PHYS 200 FINALS 4/5/2015

175/180 = 97%

I. i) $Q = Pt = 2300 \times 5 \times 60 = 6.9 \times 10^5 J$

$(C_{Al} m_{Al} + C_w m_w)\Delta T = Q$

$\Delta T = \frac{Q}{C_{Al} m_{Al} + C_w m_w}$

$= \frac{6.9 \times 10^5 J}{0.92 \times 55 + 4.2 \times 2000}$

$= 82°C$

$T = T_0 + \Delta T = 97°C$

ii) $\Delta Q = c_{Al} m_{Al} \Delta T + C_w m_w \Delta T + \frac{dm_R}{dt} \cdot t \cdot C_R \Delta T$

$\Delta T = \frac{\Phi P \cdot t}{C_{Al} m_{Al} + C_w m_w + \frac{dm}{dt} \cdot t C_w}$

$= \frac{2300 \times 300}{1.92 \times 55 + 4.2 \times (2000 + 0.5 \times 300)}$

$= 76°C$

$T = T_0 + \Delta T =$ 91°C

II.

$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$

$r_1^2 v_1 = r_2^2 v_2$

$4 r_2^2 v_1 = r_2^2 v_2$

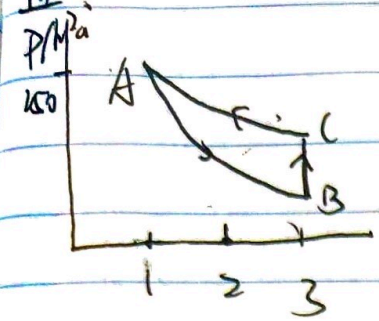
$v_2 = 4 v_1$

$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + 8 \rho v_1^2$

$P_1 - P_2 = \frac{15}{2}\rho v_1^2$

$\rho = \frac{2}{15 v_1^2}(P_1 - P_2) = \frac{2}{15 \times 1.9^2} \times 16 \times 10^3 =$ 900 kg/m³

III



i) $P_A V_A^\gamma = P_B V_B^\gamma$

$P_B = \frac{P_A V_A^\gamma}{V_B^\gamma} = \frac{150 \times 1^{\frac{5}{3}}}{3^{\frac{5}{3}}} = 40\ kPa$

ii) $P_A V_A = P_C V_C$

$P_C = \frac{P_A V_A}{V_C} = \frac{150 \times 1}{3} = 83\ kPa$

iii) $W = \frac{P_A V_A - P_B V_B}{\gamma - 1} + P_A V_A \ln \frac{V_A}{V_C}$

$= \frac{150 - 40 \times 3}{\frac{2}{3}} + 150 \ln \frac{1}{3}$

$= -80\ J$

(iv) $\Delta U = Q - W$

$Q = W = -80\ J$

IV.

K: $L = \frac{\lambda}{4}$ $\lambda = 4L$ $f_1 = \frac{v}{\lambda} = \frac{v}{4L} = f_0$

K: $L = \frac{3\lambda}{4}$ $\lambda = \frac{4L}{3}$ $f_2 = \frac{v}{\lambda} = \frac{3v}{4L} = 3f_0$

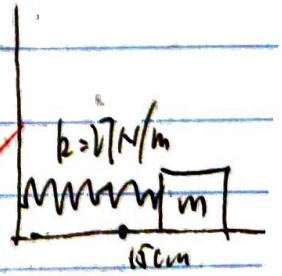
K: $L = \frac{5\lambda}{4}$ $\lambda = \frac{4L}{5}$ $f_3 = \frac{v}{\lambda} = \frac{5v}{4L} = 5f_0$

V. i) $E = U = \frac{1}{2}kx_0^2 = \frac{1}{2} \times 27 \times 0.15^2 = 0.30375 \approx 0.30\ J$

ii) $U = \frac{1}{2}kx^2 = \frac{1}{2} \times 27 \times 0.1^2 = 0.135\ J$

$K = E - U = 0.675\ J = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2K}{m}} = \sqrt{\frac{kx_0^2 - kx^2}{m}} = \sqrt{\frac{0.675}{0.25}} = 1.2\ m/s$



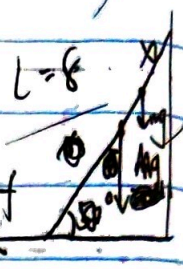
iii) $\mu_k mg x_0 = \frac{1}{2}kx_0^2$

$\mu_k = \frac{kx_0}{2mg} = \frac{27 \times 0.15}{0.5 \times 9.8} = 0.83$

VI. $T(y) = \mu y g$

$v(y) = \sqrt{\frac{T}{\mu}} = \sqrt{yg}$

VII. $Mg\cos\theta \cdot \frac{L}{2} + mg\cos\theta \cdot x = \mu_s(M+m)g\sin\theta \cdot L$



$m\cos\theta\, x = \mu_s(M+m)g\sin\theta \cdot L - Mg\cos\theta \cdot \frac{L}{2}$

$x = \frac{\left(\mu_s(M+m)g\sin\theta - \frac{1}{2}Mg\cos\theta\right)L}{mg\cos\theta}$

