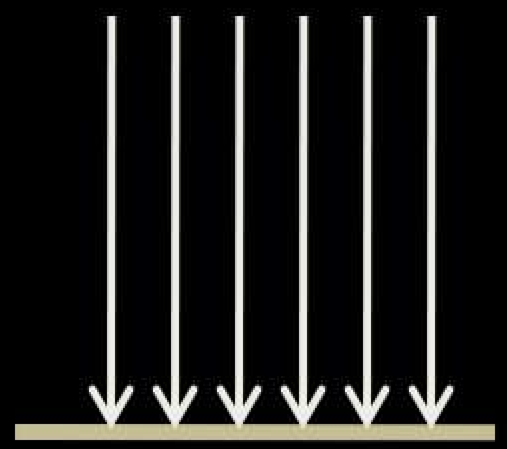
Find radiation pressure due to the light of intensity I_0 falling normally on surface area A

Case 1). $a = 1, r = 0$

Case 2). $a = 0, r = 1$

Case 3). $0 < r < 1, a + r = 1$



(i)

ABLES KOTA

Q 1). A perfectly absorbing plate of mass 10 gm is in equilibrium in air due to force exerted by light beam on plate. Calculate power of beam

A). 20 MW

~~B)~~. 30 MW

C). 50 MW

D). 10 MW

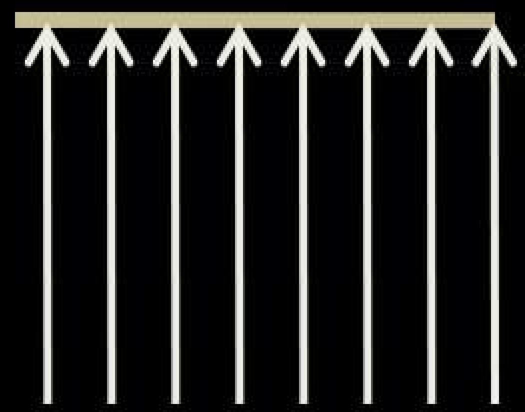
$F_s = mg$

$\frac{P}{c} = 10 \times 10^{-3} \times 10$

$P = 3 \times 10^{8} \times 10^{-1}$

$= 3 \times 10^{7}\ W$

$= 30\ MW.$



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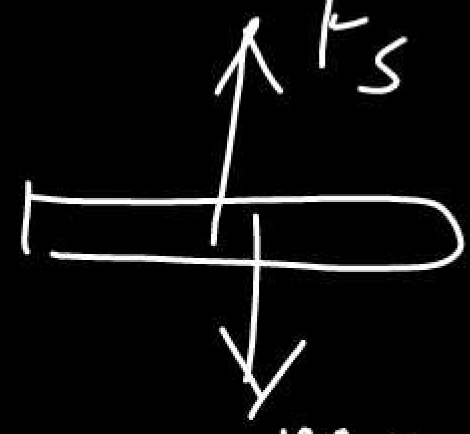
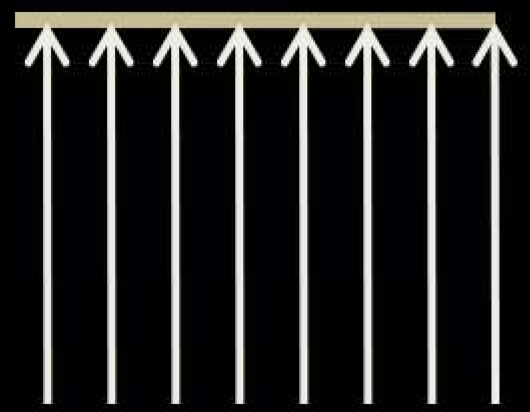




A). 20 MW

B). 30 MW

C). 50 MW

D). 10 MW

$F_s = mg$

$\frac{P}{C} = mg$

$P = C \times mg$

$= 3\times10^{8} \times 10\times10^{-3} \times 10$

$= 3\times10^{7} = 30\times10^{6}\,W = 30\,MW$

Normal Incidence

$$N_p = \frac{I_0 A \lambda}{hc} \times a$$

$$p_L = \frac{I_0 A}{c} \times a$$

$$\text{Force} = \frac{dp}{dt}$$

$$F_L = 0 - \left(\frac{I_0 A}{c} \times a\right)$$
$$= -I_0 A / c \times a$$

(i) $a = 1,\ r = 0$.

