

## **Exercise: What are the faintest stars you can see?**

### **Difficulty: Basic**

#### **OBJECTIVE**

On a clear night some 2,860 stars are visible with the naked eye from the Northern hemisphere. These stars are our Sun's neighbours in the spiral arm of our galaxy, the Milky Way. Unfortunately, light pollution from urban areas swamps the light from fainter stars and reduces the number of stars we can see without a telescope or binoculars. In most towns we see less than 200 stars and in heavily light polluted areas there may only be 4 or 5 stars visible to the naked eye!

This exercise introduces the concepts of stellar magnitude and light pollution. Through simple naked eye observation you will learn to estimate the limiting magnitude of your observing location. This is a 'naked eye' exercise and requires no equipment and no special knowledge of astronomy or mathematics.

Learning how to estimate the magnitude of stars is an important skill and provides a base to other exercises in this series e.g. Light curves of variable stars.

#### **EQUIPMENT**

All you need to perform this experiment are:

- A star chart or planetarium program
- A small torch, preferably a red light
- A magnitude guide (provided at the end of this document)
- A pen and paper
- Clear skies!

#### **SOME BACKGROUND**

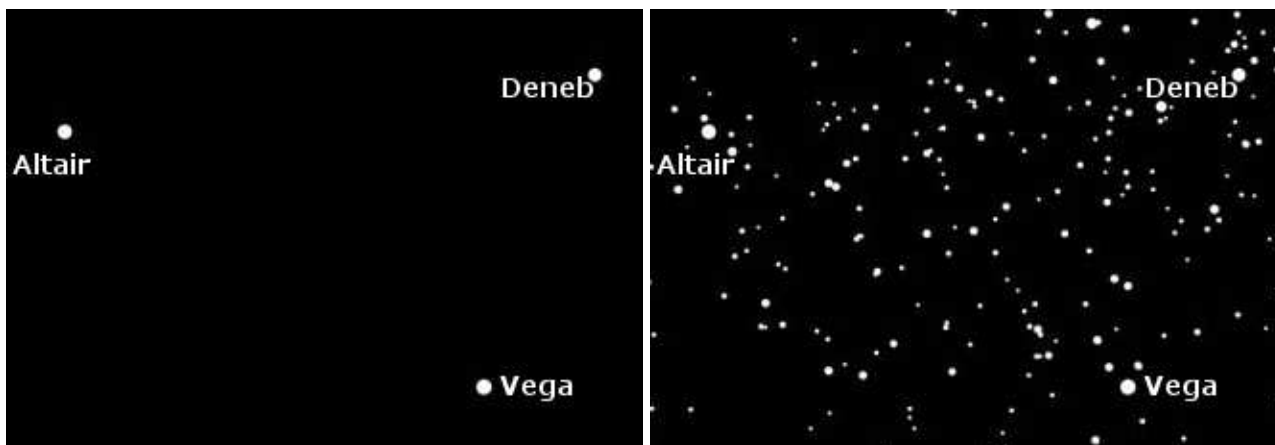
Over 2,000 years ago the Greek astronomer Hipparchos started to catalogue stars according to their relative brightness. He devised a scale where the brightest stars were first magnitude, the next brightest as second magnitude and so on. Some 300 years later, Hipparchos' work was carried on in Egypt by the Roman astronomer Ptolemy and by this time the system had been extended to sixth magnitude stars that were only just visible to the naked eye. When telescopes were introduced in the 17th century, fainter stars were observed and the scale was extended beyond magnitude 6.

Our modern magnitude scale retains much of Hipparchos' system but allows for non-integer numbers and negative magnitudes to represent objects brighter than magnitude 1. For example planets such as Jupiter or Venus can appear as magnitude -4 or brighter. The magnitude scale can also be applied to comets, meteors, satellites, nebulae and supernovas.

## What are the faintest stars you can see?

There are other factors that affect our view of the stars including the Earth's atmosphere, humidity, cloud cover and light pollution. Astronomers talk in terms of good or bad "seeing" to describe these affects. "Limiting magnitude" is defined as the magnitude of the faintest object that can be observed and is a useful measure of the quality of the seeing. Limiting magnitude will also vary with the time of day and obviously more stars are visible when it is fully dark as opposed to twilight.

Three bright stars make up the "Summer Triangle": Vega in Lyra, Altair in Aquilla and Deneb in Cygnus. The pictures below give an example of how these stars would appear in the night sky when the limiting magnitude is 2 (on the left) and 6 (on the right).



As you can see there is big difference in the number of visible stars and the Triangle becomes harder to spot at magnitude 6. At magnitude 5 the Milky Way starts to be clearly visible and at magnitude 6 it would be possible to distinguish the dust lanes running through the denser patches of stars.