$= \frac{\left(0.35(200+60.0)\tan 50^\circ - 100\cos 50^\circ\right)\times 8}{60.0\cos 50^\circ}$

$= 5.1\,m$

$h = (L-x)\sin 50^\circ = 2.8\,m$

VIII. • $x_P = 210\,m$ $x_B = 480\,m$. $\Delta t = 4.96\,\mu s$

i) $\Delta x' = \frac{\Delta x - u\Delta t}{\sqrt{1-u^2/c^2}}$

$0 = \Delta x - u\Delta t$

$u = \frac{\Delta x}{\Delta t} = \frac{(210-480)\,m}{4.96\,\mu s} = -1.47\times 10^8\,m/s$

iv) P' is before B'

$(c\Delta t)^2 + (\Delta x)^2 = (c\Delta t')^2 + (\Delta x')^2$

$(c\Delta t')^2 = (c\Delta t)^2 + (\Delta x)^2$

$\Delta t' = \sqrt{\Delta t^2 + \left(\frac{\Delta x}{c}\right)^2} = 1.21\times 10^{-11}\,s$

IX. $P_1+P_2=K$

$(P_1+P_2)^2=K^2$

$P_1^2+P_2^2+2P_1\cdot P_2=0$

$2m_0^2+2(m_0^2(\gamma_1\gamma_2-\gamma_1\gamma_2\vec{v}_1\cdot\vec{v}_2))=0$

$\therefore \gamma_1\gamma_2=\gamma_1\gamma_2\vec{v}_1\cdot\vec{v}_2$

$m_0^2+E_1E_2=\vec{p}_1\cdot\vec{p}_2$

$\frac{E_1E_2}{c^2}=\vec{p}_1\cdot\vec{p}_2-m_0^2c^2$

$\frac{E_1^2}{c^2}=p_1^2+m_0^2c^2 \quad \frac{E_2^2}{c^2}=p_2^2+m_0^2c^2$

$|p_1|<\frac{E_1}{c} \quad |p_2|<\frac{E_2}{c}$

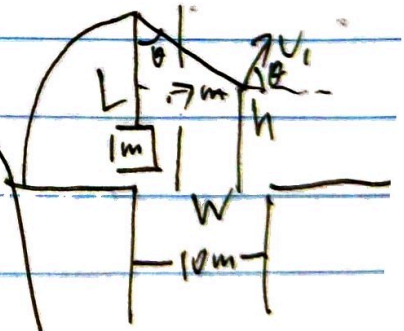
$\frac{E_1E_2}{c^2}>|p_1||p_2|>\vec{p}_1\vec{p}_2-m_0^2c^2$

$\therefore \frac{E_1E_2}{c^2}\neq\vec{p}_1\cdot\vec{p}_2-m_0^2c^2$

$\therefore P_1+P_2\neq K$

X. $\frac{1}{2}mv_0^2=mgh$

$L^2=(L-h)^2+W^2$



$\frac{L-h}{L}=\cos\theta \quad \sin\theta=\sqrt{1-\cos^2\theta}=\sqrt{1-\frac{h^2}{L^2}+\frac{2h}{L}}$

$v_{1x}=v_1\cos\theta=\frac{L-h}{L}v_1=(1-\frac{h}{L})v_1$

$v_{1y}=v_1\sin\theta=v_1\sqrt{\frac{2hL-h^2}{L^2}}$

$v_{1y}t-\frac{1}{2}gt^2=h$

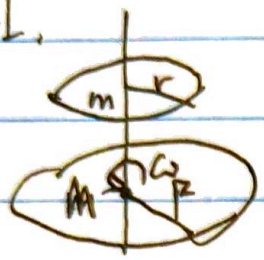
$v_{1x}+l\sin\theta=(1-\frac{h}{L})v_1+\sqrt{2hL-h^2}=W$

$h=L-\sqrt{L^2-W^2} \quad v_0=\sqrt{2gh}=\sqrt{2g(L-\sqrt{L^2-W^2})}=8.0\,m/s$

$T - mg = m\frac{v_0^2}{L}$

$T = m\frac{v_0^2}{L} + mg = 100\left(\frac{64}{17} + 9.8\right) = 1360\,N$

XI.



~~$\omega_0 = 180 \times 2\pi / 60 = 6\pi$ rad/s~~

$I_1 = \frac{1}{2}MR^2$ & $I_2 = \frac{1}{2}mr^2$

$I_1\omega_0 = (I_1 + I_2)\omega$ Conservation of angular

$\omega = \frac{I_1\omega_0}{I_1 + I_2} = \frac{MR^2\omega_0}{\frac{1}{2}(MR^2 + mr^2)} = \frac{\omega_0}{1 + \frac{mr^2}{MR^2}}$

$= 142$ rpm

$\frac{\Delta E}{E_0} = 1 - \frac{E}{E_0} = 1 - \frac{I\omega^2 + I_2\omega^2}{I\omega_0^2}$

$= 1 - \frac{\omega^2\left(1 + \frac{I_2}{I}\right)}{\omega_0^2}$

$= 1 - \frac{142^2\left(1 + \frac{270 \times 2 \cdot 3^2}{4000 \times 3 \cdot 1^2}\right)}{180^2}$

$= 0.18$