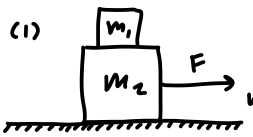
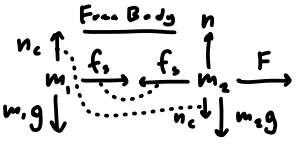
Jonah Spector 10/29/24 ANA20 W118 5pm **Practice Exam**

(1)





$\mu_s g = (F - \mu_s m_1 g)/m_2$

$F = \mu_s m_2 + \mu_s g m_1$

$\boxed{F = \mu_s g (m_1 + m_2)}$

1 $\begin{cases} \Sigma F_x = f_s = f_{s\max} = \mu_s n_c = m_1 a_x \\ \Sigma F_y = n_c - m_1 g = 0 \end{cases}$

2 $\begin{cases} \Sigma F_x = F - f_s = F - \mu_s n_c = m_2 a_x \\ \Sigma F_y = n - n_c - m_2 g = 0 \end{cases}$

$n_c = m_1 g$

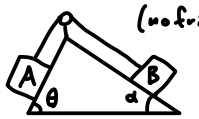
$\mu_s m_1 g = m_1 a_x$

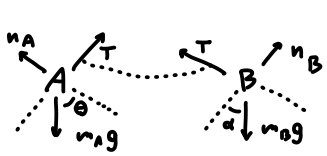
$\mu_s g = a_x$

$a_x = a_x$

$F - \mu_s m_1 g = m_2 a_x$

(2) (no friction)





A ΣF_x: $m_A g \sin(\theta) - T = m_A a_x$

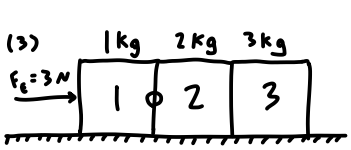
B ΣF_x: $T - m_B g \sin(\alpha) = m_B a_x$ → $T = m_B a_x + m_B g \sin(\alpha)$

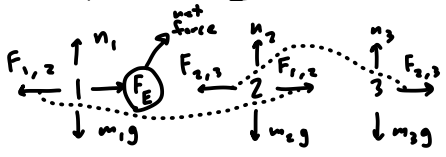
$m_A g \sin(\theta) - (m_B a_x + m_B g \sin(\alpha)) = m_A a_x$

$m_A g \sin(\theta) - m_B g \sin(\alpha) = m_A a_x + m_B a_x = a_x (m_A + m_B)$

$\boxed{a_x = g(m_A \sin(\theta) - m_B \sin(\alpha))(m_A + m_B)^{-1}}$

(3)





$m_1 a = F_E - F_{1,2}$

$m_2 a = F_{1,2} - F_{2,3}$

$m_3 a = F_{2,3}$

Total Net force $= F_E$

All blocks accel $= a$

$\therefore F_E = (m_1 + m_2 + m_3) a$

$F_{1,2} = F_E - m_1 a$ →

$F_{1,2} = F_E - m_1 F_E / (m_1 + m_2 + m_3)$

$F_{1,2} = F_E (m_2 + m_3)/(m_1 + m_2 + m_3)$

$\boxed{F_{2,1} = -F_E (m_2 + m_3)/(m_1 + m_2 + m_3) = -2.5\ N}$

(4)

$m = 1200\ kg$

$R = 15\ m$

$\mu_s = 0.25$

$\mu_k = 0.15$

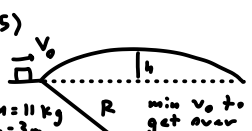
$v = 6.1\ m/s$

$a_r = \frac{v^2}{R}$ → $\boxed{\sqrt{\mu_s g R} = v}$

(static, not kinetic because rotation is not slipping)

$\Sigma F_r = f_s = \mu_s n = \mu_s m g = m a_r$

(5)



$m = 11\ kg$

$h = 3m$

$R = 10m$

min v_0 to get over bump

$E_i = E_f$ → $\frac{1}{2} m v_0^2 = mgh$

$\boxed{v_0 = \sqrt{2gh}}$ → $v_0 = 7.67$

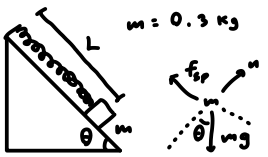
(6)

$a_r = \frac{v^2}{R}$ $\Sigma F = n - mg = ma_r$

$mgh = \frac{1}{2} m v^2$ → $\sqrt{2gR} = v$

$n = m(g + \frac{v^2}{R})$ → $n = m(g + (\sqrt{2gR})^2/R)$ → $\boxed{n = 3mg}$

(8) $k = 4\ N/m$ $\theta = 35°$ $m = 0.3\ kg$



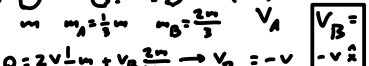
$\Sigma F_x = f_{sp} - mg\sin\theta = 0$

$kL = mg\sin\theta$

$\boxed{L = mg\sin\theta/k}$

$L = 42.2\ cm$

(7)



$x: 0 = 2v\frac{1}{3}m + v_{Bx}\frac{2m}{3}$ → $v_{Bx} = -v$

$y: 0 = v\frac{1}{3}m + v_{By}\frac{2m}{3}$ → $v_{By} = -\frac{1}{2}v$

$\boxed{V_B = -v\hat{x} - \frac{v}{2}\hat{y}}$

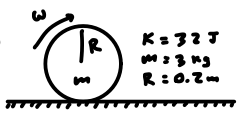
(9)

