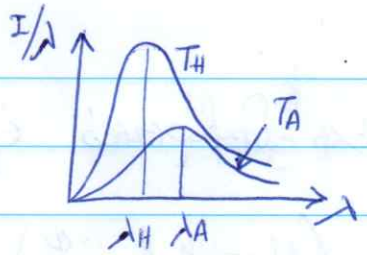
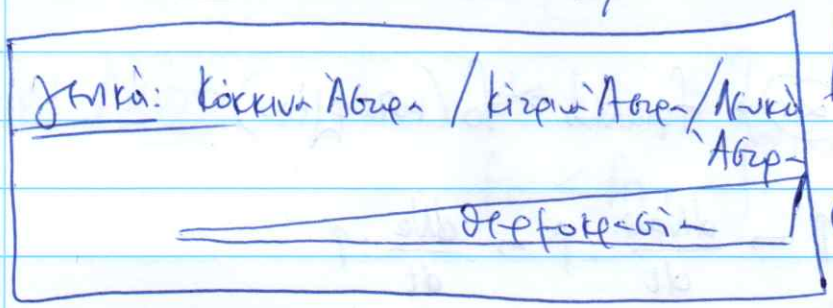
7.1

$T_A < T_H$



άρα $\lambda_A > \lambda_H$

λ_H : κίτρινο ⇒ λ_A : πορτοκαλί/κόκκινο



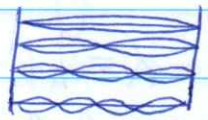
$\lambda_{max} \cdot T$ = σταθερό (ν. Wien)

$\lambda_A \cdot T_A = \lambda_H \cdot T_H$ } $\lambda_A > \lambda_H$ (κοκ. / κιτρ.)

$T_A < T_H$

7.2 ΝΑΙ : 1) Φορτίο: $Q = N \cdot e$ $(e = 1.6 \cdot 10^{-19} C)$ $(Q = \pm N \cdot e)$.

2) λ για σταθερά κύματα



7.3

e^-	φωτόνιο
m_e	$m_\phi = 0$
q_e	$q_\phi = 0$
$v_e < C$	$v_\phi = C$

7.4

Όχι : 1 φωτόνιο ⇔ 1 μόνος κύματος

(Λευκό φως : όλα τα μήκη κύματος μαζί)

7.5 κάθε υλικό (μέταλλο) έχει διαφορετικό έργο εξαγωγής

$(K = hf - \phi)$ $\quad$ $\left(V_0 = \frac{h}{e} f - \frac{\phi}{e}\right)$

7.6

α) Σωστό (αν) → $f_{φωτονίων} > f_0$ (καθοδίου)

τότε αν $I:\uparrow \Rightarrow \frac{dN_{φωτ.}}{dt}:\uparrow \Rightarrow \frac{dN_e}{dt}:\uparrow$

β) Λάθος εφόσον $f_{φωτ.} > f_0$

γ) Σωστό: $\left.\begin{matrix} K = hf - \phi \\ αν\ f:\uparrow \end{matrix}\right\} \Rightarrow K:\uparrow \Rightarrow \frac{1}{2}mυ^2:\uparrow \Rightarrow υ:\uparrow$

δ) Λάθος (αλλά με την μονοχρωματική είναι ευκολότερη η τήξη και οι τριβές)

7.7 α) Λάθος $\left.\begin{matrix} V_0 = \frac{h}{e} f - \frac{\phi}{e} \\ f_κ < f_π \end{matrix}\right\}$ $\boxed{V_{0(κ)} < V_{0(π)}}$

β) Λάθος $\left.\begin{matrix} K = hf - \phi \\ K \geq 0 \end{matrix}\right\} hf - \phi \geq 0 \Rightarrow f \geq \frac{\phi}{h} \Rightarrow \boxed{f_0 = \frac{\phi}{h}}$

γ) Σωστό $\boxed{f_0 = \frac{\phi}{h}}$

(7.7)

δ) Λάθος

$$V_0 = \frac{h}{e} f - \frac{\phi}{e}$$

$\phi_K = 2{,}2\,eV$, $\phi_{Cs} = 1{,}4\,eV$ $\Big\}$ $\phi_K > \phi_{Cs}$

$\Big\}$ $\Rightarrow V_{0(K)} < V_{0(Cs)}$

ε) Λάθος

$K = hf - \phi$, $f_K < f_n$ $\Big\}$ $\Rightarrow K_{(K)} < K_{(n)}$

στ) Λάθος

$$V_0 = \frac{h}{e} f - \frac{\phi}{e}, \quad E_\phi = hf$$

$\Rightarrow V_0 = E_\phi/e - \phi/e$

άρα: $E_\phi \uparrow \Rightarrow V_0 \uparrow$

(7.8) μεγαλύτερο φωτόνιο, μικρότερης φωτονίων ανακρούστηκαν ηλεκτρονίων

$$\lambda' - \lambda = \frac{h}{mc}(1-\sigma\upsilon\nu\theta) \Rightarrow$$

$$\Rightarrow \lambda' = \lambda + \frac{h}{mc}(1-\sigma\upsilon\nu\theta)$$

$-1 \le \sigma\upsilon\nu\theta \le 1 \Rightarrow 1-\sigma\upsilon\nu\theta > 0$ (πάντα)

