The Answer Sheet

Contents For the Observation Round Answers

Instructions

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The Theory Paper

1. An Astronomy Cloze Passage

Instead of starting with normally eye-taxing constellation identification, quizmasters this year have come up with a fun activity to get you all warmed up. You are given 2 cloze passages and you are required to decode what are the objects/constellations/stars lettered A to J for each of them. Each blank will be worth 2 points. 1 point may be awarded for each answer which is partially correct.

Cloze 1 [20 pts]

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 Achird. **K** lies midway and slightly South of the two.

Hence or otherwise, solve for:

A – Ophiuchus

B – Rasalhague

C – Serpens

D – Hadar/Agena

E – Omega Centauri/NGC5139/Caldwell 80

F – Hyades Cluster/Caldwell 41

G – Taurus

H – Pleiades/M45

J – Cassiopeia

K – Pacman Nebula/NGC281

Cloze 2 [20 pts]

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 starhop 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 would most probably halt at the relatively bright group of 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 brightnesses. 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)

Hence or otherwise, solve for:

A _____Regulus

B _____Leo

C _____Leo Triplet

D _____Big Dipper

E _____Ursa Major

F _____Gemini

G _____Cancer

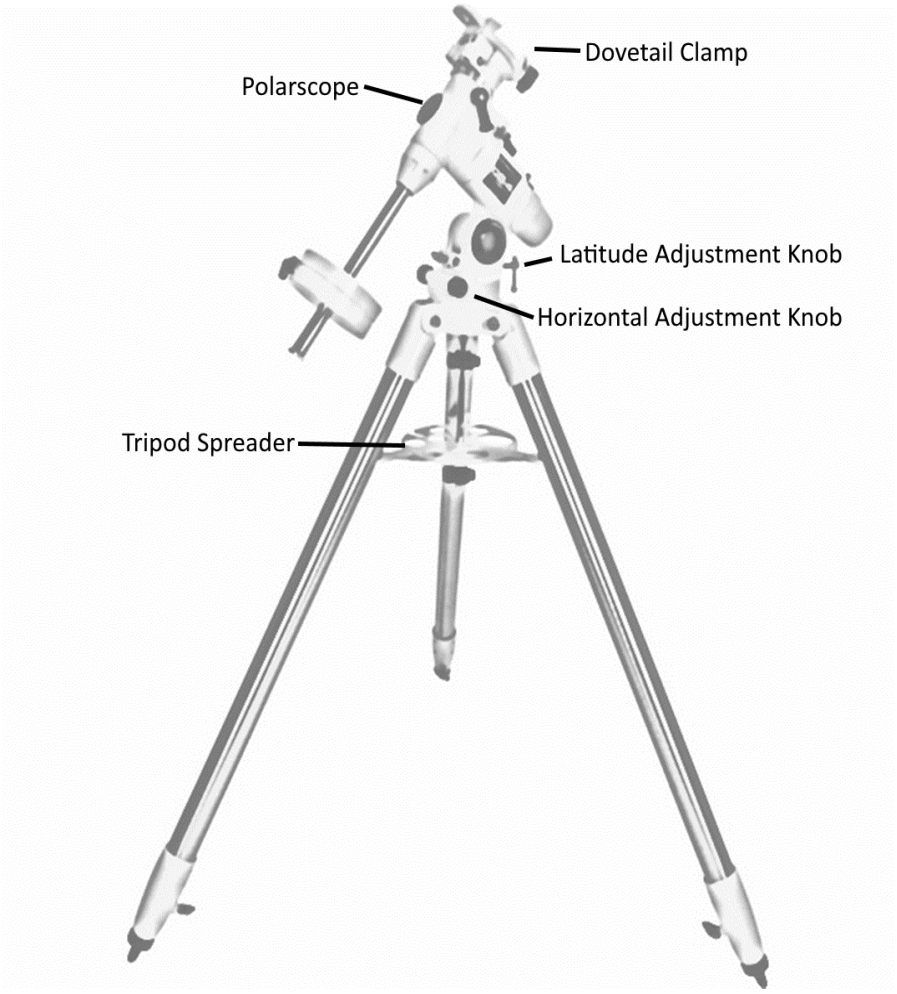
H _____M44 Beehive

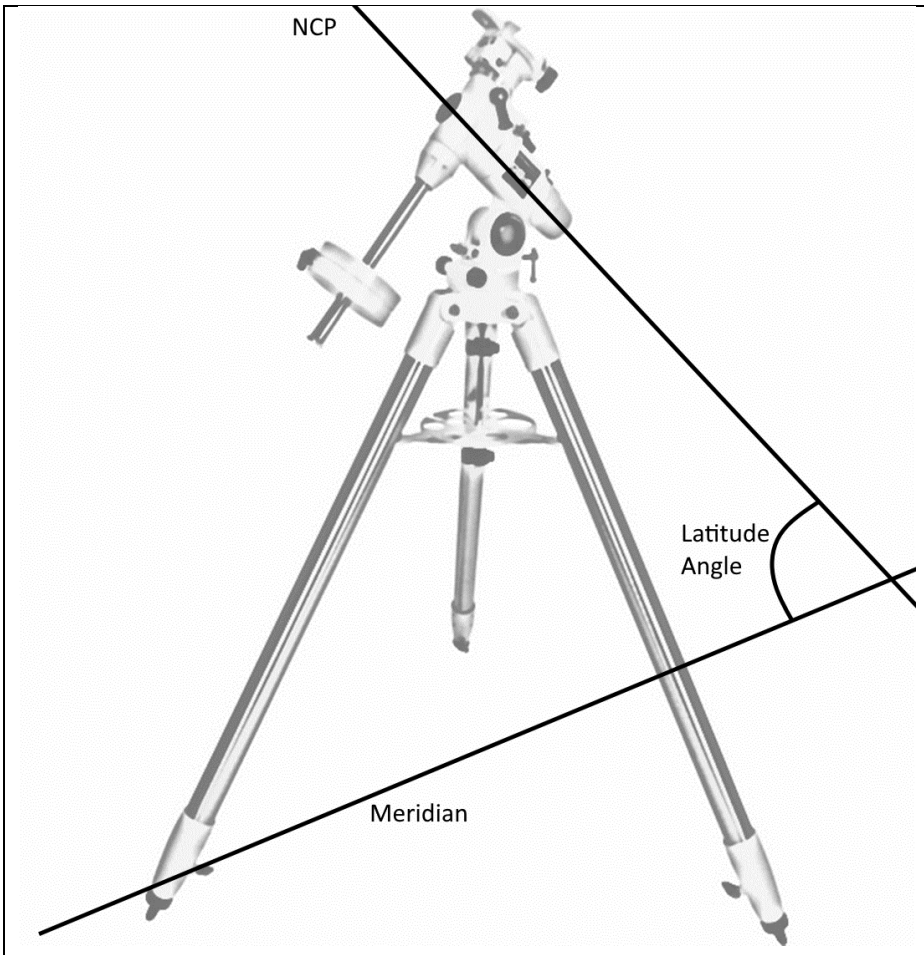
J _____Pollux (beta gem)

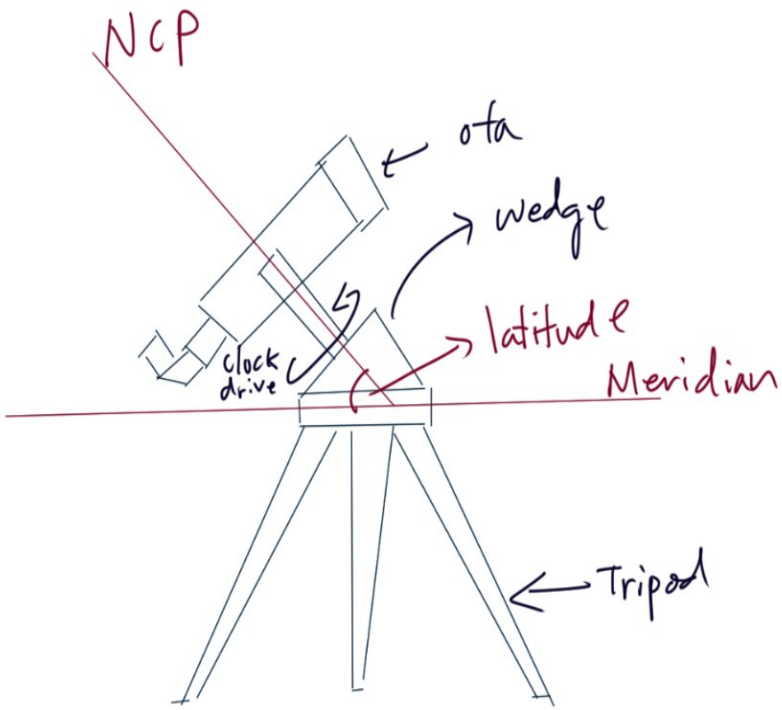
K _____Castor (alpha gem)

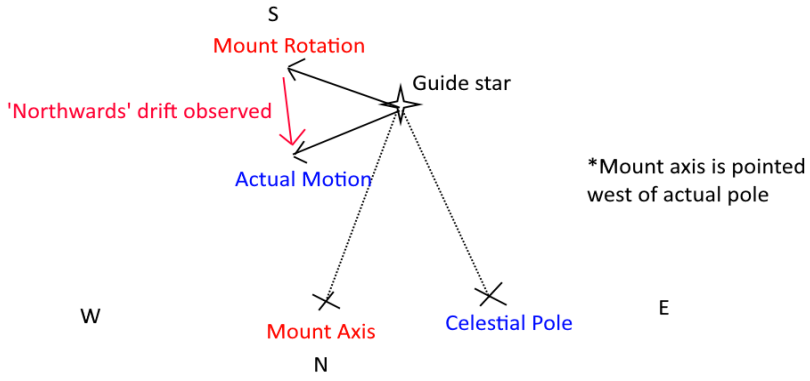
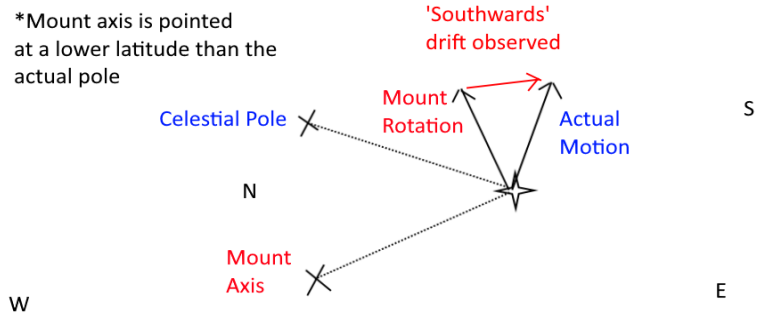
2. Equipment OEQ (20pc)

