1) since plane moving at a const velocity $\vec{a}=0$
so Net force = 0 so drag force must equal thrust
of engines & be in opposite direction.

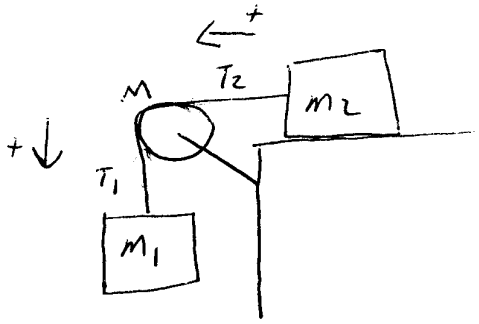
(E)

2) $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$

$v^2 = \frac{k}{m}x^2$

$v = \sqrt{\frac{k}{m}}x = \sqrt{\frac{16\,N/m}{.005\,kg}} \cdot .08\,m = 4.53\,m$ (E)

3)



$T_2 = m_2 a$

$m_1 g - T_1 = m_1 a$

$T_1 R - T_2 R = I\alpha \qquad \alpha = \frac{a}{R}$

$T_1 R - T_2 R = \frac{1}{2}MR^2\frac{a}{R}$

$T_1 - T_2 = \frac{1}{2}Ma$

$m_1 g - m_1 a - m_2 a = \frac{1}{2}Ma$

$m_1 g = \frac{1}{2}Ma + m_1 a + m_2 a$

$m_1 g = (\frac{1}{2}M + m_1 + m_2)a \Rightarrow a = \frac{m_1 g}{\frac{1}{2}M + m_1 + m_2}$ (B)

$a = \frac{4g}{2+4+4} = .4g = 3.92\,m/s^2$

4) since $F_{friction} = \mu N$

Just before slipping $F_{gravity} = F_{friction\ static}$

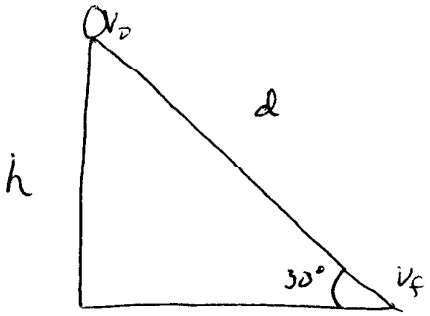
as soon as it slips, friction is kinetic & since

$\mu_k < \mu_s$ $F_{gravity} > F_{friction}$ we have a net

force => acceleration => object speeds up

(C)

5)



$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$ $\quad I_{sphere} = \frac{2}{3}mR^2$

$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\frac{2}{3}mR^2 \cdot \frac{v^2}{R^2}$

$gh = \frac{5}{6}v_f^2$ $\quad v_f = \sqrt{\frac{6}{5}gh}$ $\quad v_{avg} = \frac{v_0 + v_f}{2}$

$v_{avg} = \frac{\sqrt{\frac{6}{5}gh}}{2}$

$d = \frac{1}{2}at^2$ $\quad t = \frac{d}{v_{avg}}$

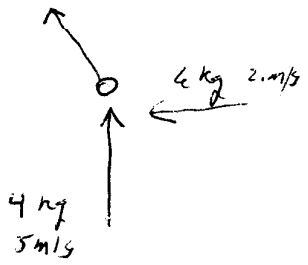
$h = d\sin\theta$

$d = \frac{1}{2}a\frac{d^2}{v_{avg}^2} = \frac{1}{2}a\frac{d^2}{\frac{6}{5}gh/4} = 2a\frac{d^2}{\frac{6}{5}gd\sin\theta}$

$1 = \frac{10a}{6g\sin\theta} \Rightarrow a = \frac{6}{10}g\sin\theta = \boxed{2.94\ m/s^2}$

(e)

6)



$P_{x_i} = 12\ kg\ m/s = 10kg\ V_x$

$P_{y_i} = 20\ kg\ m/s = 10kg\ V_y$

$V_x = 1.2\ kg\ m/s$

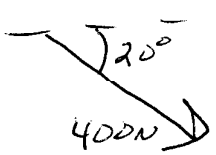
$V_y = 2\ kg\ m/s$

$V_T = \sqrt{V_x^2 + V_y^2} = \underline{2.33\ m/s}$

$\tan\theta = \frac{2}{1.2} \Rightarrow \theta = \underline{59°}$

(D)

