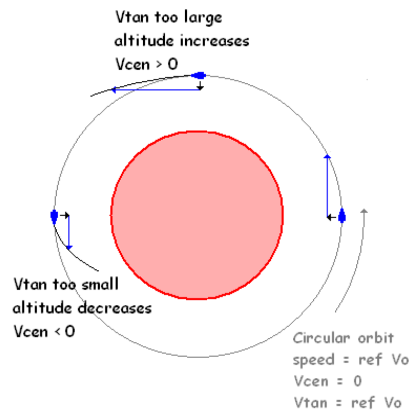
Print and read the orbit controls document.
For additional explanations, read pages 5, 6, 11, 12, & 13 in the procedures manual (from spacesim website).
All software is available from the spacesim website.



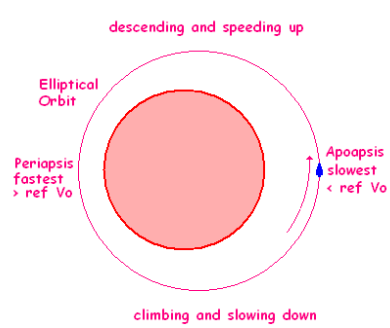
<u>Training Assignment 1A: circularize orbit</u>

a) start ORBIT5Tm.exe
press ***ENTER***
press ***X***
press R to load the file **TEST1A**

b) press ***p*** to display target velocities
c) set earth as **center**, **target**, **ref**
d) check apoapsis and periapsis
if the periapsis is less than 100 km, the orbit will enter the atmosphere, and you will crash

Circularize the Orbit
e) select NAVmode app targ; wait for spacecraft to reorient
f) use main engines at high negative thrust to change Vcen to zero (it will drift)
in a circular orbit - the in-and-out velocity (Vcen) should be zero
- Vtan will equal ref Vo
- the apoapsis and periapsis should be zero
check apoapsis and periapsis to see if orbit is more circular (press **o** to display orbit path).
g) select NAVmode ccw prog; wait for spacecraft to reorient
h) use main engines at high thrust to change Vtan to match ref Vo (it will drift)
In a circular orbit, the spacecraft has a sideways velocity (Vtan) that is just fast enough to counteract the downward acceleration due to gravity at that orbital altitude.
check apoapsis and periapsis to see if orbit is more circular (press **o** to display orbit path).
i) repeat steps e & f using lower thrust settings
j) repeat steps g & h using lower thrust settings
k) staying in NAVmode ccw prog, use RCS thrusters to complete the process of setting Vcen and Vtan
l) check apoapsis and periapsis to see if orbit is more circular (press **o** to display orbit path).

Note: if Vtan < ref Vo or Vcen < 0 (you are dropping)
- you are **<u>not</u>** necessarily going to crash
- as the spacecraft falls, it speeds up like a car rolling down a hill
- as it speeds up, Vcen will get less negative
- the speed will eventually get so high that Vcen will get positive



Training Assignment 1B: shift to a higher circular orbit

a) start ORBIT5Tm.exe
press ***ENTER***
press ***X***
press R to load the file **TEST1B**

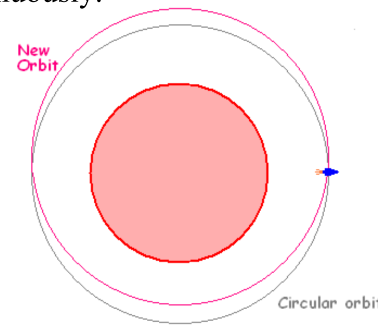
b) press ***p*** to display target velocities

c) set earth as **center**, **target**, **ref**

Goal: investigate the effect of changing velocity on orbital altitude.
The ultimate goal of this activity is to rendevous with a target in a higher orbit: the AYSE drive unit. To do this, we will make use of the HAB engines to alter the orbit of the HAB.
HAB initial altitude : 500 km & circular (check the distance readout and press **o** to verify)
AYSE initial altitude: 2509 km & circular

Circular orbit means that apoapsis (high point) = periapsis (low point)

Orbit display (press **o**) shows you the path around the reference object that the HAB *will follow **if*** the engines are turned off. Periapsis and apoapsis values update continuously.



Trial 1) use engines to push HAB upwards

d) set NAVmode to deprt ref

e) set engines to +100%

f) monitor apoapsis, periapsis, Vcen, and Vtan
Q: does the apoapsis increase?
Q: does Vcen increase?
Q: what happens to Vtan?
Check the projected path displayed by pressing **o**.
Q: Where does the high point occur relative to the current location (which side of earth)?
Q: What is happening to the periapsis as the apoapsis increases?
Q: What happens to the periapsis before the apoapsis reaches 2509 km?
Q: Why is this an unsafe means of moving to a higher orbit (think engine failure)?

