2014-2015 第一学年

理论力学试卷标准答案与评分标准

一. 基本概念及运算题.

1. $F_{Ry} = F_2 + F_1 \times \frac{4}{5} = 200 + 100 \times \frac{4}{5} = 280N$

$F_{Rx} = F_1 \times \frac{3}{5} = 100 \times \frac{3}{5} = 60N$

$F_R = \sqrt{F_{Rx}^2 + F_{Ry}^2} = 286.36N$ 2'

$M_A(\vec{F}_1) = \frac{4}{5} \times F_1 \times 2 - \frac{3}{5} \times F_1 \times 2 = \frac{1}{5} \times 100 \times 2 = 40\ N \cdot m$ 2'

不变, 1' 改变. 1'

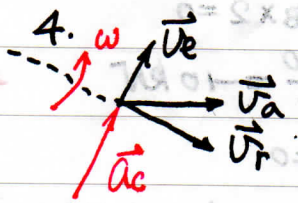
2. $F_x = -\frac{\sqrt{2}}{2} F$ 3'

$M_z(F) = \frac{\sqrt{2}}{2} F \cdot a$ 3'

3. $v_C = \omega r = 2 \times 0.5 = 1\ m/s$

$a_C^n = \frac{v_C^2}{R-r} = \frac{1^2}{1-0.5} = 2m/s^2$ 2' 方向 ↑ 2'

$a_C^t = \alpha \cdot r = 2 \times 0.5 = 1\ m/s^2$ 2'

4. 

3'

$v_e = |OB| \cdot \omega = \frac{h}{\sin 30^\circ} \cdot \omega = 2 \times 1 = 2m/s$

$v_a \cdot \sin 30^\circ = v_e$

$v_a = 4\ m/s$ 3'

$a_C$ 方向 (↑) 见图 2'

5. AB杆瞬时平移. $v_B = v_A = \omega \cdot r$ 2'

$\omega_{AB} = 0$ 2'

$\vec{p} = \vec{p}_{OA} + \vec{p}_{AB} + \vec{p}_B$ 均水平向左

$p_{OA} = m_1 \cdot \frac{\omega}{2} \cdot r + 2m_1 \cdot \omega r + m_2 \omega r = (\frac{5}{2} m_1 + m_2) \omega r$ 2'

$E_K = E_{KOA} + E_{KAB} + E_{KB}$

$= \frac{1}{2}(\frac{1}{3} m_1 r^2) \omega^2 + \frac{1}{2}(2m_1)(\omega r)^2 + \frac{1}{2} m_2 (\omega r)^2$

$= (\frac{1}{6} + 1) m_1 \omega^2 r^2 + \frac{1}{2} m_2 \omega^2 r^2$

$= (\frac{7}{6} m_1 + \frac{1}{2} m_2) \omega^2 r^2$ 2'

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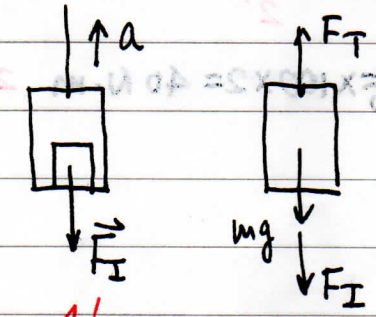
6. $L_O^{M_2} = m_2 v \cdot r_2$ 3'

$L_O = J_O\omega + m_2 v r_2 + m_1 v r_1 = J_O\omega + m_2\omega r_2^2 + m_1\omega r_1^2$

$\frac{dL_O}{dt} = \Sigma M_O(F_i^e)$ $\quad (J_O + m_2 r_2^2 + m_1 r_1^2)\alpha = m_1 g r_1 - m_2 g r_2$

$\alpha = \frac{(m_1 r_1 - m_2 r_2)g}{J_O + m_1 r_1^2 + m_2 r_2^2}$ 4'

7




1'

$F_T - mg - F_I = 0$

或: $F_T - mg - ma = 0$ 2'

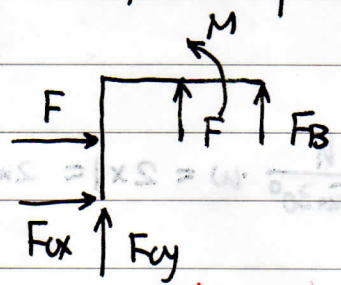
或 $F_T - m(g+a) = 0$

$F_T = m(g+a) = 1000 \times 12.5$

$= 12500\ N$ 1'

计算题 1

(1). 分析 BDC 部分:




4'

$\Sigma F_x = 0$ $\quad F + F_{Cx} = 0$ $\quad F_{Cx} = -F = -40\ kN$. 2'

$\Sigma M_C = 0$

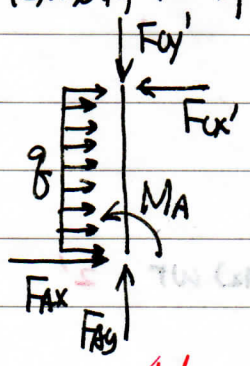
$-F \times 1 + F \times 1 + M + F_B \times 2 = 0$