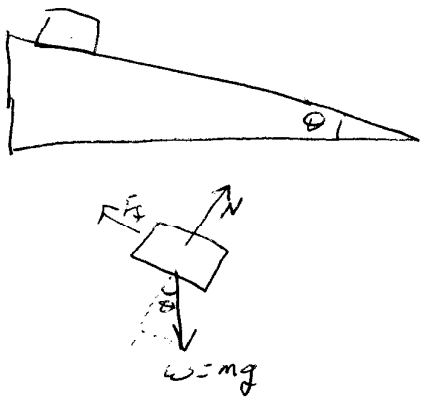
7) $\frac{30 \text{ Days} \mid 24 \text{ hours} \mid 60 \text{ min} \mid 60 \text{ s}}{\text{Day} \mid \text{hour} \mid \text{min} \mid} = 2.6 \times 10^6$ (E)

8) 

$F_x = 400 \cos 20° = +376$

$F_y = -400 \sin 20° = -137$

(C)

9) 

$F_f = \mu N$

$N = mg\cos\theta$

$F_f = \mu mg\cos\theta$

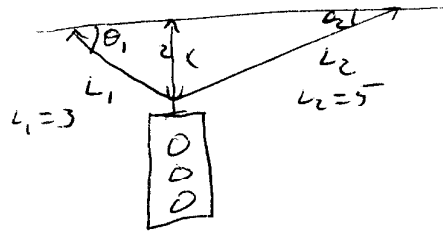
$mg\sin\theta - F_f = 0$

$mg\sin\theta - \mu mg\cos\theta = 0$

$\sin\theta - \mu\cos\theta = 0$

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

$.2 = \tan\theta$ $\boxed{\theta = 11.3°}$ (a)

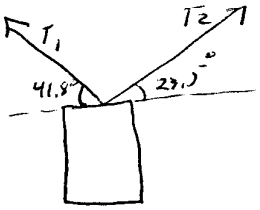
10) 

$\sin\theta_1 = \frac{2}{3}$

$\theta_1 = 41.8°$

$\sin\theta_2 = \frac{2}{5}$

$\theta_2 = 23.5°$



x: $T_2\cos 23.5° - T_1\cos 41.8° = 0$

y: $T_1\sin 41.8° + T_2\sin 23.5° - 100N = 0$

x: $T_2 = T_1\frac{\cos 41.8°}{\cos 23.5°} = .81T_1$

y: $T_1\sin 41.8° + .81T_1\sin 23.5° - 100N = 0$

$.666T_1 + .32T_1 - 100N = 0$

$.988T_1 = 100N$

$\boxed{T_1 = 101N}$ (B)

11) You want to have the smallest moment of Inertia so less energy in rotation and more in Translation. The object with smallest I is a light thin disk (B)

12) $F = PA = \rho g h A$ $\quad A = \pi r^2 = \pi (.5\,m)^2 = .79\,m^2$

$F = (1.025\ kg/m^3)(9.8\,m/s^2)(500\,m)(.79\,m^2) = \boxed{3.95 \times 10^6\ N}$

(B)

13) $m_1 v_1 = m_2 v_2$

$\frac{1}{2} m_1 v_1^2 = \frac{1}{2} m_2 v_2^2$

$m_1 = m_2$ so (E)

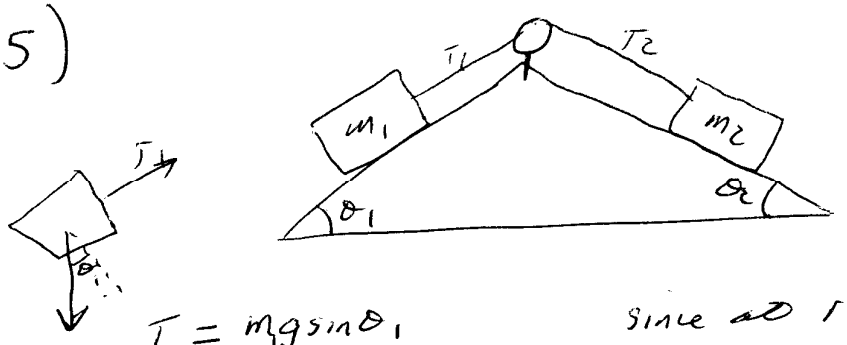
14) $F(N)$

$V(m/s^2)$

$N = b\frac{m^2}{s^2}$ units of b $\quad N\frac{s^2}{m^2} = \left(\frac{kg \cdot m}{s^2}\right)\left(\frac{s^2}{m^2}\right)$

$= \boxed{\frac{kg}{m}}$ (a)

15)