Mounts and Setup

Q1.  	M1 for each correctly labelled part
Q2.	M1 - Labelled line drawn through Polarscope M0.5 - Labelled line drawn on the ground/parallel to the ground and aligned with the meridian M0.5 - Any

	correctly labelled Latitude angle -0.5M - If lines are drawn with bad perspective, but intention is still accurate.
Q3. - Set up and align the tripod in towards the North with a compass. - Attach the mount to the tripod and adjust the latitude according to the local latitude. - Attach the counterweights to the mount. - Attach the OTA, as well as any finders, diagonals, eyepieces, and accessories. - Balance the setup by adjusting the counterweight and dovetail clamp position. - Fine align the mount to the NCP by using the polar scope and the latitude and horizontal adjustment knobs.	M0.5 for each point. Cap 1.5 marks if failed to align tripod before attaching mount and OTA. Capped 1.5 marks if failed to attach counterweight before OTA Accept any reasonable changes in order, additions, or

	omissions.
Q4.  	M1.5 – Correct setup of an equatorial wedge between the mount and tripod M1.5 – Correct alignment of clock drive axis with the NCP and Meridian
Q5. As Singapore is just 1 degree North of the equator, any equatorial wedge used will have to tilt the mount at nearly a right angle to the tripod. This is likely to result in a highly unstable setup as the centre of mass is highly off-centre.	M1 – high angle of tilt M1 – unstable setup
Q6. (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 *west* of the NCP, and if the star drifts south the mount is pointed *east* of the NCP.	M1 for each correct pair, no partial marks given. Note: It is probably smarter to attempt Q7

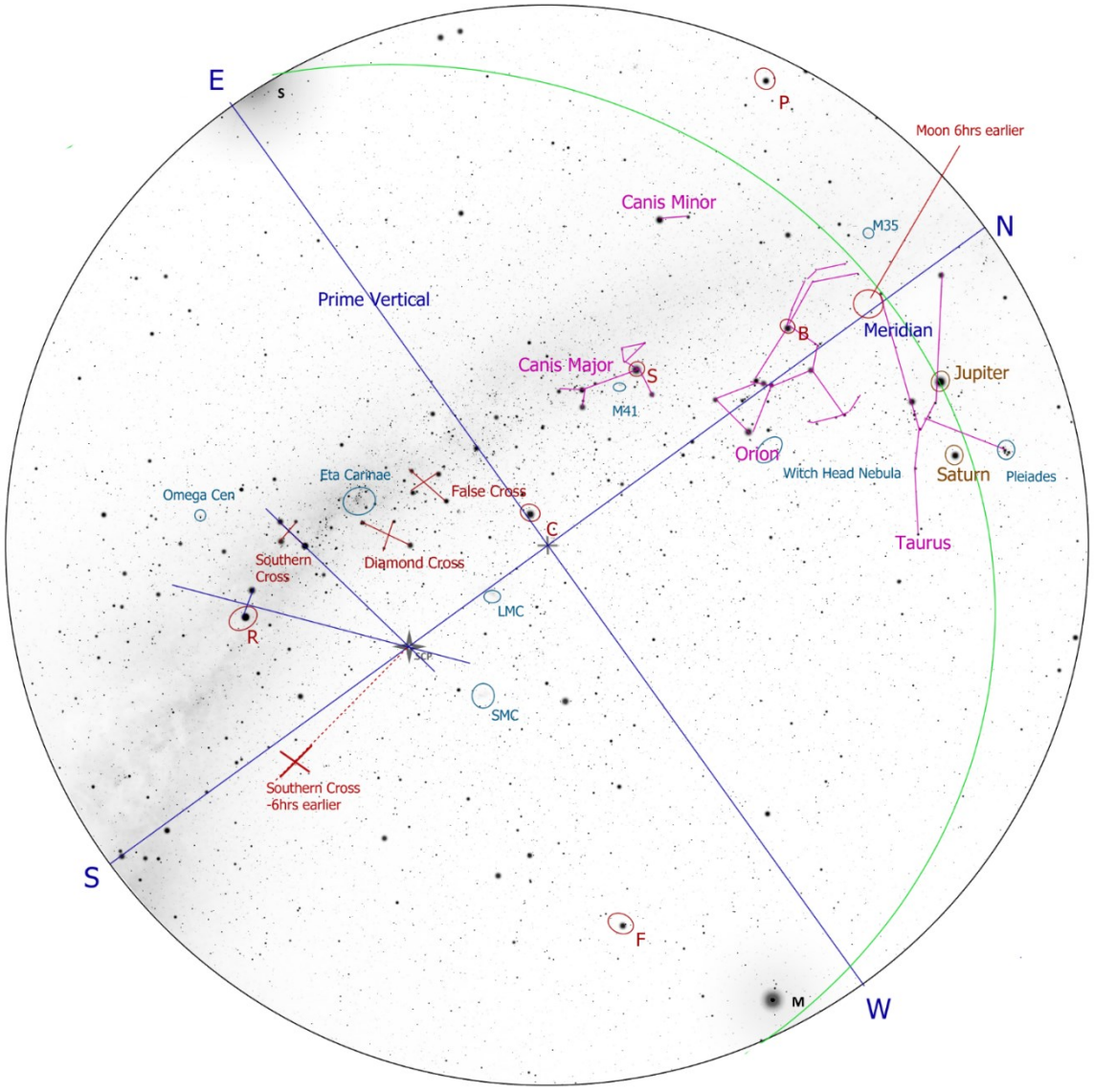
(2) Next, point your telescope towards a star near the celestial equator and right above the eastern horizon. If the star drifts north in your eyepiece FOV over time, the altitude of the mount is *higher* than the NCP, and if the star drifts south the altitude of the mount is *lower* than the NCP. Repeat both procedures (1) and (2) until no discernable drift is observed.	before Q6. Note2: Note that star drift directions are relative to eyepiece FOV, while mount adjustment directions are relative to the local horizon.
Q7.  (1) Azimuthal Drift Alignment  (2) Latitude Drift Alignment *Note: N-S direction is defined as towards/away from mount axis in eyepiece FOV	M1 – Discrepancy in mount rotation vs. rotation of celestial pole due to misalignment identified. M1 – Correct labelling of drift directions eg. N-S direction in eyepiece, W-E in azimuth direction M1 – Both azimuthal misalignment and latitude misalignment explained.
Q8.	