άρα $\lambda' = \lambda +$ θετικό $\Rightarrow \boxed{\lambda' > \lambda}$

$$E = hf = h\frac{c}{\lambda} \xrightarrow{\lambda' > \lambda} \boxed{E' < E}$$

$$E_\phi + \cancel{K_e}^{\,0} = E'_\phi + K'_e \Rightarrow K'_e = E_\phi - E'_\phi \Rightarrow \boxed{K'_e = \Delta E_\phi}$$

7.9

$$\lambda' - \lambda = \frac{h}{mc}(1-\sigma\upsilon\nu\phi) \Rightarrow \boxed{\lambda' = \lambda + \frac{h}{mc}(1-\sigma\upsilon\nu\phi)} \quad (1)$$

α) $\left.\begin{matrix}\lambda_1 > \lambda_2 \\ \phi_1 = \phi_2\end{matrix}\right\} \xrightarrow{(1)} \boxed{\lambda_1' > \lambda_2'}$ άρα σωστή (1η)

αν ήθελε την αύξηση του μήκους κύματος:

$\lambda' - \lambda = \Delta\lambda = \frac{h}{mc}(1-\sigma\upsilon\nu\phi)$ θα ήταν η ίδια

(Λάθος - λύση το λυσάρι)

β) $\left.\begin{matrix}E_1 = hf_1 = h\frac{c}{\lambda_1} \\ E_2 = hf_2 = h\frac{c}{\lambda_2}\end{matrix}\right\} \lambda_1 > \lambda_2 \Rightarrow E_1 < E_2$

ΑΔΕ: $E + K_e^{\,0} = E' + K_e' \Rightarrow K_e' = E - E' = h\frac{c}{\lambda} - h\frac{c}{\lambda'} \Rightarrow$

$$\Rightarrow K_e' = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda'}\right) = hc\,\frac{\lambda' - \lambda}{\lambda\lambda'} \Rightarrow$$

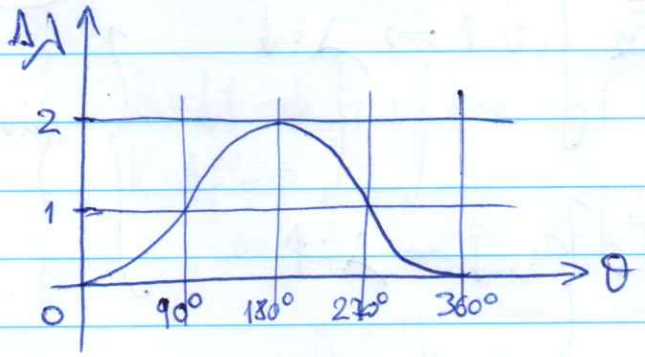
$$\Rightarrow K_e' = hc\,\frac{\frac{h}{mc}(1-\sigma\upsilon\nu\phi)}{\lambda\left(\lambda + \frac{h}{mc}(1-\sigma\upsilon\nu\phi)\right)} = \frac{A}{\lambda(\lambda + A)}$$

$A = \frac{h}{mc}(1-\sigma\upsilon\nu\phi) = $ σταθερό | αφού $\lambda_1 > \lambda_2 \Rightarrow \boxed{K_{e(1)}' < K_{e(2)}'}$

άρα η (2η)

7.10

$$\lambda' - \lambda = \frac{h}{mc}(1-\sigma\upsilon\nu\theta) \Rightarrow \Delta\lambda = \lambda_c \cdot (1-\sigma\upsilon\nu\theta)$$



$1-\sigma\upsilon\nu\theta = (-\sigma\upsilon\nu\theta)+1$

α) $1-\sigma\upsilon\nu 0° = 1-1 = 0$
β) $1-\sigma\upsilon\nu 45° = 1-0{,}7 = 0{,}3$
γ) $1-\sigma\upsilon\nu 90° = 1-0 = 1$

$\rightsquigarrow$ άρα (γ): $\Delta\lambda = max$ όταν $\theta = 90°$

7.11

$K_e = K_\alpha = K_n$

$$K = \frac{p^2}{2m} \Rightarrow p = \sqrt{2mK} \Rightarrow \lambda = \frac{h}{p} \Rightarrow$$

$$\Rightarrow \boxed{\lambda = \frac{h}{\sqrt{2mK}}}$$

αφού $m_\alpha > m_n > m_e$

$m_\alpha = 4m_p$
$m_n = m_p$
$m_e = \frac{1}{1836} m_e$

$\lambda_\alpha < \lambda_n < \lambda_e$

άρα το e^- έχει το μεγαλύτερο λ και το σωμάτιο α έχει το μικρότερο.

