- Start and End points labelled clearly
- True Field of View calculations for each eyepiece
- Instructions on how to slew the setup from the start to end points
  (e.g. Using the 26mm Eyepiece, when centered on Acrux, slew the field of view diagonally toward the cross-shaped grouping of stars)

Once you have completed your star chart, take a **CLEAR** picture and send it via Telegram to your invigilator within the 15 minutes. Your time will begin once the next slide is viewed.


Hamal
Aldebaran
+10°
+5°
+0°
-5°
-10°
4h50m
4h40m
4h30m
4h20m
4h10m
4h
3h50m
3h40m
3h30m
3h20m
3h10m
3h
2h50m
2h40m
2h30m
2h20m
2h10m
2h
1h50m


Time's Up

Finding Segment:

Group B will now enter the room. No communication is allowed between Group A and B

Time Limit: 5 minutes

Finding Instructions

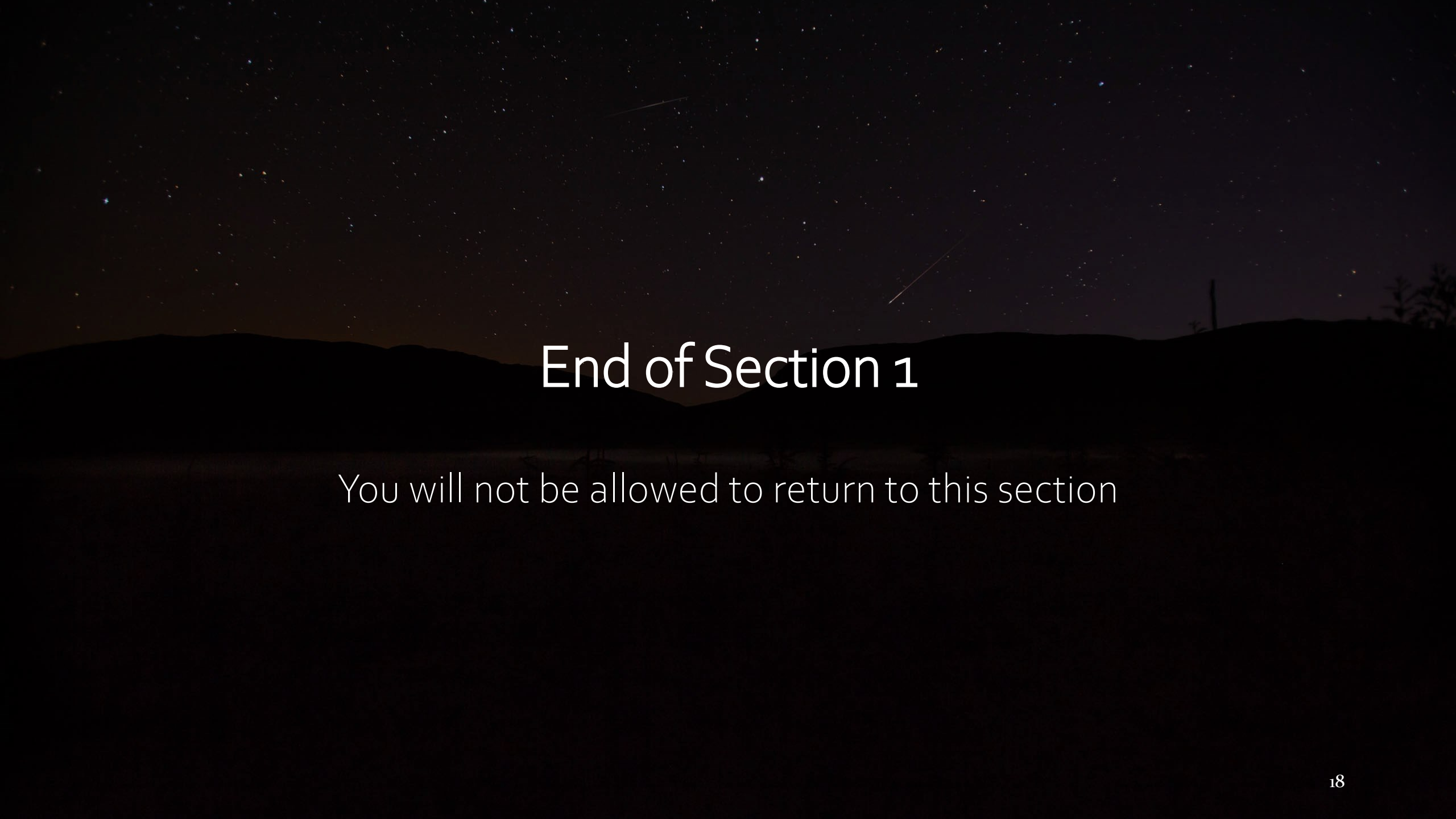
1. You will be given 5 minutes to find the end object from the given starting location.
   - The Invigilator will send the Starchart through telegram
2. The Invigilator will share their Stellarium after they are ready.

