M-41-4

MAX LINDQUIST

36/26

b) A, the intensity will increase since there is no interference and therefore no destructive interference is taking place. → No minimums.

c) B, the intensity will decrease since there is no constructive interference, only "normal" intensity, which is lower than maximums created by interference.

E41

3) $\lambda = 512\,nm = 5{,}12 \cdot 10^{-7}\,m$

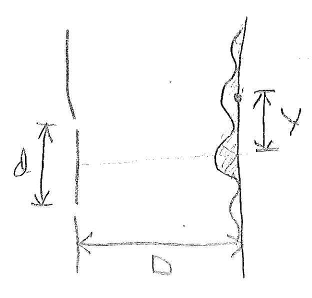
$d = 0{,}12\,mm = 1{,}2 \cdot 10^{-4}\,m$

$D = 5{,}4\,m$

$n = 1$

$$\frac{y}{D} = n \cdot \lambda \cdot \frac{1}{d} \Longleftrightarrow y = Dn\lambda \cdot \frac{1}{d} \;;\; n \in \mathbb{Z}$$

$$y = \frac{5{,}4\,m \cdot 1 \cdot 5{,}12 \cdot 10^{-7}\,m}{1{,}2 \cdot 10^{-4}\,m} = \boxed{2{,}3 \cdot 10^{-3}\,m}$$



E41

9

The distance between the first and tenth min is the same as the distance from the central max to the first max times 9, since the distance between two neighburing maximums is the same as between two minimums.

(4)

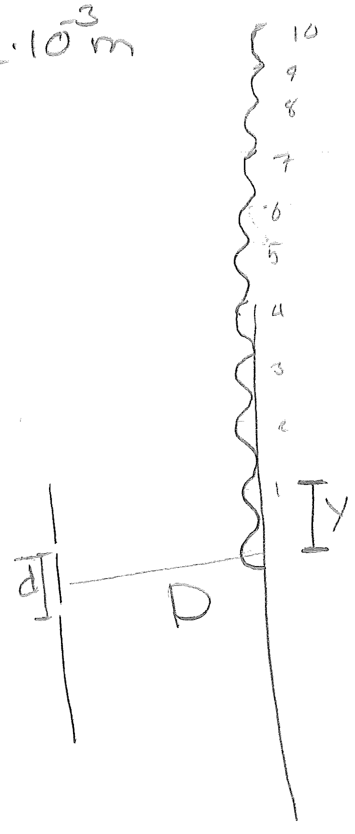
$9y = 18\,mm \Leftrightarrow y = 2\,mm = 2\cdot10^{-3}\,m$

$d = 0{,}15\,mm = 1{,}5\cdot10^{-4}\,m$

$D = 50\,cm = 0{,}5\,m$

$n = 1$

for $d \ll D$: $\frac{y}{D} = \frac{\lambda}{d} \Leftrightarrow \lambda = \frac{y\cdot d}{D}$ (1)



$$\lambda = \frac{2\cdot10^{-3}m \cdot 1{,}5\cdot10^{-4}m}{0{,}5\,m} = 6\cdot10^{-7}m$$

$= \boxed{600\,nm}$

M45

MAX LINDQUIST

$$c = f\lambda$$ constant

4 C (1) Increased wavelength means decreased frequency.

$$E = hf$$ constant

(2) Lower frequency means lower energy. Since one photon interacts with only one electron the escaping electrons will have a lower energy and therefore ~~[illegible]~~ we need lower voltage to stop all electrons from escaping. (1)

5

E (1) The intensity of the light is only relevant to the amount of electrons being emitted, not the way any single electron behaves. (1)

(2) Neiter does it affect the work function nor the cutoff frequency.