7.12 $\lambda = \frac{h}{p} = \frac{h}{mv}$

$\vec{F}_{ηλ} = q\cdot\vec{E} \xrightarrow[e^-]{q<0} \vec{F}_{ηλ} \uparrow\downarrow \vec{E}$

α) e^- $\vec{v}$ $\vec{F}_{ηλ}$; $\vec{E}$ ← $\Big\}$ $v:\uparrow \Rightarrow \lambda:\downarrow$

β) $\vec{v}$ e^- $\vec{F}_{ηλ}$; $\vec{E}$ ← $\Big\}$ $v:\downarrow \Rightarrow \lambda:\uparrow$

$\Big\}$ Λάθος χώρια θεο λυδιει

γ) v e^- $\vec{F}_{Lo}=0$; B ← $\Big\}$ $v:$ σταθ $\Rightarrow \lambda:$ σταθερό

δ) v ↑ e^- $\otimes \vec{F}_{Lo}$; B ← $\Big\}$ $\vec{F}_{Lo}=\vec{F}_K \Rightarrow v:$ σταθ $\Rightarrow \lambda:$ σταθερό

7.13 α) Σωστό: $\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{6{,}64\cdot10^{-34}}{mv}$: πολύ μικρό

7.14 $\Delta x \ll$ Διαστάσεις των αντικειμένων

ΑΣΚΗΣΕΙΣ ΚΒΑΝΤΟΜΗΧΑΝΙΚΗΣ
ΣΧΟΛΙΚΟΥ ΒΙΒΛΙΟΥ

7.15

$\lambda = 400\,nm$
$K = 0{,}8\,eV$
$K' = ?$
$\lambda' = 500\,nm$
$h = 6{,}626 \cdot 10^{-34}\,J\cdot s$
$c = 3 \cdot 10^8\,m/s$
$1\,eV = 1{,}6 \cdot 10^{-19}\,J$

$$\left.\begin{matrix} K = hf - \phi \\ K' = hf' - \phi \end{matrix}\right\} (-1) \Rightarrow K - K' = hf - hf' = h(f - f') = h\left(\frac{c}{\lambda} - \frac{c}{\lambda'}\right)$$

$$\Rightarrow K - K' = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda'}\right) \Rightarrow$$

$$\Rightarrow \boxed{K' = K - hc\left(\frac{1}{\lambda} - \frac{1}{\lambda'}\right)} \Rightarrow$$

$$\Rightarrow K' = 0{,}8eV - 6{,}626 \cdot 10^{-34}\,J\cdot s \cdot 3 \cdot 10^8 \frac{m}{s}\left(\frac{1}{400 \cdot 10^{-9}} - \frac{1}{500 \cdot 10^{-9}}\right) =$$

$$= 0{,}8eV - 6{,}626 \cdot 3 \cdot 10^7 \left(\frac{1}{4} - \frac{1}{5}\right) \cdot 10^{-34} \cdot 10^9 =$$

$$= 0{,}8eV - 9{,}939 \cdot 10^{-20}\,J = 0{,}8eV - \frac{9{,}939 \cdot 10^{-20}}{1{,}6 \cdot 10^{-19}}\,eV =$$

$$= 0{,}8eV - 0{,}621eV \Rightarrow \boxed{K' = 0{,}1788eV}$$

7.16

$\lambda = 400\,nm$
$v = 8 \cdot 10^5\,m/s$
$\phi = ;$
$h = 6{,}626 \cdot 10^{-34}\,J\cdot s$
$c = 3 \cdot 10^8\,m/s$
$m_e = 9{,}1 \cdot 10^{-31}\,kg$
$1\,eV = 1{,}6 \cdot 10^{-19}\,J$

$$K = hf - \phi \Rightarrow \phi = hf - K \Rightarrow \boxed{\phi = h\frac{c}{\lambda} - \frac{1}{2}m_e v^2} \Rightarrow$$

$$\Rightarrow \phi = 6{,}626 \cdot 10^{-34} \cdot \frac{3 \cdot 10^8}{400 \cdot 10^{-9}} - \frac{1}{2} \cdot 9{,}1 \cdot 10^{-31} \cdot (8 \cdot 10^5)^2 =$$

$$= 2{,}0575 \cdot 10^{-19}\,J = \frac{2{,}0575 \cdot 10^{-19}}{1{,}6 \cdot 10^{-19}}\,eV \Rightarrow \boxed{\phi = 1{,}2859\,eV}$$

7.17

$\Phi = 1,8\,eV$
$V_0 = ?$
$\lambda = 400\,nm$
$h = 6,626 \cdot 10^{-34}\,J \cdot s$
$c = 3 \cdot 10^8\,m/s$
$e = 1,6 \cdot 10^{-19}\,C$
$1eV = 1,6 \cdot 10^{-19}\,J$

$K = hf - \Phi$
$K = e \cdot V_0$

$e \cdot V_0 = hf - \Phi \Rightarrow \boxed{V_0 = \frac{h}{e}\frac{c}{\lambda} - \frac{\Phi}{e}} \Rightarrow$ ($f = \frac{c}{\lambda}$)

$\Rightarrow V_0 = \frac{6,626 \cdot 10^{-34}}{1,6 \cdot 10^{-19}} \frac{3 \cdot 10^8}{400 \cdot 10^{-9}} - \frac{1,8 \cdot 1,6 \cdot 10^{-19}}{1,6 \cdot 10^{-19}} \Rightarrow$