Restart

g) reload **TEST1B** (press **r**, type Test1b...)

h) check that NAVmode is in ccw prog (HAB is pointing in direction of motion)

i) set engines to +100% (the engines are pushing the HAB sideways relative to the earth)

j) monitor apoapsis, periapsis, Vcen, and Vtan
Q: does the apoapsis increase?
Q: does Vtan increase?
Q: what happens to Vcen?
Check the projected path by pressing **o**.
Q: Where does the high point occur relative to the current location?
Q: What is happening to the periapsis?
Q: What is the lowest point that the spacecraft will reach if the engines fail at any point?

k) continue to monitor apoapsis
shut off engines when apoapsis reaches 2509 km
if you overshoot use low negative engine thrust to bring apoapsis down to 2509 km

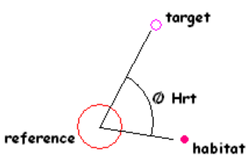
l) At this stage of the process, we just coast p to the apoapsis
press * to set time acceleration to 0.375 so that it does not take half an hour to get there.

m) monitor the progress of the HAB as it climbs up to apoapsis.
Q: what happens to Vcen and Vtan as the spacecraft climbs? what causes this?

Q: do the HAB and AYSE meet at the apoapsis?
Q: Which spacecraft reaches the apoapsis point of the HAB's orbit first?
Q: What would you have to have done differently (think timing) to make the two spacecraft meet?

Restart

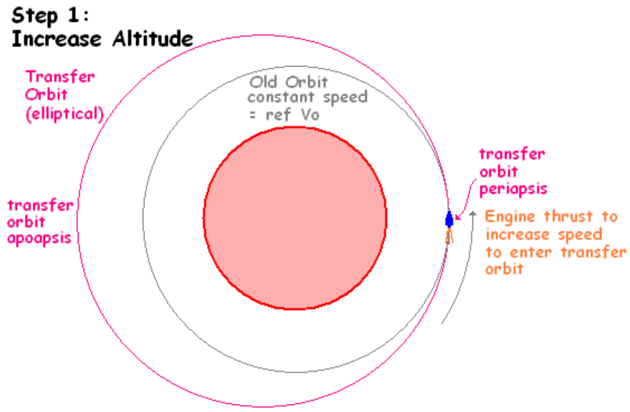
n) press **r** to reload **TEST1B**
o) press * to set time acceleration to 0.375
Q: Are the HAB and AYSE orbiting at the same speed? If not, which is faster?
Q: If you wait until the right moment, would it be possible to repeat steps **h** to **m** so that the HAB and AYSE did meet?
p) Press **q** then **y** then **ENTER** to exit the software.
q) Start the program **TRANSORB.EXE**
r) Select **Earth** (3) as the current orbit
Enter 500 km as the starting altitude
Enter 2509 km as the ending altitude
Enter 10 as the engine acceleration
Record the following output data:

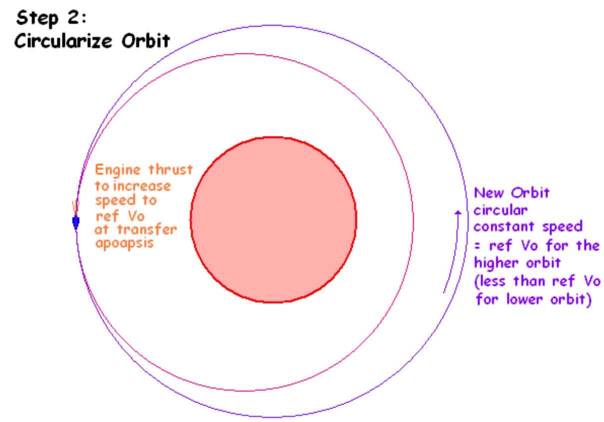


delta-V (tells you how much you need to add to your Vtan)
engine burn time (tells you how long an engine burn at the entered engine accel.)
trail object by (tells you the Hrt angle you need to have relative to the target, AYSE in this case, in order to meet it at the apoapsis).

Hrt is the angle between you and the target object with the centre of the reference object as the vertex of the angle. This angle is displayed in the orbit software. If the reference and target are the same object, the **Hrt** is zero degrees.

s) press any key to return to the select current orbit option and enter **q** to quit.
t) Restart **ORBIT5Tm.EXE**
Repeat steps **a** to **c**.
u) Press * to accelerate time to 0.375
v) Monitor **Hrt**. It should be decreasing, indicating that you are catching up with AYSE
w) Press / just before it reaches the angle given by **TRANSORB.EXE** to go back to the normal passage of time.
x) Add the delta-V given to you by **TRANSORB.EXE** to the displayed ref Vo speed.
This is your target Vtan.
Take the engine burn time given by **TRANSORB.EXE** and divide by 2
When you estimate that you are about that much time before the critical **Hrt** is reached, set the engines to generate 10 m/s^2 acceleration.
y) When your Vtan reaches the target Vtan, shut off the engines.
Since Vtan starts to decrease immediately, you cannot correct any over or undershoot of target Vtan.
z) Press * to accelerate time to 0.375 until just before apoapsis is reached.
At apoapsis: Vcen will be zero
the AYSE drive should be within a few kilometres
Vtan will be slower than ref Vo
aa) Ensure that you are still in NAVmode **ccw prog** then use engines to accelerate Vtan until it is equal to ref Vo.
ab) Set target to AYSE and monitor distance to target. It should be fairly constant.


Step 1:
Increase Altitude
Transfer
Orbit
(elliptical)
Old Orbit
constant speed
= ref Vo
transfer
orbit
periapsis
transfer
orbit
apoapsis
Engine thrust to
increase speed
to enter transfer
orbit


Step 2:
Circularize Orbit
Engine thrust
to increase
speed to
ref Vo
at transfer
apoapsis
New Orbit
circular
constant speed
= ref Vo for the
higher orbit
(less than ref Vo
for lower orbit)