(from Newton's III law)

Force on surface, F_s

$$\boxed{F_s = \frac{I_0 A}{c} a}$$

$a = 1$

$$F_s = \frac{I_0 A}{c} = P/c$$

Pressure, $(F_s/A) = P_0 = I_0/c$

Case (ii) $\gamma = 1, a = 0.$

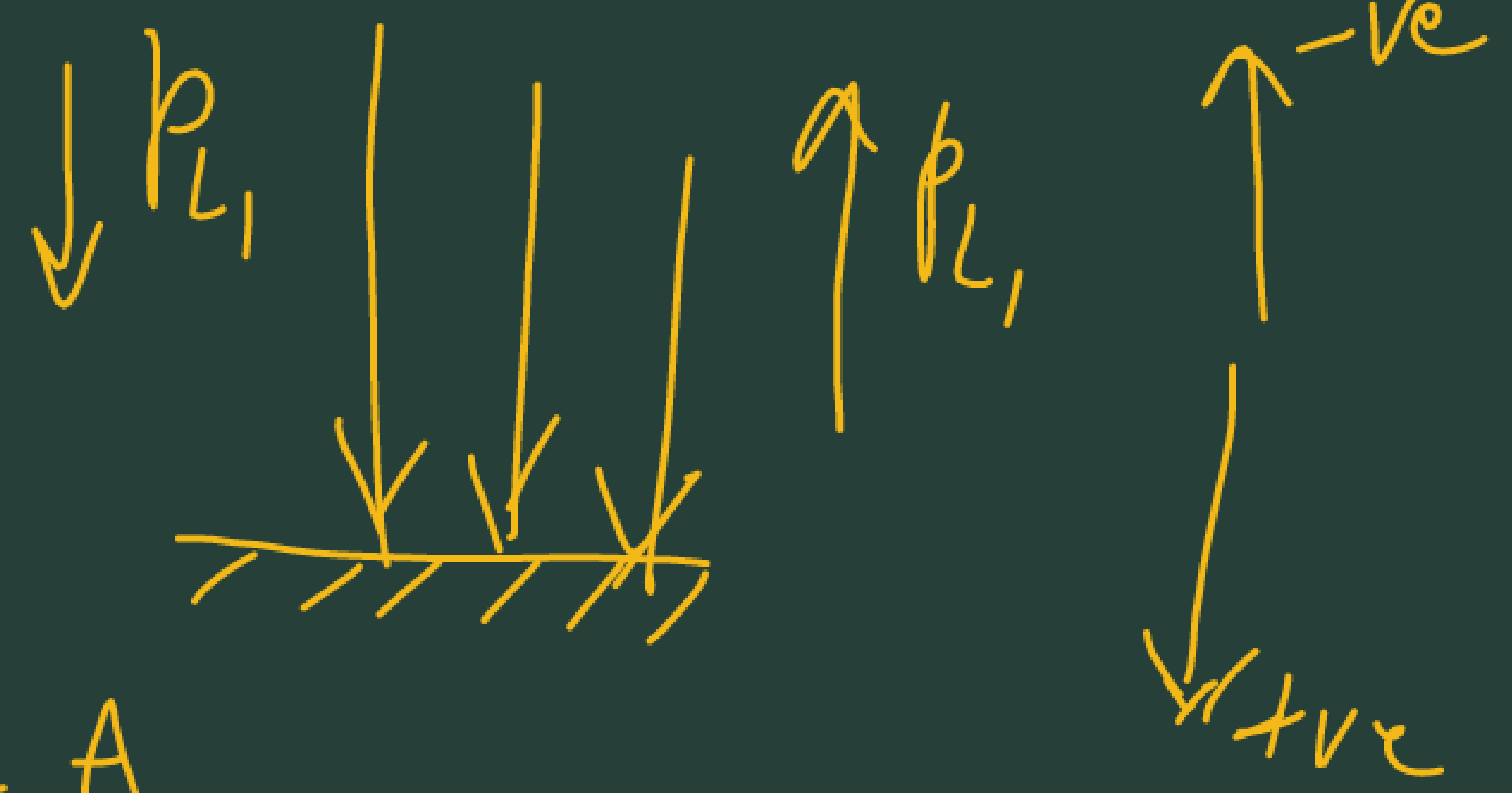
$$\Delta p_L = -p_{L_1} - p_{L_1}$$
$$= -2p_{L_1}$$