3. You are to request remote control of the invigilator's Stellarium via Zoom. You are only allowed to use the arrow keys, page up/page down, and the mouse button to change the ocular view. Pressing any other keys may cause labels to appear in Stellarium and as such, will be deemed as cheating (zero marks will be awarded for the Finding Segment).

4. You can request to slew back to the start point, but in doing so will incur a 1 minute penalty.

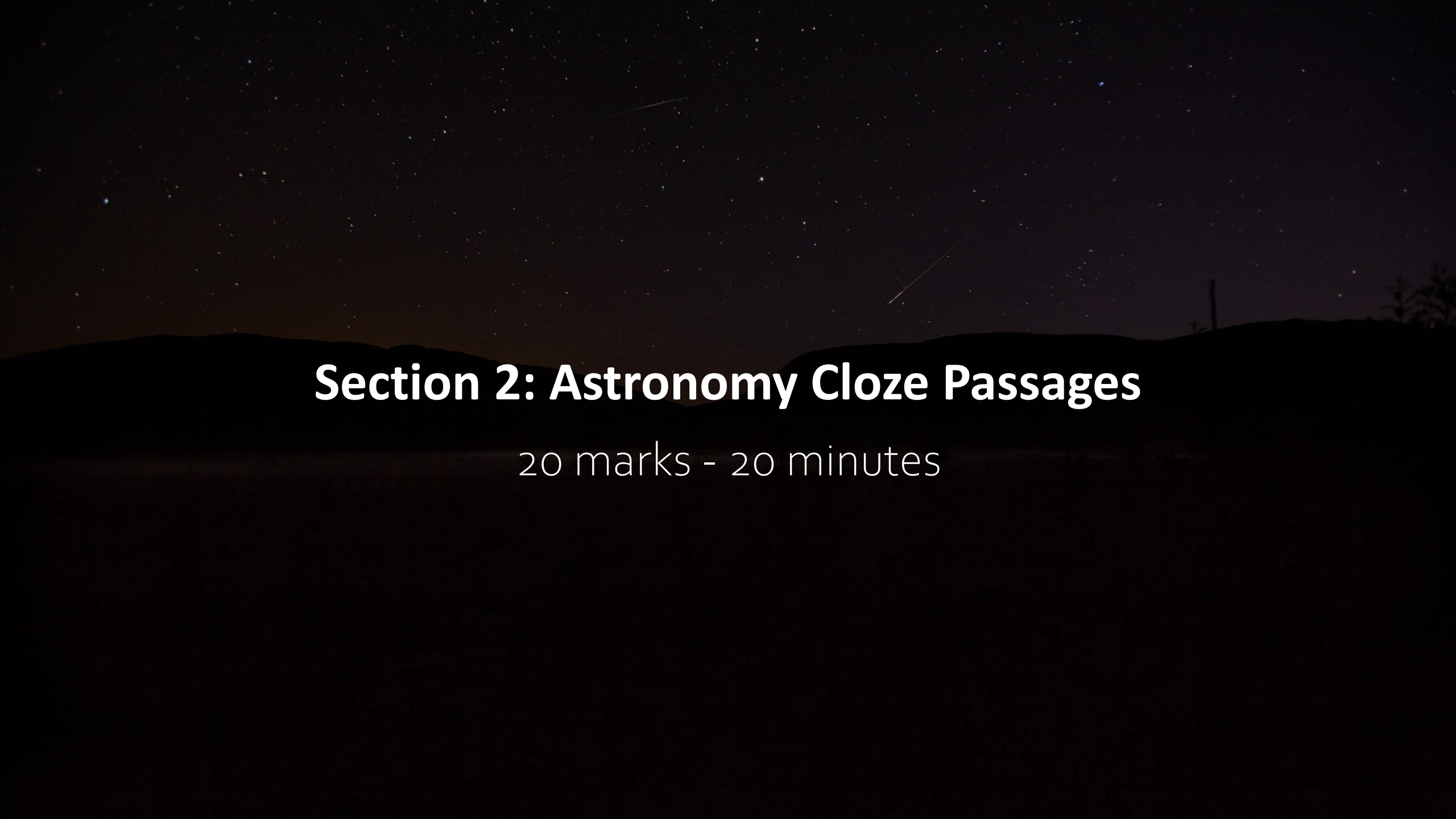
5. Your time starts on the Invigilator's cue.


Time's Up



End of Section 1

You will not be allowed to return to this section



Section 2: Astronomy Cloze Passages

20 marks - 20 minutes

Section 2: Instructions

1. This section is worth 20 marks . There will be a total of 2 cloze passages worth 10 marks each. You are given up to **20 minutes** for this section inclusive of answer submission.

2. Each cloze passage consists of **10** blanks labeled **[A, B, C, D, E, F, G, H, J, K]** and is split over two slides each.

3. At the end of each cloze passage, compile all of your answers into a single message typed into the Zoom Chat. The invigilator will only screenshot the final answer.

