15/ENG04/002

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a.) ~~$E = 44000$ lux~~

~~ρ r.f $= 85\% = \frac{85}{100} = 0.85$~~

a.) i) Illumination, $E_1 = 44000$ lux

Reflection factor, $\rho = 85\% = \frac{85}{100} = 0.85$

Brightness, $L_1 = \frac{\rho E_1}{\pi} = \frac{0.85 \times 44000}{3.142}$

$= 11904.7897$

$= 1.1904 \times 10^4$ cd/m^2

(ii) Illumination, $E_2 = 0.22$ lux

$\rho = 0.85$

$L_2 = \frac{\rho E_2}{\pi} = \frac{0.85 \times 0.22}{3.142}$

$= 0.05952$

$= 5.95 \times 10^{-2}$ cd/m^2

b.)(i) Luminous Intensity, $I = \frac{\text{flux emitted by source}}{4\pi}$

flux emitted by source $= 120 \times 4\pi$

$= 480\pi$ lm

% flux emitted by the globe = % of flux emitted by source − % of flux absorbed by globe.

$= 100\% - 30\%$

% flux emitted by the globe = 70%

flux emitted by the globe = $70\% \times 480\pi$ lm

$= 336\pi$ lm

Luminance of the globe, $L = \frac{I}{A} = \frac{336\pi}{\pi d^2}$

$= \frac{336\pi}{\pi \times 0.22^2}$

$= 6942.15\ lm/m^2$

$\simeq 6942\ lm/m^2$

(ii) Since 1 candel = 4π lm

∴ candle-power or luminous intensity of the globe is

$= \frac{\text{flux in lumens}}{4\pi} = \frac{0.7 \times 480\pi}{\pi \times 4}$

$= 84\ cd$

c.) $\varepsilon_r = 6.5$

density = $0.55 g/cm^3$

p.f = 0.04

f = 20 MHz

t = 2cm = 0.02m

A = $75 cm^2 = 75 \times 10^{-4} m$

specific heat = $0.255\ cal/g°C$

$C = \frac{\varepsilon_0 \varepsilon_r A}{t} = \frac{8.85 \times 10^{-12} \times 6.5 \times 75 \times 10^{-4}}{0.02}$

$C = 21.57 \times 10^{-12} F$

$\omega = 2\pi f$

$= 2\pi \times 20 \times 10^6$

$= 125.664 \times 10^6\ rad/s$

$\cos\phi = 0.04$

$\phi = \cos^{-1}(0.04)$

$\phi = 87.71°$

$\delta = 90° - \phi$

$\delta = 90° - 87.71°$

$\delta = 2.29°$

$\text{Density} = \dfrac{\text{mass}}{\text{volume}}$

mass of slab $= 75 * 2 * 0.55$

$= 82.5\ g$

Heat required $=$ mass $\times$ specific heat $\times$ temp rise

$= 82.5 \times 0.255 \times (80 - 30)$

$= 1051.875$ cal

Total heat required $= \dfrac{1051.875}{0.85}$

$= 1237.5$ cal

Recall 1 cal $= 4.186$ J or W-s

Therefore, energy input $= 1237.5 \text{ cal} \times 4.186 =$

$= 5180.175$ W-s

Time $= 8$ mins

$= 8 \times 60$ s

$= 480$ s

$P = \dfrac{\text{Energy input}}{\text{time}} = \dfrac{5180.175}{480} = 10.79$ W

Recall, $P_i = V^2 \omega C \tan \delta$

$10.79 = V^2 (125.664 \times 10^6)(21.57 \times 10^{-12}) \tan 2.29°$

$V = 315.51$ V

$I = \dfrac{P}{V \cos \phi} = \dfrac{10.79}{315.51 \times 0.04}$

$I = 0.855$ A