$$p_{L_1} = N_p \, h/\lambda$$
$$= \left(\frac{I_0 \times A\lambda}{hc}\right)\gamma \times \left(h/\lambda\right)$$
$$= \frac{I_0 A \gamma}{c} \rightarrow (\gamma = 1)$$

Force exerted on surface,

$$F_s = \frac{2I_0 A}{c}$$

$$P_0 = \frac{F_s}{A} = \frac{2I_0}{c}$$



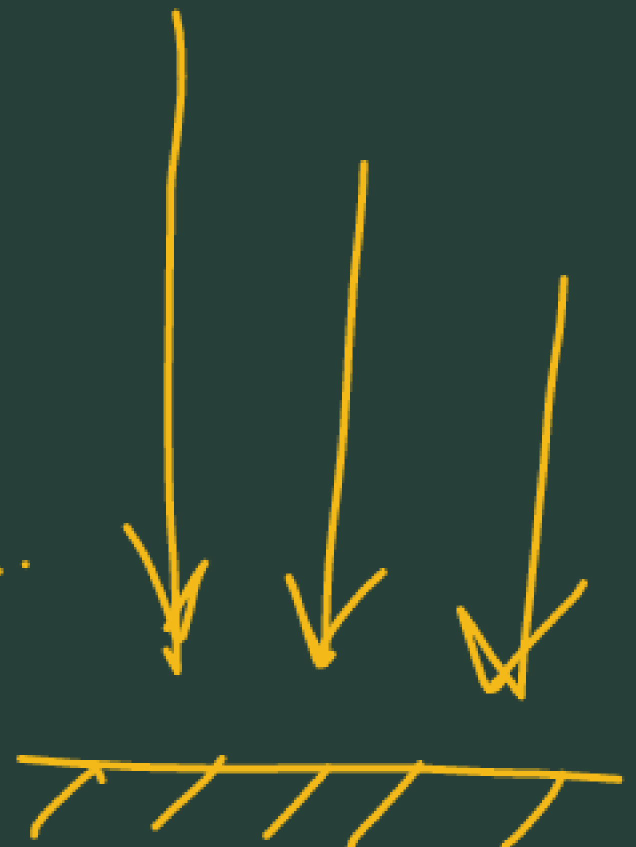
Case (iii) $0<a<1$, $0<r<1$ $\quad \boxed{a+r=1}$

$$F_s = [N_p] \times a \times \frac{h}{\lambda} + [N_p]\, r \times \frac{2h}{\lambda}$$

$$N_p = \frac{I_0 A \lambda}{hc}$$

$$F_s = \frac{I_0 A \cancel{\lambda}}{\cancel{h} c} \times a \frac{\cancel{h}}{\cancel{\lambda}} + \frac{I_0 A \cancel{\lambda}}{\cancel{h} c} \times r \times \frac{2\cancel{h}}{\cancel{\lambda}}$$

