Observation Theory Round

Instructions To Candidates

There are a total of four sections, each worth 20 marks.

1. Section 1: 20 minutes
2. Section 2: 40 minutes
3. Section 3: 45 minutes
4. Section 4: 15 minutes

Answers will be a combination of annotation and typing in chat.

The question will indicate whether you are to annotate or type your answer in the zoom chat.

Section 1: Starlore Cloze [20 Marks]

Time Limit: 20 Minutes

Section 1: Starlore Cloze [20 marks]

1. This section consists of 2 cloze passages, each with 10 blanks labeled A-K and L-U.
2. Each correct answer is worth 1 mark.
3. **Type your answers in the chat.**
4. At the end, compile the answers for each cloze passage in one zoom chat message each.
5. Your 20 min time limit will start now.

Cloze Passage 1 (pt. 1/2)

In the winter sky, three stars in a line mark a famous winter constellation. In this constellation lies a bright nebula called **(A)** which contains the Trapezium Cluster. Not far away from A, lying partly on the Galactic Plane is constellation **(B)**. Interestingly, its beta star **(C)** is brighter than its alpha star.

Moving westward along the ecliptic from **(B)**, we reach a constellation containing deep sky object M1, also known as **(D)**.

In his search for comets, Charles Messier created a list of non-comet deep sky objects that distracted him from his goal. **(D)** is the first object in this list. In the same constellation as **(D)** lies a prominent star cluster **(E)** which is so bright it can even be seen with the naked eye in Singapore on a good night.

Cloze Passage 1 (pt. 2/2)

Antipodal to the famous winter constellation containing **(A)** lies an asterism known as ‘the Teapot’. North of the ‘spout’ of ‘the Teapot’ is a deep sky object **(F)** composed of three types of nebulae: an emission nebula, a reflection nebula and a dark nebula. Further north is constellation **(G)**, the only constellation in the night sky that is split into two parts.

Moving eastwards along the Milky Way from **(G)**, we reach a famous asterism called the Summer Triangle. The Summer Triangle comprises the brightest stars from three summer constellations. One of these three constellations is **(H)**. The brightest star **(J)** in **(H)** is interestingly the only star with a magnitude of 0.00 as it was the benchmark star for the magnitude system. **(H)** also contains the well known planetary nebula **(K)**.

Cloze Passage 2 (pt. 1/2)

Constellation **(L)** is one of the 48 constellations identified by the Ancient Greek Astronomer Ptolemy. Its brightest star, a red giant Star **(M)** is also the fourth brightest star in the night sky. The Greek name of Constellation **(L)** Arctophylax means ‘Bear Watcher’, in view of its location beside the famous Asterism **(N)** which points the way to the current North Star Polaris.

Star **(M)** is one of the four readily visible red stars in the night sky, the others being Star **(O)**, Star **(P)** and Star **(Q)**. While Star **(M)** and Star **(O)** are both red giants, Star **(P)** and Star **(Q)** are red supergiants, which in itself are quite rare.

Star **(O)** lies within a famous open cluster known as the Hyades. However, Star **(O)** is not actually part of the open cluster but closer to Earth by more than 60 Light Years compared to Hyades.

Cloze Passage 2 (pt. 2/2)

Star **(P)** is located quite far south and has a very interesting name. Star **(P)**'s name means the "opponent to Mars", possibly due to the similar reddish hue as observed.

Star **(Q)** is the ninth brightest star in the night sky and part of a very famous constellation seen only in winter.

Asterism **(N)** also arcs to Star **(M)**. If we continue along the arc, we would arrive at the brightest star of Constellation **(R)**, Star **(S)**. Many galaxies and galaxy clusters are found in Constellation **(R)**, which is also the largest constellation of the Zodiac. Due to the effects of precession, one of the points where the ecliptic crosses the celestial equator, The First Point of **(T)**, is located in this constellation **(R)**. The day the Sun actually crosses the celestial equator at The First Point of **(T)** is a very important day. That day is known as **(U)** for the Northern Hemisphere.

End of Section 1

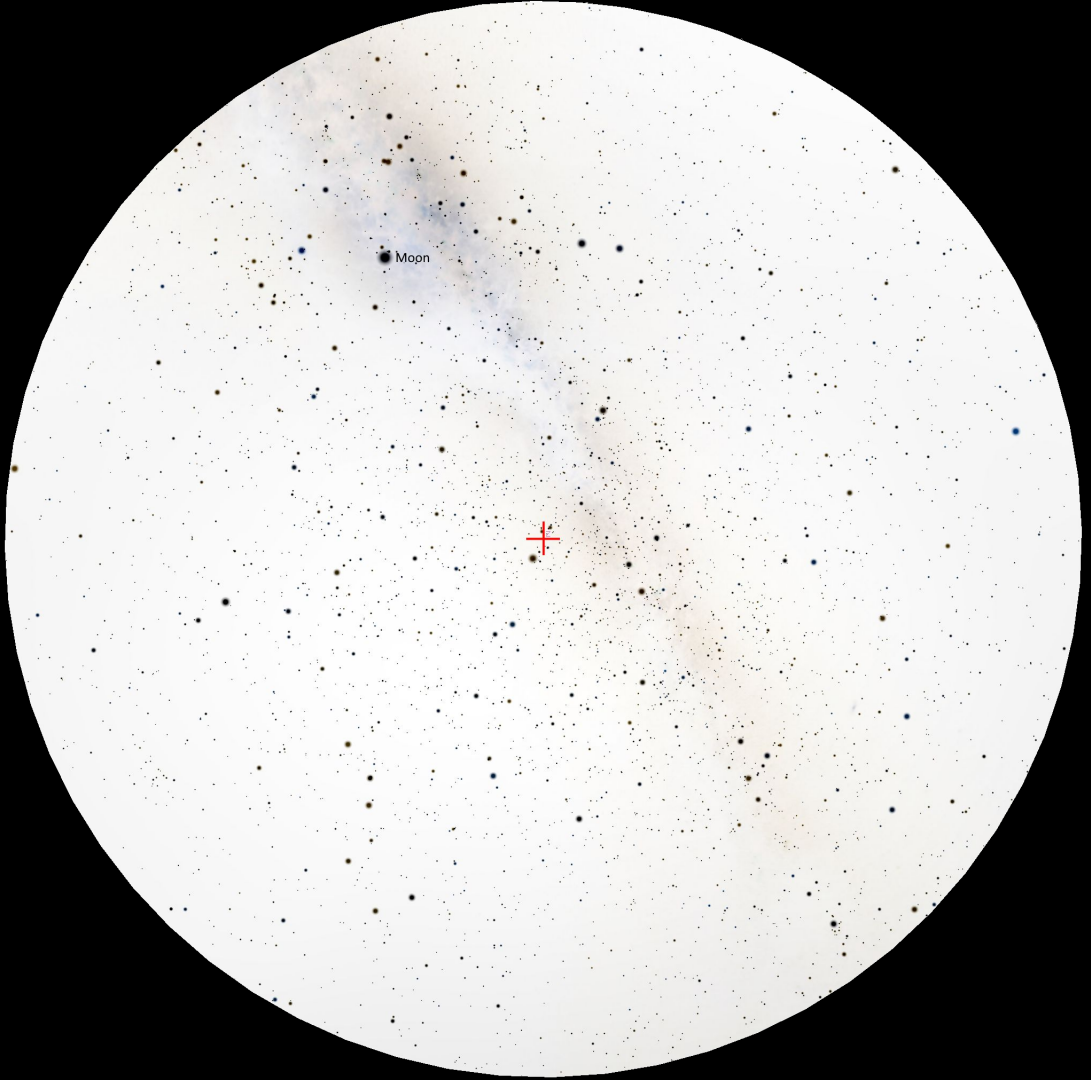
- Please confirm your answers for this question with the Team Admin before moving on to the next section.
- You will not be allowed to return to this section afterwards.

Section 2: No Man’s Sky [20 Marks]

Time Limit: 40 Minutes

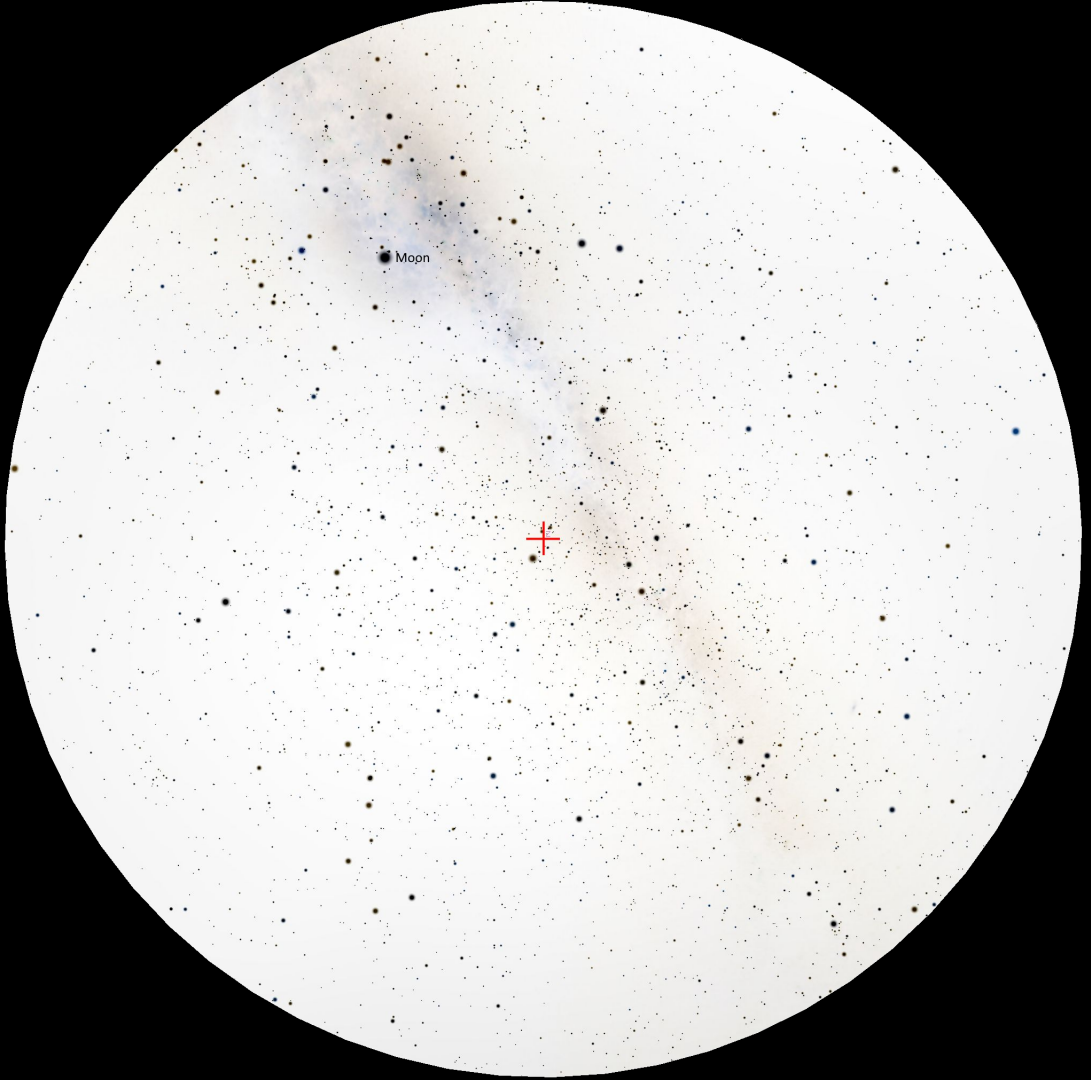
Section 2: No Man's Sky [20 marks]

