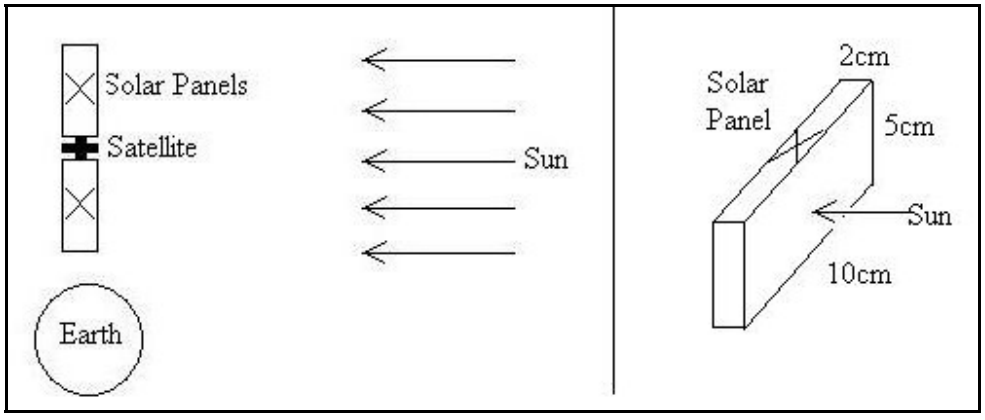
Satellite quiz 2

1. You are given a micro-satellite. It is a cube (all sides equal to 30cm). Other than the nadir surface, all other surfaces have solar cells (efficiency=0.3). **What is the maximum power that the satellite can produce?** Assume that the satellite is in polar orbit around earth. Solar constant = 1400W/m^2 {*The solar constant (as defined for planet Earth) is the power collected at the top of the atmosphere by a unit area perpendicular to the light path.*} **Also calculate the solar radiation force on the satellite. Do you think it is large enough to cause perturbation of orbit? (25M)**

2. **Arrange with reasons, the following in according to their sensitivity towards small perturbations in the satellite orbit, i.e. detecting change in attitude of the satellite:**
i) magnetometer
ii) gyroscope
iii) gravity-gradient boom
iv) star-tracker
v) sun-sensor
{ *The sensitivity of an electronic device, e.g., a communications system receiver, or detection device, e.g., PIN diode, is the minimum magnitude of input signal required to produce a specified output signal having a specified signal-to-noise ratio.* } **Explain why in a student satellite magnetometer is used for this purpose? (15M)**

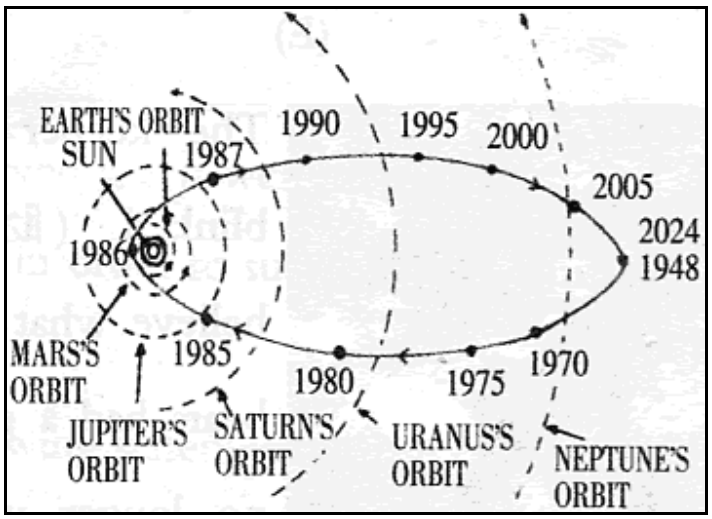
3. A satellite is in polar orbit as shown above pole. It has extended solar panels which must face the sun. **Calculate the torque on the satellite in THIS POSITION. Suggest measures to counter it.** Mass of Earth = 5.81X10^{24}kg. Radius of Earth = 6400km. Solar constant = 1400 W/m^2. Density of solar panel = 2gm/cc. **(25M)**



4. A spy satellite is viewing the earth in noon/midnight orbit. {*A sun-synchronous orbit is a geocentric orbit which combines altitude and inclination in such a way that an object on that orbit passes over any given point of the Earth's surface at the same local solar time. Special cases of the sun-synchronous orbit are the noon/midnight orbit.*} **What should the exposure**

time of the camera be, if it is taking an image of a region on the equator of the earth? Assume the resolution of the camera and state the spatial resolution. { *Spatial resolution: the area on the ground that a single pixel covers.* } Assume it is a 2 mega-pixel camera, and for a good picture about 10^6 photons must fall on each pixel. **(25M)**

5. Let us estimate the probability of our satellite being hit with meteorites. We know that the Orionids meteor shower in late October is caused because earth passes through the dust trail left by Halley's comet (which comes every 76 years). A comet is a ball of ice and dust. Halley's is about 15 kilometres long and its average density is about 0.6 g/cm³. Assume it to be a cylinder of 1km diameter. Every time it zips past the Sun, it flares up and throws away, as a beautiful tail, about one-ten thousandth of its weight. In other words, it should survive only ten thousand orbits - maybe 750,000 years. Halley's Comet, has an orbital eccentricity of 0.967 and a semi-major axis length of almost 18 AU. Assume during every orbit, it throws away its tail, and the comet dust settles on the entire length of the orbit uniformly in the form of spherical granules of 100micron diameter. **What is the probability of our satellite colliding with such a granule?** Satellite dimensions same as question1. **(30M)**



6. Most of the sensors on the satellite need very high voltage potential (about 1000V) while battery voltage is in the order of 10-30V. **How is this 'step-up' of voltage done on the satellite?** There is a process called potting. { *Potting compounds are pourable insulating resins (epoxies, silicones, urethanes and hybrids) to be cast into cavities containing electronic components to insulate, protect, and hold them in place thus protecting components from shock and vibration.*} **Explain the importance of *'protecting components from shock and vibration'* on the satellite.** Potting is also essential to prevent another trouble that arises because the voltages are very high and the air density is close to vacuum. **What is this trouble we are talking of?** **(20M)**