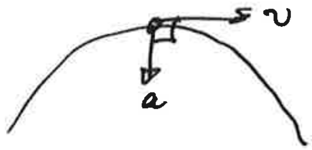
Ph105 S18
exam 3

1. no force displacement, work = 0 for both (E)

2. 

(A)

3. $W = F_{brake}\Delta x = \Delta K$ $\quad \Delta K_1 = \frac{1}{2}(4)(2)^2 = 16/2 = 8$

$\Delta K_2 = \frac{1}{2}(1)(4)^2 = 8$ $\quad \Rightarrow \Delta x$ same

(C)

4. $v_{horiz} = \text{const}, \; a_{vert} = -g$ (C)

5. $\frac{1}{2}mv^2 = mgh \quad \Rightarrow h_{max} = \frac{v^2}{2g}$ double v, 4 times higher (D)

6. $W = \int_{x_i}^{x_f} F_x\,dx = \int_0^{2.6} 3.7x^3 = \frac{3.7}{4}x^4\Big|_0^{2.6} = 42J$ (C)

7. $W = \Delta E = \left(\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2\right) + mg\Delta y = \frac{1}{2}mv_f^2 + mgh \simeq 4.08\,kJ$

$h = 20\,m \quad m = 20\,kg \quad v_i = 0 \quad v_f = 4\,m/s$ (C)

8. $\Delta x = v_x t \Rightarrow t = \frac{\Delta x}{v_x}$ $\quad \Delta y = \frac{1}{2}a_y t^2 = \frac{1}{2}a_y \frac{\Delta x^2}{v_x^2}$

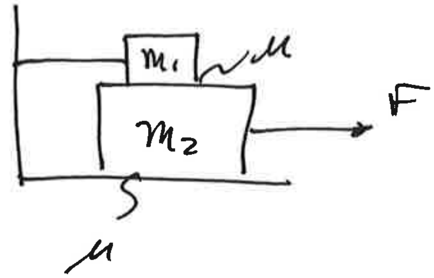
$a_y = \frac{2\Delta y\, v_x^2}{\Delta x^2} \simeq 2.5\times10^{14}\,m/s^2$ (C)

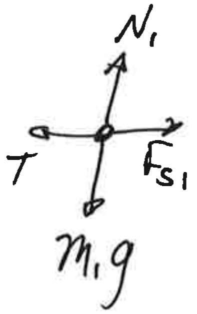
9. max range at $\theta = 45°$

$R = \frac{v_i^2 \sin 2\theta}{g} = \frac{v_i^2}{g} \simeq 0.789\,m$ (D)

10. $\alpha = \frac{d\omega}{dt} = -2\cdot(2\cdot1)t \simeq -38.2\,rad/s^2$ (C)

11.

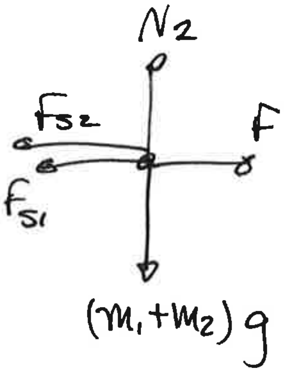




m_1

$N_1 = m_1 g$

$\Rightarrow f_{s1} = \mu N_1 = \mu m_1 g$



m_2

$N_2 = (m_1 + m_2) g \Rightarrow f_{s2} = \mu N_2 = \mu (m_1 + m_2) g$

$F = f_{s1} + f_{s2} = \mu m_1 g + \mu (m_1 + m_2) g$

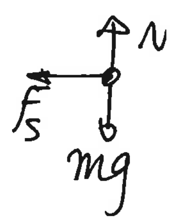
$F = \mu (2m_1 + m_2) g \simeq 78.5 N$ (A)

12. $T = \frac{2\pi}{\omega} = \frac{2\pi R}{v_t} \Rightarrow v_t = \frac{2\pi R}{T}$

$a_c = \frac{v_t^2}{R} = \frac{4\pi^2 R^2}{T^2 R} = \frac{4\pi^2 R}{T^2}$

to cut a in half, increase T by $\sqrt{2}$ (E)