$\Rightarrow V_0 = 3,106 - 1,8 \Rightarrow \boxed{V_0 = 1,306\,Volt}$

7.18

Ορατό: 400-700 nm
$\Phi_{ΤΑΛ} = 4,2\,eV$
$\Phi_{Βολ} = 4,5\,eV$
$\Phi_{ΒΑΡ} = 2,5\,eV$
$\Phi_{ΛΙΘ} = 2,3\,eV$
$h = 6,626 \cdot 10^{-34}\,J \cdot s$
$c = 3 \cdot 10^8\,m/s$
$1eV = 1,6 \cdot 10^{-19}\,J$

$K = hf - \Phi$
για να δίνουν φωτοηλεκτρόνια $\Big\} K \geq 0$

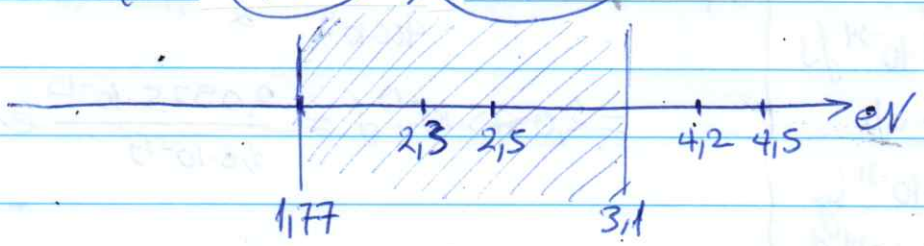
$hf - \Phi \geq 0 \Rightarrow hf \geq \Phi \Rightarrow$

$\Rightarrow \boxed{\Phi \leq \frac{hc}{\lambda}}$

400 nm: $\frac{hc}{\lambda} = \frac{6,626 \cdot 10^{-34} \cdot 3 \cdot 10^8}{400 \cdot 10^{-9}} = 4,97 \cdot 10^{-19}\,J \overset{:e}{=} 3,1\,eV$

700 nm: $\frac{hc}{\lambda} = \frac{6,26 \cdot 10^{-34} \cdot 3 \cdot 10^8}{700 \cdot 10^{-9}} = 2,84 \cdot 10^{-19}\,J \overset{:e}{=} 1,77\,eV$

Άρα: Λίθιο & Βάριο



7.19

$V_0 = 0{,}71\ V$
$\lambda = 491\ nm$
$V_0' = 1{,}43\ V$
$\phi = ?$
$\lambda' = ?$
$h = 6{,}626 \cdot 10^{-34}\ J \cdot s$
$c = 3 \cdot 10^8\ m/s$
$e = 1{,}6 \cdot 10^{-19}\ C$
$1eV = 1{,}6 \cdot 10^{-19}\ J$

$\left.\begin{array}{l} K = hf - \phi \\ K = e \cdot V_0 \end{array}\right\} e \cdot V_0 = hf - \phi \Rightarrow V_0 = \frac{h}{e} f - \frac{\phi}{e} \Rightarrow$

$$\Rightarrow \boxed{V_0 = \frac{h}{e}\frac{c}{\lambda} - \frac{\phi}{e}}$$

a) $V_0 = \frac{hc}{e\lambda} - \frac{\phi}{e} \Rightarrow 0{,}71 = \frac{6{,}626 \cdot 10^{-34} \cdot 3 \cdot 10^8}{1{,}6 \cdot 10^{-19} \cdot 491 \cdot 10^{-9}} - \frac{\phi}{e} \Rightarrow$

$$\Rightarrow \frac{\phi}{e} = 2{,}53 - 0{,}71 = 1{,}82\ V \Rightarrow$$

$$\Rightarrow \phi = 1{,}82\ V \cdot e \Rightarrow \boxed{\phi = 1{,}82\ eV}$$

b) $V_0' = \frac{h \cdot c}{e\lambda'} - \frac{\phi}{e} \Rightarrow V_0' + \frac{\phi}{e} = \frac{hc}{e\lambda'} \Rightarrow e\lambda' = \frac{hc}{V_0' + \phi/e} \Rightarrow$

$$\Rightarrow \boxed{\lambda' = \frac{hc}{e \cdot V_0' + \phi}} \Rightarrow \lambda' = \frac{6{,}626 \cdot 10^{-34} \cdot 3 \cdot 10^8}{1{,}6 \cdot 10^{-19} \cdot 1{,}43 + 1{,}82 \cdot 1{,}6 \cdot 10^{-19}} \Rightarrow$$

$$\Rightarrow \lambda' = 3{,}822 \cdot 10^{-7}\ m = 382{,}2 \cdot 10^{-9}\ m \Rightarrow$$

$$\Rightarrow \boxed{\lambda' = 382{,}2\ nm}$$

7.20

$f_0 = 5{,}6 \cdot 10^{14}\ Hz$
$K = ?$
$f = 8{,}6 \cdot 10^{14}\ Hz$
$h = 6{,}626 \cdot 10^{-34}\ J \cdot s$
$1eV = 1{,}6 \cdot 10^{-19}\ J$

