Q 1). A non monochromatic light has red and blue components, such that, $n_b = 2n_r$ (per sec).
Assume 10% Quantum efficiency of metal surface.

$$\eta = \frac{n_e}{n_p} \times 100$$

$$10 = \frac{n_e}{3n_r} \times 100$$

$$n_e = 0.3n_r$$

What would be the saturation photoelectric current ?

(A) n_r (B) $0.2n_r$ (C) $0.3n_r$ (D) $3n_r$

Q 2). In the above case, what should be the stopping potential ?

(A) $\frac{hc}{\lambda_b} - \phi$

(B) $\frac{hc}{\lambda_b e} - \frac{\phi}{e}$

(C) $\frac{hc}{\lambda_r e} - \frac{\phi}{e}$

(D) $\frac{hc}{(\lambda_b + \lambda_r)e} - \frac{\phi}{e}$

$n_b = 2n_r$

Q 3). Above source is kept at a distance of 5m from metal surface what would be the saturation current ?

$\eta = 10\%$

$N_p = \phi_p A$

$N_p = I \times A$

(A) $\dfrac{0.3n_r}{100\pi}A$ (B) $\dfrac{n_r}{\pi}A$

$\eta = \frac{10}{100} = \frac{n_e}{\phi_p \times A}$

$n_e = \frac{3n_r}{100\pi} \times 0.1 \times A$

$N_p = \frac{P}{4\pi(5)^2} \times \frac{A\lambda}{hc}$

(C) $\dfrac{n_r}{50\pi}A$ (D) $\dfrac{0.3n_r}{25\pi}A$

$= N_{p_1} + N_{p_2}$

$2n_r \quad n_r$

$\phi_p = \left[\frac{2n_r}{4\pi(5)^2} + \frac{n_r}{4\pi(5)^2}\right]$

$n_e = \frac{0.3n_r}{100\pi} \times A$

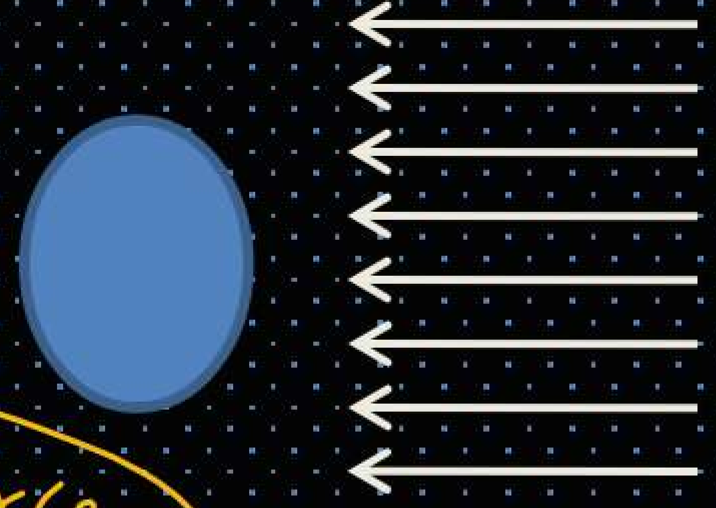
Find radiation force on a perfectly reflecting sphere if intensity of light is I_0.

