The Hertzsprung-Russell Diagram
Help Sheet

Setting up the Telescope

What is the wavelength range of an optical telescope?
Approx. 400 - 700 nm

Locating the Star Cluster

Observing the sky from the Northern hemisphere, which star remains fixed in the sky whilst the other stars rotate around it? In which direction do they rotate?
North Star/Pole Star/Polaris
Stars rotate anticlockwise around Polaris

Observing the Star Cluster - Stellar Observation

What is the difference between the apparent magnitude and the absolute magnitude of a star?
The apparent magnitude is how bright the star appears from Earth. The absolute magnitude is how bright the star would appear if it was 10pc away from Earth.

Part 1 - Distance to the Star Cluster

What is the distance to the star cluster in lightyears?
136 pc = 444 lightyears
Conversion: 1 pc = 3.26 lightyears

Why might the distance to the cluster you have calculated differ from the literature value?
Uncertainty in fit of ZAMS (due to outlying stars, for example), hence uncertainty in distance modulus and hence distance.

Part 2 - Age of the Star Cluster

Why might there be an uncertainty in the age of the cluster determined by this method?
Uncertainty in fit of isochrone; with 2 or 3 parameters to fit it can be difficult to reproduce the correct shape. Also problem with outlying stars, as explained in the manual.

How does the age you have calculated compare to the age of the universe?
Age of universe ~ 13.8 GYr

Part 3 - Comparison of Star Clusters

Consider the shape of the CMD for the Hyades. Do you expect the Hyades to be older or younger than the Pleiades?
The Hyades is older than the Pleiades. Shorter main sequence, earlier turnoff point, higher population of red giants, significant population of white dwarfs.

Consider the shape of the CMD for M67. What can be inferred about the age of the star cluster, and why?
Older than the Pleiades and the Hyades. Same reasons as above.

These stars do not belong to the main sequence, instead they are known as:
White dwarf stars

What does this population of stars suggest about the age of the cluster?
Old enough to contain stars that have evolved off the main sequence, onto the red giant branch, become planetary nebulae, and finally white dwarf stars. Must be very old!

Why is this population of stars not found in the Pleiades cluster?
The Pleiades is not old enough yet, as most of its stars are still on the main sequence.

EXTENSION

	$V-M_V$	Distance to cluster	Estimated cluster age	$B-V$ adjustment
Mel 20 Alpha-Persei	6.30	180 pc	0.063 GYr	-0.02
M44 (NGC 2632)	6.24	177 pc	0.631 GYr	-0.08
M7 (NGC 6475)	7.38	300 pc	0.200 GYr	+0.02
M16 (NGC 6611)	11.66	2150 pc	0.002 GYr	n/a

How does the age of M16 compare to the age of our Sun, or the Earth?
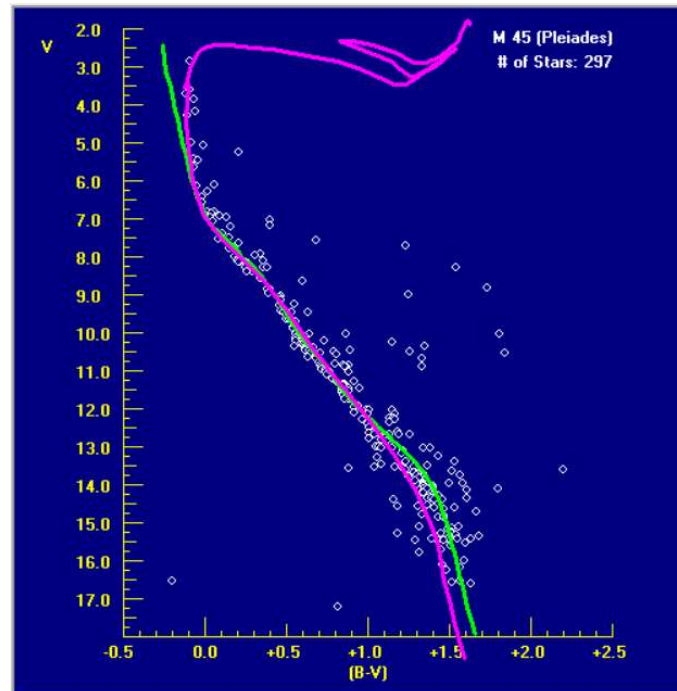Age of Sun ~ 4.6 billion years
Age of Earth ~ 4.5 billion years

