



Because many exoplanets orbit their stars in elliptical paths, they experience large swings in temperature. Generally, organisms can not survive if water is frozen (0 C = 273 K) or near its boiling point (100 C or 373 K). Due to orbital conditions, this very narrow 'zone of life' may not be possible for many of the worlds detected so far.

Problem 1 - Complete the table below by calculating

- A) The semi-minor axis distance $B = A(1-e^2)$
- B) The perihelion distance $D_p = A(1-e)$
- C) The aphelion distance, $D_a = B(1+e)$

Problem 2 - Write the equation for the orbit of 61 Vir-d in Standard Form.

Problem 3 - The temperature of a planet similar to Jupiter can be approximated by the formula below, where T is the temperature in Kelvin degrees, and R is the distance to its star in AU. Complete the table entries for the estimated temperature of each planet at the farthest 'aphelion' distance T_a , and the closest 'perihelion,' distance T_p .

$$T(R) = \frac{250}{\sqrt{R}}$$

Problem 4 - Which planets would offer the most hospitable, or the most hazardous, conditions for life to exist, and what would be the conditions be like during a complete 'year' for each world?

Planet	A (AU)	B (AU)	e	Period (days)	D _p (AU)	D _a (AU)	T _a (K)	T _p (K)
47 UMa-c	3.39		0.22	2190				
61 Vir-d	0.47		0.35	123				
HD106252-b	2.61		0.54	1500				
HD100777-b	1.03		0.36	383				
HAT-P13c	1.2		0.70	428				

Problem 1 See table below:

Planet	A (AU)	B (AU)	e	Period (days)	Dp (AU)	Da (AU)	Ta (K)	Tp (K)
47 UMa-c	3.39	3.3	0.22	2190	2.6	4.1		
61 Vir-d	0.47	0.4	0.35	123	0.3	0.6		
HD106252-b	2.61	2.2	0.54	1500	1.2	4.0		
HD100777-b	1.03	1.0	0.36	383	0.7	1.4		
HAT-P13c	1.2	0.9	0.70	428	0.4	2.0		

Problem 2 Write the equation for the orbit of 61 Vir-d in Standard Form.

Answer: A = 0.47 and B = 0.4

$$\text{So } 1 = \frac{x^2}{0.47} + \frac{y^2}{0.40} \quad \text{and also } 188 = 40x^2 + 47y^2$$

Problem 3 - See table below:

Planet	A (AU)	B (AU)	e	Period (days)	Dp (AU)	Da (AU)	Ta (K)	Tp (K)
47 UMa-c	3.39	3.3	0.22	2190	2.6	4.1	154	123
61 Vir-d	0.47	0.4	0.35	123	0.3	0.6	452	314
HD106252-b	2.61	2.2	0.54	1500	1.2	4.0	228	125
HD100777-b	1.03	1.0	0.36	383	0.7	1.4	308	211
HAT-P13c	1.2	0.9	0.70	428	0.4	2.0	417	175

Problem 4 - Which planets would offer the most hospitable, or most hazardous, conditions for life to exist, and what would be the conditions be like during a complete 'year' for each world?

Answer: For the habitable 'water' range between 273K and 373K, none of these planets satisfy this minimum and maximum condition. They are either too hot at perihelion 'summer' or too cold at 'winter' aphelion.

Only HD100777-b during perihelion is in this temperature range during 'summer', at a temperature of 308 K (35 C). During 'winter' at aphelion, it is at -62 C which is below the freezing point of water, and similar to the most extreme temps in Antarctica.

Note: These temperature calculations are only approximate and may be considerably different with greenhouse heating by the planetary atmosphere included.