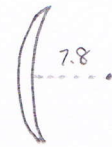


Practice Final Solution

PHYSIC6
2014 Spring

1. $T = 2\pi\sqrt{\frac{L}{g}} \Rightarrow 2 = 2\pi\sqrt{\frac{L}{9.8}} \Rightarrow L = 0.99 \text{ (m)}$



2. $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$, $f = 444 \text{ mm}$, $n = 1.56$, $R_2 = 7.8$

$\frac{1}{444} = (1.56-1)\left(\frac{1}{R_1} - \frac{1}{7.8}\right) \Rightarrow \frac{1}{R_1} - \frac{1}{7.8} = 4.02 \times 10^{-3} \Rightarrow R_1 = 7.56 \text{ mm}$

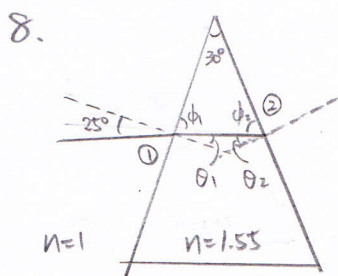
3. $\therefore m_l = -l, -l+1, \dots, l-1, l \quad \therefore m_e = -2, -1, 0, 1, 2$

4. $R = R_0 e^{-\lambda t}$, $T_{1/2} = \frac{0.693}{\lambda} = 6.05 \text{ hr} \Rightarrow \lambda = 0.115 \text{ hr}^{-1} \quad \therefore R(t=2) = 1.1 \times 10^4 \times e^{-0.115 \cdot 2} = 8.7 \times 10^3 \text{ Bq}$

5. $2t = (m + \frac{1}{2})\lambda_n = (m + \frac{1}{2})\frac{\lambda}{n}$ (longest $\lambda \Rightarrow m=0$) $\therefore 2t = \frac{1}{2}\frac{\lambda}{n} \Rightarrow \lambda = 4nt = 4 \times 1.3 \times 125 = 650 \text{ nm}$

6. $f_{\text{beat}} = |f - 264| = 2 \quad \therefore f = 262 \text{ or } 266 \text{ Hz}$

7. Refer to the lecture note / textbook.

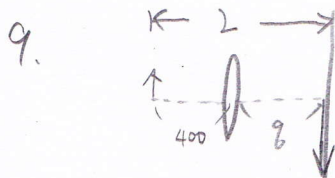


Interface ①: $1 \cdot \sin 25^\circ = 1.55 \sin \theta_1 \Rightarrow \theta_1 = 15.8^\circ$

$\Rightarrow \phi_1 = 90^\circ - \theta_1 = 74.2^\circ \Rightarrow \phi_2 = 180^\circ - 30^\circ - \phi_1 = 75.8^\circ$

$\Rightarrow \theta_2 = 90^\circ - \phi_2 = 14.2^\circ$

Interface ②: $1.55 \cdot \sin 14.2^\circ = 1 \cdot \sin \theta_3 \Rightarrow \theta_3 = 22.3^\circ$



$p = 400$, $M = -\frac{q}{p} = -3 \Rightarrow q = 3p = 1200 \text{ mm} \Rightarrow L = q + p = 1600 \text{ mm}$

and $\frac{1}{400} + \frac{1}{1200} = \frac{1}{f} \Rightarrow f = 300 \text{ mm}$

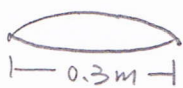
To make $M = -5 \Rightarrow -\frac{q}{p} = -5 \Rightarrow q = 5p$

$\therefore q + p = 1600 \Rightarrow 5p + p = 6p = 1600 \Rightarrow p = 266 \text{ mm}$

10. $f = 1.25$, $\lambda = 1 \Rightarrow v = f \cdot \lambda = 1.25 \text{ m/s}$ is constant. //

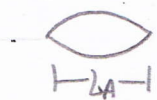
\Rightarrow When $f = 2.5 \Rightarrow \lambda = \frac{v}{f} = \frac{1.25}{2.5} = 0.5 \text{ cm}$ //

11. ① Find the speed of the wave along the string:



$L = 0.3 = \frac{\lambda}{2} \Rightarrow \lambda = 0.6 \text{ m} \Rightarrow v = f \cdot \lambda = 118.2 \text{ m/s}$

② Find the length of the string when the finger is at the position to play A (440 Hz):



$\lambda_A = \frac{v}{f_A} = \frac{118.2}{440} = 0.269 \text{ m}$, $L_A = \frac{\lambda}{2} \Rightarrow L_A = 0.134 \text{ m} = 13.4 \text{ cm}$

③ Moving the finger by $\pm 0.5 \text{ cm}$ changes L from $13.4 - 0.5 = \underline{12.9 \text{ cm}}$ to $13.4 + 0.5 = \underline{13.9 \text{ cm}}$

