**Exploring Star Clusters**

## Take a look at the Hertzsprung-Russell (HR) diagrams for six star clusters in the Milky Way. The clusters range in age from less than 20 million years (2x107 years) to 5 billion years (5x109 years). The HR diagrams are plots of the brightness of stars (their apparent or absolute magnitude) on the y-axis versus (here we use apparent magnitude), the temperature (or color) of stars on the x-axis. In the attached diagrams, the color of the star is indicated by the “B-V color,” which is the difference in brightness in Blue and yellow (Visual) filters.

## Hotter stars are brighter in blue light than in yellow light, have low values of B-V color, and are found on the left side of the diagram.

## Cooler stars are brighter in yellow light than in blue light, have larger values of B-V color, and are found on the right side of the diagram.

## Since brighter stars are designated with a smaller number for apparent magnitude, magnitudes are plotted in reverse order to put the brighter stars at the top.

## For each cluster, identify the main sequence, and sketch in a line that follows the main sequence from its brightest point to the bottom of the diagram. For some clusters, you will need to extrapolate the main sequence to magnitudes fainter than have been plotted. Sometimes astronomical photographs don’t reach faint enough stars to detect the bottom portion of the main sequence.

## Using the HR diagrams, answer the following questions.

## Which cluster contains stars with the brightest apparent magnitudes?

## Which cluster contains the stars with the brightest absolute magnitudes?

## Which cluster contains the most red giants?

## In which cluster have white dwarf stars been detected?

## For the cluster in question 4, what is the difference in magnitude between white dwarfs and main sequence stars of the same temperature (color)?

## Estimating Distances: The Sun has a B-V color of about 0.6. For each cluster, estimate the apparent magnitude of stars like our Sun.

## NGC 752 \_\_\_\_\_\_\_\_\_\_

## M67 \_\_\_\_\_\_\_\_\_\_

## Hyades \_\_\_\_\_\_\_\_\_\_

## Pleiades \_\_\_\_\_\_\_\_\_\_

## M34 \_\_\_\_\_\_\_\_\_\_

## Jewelbox \_\_\_\_\_\_\_\_\_\_

## Based on the apparent magnitudes of Sun-like stars, which cluster is the nearest to our Sun?

## Based on the apparent magnitudes of Sun-like stars, which cluster is the farthest from our Sun?

## Sun-like stars have an absolute magnitude of about 5. The difference between the apparent magnitude and the absolute magnitude of a star is called the distance modulus.

## h. From the chart below, estimate the distance to each cluster in light years.

|  |  |
| --- | --- |
| Distance Modulus | Distance in Light Years |
| 0 | 30 ly |
| 2.5 | 100 ly |
| 5 | 300 ly |
| 7.5 | 1,000 ly |
| 10 | 3,000 ly |
| 12.5 | 10,000 ly |
| 15 | 30,000 ly |
| 17.5 | 100,000 ly |
| 20 | 300,000 ly |

|  |  |  |
| --- | --- | --- |
| Cluster | Distance Modulus | Distance in Light Years |
| NGC 752 |  |  |
| M 67 |  |  |
| Hyades |  |  |
| Pleiades |  |  |
| M 34 |  |  |
| Jewelbox |  |  |

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## Estimating the Ages of Star Clusters - Massive stars burn their nuclear fuel faster than lower mass stars and leave the main sequence sooner. In a cluster in which all the stars formed at the same time, the stars “peel off” the main sequence from the top, leaving only progressively less and less massive stars remaining on the main sequence as time goes by. The main sequence turnoff is the point on the main sequence for which more massive stars have evolved away, but less massive stars still remain. Over time, the turnoff point moves down the main sequence to lower and lower mass stars. By measuring the turnoff point, astronomers can determine the age of a star cluster.

## For each cluster, estimate the “color” of the main sequence turnoff in the HR diagram and determine the cluster’s age from the chart below.

