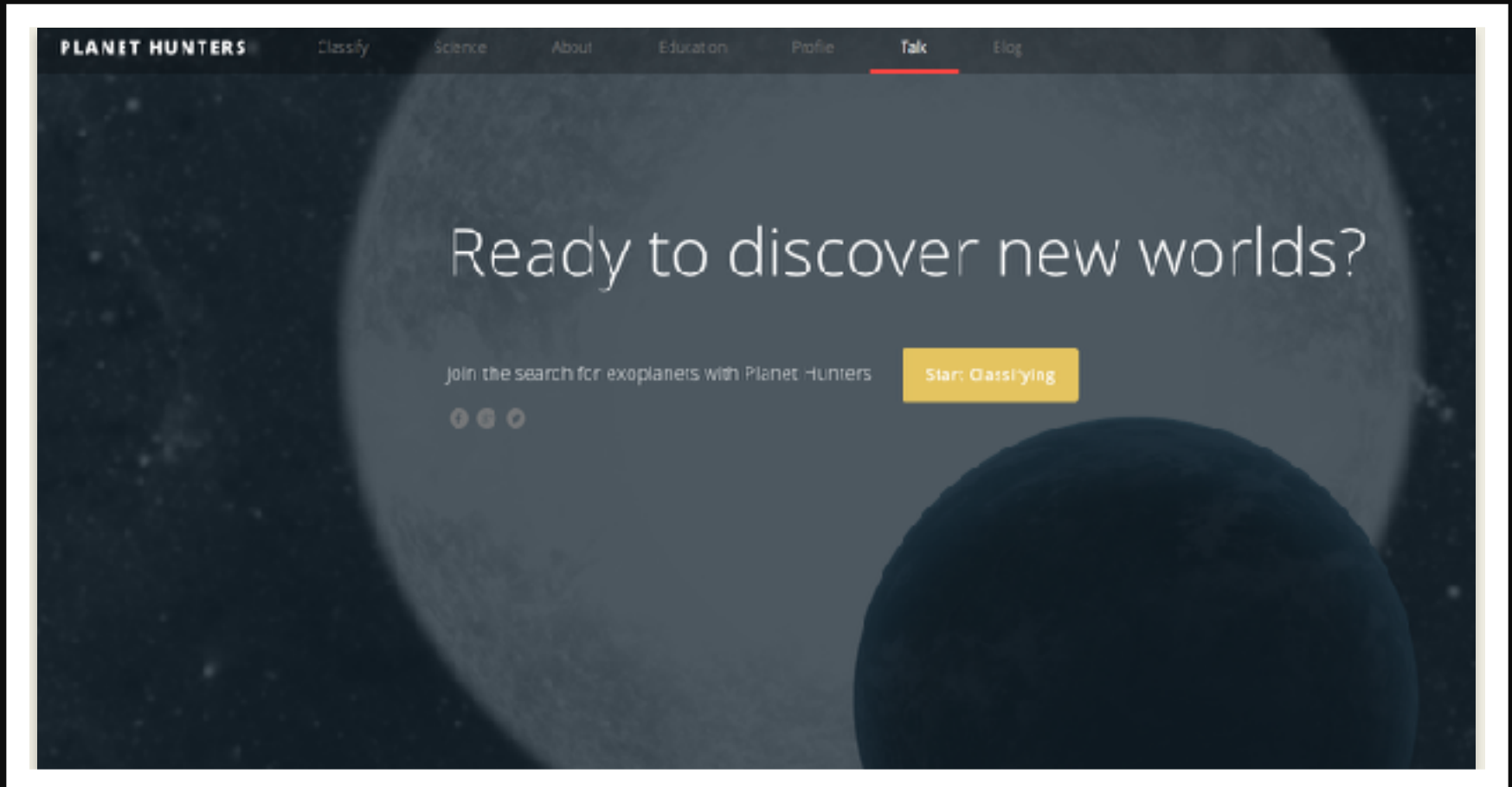


GUIDE FOR NAVIGATING PLANET HUNTERS

**CALCULATING EXOPLANET
CHARACTERISTICS**

PLANET HUNTERS



- Go to: www.planethunters.org
- Log in with the provided information