Steps for calculation of radiation force/pressure

$\text{pressure} \rightarrow \dfrac{\text{normal force}}{\text{Area}}$

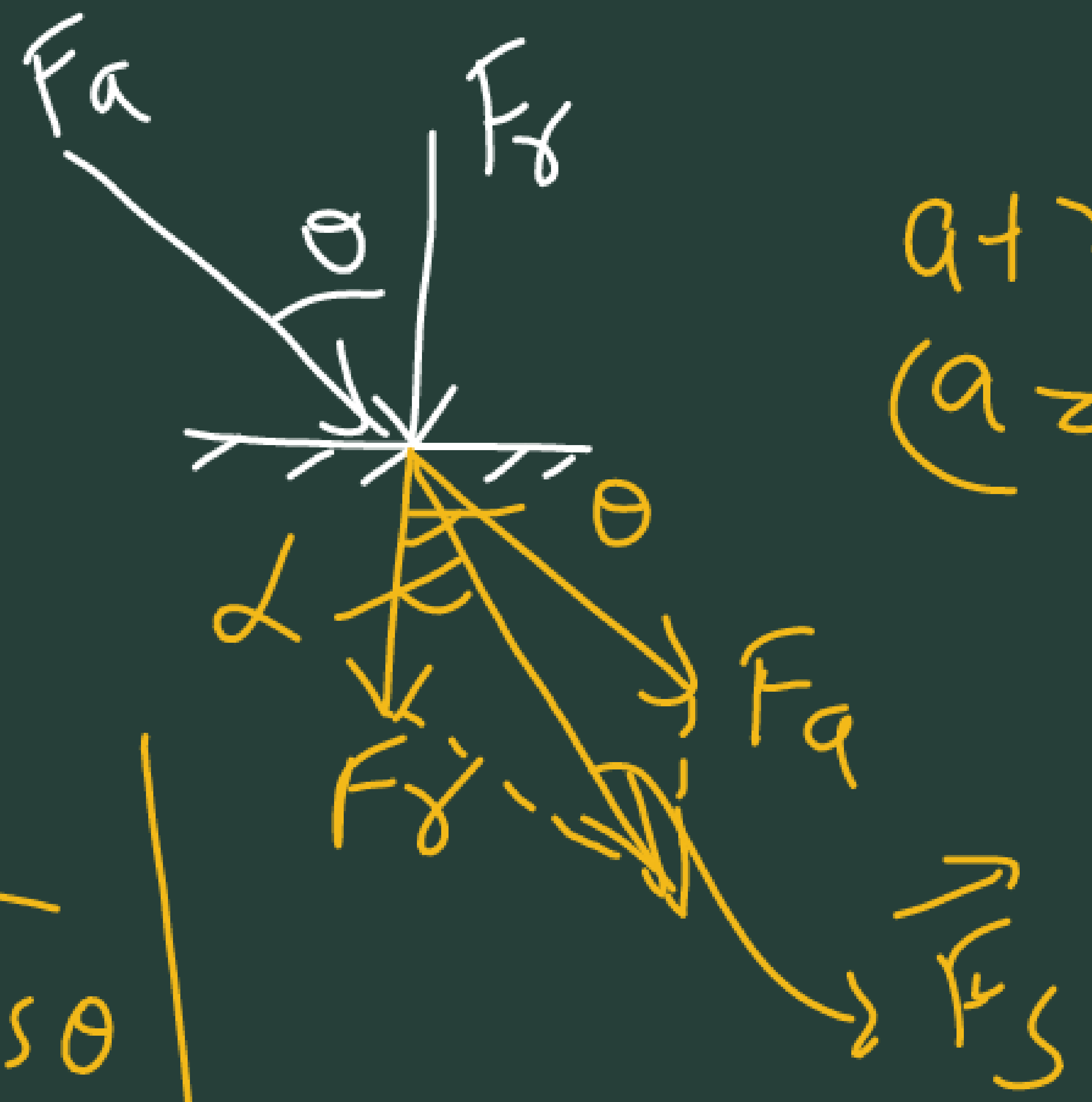
$\text{pressure} \rightarrow \dfrac{\text{force}}{\text{normal area}}$

1. Find out the power incident. (normal area).
2. Find $N_p \rightarrow \boxed{\dfrac{P\lambda}{hc}}$
3. Find out rate of change in momentum → force exerted (observe individual photon) $N_p \times \Delta p_{photon}$
4. Vector addn of forces.