$K = hf - \phi \xrightarrow{K \geq 0} hf - \phi \geq 0 \Rightarrow hf \geq \phi \Rightarrow f \geq \frac{\phi}{h} \Rightarrow$

$$\Rightarrow \boxed{f_0 = \phi/h} \Leftrightarrow \boxed{\phi = h \cdot f_0}$$

$$K = hf - \phi \Rightarrow K = hf - hf_0 \Rightarrow \boxed{K = h(f - f_0)} \Rightarrow$$

$$\Rightarrow K = 6{,}626 \cdot 10^{-34}(8{,}6 \cdot 10^{14} - 5{,}6 \cdot 10^{14}) = 1{,}9878 \cdot 10^{-19}\ Joule \Rightarrow$$

$$\overset{\div e}{\Rightarrow} \boxed{K = 1{,}242\ eV}$$

7.21

$P=200W$
$\lambda=600nm$
$r=10m$
$r'=20mm$
$N_\phi=?\ \Delta t=0,1sec$
$c=3\cdot10^8 m/s$
$h=6,63\cdot10^{-34} J\cdot s$

$$I=\frac{P}{A}=\frac{P}{4\pi r^2}=\frac{200}{4\pi\cdot10^2}=\frac{1}{2\pi}\ W/m^2$$

$$P'=I\cdot A'=I\cdot\pi r'^2=\frac{1}{2\pi}\cdot\pi\cdot(20\cdot10^{-3})^2=200\cdot10^{-6}\Rightarrow$$

$$\Rightarrow P'=2\cdot10^{-4}\ W$$

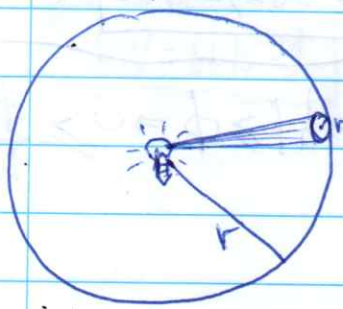
$$P'=\frac{E'}{\Delta t}\Rightarrow E'=P'\Delta t=2\cdot10^{-4}\cdot0,1\Rightarrow E'=2\cdot10^{-5}\ Joule$$

$$E'=N_\phi\cdot hf=N_\phi hc/\lambda\Rightarrow N_\phi=\frac{E'\lambda}{hc}=\frac{2\cdot10^{-5}\cdot600\cdot10^{-9}}{6,63\cdot10^{-34}\cdot3\cdot10^8}\Rightarrow$$

$$\Rightarrow\boxed{N_\phi=6,03318\cdot10^{13}\ \text{φωτόνια}}$$

7.21 2ος τρόπος

$$P=\frac{E}{\Delta t}\Rightarrow E=P\cdot\Delta t=200\cdot0,1\Rightarrow E=20\ Joule$$



Η "ποσότητα" της ενέργειας απέχει σε σφαίρα ακτίνας r και επιφάνειας $4\pi r^2$. Τμήμα της ενέργειας αυτής διέρχεται από την κυκλική επιφάνεια ακτίνας r' και επιφάνειας $\pi r'^2$. Άρα:

$$E'=\frac{\pi r'^2}{4\pi r^2}E=\frac{1}{4}\left(\frac{r'}{r}\right)^2E=\frac{1}{4}\left(\frac{0,02}{10}\right)^2\cdot20\Rightarrow$$

$$\Rightarrow E'=2\cdot10^{-5}\ Joule$$ και η συνέχεια η ίδια...

7.22

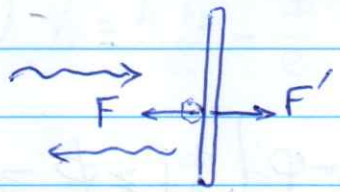
$\lambda = ?$
$P_\phi = P_e$
$v_e = 2 \cdot 10^5 \, m/s$
$c = 3 \cdot 10^8 \, m/s$
$h = 6{,}63 \cdot 10^{-34} \, Js$
$m_e = 9{,}1 \cdot 10^{-31} \, kg$

$P_\phi = P_e \Rightarrow \frac{h}{\lambda} = mv \Rightarrow \boxed{\lambda = \frac{h}{mv}} \Rightarrow$

$\Rightarrow \lambda = \frac{6{,}63 \cdot 10^{-34}}{9{,}1 \cdot 10^{-31} \cdot 2 \cdot 10^5} = 3{,}64 \cdot 10^{-9} \, m \Rightarrow \boxed{\lambda = 3{,}64 \, nm}$

7.23

$N_\phi = ?$
$\lambda = 663 \, nm$
$\Delta t = 1 \, sec$
$F = 1 N$
$h = 6{,}63 \cdot 10^{-34} \, J \cdot s$



$F = F' = \frac{\Delta P}{\Delta t} = \frac{P - (-P)}{\Delta t} = \frac{2P}{\Delta t} = \frac{2 \cdot \frac{h}{\lambda}}{\Delta t} \Rightarrow$

$\Rightarrow \boxed{F' = \frac{2h}{\lambda \cdot \Delta t}} \Rightarrow F' = \frac{2 \cdot 6{,}63 \cdot 10^{-34}}{663 \cdot 10^{-9} \cdot 1} \Rightarrow$

$\Rightarrow \boxed{F' = 2 \cdot 10^{-27} N}$ η δύναμη που ασκεί 1 φωτόνιο στην ανακλαστική επιφάνεια.

