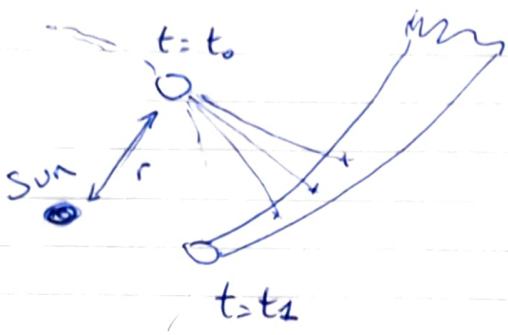
Problem 1



* dust has $\rho = \rho_p = 3 \times 10^3 \ kg/m^3$
* fully absorbing
* spherical dust particle

Q1 What is R_p for a straight line?

2 forces :
- radially outward radiation $\vec{F}_{rad} = F_{rad}\,\vec{e}_r$
- radially inward gravity $\vec{F}_{grav} = F_{grav}\,\vec{e}_r$

↳ $F_{rad} = \frac{I A}{c}$

particle cross section: $A = \pi R_p^2$ ← particle size

$I = Q_{rad} \frac{L}{4\pi r^2}$ ← sun luminosity; I ← incident irradiance; Q_{rad} ← rad pressure efficiency; r ← radius of orbit

$$\boxed{F_{rad} = \frac{L Q_{rad} R_p^2}{4 c r^2}}$$

↳ $F_{grav} = \frac{G M_s A_p \rho_p}{r^2}$ ← sun mass; ← particle mass

$$\boxed{F_{grav} = \frac{4\pi G M_s \rho_p R_p^3}{3 r^2}}$$

Straight line $\Rightarrow a_p = 0 \Rightarrow F_{rad} = F_{grav}$

$$\frac{L Q_{rad} R_p^2}{4 c r^2} = \frac{4\pi G M_s \rho_p R_p^3}{3 r^2}$$

$$\Rightarrow \boxed{R_p = \frac{3 L Q_{rad}}{16 \pi c G M_s \rho_p} \approx 10^{-7}\ m}$$

Q2] How is the trajectory changing with R_p ?

if R_p is larger $\bar{F}_{grav} > F_{rad}$

because $F_{grav} \propto R_p^3$ and $F_{rad} \propto R_p^2$

$\Rightarrow$ the particle falls into the sun.

Q3] Prove the motion is Keplerian.

$$m a_p = \bar{F}_{rad} + \bar{F}_{grav}$$

$$= \bar{F}_{grav} (1 + \alpha)$$

$$\alpha = \frac{L Q_{rad} R_p^2}{4c G M_s M_p}$$