CH 15.

15-26, $ma_m = \mu_s mg \Rightarrow \frac{k}{m+M} x_m = \mu_s g$

$\therefore x_m = \frac{0.4 \cdot 9.8 \, m/s^2 \, (1.8kg + 10kg)}{200 \, N/m} = \underline{0.23 \, m}$ #

15-34, $k = 4\pi^2 m_1 / T^2 = 1.97 \times 10^5 \, N/m$

$K = \frac{1}{2}(6.0 \, kg)(4.0 \, m/s)^2 = 48 J$

$U = \frac{1}{2}kx^2 = \frac{1}{2}(1.97 \times 10^5 \, N/m)(0.01 \, m)^2 \sim 10J$

$X = \sqrt{\frac{2E}{k}} = \sqrt{\frac{2(58 J)}{1.97 \times 10^5 \, N/m}} = \underline{0.024 \, m}$ #

15.55, (a) $T = 2\pi \sqrt{\frac{m(L^2/12 + d^2)}{mgd}} = 2\pi \sqrt{\frac{L^2 + 12d^2}{12gd}}$

$\frac{dT}{d(d)} = 0 \Rightarrow d = L/\sqrt{12}$

$\therefore T_{min} = 2\pi \sqrt{\frac{2L}{\sqrt{12} \, g}} = 2\pi \sqrt{\frac{2 \times 2.20 \, m}{\sqrt{12} \, (9.8 \, m/s^2)}} = \underline{2.26 \, s}$ #

(b) Increase

(c) same

15.60, (a) $k = \frac{(50 \, kg)(9.8 \, m/s^2)}{10cm} = \underline{4.9 \times 10^2 \, N/cm}$ #

(b) $e^{-bT/2m} = \frac{1}{2}$ where $T = \frac{2\pi}{\omega}$

$\omega' \approx \sqrt{\frac{49000 N/m}{500 kg}} = 9.9 \, rad/s$

$\therefore T \sim 0.63 \, s$

$\therefore b = \frac{2m}{T} \ln 2 \sim \underline{1.1 \times 10^3 \, kg/s}$ #

15.63.

$$\omega = \frac{2\pi v}{T} = \sqrt{\frac{k}{M+4m}}$$

$d = 4m$

$$\frac{2\pi v}{d} = \sqrt{\frac{k}{M+4m}} \Rightarrow k = (M+4m)\left(\frac{2\pi v}{d}\right)^2$$

$$x_i = (M+4m)\,g/k, \quad x_f = Mg/k$$

$$\therefore x_i - x_f = \frac{4mg}{k} = \frac{4mg}{M+4m}\left(\frac{d}{2\pi v}\right)^2 = \underline{0.05\ m}\ \#$$

CH16

16.10,

(a) $y_m = \underline{6\ cm}$ #

(b) $\lambda = \underline{1.0 \times 10^2\ cm}$ #

(c) $f = \underline{2.0\ Hz}$ #

(d) $v = f\lambda = 2.0 \times 10^2\ \underline{cm/s}$ #

(e) $\underline{-x\ \text{direction}}$, #

(f) $u_{max} = 2\pi f y_m = (4.0\pi\ s^{-1})(6.0\ cm) = \underline{75\ cm/s}$ #

(g) $y(3.5\ cm, 0.26\ s) = \underline{-2.0\ cm}$ #

16.25, (a) $v = \sqrt{\frac{\tau}{\mu}}$, $\tau = \mu g y$,

$\therefore\ \underline{v = \sqrt{gy}}$ #

(b) $dt = \frac{dy}{v} = dy/\sqrt{gy}$

$\therefore\ t = \int_0^L \frac{dy}{\sqrt{gy}} = \underline{2\sqrt{\frac{L}{g}}}$ #

16.27, $\frac{1}{2}\mu v \omega^2 y_m^2 = 10$

$y_m = \underline{0.0032\ m}$ #

16.34, (a) $P_{avg} = \frac{1}{2}\mu v \omega^2 y_m^2 = 10\ W$

(b) 20 W

(c) 40 W

(d) 26 W

(e) 0

16.59,

(a) $f = n_1 v_1 / 2L_1 = (n_1 / 2L_1) \sqrt{\tau / \rho_1 A}$

$\tau = mg$

$\therefore f = \frac{n_1}{2L_1} \sqrt{\frac{mg}{\rho_1 A}} = \underline{324 \text{ Hz}}$ #

