Build Your Own Planet  
Lesson 5: Final Planet Details

You have been traveling through space for many years at close to the speed of light. For most of those years you and your crewmates have been in a very deep sleep to cut down on the amount of food, air and water you need to survive. Suddenly, your computer wakes you and your crewmates and informs you that your space ship is getting close to the planetary system that you have decided to explore.

Now that you are much closer to your chosen planet you can study it better. Over the next few days your spaceship slowly approaches your nearest star and the planets and moons that orbit it. As you fly near your chosen planet or moon you can take more precise measurements of its BOND ALBEDO, and GREENHOUSE EFFECT, its DISTANCE from the star that it orbits, and the MASS of the star. You will this information into the ship’s computer and get an accurate reading of the planet’s average surface temperature.

It is now time to make the final decision about which planet you plan to explore. Get out the Planet Preference Survey that you filled out when you began this project. The choices that you made on the survey determine the range of values that you can enter in the Planet Temperature Calculator.

Open the Planet Temperature Calculator (http://www.astro.indiana.edu/~gsimonel/temperature1.html). Begin by entering the DISTANCE that you chose on the Planet Preference Survey. Then look back at Lessons 2, 3 and 4. In these lessons you selected values for MASS, BOND ALBEDO and GREENHOUSE EFFECT. Find these values and enter them into the calculator.

You may change these three values if you’d like, but you must stay within the range allowed for the choices you made on the Planet Preference Survey. Here are the allowable ranges, based on what you selected on your Planet Preference Survey:

For MASS:
If you chose “Low mass” enter a number between 0.1 & 0.4
If you chose “Solar type” enter a number between 0.4 & 1.5
If you chose “High mass” enter a number greater than 1.5
Remember that increasing the MASS of the nearest star decreases the life span of the star. *Your star can not be older than its total life cycle.*

For DISTANCE you must use the DISTANCE you chose on the planet preference survey.

BOND ALBEDO will depend on the type of surface you chose:
If you chose “Solid, rocky” enter a number between 1 and 15.
If you chose “Solid, ice covered” enter a number between 50 and 80 for a fresh ice covered surface, or between 10 and 50 for an old, dirty ice covered surface.
If you chose “Liquid” enter a number between 15 and 25.
If you chose “Mixture, mostly rock” enter a number between 15 and 40.
If you chose “Mixture, mostly ice” enter a number between 20 and 60.
If you chose “Mixture, mostly liquid” enter a number between 12 and 40.

GREENHOUSE EFFECT will depend on the type of atmosphere you chose:
If you chose “Trace” choose a number between 0 and 0.4.
If you chose “Thin” choose a number between 0.4 and 3.
If you chose “Thick” choose a number between 3 and 300.

Once you have found the average surface temperature, check to make sure your planet’s surface makes sense for that temperature. For example, you can not have an ice-covered surface if your planet’s average surface temperature is above 0ºC. If you need to, change your planet’s surface to one that can exist at that temperature. Adjust your BOND ALBEDO to fit your new surface and recalculate a new temperature.

1) After you have experimented with different settings, decide which values work best for your planet. Write the final values for your planet below.

**MASS of nearest star:** _______
**DISTANCE from nearest star:** _______
**BOND ALBEDO of planet:** _______
**GREENHOUSE EFFECT of planet:** _______

Enter these values into the planet temperature calculator.

2) What is the average surface temperature of your planet in degrees Celsius? _______ºC
3) What is the life cycle of your nearest star?
_________________________ years.

4) Look at your original Planet Preference Survey. What is the AGE of your nearest star?
_________________________ years.

5) Is the age of your nearest star less than the life cycle of the star?

Yes / No

(If the answer is “No” then you must go back and reduce the MASS of your nearest star until its life cycle is greater than its age.)

6) Is this planet habitable according to our definition? (Is the average surface temperature between 0 ºC and 100 ºC?)

Yes / No

If you answered “Yes” to question #6:

Congratulations! It looks like your mission is going just fine. You should plan to land on your planet soon and begin exploring it. Remember that your mission is to discover life. This is a good time to discuss your exploration plans with your crewmates. Since the planet is large the crew will divide up and explore different parts of the planet.

Fill out the Mission Update Form on the last page and send it back home to Earth with your original Planet Preference Survey.