$T_1 = m_1 g \sin\theta_1$

$T_2 = m_2 g \sin\theta_2$

Since at rest

$T_1 = T_2$

$m_1 g \sin\theta_1 = m_2 g \sin\theta_2$

$\boxed{m_1 \sin\theta_1 = m_2 \sin\theta_2}$

(d)

16) $W_f = F \cdot d = \Delta K$

$\Delta K = \frac{1}{2} m v^2 - 0$

$\frac{1}{2}(2000\ kg)(30.447\ m/s)^2 = 179828\ J$

$F = \frac{\Delta K}{d} = \frac{179828\ J}{60\ m} = \boxed{3000\ N}$ (d)

17)

40 ← (100) → 80 $\quad v_{rel} = 60\ m/s$

$m_1 v_{1i} = m_1 v_{1f} + m_2 v_{2f}$

$v_{1f} - v_{2f} = 60\ m/s$

$m_1(60 + v_{2f}) + m_2 v_{2f} = 0$

$m_1 60 + m_1 v_{2f} + m_2 v_{2f} = 0$

$v_{2f}(m_1 + m_2) = -60 m_1$

$v_{2f} = \frac{-60 m_1}{m_1 + m_2} = \frac{-60 \cdot 40\ kg}{40\ kg + 80\ kg}$

$= \boxed{20\ m/s}$ (d)

18) Angular momentum conserved so no change in angular momentum. $I = \Sigma m r^2$, r gets smaller so I smaller

(B)

19) 25 m/s at 50°

$v_y = v_{0y} - gt$ max height $v_y = 0$

$25\ m/s \cdot \sin 50^\circ - gt = 0$

$t = \frac{25\ m/s \cdot \sin 50^\circ}{9.8\ m/s^2} = \boxed{1.95\ s}$ (a)

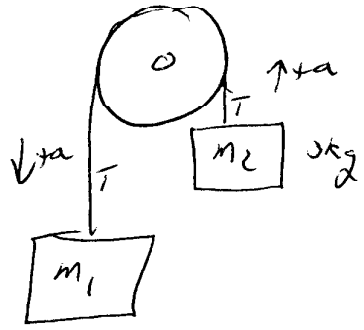
20) $SA = 4\pi r^2$ $\quad \frac{4\pi r_{new}^2}{4\pi r_{old}^2} = 1.08$

$r_{new} = 1.04\, r_{old}$

$\frac{V_{new}}{V_{old}} = \frac{4/3\pi r_{new}^3}{4/3\pi r_{old}^3} = \frac{(1.04\, r_{old})^3}{(r_{old})^3} = (1.04)^3 = 1.12 \Rightarrow 12\%$ increase

(C)

21)



$T - m_2 g = m_2 a \qquad T = m_2 a + m_2 g$

$m_1 g - T = m_1 a$

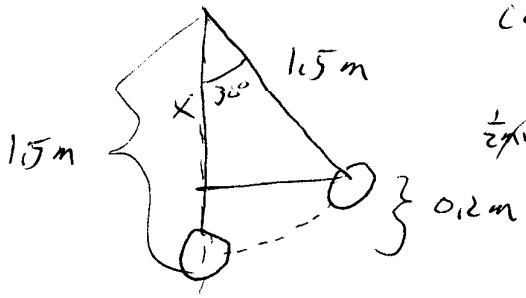
$m_1 g - m_2 a - m_2 g = m_1 a$

$m_1 g - m_2 g = m_1 a + m_2 a$

$a = \frac{(m_1 - m_2)g}{m_1 + m_2} = \left(\frac{5-3}{5+3}\right) g = \frac{1}{4} g = \boxed{2.45\ m/s}$

(d)

22)



$\cos 30° = \frac{x}{1.5} \quad x = 1.3m$

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

$v_f^2 = v_i^2 + 2gh$

$v_f^2 = (4\ m/s)^2 + 2 \cdot 9.8\ m/s^2 \cdot 0.2\ m$

$\boxed{v_f = 4.47\ m/s}$

(a)

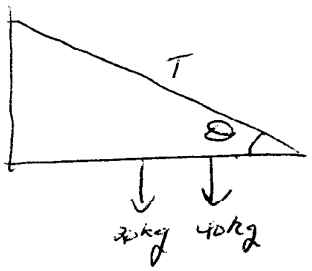
23) $F = 50N$
$r = .2m$
$\theta = 60^\circ$

$\tau = rF\sin\theta = (.2m)(50N)\sin 60^\circ$

$= \boxed{8.7\ N\text{-}m}$ (e)

24) since Energy conserved, must reach same height for both objects (c)