Για να βγει $F_{ολ.} = 1 N$ θα πρέπει:

$F_{ολ} = N_\phi \cdot F' \Rightarrow N_\phi = \frac{F_{ολ}}{F'} = \frac{1}{2 \cdot 10^{-27}} = 0{,}5 \cdot 10^{27} \Rightarrow$

$\Rightarrow \boxed{N_\phi = 5 \cdot 10^{26} \text{ φωτόνια}}$

7.24

$\phi = 5eV$
$\lambda = 200 нм$
$V_0 = ?$
$c = 3 \cdot 10^8 м/с$
$h = 6{,}63 \cdot 10^{-34} Дж \cdot с$
$1eV = 1{,}6 \cdot 10^{-19} Дж$

$K = hf - \phi \Rightarrow e \cdot V_0 = h\frac{c}{\lambda} - \phi \Rightarrow \boxed{V_0 = \frac{hc}{e\lambda} - \frac{\phi}{e}} \Rightarrow$

$\Rightarrow V_0 = \frac{6{,}63 \cdot 10^{-34} \cdot 3 \cdot 10^8}{1{,}6 \cdot 10^{-19} \cdot 200 \cdot 10^{-9}} - \frac{5 \cdot 1{,}6 \cdot 10^{-19}}{1{,}6 \cdot 10^{-19}} \Rightarrow$

$\Rightarrow V_0 = 6{,}21 - 5 \Rightarrow \boxed{V_0 = 1{,}21 Вольт}$

7.25

$\phi = 2{,}7 eV$
$\lambda_{max} = ?$
$c = 3 \cdot 10^8 м/с$
$h = 6{,}63 \cdot 10^{-34} Дж \cdot с$
$1eV = 1{,}6 \cdot 10^{-19} Дж$

$\left.\begin{matrix} K = hf - \phi \\ K \geq 0 \end{matrix}\right\} hf \geq \phi \Rightarrow f \geq \frac{\phi}{h} \Rightarrow \frac{c}{\lambda} \geq \frac{\phi}{h} \Rightarrow$

$\Rightarrow ch \geq \phi\lambda \Rightarrow \lambda \leq \frac{hc}{\phi} \Rightarrow$

$\Rightarrow \boxed{\lambda_{max} = \frac{hc}{\phi}} \Rightarrow \lambda_{max} = \frac{6{,}63 \cdot 10^{-34} \cdot 3 \cdot 10^8}{2{,}7 \cdot 1{,}6 \cdot 10^{-19}} \Rightarrow$

$\Rightarrow \lambda_{max} = 4{,}604 \cdot 10^{-7} м = 460{,}7 \cdot 10^{-9} м$

$\Rightarrow \boxed{\lambda_{max} = 460{,}7 нм}$

7.26

$\lambda_1 = 550\ nm$

$V_1 = 0,19\ Volt$

a) $\phi = ?$

b) $V_2 = ?$

$\lambda_2 = 190\ nm$

c) $f_0 = ?$

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

$h = 6,63 \cdot 10^{-34}\ J \cdot s$

$e = 1,6 \cdot 10^{-19}\ C$

$1eV = 1,6 \cdot 10^{-19}\ C$

a) $V_1 = \frac{h}{e} f_1 - \frac{\phi}{e} \Rightarrow e \cdot V_1 = h\frac{c}{\lambda_1} - \phi \Rightarrow \boxed{\phi = \frac{hc}{\lambda_1} - e \cdot V_1} \Rightarrow$

$\Rightarrow \phi = \frac{6,63 \cdot 10^{-34} \cdot 3 \cdot 10^8}{550 \cdot 10^{-9}} - 1,6 \cdot 10^{-19} \cdot 0,19 \Rightarrow$

$\Rightarrow \phi = 3,312 \cdot 10^{-19}\ J \xrightarrow{\div e} \boxed{\phi = 2,07\ eV}$

b) $V_2 = \frac{h \cdot f_2}{e} - \frac{\phi}{e} = \frac{h \cdot c}{e \cdot \lambda_2} - \frac{\phi}{e} = \frac{6,63 \cdot 10^{-34} \cdot 3 \cdot 10^8}{1,6 \cdot 10^{-19} \cdot 190 \cdot 10^{-9}} - \frac{2,07}{e}$

$\Rightarrow V_2 = 6,54 - 2,07 \Rightarrow \boxed{V_2 = 4,47\ Volt}$

c) $f_0 = \frac{\phi}{h} = \frac{2,07 \cdot 1,6 \cdot 10^{-19}}{6,63 \cdot 10^{-34}} \Rightarrow \boxed{f = 4,995 \cdot 10^{14}\ Hz}$

7.27

$\lambda = 2,4\ pm$

$\lambda' = ?$

a) $\phi = 30°$

b) $\phi = 60°$

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

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

$m_e = 9,1 \cdot 10^{-31}\ kg$

$\lambda' - \lambda = \frac{h}{mc}(1 - \cos\theta) \Rightarrow \boxed{\lambda' = \lambda + \frac{h}{mc}(1 - \cos\theta)}$

$\frac{h}{mc} = \frac{6,626 \cdot 10^{-34}}{9,1 \cdot 10^{-31} \cdot 3 \cdot 10^8} = 2,427 \cdot 10^{-12}\ m = 2,427\ pm$

a) $\lambda' = \lambda + \frac{h}{mc}(1 - \cos\theta) = 2,4 + 2,427 \cdot (1 - \cos 30°) \Rightarrow$