4. Please label your answers to each cloze passage clearly.

5. You are allowed to move back and forth within this section. Your time starts on the next slide

Cloze Passage 1

Your Time Starts Now

Constellation A is not officially recognised in western astronomy as a zodiacal constellation, but it is sometimes referred to as the 13th constellation of the zodiac as the sun passes in front of A from about 30 November to 18 December. Its brightest star is B, whose name has Arabic roots, roughly translating as "Head of the Serpent Collector". The name comes about since A bisects the constellation C into two parts.

In a nearby section of the southern sky lies a constellation that was one of the original 48 constellations listed by Ptolemy. This constellation contains the nearest star system to Earth (4.37 light years away) and its β star is known as D. A line perpendicular to the line formed through its α star and D points south. The constellation also contains the Deep Sky Object (DSO) E. To find E, simply locate Spica in Virgo when it is at its highest point and trace 35° altitude below it. This is possible because Spica and E have almost identical right ascensions, meaning they culminate at around the same time.

Unlike E, which is strongly bound by gravity, F is an open cluster that is loosely held together by mutual gravitational attraction. It is located in the constellation G and its brightest stars form a V shape at the centre of G. Although the α star of G is in the same section of sky as F, it is actually unrelated to F and just happens to lie along the same line of sight. In the same constellation lies H, another famous star cluster that is prominent in the winter. Reflection nebulae overlap H in the same section of sky, resulting in a prominent blue "mist" that appears to envelop H.

Apart from reflection, there are other categories of nebulae. The Heart Nebula (IC1805) is an example of an emission nebula, which mostly consist of ionised gases that emit various wavelengths of light. IC1805 lies in the Northern constellation J, which is easily recognisable due to its distinctive "W" asterism. Also in J lies another emission nebula, K. Informally named after a video game character, it is faint and diffuse, making it challenging to spot. To find K, one must first locate the α star of J and a nearby star known as Achrid. K lies midway and slightly South of the two.

Cloze Passage 2

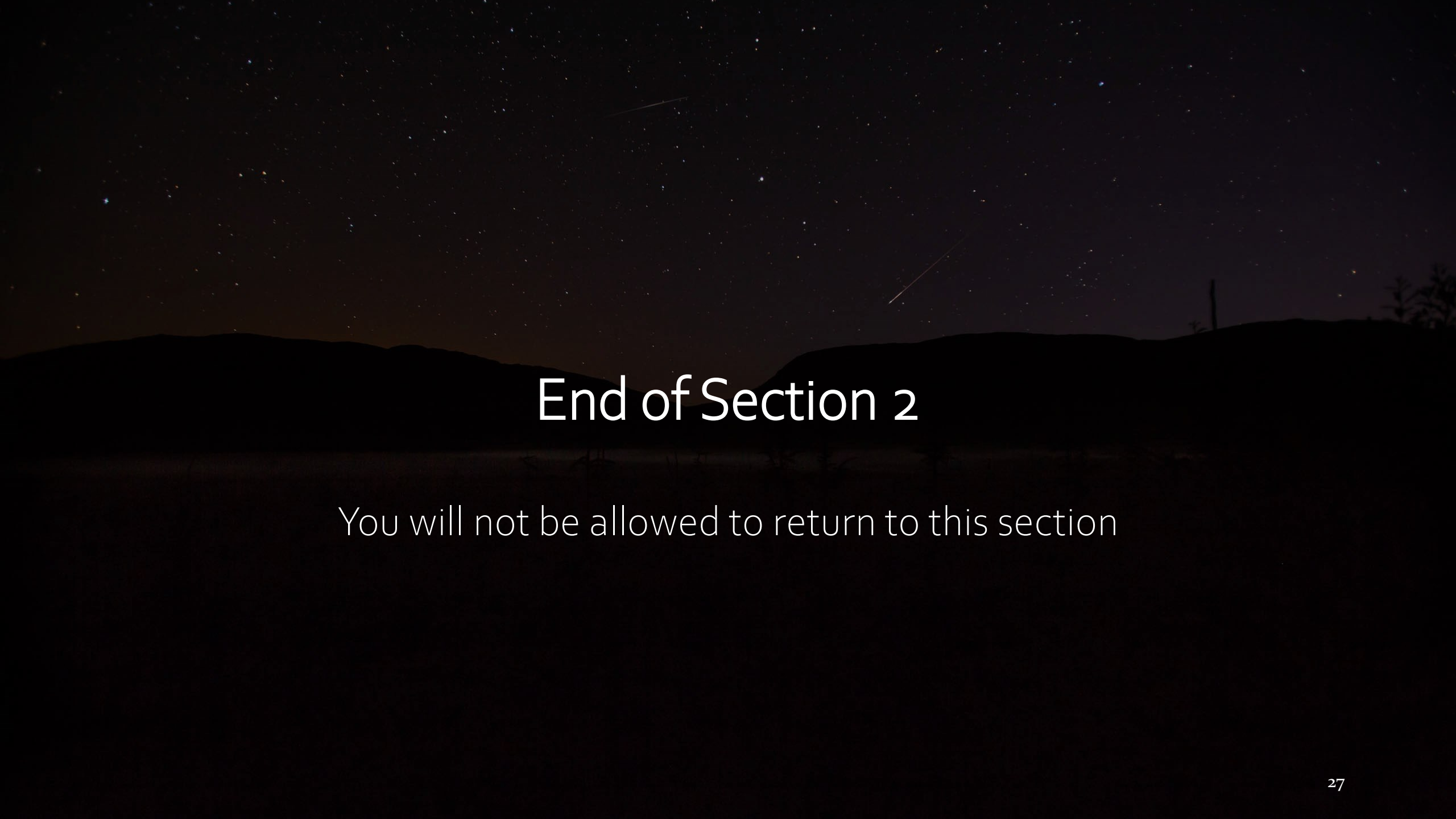
Star A is one of the famous Royal Stars of Persia. As the alpha star of Constellation B, it is described as a bright white star. Not only is Constellation B a zodiacal constellation, Star A lies extremely close to the ecliptic, such that the Moon occults Star A on occasion.