## METHOD

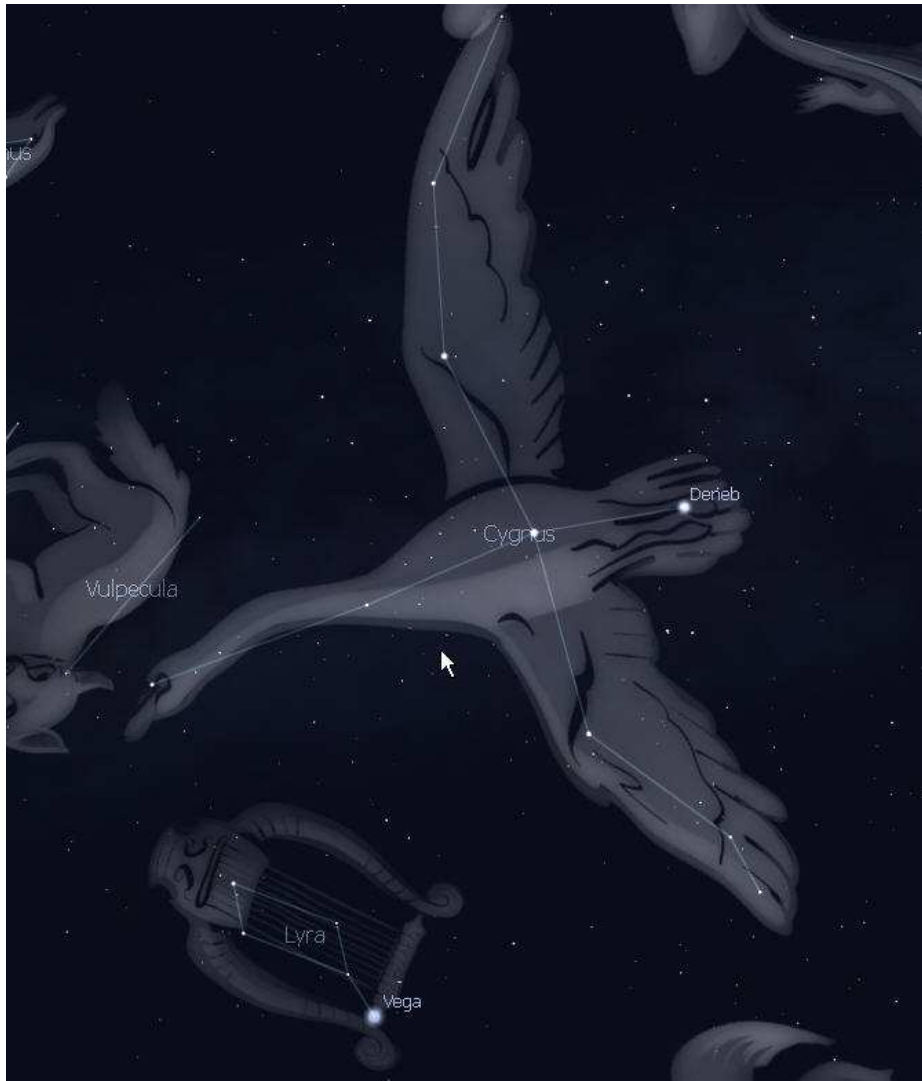
Building on the example of the Summer Triangle, the constellation of Cygnus the Swan is a good place to start learning how to estimate the limiting magnitude. For the majority of the year, Cygnus is well placed in our skies and above the horizon for most of the night.

First use a star chart or planetarium program, like Stellarium, to locate the constellation of Cygnus in the night sky. Use the picture on the next page to find Deneb and Vega so that you can work out the orientation of the constellation and the direction of the "wings."

While you have been doing this, hopefully your eyes have been adapting to the darkness. From now on you need to preserve your night vision and not look at bright lights, including the Moon. If you need to use a torch to move around in the dark, or look at charts, then use either a dim light or preferably a red light (for example a rear cycle lamp, a torch with some red cellophane over the lense, or a red LED torch). Red light does not affect your night vision and you can easily cover a small torch with red paper or plastic.

Compare the number of stars you see in Cygnus to the diagrams in the magnitude guide and this will provide an estimate of the limiting magnitude. Keep a note of your observations along with the date, time, weather conditions, cloud cover and any major light sources in the immediate vicinity.

What are the faintest stars you can see?



## ANALYSIS OF YOUR RESULTS

Are your results consistent or do they vary? Do your records suggest any reasons for the variation?

The more times you repeat this exercise, the easier it will become to estimate the limiting magnitude. To challenge yourself, you could try to make your results more accurate by using halves e.g. 1.5, 2.5...etc.

Try estimating the limiting magnitude in different places e.g. when you are on holiday, to get a comparison to your home location. If you can, try estimate the limiting magnitude in the centre of your town or city and outside of the town. How does the light pollution in a town affect the limiting magnitude?

## FURTHER RESOURCES

Magnitude scale by Peter Campbell-Burns: <http://www.farnham-as.co.uk/2009/12/the-magnitude-scale-by-peter-campbell-burns/>

What are the faintest stars you can see?

