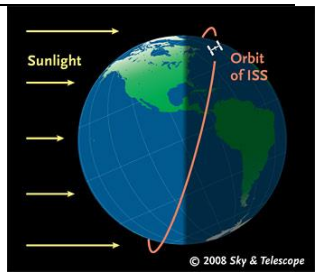
UNIVERSAL LAW OF GRAVITY

Here is the data for the International Space Station in its orbit around earth:

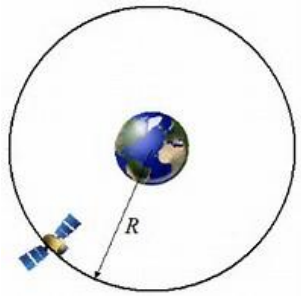
- ISS mass in orbit = 419,455 kg (924,740 lbs.)
- ISS tangential velocity when in orbit = 7670 m/sec
- ISS orbital height above Earth = 3.50 x 10^5 m
- Mass of the earth = 6 x 10^{24} kg
- Radius of the earth = 6.38 x10^6 m



1. Calculate the period for the ISS to make one revolution (cycle).

2. Draw a force diagram of the ISS in orbit around Earth.

3. Draw a centripetal force vector, Velocity vector, and Acceleration vector for the ISS below.



4. Use the principles of circular motion to find the centripetal force necessary to keep the ISS in its circular orbit around earth.

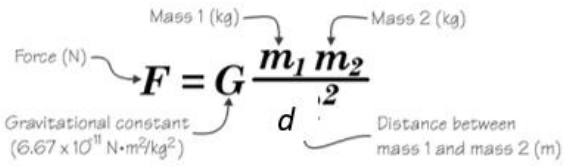
5. Use Newton's Law of Universal Gravitation to find the gravitational force the earth exerts on the ISS in orbit.

6. Calculate the gravity on the ISS.

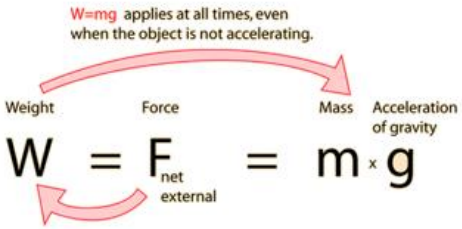
7. Use your equations above to answer the following questions:
   a. If the radius of orbit of a satellite is increased, then the orbital speed would _____ .
   b. If mass of the earth is increased, then the orbital speed would _____ .
   c. If the radius of the earth is increased, then the orbital speed would _____ .
   d. If the mass of the satellite is increased, then the orbital speed would _____ .
   e. If the radius of orbit of a satellite is increased by a factor of 2 (i.e., doubled), then the orbital speed would _____ (increase, decrease) by a factor of _____.
   f. If the mass of the earth is increased by a factor of 2 (i.e., doubled), then the orbital speed would _____ (increase, decrease) by a factor of _____.

Equations & Constant values

Equation of Universal Gravitation:



$$g = \frac{GM}{d^2}$$



8. What is the force of gravity between 45 kg Nellie and 55 kg Smellie if they are 2 meters apart?

9. Calculate the force between the Earth (m=6.0 x1024kg) and a 2.00 $x10^2$ kg boulder at the surface of the Earth (r= 6.38 $x10^6$ m)

10. On February 20, 1962, John Glenn became the 1st American to orbit Earth. If John weighed 640 N on Earth's surface.
    a. How much would he have weighed in his Mercury spacecraft if he was twice the distance from the center of Earth?

    b. Why is it said that an astronaut is never truly weightless?

11. Rank the four locations in increasing order of their acceleration of gravity value, beginning with the lowest.