Talk Planet Hunters

Following Recent Discussion boards Search Profile

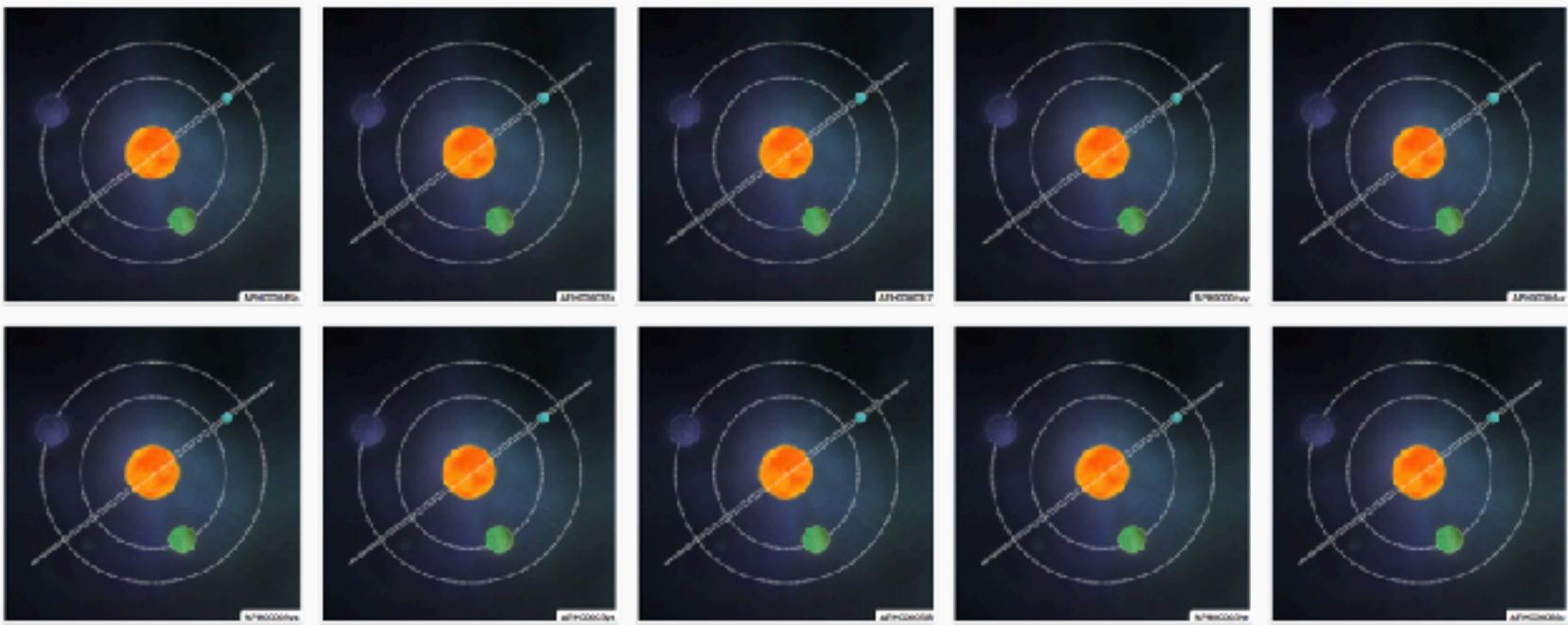
DK Talk

Parents classmate

Collection Planet Hunters Educators Guide - Collection ID: CPHS0000d9 - by jafordt (edit)