Constellation B is located far from the Galactic Plane, and thus there are no prominent star clusters located within Constellation B. For this same reason, Constellation B contains many bright galaxies, such as the galaxies that make up famous deep sky object C.

A useful way to star hop to Star A (and by extension Constellation B) is to draw a line from Megrez to Phad/Phecda. Megrez and Phad/Phecda are one of the key stars that make up famous asterism D, and both are also members of Constellation E.

If one moves westward along the ecliptic from Constellation B, their eyes will most probably halt at the group of relatively bright stars that make up Zodiacal Constellation F. In doing so, they would have skipped Zodiacal Constellation G, which is practically invisible for observers in light polluted areas. However, Zodiacal Constellation G contains the bright open star cluster known as Star Cluster H, and thus Zodiacal Constellation G is well-known among visual astronomers.

Meanwhile, Zodiacal Constellation F lies partly within the Galactic Plane, and thus contains several star clusters buried amidst a rich starfield. However, its main claim to fame is that it hosts the two bright stars known as Star J and Star K. Star J and Star K are the brightest two stars of Zodiacal Constellation F and have similar brightness. However, a keen eye would note that Star J is slightly brighter than Star K, and Star J has a slight yellow hue compared to Star K (which is white)



End of Section 2

You will not be allowed to return to this section

Section 3: Mounts and Setup

25 marks - 55 minutes

Section 3 Instructions

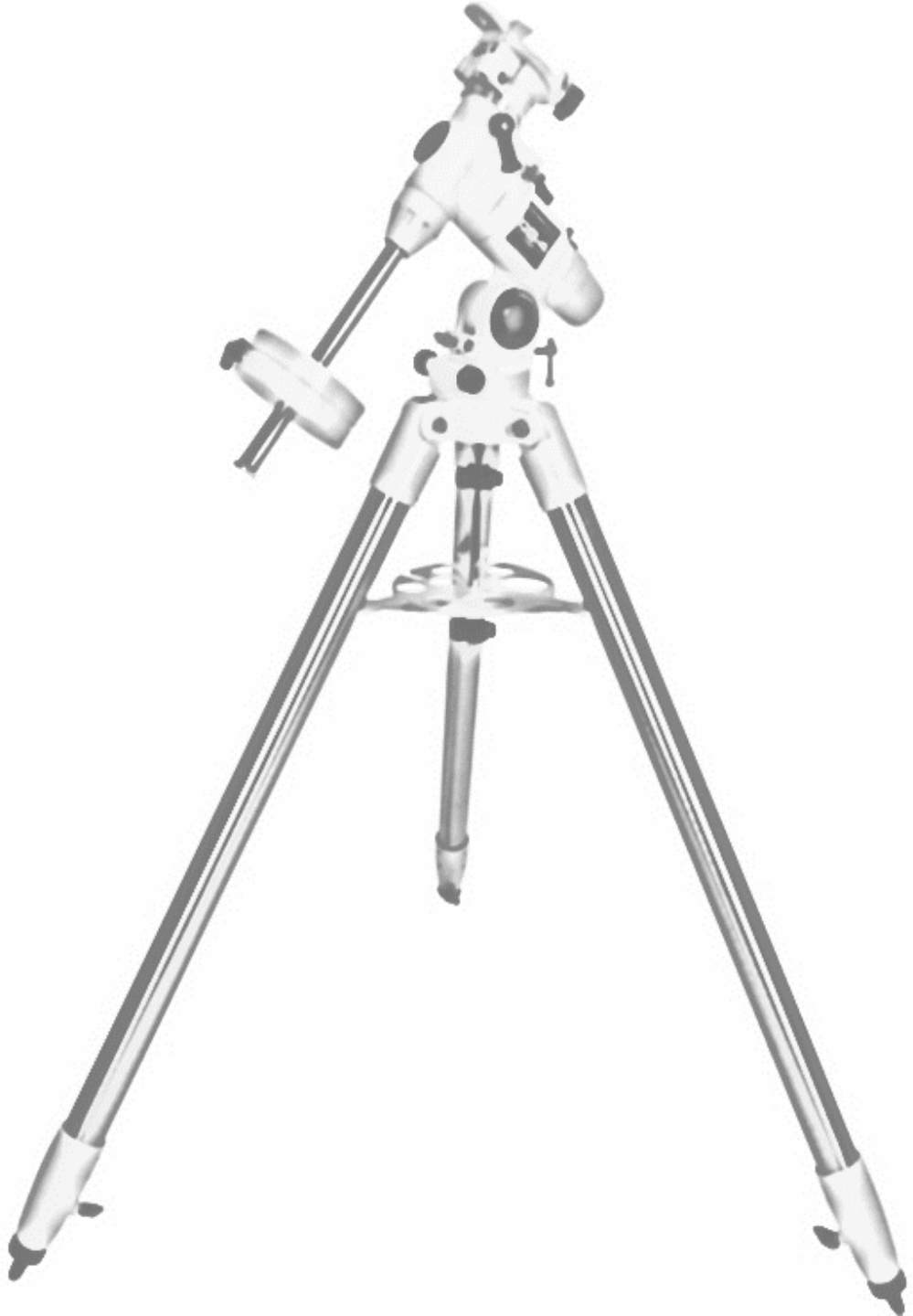
1. This section is worth 25 marks. There will be a total of 10 Questions. You are given up to 55 minutes for this section.

