DAWN ACTIVITY LEADER GUIDE

DESIGN AN ION ENGINE

Goal:

Design the most efficient ion engine by manipulating the grid charge and grid distance.

Estimated time:

10-60 minutes

Who to do it with:

Ages: 8-Adult

Numbers: 1 or more!

What you need:

- Computer with Ion Engine Interactive: http://dawn.jpl.nasa.gov/mission/ion_engine_interactive/index.html

Additional Information:

- Formal Education Teacher Guide: http://dawn.jpl.nasa.gov/DawnClassrooms/2_ion_prop/assess/1_tg_assessment.pdf
- Full Module: http://dawn.jpl.nasa.gov/DawnClassrooms/2_ion_prop/

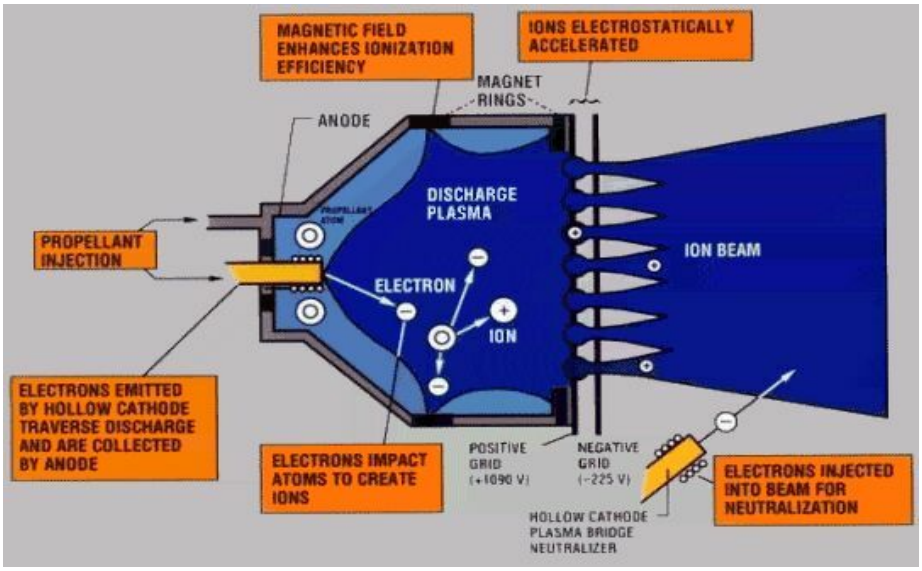
How to do it:

1. Ask learners to access the ion engine interactive simulation using the URL above.
2. Make sure learners understand:
   a. the color-scheme of the engine parts and the electrons (red dots), xenon atoms (green dots), and ions (blue dots);
   b. what they are observing on the simulation screen—the green xenon atoms, the blue and red grids, and the icon of the engine at the top of the engine;
   c. what the grid location and grid charge scale bars are indicating, and how the Fuel and Energy bar graphs can be read (or estimated); and,
   d. how the thrust of the engine is shown (rocket graphic moving left).
3. After learners have launched their engines using the default settings, you may wish to help them with the analysis of the results, which is only 30% of the maximum possible thrust.
4. Help them analyze their results by asking if they had any fuel or energy left over. Challenge them to move either the grid charge or grid location in order to improve efficiency.

5. Some learners will want to try to beat their best score and may engage for several minutes.
6. Depending on the age and interest level of your students, provide the following information:

About the ion engine:

As the separation of the grids increases, there is room for more and more ions between the grids. Each ion has a 1+ charge that forms an electric field which not only repels other ions but also shields them from the negative charge on the grid that should be attracting it. So, the attractive force on each xenon ion is either reduced or completely blocked by other positive ions. This interference is called "space charge."

Why do it:

The Dawn spacecraft uses ion propulsion to get the additional velocity needed to reach Vesta once it leaves the Delta rocket. It also uses ion propulsion to spiral to lower altitudes on Vesta, to leave Vesta and cruise to Ceres and to spiral to a low altitude orbit at Ceres. Ion propulsion makes efficient use of the onboard fuel by accelerating it to a velocity ten times that of chemical rockets.