Practice Exam Solutions

Multiple Choice Questions

(1.) (a.) Since $v = \sqrt{\frac{2\gamma k_B}{m}}\sqrt{T}$ it follows that

$$\rightarrow v_1 = \sqrt{\frac{2\gamma k_B}{m}}\sqrt{T_1} \;\&\; v_2 = \sqrt{\frac{2\gamma k_B}{m}}\sqrt{T_2}$$

$$\rightarrow \frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}} \quad \therefore v_2 = \left(\sqrt{\frac{T_2}{T_1}}\right) v_1$$

$$v_2 = \left(\sqrt{\frac{800}{20}}\right)(343 \tfrac{m}{s}) = 2(343)\tfrac{m}{s} = 686 \tfrac{m}{s}$$

(2.) (b.) Since $d = \frac{1}{2}a t_F^2$, $a = \frac{2d}{t^2} = \frac{2(90\,m)}{(3s)^2} = 20 \frac{m}{s^2}$

$$v = a t_1 = (20 \tfrac{m}{s^2})(1s) = 20 \tfrac{m}{s}$$

(3.) (c.) Since $Q = cM(\Delta T)$, $M = \frac{Q}{c(\Delta T)}$

$$M = \frac{14{,}400\,J}{(3600)(2)\,J/kg} = \frac{14{,}400}{7{,}200}\,kg = 2\,kg$$

(4.) (d.)

(5.) (b.) Since $v = \lambda f$ we have

$$v_1 = \lambda_1 f_1 \qquad v_2 = \lambda_2 f_2$$

$$v_1 = (4\,cm)(2f_2) \qquad v_2 = (8\,cm) f_2$$

$$\frac{v_2}{v_1} = \frac{(8\,cm) f_2}{(8\,cm) f_2} = 1 \rightarrow v_2 = v_1$$

(6.) (d.)

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(7.) (d.) Since at highest point $v_y = 0$
$K = \frac{1}{2} m (v_x)^2$. This cannot be a maximum & it changes

(8.) (b.) Since $p_1 = (20)(16) \frac{kg \cdot m}{s} = 320 \frac{kg \cdot m}{s}$

$p_2 = (80)(-4) \frac{kg \cdot m}{s} = -320 \frac{kg \cdot m}{s}$

$p_1 + p_2 = 0$ so after both @ rest, & $(p_1)' = 0$ and $(p_2)' = 0$

$p_1' - p_1 = \bar{F}_1 \Delta t$	$p_2' - p_2 = F_2 \Delta t$
$0 - 320 \frac{kg \cdot m}{s} = \bar{F}_1 (0.2s)$	$0 - (-320 \frac{kg \cdot m}{s}) = \bar{F}_2 (0.2$
$\bar{F}_1 = -1600\ N$	$\bar{F}_2 = 1600\ N$

Analytic Questions

(P.1) $a_c = \frac{v^2}{R}$ $K = \frac{1}{2} m v^2 = \frac{1}{2} m R a_c$

$a_{c,1} = 24\, a_{c,2}$

$K_1 = \frac{1}{2}(3\text{kg})(20\text{cm})(24\, a_{c,2})$

$K_2 = \frac{1}{2}(6\text{kg})(240\text{cm})(a_{c,2})$

$\frac{K_2}{K_1} = \frac{6(240)}{3(20)} = 24$

$K_2 = 24\, K_1 = (24)(65\text{ J}) = 1560\text{ J}$

(P.2) Momentum Before

	x-dir	y-dir
P_1	$70 \frac{kg\cdot m}{s}$	0
P_2	0	$160 \frac{kg\cdot m}{s}$
P_T	$70 \frac{kg\cdot m}{s}$	$100 \frac{kg\cdot m}{s}$

$\frac{P_{T,y}}{P_{T,x}} = \frac{100}{70} = \frac{10}{7}$

$\tan\theta = \frac{10}{7}$ $\theta = \tan^{-1}\left(\frac{10}{7}\right) = 55°$ above x-axis

$P'_{T,x} = (27\text{ kg})\, v_x'$ $70 \frac{m}{s} = 27\, v_x'$

$v_x' = \frac{70}{27} \frac{m}{s}$

$P'_{T,y} = (27\text{kg})\, v_y'$ $100 \frac{m}{s} = 27\, v_y'$

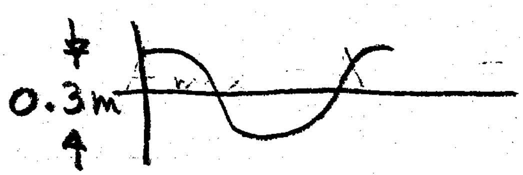
$$v_x' = \frac{70}{27}\ \frac{m}{s} \qquad\qquad v_y' = \frac{100}{27}\ \frac{m}{s}$$
$$= 2.6\ \frac{m}{s} \qquad\qquad = 3.7\ \frac{m}{s}$$

$$|\vec{v}| = \left[\sqrt{(2.6)^2 + (3.7)^2}\ \right]\frac{m}{s}$$
$$= \left[\sqrt{(6.7) \quad + (13.7)}\ \right]\frac{m}{s} = \left[\sqrt{20.4}\right]\frac{m}{s}$$
$$= 4.52\ \frac{m}{s}$$

