



## Exploring the Universe

### Michigan State High School Science Content Expectations

#### Course Description

Students begin their study of astronomy with a history of a man's view of the universe. Looking at the variety of instruments astronomers use, students will see how modern day techniques have modified these early views. Through studies of constellations, the students will learn to navigate the night sky so that they can find planets and other objects of interest. Tracing the space program from its origins to modern day, students will uncover the mysteries of the solar system as they learn about the moon, and planets.

#### Text Book

**Astronomy Today, 5E, Eric Chaisson, Tufts University**  
**Steve McMillan, Drexel University**

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#### Unit 1 Description

This unit will first introduce students to methods of stellar property measurement such as spectral and stellar parallax and star properties such as luminosity, apparent brightness, temperature, size and age. Second, students will discuss the process of and related aspects regarding the birth of stars.

#### Essential Content and Skills

The learner will master the following:

- An Introduction to Spectral Parallax
  - Luminosity and Apparent Brightness
  - Estimation of Stellar Size
  - H-R Diagram Construction
  - Determination of Distance Using the H-R Diagram
  - Measurement of Stellar Mass
  - Formation of a Sun-like Star
  - Mass Effects on Star Formation
  - Shock Wave Theory
  - Star Cluster Types
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## Course Name - Part

Michigan State Curriculum Content Standards (continued)

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### Unit 1 Michigan State Content Expectations

[Click here to view the Michigan DOE Curriculum Content Standards.](#)

#### Unit 1 Lesson 1: Measuring Nearby Stars

State Standard	Description
E5.1d	Differentiate between the cosmological and Doppler red shift.

#### Unit 1 Lesson 2: Luminosity and Apparent Brightness

State Standard	Description
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance). Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars. Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium). Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.
E5.2f	
E5.2g	
E5.2h	

#### Unit 1 Lesson 3: Stellar Temperature and sizes

State Standard	Description
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance). Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars. Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium). Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.
E5.2f	
E5.2g	
E5.2h	

#### Unit 1 Lesson 4: The H-R Diagram

State Standard	Description
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance). Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars. Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium). Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.
E5.2f	
E5.2g	
E5.2h	

## Course Name - Part

Michigan State Curriculum Content Standards (continued)

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### Unit 1 Lesson 5: Distances Further Into Space

State Standard	Description
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.

### Unit 1 Lesson 6: Mass and Other Stellar Properties

State Standard	Description
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.

### Unit 1 Lesson 7: The Beginnings of Stars

State Standard	Description
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.

### Unit 1 Lesson 8: Stars of Different Masses

State Standard	Description
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.

## Course Name - Part

Michigan State Curriculum Content Standards (continued)

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### Unit 1 Lesson 9: More About Star Formation

State Standard	Description
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance). Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars. Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium). Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.
E5.2f	
E5.2g	
E5.2h	

### Unit 1 Lesson 10: Star Clusters

State Standard	Description
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance). Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars. Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium). Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.
E5.2f	
E5.2g	
E5.2h	

## Course Name - Part

Michigan State Curriculum Content Standards (continued)

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### Unit 2 Description

This unit will begin where Unit 1 left off in the lifetime of stars and explain the theory of stellar evolution through examples of the life and death of stars. Students will examine different types of stellar explosions including novae and supernovae. Finally, students will explore the formation of the elements.

### Essential Content and Skills

The learner will master the following:

- A star's Progression off the Main Sequence
- Evolution of Low and High-Mass Stars
- The Death of Low-Mass and High-Mass Stars
- Understanding Stellar Evolution in Star Clusters
- Binary-Star System Evolution
- Novae and Supernovae Mechanisms
- Stellar Method of Element Formation
- The Cycle of Stellar Evolution

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### Unit 2 Michigan State Content Expectations

#### Unit 2 Lesson 1: Leaving the Main Sequence

State Standard	Description
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance). Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars. Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium). Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.
E5.2f	
E5.2g	
E5.2h	

#### Unit 2 Lesson 2: Evolution of a Sun-Like Star

State Standard	Description
E5.2C	Describe how nuclear fusion produces energy in the Sun. Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements. Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance). Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars. Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium). Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.
E5.2D	
E5.2e	
E5.2f	
E5.2g	
E5.2h	

## Course Name - Part

Michigan State Curriculum Content Standards (continued)

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### Unit 2 Lesson 3: The Death of a Sun-Like Star

State Standard	Description
E5.2C	Describe how nuclear fusion produces energy in the Sun.
E5.2D	Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.