Yes, step (2) will still work as intended even at higher latitudes. 1. The 0 degree declination line cuts the horizon at exactly due East (or West) regardless of latitude. Thus, a star close to due East of the eastern horizon will still be nearly 90 degrees away from the Meridian (as measured from the poles). 2. The guide star used does not need to be exactly on the Meridian/90 degree away from it. Rather it just maximizes the error contribution from misalignment in one direction and minimizes the error from the other. Drift alignment using other guide stars is still possible, but potentially more difficult and time-consuming.	M1 for each point. Accept any other reasonable explanations.
Q9. As an object rises and sets, it revolves around the celestial poles. The orientation of the object thus appears to change and rotates *relative to the local horizon*. Alt-Azimuth mounts remain in an upright position relative to the local horizon instead of rotating along with the celestial sphere. This results in a radial smear in long-exposure photographs centred on the centre of the FOV.	M1 – apparent rotation relative to the horizon M1 – radial blur in long-exposure photographs Minus 0.5m if centre of radial smear not stated
Q10. Modern large-aperture telescopes are too large and heavy to be mounted on an equatorial platform. Field de-rotators may be used (mechanism that rotates camera to compensate for field rotation).	M0.5 – too large/heavy M0.5 – de-rotator

3. Night Sky OEQ

An Unfamiliar Ceiling

Sample Star Chart:



Q1. As per diagram	M1 for each cross correctly identified
Q2. As per diagram	M0.5 for each star correctly identified
Q3. As per diagram	M0.5 – Line through southern cross

	M0.5 – Perpendicular bisector of Rigil Kentaurus and Hadar
Q4. As per diagram	M0.5 – Meridian passing through Zenith and SCP M0.5 – Prime Vertical At right angles to Meridian M0.5 – NS direction correctly identified M0.5 – EW direction correctly identified, E.C.F for subsequent questions if incorrectly flipped
Q5. Jupiter and Saturn can be identified as the 'guest stars' in the constellation of Taurus. Jupiter is also noticeably much brighter (larger in star charts) than Saturn.	M0.5 X 2 – Each 'guest star' identified in Taurus M0.5 X 2 – Correct labelling for each
Q6. As per diagram Ecliptic line is a curve passing near the Sun, Moon, Jupiter, and Saturn, and cutting the horizon at opposite sides 180 degrees apart.	M0.5 – Curve M0.5 – Passing near Solar System Bodies
Q7. 6 AM LST Sun is at the eastern horizon.	E.C.F. if E-W direction wrongly identified
Q8. Any valid constellations. Diagram shows the most easily identified constellations, which are those in the winter sky.	M0.5 for each constellation correctly drawn and identified
Q9. Any valid answer with a roughly 17hr RA. Expected Answer: Scorpius/Sagittarius	

Orion is lying on the Meridian in upper culmination, thus the summer constellations of Scorpius/Sagittarius should be at their lower culmination (below the horizon). In fact Shaula/Lesath can be seen just above the southern horizon close to the meridian line.	
Q10. Autumn. Current LST is 6AM, with the winter sky at upper culmination. Thus at midnight, the autumn sky will be at upper culmination. Do note that differing locations in the Northern/Southern hemisphere will not affect the answer, as the same constellations are opposite the sun regardless of how the celestial sphere is oriented/tilted with respect to an observer on earth.	No penalization if E-W direction wrongly identified and Autumn season is deduced.
Q11. Approximately 12hrs The sun is rising at nearly due East, so it is very close to Autumn Equinox. Actual length of day is closer to 11hr30mins. Acceptable range of answers will depend on relative position of sun to sketched Prime Vertical. If sun is slightly north of east, day will be slightly shorter than 12hrs in the southern hemisphere: Full Credit: 11hrs – 12hrs Half Credit: 10hrs – 11hrs If somehow the prime vertical is sketched in such a way that the sun is slightly south of east:	See left.

