Name:_____

Rocketry Simulation with Kerbal Space Program

I) Orbital Speed:

Create a formula to find the necessary orbital speed *v* for a spaceship to be in a circular orbit at a height *h* above the surface of a planet with mass *M* and radius *R*.

Hint: gravitational force $\left(\frac{G \cdot M \cdot m}{r^2}\right)$ must equal centripetal force $\left(\frac{m \cdot v^2}{r}\right)$

where *r* is the distance from the center of the planet (*R*+*h*)

Now calculate the speed required for low Earth orbit and low Kerbin orbit (that is, just above the atmosphere). The gravitational constant is $G = 6.67 \times 10^{-11}\,\mathrm{m}^3/\mathrm{kg}\cdot\mathrm{s}^2$; all the other information you need is on the reference sheet.

II) Orbital Maneuvers:

Read the first two pages of the "Owner's Manual" and follow the directions. Try experimenting with orbital maneuvering by applying engine thrust in different directions, and **record your results as sketches** on the attached "Orbital Maneuvers" page.

III) Orbital Energy:

Load save file #2 again to get a ship in circular orbit. Calculate your ship's kinetic energy and potential energy.

Formulas: $\mathrm{KE} = \frac{1}{2} m v^2$ Orbital $\mathrm{PE} = \frac{G \cdot M \cdot m}{r} = \frac{G \cdot M \cdot m}{R + h}$

Your ship's mass can be seen in Map View by clicking on "i."
Your ship's speed can be seen above the navball.

Circular orbit: KE = _____

PE = _____

Etot = _____

Now point your ship *prograde* and turn on the engines for a while to raise apoapsis (max height) and create an elliptical orbit.

You're going to calculate energy at three sample points in this orbit: the apoapsis (max height), periapsis (min height), and one more in-between location of your choice. (Use fast-forward!)

	KE	PE	Etot
Apoapsis			
Periapsis			
Elsewhere			

How does Etot *after* the maneuver compare to Etot *before*?
Where does this extra energy come from?
If you wanted to *remove* energy, what would you do instead?

Name:_____

IV) Move on to the rest of the manual, and try for the moon!

Questions for Further Discussion

V) Why do you think it's useful to use a multi-stage rocket when launching up into orbit? Why not just one really big rocket holding lots of fuel?

VI) Based on what you have learned about orbital maneuvering, explain what these quotes mean, and whether they seem accurate or not.

a) "If you can get your ship into orbit, you're halfway to anywhere." (Robert Heinlein, sci-fi author)

b) "Forward takes you out, out takes you back, back takes you in, and in takes you forward." (Larry Niven, sci-fi author)

c) "I think Isaac Newton is doing most of the driving now." (William Anders, astronaut, when asked by radio "who's driving" the Apollo 8 at the moment)

VII) A spaceship that is useful for one mission might not be so great for others. How would you design a vehicle for each of the following jobs?

a) deliver crew and/or cargo from home up to a larger ship or space station already in orbit

b) take passengers from orbit around the home planet to orbit around another planet

c) carry automated science equipment to lunar orbit, perform experiments, and transmit the results back to home

d) maneuver to several small asteroids in similar orbits, gather minerals from mining robots on each of them, deliver to a processing station, and repeat indefinitely

e) disposing of dead satellites and other "space junk" (you can't blow it up; that would just leave MORE debris!)