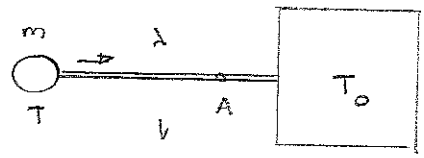
Lösningar till Fysik för Ingenjörer 1, I1 2011-05-24

①



$T_0 = 20^\circ C$
$T_1 = 80^\circ C$
$T_2 = 40^\circ C$

$\lambda_{Cu} = 390\ W/m\cdot K$
$c = 4{,}18\ J/kg\cdot K$

$$\frac{dQ}{dt} = \lambda A \frac{T-T_0}{l} = -m\cdot c\cdot \frac{dT}{dt}$$

$$\Rightarrow dt = -\frac{mcl}{\lambda A}\frac{dT}{T-T_0}$$

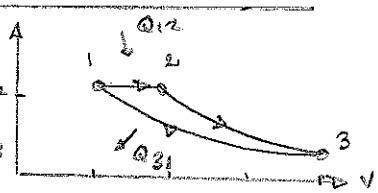
$$\Rightarrow t = -\frac{mcl}{\lambda A}\int_{T_1}^{T_2}\frac{dT}{T-T_0} = \frac{mcl}{\lambda A}\ln\frac{T_1-T_0}{T_2-T_0}$$

$$= \frac{2{,}0\cdot 4{,}18\cdot 10^3\cdot 0{,}3}{390\cdot 7\cdot 10^{-4}}\ln\frac{60}{20}\ s = 10\,092\ s = \underline{\underline{2{,}8\ h}}$$

② $n = 2$

$P_1 = nRT_1/V_1 = 6648\ N/m^2$

$V_2 = V_1\frac{T_2}{T_1} = 7/4\ m^3$



adiabat $TV^{\gamma-1} = konst$

$\gamma = 5/3 \quad \gamma - 1 = 2/3$

$T_2V_2^{2/3} = T_3V_3^{2/3}$

$$\Rightarrow V_3 = \left(\frac{T_2}{T_3}\right)^{3/2}V_2 = 4{,}05\ m^3$$

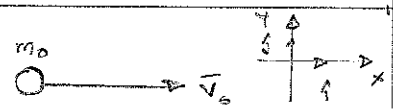
$P_3 = P_2\frac{V_2}{V_3} = 1642\ N/m^2$

	T	V	P
1	400	1	6648
2	700	7/4	6648
3	400	4,05	1642
	K	m^3	N/m^2

$$e = \frac{Q_{12}+Q_{31}}{Q_{12}} = \frac{nC_p(T_2-T_1)+nRT_1\ln\frac{V_1}{V_3}}{nC_p(T_2-T_1)} =$$

$$= \frac{5/2\,(700-400)+400\cdot\ln 1/4{,}05}{5/2\,(700-400)} = \underline{\underline{0{,}25}}$$

③ $m_0 = 20\ kg$



$\bar{P}_0 = m_0\bar{v}_0 = 4000\hat{i}\ kgm/s$

$\bar{P}_1 = 10\cdot 100\,\hat{j} = 1000\,\hat{j}\ kgm/s$

$\bar{P}_2 = 4\cdot 500(-\hat{i}) = -2000\,\hat{i}\ kgm/s$

$\bar{P}_3 = 6\cdot v_x\hat{i} + 6v_y\hat{j}$

$\bar{P}_0 = \sum_1^3\bar{P}_i \Rightarrow \bar{P}_3 = 6000\hat{i} - 1000\hat{j}$

$$\Rightarrow \boxed{\bar{v}_3 = \left(1000, -\frac{1000}{6}\right)\ m/s}$$

$K_0 = \frac{1}{2}m_0v_0^2 = 400\ kJ$

$K_1 = \frac{1}{2}10\cdot 100^2 = 50\ kJ \quad K_2 = 500\ kJ$

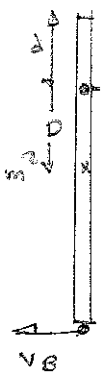
$K_3 = \frac{1}{2}6\left(1000^2 + \frac{1000^2}{6}\right) = 3\,083\ kJ.$

$\boxed{\Delta K = 3{,}2\ MJ}$

④ $I_A = I_{CM} + MD^2 =$

$= \frac{1}{12}Ml^2 + M\left(\frac{l}{2}-d\right)^2 =$

$= \frac{1}{12}3{,}0\cdot 4^2 + 3\cdot 1^2 = 7\ kgm^2$



$K_R = \frac{1}{2}I\omega^2$

$\Rightarrow \omega = \sqrt{\frac{2K_R}{I}}$

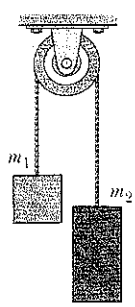
$l = 4\ m$
$d = 1\ m$
$\frac{l}{2} - d = 1\ m$

$v_B = \left(\frac{l}{2}+d\right)\omega =$

$= (2+1)\sqrt{\frac{2\cdot 20}{7}}\ m/s = 7{,}17 = \underline{\underline{7{,}2\ m/s}}$

⑤ $t = 0\ s: \quad m_1 = 1{,}30\ kg$

$m_2 = 2{,}20\ kg$



$\frac{dm_1}{dt} = -0{,}10\ kg/s$

$$a = \frac{m_2-m_1}{m_2+m_1}g \Rightarrow \frac{da}{dt} = \frac{d}{dt}\left(\frac{m_2-m_1}{m_2+m_1}\right)g$$

$$= \left[-\frac{\frac{dm_1}{dt}}{m_2+m_1} - \frac{dm_1}{dt}\frac{m_2-m_1}{(m_2+m_1)^2}\right]g$$

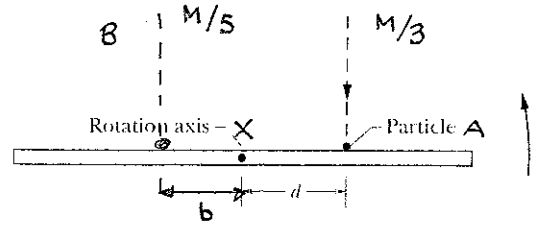
$t = 0 \quad \frac{da}{dt} = \frac{0{,}10}{2{,}20+1{,}30} + 0{,}10\frac{2{,}20-1{,}30}{(2{,}20+1{,}30)^2}$

$= \underline{\underline{0{,}033\ m/s^3}}$

$t = 3\ s \quad m_1 = 1{,}0\ kg \Rightarrow \frac{da}{dt} = \underline{\underline{0{,}058\ m/s^3}}$

max a då $m_1 = 0$ dvs efter $\underline{\underline{t = 13\ s}}$

⑥



L bevaras

n.a.p x:s

$L_i = \omega_0 I_0 + \frac{M}{5}bv_B - \frac{M}{3}dv_A$

$L_f = \omega\left(I_0 + \frac{M}{5}b^2 + \frac{M}{3}d^2\right)$

$I_0 = \frac{1}{12}Ml^2$

$l = 0{,}600\ m \quad d = 0{,}15\ m$
$b = 0{,}10\ m$
$v_B = 30\ m/s \quad v_A = 40\ m/s$

$L_i = L_f \Rightarrow$

$$\Rightarrow \omega = \frac{80\frac{0{,}36}{12} + 30\frac{0{,}10}{5} - 40\frac{0{,}15}{3}}{\frac{0{,}36}{12} + \frac{0{,}10^2}{5} + \frac{0{,}15^2}{3}} = \underline{\underline{2{,}5\ rad/s}}$$

relativ motorn