**IC200 : Introduction to Astronomy & Astrophysics** **Instructor : Dr. Mahavir Sharma**
**Tutorial-2**

1. Prove the virial theorem for an elliptic orbit (You will have to evaluate K.E. and P.E. averaged over one time period )

2. Calculate the distance of the centre of mass from the heavier body in (i) Sun-Earth system (ii) Earth-Moon system. Compare your answer with the radius of the heavier body

3. In the Bohr model of hydrogen atom, calculate the velocity of the electron in the inner-most orbit and compare it with the speed of light.

4. Calculate the wavelength of photon emitted when the electron jumps from level $n = 2$ to $n = 1$. Calculate the same for the Deuterium atom. What is the difference

5. Assume that the Sun is a spherical body of uniform density, then prove that its total gravitational potential energy is $-\frac{3}{5}\frac{GM^2}{R}$, where $M$ is the mass and $R$ is the radius of the Sun.

6. Use the virial theorem to roughly estimate the temperature of the Sun. What would be the temperature if the Sun expands by 10 times? What would be the temperature if the Sun shrinks to 10 km?

7. We found that the interior of the Sun can be very hot (easily more than a million Kelvin), but also that the surface is relatively cold (approx 6000 K). So there must be a temperature gradient across spherical layers/shells in the sun, T decreasing outwards. With this, try to explain the phenomenon of Limb darkening to your classmates, tutorial instructor. Also the sun-spots appear to be darker/fainter, give an explanation for that as well.

8. The Sun has a luminosity of $L \approx 4 \times 10^{26}$ J/s. What would be the specific intensity ($I_\nu$) for it? How would you connect it to $L$

9. A glass slab of thickness 0.2 m, absorbs 50% of the light passing through it. How thick a slab of similar glass be:
   (i) in order to absorb 90% of light passing through it
   (ii) in order to absorb 99% of light passing through it
   (iii) in order to absorb 99.9% of light passing through it