Full Credit: 12hrs – 12hrs 15min (Expected answer in this case is 12hrs, but range provided just in case some weirdos provide an answer like 12hrs05min) Half Credit: 12hrs 15min – 14hrs (Penalization as the prime vertical is very obviously not perpendicular)	
Q12. Full Moon/Waning Gibbous	
Q13. Approaching Opposition.	
Q14. - From a geocentric perspective, the sun moves through the Ecliptic 360 degrees in one tropical year from west to east. - Meanwhile Saturn moves through the ecliptic at a slower rate of 360 degrees in roughly 30 years - From the chart, the Sun is currently East of Saturn. As the Sun moves from west to east at a faster speed, the angular separation between the Sun and Saturn is increasing. - Thus Saturn is approaching Opposition	M0.5 – Sun moves from west to east along the ecliptic faster than Saturn M0.5 – Sun is east of Saturn E.C.F. if E-W is misidentified
Q15. Any valid answer. See diagram for examples.	M0.5 for each object in each quadrant correctly identified and labelled. Quadrants sketched by participants take precedence over answer key.

Q16. See diagram. Southern cross will be rotated 90 degrees corresponding to the 6 hr time difference. Rotation is in counterclockwise direction. In the southern hemisphere, the sky rotates clockwise around the south pole when time runs forward, and counterclockwise when time runs in reverse.	M0.5 for 90 degree rotation from current position M0.5 for counterclockwise rotation
Q17. See diagram. Moon should be near the Meridian at roughly the same declination angle from the SCP.	M0.5 - Near Meridian M0.5 – Correct distance from SCP

4. Finderchart Question

Team A is Given: Starmap Making (15 Mins)

Team B is Given: Stellarium (5 Mins)

Instructions

Team A:
You are given 15 minutes to draw up a star chart for the other half of your team to navigate within 5 minutes. An image will be shown for participants to take reference from when drawing their starcharts. The following deliverables should be included with your starchart:

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

Team B:
You are given the starchart drawn by your teammates. You are currently at the start point. Using **Stellarium** and the given starchart, you are to navigate to the end point in less than 5 minutes. Full marks will be awarded if the object is found, whereas no marks will be given if participants are unable to find the object.

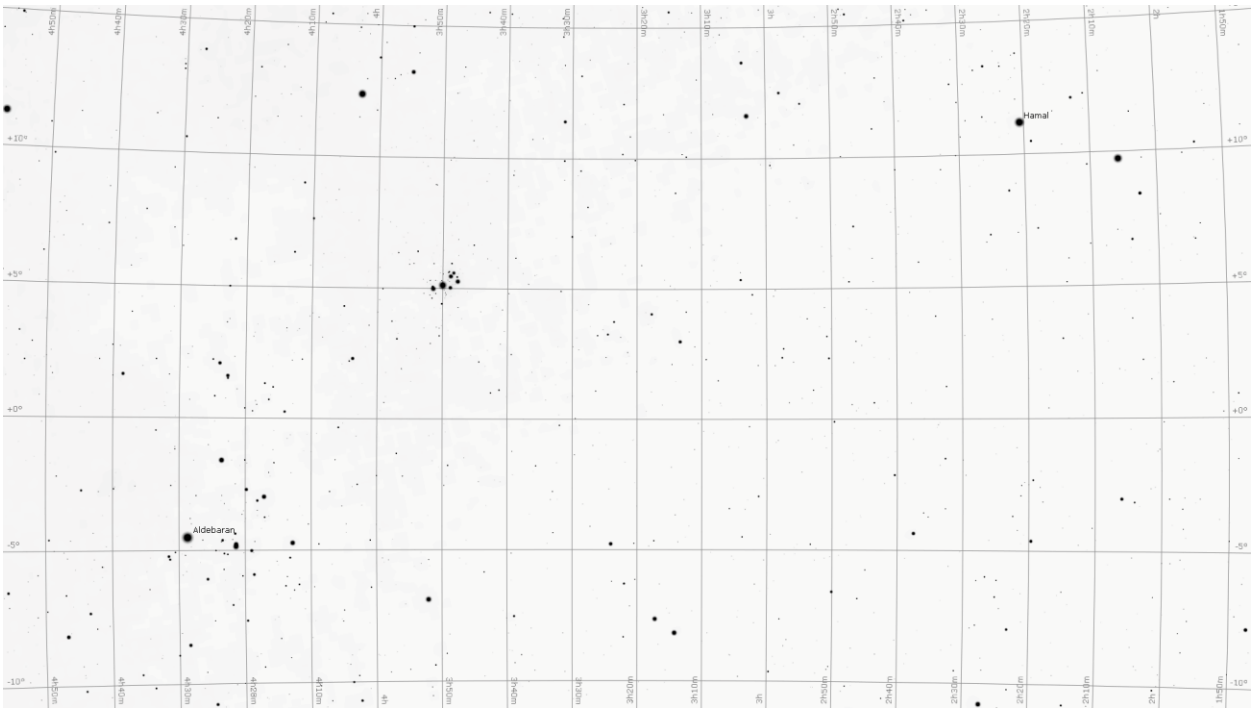
In this section, participants will be given remote control of the Assessor's Stellarium. This will enable you to control your field of view during the assessment.

