Astrophysics IB Physics Content Guide

Big Ideas

- A variety of measurements from earth can be used to calculate the distance of stars and galaxies
- The scale of our universe is so vast that we need to define new units to help conceptualize its overall size
- It is possible to measure the emission or absorption spectrum of a star to determine its composition
- The properties of stars can be organized into a chart and used to predict the future life cycles

Content Objectives

1 – The Scale of Astrophysics

I can describe the relative scale of the solar system			
I can identify the defining characteristics required for a celestial body to be a planet			
I can define a light year (ly) as a unit of distance in terms of meters			
I can define the meaning of one astronomical unit (AU)			
I can relate degrees and seconds as units of angular measurement			
I can describe the meaning of 1 parsec as a unit of distance			

2 – Stellar Quantities

I can describe the phenomenon of stellar parallax and how it can be used to measure distance			
I can calculate distance in parsecs of a nearby star when given the parallax angle in arc seconds			
I can compare the definitions of brightness and luminosity			
I can conceptually describe the relationship between a star's brightness and distance from viewer			
I can calculate the brightness of a star with a known luminosity and distance			
I can describe how different stars can appear the same brightness on earth			
I can use Wien's Displacement Law to mathematically relate peak wavelength and temperature			
I can use Stefan-Boltzmann's Law to mathematically relate luminosity, radius and temperature			

3 – H-R Diagrams and Stellar Spectra

I can place a star on an axis showing luminosity vs temperature			
I can describe the organization of the Hertzsprung-Russell Diagram			
I can use the main sequence to calculate the distance of a star from its wavelength and brightness			
I can proportionally relate a star's luminosity to its mass			
I can identify the chemical makeup of a star from its absorption spectrum			

4 – Evolution of Stars

I can predict the relative life span of a star based on its type			
I can explain the process of stellar equilibrium and how the temperature affects size			
I can describe the life cycle of a low mass star like the Sun and plot it on an H-R Diagram			
I can describe the nature and formation process of a white dwarf star			
I can define the Chandrasekhar Limit as the maximum mass of a core that can become a white dwarf			
I can define the Oppenheimer-Volkhoff Limit as the maximum mass of a neutron star			
I can predict the fate of a star based on its mass			

5 – The Expanding Universe

I can describe the nature of Cephid Variables			
I can use a table to relate the luminosity and period of a Cephid Variable			
I can outline the process that results in a Type IA Supernova			
I can describe the value of a “standard candle” in making measurements about distance			
I can use wavelength shift to calculate the relative speed of an object			
I can describe the important discovery that Hubble made when analyzing redshift of distant stars			
I can relate the distance of an object to its relative velocity using the Hubble Constant			
I can calculate redshift based on the expansion of the universe			

6 – The Beginning and The End

I can describe the different methods to find the distances of objects based on magnitude			
I can use Hubble’s constant to estimate the age of the universe			
I can outline the steps in the Big Bang			
I can describe the CMB and why it is important evidence of the Big Bang			
I can provide the peak wavelength and average temperature of the CMB			
I can describe the current theory about the expansion of the universe			

Astrophysics Shelving Guide

The Scale of Astrophysics

Unit Conversion	Definition
1 light year (ly) =	
1 parsec (pc) =	
1 astronomical unit (AU) =	

Stellar Quantities

Brightness	Luminosity

	Variable Symbol	Unit
Distance		
Parallax Angle		
Brightness		
Luminosity		
Max Wavelength		
Temperature		
Surface Area		

Data Booklet Equations:

$$d\ (\text{parsec}) = \frac{1}{p\ (\text{arc} - \text{second})}$$

$$b = \frac{L}{4\pi d^2}$$

$$\lambda_{\max} T = 2.9 \times 10^{-3}\ \text{m K}$$

$$L = \sigma A T^4$$

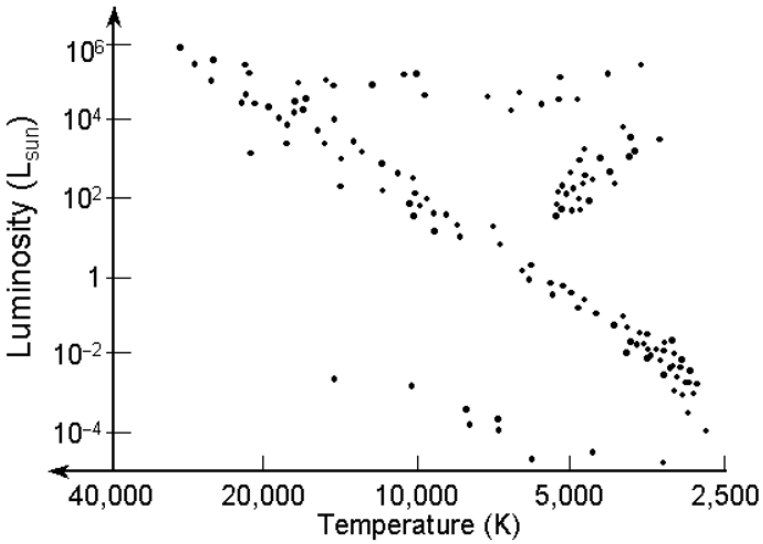
$$\sigma = 5.67 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4}$$

Describe the process of Stellar Parallax:

H-R Diagrams and Life Cycle of a Star

Label the Following:

- ☐ Main Sequence
- ☐ White Dwarfs
- ☐ Red Giants
- ☐ The Sun
- ☐ Line representing the life cycle of our sun



Chandrasekhar Limit	Oppenheimer-Volkhoff Limit

Sun Like Stars (< 1.5 $M_\odot$) ⬇	Huge Stars (1.5 – 3 $M_\odot$) ⬇	Giant Stars (> 3 $M_\odot$) ⬇

The Expanding Universe

Standard Candles	Evidence for Expanding Universe

	Variable Symbol	Unit
Redshift		---
Change in Wavelength		
Original Wavelength		
Relative Velocity of Source		
Speed of Light		
Current Scale Factor		---
Scale Factor when Emitted		---
Hubble's Constant		

Data Booklet Equations:

$$z = \frac{\Delta\lambda}{\lambda_0} \approx \frac{v}{c}$$

$$z = \frac{R}{R_0} - 1$$

$$v = H_0 d$$

$$c = 3.00 \times 10^8 \text{ m s}^{-1}$$

$$H_0 \approx$$

The Big Bang

	Peak Wavelength	Temperature
Cosmic Microwave Background Radiation		

Describe why the CMB is evidence of the Big Bang: