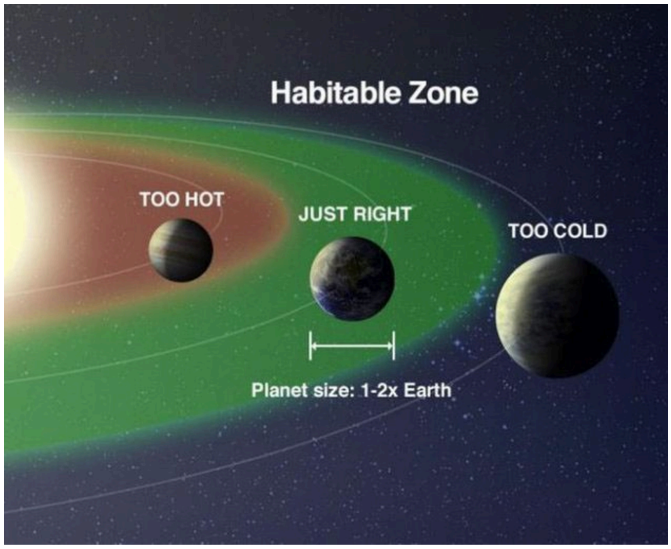
Kepler's Laws Project | *Finding a Habitable Planet*

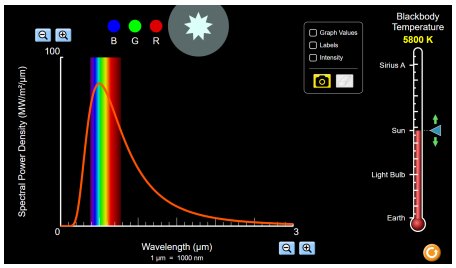
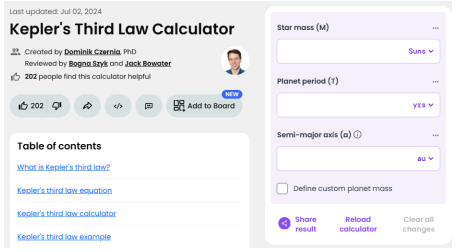
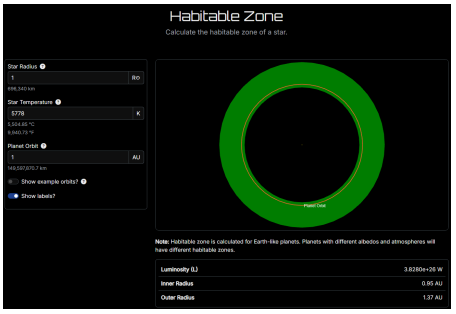
Background

The *Circumstellar Habitable Zone* (CHZ) is the region around a star where water could exist on the surface of an Earth-like planet. Water is understood to be vital in the formation of life due to its many important functions in biochemistry. Although the region is a spherical shell that surrounds a star, it is often shown as a ring in diagrams looking down onto the plane of a star system. Realize that the CHZ is closely related to the inverse-square law – how energy quickly falls off with distance from a star. Thus, the size and location of the CHZ change over time as a star evolves. For our Sun at present, the CHZ ranges from 0.97 AU to 1.37 AU but this range varies from star to star.



What Is the Habitable Zone?

Tools

Blackbody Spectrum PhET	Kepler's 3rd Law Calculator	Habitable Zone Calculator
		
Use this site to analyze stellar spectra for peak emission/temperature data for stars	*Use this site to calculate an unknown stellar mass, orbital period, or semi-major axis using Kepler's 3rd Law*	*Use this site to calculate the inner and outer radii of the habitable zone of a star. Be sure to hit "return" after each new value*

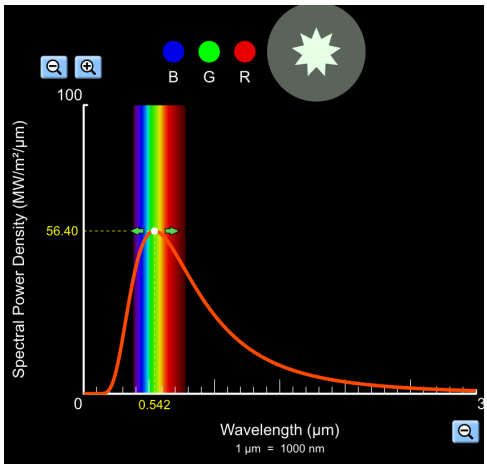
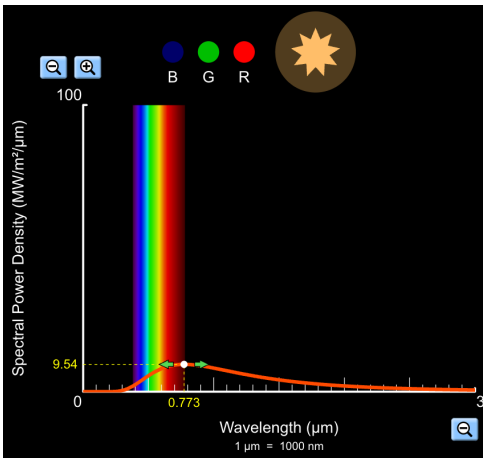
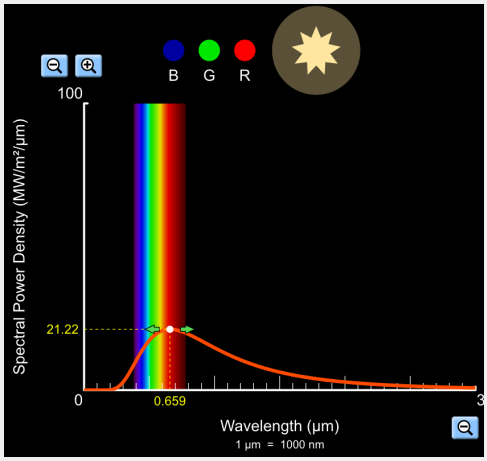
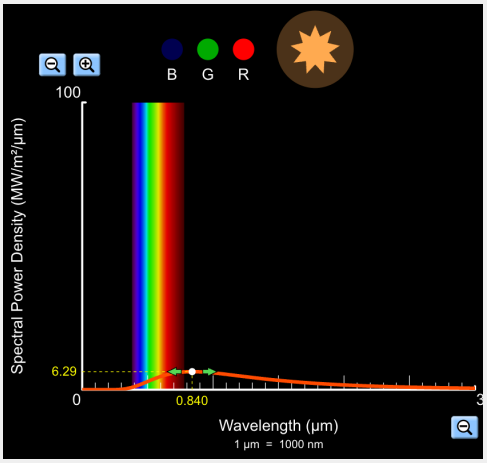
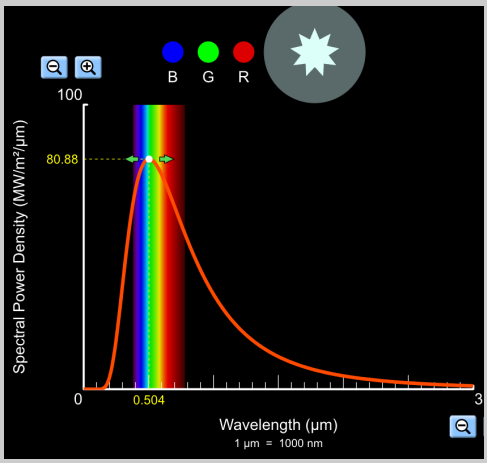
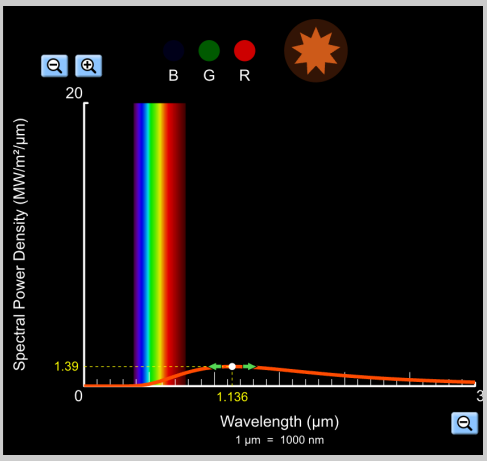
The List of Possibilities

You have been given data about 6 stars that have had exoplanets discovered in their system. Of these 10 exoplanets, you need to determine which ones have orbits in the Goldilocks zone and could potentially support life

Stars	Kepler-18	Kepler-186	Kepler-442	TOI-2257	HD-20782	Trappist-1
Planets	• Kepler-18 b • Kepler-18 d	• Kepler-186 b • Kepler-186 d • Kepler-186 f	• Kepler-442 b	• TOI-2257 b	• HD-20782 b	• Trappist-1 b • Trappist-1 h

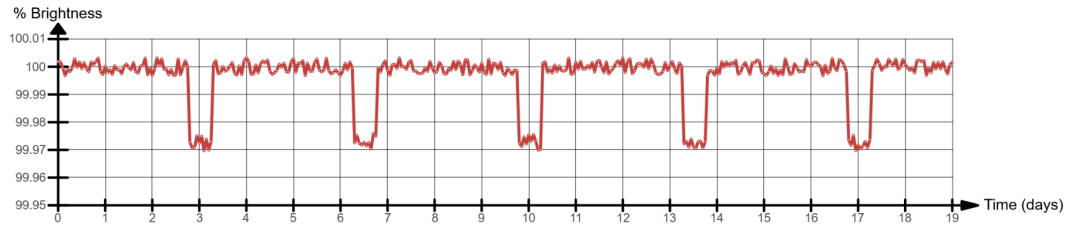
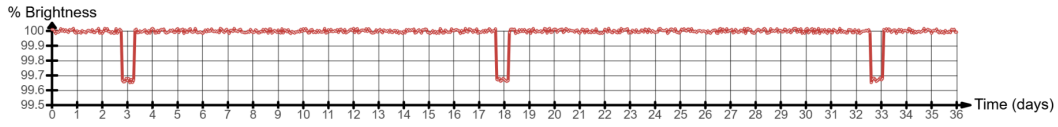
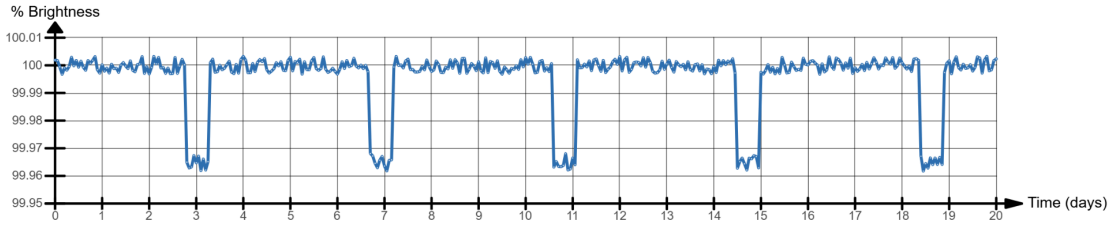
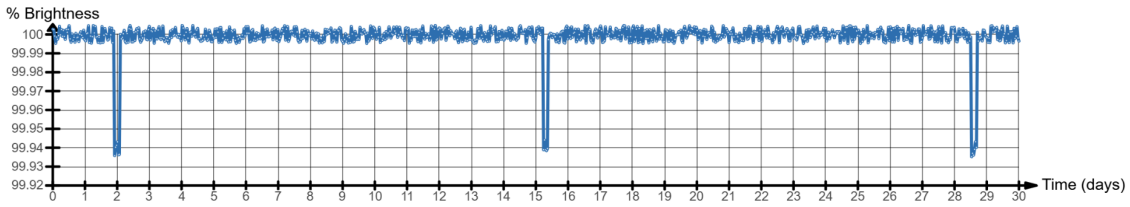
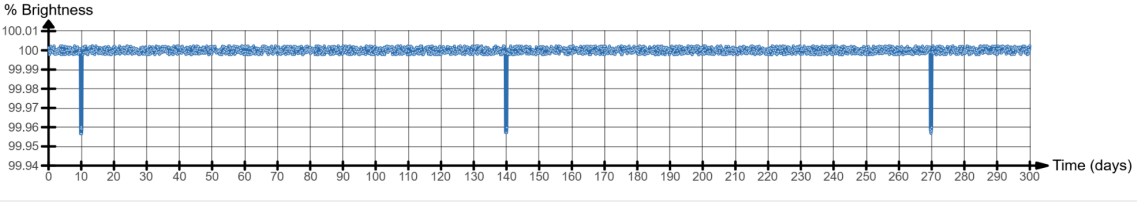
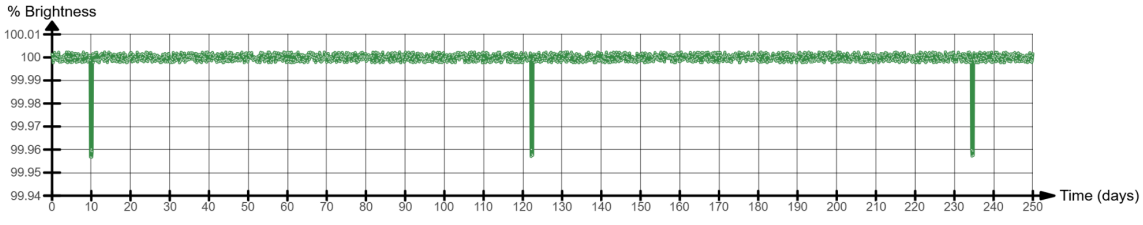
Star Spectra

