Lesson 2 – Is Your Planet in a Habitable Zone?

Group name: ________________________________

Are you likely to discover life on the surface of your planet? Could any life survive there? This lesson will explore that question. Recall that a “habitable zone” is an area around a star where a planet or moon would have an average surface temperature between 0ºC and 100ºC. In this lesson we will find out the average surface temperature of your planet and decide whether or not your planet is in a habitable zone.

1) Open the Planet Temperature Calculator:

www.astro.indiana.edu/~gsimonel/temperature1.html

2) Click “continue” in the bottom right corner and then click the “review” button on the next screen. That will take you to the “review” screen. For now, enter 29 for BOND ALBEDO and 1 for GREENHOUSE EFFECT. (These are Earth’s values. You’ll probably be changing them later.)

3) Get out your Planet Preference Survey and look at Question 3. How far away from your star did you place your planet? Enter this number for DISTANCE in the Planet Temperature Calculator.

4) Look at Question 1 of the Planet Preference Survey. What type of star are you orbiting? The type of star you chose will determine the range of numbers that you may enter for MASS in the Planet Temperature Calculator.
   - If you chose “Low mass” choose a number between 0.1 & 0.4
   - If you chose “Solar type” choose a number between 0.4 & 1.5
   - If you chose “High mass” choose a number between1.5 & 100

Enter a number in your allowable range then click “calculate.”

5) First check the life cycle of the star you are orbiting. The life cycle is how long your star will last before it uses up all its nuclear fuel and blows itself up. This number must be greater than the age of your star (Question 2 of the Planet Preference Survey). Your star can not have a life cycle shorter than its age. If it does then you star has already burnt up all its fuel. No life will survive on your planet and your mission will be unsuccessful. You need to check this every time you change the mass of your nearest star.
Try changing the MASS of the star to see how this affects its life cycle. As the MASS of a star increases, what happens to its life cycle? ____________

6) Now check the average surface temperature of your planet. If the temperature is between 0ºC and 100ºC, congratulations! Your planet is in a habitable zone. If not, you can go back to the “review” screen and try changing the MASS of your nearest star to see if you can get your planet within a habitable zone, but you must keep the MASS of the star within the ranges listed in step #4.

7) Experiment with different numbers for MASS, within your allowable range, until you find one that you like. Remember to check the star’s life cycle to make sure it is greater than the age of the planet.

Don’t get discouraged if you can’t get your planet within a habitable zone yet. Later we will look at other things you can change that might help you.

When you have decided on a suitable number for the MASS of the star you are orbiting, write it here: ____________. You will use this number for MASS for the rest of this project.

8) Now determine the habitable zone for your nearest star. Enter the number that you just decided on for MASS, enter 29 for BOND ALBEDO and 1 for GREENHOUSE EFFECT. You will keep these three values the same as you change the DISTANCE. Enter a number larger than the number you chose for DISTANCE and click “calculate.” Does the temperature go up or down? _______________________

Now enter a new number less than your DISTANCE. What happens to the temperature? ________________________________. In your own words, explain how the average surface temperature of a planet changes as the DISTANCE to its nearest star changes. ___________

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9) Keep changing the DISTANCE and checking the temperature until you find the DISTANCE at which your average surface temperature is 100°C. (You may have to use decimals.) If you can’t get it exactly 100°C, just get it as close as possible. This is the inner limit of your star’s habitable zone. Record this number here: ___________AU inner limit.

10) Keep changing the DISTANCE and checking the temperature until you find the DISTANCE at which your average surface temperature is 0°C, or as close to 0°C as possible. (You may have to use decimals.) This is the outer limit of your star’s habitable zone. Record this number here: ____________AU outer limit.

11) Finally, see how close your planet is to the habitable zone of your nearest star. Is it in a habitable zone?
   _____ yes, yippee!
   _____ no, it is _____AU away from the inner/outer limit of the zone. (If your planet is too hot, subtract its DISTANCE from the inner limit of the habitable zone. If it is too cold, subtract the outer limit of the habitable zone from your planet’s DISTANCE.)

You might also want to make a graph of the habitable zone of your nearest star using Microsoft Excel. Choose about 10 to 15 different DISTANCES, a couple of which are outside the boundaries of your star’s habitable zone. See if you can place your planet on the graph. The instructions for making a graph in Microsoft Excel are in Lesson 1.