

## Worksheet – Astronomical Distances - Answers

### HR diagram (I allowed a difference of $\pm 0.5$ for the absolute magnitude)

1. Star A has a relative magnitude of 5.8, and a surface temperature of 9000 K.
  - a) What is its absolute magnitude? 2.0
  - b) What is its distance modulus?  $5.8 - 2.0 = 3.8$
  - c) What is its distance?
    - i.  $m - M = 5 \log(d) - 5$
    - ii.  $3.8 = 5 \log(d) - 5$
    - iii.  $5 \log(d) = 3.8 + 5 = 8.8$
    - iv.  $\log(d) = 8.8/5 = 1.76$
    - v.  $d = 10^{1.76} = 57.5 \text{ pc}$
  
2. Star B has a relative magnitude of 3.6, and a surface temperature of 20,000 K.
  - a) What is its absolute magnitude? -2.5
  - b) What is its distance modulus?  $3.6 - (-2.5) = 6.1$
  - c) What is its distance?
    - i.  $m - M = 5 \log(d) - 5$
    - ii.  $6.1 = 5 \log(d) - 5$
    - iii.  $5 \log(d) = 6.1 + 5 = 11.1$
    - iv.  $\log(d) = 11.1/5 = 2.22$
    - v.  $d = 10^{2.22} = 166 \text{ pc}$

### Cepheid variables (I allowed an difference of $\pm 0.1$ for the absolute magnitude)

3. Star C is a Cepheid variable with a period of 3 days, and a relative magnitude of 2.8
  - a) What is its absolute magnitude? -2.3
  - b) What is its distance modulus?  $2.8 - (-2.3) = 5.1$
  - c) What is its distance?
    - i.  $m - M = 5 \log(d) - 5$
    - ii.  $5.1 = 5 \log(d) - 5$
    - iii.  $5 \log(d) = 5.1 + 5 = 10.1$
    - iv.  $\log(d) = 10.1/5 = 2.02$
    - v.  $d = 10^{2.02} = 105 \text{ pc}$
  
4. Star D is a Cepheid variable with a period of 37 days, and a relative magnitude of 4.9
  - a) What is its absolute magnitude? -4.8
  - b) What is its distance modulus?  $4.9 - (-4.8) = 9.7$
  - c) What is its distance?
    - i.  $m - M = 5 \log(d) - 5$
    - ii.  $9.7 = 5 \log(d) - 5$
    - iii.  $5 \log(d) = 9.7 + 5 = 14.7$
    - iv.  $\log(d) = 14.7/5 = 2.94$
    - v.  $d = 10^{2.94} = 870 \text{ pc}$

## Supernovae (Constant absolute magnitude of -19.3)

5. Star E is a type 1 supernova, and a relative magnitude of 2.8

a) What is its distance modulus?  $2.8 - (-19.3) = 22.1$

b) What is its distance?

i.  $m - M = 5 \log(d) - 5$

ii.  $22.1 = 5 \log(d) - 5$

iii.  $5 \log(d) = 22.1 + 5 = 27.1$

iv.  $\log(d) = 27.1/5 = 5.42$

v.  $d = 10^{5.42} = 263,000 \text{ pc}$

6. Star E is a type 1 supernova, and a relative magnitude of 8.0

a) What is its distance modulus?  $8.0 - (-19.3) = 27.3$

b) What is its distance?

i.  $m - M = 5 \log(d) - 5$

ii.  $27.3 = 5 \log(d) - 5$

iii.  $5 \log(d) = 27.3 + 5 = 32.3$

iv.  $\log(d) = 32.3/5 = 6.46$

v.  $d = 10^{6.5} = 2,880,000 \text{ pc}$