1. This section will test your knowledge of the full night sky. There are 12 questions in this section.
2. Some questions will require you to **draw and mark your answers on a given sky chart** using the zoom on-screen annotation tools. **The rest of the questions will state 'Answer in the chat'.**
3. At the end of this section your Team Admin will screenshot your on-screen annotations for answer submission. Text answers submitted in the chat will be recorded separately.
4. Please ensure that your annotations are clear and neatly written for ease of marking. You are encouraged to use the straight line tool, text tool, and stamps.
5. Your 40 min time limit will start now.



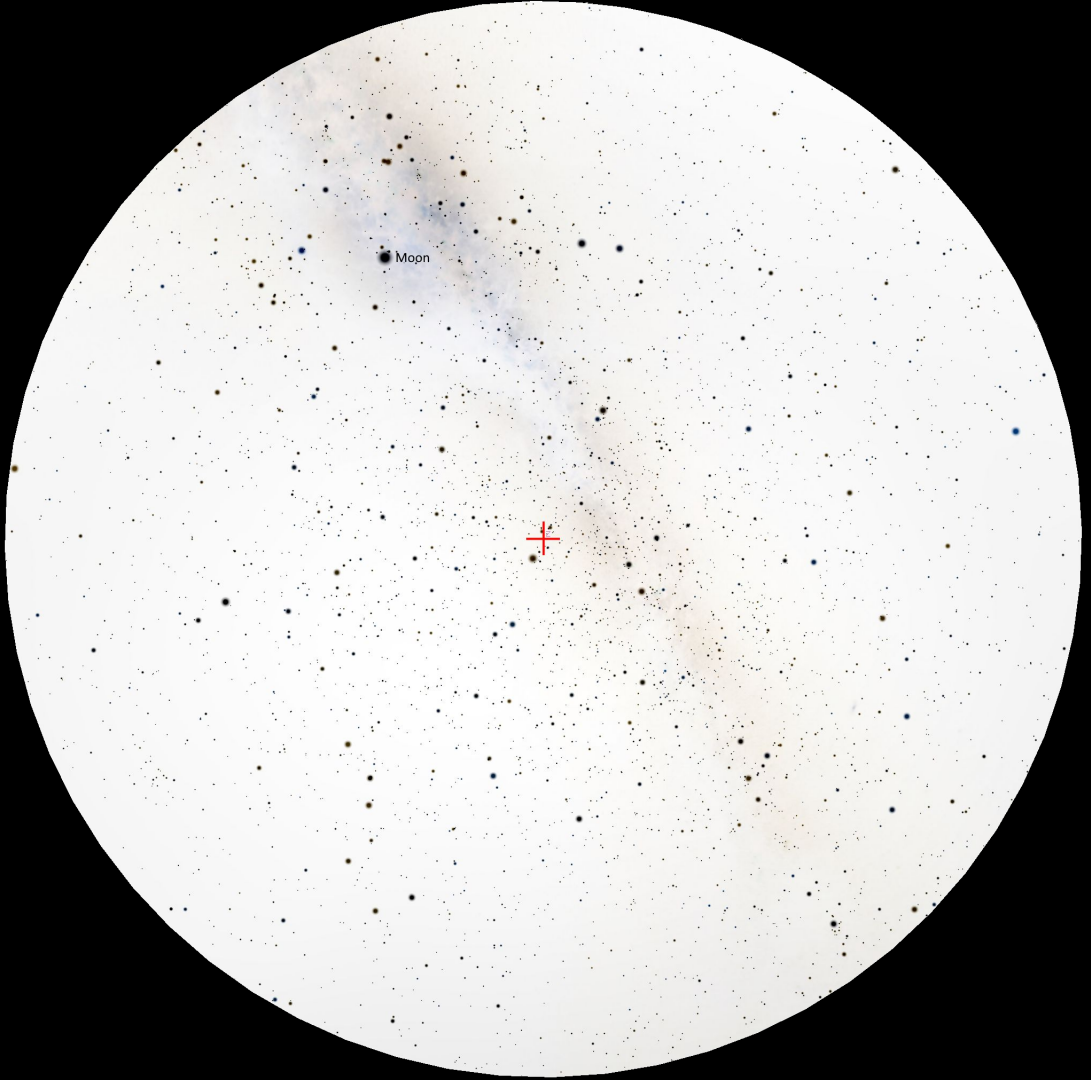
The given sky chart (in standard stereographic projection) shows the whole night sky at an unknown location K at an unknown date, **local solar time 12 midnight.**

The rim of the chart is the horizon, and the **red cross marks out the zenith point** (point in the sky directly above the observer). The **moon is also labelled** on the chart.



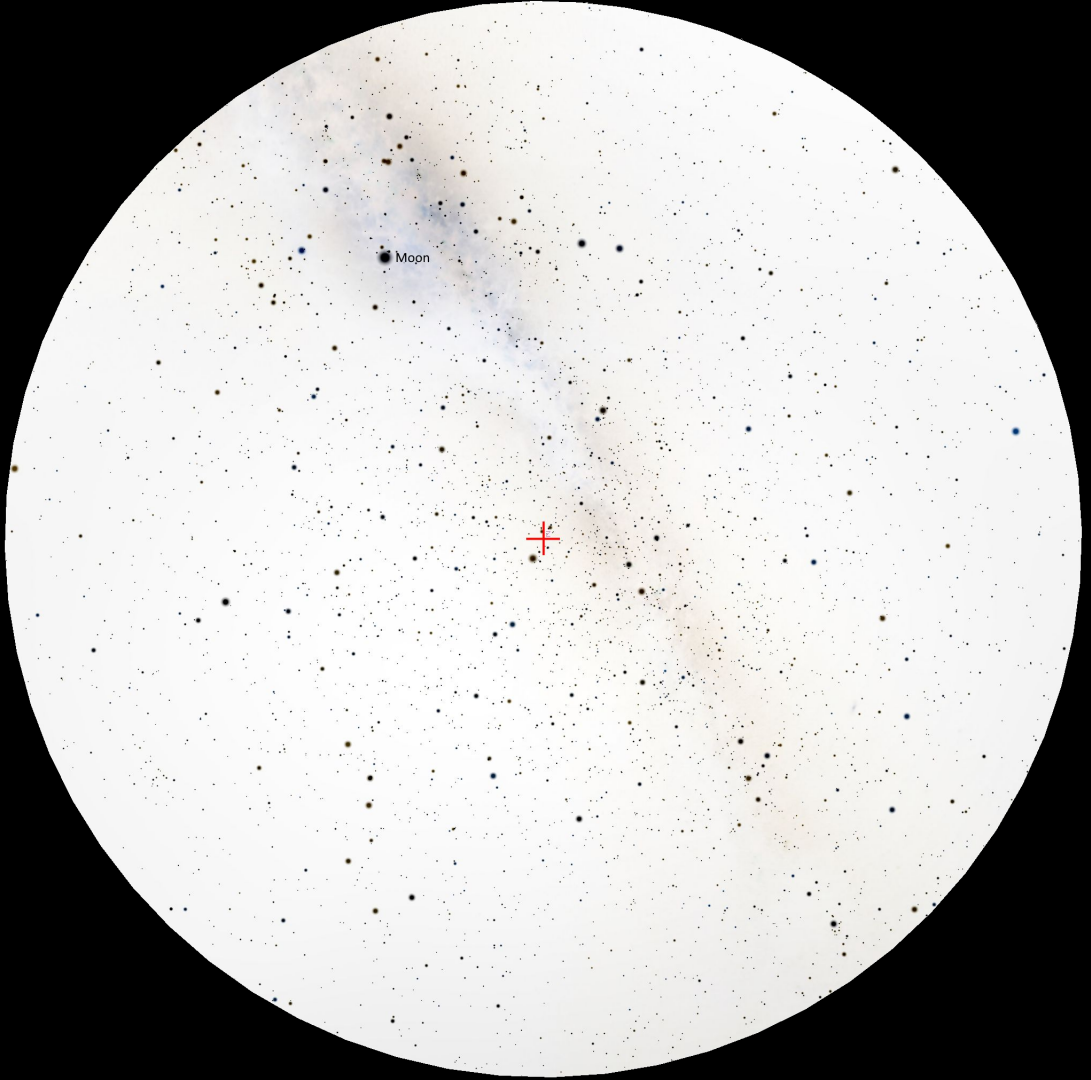
Q1. Trace the Big Dipper Asterism and 4 other Constellations on the chart, and label them accordingly.