(b) 8

CH 17,

17.5, $t_p = d/v_p$

$\Delta t = (d/v_s) - (d/v_p) = d(v_p - v_s)/v_s v_p$

$\therefore d = \frac{v_s v_p \Delta t}{v_p - v_s} = 1.9 \times 10^3$ km #

17.15, (a) $f = \frac{1}{\Delta t} = \frac{v}{2W} = 2.3 \times 10^2$ Hz

(b) Higher

17.23, (a) 0

(b) Fully constructive,

(c) Increase

(d) 128 m

(e) 63 m

(f) 41.2 m

17.36. $\Delta\beta = \beta_f - \beta_i = 10\,(\text{db}) \log\left(\frac{I_f}{I_i}\right)$

if $\Delta\beta = 5$ db, $\log(I_f/I_i) = 1/2$

$\therefore I_i r_i^2 = I_f r_f^2$

$\Rightarrow r_f = \left(\frac{I_i}{I_f}\right)^{1/2} r_i = 0.67$ m #

$f = \frac{n}{2L}\sqrt{\frac{T}{\mu}}$

17.49,

$f_2 = \frac{n_1+1}{2L}\sqrt{\frac{T}{\mu}} = \frac{n_1}{2L}\sqrt{\frac{T}{\mu}} + \frac{1}{2L}\sqrt{\frac{T}{\mu}} = f_1 + \frac{1}{2L}\sqrt{\frac{T}{\mu}}$

$\therefore f_2 - f_1 = \left(\frac{1}{2L}\right)\sqrt{\frac{T}{\mu}}$

$\therefore T = \underline{45.3\,N}$ #

17.67,

$f' = f\,\frac{v \pm v_0}{v \mp v_s}$

(a) $f' = f\,\frac{v}{v+v_s} = (500\,Hz)\left(\frac{343\,m/s}{343\,m/s + 10\,m/s}\right) = \underline{485.8\,Hz}$ #

(b) $(v+v_0) = (v+v_s) \Rightarrow f' = f = 500\,Hz$

(c) $f' = f\,\frac{v+v_0}{v+v_s} = (500\,Hz)\left(\frac{343\,m/s + 10\,m/s}{343\,m/s + 20\,m/s}\right)$

$= \underline{486.2\,Hz}$ #

(d) $f' = f = \underline{500\,Hz}$ #

CH 18

18.21, $x^2 = l^2 - l_0^2 = l_0^2(1+\alpha\Delta T)^2 - l_0^2$

$x^2 = l_0^2 + 2l_0^2\alpha\Delta T - l_0^2 = 2l_0^2\alpha\Delta T$

$\Rightarrow x = l_0\sqrt{2\alpha\Delta T} = \underline{7.5\cdot 10^{-3}\ m}$ #

18.34, $c_A m_A(T_f - T_A) + c_B m_B(T_f - T_B) = 0$

$\therefore c_A(5.0kg)(40°C - 100°C) + (4000\ J/kg°C)(1.5kg)(40°C - 20°C) = 0$

$\Rightarrow \underline{c_A = 4\times 10^2\ J/kg\cdot K}$ #

18.50,

(a) $Q_{ab} = +8.0\ J$

(b) $Q_{bc} = -9.3\ J$

18.66, $L_v \frac{dm}{dt} = P_{rad} = \sigma\varepsilon A(T_{env}^4 - T^4)$

$A = \pi r^2 + 2\pi r h = \pi(0.022m)^2 + 2\pi(0.022m)(0.10m)$

$= 1.53\times 10^{-2}\ m^2$

$\frac{dm}{dt} = \frac{\sigma\varepsilon A}{L_v}(T_{env}^4 - T^4)$

$\cong \underline{0.68\ mg/s}$ #

18.88, $T_{wi} = \frac{c_t m_t(T_f - T_{ti})}{c_w m_w} + T_f = \frac{(0.055\ kg)(0.837\ kJ/kg\cdot K)(44.4 - 15)K}{(4.18\ kJ/kg\cdot°C)(0.3kg)} + 44.4°C$