Stellarium – an open source planetarium program that shows a realistic sky from any location and time in the world: <http://www.stellarium.org/>

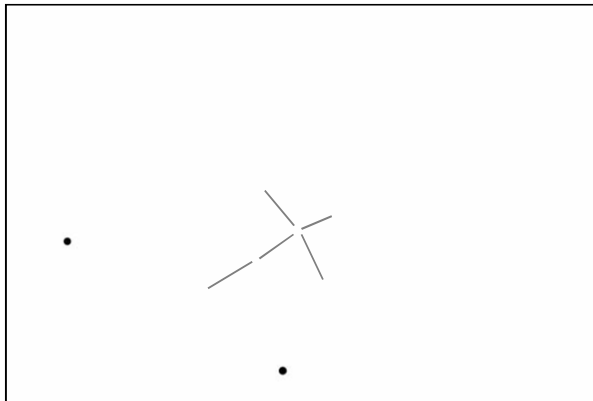
## CREDITS

Picture of Cygnus taken from Stellarium

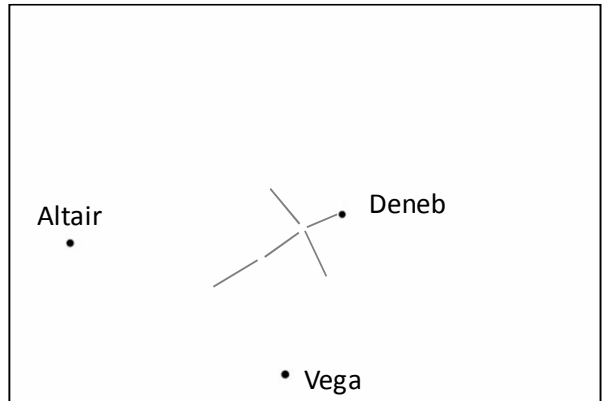
## Estimating Magnitude from your location by using the stars that you can see in the constellation of Cygnus.

The three bright stars Altair in Aquilla, Vega in Lyra and Deneb in Cygnus form the "Summer Triangle". The charts below are a guide to estimating the limiting magnitude based on how many stars you can see with reasonably dark-adapted eyes.

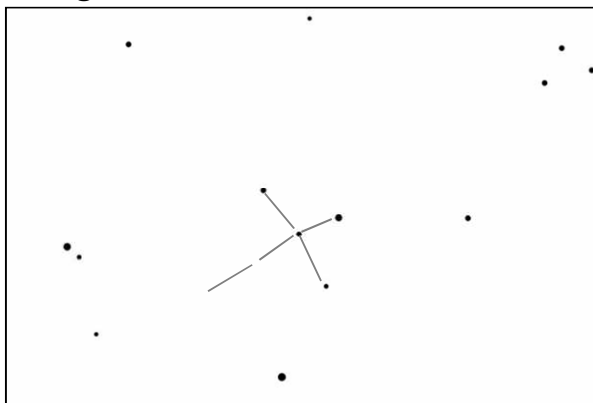
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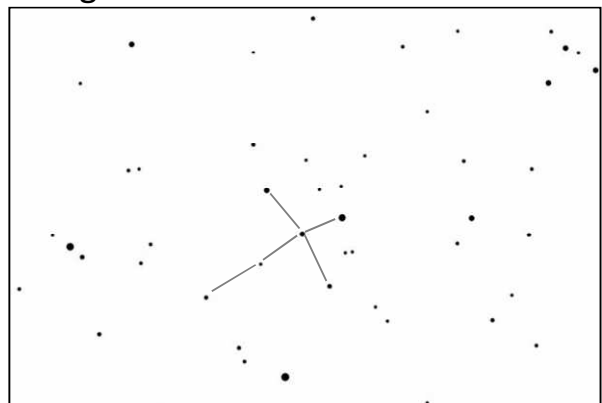
Magnitude 2



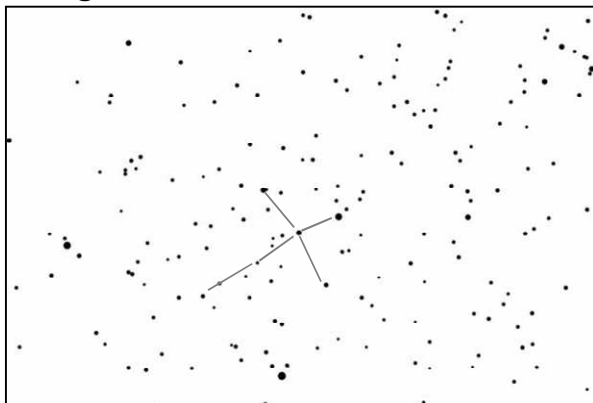
Magnitude 3



Magnitude 4



Magnitude 5



Magnitude 6

