Planning Your Trip

Procedure

1. Read your "Reaction Worksheet" handout carefully.
2. For your trip to Pluto, you will be riding in a spacecraft that has a mass of 135,000 kilograms. Most of the mass is in the rocket boosters, which are needed for taking off and escaping Earth's gravitational field. Your task is to travel to Pluto, land on its surface, take samples of the surface ice and rocks, and then return to Earth. To accomplish this trip, you will require a lot of energy—a total of 8×10^{32} electron Volts (eV)! Your cruising velocity will be 12.0 kilometers per second (a speedy 27,000 miles per hour!).
3. Refer to the equations on your "Reaction Worksheet" handout to obtain the amount of energy released per molecule burned (or reaction occurred) for each of your fuels. Write these in the tables below. To find the number of reactants (or reactions) you need for your round trip, divide your total round trip energy by the energy released per molecule (or reaction) for each fuel type/process listed. Record your results.

Sample calculation for wood

$$8 \times 10^{32} \text{ eV} \times \frac{1 \text{ molecule of wood}}{25 \text{ eV}}$$

$= 3.2 \times 10^{31}$ wood molecules (# of reactants needed for round trip)

4. To determine the total mass (g) of fuel required to make the trip, multiply the number of reactants (or reactions) needed for the round trip by the mass in grams per molecule (or reaction) for each fuel type/process listed. Record your results.

Sample calculation for wood

$$3.2 \times 10^{31} \text{ wood molecules} \times \frac{3.0 \times 10^{-22} \text{ grams}}{1 \text{ molecule}}$$

$= 9.6 \times 10^{9}$ grams (total mass of fuel required)
(That's almost 10 billion grams!)

Questions

Write your answers on a separate sheet of paper.

1. What do all the reactants of wood and fossil fuels have in common?
2. Compare the products of wood and fossil fuel reactions with the products of nuclear reactions. How are they the same? How are they different?
3. Compared to pure uranium fission, how many times more wood would you have to burn to make the trip to Pluto? How many times more wood compared to a photon drive engine?
4. If Pluto is 5.9×10^{9} kilometers from Earth, how long will it take you, in years, to make the trip to Pluto and return home? (Assume a straight line, a constant velocity with no deceleration or acceleration, and a speed of 12.0 kilometers per second.)

Fuel Type	Mass (g) per Molecule	Energy Released per Molecule (eV)	# Reactants Needed for Round Trip	Total Mass (g) of Fuel Required
wood	3.0×10^{-22}	25 eV	3.2×10^{31}	9.6×10^{9}
coal	2.0×10^{-23}			
natural gas	2.7×10^{-23}			
gasoline	1.9×10^{-22}			

Fuel Process	Mass (g) per Reaction	Energy Released per Reaction (eV)	# Reactions Needed for Round Trip	Total Mass (g) of Fuel Required
fission	4.0×10^{-22}			
fusion	1.7×10^{-23}			
photon drive	3.4×10^{-24}			