The Assessor will set Stellarium to the necessary settings before granting control. The time will begin once control has been handed over and you are to make full use of it to find what you need.

Participants should take note of the following:

1) You are only allowed to use the up, down, left, right keys, as well as change the oculars using your mouse (if required).

2) If any other key is pressed, the section in question will be terminated; any marks obtained so far will be recorded and you will have to move on to the next section. There will not be a second chance.



Stellarium **Conditions**

Current Position: Venus, N 5° 0′ 0″, E 20° 0′ 0″

Elevation : 0m

Starting Center: Aldebaran

Destination: Hamal

Time and Date: 2020 Mar 15, 00:00:00 UTC
All labels and markers off, atmosphere off, time will be paused.

Your Equipment:

- 50mm Finder (7° FOV, 2x magnification)
- Altitude-azimuth mount
- Telescope (60mm Aperture (Diameter), 1000mm Focal Length)
- Eyepiece (40mm Focal Length, 43° Ocular aFOV)
- Eyepiece (26mm Focal Length, 52° Ocular aFOV)

- Eyepiece (14mm Focal Length, 50° Ocular aFOV)

Mark Scheme

Starmap Making

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

Star Map Making

Component	Percentage (%)
Object is Found	100

The Practical Paper

1. General Instructions

In this paper, participants will be given remote control of the Assessor's Stellarium. This will enable you to control your field of view during the assessment.

The Assessor will set Stellarium to the necessary settings and starting location before granting you remote-control. The time will begin once control has been handed over and you are to make full use of it to find what you need.

Participants should take note of the following:

1) You are only allowed to use the up, down, left, right keys, as well as change the oculars using your mouse (if required).
2) If any other key is pressed, the section in question will be terminated; any marks obtained so far will be recorded and you will have to move on to the next section. There will not be a second chance.

You are reminded that only one object within one field of view may be counted.

We will only accept deep sky objects/asterisms if they:

a. Have widely recognized standalone names (e.g. the Coathanger/Coma Star Cluster/Cat's Eye Nebula); **AND/OR**
b. Are listed in the Messier Catalogue (e.g. M42: the Orion Nebula); **AND/OR**
c. Are listed in the Caldwell Catalogue (e.g. C76: the False Comet).

Participants are only allowed hardcopy reference materials.

At any point in the competition, the Assessor is allowed to verify the item found however he wishes (including pressing D on

Stellarium). If the object shown is not what the team claims it to be, the team will be awarded 0 for that object and is not allowed to find that particular object again.

> For Example, the team finds a "fuzzy blob" and claims that it is M3. The assessor presses D to check and the "fuzzy blob" turns out to be the whirlpool galaxy. In this case, the team will be awarded 0 for this object and is not able to find the whirlpool galaxy again.

2. Star Party (Free for all)

You open your eyes and realise you have been teleported to an unknown location. Clouds are coming in fast, so you want to see as many objects as possible.

You have 20 minutes and you find a telescope right beside you. You start now.

Instructions

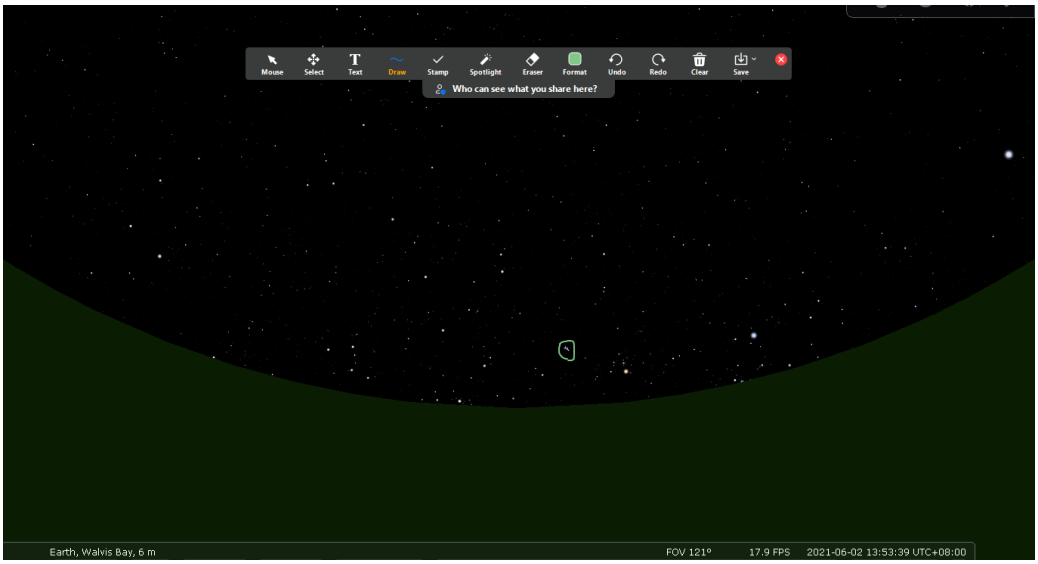
In this section, you are required to find as many objects as possible within 20 minutes. Objects must be visible with the settings given and must be named correctly.