[3 marks]



Q2. Mark and label Polaris, Vega, Arcturus and Antares on the chart.

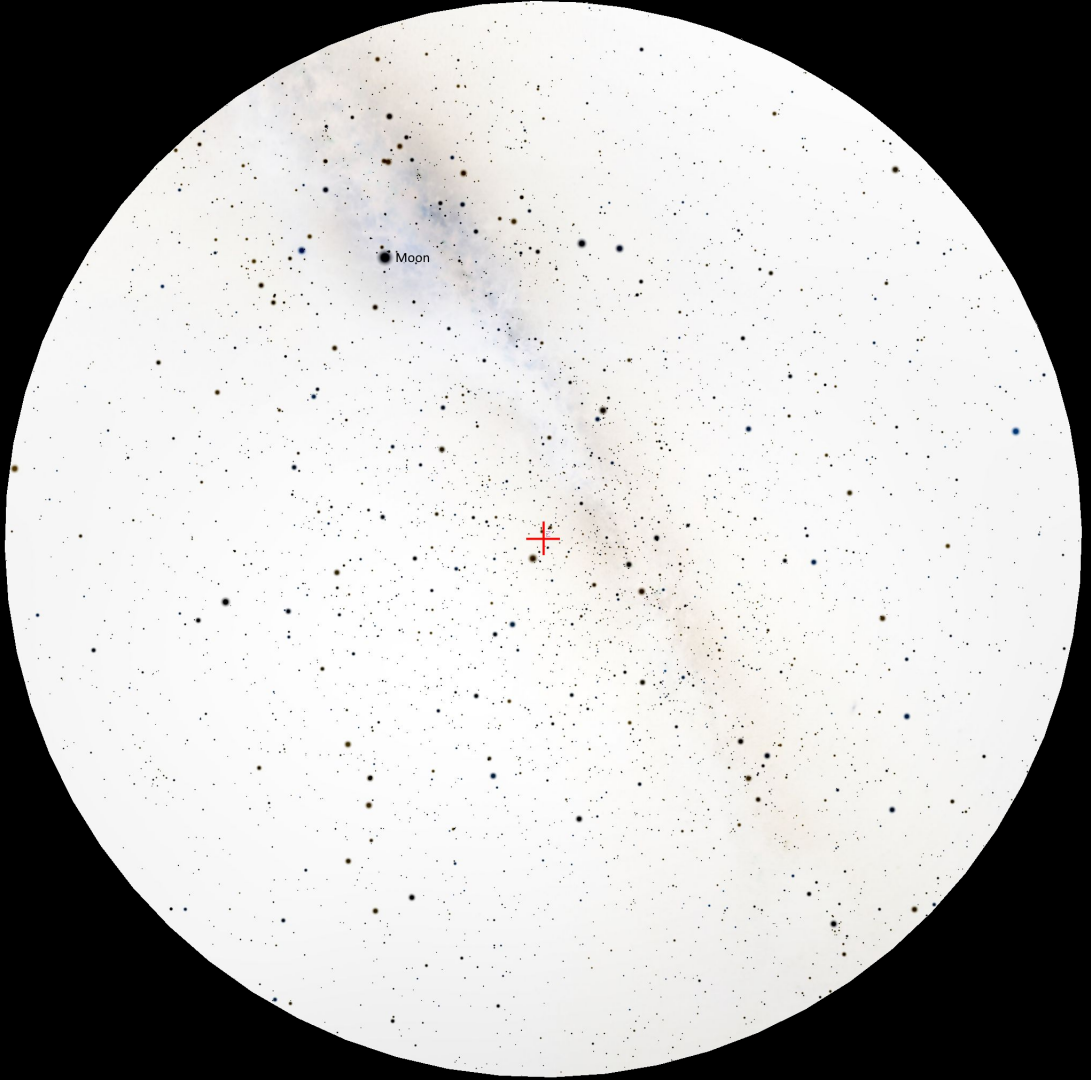
[2 marks]



Q3. Mark and label 6 DSOs in the chart with the numbers 1-6. Type their corresponding common name/catalogue number.

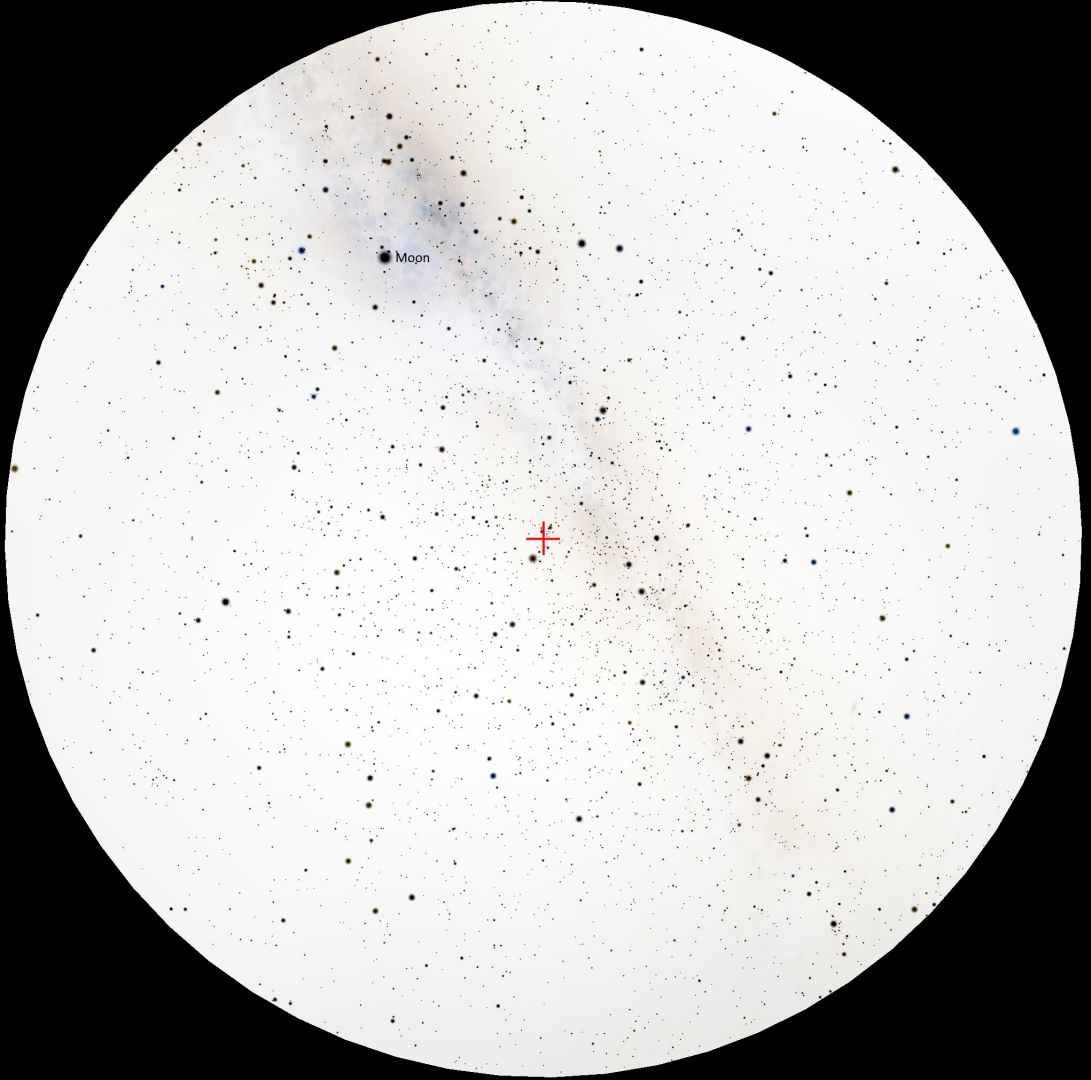
[3 marks]

Answer **in the chat**



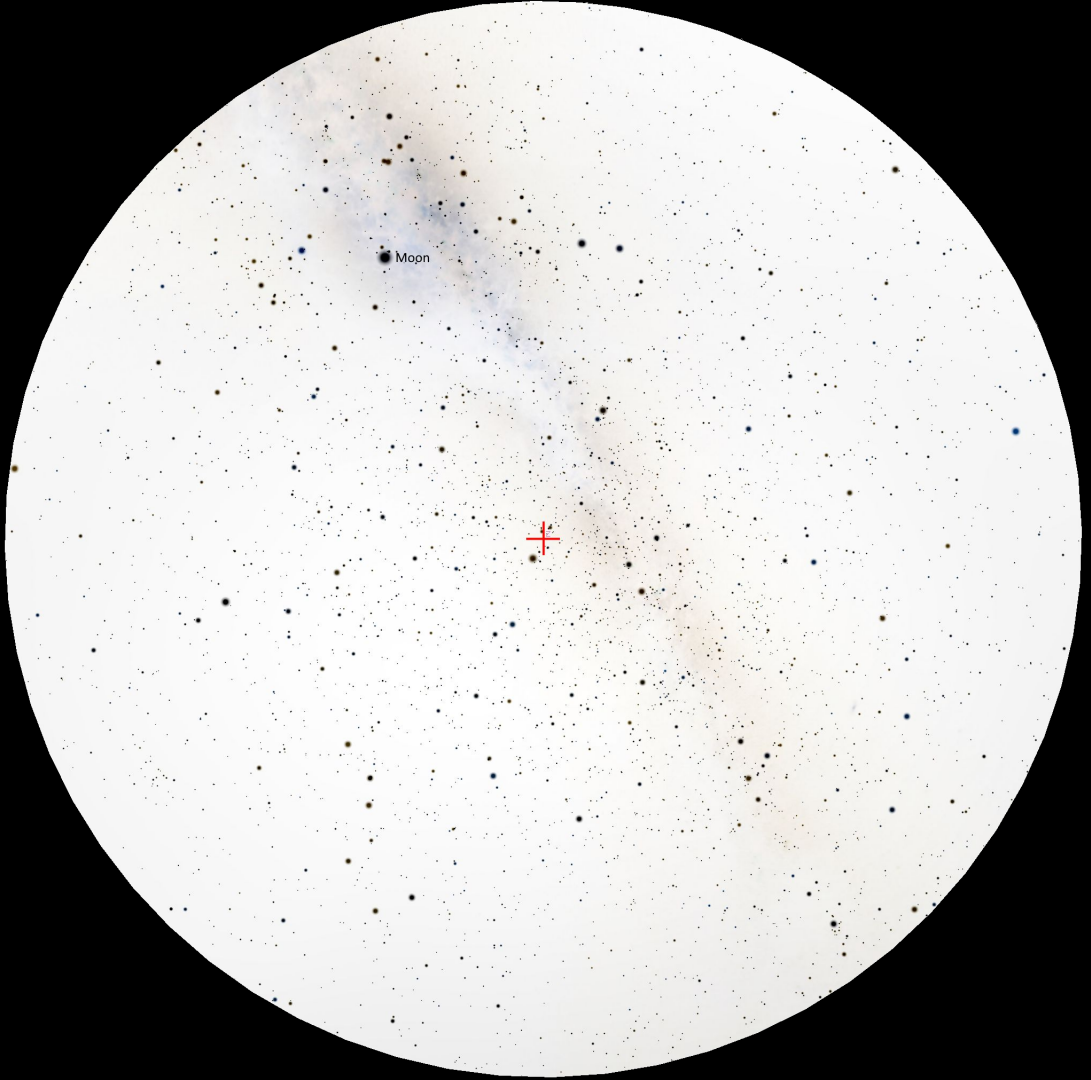
Q4. Label the 4 cardinal points (NSEW) around the horizon line of the chart.