The energy with which they are emitted is not affected

$\boxed{E\ 45}$

$\boxed{3}$

$\lambda_1 = 375\,nm = 3{,}75 \cdot 10^{-7}\,m$ $\quad h = 6{,}626 \cdot 10^{-34}\,m$

$\lambda_2 = 5{,}80 \cdot 10^{-7}\,m$ $\quad c = 2{,}998 \cdot 10^{8}\,m/s$

$$c = f\lambda \Leftrightarrow f = \frac{c}{\lambda}$$

$$E = hf = h \cdot \frac{c}{\lambda}$$ (1)

$$E_{in} = \frac{hc}{\lambda_1}$$

(4)

$$E_{out} = \frac{hc}{\lambda_2}$$ (1)

$$E_{abs} = E_{in} - E_{out} = \frac{hc}{\lambda_1} - \frac{hc}{\lambda_2} = hc\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right) =$$

$$= 6{,}626 \cdot 10^{-34}\,Js \cdot 2{,}998 \cdot 10^{8}\,m/s \left(\frac{1}{3{,}75 \cdot 10^{-7}\,m} - \frac{1}{5{,}80 \cdot 10^{-7}\,m}\right)$$ (1)

$$\boxed{E_{abs} \approx 1{,}87 \cdot 10^{-19}\,J}$$ (1) $\quad \left[Js \cdot m/s \cdot \left(\frac{1}{m}\right) = J\right]$

MAX LINDQVIST

E45

19

$V_0 = 2{,}28\,eV$

$\alpha = 1240\,nm \cdot eV$

$\lambda_{red} = 678\,nm$

cutoff wavelenght

(1)

a) and b) $\lambda = \frac{\alpha}{V_0} = \frac{1240\,nm \cdot eV}{2{,}28\,eV} \approx \boxed{544\,nm}$ (1)

unit?

Red light with $\lambda = 678$ does not carry enough energy to remove an electron from sodium. (1) (6)

(the wavelength is greater than the cutoff wavelenght 544nm) (1)

b) color?

EXTRA

E41

19

(6)

$d = 4{,}17\,m$

$\lambda = 1{,}06\,m$

~~number of~~

$\boxed{x^2 + d^2 = y^2}$ (pythagoras's, see figure) (1)

$\boxed{y = x + n \cdot \lambda}$, $n \in \mathbb{Z}$

To create a maxima, the ~~difference~~ distance from S_2 to D has to be $n \in \mathbb{Z}$ times... (5)

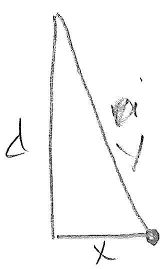
MAX LINDQUIST

∴ longer than S_1 to D.

$$X=\sqrt{y^2-d^2} \overset{(1)}{\Longleftrightarrow} X=\sqrt{(X-n\lambda)^2-d^2}$$

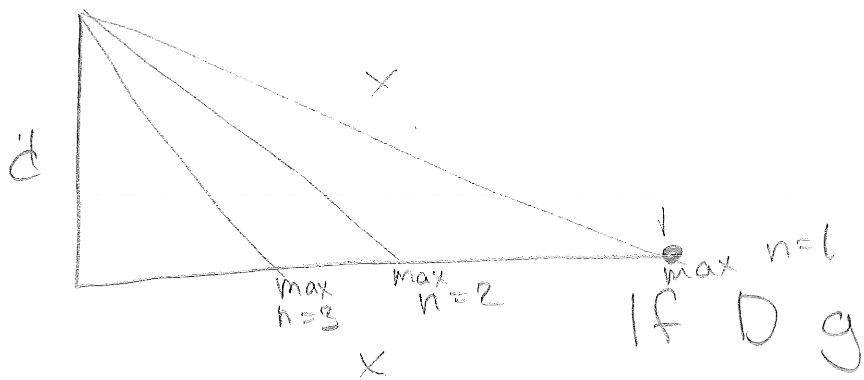
$$\Leftrightarrow X=\frac{d^2-(n\lambda)^2}{2n\lambda}, \quad n\in\mathbb{Z}, \quad n\neq 0.$$

a) We will get the first max when $n\cdot\lambda$ is as big as possible but lower than or equal to d.



$$\frac{d}{\lambda}=\frac{4{,}17m}{1{,}06m}=3{,}93396$$

so we get that $1\leq n\leq 3$,



If D goes further than max, n=1 then the difference in distance will get lower than λ, therefore, no more maximas will occur.