Follow

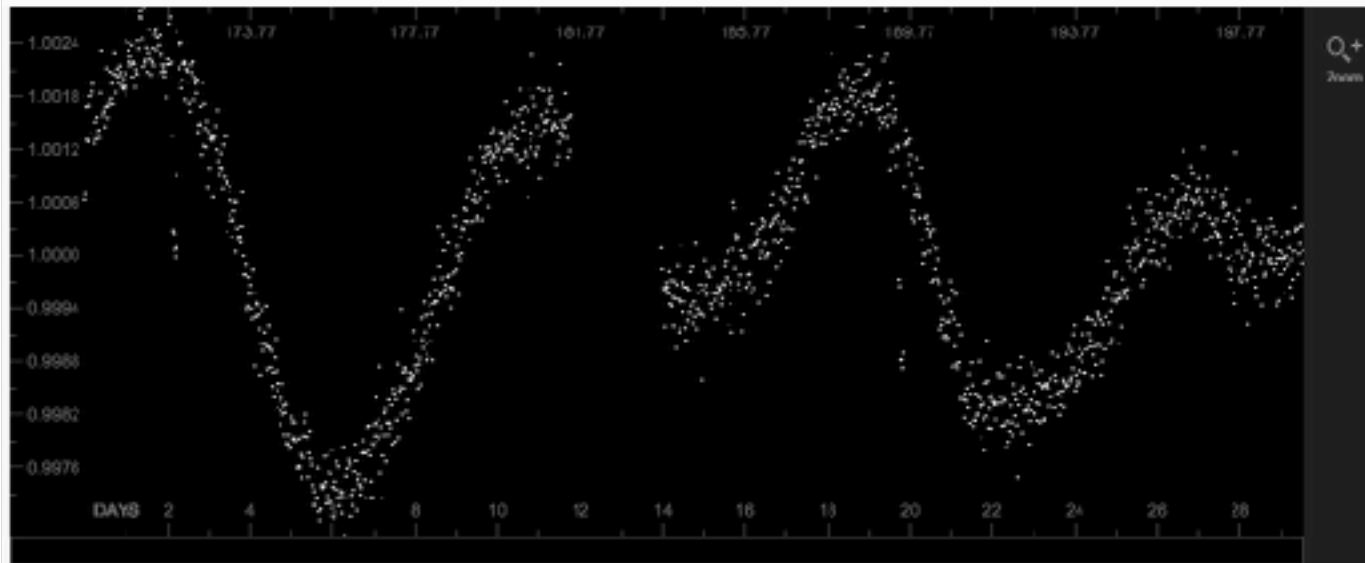
Subjects in this collection



The image displays a grid of 10 identical diagrams, arranged in two rows of five. Each diagram shows a central orange star with three concentric white orbits. A dashed white line represents the ecliptic plane. Three planets are shown: a blue planet on the outermost orbit, a green planet on the middle orbit, and a cyan planet on the innermost orbit. The planets are positioned at different points along their respective orbits, illustrating the search for transits.

- Go to the Planet Hunter Educators Guide collection:
<http://talk.planethunters.org/#/collections/CPHS0000d9>
- Here you will find stars with known exoplanets around them.
- Select a star to focus on, try to select a different star from your other classmates.

Image APH00003yy



Quarters

1-1 1-2 1-3 **2-1** 2-2 2-3 3-1 3-2 3-3 4-1 4-2 4-3 6-1 6-2 6-3 7-1 7-2 7-3 8-1 8-2 8-3 10-1 10-2 10-3 11-1 11-2 11-3 12-1 12-2 12-3 14-1 14-2 14-3 15-1 15-2 15-3 16-1 16-2 16-3

Metadata

Type: Dwarf

Mag: 14.807

Radius: 0.470

Kepler ID: 6185476

Known planet details

Planet radius: 2.94 Earth radii

Planet period: 17.660113 Days

[Known planet system](#)

External Resources

[View on old task](#)

[View KORT image](#)

