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1) $\lambda = \frac{c}{f}$

$n = \frac{c}{v}$

$n = \frac{f\lambda}{v}$

2) $\frac{n_1}{n_2} = \frac{\sin 52°}{\sin 33°}$

$= 1.45$

3) $\theta + \phi = 90°$

$\theta = 90° - \phi$

$n_a \sin\theta = n_w \sin\phi$

~~$1 \sin(90° - \phi) = 1.33 \sin\phi$~~ $1 \sin\theta = 1.33 \sin(90° - \theta)$

$\sin\theta = 1.33 \cos\theta$

$\tan\theta = 1.33$

$\theta = 53.1°$

4) $\frac{\sin\theta}{\sin 90°} = 1.52$ $n_g \sin\theta = n_w \sin 90°$

$\theta =$ $\sin\theta = \frac{1.33 \sin 90°}{1.52}$

$\theta = 61.0°$

~~$\frac{n_w}{n_g} = \frac{\sin 35°}{\sin\theta}$~~ $n_2 \sin\theta =$

$\frac{1.33}{1.52} = \frac{\sin 55°}{\sin\theta}$ $1.52 \sin\theta_r = 1.33 \sin 50°$

$\theta = 69.4°$ $\theta_r = 45.8°$

5) $n = \frac{c}{v}$

$v = \frac{c}{n}$

$\frac{\sin i}{\sin r} = \frac{1}{n}$

6)

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1a)

1b) $\omega R = V$

$\omega = \frac{V}{R}$

$= \frac{1.5}{0.5}$

$= 1.8 \text{ rads}^{-1}$

1c) $K = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$= \frac{1}{2}mv^2 + \frac{1}{2} \ldots$

$= \frac{1}{2}\left(\frac{3}{2}m\right)v^2$

$= \frac{3}{4}(1.4)(0.15)$

$= 0.078 \text{ J}$

2a) $mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$= \frac{1}{2}\left(mv^2 + I\frac{v^2}{R^2}\right)$

$= \frac{1}{2}\left(m + \frac{I}{R^2}\right)v^2$

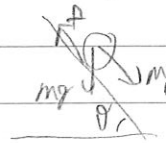
Hoop $= I = mR^2$

disk: $I = \frac{1}{2}mR^2$

sphere: $I = \frac{2}{5}mR^2$

$\therefore$ sphere reaches bottom first

3a)



$mg\sin\theta - f = ma$ — (1)

$a = g\sin\theta - \frac{f}{m}$

3b) $T = I\alpha$

$fR = I\alpha$

$= I\frac{a}{R}$

$f = \frac{I}{R^2}a$ — (2)

$mg\sin\theta - \frac{I}{R^2}a = ma$

$a = \frac{mg\sin\theta}{\left(m + \frac{I}{R^2}\right)}$

$f = \frac{I}{R^2}\left(\frac{mg\sin\theta}{\left(m + \frac{I}{R^2}\right)}\right)$

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3c) $v^2 = u^2 + 2as$

6a) Loss in KE = gain in PE

$\frac{1}{2}mv^2 + \frac{1}{2}Iw^2 = mgh$

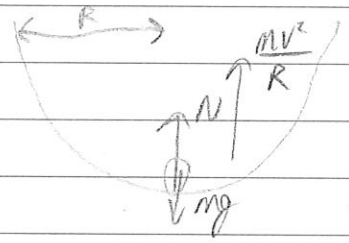
$mv^2 + Iw^2 = 2mg\left(\frac{3v^2}{4g}\right)$

$mv^2 + \frac{Iv^2}{R^2} = 2mg\left(\frac{3v^2}{4g}\right)$

$\frac{I}{R^2} = \frac{3}{2}m - m$

$I = \frac{1}{2}mR^2$

6b) Circular disc

7a) 

KE gain = PE lost

$= mgR$

7b) $\frac{1}{2}mv^2 + \frac{1}{2}Iw^2 = \frac{1}{2}mv^2 + \frac{1}{5}mv^2$ $I = \frac{2}{5}mr^2$

$= \frac{7}{10}mv^2$ $w = \frac{v}{r}$

$\frac{\frac{1}{5}}{\frac{7}{10}} = \frac{2}{7}$

7c) $\frac{1}{2}\left(mv^2 + \left(\frac{2}{5}\right)mr^2w^2\right) = mgR$

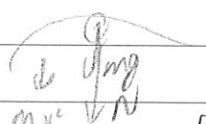
$\frac{7}{10}v^2 = gR$

$\frac{v^2}{R} = \frac{10}{7}g$

$N - mg = \frac{mv^2}{R}$

$N = mg + \frac{mv^2}{R}$

$= \frac{17}{7}mg$

8a) 

$N + mg = \frac{mv^2}{R}$

$N = \frac{mv^2}{R} - mg$

For object to be in contact

$N > 0$

$\frac{mv^2}{R} > mg$

$v^2 > Rg$

$mg(h-2R) = \frac{1}{2}mv^2 + \frac{1}{2}Iw^2$

$mg(h-2R) = \frac{7}{10}mv^2$

$v^2 = \frac{10}{7}(h-2R)g$

$\frac{10}{7}(h-2R)g > Rg$

$h - 2R > \frac{7}{10}R$

$h > 2\cdot 7R$

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8b) $mg(5R) = \frac{mV^2}{R}$ $mg(5R) = \frac{2}{5}mV^2$

$V^2 = \frac{50}{7}gR$

$N = \frac{mV^2}{R}$

$I = m(\frac{50}{7})g$

9a) $V_A = V_B$

$W_A R_A = W_B R_B$

$\frac{W_A}{W_B} = \frac{R_B}{R_A}$

$= 3$

$I_A W_A = I_B W_B$

$\frac{I_A}{I_B} = \frac{W_B}{W_A}$

$= \frac{1}{3}$

9b) $\frac{1}{2}I_A W_A^2 = \frac{1}{2}I_B W_B^2$

$I_A W_A^2 = I_B W_B^2$

$\frac{I_A}{I_B} = \frac{W_B^2}{W_A^2}$

$= \frac{R_B^2}{R_B^2}$

$= \frac{1}{9}$

4a) $L = Iw$

$= \frac{2}{5}mR^2w$

$= 7.1 \times 10^{33}\ kgm^2s^{-1}$

4b) $l = mvr$

$= mwr^2$

$= (5.98 \times 10^{24})\left(\frac{2\pi}{(365\frac{1}{4})(24)(3600)}\right)$

$= 2.7 \times 10^{40}\ kgm^2s^{-1}$

5) $L_i = (I_f)w_i + mv_i d$

$= \left(\frac{1}{12}\left(\frac{m}{2}\right)l^2 + \frac{1}{2}\left(\frac{m}{2}\right)l^2\right)w_i + mv_i d$

$= \frac{m}{12}(2d)^2 w_i + mv_i d$

$L_f = \left(\frac{m}{12}(2d)^2 + md^2\right)w_f$

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12a) $L_c = mvR$

$L_{is} = -I\omega_0$

$L_f = (mR^2 + I)\omega$

$mvR - I\omega_0 = (mR^2 + I)\omega$

$\omega = \frac{mvR - I\omega_0}{mR^2 + I}$

13) $mgh = \frac{1}{2}mv^2$

$v^2 = 2gh$

$mvl = (\frac{1}{3}ml^2 + ml^2)\omega^2$ conv

$\frac{1}{2}(\frac{1}{3}ml^2\omega^2 + ml^2\omega^2) = (m+M)gl(1-\cos\theta)$

conserv of energy

Rot KE