(iii)

$$\vec{F}_s = \frac{IA\cos\theta}{c}\left[\overbrace{a(\hat{n})}^{F_a} + \overbrace{2\gamma\cos\theta(\hat{n})}^{F_\gamma}\right]$$



$a+\gamma=1$

$(a = 1-\gamma)$

$$|\vec{F}_{res}| = \sqrt{|F_1|^2 + |F_2|^2 + 2|F_1||F_2|\cos\phi}$$

$$|\vec{F}_s| = \left(\frac{IA\cos\theta}{c}\right)\sqrt{a^2 + (2\gamma\cos\theta)^2 + 2\cdot a\cdot(2\gamma\cos\theta)\cos\theta}$$

$$= \left(\frac{IA\cos\theta}{c}\right)\sqrt{(1-\gamma)^2 + 4\gamma^2\cos^2\theta + 4(1-\gamma)\gamma\cos^2\theta}$$

$$\boxed{|\vec{F}_s| = \frac{IA\cos\theta}{c}(1+\gamma)}$$

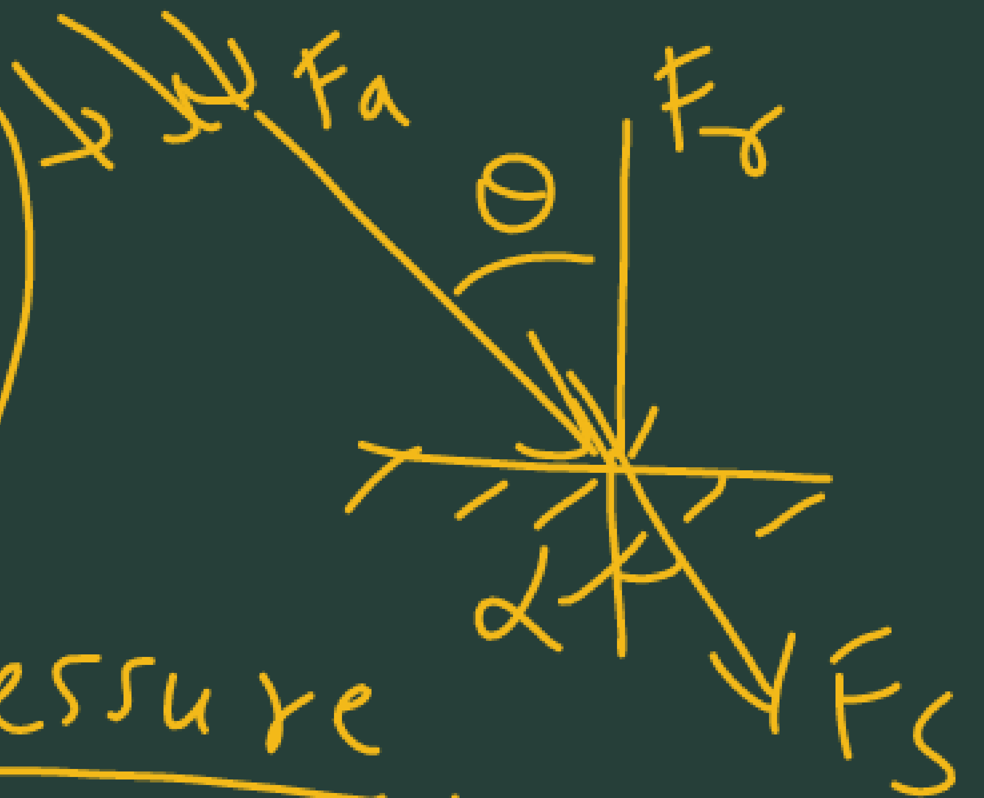
$$\tan\alpha = \frac{F_a\sin\theta}{F_\gamma + F_a\cos\theta} = \frac{a\sin\theta}{2\gamma\cos\theta + a\cos\theta}$$

$$= \frac{\sin\theta(1-\gamma)}{\cos\theta(1+\gamma)}$$

$$\boxed{\tan\alpha = \left(\frac{1-\gamma}{1+\gamma}\right)\tan\theta}$$

if $\theta = 0$, $|\vec{F}_s| = \frac{IA(1+\gamma)}{c}$

$$\boxed{|\vec{F_s}| = \frac{IA\cos\theta(1+\gamma)}{c} \quad \ldots \quad \tan\alpha = \left(\frac{1-\gamma}{1+\gamma}\right)\tan\theta}$$



