

Going Through the Motions: It's all Relative

1. The Nature of Science

- How can we distinguish science from nonscience?
- What is a scientific theory?

2. Describing Motion: Examples from Daily Life

- How do we describe motion?
- How is mass different from weight?

3. Newton's Laws

- How did Newton change our view of the universe?
- Newton's three laws of motion
- The Law of Universal Gravitation
- What determines the strength of gravity?
- How does Newton's law of gravity extend Kepler's laws?
- Conservation laws

4. Einstein's Special Theory of Relativity

- Maxwell's equations and the unification of physics
- Failure of the Michelson-Morley experiment
- What are the postulates of special relativity
- Consequences of relativistic motion

5. Einstein's General Theory of Relativity

- What is the principle of equivalence?
- How does Einsteinian spacetime differ from classical space and time?
- How does the curvature of spacetime explain gravity?

Key Definitions and Terms

Inertia

Velocity

Angular momentum

Theory

Mass

Acceleration

Simultaneity

Scientific Model

Semi-major axis

Weight

Hypothesis

Reading Assignments

Bartusiak, *Archives of the Universe*, chapters 7 – 11, 35, 36

Ferris, *Coming of Age in the Milky Way*, chapters 3 – 7

Comins, *Discovering the Essential Universe*, chapter 2

Tools of the Trade

1. Basic Properties of Light and Matter

- What is light?
- How do light and matter interact?
- The electromagnetic spectrum

2. Learning From Light

- What types of light spectra can we observe?
- The Doppler effect: How does light tell us the speed of a distant object?
- The Stefan-Boltzmann law
- Luminosity
- Wein's law
- Kirchhoff's laws of spectroscopy
 - How does light tell us what things are made of?
 - How does light tell us the temperatures of planets and stars?

Key Definitions and Terms

Blueshift

Redshift

Spectrum

Luminosity

Flux

Absorption

Emission

Ion

Plasma

Reading Assignments

Bartusiak, *Archives of the Universe*, Chapters 13 – 20, 23 – 26

Ferris, *Coming of Age in the Milky Way*, Chapters 8 – 10

Comins, *Discovering the Essential Universe*, Chapter 3

The Nature of the Stars and a Star of Our Own

1. Properties of Stars

- How luminous are stars?
- How hot are stars?
- How massive are stars?

2. Classifying Stars

- How do we classify stars?
- Why is a star's mass its most important property?
- What is the Hertzsprung–Russell diagram?

3. What is the Sun's Structure?

- Features, properties, and dimensions of each atmospheric region
- Basic properties and dimensions of each interior region
- How does energy get out of the Sun?
- How do we know what is going on inside of the Sun?
- How is energy created inside the Sun?

Key Definitions and Terms

Convection	Radiative flow	Conduction
Energy transport	Spectral class	Proton-proton cycle
Main sequence	Red giant	Supergiant
Red dwarf	H-R diagram	Plasma
Photosphere	Chromosphere	Transition region
Corona	Convective zone	Radiative zone
Sunspots	Prominence	Solar wind
Mass-Luminosity relation	Standard solar model	

Reading Assignments

Bartusiak, *Archives of the Universe*, Chapters 27 – 31, 43

Ferris, *Coming of Age in the Milky Way*, Chapters 11 – 15

Comins, *Discovering the Essential Universe*, Chapters 7 – 8

The Evolution of Stars

1. Life as a Sun-Like Star

- What are the life stages of a Sun-like star?
- How do high-mass stars make the elements necessary for life?
- How does a Sun-like star die?

2. Life as a High-Mass Star

- What are the life stages of a high-mass star?
- How do high-mass stars construct the periodic table?
- How does a high-mass star die?

3. Summary of Stellar Lives

- How does a star's mass determine its life story?
- How are the lives of stars with close companions different?

4. Star Clusters

- What are the two types of star clusters?
- How do we measure the age of a star cluster?

5. The Stellar Graveyard

- What is a white dwarf?
- What can happen to a white dwarf in a close binary system?
- What is a neutron star?
- How were neutron stars discovered?
- What is a pulsar?

Key Definitions and Terms

Electron degeneracy

Cepheid variable

Helium flash

Apparent magnitude

Neutron degeneracy

Supernova remnant

Black widow pulsar

Galactic (open) cluster

Type Ia supernova

Triple-alpha process

RR Lyrae variable

Chandrasekhar limit

Distance modulus

Neutron star

Shock restart

Globular cluster

Population I

Planetary nebula

Asymptotic giant branch

Absolute magnitude

Supernova

Pulsar

Turn-off point

Period-luminosity relation

Population II

Reading Assignments

Bartusiak, *Archives of the Universe*, Chapters 39 – 41, 46 – 48

Ferris, *Coming of Age in the Milky Way*, Chapters 11 – 15

Comins, *Discovering the Essential Universe*, Chapters 9 – 10