Each object will be granted points as follows:

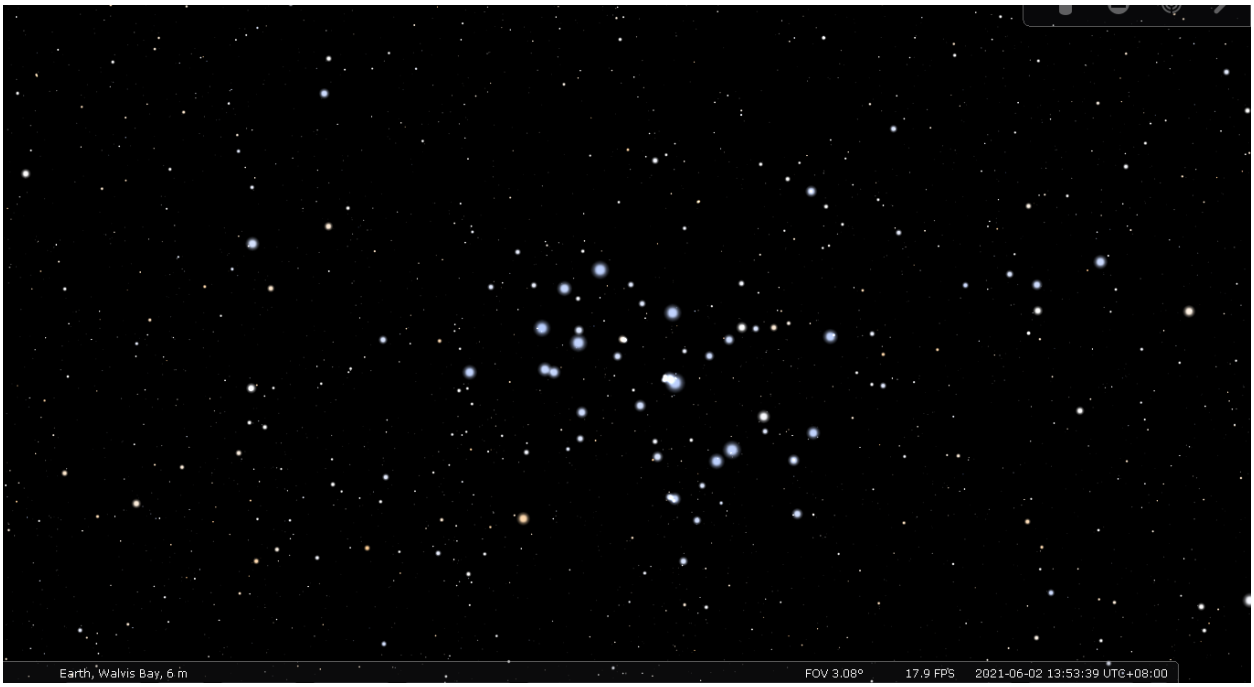
1. Deep-Sky Object (DSO) (4 point per correct name and location)
2. Common Asterism (2 points per correct name and shape)
3. Bright or Double Star (1 point per correct name and location)
4. Solar System Objects (1 point per correct identification and location)

Notes on acceptable Answers:

