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| **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

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| 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 | |  |  |  |

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| 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 | |  |  |  |

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| 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 | |  |  |  |

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| 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 | |  |  |  |

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| 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 | |  |  |  |

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| 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 | |  |  |  |

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| **Astrophysics** | Shelving Guide |

# The Scale of Astrophysics

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

# Stellar Quantities

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| --- | --- |
| Brightness | Luminosity |
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| --- | --- | --- | --- | --- |
|  | Variable Symbol | Unit |  | *Data Booklet Equations:* |
| Distance |  |  |  |  |
| Parallax Angle |  |  |  |
| Brightness |  |  |  |  |
| Luminosity |  |  |  |
| Max Wavelength |  |  |  |  |
| Temperature |  |  |  |  |
| Surface Area |  |  |  |  |

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| Describe the process of Stellar Parallax: |

# H-R Diagrams and Life Cycle of a Star

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| Label the Following:  * Main Sequence * White Dwarfs * Red Giants * The Sun * Line representing the life cycle of our sun |  |

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| --- | --- | --- | --- | --- |
| Chandrasekhar Limit | | Oppenheimer-Volkhoff Limit | | |
|  | |  | | |
| Sun Like Stars (< 1.5 Mʘ)  ⬇ | Huge Stars (1.5 – 3 Mʘ)  ⬇ | | Giant Stars (> 3 Mʘ)  ⬇ |

# The Expanding Universe

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| Standard Candles | Evidence for Expanding Universe |
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|  | Variable Symbol | Unit |  | *Data Booklet Equations:* |
| Redshift |  | --- |  |  |
| Change in Wavelength |  |  |  |
| Original Wavelength |  |  |  |  |
| Relative Velocity of Source |  |  |  |
| Speed of Light |  |  |  |  |
| Current Scale Factor |  | --- |  |  |
| Scale Factor when Emitted |  | --- |  |  |
| Hubble’s Constant |  |  |  |  |

# The Big Bang

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|  | Peak Wavelength | Temperature |
| Cosmic Microwave Background Radiation |  |  |

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| Describe why the CMB is evidence of the Big Bang: |