$\boxed{\omega = \sqrt{\frac{k}{3m}}}$

(10) $\frac{1}{2} k x^2 = \frac{1}{2}(3m) v_0^2$ $mv_0 = (3m) v_c$ → $v_c = \frac{1}{3} v_0$

$kx^2 = 3m(\frac{1}{3} v_0)^2$ → $\boxed{x = (\frac{m v_0^2}{3k})^{1/2}}$

(11)



$K = 32\ J$

$m = 3\ kg$

$R = 0.2m$

$K = K_{rot} + K_{trans}$ $\omega = \frac{v}{R}$

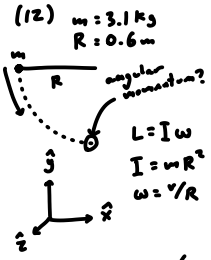
$K = \frac{1}{2} I \omega^2 + \frac{1}{2} m v^2$

$K = \frac{1}{2}(\frac{1}{3} m R^2)(\frac{v}{R})^2 + \frac{1}{2} m v^2$

$K = \frac{1}{4} m v^2 + \frac{1}{2} m v^2 = \frac{3}{4} m v^2$

$\boxed{v = \sqrt{\frac{4K}{3m}}}$ $v = 3.77\ m/s$

(12)



$m = 3.1\ kg$

$R = 0.6\ m$

$L = mvR$

$mgh = \frac{1}{2} m v^2$

$v = \sqrt{2gR}$

$\boxed{L = mR\sqrt{2gR}}$

$L = 6.38\ \hat{z}$ (not magnitude)

(13)

$D = 0.24m$

$m = 19\ kg$

$\boxed{I = \frac{2}{5} m (\frac{D}{2})^2}$

$I = 0.10944$

(14) Harmonic Motion

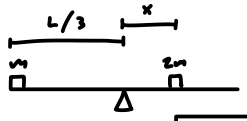
$x(t) = A\cos(\omega t + \phi)$

amplitude, T (period), frequency, phase

$x(t) = 3\cos(32t + 4)\ cm$

$\omega = 32$ $\omega = 2\pi f$ $\boxed{f = 5.1\ Hz}$

(15)

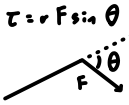


$\tau_1 = mg(L/3) = \tau_2 = 2mgx$ $\boxed{x = L/6}$

Equations

$\omega = 2\pi f$ $x(t) = A\cos(\omega t + \phi)$

$\tau = rF\sin\theta$



$U_{sp} = \frac{1}{2} k x^2$

$J = \int F\,dt = \Delta p$

$v_x = v_{x0} + a_x t$

$x = x_0 + v_{x0} t + \frac{1}{2} a_x t^2$

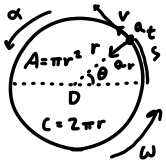
$v_x^2 = v_{x0}^2 + 2 a_x \Delta x$

$x \to \theta$ $a \to \alpha$ $p \to L$

$v \to \omega$ $m \to I$ $F \to \tau$

SOHCAHTOA

$\theta = \frac{2\pi}{360°}\theta°$



$s = r\theta$

$r = D/2$

$v = r\omega$

$\omega = 2\pi/T$

$f = 1/T$

$\tan\theta = \frac{\sin\theta}{\cos\theta}$

$\sin\theta = \frac{O}{H}$

$\theta = \sin^{-1}(\frac{O}{H})$

$a_r = \frac{v^2}{r} = r\omega^2$

$a_t = r\alpha$

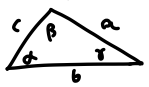
$a_{total} = \sqrt{a_r^2 + a_t^2}$

$\sin^2\theta + \cos^2\theta = 1$

$\tan^2\theta + 1 = \sec^2\theta$

$1 + \cot^2\theta = \csc^2\theta$

$\frac{\sin\alpha}{a} = \frac{\sin\beta}{b} = \frac{\sin\gamma}{c}$



$a^2 = b^2 + c^2 - 2bc\cos\alpha$

$b^2 = a^2 + c^2 - 2ac\cos\beta$

$c^2 = a^2 + b^2 - 2ab\cos\gamma$

$\cot\theta = \frac{\cos\theta}{\sin\theta}$

$\csc\theta = 1/\sin\theta$

$\sec\theta = 1/\cos\theta$

$\sin 2\theta = 1 - 2\sin^2\theta$ $\cos 2\theta = \cos^2\theta - \sin^2\theta$

$\sin 2\theta = 2\sin\theta\cos\theta$ $\cos 2\theta = 2\cos^2\theta - 1$

°	rad	cos	sin
0°	0	1	0
30°	π/6	√3/2	1/2
45°	π/4	√2/2	√2/2
60°	π/3	1/2	√3/2
90°	π/2	0	1
120°	2π/3	−1/2	√3/2
135°	3π/4	−√2/2	√2/2
150°	5π/6	−√3/2	1/2
180°	π	−1	0
210°	7π/6	−√3/2	−1/2
225°	5π/4	−√2/2	−√2/2
240°	4π/3	−1/2	−√3/2
270°	3π/2	0	−1
300°	5π/3	1/2	−√3/2
315°	7π/4	√2/2	−√2/2
330°	11π/6	√3/2	−1/2
360°	2π	0	1