$\Rightarrow \boxed{\lambda' = 2,72\ pm}$

b) $\lambda' = \lambda + \frac{h}{mc}(1 - \cos\theta) = 2,4 + 2,427(1 - \cos 60°) \Rightarrow$

$\Rightarrow \boxed{\lambda' = 3,61\ pm}$

7.28

$\lambda = 10^{-11} m$

$\phi = 180^\circ$

$\Delta E = ?$

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

$c = 3 \cdot 10^{8} m/s$

$m_e = 9{,}1 \cdot 10^{-31} kg$

$1eV = 1{,}6 \cdot 10^{-19} J$

$$\lambda' - \lambda = \frac{h}{mc}(1-\cos\theta) \Rightarrow \lambda' = \lambda + \frac{h}{mc}(1-\cos\theta) \Rightarrow$$

$$\Rightarrow \lambda' = 10^{-11} m + \frac{6{,}63 \cdot 10^{-34}}{9{,}1 \cdot 10^{-31} \cdot 3 \cdot 10^{8}}(1-\cos 180^\circ) \Rightarrow$$

$$\Rightarrow \lambda' = 10^{-11} + 4{,}857 \cdot 10^{-12} = 10 \cdot 10^{-12} + 4{,}857 \cdot 10^{-12} \Rightarrow$$

$$\Rightarrow \boxed{\lambda' = 1{,}485 \cdot 10^{-11} m}$$

$$\Delta E = E' - E = hf' - hf = h\frac{c}{\lambda'} - h\frac{c}{\lambda} = hc\left(\frac{1}{\lambda'} - \frac{1}{\lambda}\right) \Rightarrow$$

$$\Rightarrow \Delta E = 6{,}63 \cdot 10^{-34} \cdot 3 \cdot 10^{8}\left(\frac{1}{1{,}485 \cdot 10^{-11}} - \frac{1}{10^{-11}}\right) \Rightarrow$$

$$\Rightarrow \Delta E = -6{,}5 \cdot 10^{-15} J \xrightarrow{\div e} \boxed{\Delta E = -40{,}6 keV}$$

20 "–" διαγών ΜΓΟΔΗ

7.29

Δίνεται: $E_\phi = 0{,}2 MeV$

α) $\lambda = ?$

β) $\lambda' = ?$ $\varphi = 90^\circ$

γ) $E_{1\phi} = ?$, $\varphi' = 60^\circ$

$c = 3 \cdot 10^{8} m/s$

$h = 6{,}63 \cdot 10^{-34} J\cdot s$

$1eV = 1{,}6 \cdot 10^{-19} J$

$m_e = 9{,}1 \cdot 10^{-31} kg$

α) $E = hf \Rightarrow E = hc/\lambda \Rightarrow \lambda = \frac{hc}{E} \Rightarrow$

$$\Rightarrow \lambda = \frac{6{,}63 \cdot 10^{-34} \cdot 3 \cdot 10^{8}}{0{,}2 \cdot 10^{6} \cdot 1{,}6 \cdot 10^{-19}} \Rightarrow \lambda = 6{,}125 \cdot 10^{-12} m \Rightarrow$$

$$\Rightarrow \boxed{\lambda = 6{,}125 pm}$$

β) $\lambda' = \lambda + \frac{h}{mc}(1-\cos\varphi) = 6{,}125 \cdot 10^{-12} + \frac{6{,}63 \cdot 10^{-34}}{9{,}1 \cdot 10^{-31} \cdot 3 \cdot 10^{8}}(1 - \cos 90^\circ) \Rightarrow$

$$\Rightarrow \lambda' = 8{,}553 \cdot 10^{-12} m \Rightarrow \boxed{\lambda' = 8{,}553 pm}$$

(7.29)

δ) $\lambda' = \lambda + \frac{h}{mc}(1-\cos\vartheta) = 6{,}125\cdot10^{-12} + \frac{6{,}63\cdot10^{-34}}{9{,}1\cdot10^{-31}\cdot3\cdot10^{8}}(1-\cos60^\circ) = 7{,}34\cdot10^{-12}\,m$

$E = hf = hc/\lambda = 6{,}63\cdot10^{-34}\cdot3\cdot10^{8}/7{,}34\cdot10^{-12} = 2{,}71\cdot10^{-14}\,J \Rightarrow$

$\div e \Rightarrow \boxed{E = 0{,}169\cdot10^{6}\,eV = 0{,}169\,MeV}$

7.30

$\lambda = ?$

α) e: $m_e = 9{,}1\cdot10^{-31}$
$v_e = 2\cdot10^{6}\,m/s$

β) p: $m_p = 1{,}67\cdot10^{-27}\,kg$
$v_p = 2\cdot10^{6}\,m/s$

δ) ball: $m = 0{,}2\,kg$
$v_b = 2\cdot10^{6}\,kg$

$h = 6{,}63\cdot10^{-34}\,J\cdot s$

$\lambda = \frac{h}{p} = \frac{h}{mv}$

α) $\lambda_e = \frac{6{,}63\cdot10^{-34}}{9{,}1\cdot10^{-31}\cdot2\cdot10^{6}} = 3{,}64\cdot10^{-10}\,m$