13. friction provides centr. force



$N = mg$

$f_s = \mu mg = \frac{mv^2}{R}$

(B) $\Rightarrow \mu = \frac{v^2}{gR} \simeq 0.816$

14. $K_{s,r} = \frac{1}{2} I_s \omega_s^2 = \frac{1}{2} \cdot \frac{2}{5} M R^2 \omega_s^2$

$K_{c,r} = \frac{1}{2} I_c \omega_c^2 = \frac{1}{2} \cdot \frac{1}{2} M R^2 \omega_c^2$ length irrelevant here

$\Rightarrow \frac{1}{5} M R^2 \omega_s^2 = \frac{1}{4} M R^2 \omega_c^2$

$\omega_c = \frac{2}{\sqrt{5}} \omega_s$ (E)

15. rotational collision $\Rightarrow$ L conv.

$I_m = 2000\,kg\,m^2 \quad \omega_i = 1\,rad/s \quad R = 5m$

$m = 60\,kg \quad$ 2 humans

$$L_i = I_m \omega_i = L_f = I_m \omega_f + 2 \cdot m R^2 \omega_f = (I_m + 2mR^2)\omega_f$$

$$\Rightarrow \quad \omega_f = \frac{I_m \omega_i}{I_m + 2mR^2} \simeq 0.4\,rad/s \quad \text{A}$$

16. $\omega_i = 30\,rpm = 30\,\frac{rot}{min} \cdot \frac{2\pi\,rad}{rot} \cdot \frac{1\,min}{60\,s} = 3.14\,rad/s$

$\Delta\theta = 240\,rev \cdot \frac{2\pi\,rad}{rev} = 1.51 \times 10^3\,rad \qquad I = 0.085\,kg\,m^2$

$$W = \tau\Delta\theta = \Delta K = \tfrac{1}{2} I \omega_i^2$$

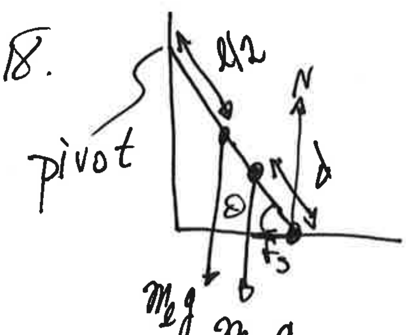
$$\tau = \frac{I\omega_i^2}{2\Delta\theta} \simeq 2.78 \times 10^{-4}\,N \cdot m \quad \text{D}$$

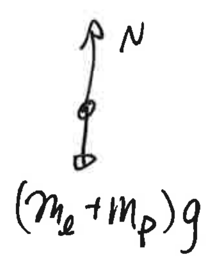
17. $v = R\omega$ no slip $\quad I = \frac{2}{5}MR^2$

$$K_t = \tfrac{1}{2}mv^2 \qquad K_{rot} = \tfrac{1}{2}I\omega^2 = \tfrac{1}{2} \cdot \tfrac{2}{5}MR^2 \cdot \frac{v^2}{R^2} = \tfrac{1}{5}mv^2 < K_t$$

C

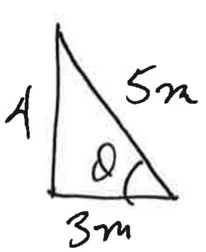
18.





$f_s = \mu N = \mu(m_l + m_p)g$

$$\sum \tau_p = -F_s l \sin\theta - m_p g(l-d)\sin(90-\theta) - mg\tfrac{l}{2}\sin(90-\theta) + F_N l \sin(90-\theta) = 0$$



same as HW problem ...

$$d = l - l\left(1 + \frac{m_l}{m_p}\right)(1 - \mu\tan\theta) + \frac{m_l l}{2m_p} \simeq 1.7m$$

$\theta = \cos^{-1}\left(\frac{3}{5}\right) \quad \tan\theta = \frac{4}{3}$

D

19. from lecture: $a_{cm} = \frac{g \sin\theta}{1+c}$ w/ $I = cmR^2$

larger c $\Rightarrow$ smaller a_{cm} $\Rightarrow$ longer to get to bottom

$c_{sph} < C_{cyl} < C_{pipe}$ sphere reaches first (A)

20. $\Sigma \tau = I\alpha = \tau$ $\quad I = \frac{1}{2}MR^2$

$\Rightarrow \frac{1}{2}MR^2\alpha = \tau \quad M = \frac{2\tau}{R^2\alpha} \simeq 17kg$ (B)