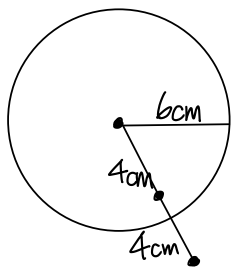
Q1.



$E = \left(\frac{10^3}{\pi} t\right) \frac{V}{m \cdot s}$

① 4cm: $B(2\pi r) = \mu_0 \varepsilon_0 \pi r^2 \frac{10^3}{\pi}$ V/ms

for $r = 0.04m \Rightarrow B = \frac{1}{2\cancel{\pi}\cancel{0.04}} \mu_0 \varepsilon_0 \cancel{\pi} (\cancel{0.04})^2 \frac{10^3}{\pi}$

$= \mu_0 \varepsilon_0 \cdot \frac{1}{\pi} \cdot 20$

$= 4\cancel{\pi} \times 10^{-7} \times 8.85 \times 10^{-12} \times \frac{1}{\cancel{\pi}} \times 20$

$= 7.08 \times 10^{-17}$ T

② 8cm: $B(2\pi r) = \mu_0 \varepsilon_0 \pi R^2 \left(\frac{10^3}{\pi}\right)$

$B = \frac{1}{2\cancel{\pi}(0.08)} 4\cancel{\pi} \times 10^{-7} \times 8.85 \times 10^{-12} \times \cancel{\pi} \times (0.06)^2 \frac{10^3}{\cancel{\pi}}$

$= 0.7965 \times 10^{-16}$

$= 7.965 \times 10^{-17}$ T

Q2 (a) n type; Electrons ※

(b) $n_{Si} = \frac{(2330\,kg/m^3)(6.02\times10^{23}\,atoms/mol)}{0.0281\,kg/mol} = 5\times10^{28}\,\frac{1}{m^3}$

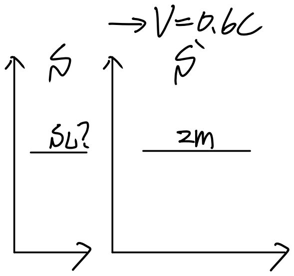
$n_p = 10^{-7} n_{Si} = 10^{-7}\cdot 5\cdot 10^{28} = 5\cdot 10^{21}\,m^{-3}$ ※

(c) pure silicon : $5\times10^{15}\times 2$ (e^- & 電洞) $= 10^{16}$

$\therefore$ ratio $= \frac{5\times10^{21}}{10^{16}} = 5\times10^{5}$ ※

Q3

(a)



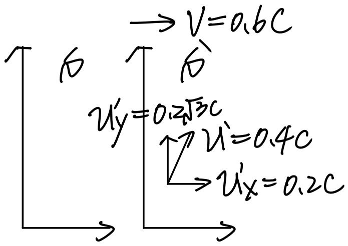
$\gamma = \dfrac{1}{\sqrt{1-\left(\frac{0.6c}{c}\right)^2}} = \dfrac{1}{\frac{4}{5}} = \dfrac{5}{4}$

$\because L = \dfrac{L_0}{\gamma} \therefore 2 = \dfrac{L_0}{\frac{5}{4}} \Rightarrow L_0 = 2 \times \dfrac{5}{4} = \dfrac{5}{2} m$ ※

(b) using time dilation : $\Delta t = \gamma \Delta t_0 = \frac{5}{4} \Delta t_0 \Rightarrow t_0 = \frac{5}{4} m$

$\therefore 72 \text{ times}/\text{sec}_S = 72 \times \frac{4}{5} \text{ times}/\text{sec}_{S'} = 57.6 \text{ times}/\text{sec}$ ※

(c)



using $u = \dfrac{u' + V}{1 + \frac{u'V}{c^2}}$; $u_y = \dfrac{u_y'}{\gamma\left(1 + \frac{u_x'V}{c^2}\right)}$

$u_x = \dfrac{0.2C + 0.6C}{1 + (0.2)(0.6)} \doteqdot 0.71C$

$u_y = \dfrac{0.2\sqrt{3}C}{\frac{5}{4}\left(1 + \frac{0.2c \cdot 0.6c}{c^2}\right)} = \dfrac{0.2\sqrt{3}}{\frac{5}{4}(1+0.12)} = \dfrac{0.3464}{1.4} = 0.247c$ ※