[1 mark]



Q5. Draw the local meridian on the chart.

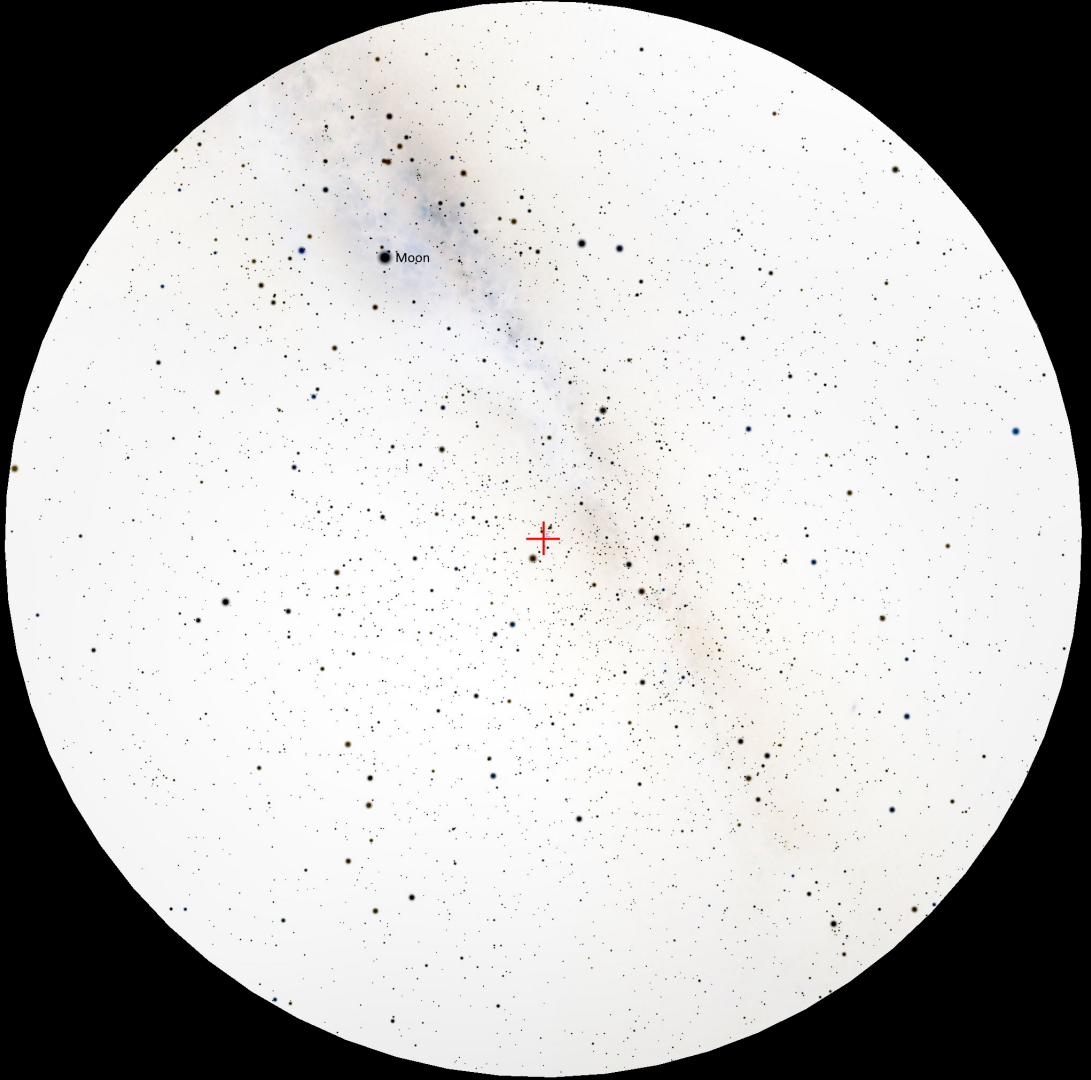
[1 mark]



Q6. State if Sagittarius is at its upper/lower culmination.

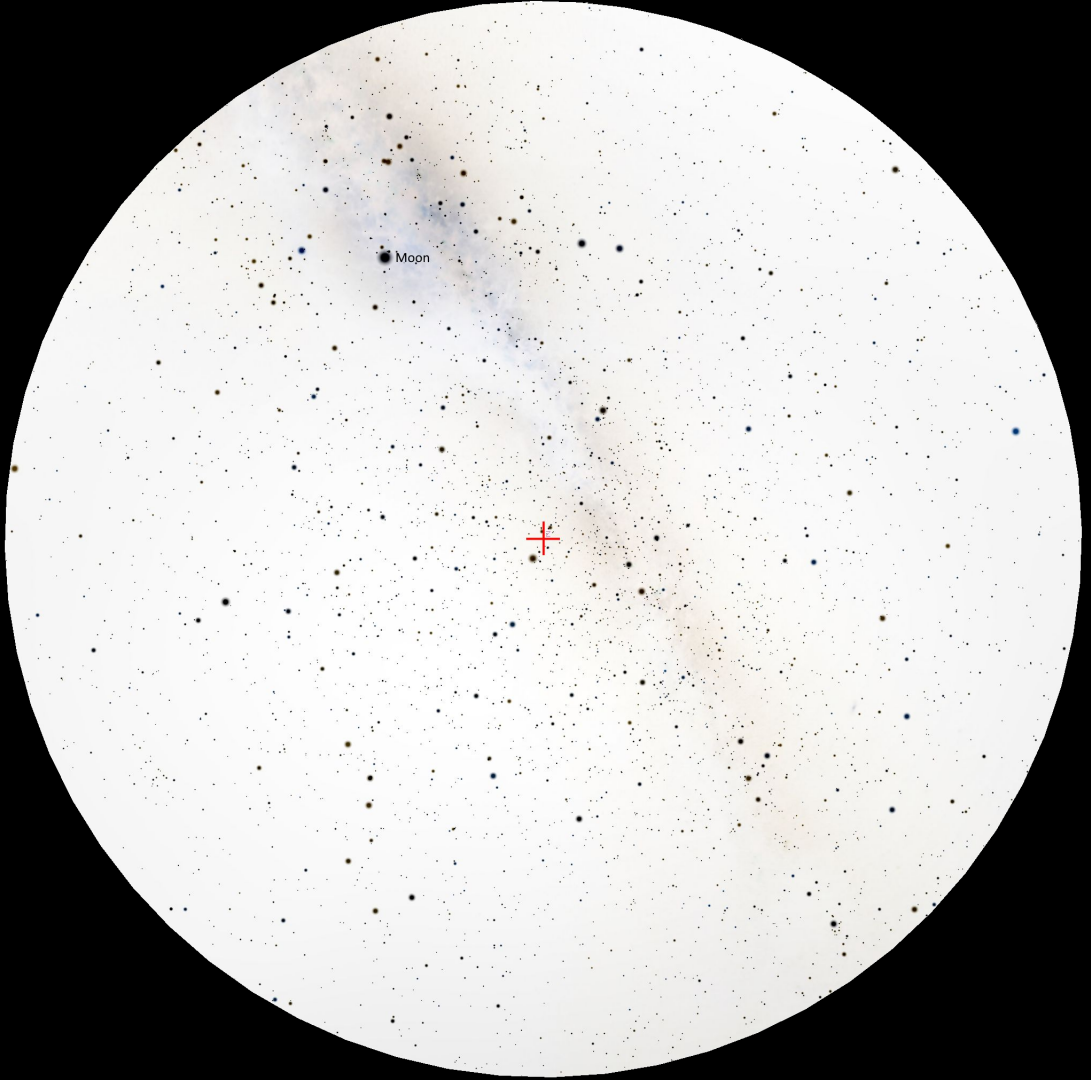
[1 mark]

