Physics IB HW #3

15.22) $m = 2.60g = 0.0026kg$

$L = 83.0cm = 0.830m$

$T = 29.0N$

$f = 120Hz$, $A = 1.60mm$

$\bar{P} = \frac{1}{2}\mu A^2\omega^2 v$

$\mu = \frac{m}{L} = \frac{0.0026kg}{0.830m} = 0.00313\frac{kg}{m}$

$\bar{P} = \frac{1}{2}(0.00313\frac{kg}{m})(0.00160m)^2(2\pi 120Hz)^2 v$

$v^2 = \frac{T}{\mu} = \frac{29.0N}{0.00313\frac{kg}{m}} = 9257.67\frac{m^2}{s^2}$

$v = 96.22\frac{m}{s}$

$\boxed{\bar{P} = 0.219W}$

b) $\frac{1}{2}A \rightarrow \frac{1}{4}\bar{P}$

$\bar{P}_{new} = \frac{1}{4}(0.219W)$

$\boxed{\bar{P}_{new} = 0.0548W}$

15.34) antinodes 0.15m apart

$\therefore \lambda = 0.3m$

$A = 0.850cm = 0.0085m$

$T = 0.0750s$

a) $0.15m = \boxed{15cm}$

b) $\boxed{\lambda = 0.3m}$

c) $A_{SW} = 2A$

$A = \frac{1}{2}(0.850cm)$

$\boxed{A = 0.425cm}$

d) $f = \frac{1}{T} = \frac{1}{0.0750s} = 13.33Hz$

$v = \lambda f = 0.3m(13.33Hz)$

$\boxed{v = 4\frac{m}{s}}$

e) $y(x,t) = 2A\sin kx \sin\omega t$

$v_y(x,t) = 2A\sin kx(\omega\cos\omega t)$

$k = \frac{\omega}{v}$

$\omega = 2\pi f = 83.776\frac{rad}{s}$

$k = 20.94\frac{rad}{m}$

$v_y = (0.0085m)\sin(20.94\frac{rad}{m}x)(83.776\frac{rad}{s}\cos(83.776t))$

$v_y = 0.712\frac{m}{s}\sin(20.94\frac{rad}{m}x)(\cos 83.776\frac{rad}{s}t)$

$\boxed{v_{max} = 0.712\frac{m}{s},\ v_{min} = 0\frac{m}{s}}$

f) $\Delta x = \frac{1}{4}\lambda = \frac{1}{4}(30cm)$

$\boxed{\Delta x = 7.5cm}$

15.42) $L = 72.0cm$

$m = 8.80g$

$v = 344\frac{m}{s}$

a) $n = 3$

$f_3 = nf_1$

$f_1 = \frac{1}{2L}\sqrt{\frac{F}{\mu}}$

$f_1 = \frac{v}{2L} = \frac{344\frac{m}{s}}{1.44m}$

$f_1 = 238.89Hz$

$\mu = \frac{m}{L} = \frac{8.80g}{0.72m} = 12.22\frac{g}{m}$

$\frac{12.22g}{1m} \times \frac{100cm}{1m} \times \frac{1kg}{1000g} = 0.01222\frac{kg}{m}$

$F = 4\mu L^2 f_1^2 = 4(1.22\frac{kg}{m})(0.72m)^2(238.89Hz)^2$

$F =$

$f_3 = 3f_1$

$\lambda_3 = \frac{2L}{3} = \frac{2(0.72m)}{3} = 0.48m$

$0.763 = \frac{2(0.72m)}{n} =$

$v = \sqrt{\frac{F}{\mu}}$

$f\lambda$

$f_3 = n\frac{v}{2L}$

$f_3 = 2.0833v$

$f_3\lambda_3 = 344\frac{m}{s}$

$f_3 = 450.85Hz$

$\lambda_n = \lambda_3 = \frac{2L}{n} = \frac{1.44m}{3} = 0.48m$

$v = 0.48m(450.8Hz) = 216.41\frac{m}{s}$

$216.41\frac{m}{s} = \sqrt{\frac{F}{0.01222kg/m}}$

$\boxed{F = 572.4N}$

b) $f_3 = 3f_1$

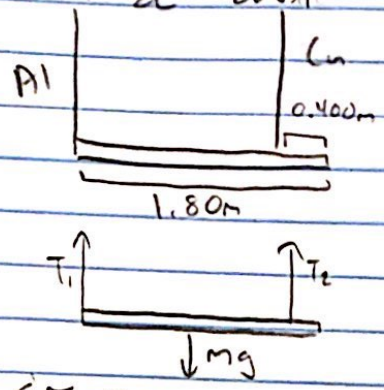
$450.85Hz = 3f_1$

$\boxed{f_1 = 150.28Hz}$

15.57) $L = 0.600m$, $r = 0.25mm$

$W = 688N$

a) $f_1 = \frac{v}{2L} = \frac{1}{2L}\sqrt{\frac{F}{\mu}}$



$\sum T = I\alpha$

$T = Fr$

$T_1 = T_2$

$T_1 + T_2 = mg$

$T_1 r_1 = T_2 r_2$

$T_2 = mg - T_1$

$T_1 r_1 = (mg - T_1) r_2$

$T_1 r_1 = mgr_2 - T_1 r_2$

$T_1 r_1 + T_1 r_2 = mgr_2$

$T_1 = \frac{mgr_2}{r_1 + r_2}$

$r_1 = 0.90m$, $r_2 = 0.50m$

$T_1 = 245.71 = F$

$f_1 = \frac{1}{2L}\sqrt{\frac{F}{\mu}}$

$\rho_{al} = 2.7 g/cm^3$

$\frac{2.7g}{1cm^3} \times \frac{1kg}{1000g} \times \frac{100^3 cm^3}{1m^3} = 2700 kg/m^3$