2. This section involves drawing and submission of diagrams on paper. Please follow the instructions given in the questions.

3. This section involves drawing and annotating of on-screen diagrams with the zoom annotation tools. Please familiarize yourself with the line and stamp tools as well as text input.

4. You are allowed to move back and forth through this section.

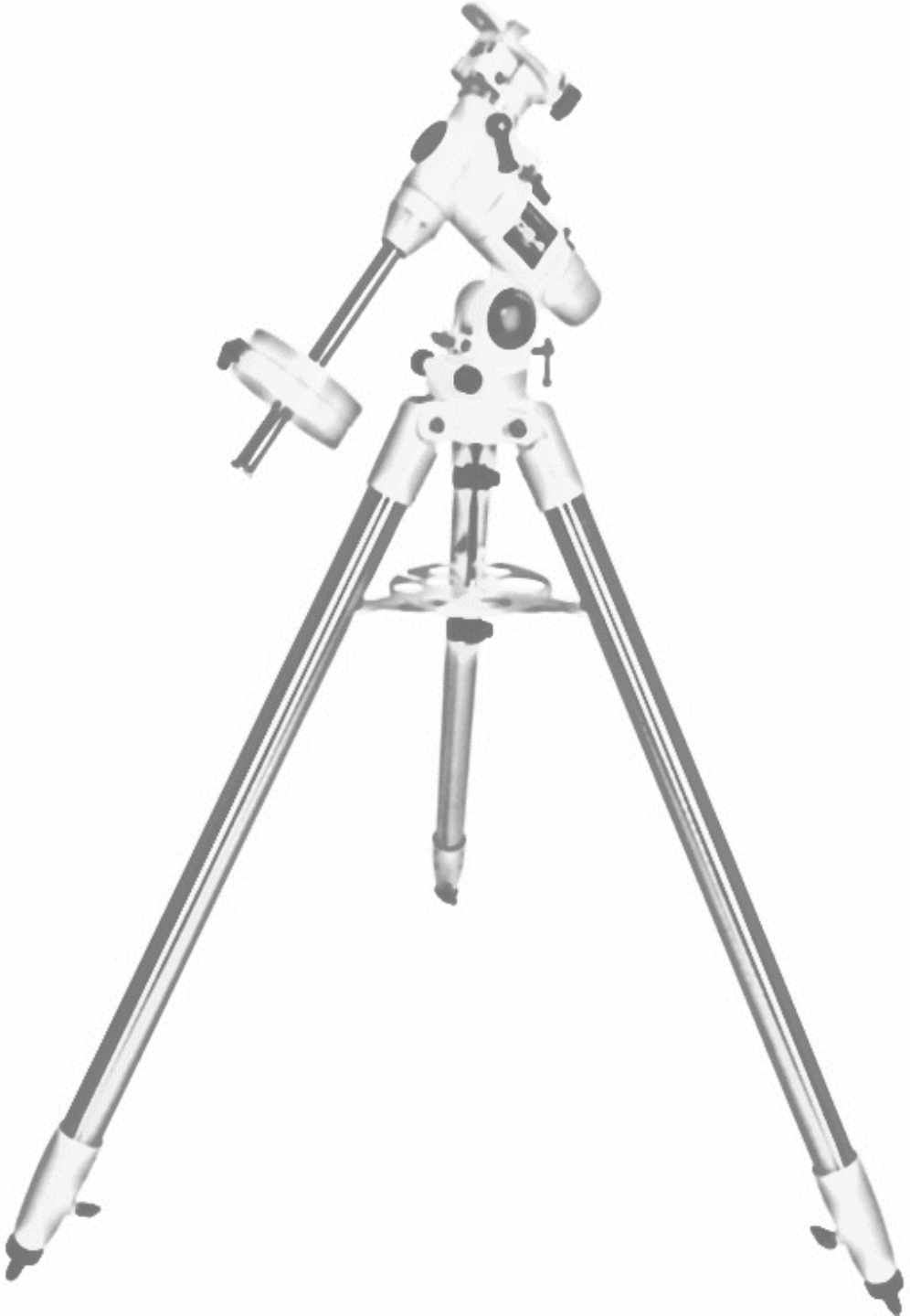
5. Your time starts on the next slide.