Answer **in the chat**



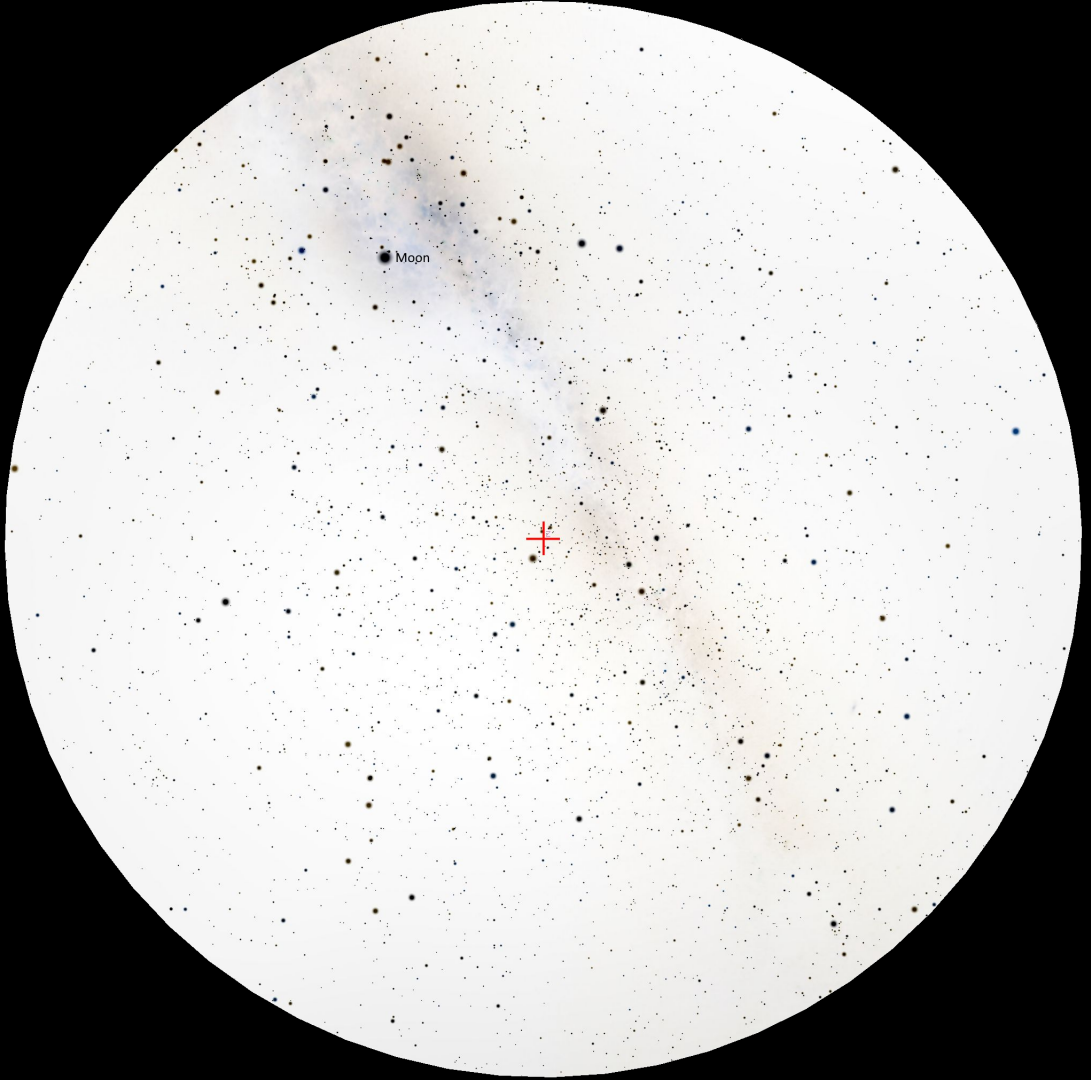
Q7. Circle any Planets in this chart and label with ‘P’.

[2 marks]



Q8. Draw the ecliptic line and mark the direction the planets move along the ecliptic with an arrow (ignore retrograde motion).

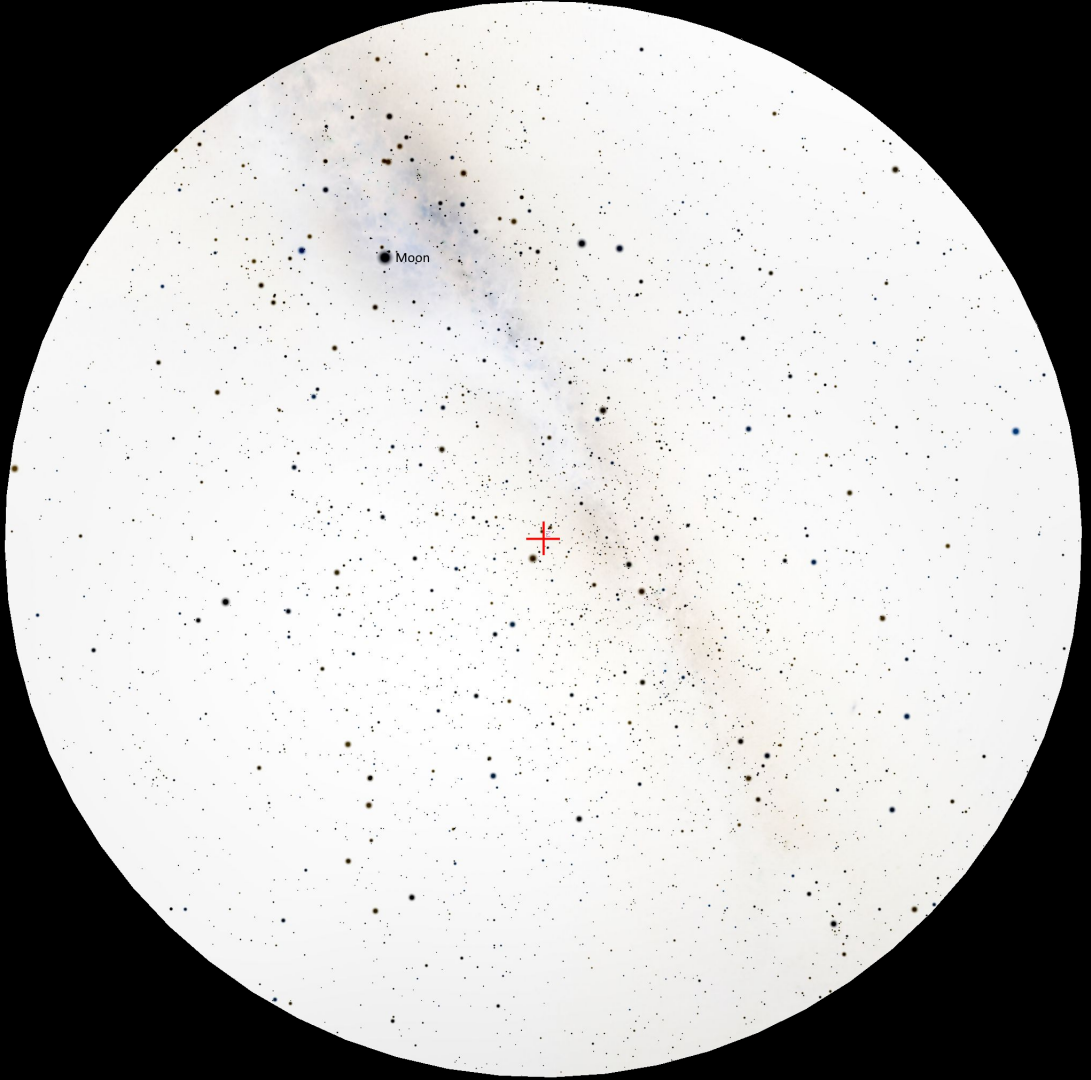
[2 marks]



Q9. Based on the local solar time, identify the season.

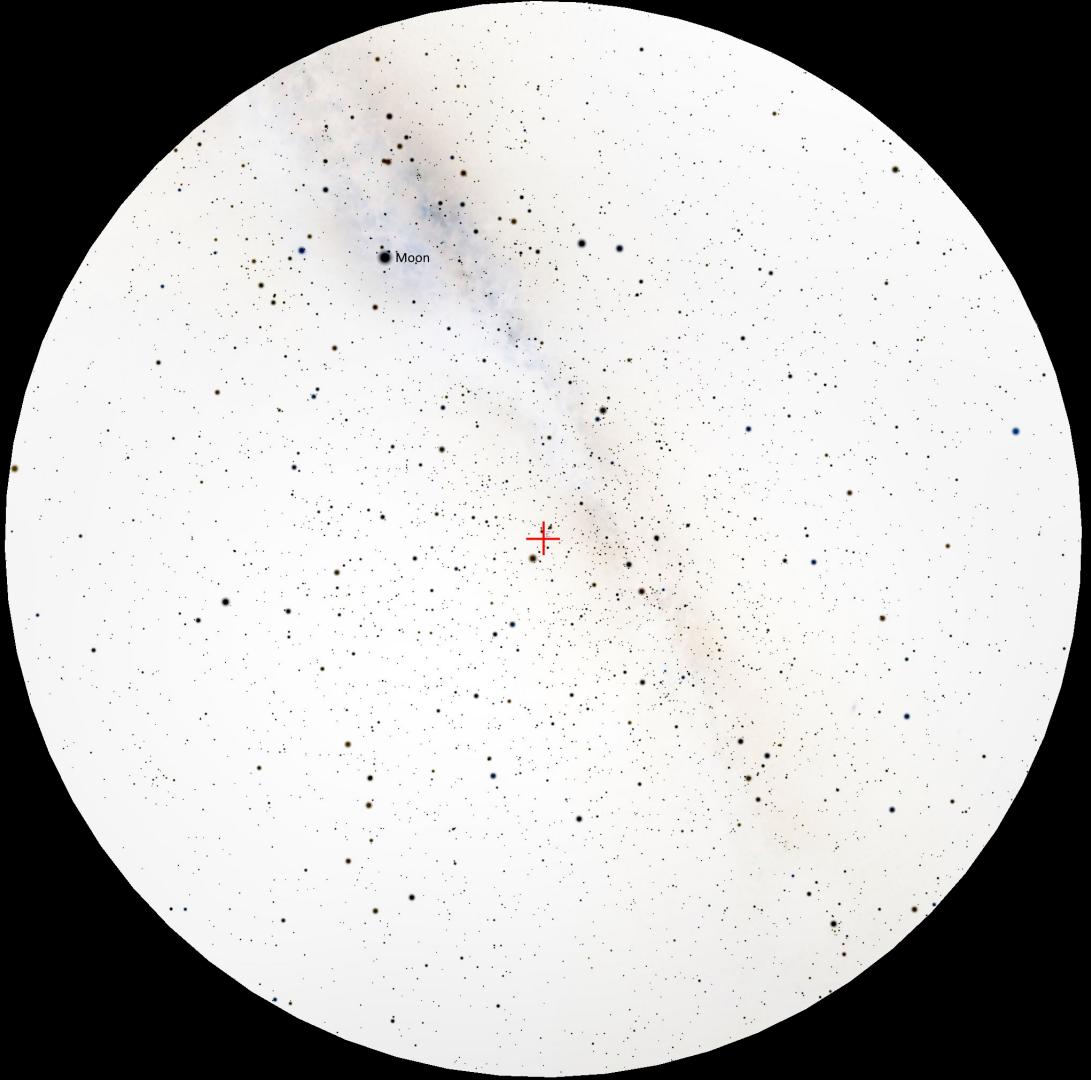
[1 mark]