Circle with visible object

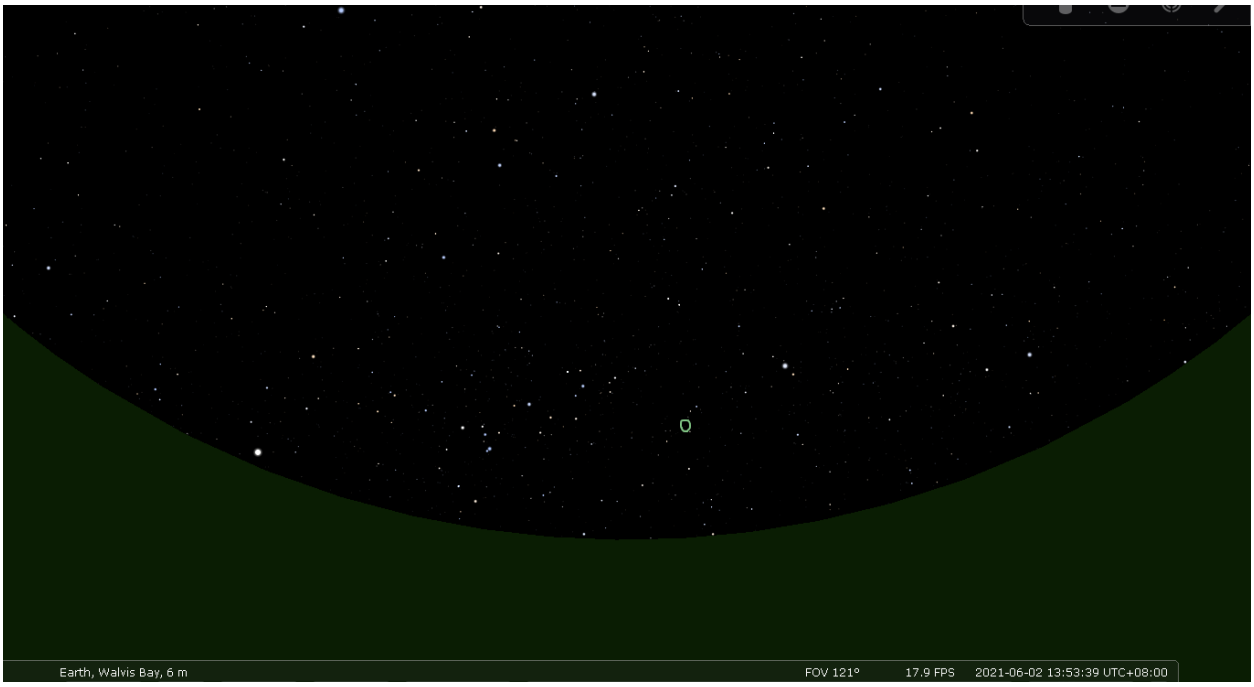


Zoomed in view

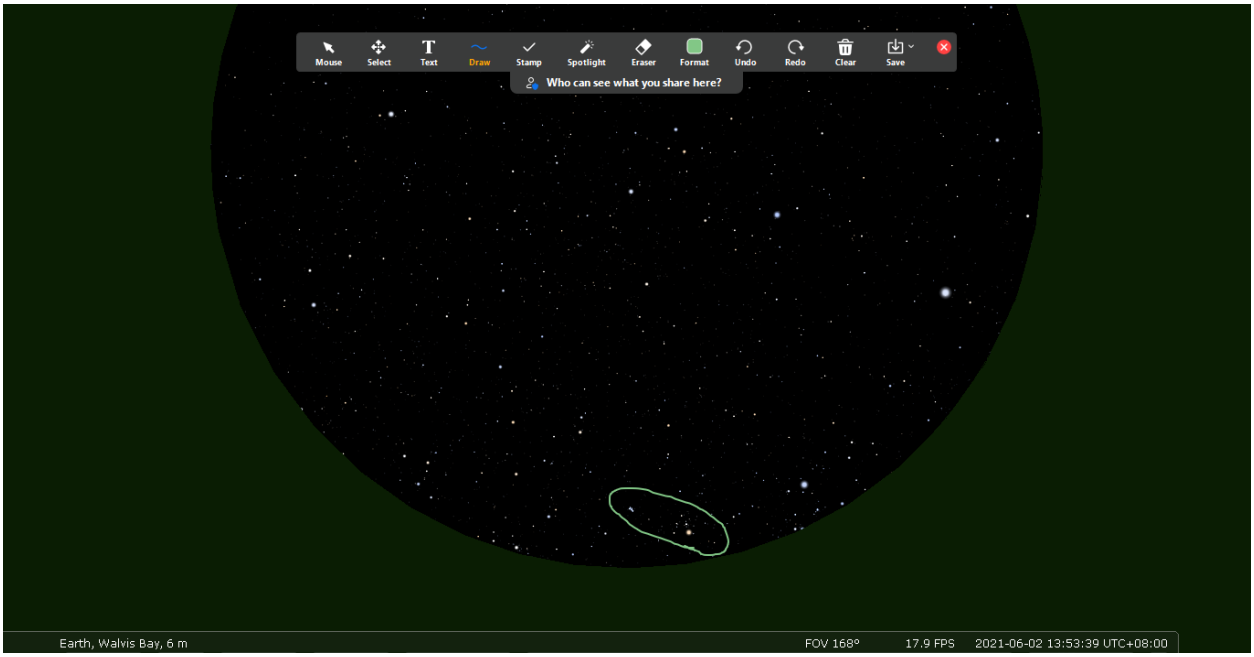


Not acceptable:

Circle of empty space



Circle with multiple objects inside



Assessor has final discretion to demand team zooms into specific objects for a better view if he cant see it at that level of zoom

Location: 42° 3' 15.12" N, 78° 46' 21,00" W
Elevation: 100m
Date and Time: 15th May 2022 22:50:00 UTC-4 PAUSED
Turn OFF constellation lines, names and art
Turn OFF cardinal points (Key=Q)
Turn OFF equatorial and azimuthal grids (Key=E and Z)
Turn OFF labels for planets, deep sky objects, exoplanets, satellites, and meteor showers
Turn OFF star labels and markers
Turn OFF Deep Sky Object images (Key=I)
Turn ON ground (zero horizon landscape)
Turn ON atmosphere
Projection - Stereographic
Light pollution - 1

3. Speed Round (Closed List)

You are required to order yourselves into player number 1 to player number 4. You may not swap out yourselves at any time during the competition.

In this round, players take turns to find the objects in an ordered list. Players will have 90 seconds to locate the object and will only be told of the object to locate when it is their turn. Each player will expect to go 3 times.

Location: Singapore (Built-in)

Date: 22nd August 2021

Time: 22:00:00 CST (UTC+8) PAUSED

Light pollution – 6

All other settings as before

Object List (Go in order and Reveal one by one)

1. M6 (Butterfly)
2. M57 (Ring)
3. M7 (Ptolemy)
4. Saturn
5. Albireo (Beta Cygnii)
6. Epsilon Lyrae (Double Double)
7. M31 (Andromeda)
8. M8 (Lagoon)
9. M11 (Wild Duck)
10. Rigel Kentaurus (Alpha Centauri)
11. Arcturus (Alpha Boötis)
12. Alpheratz (Alpha Andromedae)