(i) When $L = 12.9 \text{ cm} = 0.129 \text{ m} = \frac{\lambda}{2} \Rightarrow \lambda = 0.258 \text{ m} \Rightarrow f = \frac{118.2}{0.258} = 458 \text{ Hz}$

(ii) When $L = 13.9 \text{ cm} = 0.139 \text{ m} = \frac{\lambda}{2} \Rightarrow \lambda = 0.278 \text{ m} \Rightarrow f = \frac{118.2}{0.278} = 425 \text{ Hz}$

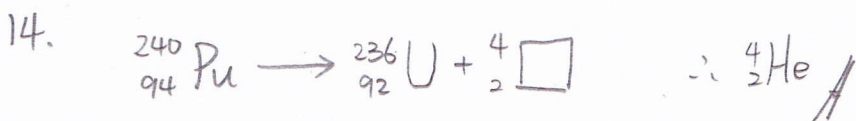
$\therefore 425 - 458 \text{ Hz}$ //

12. $\frac{1}{3600} \text{ degree} = 4.85 \times 10^{-6} \text{ rad}$. $\theta_{\min} = 1.22 \cdot \frac{\lambda}{d} \Rightarrow 4.85 \times 10^{-6} = 1.22 \cdot \frac{550 \times 10^{-9}}{d}$

$\Rightarrow d = 0.138 \text{ m} = 13.8 \text{ cm}$ //

13. $\lambda_{\text{de Broglie}} = \frac{h}{p} = \frac{h}{\sqrt{2mE}} \Rightarrow \lambda^2 = \frac{h^2}{2mE} \Rightarrow E = \frac{h^2}{2m\lambda^2} = \frac{(6.626 \times 10^{-34})^2}{2 \times 9.11 \times 10^{-31} \times (0.85 \times 10^{-10})^2}$

$= 3.34 \times 10^{-17} \text{ J} = 208 \text{ eV}$ //



15. $E_0 = 75 \text{ keV} = 1.2 \times 10^{-14} \text{ J} = \frac{hc}{\lambda_0} \Rightarrow \lambda_0 = 1.66 \times 10^{-11} \text{ cm}$

$$\Delta\lambda = \lambda' - \lambda_0 = \frac{h}{m_0 c} (1 - \cos\theta) = \frac{6.626 \times 10^{-34}}{9.11 \times 10^{-31} \times 3 \times 10^8} \times (1 - \cos 75^\circ) = 1.80 \times 10^{-12} \text{ cm}$$

$$\therefore \lambda' = \Delta\lambda + \lambda_0 = 1.84 \times 10^{-11} \text{ cm} //$$

16. ${}_{79}^{197}\text{Au}$ has 79 protons (1.007276 u) and 118 neutrons (1.008665 u)

$$\begin{aligned} \therefore E_b &= (1.007276 \times 79 + 1.008665 \times 118 - 196.966543) \times 931.494 \\ &= (79.574804 + 119.02247 - 196.966543) \times 931.494 \end{aligned}$$

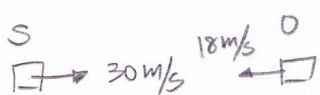
$$= 1519 \text{ MeV} \quad \therefore \text{Binding energy per nucleon} = \frac{1519}{197} = 7.71 \text{ MeV} //$$

17. $T = 2\pi\sqrt{\frac{l}{g}}$

18. $m = 0.2 \text{ kg}$, $k = 40 \text{ N/m}$, $A = 0.04 \text{ m} \Rightarrow E = \frac{1}{2} kA^2 = \frac{1}{2} \times 40 \times 0.04^2 = 0.032 \text{ J}$

At the equilibrium point, $U_k = 0 \therefore E = K = \frac{1}{2} m v^2 \therefore v = \sqrt{\frac{2E}{m}} = \sqrt{\frac{2 \times 0.032}{0.2}} = 0.57 \text{ m/s} //$

19.



$$f' = \frac{340 + 18}{340 - 30} \times 262 = 303 \text{ Hz} //$$

20. $T_{1/2} = \frac{0.693}{\lambda} = 2 \text{ min} \Rightarrow \lambda = 0.3465 \text{ min}^{-1}$

$$N = N_0 e^{-\lambda t} \Rightarrow \frac{N}{N_0} = e^{-\lambda t} \quad \therefore \frac{N}{N_0} = \frac{1}{1000} = 0.001 = e^{-0.3465 \cdot t}$$

$$\ln(0.001) = \ln(e^{-0.3465 \cdot t}) = -0.3465 t \quad (\ln 0.001 = -0.6908)$$

$$\Rightarrow t = 20 \text{ mins} //$$