Cases

1 if $\theta = 0 \Rightarrow$ normal incidence.

$$|\vec{F_s}| = \frac{IA(1+\gamma)}{c} \qquad \tan\alpha = 0 \Rightarrow \alpha = 0$$

$\gamma = 1$

$\gamma = 0$

2 $\gamma = 0$

$$|\vec{F_s}| = \frac{IA\cos\theta}{c} \quad \Big| \quad \tan\alpha = \tan\theta \Rightarrow \boxed{\alpha = \theta}$$

3 $\gamma = 1$

$$|\vec{F_s}| = \frac{2IA\cos\theta}{c} \quad \Big| \quad \tan\alpha = 0 \qquad \boxed{\alpha = 0}$$

Pressure

$$P_0 = \frac{|\vec{F_r}| + |\vec{F_a}|\cos\theta}{A}$$

$$P_0 = \frac{IA\cos\theta}{cA}\left[a\cos\theta + 2\gamma\cos\theta\right]$$

$$P_0 = \frac{I\cos\theta}{c}\left[1+\gamma\right]\cos\theta$$

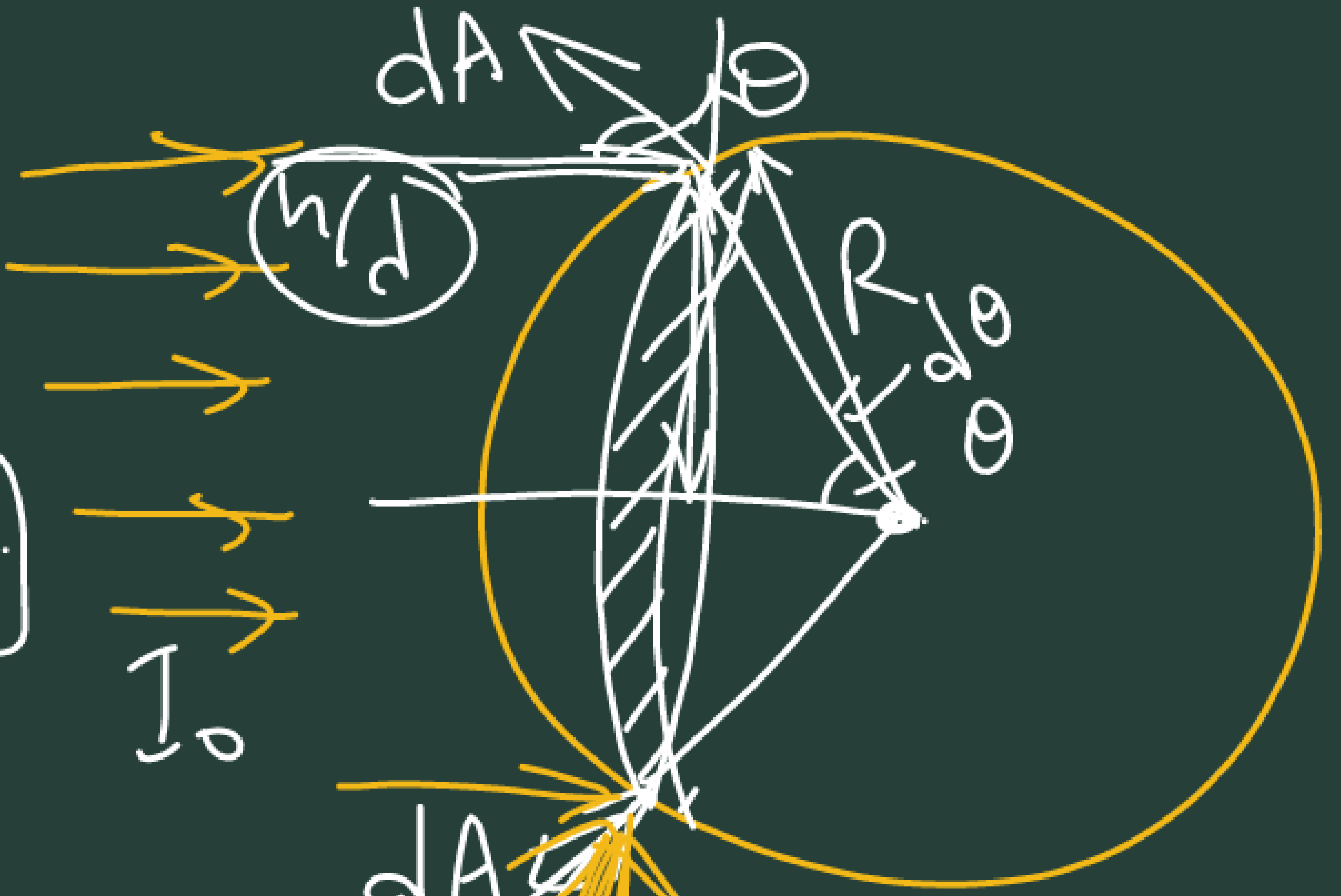
$$\boxed{P_0 = \frac{I(1+\gamma)}{c}\cos^2\theta}$$