$F_B = -\frac{M}{2} = -\frac{20}{2} = -10\ kN$ 2'

$\Sigma F_y = 0$ $\quad F_{Cy} + F + F_B = 0$

$F_{Cy} = -F - F_B = -40 - (-10) = -30\ kN$ 2'

(2). 分析 AC 部分




4'

(不画 $M_A$ 受力图不给分)

$\Sigma F_x = 0$ $\quad F_{Ax} + q \times 2 - F_{Cx}' = 0$

$F_{Ax} = F_{Cx}' - 2q = (-40) - 2 \times 10 = -60\ kN$ 2'

$\Sigma F_y = 0$ $\quad F_{Ay} - F_{Cy}' = 0$

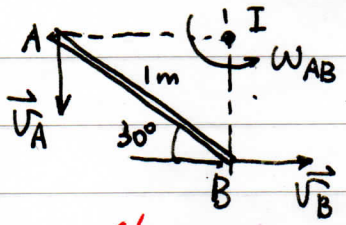
$F_{Ay} = F_{Cy}' = -30\ kN$ 2'

$\Sigma M_A = 0$ $\quad M_A - q \times 2 \times 1 + F_{Cx}' \cdot 2 = 0$

$M_A = 2q - 2F_{Cx}'$

$= 2 \times 10 - 2 \times (-40) = 100\ kN \cdot m$ 2'

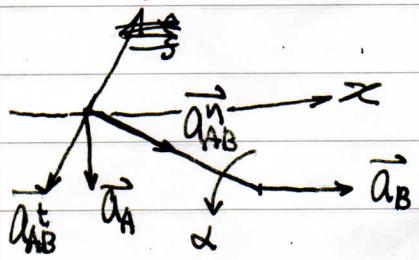
计算题 2.




$\omega_{AB} = \frac{v_B}{BI} = \frac{1}{0.5} = 2\ rad/s$ 2'

$\vec{a}_A = \vec{a}_B + \vec{a}_{AB}^n + \vec{a}_{AB}^t$ 1'

4'




6'

$[\vec{a}_A = \vec{a}_B + \vec{a}_{AB}^n + \vec{a}_{AB}^t]$ 向 x

$0 = a_B + a_{AB}^n \cdot \cos 30° - a_{AB}^t \sin 30°$ 2'

$\frac{1}{2} a_{AB}^t = a_B + a_{AB}^n \cos 30°$

$a_{AB}^n = \omega_{AB}^2 |AB| = 4 \times 1 = 4\ m/s^2$ 2'

$a_{AB}^t = 2 \times (2 + 4 \times \frac{\sqrt{3}}{2}) = 4 + 4\sqrt{3}\ m/s^2 = 10.93\ m/s^2$ 2'

$\alpha_{AB} = a_{AB}^t / AB = 10.93/1 = 10.93\ rad/s^2$ 1'

计算题 3.

(1) 竖直时 $\delta_1 = 400\ mm$.

水平时. $\delta_2 = 300\ mm$

$E_{K1} = \frac{1}{2} J \omega^2 = \frac{1}{2}(\frac{1}{3} m l^2) \cdot \omega^2 = \frac{1}{6} \times 15 \times 0.4 \times 4 = 1.6\ J$ 3'

$E_{K2} = \frac{1}{2}(\frac{1}{3} m l^2) \omega_1^2$ 1'

外力功 $W_{12} = m_1 g \cdot \frac{l}{2} + \frac{1}{2} k \delta_1^2 - \frac{1}{2} k \delta_2^2$

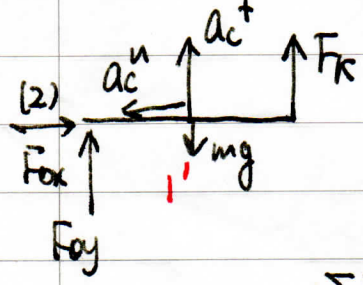
$= 15 \times 9.8 \times \frac{0.4}{2} + \frac{1}{2} \times 0.5 \times 1000 \times (0.1^2 - 0.3^2)$

$= 9.4\ J$ 2'

$W_{12} = \Delta E_K$ 1' $\frac{1}{6} m l^2 \omega_1^2 - 1.6\ J = 9.4\ J$

$\omega_1 = \sqrt{\frac{(9.4 + 1.6) \times 6}{15 \times 0.4^2}} = 5.24\ rad/s$ 2'

(2)




1'

$J_O \alpha = \Sigma M_O(F)$

$\frac{1}{3} m l^2 \cdot \alpha = F_K l - mg \cdot \frac{l}{2}$ 计算得 $\alpha = 38.25\ rad/s^2$ 2'

$a_C^n = \omega^2 \cdot \frac{l}{2} = 5.49\ m/s^2$ $a_C^t = 38.25 \times \frac{l}{2} = 7.65\ m/s^2$ 1'

$\Sigma F_{ix} = m a_{Cx}$ $F_{Ox} = -m a_C^n = -15 \times 5.49 = -82.35\ N$ 1'

$\Sigma F_{iy} = m a_{Cy}$ $F_K - mg + F_{Oy} = m a_{Cy}$ $F_{Oy} = 111.75\ N$ 1'