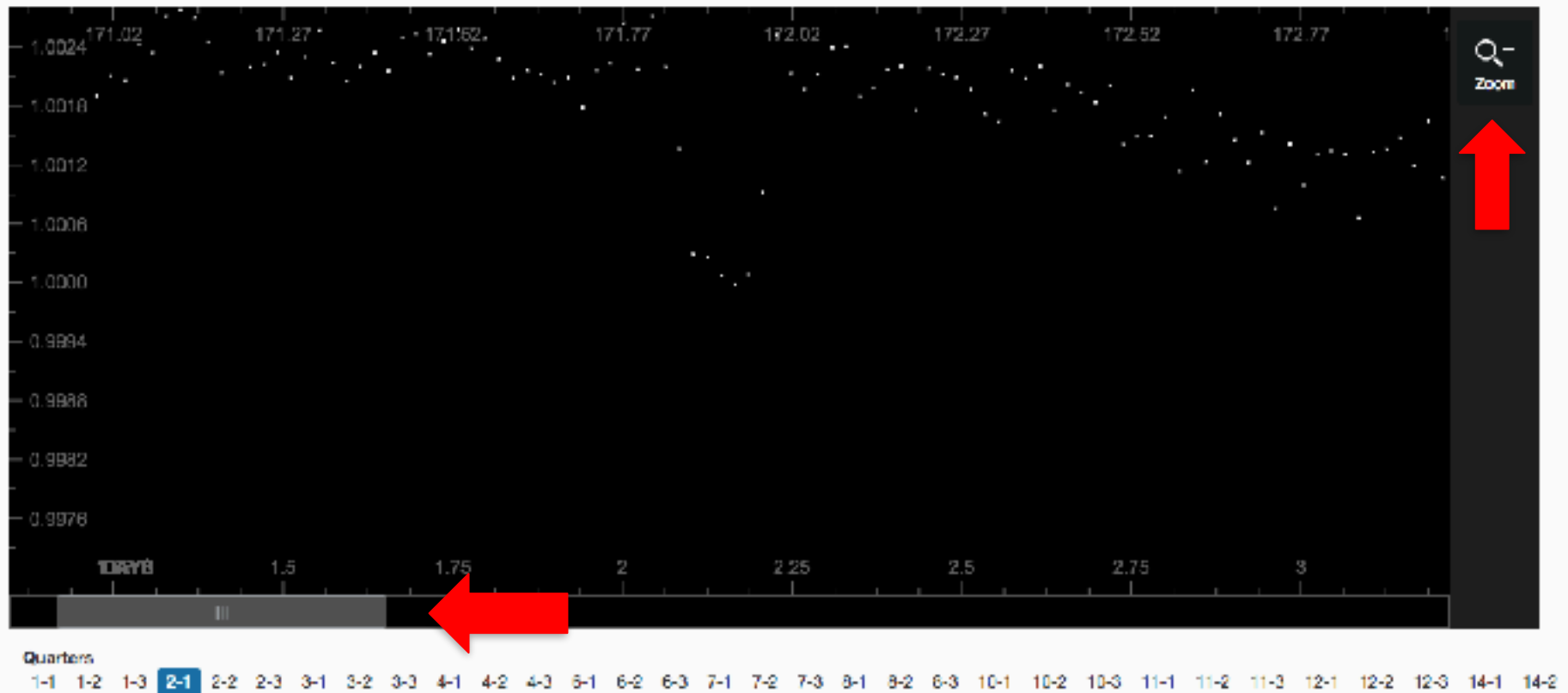
[Kepler TPO](#)

[View on MAST](#)

[Stellar Properties](#)