Answer **in the chat**



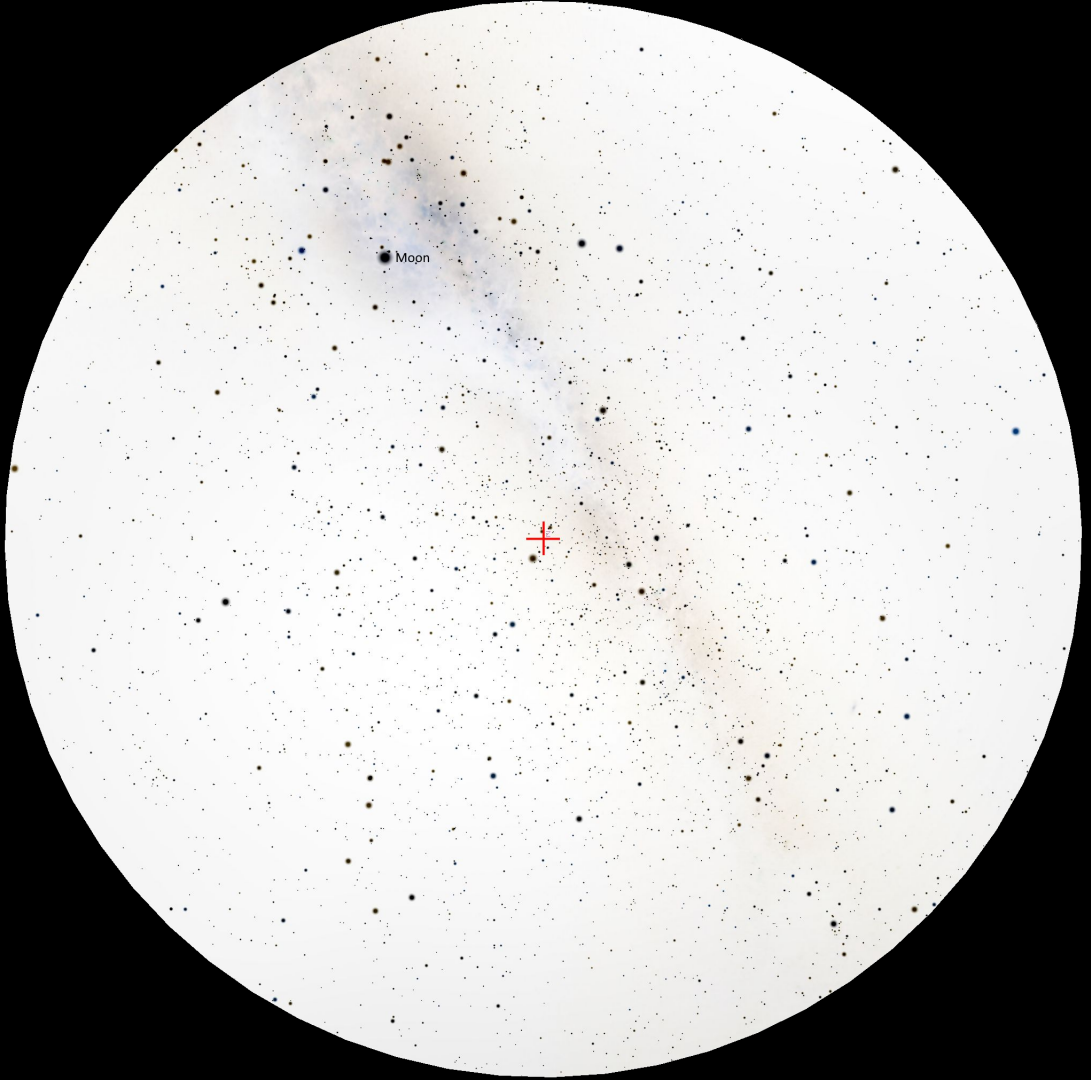
Q10. State which ecliptic constellation is currently rising in the east. [1 marks]

Answer **in the chat**



Q11. Sketch the rough position and orientation of the Big Dipper Asterism in the chart for the same date, 6 hours later.

[2 marks]



Q12. Based on the local solar time, identify the lunar phase. [1 mark]

Answer **in the chat**

End of Section 2

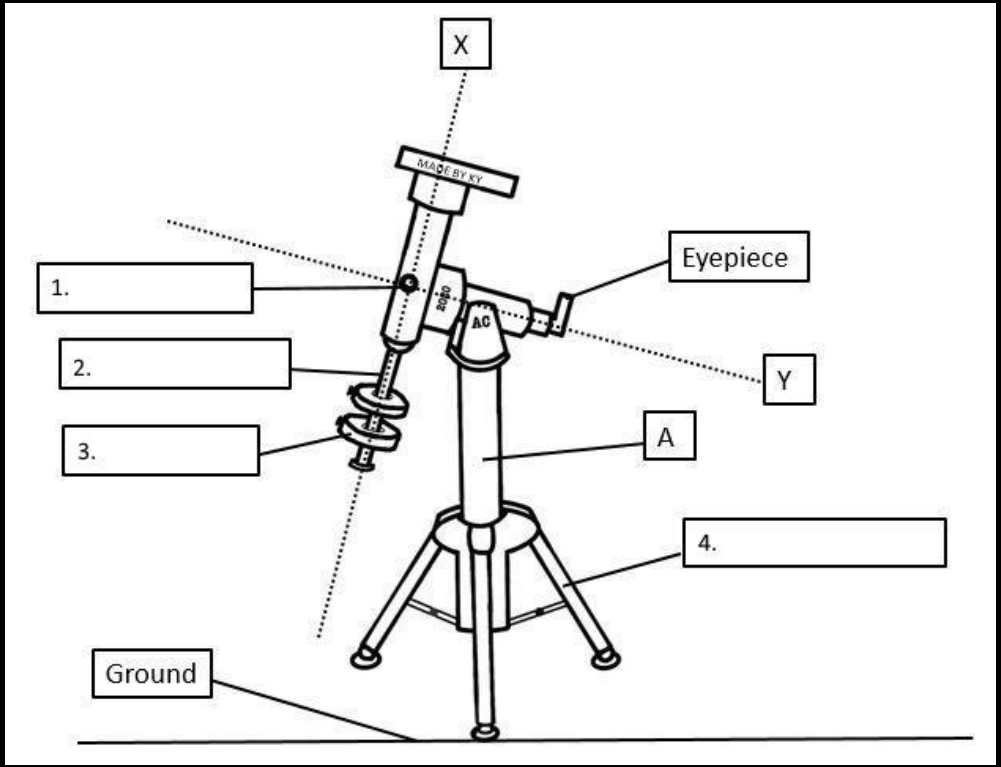
- Please confirm your answers for this section with the Team Admin before moving on to the next section.
- You will not be allowed to return to this section afterwards.

Section 3: Top Gear [20 Marks]

Time Limit: 45 Minutes

Section 3: Top Gear [20 marks]

1. This section will test your knowledge of telescope gear. There are 14 questions in this section.
2. Some questions will require you to **draw and mark your answers on a given diagram** using the zoom on-screen annotation tools. Your Team Admin will screenshot the annotations for answer submission.
3. **The rest of the questions will state 'Answer in the chat'.** Answers will be submitted as written.
4. Your 45 min time limit will start now.

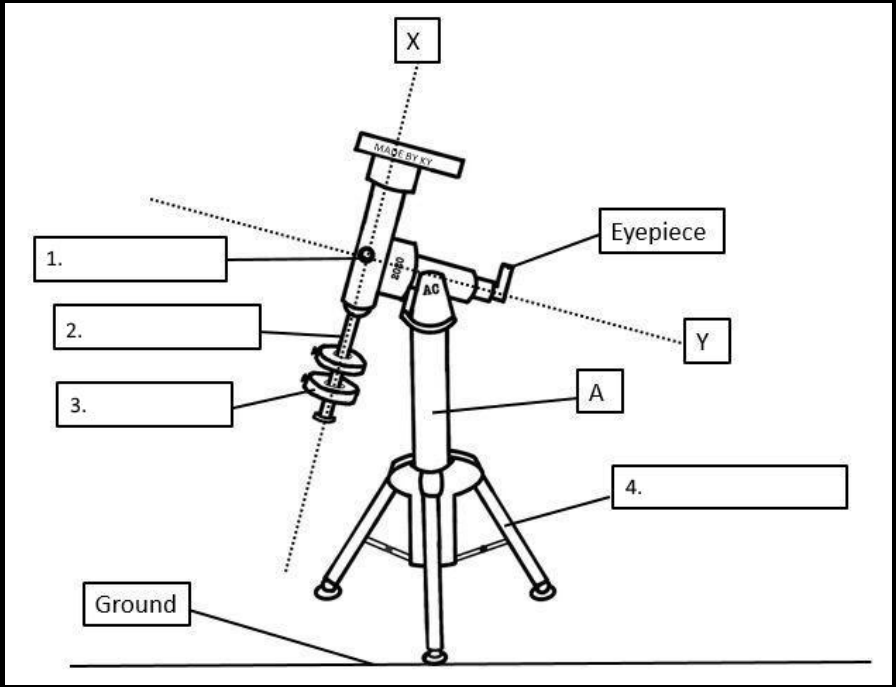


The diagram shows a typical German Equatorial Mount (GEM).

