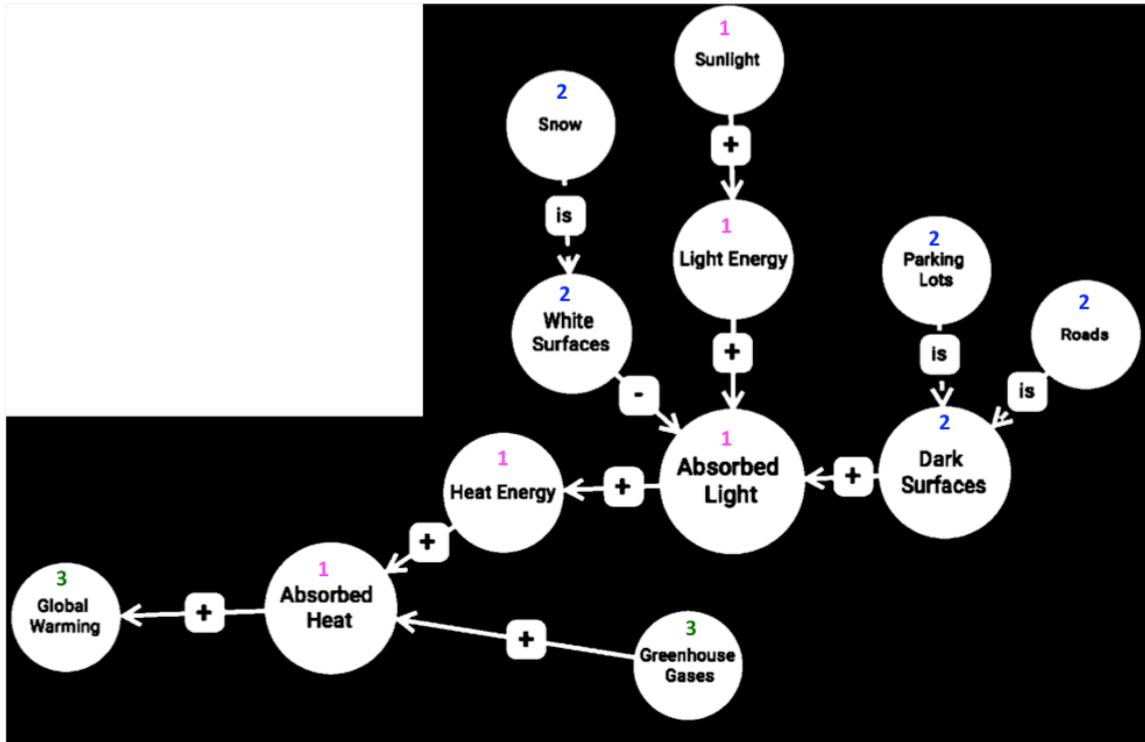


## Teachable Agents -- Planetary Rescue Teacher's Guide for Galaxy 2: Mechanisms

### Expert "Answer Key" Map

This is the underlying expert map that represents what the game considers correct. The numbers refer to the order in which the concepts are introduced.