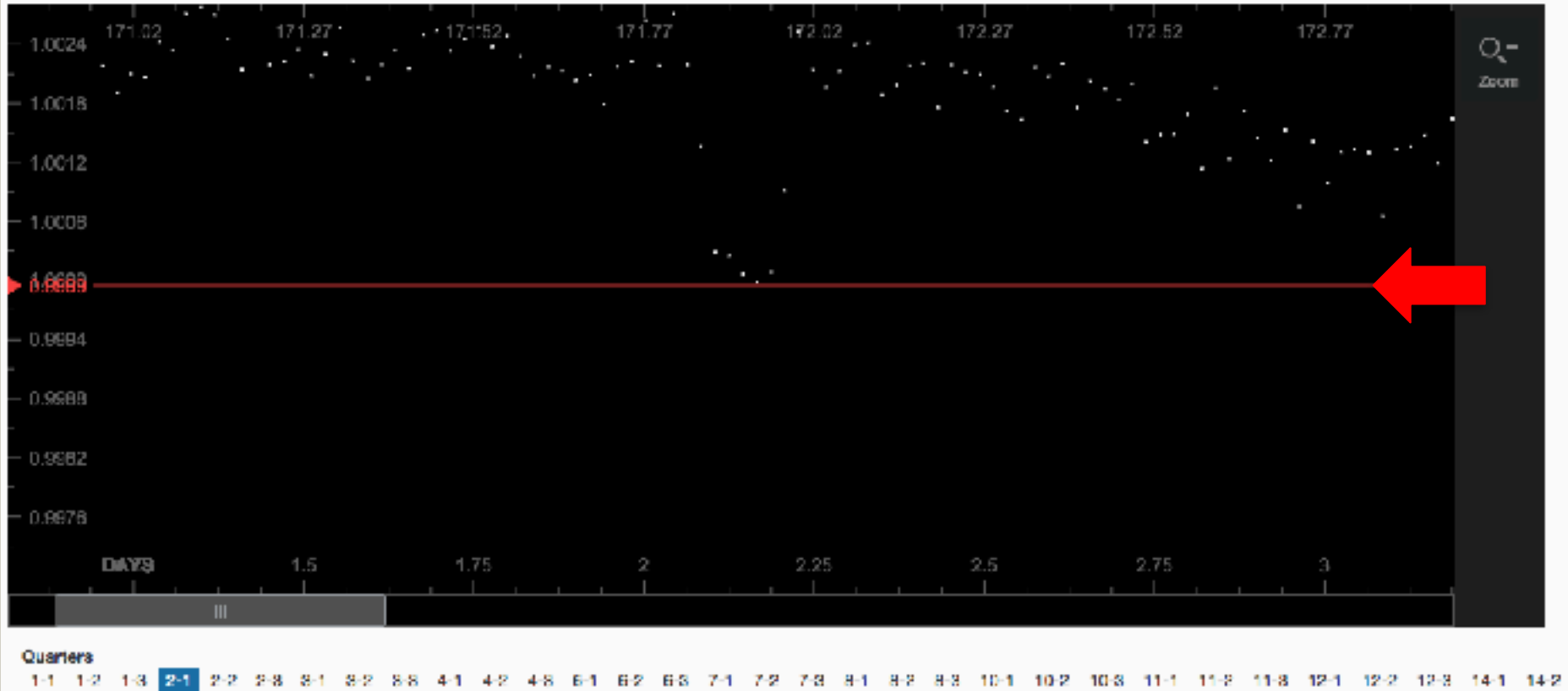
- Once you select a star, you should be able to see the light curves for this star.
- Note: Each star can have multiple light curves taken at different times.
- Select a Quarter to see other time periods.
- Try to identify where the transits are in the curve (there are 2 in the image above)

Image APH00003yy



- Zoom in on the transit to see the transit more closely.
- Use the scroll bar on the x-axis to move to different moments in the transit.

Image APH00003yy



- Run your cursor over the y-axis for a red line to appear.
- Use this to determine the amount of change in brightness.

Equations

Orbital period

$$\begin{aligned}p_1 &= d_2 - d_1 \\p_2 &= d_3 - d_2 \\p &= \frac{(p_1 + p_2)}{2}\end{aligned}$$

Note: you may see more or fewer than 3 transits. You want to calculate the average of all the periods you find. If you only see one transit, then you cannot find the orbital period.

Radius

$$\text{Drop in Brightness} = \frac{r^2}{R^2}$$

- r = radius of the planet (km)
- R = radius of the star (km)
- Earth radius ($r_{\text{Earth}} = 6378.1 \text{ km}$)

Mass

This can be estimated based on the size of the planet and its distance from its star.

- If $r < 6 r_{\text{Earth}}$, then:

$$m = 0.9515r^{3.1}$$

- If $6 r_{\text{Earth}} \leq r < 10 r_{\text{Earth}}$, then:

$$m = 1.7013r^{2.0383}$$

- If $r \geq 10 r_{\text{Earth}}$, then:

$$m = 0.6631r^{2.4191}$$

- r = radius of planet (km)
- Earth mass ($m_{\text{Earth}} = 5.976 \times 10^{24} \text{ kg}$)

For the planet types discussed in class, the masses would be approximately:

- **Hot Jupiter:** $1.90 \times 10^{27} \text{ kg} = 317.8 m_{\text{Earth}}$
- **Hot Neptune:** $1.03 \times 10^{26} \text{ kg} = 17.23 m_{\text{Earth}}$
- **Super-Earth:** $1.90 \times 10^{27} \text{ kg} = 317.8 m_{\text{Earth}}$
- **Exo Earth:** $5.976 \times 10^{24} \text{ kg} = 1 m_{\text{Earth}}$

Semi-major axis (the distance of the planet from the star)

Listen to your instructor as to which way they would like you to calculate this.