Radiation force on a sphere ($r = 1$)

$r = R\sin\theta$

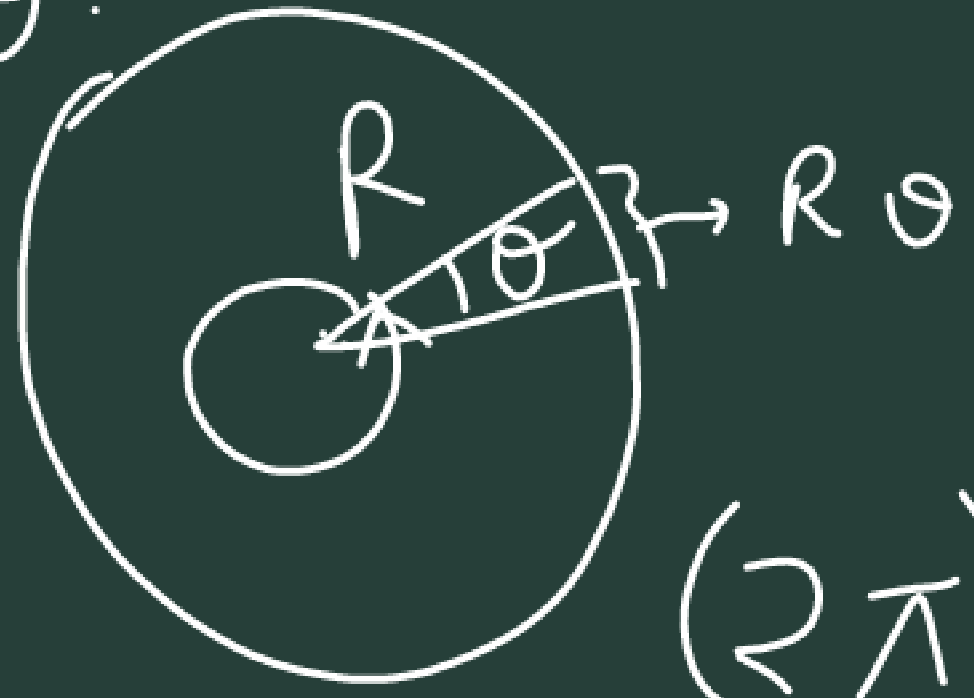
$dA = (2\pi r)R\,d\theta$

$\boxed{dA = 2\pi R^2 \sin\theta\, d\theta}$



(1) Power incident

$\mathbb{P} = I_0 \times dA\cos\theta$



(2) $N_p = \frac{\mathbb{P}\lambda}{hc}$

$= \frac{I_0\,dA\cos\theta\,\lambda}{hc}$

(3) $\Delta P_{photon} = \frac{2h}{\lambda}\cos\theta$

$F_{ring} = N_p \times \Delta P_{photon}$

$\underbrace{(2\pi)}R = \ell$

$\boxed{\ell = R\theta}$

$v = R\omega$

$a = R\alpha$

(4) vector addition

$(F_{net})_{ring} = (F_{ring}\cos\theta)$