Ministry of Higher Education	
Higher Institute for Engineering and Technology at Manzala	
First Semester 2022/2023	Date: 28 /11/2022
Mid-term Exam	Year: 1
Department: Civil & electronic Eng.	Time allowed: 60 mins.
Total mark:	Code: BS111
Course title : Physics 3	Examiner: Dr. Ali Samir Awad
رقم المسلسل :	اسم الطالب : .....

Answer all of the following questions

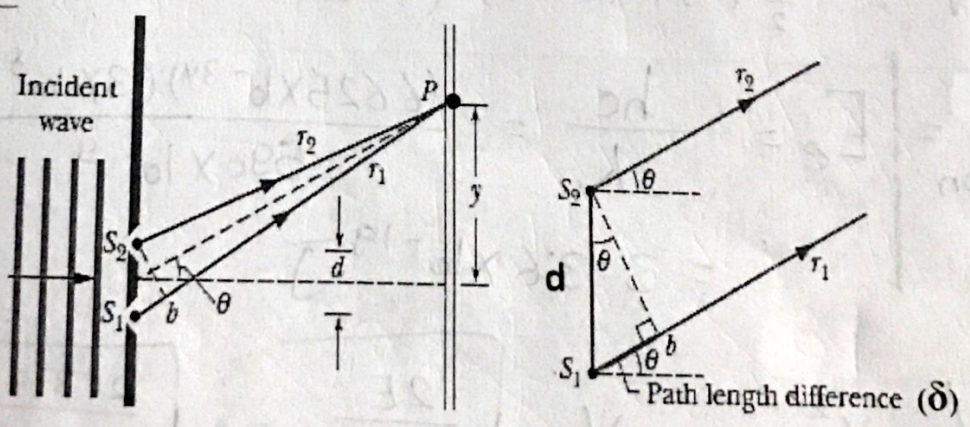
Q1: Two bodies *A* and *B* have thermal emissivities of 0.4 and 0.8 respectively. The outer surface area of the two bodies are the same. The two bodies emit total radiant power at the same rate. The wavelength λ_B corresponding to maximum spectral radiance in the radiation from *B* is shifted from the wavelength corresponding to maximum spectral radiance in the radiation from *A* by 1.00μm. If the temperature of *A* is 5802 K. calculate λ_B and T_B.

Q2: What is the energy of an electron whose de Broglie wavelength is that of a photon of yellow light with wavelength 590 nm? Then, what is the de Broglie wavelength of an electron whose energy is that of the photon of yellow light? $h=6.625\times10^{-34}$J.S , $c=3\times10^{8}$m/s and $m_e=9.1\times10^{-31}$kg.

Q3: White light, with a uniform intensity across the visible wavelength range of 400 to 690 nm, is perpendicularly incident on a water film, of index of refraction 1.33 and thickness 320 nm, that is suspended in air. At what wavelength λ is the light reflected by the film brightest to an observer?

Q4:Into one arm of a Michelson interferometer, a plastic sheet of thickness 75mm is inserted, which causes a shift in the interference pattern by 86 fringes. The light source has wavelength of 610 nm in air. What is the index of refraction of this plastic?

Q5: Calculate the intensity of laser beam (λ=625nm) fringe at point P. In case of d = 0.5μm, θ =30 and I_0 = 20 Lux.



The end of exam

Good luck,

$A_A = A_B$

$P_A = P_B$

$\lambda_B - \lambda_A = 1 \times 10^{-6}\ m$

$T_A = 5802\ ^\circ K$

$\varepsilon_A = 0.4$

$\varepsilon_B = 0.8$

Q1:- $* P_A = P_B$

$(\sigma \varepsilon A T^4)_A = (\sigma \varepsilon A T^4)_B$

$(0.4)(5802)^4 = (0.8)(T_B^4)$

$\therefore T_B = 4879\ ^\circ K$

$*$ From $\lambda_m T = \text{Constant}$ $\therefore \frac{\lambda_A}{\lambda_B} = \frac{T_B}{T_A}$

$\therefore \lambda_B = \frac{\lambda_A T_A}{T_B} = \frac{5802}{4879} \lambda_A$ $\therefore \lambda_B = 1.2 \lambda_A$

From $\lambda_B - \lambda_A = 1 \mu m$ $\therefore \lambda_B - \frac{\lambda_B}{1.2} = 1 \mu m$

$\therefore \lambda_B = 6\ \mu m = 6 \times 10^{-6}\ m$

Q2:- (a) $\lambda_e = \lambda_y = 590 \times 10^{-9}\ m$

$\lambda_y = 590 \times 10^{-9}\ m$

$h = 6.625 \times 10^{-34}$

$c = 3 \times 10^8\ m/s$

$m = 9.1 \times 10^{-31}\ kg$

$\lambda = \frac{h}{mV}$ $\therefore V = \frac{h}{m_e \lambda_e} = \frac{6.625 \times 10^{-34}}{(9.11 \times 10^{-31})(590 \times 10^{-9})}$

$= 1232.58\ m/s$

$E_e = \frac{1}{2} m V^2 = \frac{1}{2}(9.11 \times 10^{-31})(1232.58) = 6.92 \times 10^{-25}\ J$

(b) $E_{photon} = E_e = \frac{hc}{\lambda} = \frac{(6.625 \times 10^{-34})(3 \times 10^8)}{590 \times 10^{-9}}$

$= 3.36 \times 10^{-19}\ J$

$E_e = \frac{1}{2} m V^2$ $\therefore V = \sqrt{\frac{2E}{m}} = \sqrt{\frac{2(3.36 \times 10^{-19})}{(9.11 \times 10^{-31})}}$

$= 859.9 \times 10^3\ m/s$

$\therefore \lambda_e = \frac{h}{mV} = \frac{6.625 \times 10^{-34}}{(9.11 \times 10^{-31})(859.9 \times 10^3)} = 8.45 \times 10^{-10}\ m$

Q_3 :- $2L = (m + \frac{1}{2}) \frac{\lambda}{n_m}$ for $m = 0, 1, 2$

$\therefore \lambda_{at\,0} = \frac{2 n_m L}{(m + \frac{1}{2})} = \frac{2 \times 1.33 \times 320}{0 + \frac{1}{2}} = 1702.4\ nm$

$\therefore \lambda_{at\,1} = \frac{2 \times 1.33 \times 320}{1 + \frac{1}{2}} = 567.46\ nm$

$\therefore \lambda_{at\,2} = \frac{2 \times 1.33 \times 320}{(2 + \frac{1}{2})} = 340.48\ nm$

$\therefore$ the wavelength at which light seen by observer is brightest

$\lambda = 567.46\ nm.$

Q_4 :- $N_m - N_{air} = \frac{2t}{\lambda}(n-1)$

$86 = \frac{2 \times 75 \times 10^{-3}}{610 \times 10^{-9}}(n-1) \quad \therefore n = 1$

$N_m - N_{air} = 86$
$t = 75 \times 10^{-6}$
$\lambda = 610 \times 10^{-9}$

Q_5 :- $I = 4 I_0 \cos^2 \frac{1}{2} \phi$

From $\phi = \frac{2\pi d}{\lambda} \sin\theta \quad \therefore \phi = \frac{2\pi \times (0.5 \times 10^{-6})}{(625 \times 10^{-9})} \sin 30$

$= 144^\circ$

$\therefore I = 4(20) \cos^2 \frac{1}{2}(144) = 8$ Lux

$\lambda = 625$
$d = 0.5$
$\theta = 30$
$I = 20$