Q1. Identify and name the parts labeled 1-4. [2]

Q2. Name and explain what part A is used for. [2]

Answer **in the chat**

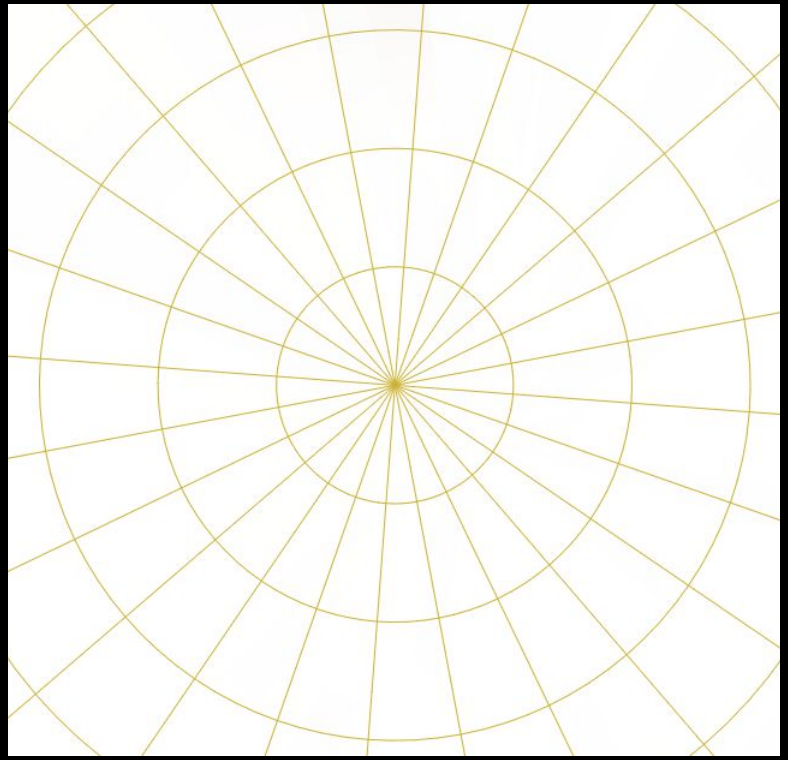


The GEM has two rotating axes (X & Y) which helps with finding objects in the sky.

Q3. What are axes X and Y called?
[1 mark]

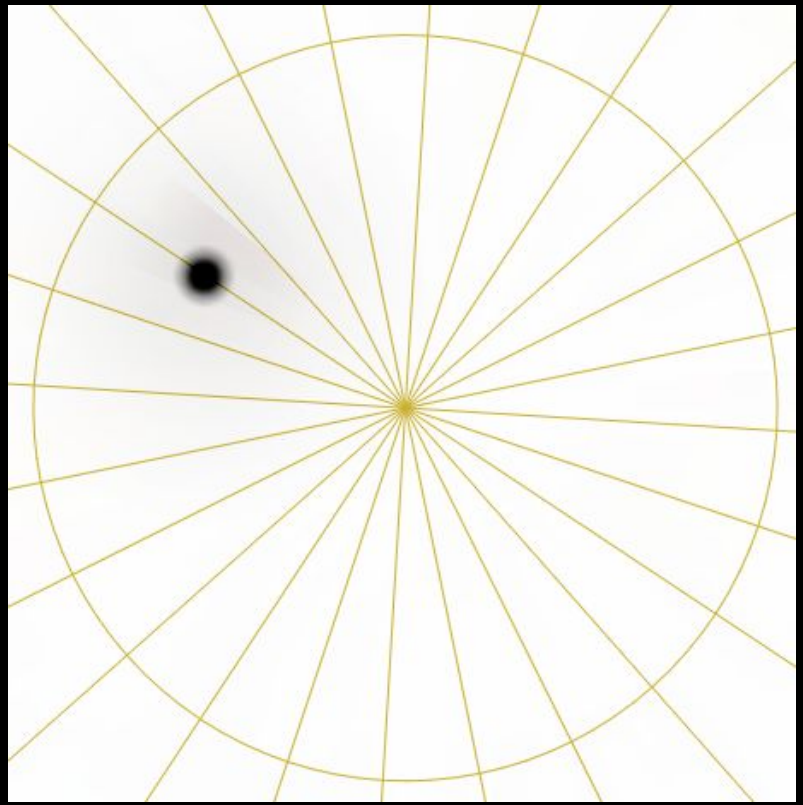
Q4. Briefly explain how the GEM works with respect to the two axes. [2 marks]

Answer **in the chat**



The star Polaris is often called the North Star as it seems to lie on the North Celestial Pole (NCP). However, it does not lie exactly on the NCP.

Q5. (i) Assuming the declination of Polaris is about 89°20', mark out a possible position which Polaris can be at with X. Each circle is ⅓ of a degree. [1 mark]

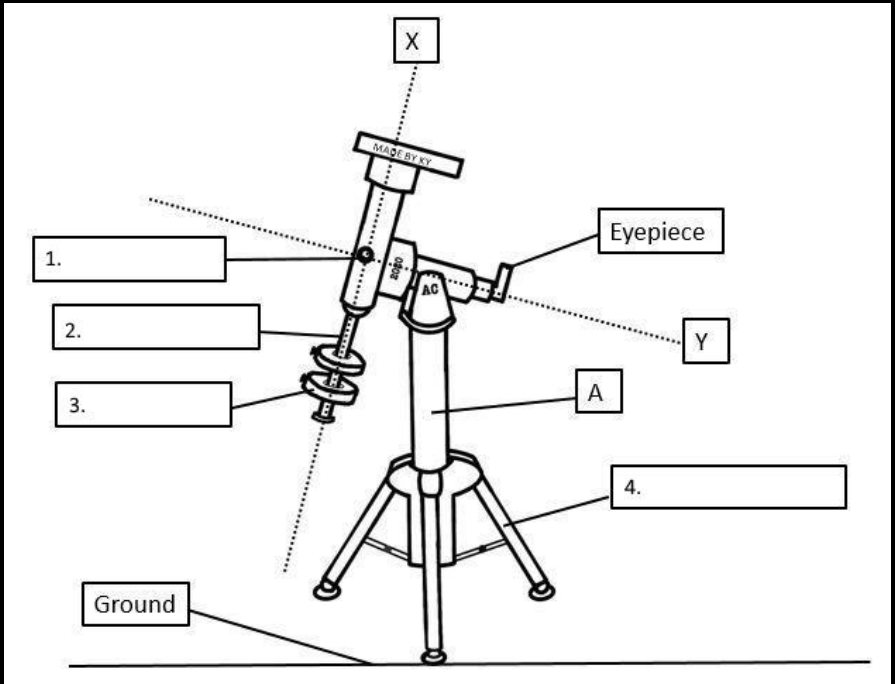


Q5. (ii) The Earth rotates about the NCP roughly once every day. The star in the diagram below is Polaris at 7:00 pm Local Solar Time (LST). Mark the position of Polaris in 6 months time at 7:00 pm LST on the diagram with an X. [1 marks]

Q6. Computerised GEMs often come with the GOTO and tracking function which helps you to find objects in the night sky. However, they also often come with a periodic error which causes the set up to “vibrate” over a period of time. Explain how periodic error can affect a long exposure image even with GOTO and tracking function. [1 mark]

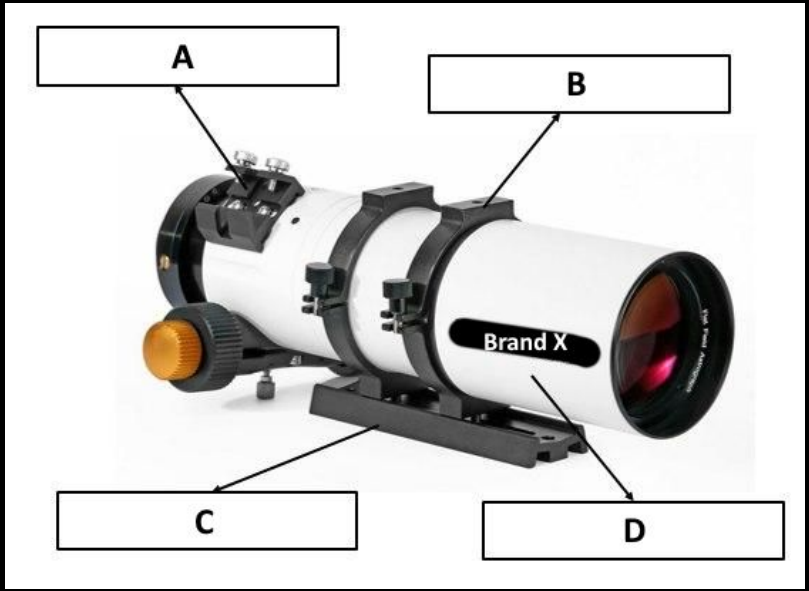
Q7. Suggest an additional equipment to reduce periodic error without changing the mount. [1 mark]

Answer **in the chat**



Q8. Assuming the GEM in the diagram is already properly set up, estimate the latitude the observer is at. [1 mark]

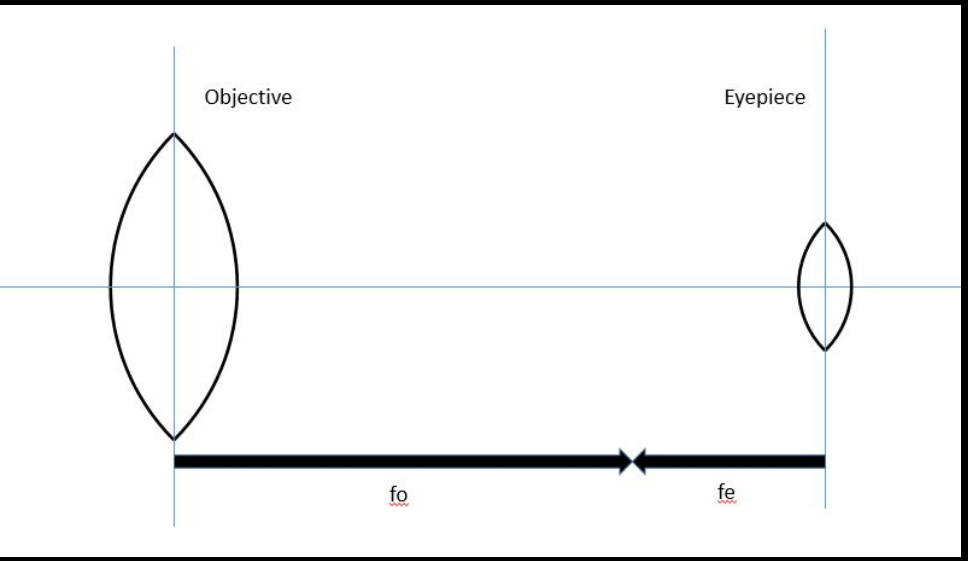
Answer **in the chat**



The picture shows a refractor optical tube assembly (OTA).

