Einstein's Garden

Overview During photosynthesis, plants take in energy from the sun (sunlight). They combine it with carbon dioxide and water. Einstein told us that energy can neither be created nor destroyed. In other words, the energy that plants take in remains with the plant. In this experiment, we will measure how much energy remains with the plant by weighing the plant each day.

What to Learn Most people don't understand that energy means *all* the energy transformations, not just the energy inside of an atom. The energy could be burning gasoline, fusion reactions (like in the sun), metabolizing your lunch, elastic energy in a stretched rubber band… every kind of energy stored inside of mass is what energy means.

For plants, this means that energy from captured sunlight, combined with carbon dioxide and water, both of which have mass, make the plant heavier. Let's find out how Einstein would have planted a garden while thinking about his big ideas.

Materials

- scale for weighing your plant
- pot with soil
- plant (not potted yet)
- water
- time

Experiment

1. Prepare a pot with dirt. Add a measured amount (like 1 cup) of water to dampen the soil. Weigh the pot filled with soil (but no plant).
2. Add a plant to the pot and weigh the whole thing.
3. Subtract the weight you found in step 1 from step 2 to find out how much the plant weighs.
4. You'll be weighing your pot each day. Weigh the plant before watering (water it the same amount each day) and write it down in your data table . If you're giving it water and sunlight, the plant should be getting heavier.

Einstein's Garden Data Table

Date	Weight	Total Change in Weight

Reading

Mass and energy are conserved. This means you can't create or destroy them, but you can change their location or form. Most people don't understand that the energy term means *all* the energy transformations, not just the energy inside of the atom.

The energy could be burning gasoline, fusion reactions (like in the sun), metabolizing your lunch, elastic energy in a stretched rubber band… every kind of energy stored in the mass is what "energy" means.

For example, if I were to stretch a rubber band and somehow weigh it in the stretched position, I would find it weighed slightly more than in the unstretched position. Why? How can this be? I didn't add any more particles to the system – I simply stretched the rubber band. I added energy to the system, which was stored in the electromagnetic forces inside the rubber band, which add to the mass of the object (albeit very slightly).

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Exercises

1. Where does this mass come from? You can't create mass, and yet the plant is getting heavier. How?

2. Can energy be created?

3. Can energy be destroyed?

Answers to Exercises: Einstein's Garden

1. Where does this mass come from? You can't create mass, and yet the plant is getting heavier. How? (You and I get heavier when we eat food. You aren't giving the plant food, but it is getting food. How? Where does its food come from? The energy from the sun is changed to sugars during photosynthesis, increasing the mass of the plant).
2. Can energy be created? (no)
3. Can energy be destroyed? (no)