### Unit 2 Lesson 4: Evolution of Bigger Stars

State Standard	Description
E5.2C	Describe how nuclear fusion produces energy in the Sun.
E5.2D	Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.

### Unit 2 Lesson 5: Star Clusters Over Time

State Standard	Description
E5.2C	Describe how nuclear fusion produces energy in the Sun.
E5.2D	Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.

## Course Name - Part

Michigan State Curriculum Content Standards (continued)

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### Unit 2 Lesson 6: Evolution of Two Star Systems

State Standard	Description
E5.2C	Describe how nuclear fusion produces energy in the Sun.
E5.2D	Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.

### Unit 2 Lesson 7: Stellar Explosions

State Standard	Description
E5.2C	Describe how nuclear fusion produces energy in the Sun.
E5.2D	Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.

### Unit 2 Lesson 8: More About Supernovae

State Standard	Description
E5.2C	Describe how nuclear fusion produces energy in the Sun.
E5.2D	Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.

## Course Name - Part

Michigan State Curriculum Content Standards (continued)

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### Unit 2 Lesson 9: The Formation of the Elements

State Standard	Description
E5.2C	Describe how nuclear fusion produces energy in the Sun.
E5.2D	Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.

### Unit 2 Lesson 10: The Circle of Star Life

State Standard	Description
E5.2C	Describe how nuclear fusion produces energy in the Sun.
E5.2D	Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.

## Course Name - Part

Michigan State Curriculum Content Standards (continued)

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### Unit 3 Description

This unit will introduce the Milky Way Galaxy, including its measurement, galactic structure, formation, galactic spiral arms, its mass, and its center. Also, other galaxies will be touched upon with an introduction including Hubble's galaxy classification and the distribution of galaxies in space.

### Essential Content and Skills

The learner will master the following:

- The Milky Way
- Measuring Our Galaxy
- Galactic Structure
- The Formation of the Milky Way
- Galactic Spiral Arms
- The Mass of the Milky Way Galaxy
- Examining the Galactic Center
- Hubble's Galaxy Classification
- Galaxy Distribution in Space

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### Unit 3 Michigan State Content Expectations

#### Unit 3 Lesson 1: Explore the Milky Way!

State Standard	Description
E5.p1C E5.1A	Explain how a light year can be used as a distance unit. (prerequisite) Describe the position and motion of our solar system in our galaxy and the overall scale, structure, and age of the universe.

#### Unit 3 Lesson 2: Measuring Our Galaxy

State Standard	Description
E5.p1C E5.1A	Explain how a light year can be used as a distance unit. (prerequisite) Describe the position and motion of our solar system in our galaxy and the overall scale, structure, and age of the universe.

#### Unit 3 Lesson 3: Size and Shape of the Milky Way

State Standard	Description
E5.p1C E5.1A	Explain how a light year can be used as a distance unit. (prerequisite) Describe the position and motion of our solar system in our galaxy and the overall scale, structure, and age of the universe.

#### Unit 3 Lesson 4: Galactic Structure

State Standard	Description
E5.p1C E5.1A	Explain how a light year can be used as a distance unit. (prerequisite) Describe the position and motion of our solar system in our galaxy and the overall scale, structure, and age of the universe.

## Course Name - Part

Michigan State Curriculum Content Standards (continued)

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### Unit 3 Lesson 5: The Formation of the Milky Way

State Standard	Description
E5.3A	Explain how the solar system formed from a nebula of dust and gas in a spiral arm of the Milky Way Galaxy about 4.6 Ga (billion years ago).

### Unit 3 Lesson 6: Galactic Spiral Arms

State Standard	Description
E5.3A	Explain how the solar system formed from a nebula of dust and gas in a spiral arm of the Milky Way Galaxy about 4.6 Ga (billion years ago).