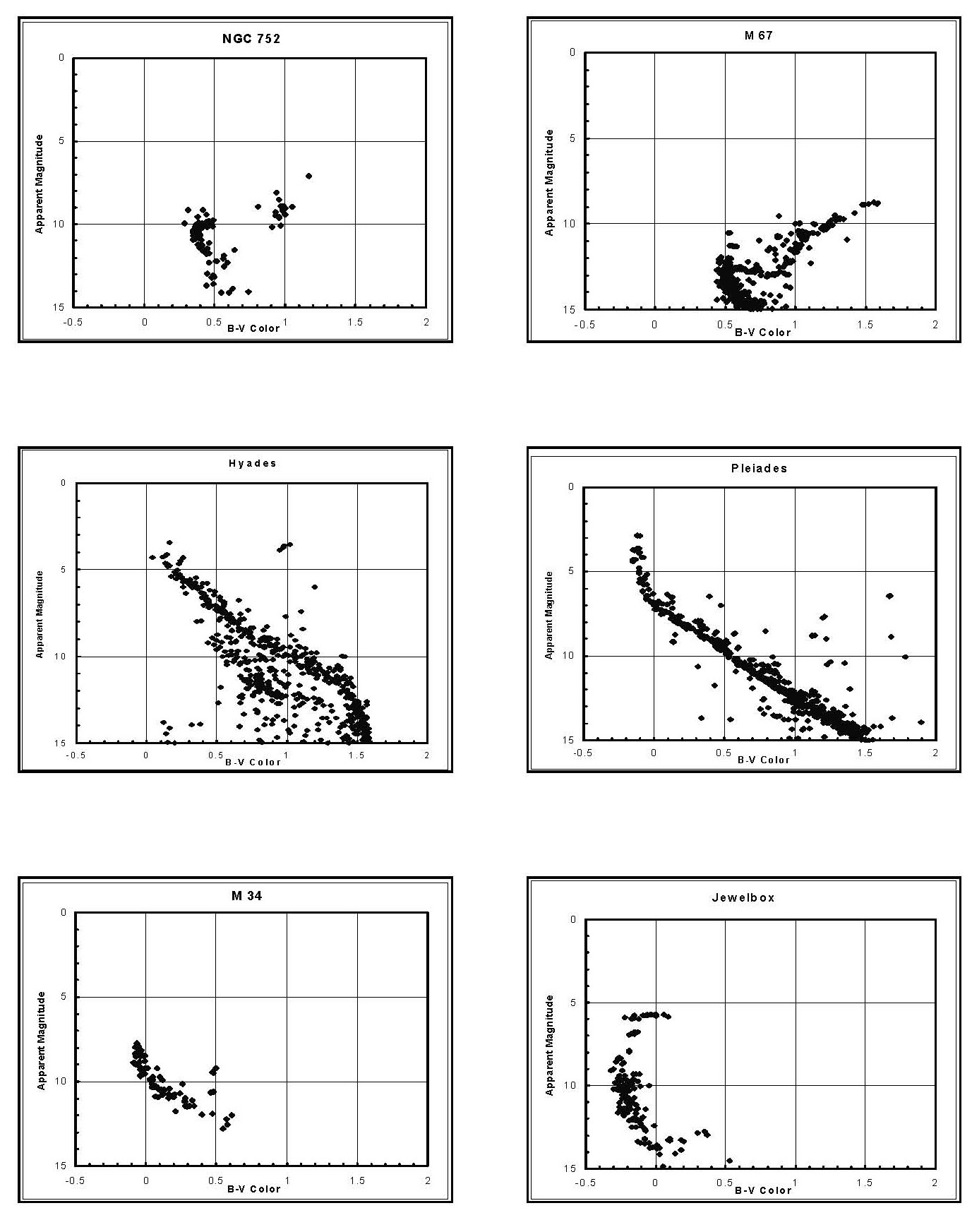
## 

|  |  |  |
| --- | --- | --- |
| Cluster | Turnoff Color | Age |
| NGC 752 |  |  |
| M 67 |  |  |
| Hyades |  |  |
| Pleiades |  |  |
| M 34 |  |  |
| Jewelbox |  |  |

i. Which cluster is the youngest?

j. Which cluster is the oldest?

k. Why has a cluster with a turnoff color of B-V=0.9 never been discovered?

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