Q4 using $V = \frac{|\Delta\lambda|}{\lambda_0} c$

$$= \frac{|656.46 - 660.28|}{656.46} \times 3 \times 10^8 \, m/s$$

$$= 0.0174597270816 \times 10^8 \, m/s$$

$$\doteq 1.75 \times 10^6 \, m/s \#$$

Q5

$$f_0 = \frac{f_s}{\gamma\left(1 - \frac{V\cos\theta}{c}\right)}$$

$$\because f_0 = f_s \quad \therefore \gamma\left(1 - \frac{V\cos\theta}{c}\right) = 1$$

$$\frac{1}{\sqrt{1-(0.6)^2}}\left(1 - \frac{0.6c\cos\theta}{c}\right) = 1$$

$$\frac{5}{4}(1 - 0.6\cos\theta) = 1$$

$$1 - 0.6\cos\theta = \frac{4}{5} \quad \therefore \cos\theta = \frac{\frac{1}{5}}{\frac{3}{5}} = \frac{1}{3} \longrightarrow \theta = 70.53^\circ$$

Q6 $E = mc^2 + (\gamma - 1)mc^2 = \gamma mc^2$

$3\times10^9 \times 1.6\times10^{-19} = \gamma \cdot 9.1\times10^{-31} \times 9\times10^{16}$

$4.806\times10^{-10} = 8.19\times10^{-14}\gamma \Rightarrow \gamma \fallingdotseq 5868$

$\frac{1}{\sqrt{1-(\frac{v}{c})^2}} = 5868 \Rightarrow 1-(\frac{v}{c})^2 = 2.90\times10^{-8}$

$\Rightarrow v = \sqrt{(1-2.90\times10^{-8})(9\times10^{16})} \approx 2.99\times10^8\, m/s$ #

$P = \gamma m v = 5868\times9.1\times10^{-31}\times2.99\times10^8$

$= 1.57\times10^{-18}\, kgm/s$ #

Q7 $K_{max} = (hf - \phi)$ n(intensity)不影響K大小

$= (h\frac{c}{\lambda} - \phi)$

$= (6.63\times10^{-34}\frac{3\times10^{8}}{650\times10^{-9}} - 1.2\times1.6\times10^{-19})$

$= (0.0306\times10^{-17} - 1.92\times10^{-19})$

$= (1.14\times10^{-19}J)$

$V_{stop} = \frac{K_{max}}{q_e} = \frac{1.14\times10^{-19}}{1.6\times10^{-19}} \approx 0.713V$ #

Q8 $\frac{E-E_n}{E} = \frac{\Delta\lambda}{\lambda+\Delta\lambda} = \frac{\frac{h}{mc}(1-\cos\phi)}{\frac{hc}{E}+\frac{h}{mc}(1-\cos\phi)}$

$\because K = E - E'$ & $\phi = 180°$ in K_{max} case

$\therefore \frac{K}{E} = \frac{\frac{h}{mc}(1-\cos 180°)}{\frac{hc}{E}+\frac{h}{mc}(1-\cos 180°)}$

$= \frac{\frac{2h}{mc}}{\frac{hc}{E}+\frac{2h}{mc}} = \frac{\frac{2\cancel{h}}{\cancel{mc}}}{\frac{\cancel{h}mc^2+2\cancel{h}E}{E\cancel{mc}}} = \frac{2E}{mc^2+2E}$

$\Rightarrow K = \frac{2E^2}{mc^2+2E} = \frac{E^2}{\frac{mc^2}{2}+E}$ (max)

$1\,MeV = 1.6\times10^{-19}\times10^{6}\,J$
$= 1.6\times10^{-13}\,J$

所求 $= \frac{(1.6\times10^{-13})^2}{(1.6\times10^{-13})+\frac{9.1\times10^{-31}\times9\times10^{16}}{2}}$

$\fallingdotseq \frac{2.56\times10^{-26}}{1.6\times10^{-13}+0.41\times10^{-13}}$

$= \frac{2.56\times10^{-26}}{2.01\times10^{-13}}$

$= 1.27\times10^{-13}\,J_{\#}$

Q9

$^{152}_{63}Eu \rightarrow 89$ 中 $+ 63$ 質子

中 $\downarrow$ 1.008665 質子 $\downarrow$ 1.007825

$$\Delta E_{ben} = \frac{\Delta E_{be}}{A} = \frac{\Delta M c^2}{A}$$

$$= \frac{(89\times1.008665+63\times1.007825-151.921742)1.66\times10^{-27}(3\times10^8)^2}{152(1.6\times10^{-19})}$$

$$= \frac{1.342418\times9.31\times10^8}{152}$$

$$= \frac{1.25\times10^9}{152}$$

$$\fallingdotseq 8.22\times10^6$$

$$= 8.22MeV_{\#}$$

Q10

$$P = \frac{I}{c} = \frac{24}{3\times10^{8}} = 8\times10^{-8}\ N/m^{2}$$