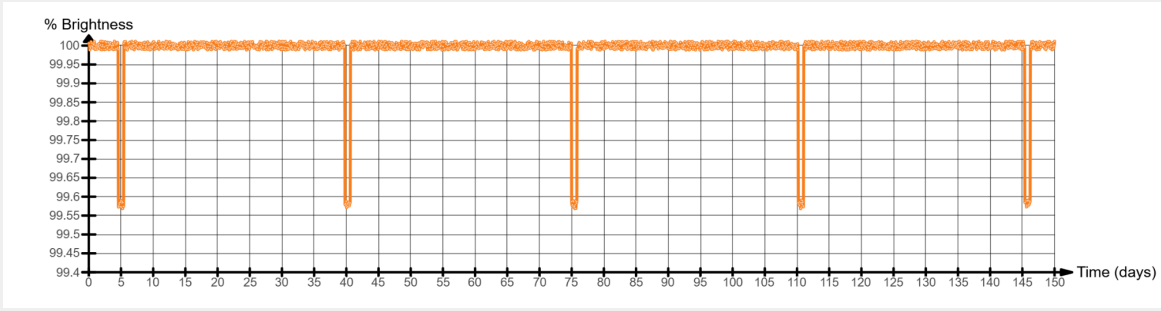
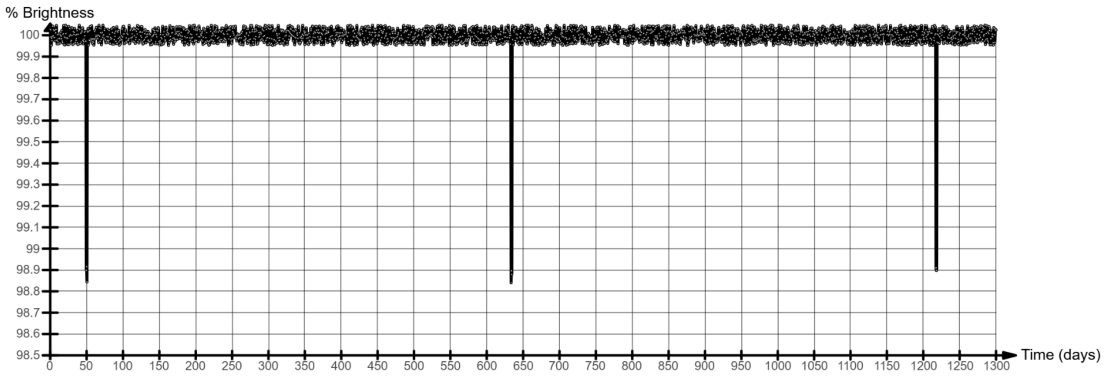
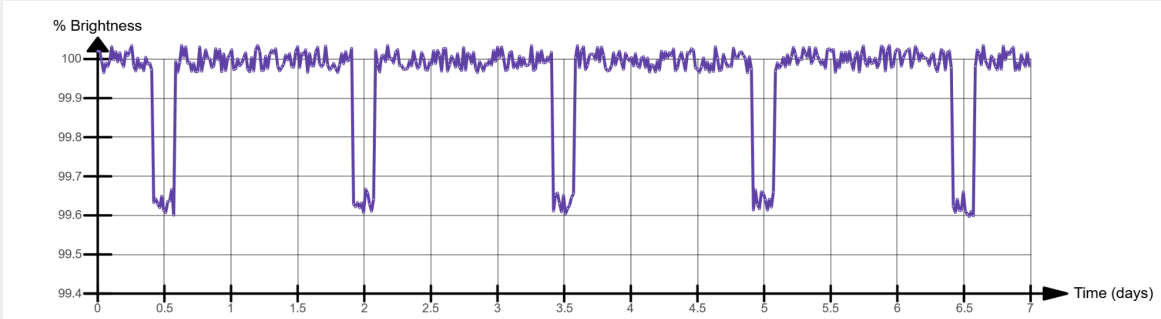
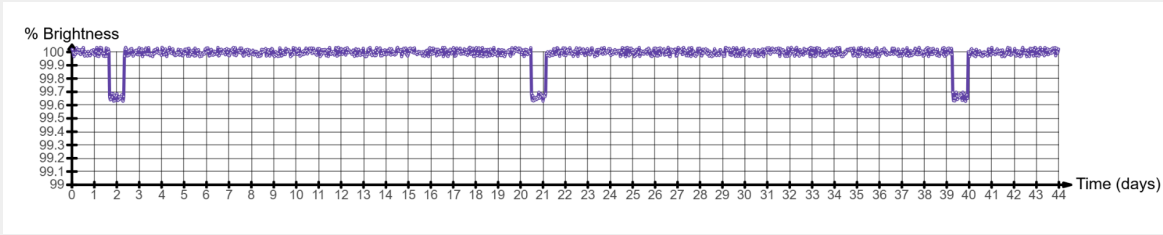
You measure the unique spectra of each star to use to determine the star temperatures