$= \underline{45.5\ °C}$ #

CH19,

19.16, $n = P_1 V_1 / RT_1 = (P_0 + \rho g d) V_1 / RT_1$

$$V_2 = \frac{T_2}{T_1} \frac{P_0 + \rho g d}{P_0} V_1$$

$$= 1 \times 10^2 \text{ cm}^3$$

19.32, (a) $\frac{\lambda_{Ar}}{\lambda_{N_2}} = \frac{1/(\pi\sqrt{2}\, d_{Ar}^2 (N/V))}{1/(\pi\sqrt{2}\, d_{N_2}^2 (N/V))} = \left(\frac{d_{N_2}}{d_{Ar}}\right)^2$

$\therefore \frac{d_{Ar}}{d_{N_2}} = \sqrt{\frac{\lambda_{N_2}}{\lambda_{Ar}}} = 1.7$

(b) $\lambda = \frac{RT}{\pi\sqrt{2}\, d^2 p N_A}$

$\frac{\lambda_2}{\lambda_1} = \left(\frac{T_2}{T_1}\right)\left(\frac{P_1}{P_2}\right)$

$\Rightarrow \lambda_2 = 5 \times 10^{-5}$ cm

(c) $\lambda_2 = 7.9 \times 10^{-6}$ cm, $(T_2 = 233\text{ K},\ P_2 = 750 \text{ torr})$

19.39, (a) $T = 1.0 \times 10^4$ K

(b) $T = 1.6 \times 10^3$ K

(c) $T = 4.4 \times 10^2$ K

(d) $T = 7 \times 10^3$ K

(e) no

(f) yes

19. 47. $C_V = \frac{3}{2} R$

(a) 0

(b) $+374\ J$

(c) $\Delta E_{int} = Q - W = +374\ J$

(d) $3.11 \times 10^{-22}\ J$

19. 58. $P_i V_i^{\gamma} = P_i (T_i / P_i)^{\gamma} = P_i^{1-\gamma} T_i^{\gamma} = \text{constant},$

$T_f = \left(\frac{P_i}{P_f}\right)^{\frac{1-\gamma}{\gamma}} T_i = 186\ K = -87\ °C$ #

CH 20,

20.21,

$$\Delta S = \Delta S_{12} + \Delta S_{23} + \Delta S_{34}$$

$$= m c_w \ln\left(\frac{T_2}{T_1}\right) - m L_F/T_2 + m c_I \ln\left(\frac{T_4}{T_3}\right)$$

$$= \underline{-1.18\ J/K}\ \#$$

20.33,

(a) $\Delta T = (1/nR)(P_b V_b - P_a V_a)$

$$P_a = P_c = \left(\frac{V_b}{V_c}\right)^{\gamma} P_b = 3.167\times10^{4}\ Pa$$

$$\therefore\ Q_{in} = \frac{3}{2}(P_b - P_a)V_b = \underline{1.47\times10^{3}\ J}\ \#$$

(b) $Q_{out} = n C_p \Delta T$

$$= \frac{5}{2}(P_a V_a - P_c V_c) = \underline{-5.54\times10^{2}\ J}\ \#$$

(c) $W = Q = 1.47\times10^{3}\ J - 5.54\times10^{2}\ J$

$$= \underline{9.18\times10^{2}\ J}\ \#$$

(d) $\varepsilon = W/Q_{in} = \underline{62.4\ \%}\ \#$

20.44, (a) $W = (0.222)(750\ J) = \underline{167\ J}\ \#$

(b) $|W| = 1200/3.5 = \underline{343\ J}\ \#$

20.47, (a) $W = \dfrac{N!}{n_1!\,n_2!\,n_3!}$ (c) $\underline{4.2\times10^{16}}\ \#$

(b) $\dfrac{(\frac{N}{2})!\,(\frac{N}{2})!}{[(\frac{N}{3})!\,(\frac{N}{3})!\,(\frac{N}{3})!]}$