### Notes about the map and opportunities for extension

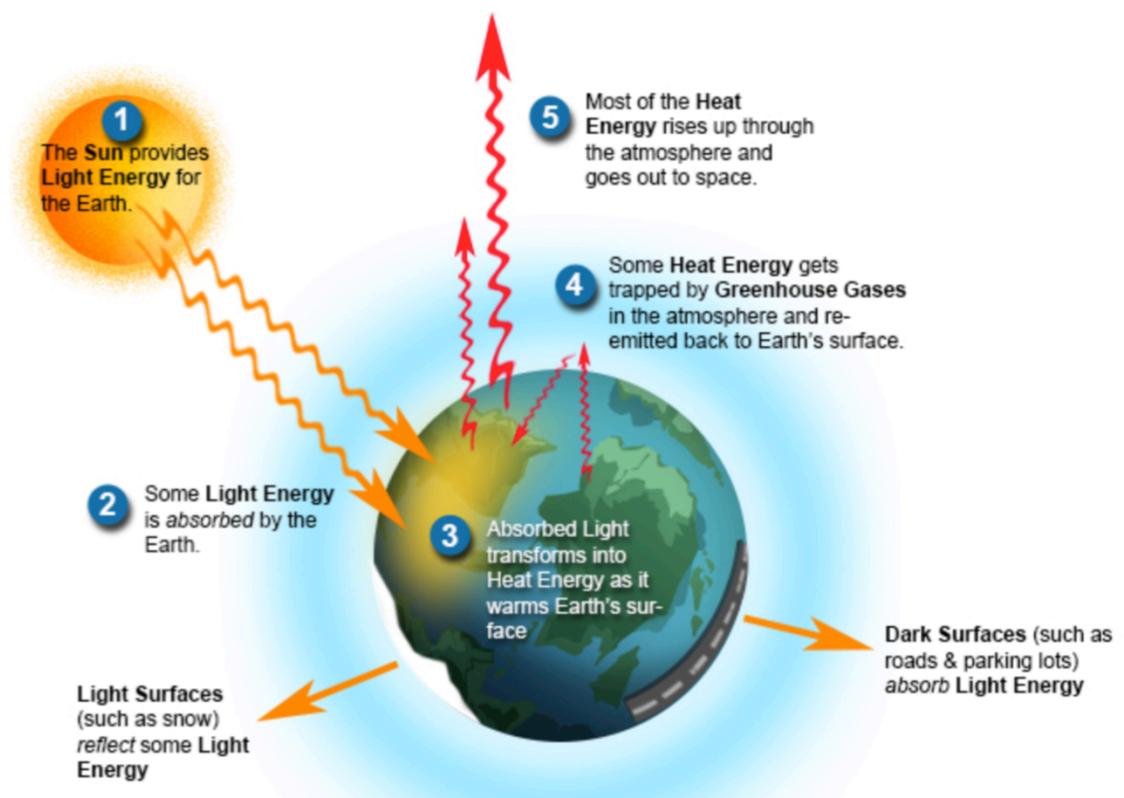
- The game refers to light energy from the sun being absorbed by the planet and converted to heat energy. A more technical way this same idea is sometimes discussed is by talking about solar radiation (visible and ultra-violet light) from the sun being absorbed by the planet and reemitted as long wave infrared radiation (heat radiation). For an example of this kind of description see: <http://www.howglobalwarmingworks.org/in-under-3-minutes-ba.html>
- Additional class activity ideas related to this galaxy:
  - Students explore the effect of different colors on absorbed heat energy. [https://www.teachengineering.org/activities/view/colors\\_absorb\\_heat\\_better](https://www.teachengineering.org/activities/view/colors_absorb_heat_better)
  - Students work together in groups to create a skit to act out or explain the greenhouse effect.
  - Students create a "greenhouse in a bottle" experiment, such as in the Carbon Dioxide lab here, and after discuss the ways it does and does not match how the greenhouse effect works: <https://pmm.nasa.gov/education/lesson-plans/climate-change-inquiry-lab>

### Challenging Concepts:

- This is the first time “is” nodes are introduced, which can initially cause confusion. These nodes are yellow (parking lots, roads, snow) and they can only be connected as a ‘type of’ link. For example, snow “is” a white surface. Parking lots “is” (are) dark surfaces.
- Many of the concepts in this galaxy are conceptually challenging. Encouraging students to look at the supporting diagrams and the handbook will be especially useful in this galaxy. Additionally, this short video from the National Resource Council can be used as an introduction. <https://youtu.be/3JX-ioSmNW8>
- If students have ever created a solar oven, they may be able to use that experience to think about how energy from the sun gets converted to heat.

### Diagrams and node information text included in the unit:

The handbook expands upon the information below, which is what students see when clicking on each node’s information icon.



**Sunlight:** The sun is the primary source of energy for Earth. The sun provides energy in the form of light.

**Light Energy:** Light Energy is produced by the sun. When the light reaches Earth, it can either be reflected or absorbed.

**Absorbed Light:** Light Energy that is not reflected is absorbed. When the Light Energy is absorbed by the Earth, it is converted to heat energy.

**Heat Energy:** Light energy from the sun is changed to heat energy on the surface of the Earth.

**Absorbed Heat:** Some heat energy gets trapped by greenhouse gases in the atmosphere. It does not leave the atmosphere and is absorbed, making the planet warmer.

**Parking Lots:** Parking lots are an example of man-made dark surfaces that may absorb incoming sunlight.

**Roads:** Paved roads are an example of man-made dark surfaces that may absorb incoming sunlight.

**Dark Surfaces:** The sun's light can be absorbed by dark surfaces (like soil and pavement.)

**White Surfaces:** The sun's light can be reflected by white surfaces (like snow and ice) on Earth's surface.

**Snow:** Snow is a white surface and naturally reflects sunlight back into space, preventing the Light Energy from being absorbed.

**Greenhouse Gases:** Carbon Dioxide, Water Vapor, and Methane are Greenhouse Gases. Greenhouse Gases increase the amount of Absorbed Heat Energy. They are natural and help create the greenhouse effect that makes our planet warm enough for life. Humans are creating extra Greenhouse Gases, which is causing extra warming.

Printable Expert map: (Only to be used for post-play discussion)