β) $\lambda_p = \frac{6{,}63\cdot10^{-34}}{1{,}67\cdot10^{-27}2\cdot10^{6}} = 1{,}98\cdot10^{-13}\,m$

δ) $\lambda_b = \frac{6{,}63\cdot10^{-34}}{0{,}2\cdot2\cdot10^{6}} = 1{,}65\cdot10^{-39}\,m$

7.31

$V = 150\,Volt$
$(v_0 = 0)$
$\lambda = ?$
$h = 6{,}626\cdot10^{-34}\,J\cdot s$
$e = 1{,}6\cdot10^{-19}\,C$
$m_e = 9{,}1\cdot10^{-31}\,kg$

$\lambda = \frac{h}{p}$

$k = \frac{p^2}{2m} \Rightarrow p = \sqrt{2mk}$

$k = e\cdot V$

$\Rightarrow p = \sqrt{2meV} \Rightarrow \boxed{\lambda = h/\sqrt{2meV}}$

7.31

$$\lambda = \frac{h}{\sqrt{2 m_e e V}} = \frac{6{,}63 \cdot 10^{-34}}{\sqrt{2 \cdot 9{,}1 \cdot 10^{-31} \cdot 1{,}6 \cdot 10^{-19} \cdot 150}} = 1{,}003 \cdot 10^{-10}\ m =$$

$$= 1093 \cdot 10^{-12}\ m \Rightarrow \boxed{\lambda = 109{,}3\ pm}$$

7.32

a) $E_\phi = ?$ $\lambda = 1\ nm$

b) $K_e = ?$ $\lambda = 1\ nm$

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

$m_e = 9{,}1 \cdot 10^{-31}\ kg$

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

$1\ eV = 1{,}6 \cdot 10^{-19}\ J$

a) $E_\phi = hf = \frac{hc}{\lambda} = \frac{6{,}626 \cdot 10^{-34} \cdot 3 \cdot 10^8}{1 \cdot 10^{-9}} = 1{,}987 \cdot 10^{-16}\ J \Rightarrow$

$\div e \Rightarrow \boxed{E_\phi = 1242{,}37\ eV}$

b) $\lambda = \frac{h}{p} \Rightarrow p = \frac{h}{\lambda} \Rightarrow p^2 = \frac{h^2}{\lambda^2} \Rightarrow \frac{p^2}{2m} = \frac{h^2}{2m\lambda^2} \Rightarrow$

$\Rightarrow K_e = \frac{h^2}{2 m_e \lambda^2} = \frac{(6{,}63 \cdot 10^{-34})^2}{2 \cdot 9{,}1 \cdot 10^{-31} \cdot (1 \cdot 10^{-9})^2} \Rightarrow$

$\Rightarrow K_e = 2{,}41 \cdot 10^{-19}\ J \div e \Rightarrow \boxed{K_e = 1{,}51\ eV}$

7.33

$h = 0{,}6\ J \cdot s$

$\Delta x = ?$

$m = 0{,}5\ kg$

$v = 20\ m/s$

$\Delta P\% = 1\%$

$P = mv = 0{,}5 \cdot 20 = 10\ kg \cdot m/s$

$\Delta P_x = 1\% \cdot P = \frac{1}{100} \cdot 10 \Rightarrow \Delta P_x = 0{,}1\ kg\,m/s$

$\Delta x \cdot \Delta P_x \geq \frac{h}{2\pi} \Rightarrow \Delta x \cdot 0{,}1 \geq \frac{0{,}6}{2 \cdot 3{,}14} \Rightarrow$

$\Rightarrow \boxed{\Delta x \geq 0{,}955\ m}$

7.34

$n=2 \rightarrow n=1 \quad (\Delta t = 10^{-8}\,sec)$

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

$1eV = 1,6 \cdot 10^{-19}\,J$

$\Delta E = ?$

$$\Delta E \cdot \Delta t \geq \frac{h}{2\pi} \Rightarrow \Delta E \geq \frac{h}{2\pi \Delta t} \Rightarrow$$

$$\Rightarrow \Delta E \geq \frac{6,626 \cdot 10^{-34}}{2 \cdot 3,14 \cdot 10^{-8}} \Rightarrow \Delta E \geq 1,055 \cdot 10^{-26}\,J$$

$$\xrightarrow{\div e} \boxed{\Delta E \geq 6,59 \cdot 10^{-8}\,eV}$$

7.35

$\Delta x = \lambda_{deB}$

$\rightsquigarrow$ וכן: $\Delta v_x \geq \frac{1}{2\pi} v_x$

$$\Delta x \cdot \Delta p_x \geq \frac{h}{2\pi} \Rightarrow \lambda_{deB} \cdot m \cdot \Delta v_x \geq \frac{h}{2\pi} \Rightarrow$$

$$\Rightarrow \frac{h}{p_x} \cdot m \cdot \Delta v_x \geq \frac{h}{2\pi} \Rightarrow \frac{1}{m \cdot v_x} m \cdot \Delta v_x \geq \frac{1}{2\pi}$$

$$\Rightarrow \boxed{\Delta v_x \geq \frac{1}{2\pi} v_x} \quad \therefore$$

12/2/2023