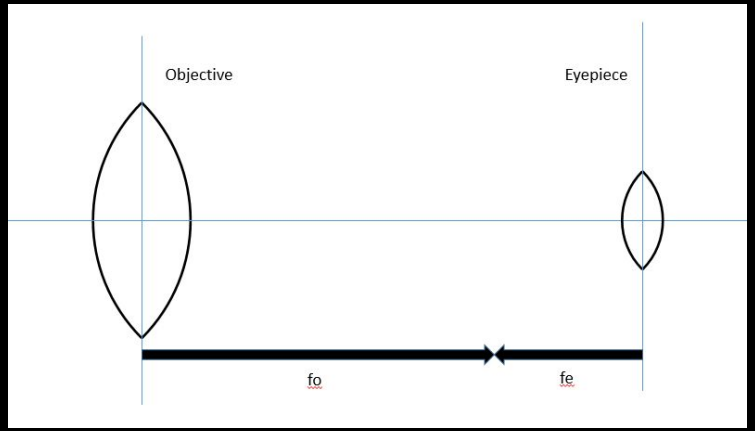
Q9. Identify and name parts A-D

Answer **in the chat**.



The following is a ray diagram of a typical refractor OTA.

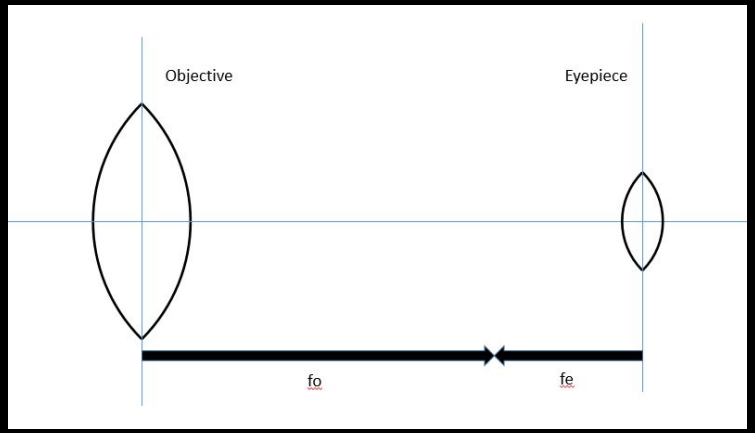
Q10. Assuming light rays from a far away star are travelling parallel to the principal axis, complete the ray diagram above.



Q11. The human pupil dilates to a size of 7mm in total darkness in youth, and slowly decreases with age.

Explain what happens to the image seen when the observer's pupil size is smaller than the exit pupil produced by the telescope. [1 mark]

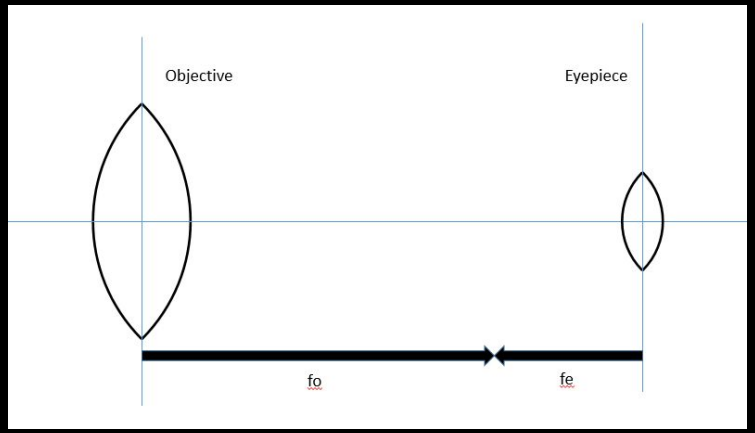
Answer **in the chat**



Q12. A single objective lens refractor such as the one shown above has many problems. One such problem is false colour, more commonly known as chromatic aberration.

Explain why such a problem will arise in the design above. [1 mark]

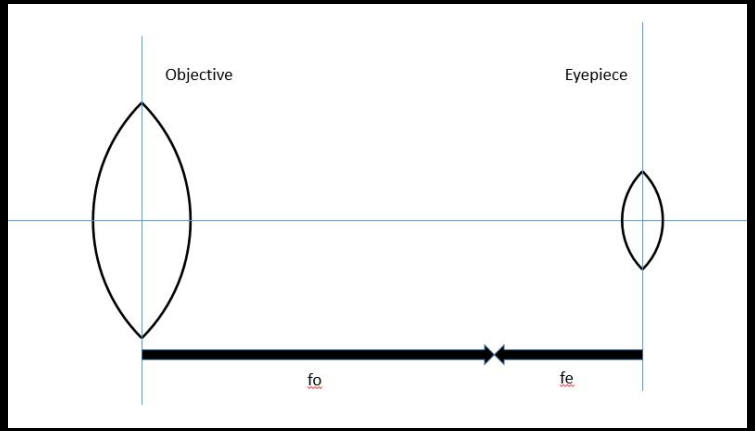
Answer **in the chat**



Q12. A single objective lens refractor such as the one shown above has many problems. One such problem is false colour, more commonly known as chromatic aberration.

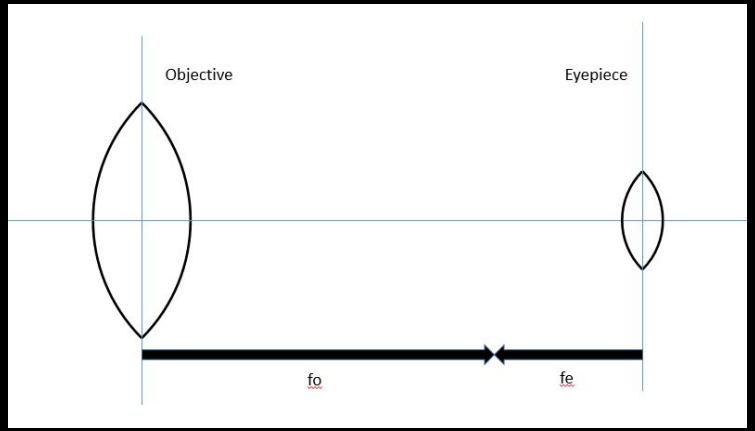
Explain why such a problem will arise in the design above. [1 mark]

Answer **in the chat**



Q13. Explain how chromatic aberration can be reduced in refractor designs. [1 mark]

Answer **in the chat**



Q.14 Reflecting telescopes on the other hand intrinsically do not suffer from chromatic aberration. However, they can be prone to other kinds of optical aberrations. Name 2 types of optical aberrations that can occur in reflecting telescopes.
[2 marks]

Answer **in the chat**

End of Section 3

- Please confirm your answers for this section with the Team Admin before moving on to the next section.
- You will not be allowed to return to this section afterwards.

Section 4: Manual Plate Solving [20 Marks]

Time Limit: 15 Minutes

Section 4: Manual Plate Solving [20 marks]

1. This section will test your knowledge of constellations. You will be given a set of 4 images of a sector of the night sky in stellarium. The images are in negative color, of an undetermined field of view. Each individual image is worth a total of 5 marks.
2. **All questions will require you to draw and mark your answers** on a given diagram using the zoom on-screen annotation tools. Your Team Admin will screenshot the annotations for answer submission.
3. Please ensure that your annotations are clear and neatly written for ease of marking. You are encouraged to use the straight line tool, text tool, and stamps.

For each image given [Total 5 marks]:

- Name and link **one complete** constellation in each image. [1 mark]
- Label and name any **two** bright stars within the image (Common Name/Bayer Designation). [1 mark]
- Identify and label **three** deep sky objects or double stars. [3 marks] They should be:
    - Sufficiently bright to be captured with a 30 sec exposure with a DSLR OR
    - From the Messier/Caldwell Catalogues OR
    - Visual double stars, labeled as a double in addition to its common name/bayer designation.
    - They do not have to be within the complete constellation identified.

Do not repeat your answers. No additional marks will be given for additional objects identified.

Your 15 min time limit will start now.

Q1 Name+link 1 constellation, Label 2 stars, Mark/label 3 DSOs/Double Stars

Q2 Name+link 1 constellation, Label 2 stars, Mark/label 3 DSOs/Double Stars

Q3 Name+link 1 constellation, Label 2 stars, Mark/label 3 DSOs/Double Stars

Q4 Name+link 1 constellation, Label 2 stars, Mark/label 3 DSOs/Double Stars

End of Section 4

- Please confirm your answers for this section with the Team Admin.
- This is the end of the Theory Obs Round.