- *Kepler's Third Law graphs from Lesson 7: Creating and Interpreting Light Curves*
 - Using the orbital period, find the corresponding semi-major axis value on the line.
- Kepler's Third Law:

$$P^2 = \frac{4\pi^2}{G(m + M)} a^3$$

- P = orbital period
 - G = gravitational constant ($6.67384 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$)
 - m = mass of the planet
 - M = mass of the star
 - a = semi-major axis
 - For this equation, the units need to match up with those of the gravitational constant and would need to estimate the mass of the planet and star first.
- Approximation of Kepler's Third Law:

$$P^2 = a^3$$

- P = orbital period (yrs)
- a = semi-major axis (AU)
- 1 AU is equal to the distance between Earth and the Sun (149597871 km).

Density

$$V = \frac{4}{3}\pi r^3$$
$$d = \frac{m}{V}$$

The units should be in kilograms per meter cubed, ($\frac{kg}{m^3}$).

Surface temperature

$$T_P = \left(\frac{L(1-A)}{16\pi\sigma a^2} \right)^{\frac{1}{4}} = \left(\frac{R^2 T_S^4 (1-A)}{4a^2} \right)^{\frac{1}{4}}$$

- T_P = surface temperature of the planet
- L = luminosity of the star ($L = 4\pi R^2 \sigma T^4$)
- a = semi-major axis
- T_S = temperature of the star
- σ = Stefan-Boltzmann constant ($5.670 \times 10^{-8} W m^{-2} K^{-4}$)
- A = albedo of the planet

For the types of planets discussed in class the albedo would be:

- **Hot Jupiter:** $A = 0.52$
- **Hot Neptune:** $A = 0.35$
- **Super-Earth:** $A = 0.39$
- **Exo Earth:** $A = 0.39$

Planetary Information Sheet

IMPORTANT SOLAR SYSTEM PLANETARY INFORMATION

	Mass (x10 ²⁴ kg)	Radius (km)	Density (kg/m ³)	Period (days)	Distance from Sun (x10 ⁶ km)	Mean Temp. (°C)
Mercury	.330	2440	5427	88	57.9	167
Venus	4.87	6052	5243	244.7	108.7	464
Earth	5.97	6378	5515	365.2	49.6	15
Mars	0.642	3396	3933	687.0	227.9	-65
Jupiter	1899	71492	1326	4331	778.6	-110
Saturn	568	60268	687	10747	1433.5	-140
Uranus	86.8	25559	1270	30589	2872.5	-195
Neptune	102	24764	1638	59800	4495.1	-200

TYPES OF EXOPLANETS

Hot Jupiter - A gaseous planet that has a mass similar to Jupiter, but is much closer to its star, creating very hot surface temperatures.

Hot Neptune - A gaseous planet that has a mass and characteristics similar to Neptune, but is much closer to its star, creating high surface temperatures.

Super-Earth - A gaseous planet that has a mass greater than Earth's but less than Neptune.

Exo Earth - A rocky planet with characteristics similar to Earth.

Exoplanet Data Sheet

NAME _____

DATE _____

Part 1

Transit 1

Star I.D.	_____	_____	_____	_____
Total Brightness				
Transit Brightness				
Transit Day				

Transit 2

Star I.D.	_____	_____	_____	_____
Total Brightness				
Transit Brightness				
Transit Day				

Transit 3

Star I.D.	_____	_____	_____	_____
Total Brightness				
Transit Brightness				
Transit Day				

Part 2

Star I.D.	_____	_____	_____	_____
Orbital Period				
Radius				
Mass				
Semi-Major Axis				
Density				
Surface Temperature				