$n=1$

$$X=\frac{d^2-n\lambda^2}{2\lambda}=\frac{(4{,}17\,m)^2-(1{,}06\,m)^2}{2\cdot 1{,}06\,m}\approx\boxed{7{,}67\,m}$$ (1)

$\left[\frac{m^2}{m}\right]$

$n=2$

$$X=\frac{d^2-(2\lambda)^2}{4\lambda}=\frac{(4{,}17\,m)^2-(2\cdot 1{,}06\,m)^2}{4\cdot 1{,}06\,m}\approx\boxed{3{,}04\,m}$$ (1)

$n=3$

$$X=\frac{d^2-(3\cdot\lambda)^2}{\cancel{4}\,6\cdot\lambda}=\frac{\overset{(4{,}17\,m)^2}{(4\cdot 17\,m)^2}-(3\cdot 1{,}06\,m)^2}{6\cdot 1{,}06\,m}\approx\boxed{1{,}44\,m}$$ No. 1,14...

Answer: maximas occur at 1,44m, 3,04m and 7,67m from S_1.

b) ~~the~~ Since the point light sources are coherent, ~~and~~ in phase and have the same intensity the intensity ~~m~~ at a minima will be equal to zero. The two waves cancel each other out completely.

No. Not at the minimum closest to the screen

(7)

E45

$h = 6{,}626 \cdot 10^{-34}$ Js

$c = 2{,}998 \cdot 10^{8}$ m/s

n = number of photons emitted

t = time ~~..~~

MAX LINDQVIST

7 <u>UV</u>

$\lambda_{UV} = 400\,nm = 4{,}00 \cdot 10^{-7}\,m$

$P = 130\,W$

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<u>IR</u>

$\lambda_{IR} = 700\,nm = 7{,}00 \cdot 10^{-7}\,m$

$P = 130\,W$

Energy of <u>one</u> photon: $E_{ph} = hf$ 1

~~...~~

I want to investigate how many photons are emitted during the time t.

Total energy: $E = E_{ph} \cdot n$, $n \in \mathbb{Z}$

n is the number of photons.

$$E_{ph} = \frac{E}{n} = hf \Leftrightarrow \frac{E}{n} = h\frac{c}{\lambda} \Leftrightarrow \boxed{n = \frac{E\lambda}{hc}}$$

$$P = \frac{E}{t} \Leftrightarrow E = t \cdot P \text{, so } \boxed{n = \frac{tP\lambda}{hc}}$$

UV

$$\frac{n_{UV}}{t} = \frac{P\lambda_{UV}}{hc} = \frac{130\,W \cdot 4{,}00 \cdot 10^{-7}\,m}{6{,}626 \cdot 10^{-34}\,Js \cdot 2{,}998 \cdot 10^{8}\,m/s} \approx 2{,}62 \cdot 10^{20}\,s^{-1}$$

IR

$$\frac{n_{IR}}{t} = \frac{tP\lambda_{IR}}{hc} = \frac{160\,W \cdot 7{,}00 \cdot 10^{-7}\,m}{6{,}626 \cdot 10^{-34}\,Js \cdot 2{,}998 \cdot 10^{8}\,m/s} \approx 4{,}58 \cdot 10^{20}\,s^{-1}$$

Answer: During a certain time t, the UV-light will emit $3{,}22 \cdot t$ photons and IR-light will emit $5{,}64 \cdot t$ photons.
The IR light emitts photons at a greater rate (1)

b) $t = 1\,s$

$$n_{IR} - n_{UV} = \frac{tP\lambda_{IR}}{hc} - \frac{tP\lambda_{UV}}{hc} = \frac{tP}{hc}(\lambda_{IR} - \lambda_{UV}) =$$

$$= \frac{1\,s \cdot 130\,W}{6{,}602 \cdot 10^{-34}\,Js \cdot 2{,}998 \cdot 10^{8}\,m/s}\left(7{,}00 \cdot 10^{-7}\,m - 4{,}00 \cdot 10^{-7}\,m\right) \approx \boxed{1{,}96 \cdot 10^{20}} \; (1)$$

$$\left[\frac{s \cdot \cancel{J}/\cancel{s}}{\cancel{J}\cancel{s} \cdot \frac{m}{\cancel{s}}} \cdot m = 1\right]$$

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