$$= \frac{I_0 A}{c}\left[a + 2r\right] = \frac{I_0 A}{c}(1+r)$$



radiation pressure

$$\boxed{P_0 = \frac{F_s}{A} = \frac{I_0}{c}(1+r)}$$

Case (iii)
$0 < a < 1$
$0 < r < 1$
$0 < a + r = 1$

$$N_p = \frac{I A \lambda}{hc}$$

$$N_p = \frac{I A\cos\theta \lambda}{hc}$$

Area of surface

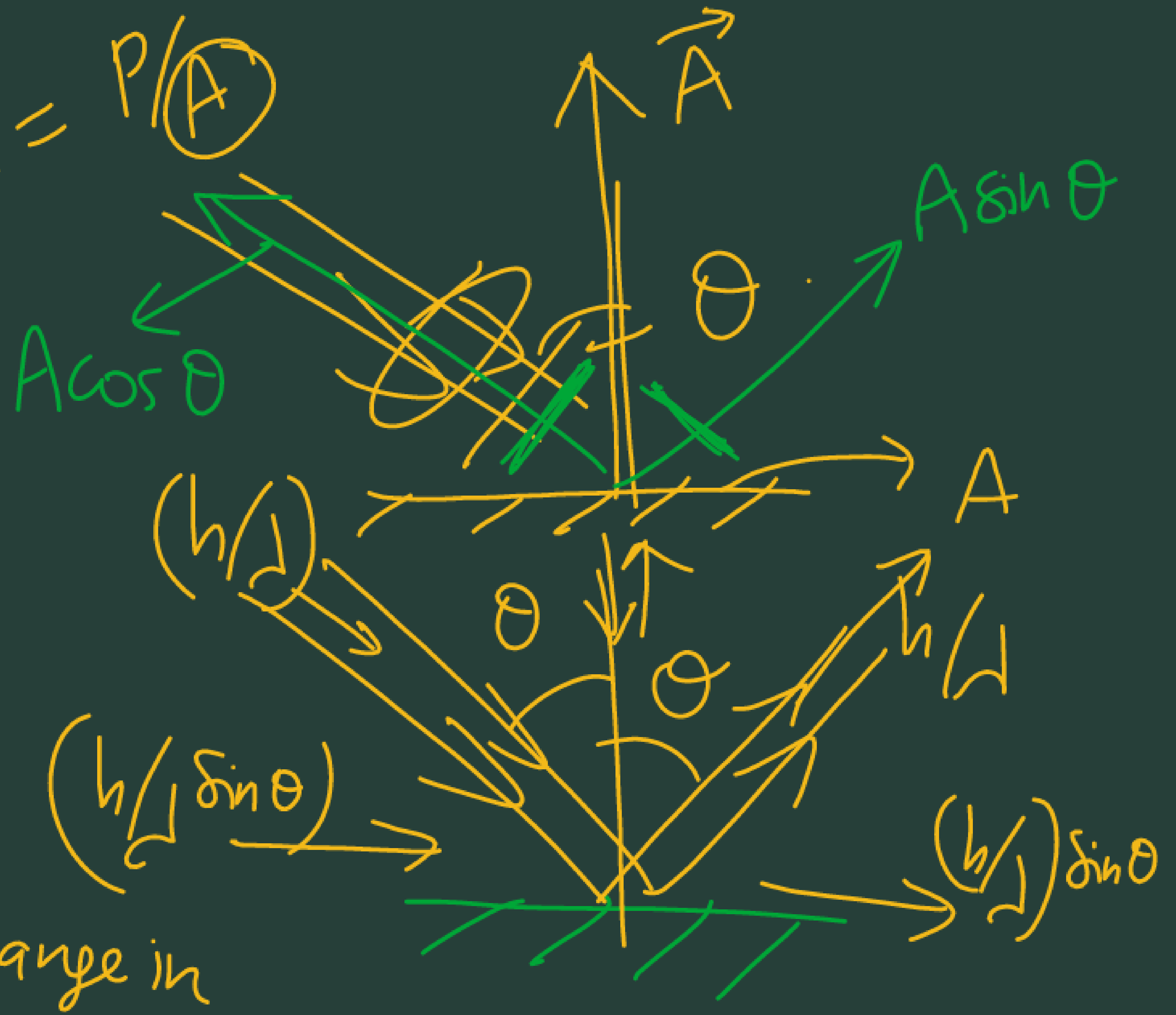
$$F_s = (N_p)\, a\left(\frac{h}{\lambda}\right)(\searrow) + (N_p)\, r\,(\quad)\downarrow$$

$$= \frac{I A \cos\theta \lambda}{hc}\left[a\frac{h}{\lambda}(\searrow) + r\cdot\frac{2h}{\lambda}\cos\theta(\downarrow)\right]$$

rate of change in momentum

$$\left(\frac{2h}{\lambda}\right)\cos\theta$$

$I = P/A$



what will be the dirn of force
(i). normal (ii) @ angle θ (iii) parallel