Satellite Motion Lab Name ________________________________
AP Physics C 1 2 3 4 5 6 7 8

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$|F_g| = \frac{Gm_s m_{Earth}}{r^2}$ $U_g = -\frac{Gm_s m_{Earth}}{r}$ $K = \frac{1}{2}mv^2 G = 6.67\times10^{-11}\frac{Nm^2}{kg^2}$ $m_{Earth} = 5.97\times10^{24}kg$ $a_c = \omega^2 r = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2} = 4\pi^2 r f^2$ $L_s = rmvsin\theta$

Part I - Low Earth Orbit Satellite Mass = __________ kg Satellite Speed = _______________ m/s

1. Hit the "Play" button and watch as the satellite makes one complete orbit. Use the satellite's mass, speed, and orbital radius to compute the energies below:

   a. The kinetic energy is (*positive / zero / negative*) ____________________ J.

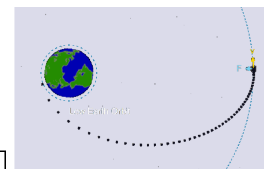
   b. The potential energy is (*positive / zero / negative*) ____________________ J.

   c. The total mechanical energy is (*positive / zero / negative*) ____________________ J.

   d. The total mechanical energy is (*almost the same as / exactly one half of the*) potential energy.

Part II - Transfer Orbit

2. Hit the "Pause" button to stop the satellite. Adjust the speed of the satellite so that it achieves an elliptical transfer orbit between Low Earth Orbit (LEO) and Geosynchronous Orbit (GEO). Fill in the table below.



Satellite Mass: _________________ kg

	Satellite at LEO Radius	Satellite at GEO Radius
Speed (m/s)		
Orbital Radius (m)		
Kinetic Energy (J)		
Potential Energy (J)		
Total Energy (J)		
Angular Momentum ($\frac{kg\times m^2}{s}$)		

   a. What happened to the speed as it traveled from the LEO radius to the GEO radius?
      i. Explain the change in speed in terms of energy transformation.

      ii. Explain the change in speed in terms of the force of gravity.

   b. How do the angular momenta at the LEO radius and the GEO radius compare? Why are they the same?

Part III – Geosynchronous Orbit

3. Use Newton's Law of Gravity, Newton's 2nd Law of Motion, and the equation for centripetal acceleration in uniform circular motion to derive the radius of a geosynchronous orbit. Show all work.

4. Use Newton's Law of Gravity, Newton's 2nd Law of Motion, and the equation for centripetal acceleration in uniform circular motion to derive the orbital speed of a geosynchronous orbit. Show all work.

5. Set the satellite at the geosynchronous orbital radius and speed you determined above and complete the table. Use the same satellite mass as in Part II.

Satellite Mass: ___________________ kg

	Satellite at LEO Radius	Transfer Orbit GEO Radius (from Part II)	Circular Geosynchronous Orbit (Part III)
Speed (m/s)	X		
Orbital Radius (m)	X		
Kinetic Energy (J)	X		
Potential Energy (J)	X		
Total Energy (J)	X		
Angular Momentum ($\frac{kg \times m^2}{s}$)	X		

a. The speed and kinetic energy are (*larger* / *the same as* / *smaller*) in a circular GEO orbit.

b. The radius and potential energy are (*larger* / *the same as* / *smaller*) in a circular GEO orbit.

c. Transfer orbit at GEO radius: The total mechanical energy is (*almost the same as* / *exactly one half of the*) potential energy.

d. Circular GEO orbit: The total mechanical energy is (*almost the same as* / *exactly one half of the*) potential energy.

e. How do the angular momenta compare between the satellite in the transfer orbit at GEO radius and the satellite in a circular GEO orbit? Why are they different?