$V_{wire} = \pi r^2 h = \pi(0.00025m)^2(0.600m)$

$= 1.18 \times 10^{-7} m^3$

$\rho = \frac{m}{V}$

$2700 \frac{kg}{m^3} = \frac{m}{1.18 \times 10^{-7} m^3}$

$m = 3.18 \times 10^{-4} kg$

$\mu = 5.3 \times 10^{-4} \frac{kg}{m}$

$\boxed{f_1 = 567.33 Hz}$

b) $T_2 = mg - T_1 = 688N - 245.71N$

$T_2 = 442.29N$

$\rho_{Cu} = 8960 kg/m^3$

$V_{wire} = 1.18 \times 10^{-7} m^3$

$m = 0.00106 kg$

$\mu = 0.00176 \frac{kg}{m}$

$\boxed{f_1 = 417.5 Hz}$

16.5) $v = \sqrt{\frac{B}{\rho}}$

$v_{sound} = 344 \frac{m}{s}$

$L = 70.0m$

$Y_{brass} = 7.0 \times 10^{10} Pa$

$\rho_{brass} = 8.6 \times 10^3 kg/m^3$

$v = \sqrt{\frac{Y}{\rho}}$

$v = 3234.78 \frac{m}{s}$

$v = \frac{\Delta x}{t}$

$t = \frac{\Delta x}{v}$

$t_1 = \frac{70m}{3234.78 s}$

$t_2 = \frac{70m}{344 s}$

$t_{diff} = t_2 - t_1$

$t_{diff} = 0.20s - 0.0216s$

$\boxed{t_{diff} = 0.182s}$

16.11) a) $d_{eardrum} = 8.4mm$

$20dB =$

$\beta = 10 \log\left(\frac{I}{I_0}\right)$

$20dB = 10 \log \frac{I}{10^{-12} W/m^2}$

$2 = \log\left(\frac{I}{10^{-12} W/m^2}\right)$

$100 = \frac{I}{10^{-12} W/m^2}$

$I = 10^{-10} \frac{W}{m^2}$

$E = IA\Delta t$

$A = \pi r^2 = \pi(0.0042m)^2$

$A = 5.54 \times 10^{-5}$

$\boxed{E = 5.54 \times 10^{-15} J}$

b) $m = 2mg$

$2mg \times \frac{1g}{1000mg} \times \frac{1kg}{1000g} =$

$2 \times 10^{-6} kg$

$KE = \frac{1}{2}mv^2$

$5.55 \times 10^{-15} = \frac{1}{2}(2 \times 10^{-6} kg)(v^2)$

$v = 7.449 \times 10^{-5} \frac{m}{s}$

$0.0744 \frac{mm}{s}$

16.22) Antinode @ start

↳ open pipe

b) 5 nodes

∴ 5th harmonic

c) $f = 1710Hz$

$T = 20°C$

$v = 344 \frac{m}{s}$

$f_5 = 1710Hz$

$1710Hz = \frac{5(344\frac{m}{s})}{2L}$

$L = 0.50m$

d) $f_n = f_1 n$

$f_5 = 5f_1$

$1710Hz = 5f_1$

$f_1 = 342Hz$

e) $f_1 = \frac{v}{2L}$

$f_1 = \frac{999\frac{m}{s}}{1m}$

$f_1 = 942.5Hz$

$f_1 = \frac{v}{2L}$

$f_1 = \frac{999\frac{m}{s}}{2(0.50m)}$

$f_1 = 973Hz$

16.26) $v = 354\frac{m}{s}$

$f_1 = \frac{v}{4L}$

$220Hz = \frac{354\frac{m}{s}}{4L}$

$L = 0.40m$

b) yes

16.30) $n = 3$

$v = 344\frac{m}{s}$

$f_1 = \frac{v}{4L}$

$f_3 = 3\frac{v}{2L}$

$3\frac{1}{2L}\sqrt{\frac{F}{\mu}} = \frac{344\frac{m}{s}}{4L}$

$m_{wire} = 7.25g = 0.00725kg$

$L_{wire} = 62.0cm = 0.62m$

$L = \frac{344\frac{m}{s}}{4(2423.39Hz)}$

$L = 0.0355m$

$f_3 = \frac{3}{2L}\sqrt{\frac{F_L}{m}}$

$f_3 = 3\sqrt{\frac{F}{4Lm}}$

$f_3 = 3\sqrt{\frac{456N}{4(0.62)(0.00725kg)}}$

$f_3 = 1502.5Hz = f_1$

$f_1 = \frac{v}{4L}$

$L = 0.057m$

16.55) $v = \sqrt{\frac{\gamma RT}{M}}$

$R = 8.314 J/mol \cdot K$

$v = \sqrt{\frac{1.40(R)(273K)}{28.6 \times 10^{-3}}}$

$v = 332.17\frac{m}{s}$

b) $v = 332\frac{m}{s}\left(1 + \frac{T_C}{546}\right)$

c) $v = 332\frac{m}{s} + 332(20)/546$

$v = 344\frac{m}{s}$

d) not all values, taylor approx. used

e) close, not within 1%.