For questions 1-2, please refer to this image of a typical German Equatorial Mount.

You will need to sketch/label the image with Zoom on-screen annotation tools. Once completed, please inform the invigilator who will take a screenshot of your answer.

Continue to the Next Slide



Q1. In the image of the mount given, identify and label the parts listed below. [5m]

A. Dovetail Clamp

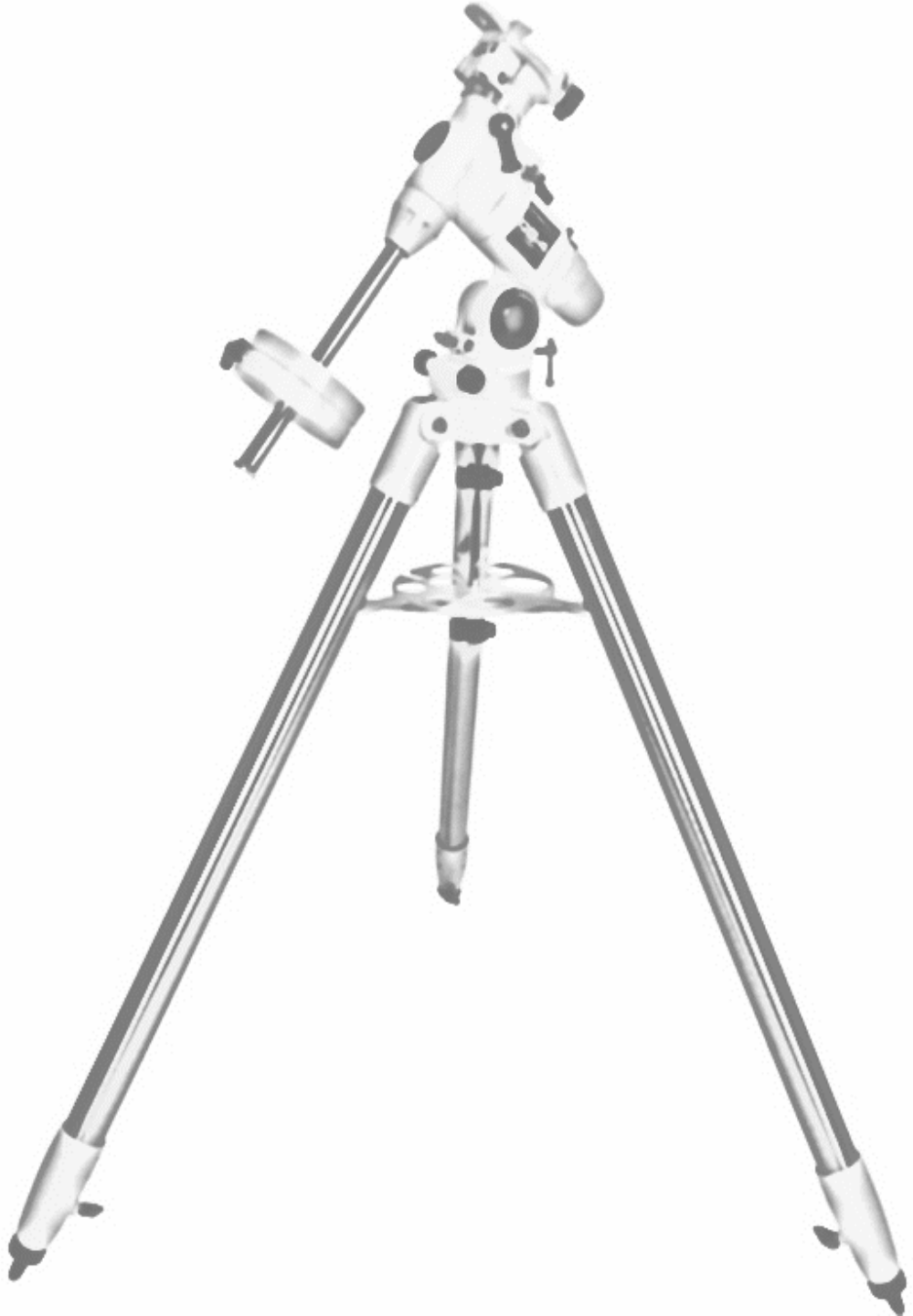
B. Polarscope

C. Latitude Adjustment Knob

D. Horizontal Adjustment Knob

E. Tripod Spreader

You may continue to the next slide



Q2. An equatorial mount works by aligning the mount's axes with the axes of Earth's rotation. By drawing and labeling appropriate lines through the mount in the image above, show:

1. The alignment of the mount with the NCP, and mark the latitude angle.
2. The alignment of the mount with the local meridian.

