Grav

Kepler's laws of planetary motion, universal law of gravitation. Acceleration due to gravity (g) and its variation with altitude, latitude and depth.

Gravitational potential and gravitational potential energy, escape velocity, orbital velocity of a satellite, Geo-stationary satellites.

(i) Newton's law of universal gravitation; Statement; unit and dimensional formula of universal gravitational constant, G [Cavendish experiment not required]; gravitational acceleration on surface of the earth (g), weight of a body W= mg from F=ma.

(ii) Relation between g and G. Derive the expression for variation of g above and below the surface of the earth; graph; mention variation of g with latitude and rotation, (without derivation).

(iii) Gravitational field, intensity of gravitational field and potential at a point in earth's gravitational field. Vp = Wαp/m. Derive expression (by integration) for the gravitational potential difference ΔV = VB-VA = G.M(1/rA-1/rB); here Vp = V(r) = -GM/r; negative sign for attractive force field; define gravitational potential energy of a mass m in the earth's field; expression for gravitational potential energy U(r) = Wαp = m.V(r) = -G M m/r; show that ΔU = mgh, for h << R. Relation between intensity and acceleration due to gravity.

(iv) Derive expression for the escape velocity of earth using energy consideration; ve depends on mass of the earth; for moon ve is less as mass of moon is less; consequence - no atmosphere on the moon.

(v) Satellites (both natural (moon) and artificial) in uniform circular motion around the earth; Derive the expression for orbital velocity and time period; note the centripetal acceleration is caused (or centripetal force is provided) by the force of gravity exerted by the earth on the satellite; the acceleration of the satellite is the acceleration due to gravity [g'= g(R/R+h)2 ; F'G = mg'].

Weightlessness; geostationary satellites; conditions for satellite to be geostationary; parking orbit, calculation of its radius and height; basic concept of polar satellites and their uses.

(vi) Kepler's laws of planetary motion: explain the three laws using diagrams. Proof of third law (for circular orbits only)