The Pleiades

Distance = 136 pc

Distance modulus $V-M_v$ = +5.67

Age = 0.075 to 0.150 GYr

$B-V$ adjustment = +0.00 to -0.03

The Pleiades is an open star cluster in the constellation Taurus. Very obvious to the naked eye, dominated by hot/blue/extremely luminous stars. Known for its seven brightest stars, named after the Seven Sisters of Greek mythology.
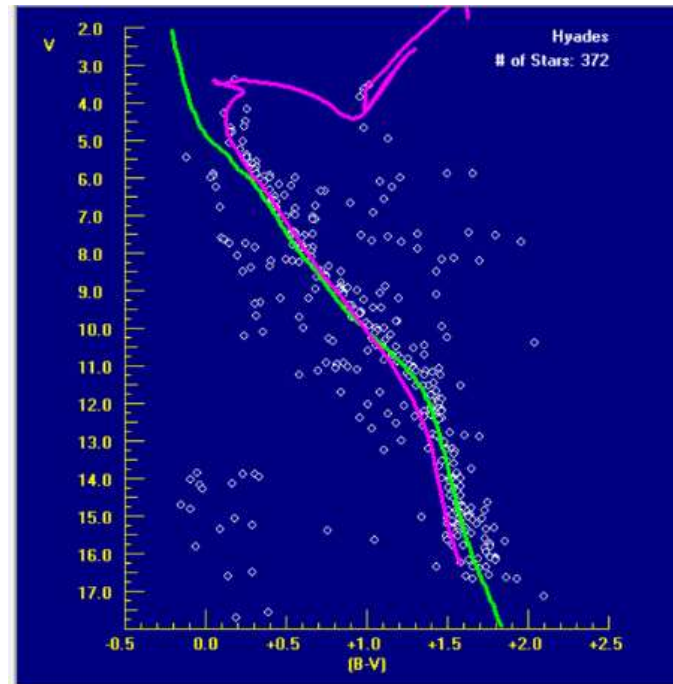
The Hyades

Distance = 47 pc

Distance modulus $V-M_v$ = +3.36

Age = 0.625 GYr

$B-V$ adjustment = +0.01

The Hyades is the nearest open star cluster to Earth, and appears in the constellation Taurus. The five brightest stars in the cluster have ended their main sequence lives, and are evolving to become red giant stars. The Hyades were the half-sisters of the Pleiades, all being daughters of the Greek god Atlas.
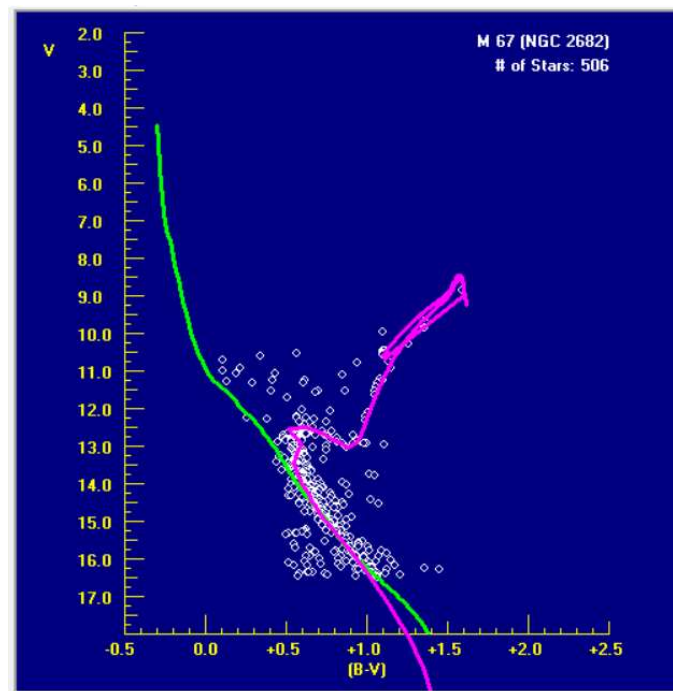
M67 (NGC 2682)

Distance = 800 to 900 pc

Distance modulus $V-M_v$ = +9.65

Age = 3.2 to 5 GYr

B-V adjustment = -0.03 to -0.06

M67 (NGC 2682) is an open cluster in the constellation Cancer. M67 is its ID number in the *Messier Catalogue* of astronomical objects; NGC 2682 is its ID number in the *New General Catalogue of Nebulae and Clusters of Stars*. It is a relatively ancient star cluster, and is extensively studied as the cluster is unobscured by gas and dust.

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