[2m]

Your invigilator will screenshot the answers once confirmed.

Q3. Briefly describe the steps to set up an equatorial mount (and OTA) like the one depicted in the image, **in the northern hemisphere**. [3m]

Type your answer into the chat.

For questions 4-5, please refer to the passage below.

Apart from the Equatorial Mount, another type of mount popular with Amateur Astronomers is the Altitude-Azimuth (Alt-Az) Mount (Fig. 1). An Alt-Az mount does not need to be aligned in the same manner as an equatorial mount, making it a convenient option for casual grab-and-go visual observation.

An equatorial mount on the other hand can easily track objects along the sky's rotation with a simple clock drive, a motor which rotates the Polar Axis of the mount at a rate of 360 deg/24hr. An Alt-Az mount on the other hand has to be computerized in order to be able to track objects along the sky's rotation.

Nevertheless, some older Alt-Az mount designs do come with a motorized clock drive which rotates the azimuth axis of the mount. In fact, Alt-Az mounts can easily be converted into an equatorial platform with the use of an equatorial wedge (Fig. 2), which is installed between the tripod and mount piece to tilt the mount at an angle. The angle of the wedge can be adjusted according to the user's latitude.

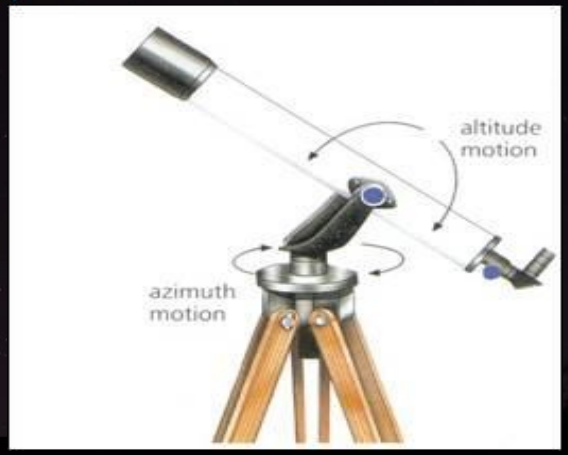


Fig. 1

Fig. 2

You may continue to the next slide

Q4. Draw a diagram on paper to illustrate how such an Alt-Az mount with an equatorial wedge should be set-up and aligned, in order to track objects with a clock drive.

Do indicate how the mount should be aligned with the local meridian and the rotational axis of the celestial sphere. [3m]

Your diagram should be similar to the image of the Equatorial mount marked and labeled in Q1-2.

When you are done take a photo of the drawing and send it to the invigilator.

You may use the space provided on the right for on-screen drafting and discussion.

Q5. Explain why it may not be advisable to use such an Alt-Az and equatorial wedge mounting configuration in Singapore.[2m]

Type your answers into the chat.

You may use the space provided on the right for on-screen drafting and discussion.

In Singapore, the use of equatorial mounts is also complicated by the difficulty of polar alignment. As Polaris lies far too close to the horizon, it is nearly impossible to sight and align the mount against Polaris. Instead, a method called drift alignment is used instead.

For Q6, a fill-in-the-blanks passage about drift alignment will be provided. For Q6-8, please refer to the same passage provided.

You may continue to the next slide

Q6. The paragraph on the right describes the process of drift alignment. Fill in the blanks with the following directional terms: Higher, Lower, East, West. [2m]

Type your answers on-screen with the text box tool. Your invigilator will screenshot the answers once confirmed.

(1) After doing a rough alignment of your mount, turn on the clock drive of the mount and point your telescope towards a star in the northern celestial hemisphere, near the local meridian. If the star drifts north in your eyepiece FOV over time, the mount is pointed _____ of the NCP, and if the star drifts south the mount is pointed _____ of the NCP.

(2) Next, point your telescope towards a star near the celestial equator and right above due East on the eastern horizon. If the star drifts north in your eyepiece FOV over time, the mount is pointed to a _____ altitude than the NCP, and if the star drifts south the mount is pointed to a _____ altitude than the NCP.

Repeat both procedures (1) and (2) until no discernable drift is observed.

Note: 'Northwards' drift in eyepiece FOV refers to drift towards the RA axis of the mount, and 'Southwards' drift refers to drift away from the RA axis of the mount.

Q7. Explain your answers to Q6 with the aid of a diagram. [3m]

Draw your diagram on the paper. When you are done, take a photo of the drawing and send it to the invigilator. You may write down any explanations legibly below the drawing.

You may use the space provided on the right for on-screen drafting and discussion.

Hint: Draw a diagram with the NCP, mount axis, and a guide star, and work out their relative motions.