### Unit 3 Lesson 7: How Heavy is Our Galaxy?

State Standard	Description
E5.1A	Describe the position and motion of our solar system in our galaxy and the overall scale, structure, and age of the universe.
E5.1c	Explain how observations of the cosmic microwave background have helped determine the age of the universe.

### Unit 3 Lesson 8: To the Center of the Galaxy!

State Standard	Description
E5.1A	Describe the position and motion of our solar system in our galaxy and the overall scale, structure, and age of the universe.
E5.1c	Explain how observations of the cosmic microwave background have helped determine the age of the universe.

### Unit 3 Lesson 9: Other Galaxies

State Standard	Description
E5.1d	Differentiate between the cosmological and Doppler red shift.

### Unit 3 Lesson 10: How are Galaxies Spread Out?

State Standard	Description
E5.1d	Differentiate between the cosmological and Doppler red shift.

## Course Name - Part

Michigan State Curriculum Content Standards (continued)

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### Unit 4 Description

This unit will introduce students to normal and active galaxies, which are described as the building blocks of the universe. Hubble's law and galactic nuclei will first be examined. Students will then study dark matter and galaxies, and shift focus toward the large-scale structure of the cosmos. Collisions, formation and evolution of galaxies will be examined, as well as black holes in the centers of galaxies.

### Essential Content and Skills

The learner will master the following:

- Hubble's Law
- Active Galactic Nuclei
- Dark Matter
- Galaxy Collisions
- Galaxy Formation and Evolution
- Black Holes in Galactic Nuclei
- The Universe on Large Scales

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### Unit 4 Michigan State Content Expectations

#### Unit 4 Lesson 1: Hubble's Law

State Standard	Description
E5.1c E5.1d	Explain how observations of the cosmic microwave background have helped determine the age of the universe. Differentiate between the cosmological and Doppler red shift.

#### Unit 4 Lesson 2: Active Centers of Galaxies

State Standard	Description
E5.1c E5.1d	Explain how observations of the cosmic microwave background have helped determine the age of the universe. Differentiate between the cosmological and Doppler red shift.

#### Unit 4 Lesson 3: More on Active Galaxies

State Standard	Description
E5.1c E5.1d	Explain how observations of the cosmic microwave background have helped determine the age of the universe. Differentiate between the cosmological and Doppler red shift.

#### Unit 4 Lesson 4: The Central Engine of an Active Galaxy

State Standard	Description
E5.1c E5.1d	Explain how observations of the cosmic microwave background have helped determine the age of the universe. Differentiate between the cosmological and Doppler red shift.

## Course Name - Part

Michigan State Curriculum Content Standards (continued)

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### Unit 4 Lesson 5: Dark Matter in the Universe

State Standard	Description
E5.1c E5.1d	Explain how observations of the cosmic microwave background have helped determine the age of the universe. Differentiate between the cosmological and Doppler red shift.

### Unit 4 Lesson 6: Galaxy Collisions

State Standard	Description
E5.1c E5.1d	Explain how observations of the cosmic microwave background have helped determine the age of the universe. Differentiate between the cosmological and Doppler red shift.

### Unit 4 Lesson 7: Galaxy Formation and Evolution

State Standard	Description
E5.1c E5.1d	Explain how observations of the cosmic microwave background have helped determine the age of the universe. Differentiate between the cosmological and Doppler red shift.

### Unit 4 Lesson 8: Active Galaxies and Black Holes

State Standard	Description
E5.1c E5.1d	Explain how observations of the cosmic microwave background have helped determine the age of the universe. Differentiate between the cosmological and Doppler red shift.

### Unit 4 Lesson 9: The Whole Universe

State Standard	Description
E5.1c E5.1d	Explain how observations of the cosmic microwave background have helped determine the age of the universe. Differentiate between the cosmological and Doppler red shift.

### Unit 4 Lesson 10: Mapping Dark Matter

State Standard	Description
E5.1c E5.1d	Explain how observations of the cosmic microwave background have helped determine the age of the universe. Differentiate between the cosmological and Doppler red shift.