Kepler-18	Kepler-186
	
Kepler-442	**TOI-2257**
	
HD-20782	**Trappist-1**
	

Planet Light Curves

Each time a planet passes between its star and the earth, the star's brightness drops slightly, this transit data can be used to determine the orbital period and distance of each planet

Kepler-18 b	
Kepler-18 d	
Kepler-186 b	
Kepler-186 d	
Kepler-186 f	
Kepler-442 b	

TOI-2257 b	
HD-20782 b	
Trappist-1 b	
Trappist-1 h	

Data Dashboard | *Determine all unknown values*

In the tables below, use the tools on the first page for information about the stars and their planets to complete these lists of properties and determine which exoplanets could support life.

Stars

Star Name	Mass *(suns)*	Radius *(suns)*	Temperature *(K)*	Habitable Zone	
				Inner Radius *(AU)*	Outer Radius *(AU)*
Kepler-18	0.972	1.108			
Kepler-186	0.544	0.523			
Kepler-442	0.610	0.60			
TOI-2257	0.33	0.31			
HD-20782	0.96	1.17			
Trappist-1	0.090	0.119			

Planets

Star	Planet	Eccentricity	Period *(days)*	Semi Major Axis *(AU)*	Habitable? *(Yes or No)*
Kepler-18	*Kepler-18 b*	0.0			
	Kepler-18 d	0.0			
Kepler-186	*Kepler-186 b*	0.0			
	Kepler-186 d	0.0			
	Kepler-186 f	0.04			
Kepler-442	*Kepler-442 b*	0.04			
TOI-2257	*TOI-2257 b*	0.5			
HD-20782	*HD-20782 b*	0.95			
Trappist-1	*Trappist-1 b*	0.01			
	Trappist-1 h	0.01			

Post-Lab Analysis Questions

1. Of the ten planets assessed, which fall within the habitable zone?

2. Of the planets that fall within the habitable zone, what is the eccentricity of each of their orbits?

3. Click on the links for the stars of the potentially habitable exoplanets from the list below

Stars	Kepler-18	Kepler-186	Kepler-442	TOI-2257	HD-20782	Trappist-1

   As you drag the image around, notice the orbit of the planet relative to the green band marking the habitable zone (the planet's current location is marked with the planet's name). **What impact does the eccentricity of a planet's orbit have on its habitability?**

4. Based on everything that you've learned in this lab, if you were to choose one habitable planet from the 10 candidates provided, which one would it be and why?