25)



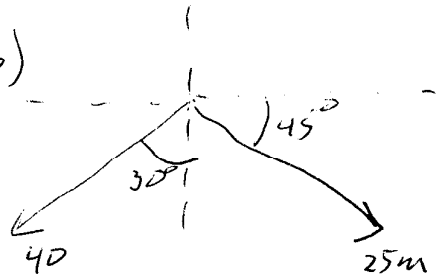
$\Sigma\tau = 0$

$T \cdot 2m \cdot \sin 20^\circ - mg(1m) - Mg(1.2m) = 0$

$T = \frac{(1)20g + 40\cdot(1.2)g}{2\sin 20^\circ}$

$= \frac{20g + 48g}{.684} = \boxed{970\ N}$ (a)

26)



$S = A + B$

$A_x = 25\cos 45^\circ$ $\quad B_x = -40\sin 30^\circ$

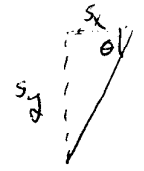
$A_y = 25\sin 45^\circ$ $\quad B_y = 40\cos 30^\circ$

$S_x = A_x + B_x$ $\quad S_y = A_y + B_y$

$= 17.68 + -20$ $\quad S_y = 17.68 + 34.64$

$S_x = -2.32$ $\quad S_y = 52.32$

$S = \sqrt{S_x^2 + S_y^2} = \boxed{52.4\ cm}$ (d)

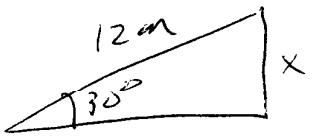


$\tan\theta = \frac{S_y}{S_x}$

$\theta = \tan^{-1}\frac{52.32}{2.32} = \boxed{87.5^\circ}$

27) $\tan\theta = \frac{v^2}{rg}$ $\frac{(25\ m/s)^2}{(500\ m)(9.8\ m/s^2)} = \tan\theta$

$\theta = 7.27^\circ$ (e)

28) 

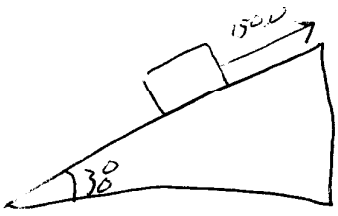
$\sin 30 = \frac{x}{12\ m}$

$x = 6\ m$

$mgh = \Delta U$

$(30\ kg)(9.8\ m/s^2)(6\ m) = 1764\ J$

(d)

29) 

$W = Fd\cos\theta$

$W = 150N \cdot 12m \cdot \cos 10^\circ = 1770\ J$

(b)

30) $m_1v_1 \rightarrow$ $\quad p_i = 20\ kg\,m/s$

$\leftarrow m_2v_2$ $\quad p_f = -16\ kg\,m/s$

$\Delta p = 20 - (-16)\ kg\text{-}m/s$

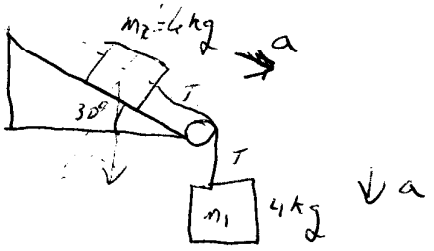
$= 36\ kg\text{-}m/s$ (e)

31) $m = 7000\,kg$

$a = 2\,m/s$

$F = ma = (7000\,kg)(2\,m/s) = \boxed{14000\,N}$

32)



$m_1 g - T = m_1 a$

$T + m_2 g \sin\theta = m_2 a$

$m_1 g - m_1 a + m_2 g \sin\theta = m_2 a$

$m_1 g + m_2 g \sin\theta = (m_2 + m_1) a$

$a = \dfrac{(m_1 + m_2 \sin\theta) g}{m_2 + m_1}$

$a = \dfrac{(4\,kg + 6\,kg \sin 30^\circ) g}{10\,kg}$

$= \boxed{6.86\,m/s^2}$ (d)

33) $F = \dfrac{mv^2}{r}$ $\quad v = \omega r$ $\quad r = \dfrac{v}{\omega} = \dfrac{3.5\,m/s}{5.5\,rad/s} = .63\,m$

$F = m\omega^2 r = (2.6\,kg)(5.5\,rad/s)^2 (.63\,m) = \boxed{50\,N}$

(C)

34) $T = 2\pi\sqrt{\dfrac{L}{g}} = 2\pi\sqrt{\dfrac{4m}{9.8\,m/s^2}} = \boxed{4\,s}$ (d)