If you answered “No” to question #6:

All is not lost. There are still ways life might be able to survive on your planet. Just because a planet’s average surface temperature is below 0ºC or above 100ºC does not mean that water can never exist there as a liquid.
Temperatures on a planet can be much higher or lower than the average temperature. If your planet has very long days and nights, then the side of the planet facing the nearest star (the “day” side) heats up while the side facing away (the “night” side) cools down.

Many planets, like Earth, have seasons, so some places will be much warmer in the summer and cooler in the winter. If your planet has an average surface temperature within 50ºC of the 0 - 100ºC range, then you might have areas of the planet where water can exist as a liquid. However, remember that the greenhouse effect traps heat, which reduces the temperature range. If your greenhouse effect is greater than 3, then this approach may not work for your planet. For an idea of how extreme a temperature range can be on a planet, look at the temperature range of Mercury, which has a very long day/night cycle and almost no atmosphere to trap heat. Compare this with Venus, which has even longer days and nights but almost no change in temperature because of its strong greenhouse effect.

Planets that are too cold to have liquid water at their surface can often have liquid water under their surface. If your planet has a rocky surface you can have water under the ground. Some scientists think Mars has water underground. Underground caves filled with water might be a good place to look for life. Planets with ice-covered surfaces might have liquid oceans under the ice. Scientists think Europa, a moon of Jupiter, has an ice-covered ocean.

Most scientists think liquid water is needed to support any life, but not everyone agrees, and some people try to imagine how life might survive using other liquids or even no liquids at all. You might have a hard time convincing mission control on Earth that it is worth the effort and expense to explore a planet without any liquid water, but it is worth a try. If your crew can imagine a way that life can survive without any liquid water, then it is worth telling mission control your ideas. If you can present a good case then they may approve your mission. Keep in mind, however, that your chances of finding life seem much greater on a planet with liquid water somewhere.

If you think your planet or moon is much too hot or cold to support life, then you may have to change your plans. Fortunately, there are a lot of other planets and moons fairly close by, and even a few nearby stars. If you think that there is little hope of finding life on your current planet or moon then you may explore a different one. However, the new planet or moon must be similar to your original one because that is what your mission has prepared for. Therefore,
you may change any ONE choice that you made on your Planet Preference Survey. Discuss with your group which choice you should change and what your new choice is. Then go back and recalculate your new average surface temperature using a value from the new allowable range for that choice. Fill out the Mission Update form on the last page and send it back home to Earth with your original Planet Preference Survey.

Good luck to all explorers!
Mission Update Form

Name of Group: ______________________________.

Name of Planet: ______________________________.
(Since you and your crewmates are the first Earthlings to land on the planet, you get to name it!)

Mark your final selections with an “X” and write in the final values that you entered into the planet preference calculator.

1) Type of nearest star:
   ____ Low mass
   ____ Solar type
   ____ High mass    MASS of nearest star: ______

2)    AGE of nearest star: ______ billion years old

3)    DISTANCE to nearest star: ______AU

4) Type of surface:
   ____Solid, rocky
   ____Solid, ice covered
   ____Liquid
   ____Mixture, mostly rock
   ____Mixture, mostly ice
   ____Mixture, mostly liquid    BOND ALBEDO of planet: ______

5) Type of atmosphere:
   ____Trace
   ____Thin
   ____ Thick    GREENHOUSE EFFECT on planet: ______

6) Type of planet:
   ____Small rocky
   ____Large rocky
   ____Moon of a rocky planet
   ____Moon of a gas giant
   ____Moon of an ice giant
   ____Moon of a brown dwarf
Use the Planet Temperature Calculator to fill in lines 7 and 8.

7) Life cycle of nearest star: __________________ years

8) Average surface temperature of the planet: __________ºC.

9) Describe anything else that affects the surface temperatures on your planet, such as the seasons or the day/night cycle.
   ______________________________________________________________________
   ______________________________________________________________________
   ______________________________________________________________________
   ______________________________________________________________________

10) Where are you likely to find liquid water on your planet? ________________
    ______________________________________________________________________
    ______________________________________________________________________
    ______________________________________________________________________

11) Check here _____ if you made a change from your Planet Preference Survey. What did you change?
    ______________________________________________________________________

12) Describe where on your planet you intend to look for life and why you intend to look there.
    ______________________________________________________________________
    ______________________________________________________________________
    ______________________________________________________________________
    ______________________________________________________________________