Q8. For drift alignment in locations at higher latitudes, is it still advisable to perform drift alignment using a star at due east, right above the eastern horizon (as per step (2) in the provided passage)? Why or why not? [2m]

Type your explanation into the chat.

(1) After doing a rough alignment of your mount, turn on the clock drive of the mount and point your telescope towards a star in the northern celestial hemisphere, near the local meridian. If the star drifts north in your eyepiece FOV over time, the mount is pointed _____ of the NCP, and if the star drifts south the mount is pointed _____ of the NCP.

(2) Next, point your telescope towards a star near the celestial equator and right above due East on the eastern horizon. If the star drifts north in your eyepiece FOV over time, the mount is pointed to a _____ altitude than the NCP, and if the star drifts south the mount is pointed to a _____ altitude than the NCP.

Repeat both procedures (1) and (2) until no discernable drift is observed.

For Q9-10, please type your answer into the chat.

Q9. In long-exposure deep sky astrophotography, Equatorial mounts are often preferred over Alt-Az designs as the effects of field rotation are minimized. Explain what causes field rotation and how it affects long-exposure astrophotography. [2m]

Q10. Despite the advantages of Equatorial mounts in long-exposure astrophotography, most large modern observatories (such as the Very Large Telescope) no longer use Equatorial mounts, preferring to use Alt-Az mounting configurations instead. Suggest a reason why this is the case and explain how the field rotation issue can be resolved. [1m]

End of Section 3

You will not be allowed to return to this section

Remember to submit your answers/diagram photos to the invigilator if you have not already done so.
The Invigilator will screenshot the Chat

Section 4: An Unfamiliar Ceiling

25 marks - 55 minutes

Section 4: Instructions

1. There will be 17 Questions in this section for a total of 25 marks, you are given up to 55 minutes for this section.

2. You are allowed to move back and forth through this section.

3. Most questions will require you to annotate on a on-screen chart using the annotation tools. You are advised to not clear the screen in-between questions as answers carry forward into the subsequent questions.

Section 4: Instructions

4. A screenshot of the chart will be taken after you have completed the entire section.

5. Certain questions may ask you to type your answer on-screen in a box provided. Your invigilator will take a screenshot of your answer afterwards.

6. Your time begins on the next slide.

The diagram provided is a full 180-degree star chart. Please refer to this star-chart for the entire section.

The star chart is in standard stereographic projection, which is the default setting on Stellarium.

On the chart, the zenith point on the chart is marked out with a cross while the South Celestial Pole (SCP) is marked with a four-pointed star. The Sun and Moon are labeled by a small ‘S’ and ‘M’ respectively

You may continue to the next slide

Q1. Sketch and label the Southern Cross (SC), False Cross (FC) and Diamond Cross (DC). [3m]

You may continue to the next slide

Q2. Circle and label the following stars:

- Betelgeuse (B)
- Canopus (C)
- Rigil Kentaurus (R)
- Pollux (P)
- Formalhaut (F)
- Sirius (S).

[3m]

You may continue to the next slide

Q3. Sketch construction lines showing how the South Celestial Pole can be located with the naked eye. [1m]

Q4. With the aid of the zenith point, construct and label the Local Meridian (LM) and Prime Vertical (PM), and label the cardinal points (NSEW). [2m]

You may continue to the next slide

Q5. Identify and label Jupiter and Saturn. [2m]

Q6. Sketch the ecliptic line. [1m]

Q7. Thus, estimate the local solar time. Type your answer in the box provided. [1m]

Your invigilator will screenshot the answers once confirmed.

Q8. Draw and label 4 <u>other</u> complete constellations. [2m]

Q9. State a constellation in its lower culmination. Type in the box provided below. [1m]

Q10. Thus, identify the current season in the Northern hemisphere. Type in the box provided below. [1m]

Your invigilator will screenshot the answers once confirmed.

Q11. **Estimate** the length of a day to the nearest hourat your current location and season. Type in the box provided. [1m]

Q12. Identify the current lunar phase. Type in the box provided. [1m]

Your invigilator will screenshot the answers once confirmed.

Q13. Is Saturn approaching or leaving opposition (whichever is closer)? Type in the box provided. [1m]

Q14. Explain your answer. Type in the box provided. [1m]

Your invigilator will screenshot the answers once confirmed.

Q15. Identify, label and mark the position of 1 deep sky object from each quadrant of the sky (as divided by the Meridian and Prime Vertical), 4 objects in total. [2m]

You may continue to the next slide

Q16. Sketch the approximate <u>orientation</u> and <u>position</u> of the Southern Cross 6 hours **earlier**. [1m]

Q17. Thus, mark and label the approximate position of the moon 6 hours **earlier**. [1m]

Your invigilator will screenshot the answers once confirmed.

End of Section 4

R.I.P.
Here lies your hopes and dreams of AC Championship

This is the end of the Theory Observation Round

Remember to submit your answers/diagram photos to the invigilator if you have not already done so.