10310 Exam III 2005

MC

1. (C)

2. (E)

3. (D)

4. (A)

5. (E)

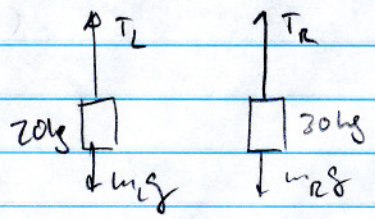
II. a) $\frac{1}{2} m_s v_s^2 = m_s g \ell (1 - \cos\theta)$

$$v_s = \sqrt{2g\ell(1-\cos\theta)} = 1.99 \text{ m/s}$$

b) $m_b v_i = m_b v_f + m_s v_s$

$$m_s = m_b \frac{v_i - v_f}{v_s} = 0.881 \text{ kg}$$

III.



acc. is positive upwards on left side & down on right side.

$(T_L - m_L g) = m_L a$ $\qquad T_L = m_L(g+a)$

$(m_R g - T_R) = m_R a$ $\qquad T_R = m_R(g-a)$.

a) Cons. energy:

$$(m_R - m_L) g h = \frac{1}{2}(m_R + m_L) v_f^2 + \frac{1}{2}\cdot\frac{1}{2} m_p r^2 \omega^2 \qquad v_f = \omega r$$

$$= \frac{1}{2}\left(m_R + m_L + \frac{1}{2} m_p\right) v_f^2$$

$$v_f = \sqrt{\frac{2(m_R - m_L) g h}{m_R + m_L + \frac{1}{2} m_p}} = 2.73 \text{ m/s}$$

b) $\omega = v/r = 27.3 \text{ rad/s}$

d) $h = \frac{1}{2} a t^2$; $v_f = at$ $\Rightarrow$ $h = \frac{1}{2} v_f t$

$t = 2h/v_f = 1.46 \text{ s}$

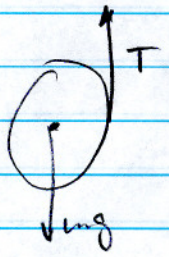
c) $a = v_f/t = 1.87 \text{ m/s}^2$

$T_L = m_L(g+a) = 233.6 \text{ N}$

$T_R = m_R(g-a) = 238.2 \text{ N}$

IV

a)



Careful w/ signs.

we know that a must be negative!

b) $F_y = T - mg = ma$

$\tau = mgr = I\alpha \qquad I = \frac{1}{2}mr^2 + mr^2 = \frac{3}{2}mr^2$.

c) $mgr = \frac{3}{2}mr^2\alpha$

$\alpha = \frac{2g}{3r} = 65.4\ rad/s^2$

$a = \alpha r = 6.54\ m/s.$

d) $T = m(a+g) = 0.3kg\,(-6.54\ m/s + 9.81\ m/s^2) = \underline{\underline{0.981\ N}}$

Alternative: Rotation around center

$mg - T = ma \quad \& \quad TR = I\alpha = \frac{1}{2}mR^2\,a/R \Rightarrow T = \frac{1}{2}ma$

$mg - \frac{1}{2}ma = ma \Rightarrow g = \frac{3}{2}a \Rightarrow a = 2/3\,g$

$\alpha = 2/3\,g/R$

V.

a) $I = \frac{1}{3} m L^2 + \frac{1}{2} M r^2 + M d^2 = 0.688 \text{ kg m}^2$

b) Starting from top

$$(m+M) y_{cm} = m \tfrac{L}{2} + M d$$

$$y_{cm} = \frac{m \frac{L}{2} + M d}{m+M} = 61.8 \text{ cm}$$

c) $(m+M) g y_{cm} (1 - \cos\theta) = \frac{1}{2} I \omega^2$

$$\omega = \sqrt{\frac{2(m+M) g y_{cm} (1 - \cos\theta)}{I}} = 1.67 \text{ rad/s}$$