(P.3) $$v_{wave} = \frac{16m - 12m}{3s} = \frac{4}{3}\ \frac{m}{s}$$

$$\lambda = 16m - 12m = 4m$$

$$v_{wave} = \lambda f \rightarrow \frac{4}{3}\ \frac{m}{s} = (4m) f \rightarrow f = \frac{1}{3} Hz$$



$$\rightarrow A = 0.15m$$

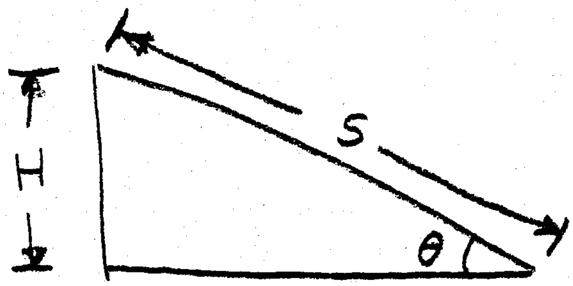
$$y = (0.15m) \sin\left[2\pi\left(\tfrac{1}{3} Hz\right)t - \frac{2\pi X}{4m}\right]$$

(P.4) $$L_o = 0.6m \qquad \Delta L = \alpha L_o(\Delta T) \qquad \alpha = 3\beta$$
$$V_o = (L_o)^3 = (0.6m)^3 \qquad \Delta V = \beta V_o (\Delta T)$$

$$\frac{\Delta V}{\Delta L} = \frac{\beta (L_o)^3}{\alpha L_o} = \frac{1}{3}(L_o)^2$$

$$\frac{\Delta V}{\Delta L} = \frac{1}{3}(0.6m)^2 = 0.12m^2$$

(P.5)



$H = 2.3\,m$, $\theta = 33^\circ$,
$M = 3\,kg$, $\mu = 0.3$

$$\frac{H}{S} = \sin\theta \,, \quad S = \frac{H}{\sin\theta}$$

$$S = \frac{2.3\,m}{\sin(33^\circ)} = 4.2\,m$$

$$KE_T = 0 \,, \quad U_T = MgH$$

$$KE_B = \tfrac{1}{2}M(V_B)^2 \,, \quad U_B = 0$$

$$W_F = -\mu[Mg\cos(33^\circ)]\,S$$

$$E_B - E_T = W_F$$

$$\tfrac{1}{2}M(V_B)^2 - MgH = -\mu Mg[\cos(33^\circ)]\,S$$

$$(V_B)^2 = 2g[H - \mu(\cos(33^\circ))S]$$

$$= 2(9.8\,\tfrac{m}{s^2})[2.3 - (0.3)(4.2)\cos(33^\circ)]\,m$$
$$= (19.6)[2.3 - (1.3)(0.\cancel{8})]\,\tfrac{m^2}{s^2}$$
$$= (19.6)[2.3 - 1.1](\tfrac{m}{s})^2$$
.839
$$= (19.6)(1.2)(\tfrac{m}{s})^2$$
$$(V_B)^2 = \cancel{21.4}\,(\tfrac{m}{s})^2$$
24.225

$$V_B = \cancel{(4.6)}\,\tfrac{m}{s} \qquad 4.927$$

$$KE_B = \frac{1}{2}(3kg)(21.4)\left(\frac{m}{s}\right)^2 = 32.1 \text{ J}$$

$$\frac{1}{2}k(x)^2 = 32.1 \text{ J}$$

$$\frac{1}{2}\left(2\frac{N}{m}\right)(x)^2 = 32.1 \text{ J}$$

$$x = \left[\sqrt{32.1}\right]m = 5.7 \text{ m}$$

(P.6) $Q_L = M\,L = (5kg)(207{,}000)(J/kg)$

$$= 1{,}035{,}000 \text{ J}$$

$$Q_1 = C_S M(\Delta T)$$

$$= (387)(5)(1083-1000) \text{ J}$$

$$= (387)(5)(83) \text{ J}$$

$$= 160{,}605 \text{ J}$$

$$Q_2 = C_\ell M(\Delta T)$$

$$= (387)(5)(2000-1083)$$

$$= (387)(5)(917)$$

$$= 1{,}774{,}395 \text{ J}$$

$$Q_{Total} = Q_L + Q_1 + Q_2$$

$$= 2{,}970{,}000 \text{ J}$$

(P. 7) $L = I\omega$ $\qquad \omega_B = \frac{2\pi \text{ rad}}{(12)(24)(3600) s} = 6.06 \times 10^{-6} \left(\frac{\text{rad}}{s}\right)$

$$L_A = L_B$$

$$I_A \omega_A = I_B \omega_B$$

$$\tfrac{2}{5} M_A (R_A)^2 \omega_A = \tfrac{2}{5} M_B (R_B)^2 \omega_B$$
$$M_A (R_A)^2 \omega_A = M_B (R_B)^2 \omega_B$$

$$\omega_A = \left(\frac{M_B}{M_A}\right)\left(\frac{R_B}{R_A}\right)^2 \omega_B$$
$$= 2\,(100)\,\omega_B$$
$$= 1.2 \times 10^{-3} \ \frac{\text{rad}}{s}$$

(P.8) Since she falls at half g we have $g_{Planet} = \frac{1}{2}(9.8)\,\frac{m}{s^2} = 4.9\,\frac{m}{s^2}$

$$P_1 = P_{surface} + \rho\, g_{Planet} H_1$$

$$P_2 = P_{surface} + \rho\, g_{Planet} H_2$$

$$\Delta P = P_2 - P_1 = \rho\, g_{Planet} (H_2 - H_1)$$

$$(30 - 1.55) \times 10^5\, Pa = \rho\, (4.9\,\tfrac{m}{s^2})\,(10 - 5.5)\,m$$
$$(28.45 \times 10^5\, Pa) = \rho\,(22.05)\,\frac{m^2}{s^2}$$

$$\rho = \left(\frac{28.45}{22.05}\right) kg/m^3 = 1.3\ kg/m^3$$

(P.9) $T_F = \frac{9}{5} T_c + 32$

$$4T_c = \frac{4}{5} T_c + 32$$

$$\frac{16}{5} T_c = 32$$

$$T_c = \frac{160}{16} = 10°C$$