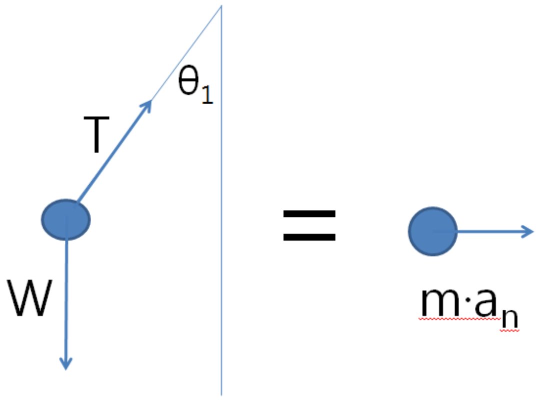
1. 길이 l_1의 줄이 회전 중 l_2의 길이만큼 줄어들 때, 그 각도를 구하는 문제

a) 관계식은? (**20 points**)

1) Draw Free Body Diagram (FBD) **(5 points)**



2) Governing Equation (**5 points**)

$\uparrow(+)\sum F_y = 0;$ $T\cdot\cos\theta_1 - W = 0$ $T = W/\cos\theta_1$

$\rightarrow(+)\sum F_x = m\cdot a_n;$ $T\cdot\sin\theta_1 = W\cdot\tan\theta_1 = mg\tan\theta_1 = mv_1^2/r$ Where $r = l\cdot\sin\theta$

3) 각속도 보존법칙 사용 or 계산 (**5 points**)

$\sum M_y = 0;$ H_y = constant $\mathbf{r_1 m v_1 = r_2 m v_2}$ -------------(*)

또, $v^2 = l\cdot g\cdot\sin\theta\cdot\tan\theta$ 이므로,

$v_1 = \sqrt{l_1\cdot g\cdot\sin\theta_1\cdot\tan\theta_1}$ 그리고, $v_2 = \sqrt{l_2\cdot g\cdot\sin\theta_2\cdot\tan\theta_2}$ -----(**)

4) (*)에 (**)을 넣어 정리하면, (**5 points**)

$$l_1^3\cdot\sin^3\theta_1\cdot\tan\theta_1 = l_2^3\cdot\sin^3\theta_2\cdot\tan\theta_2$$

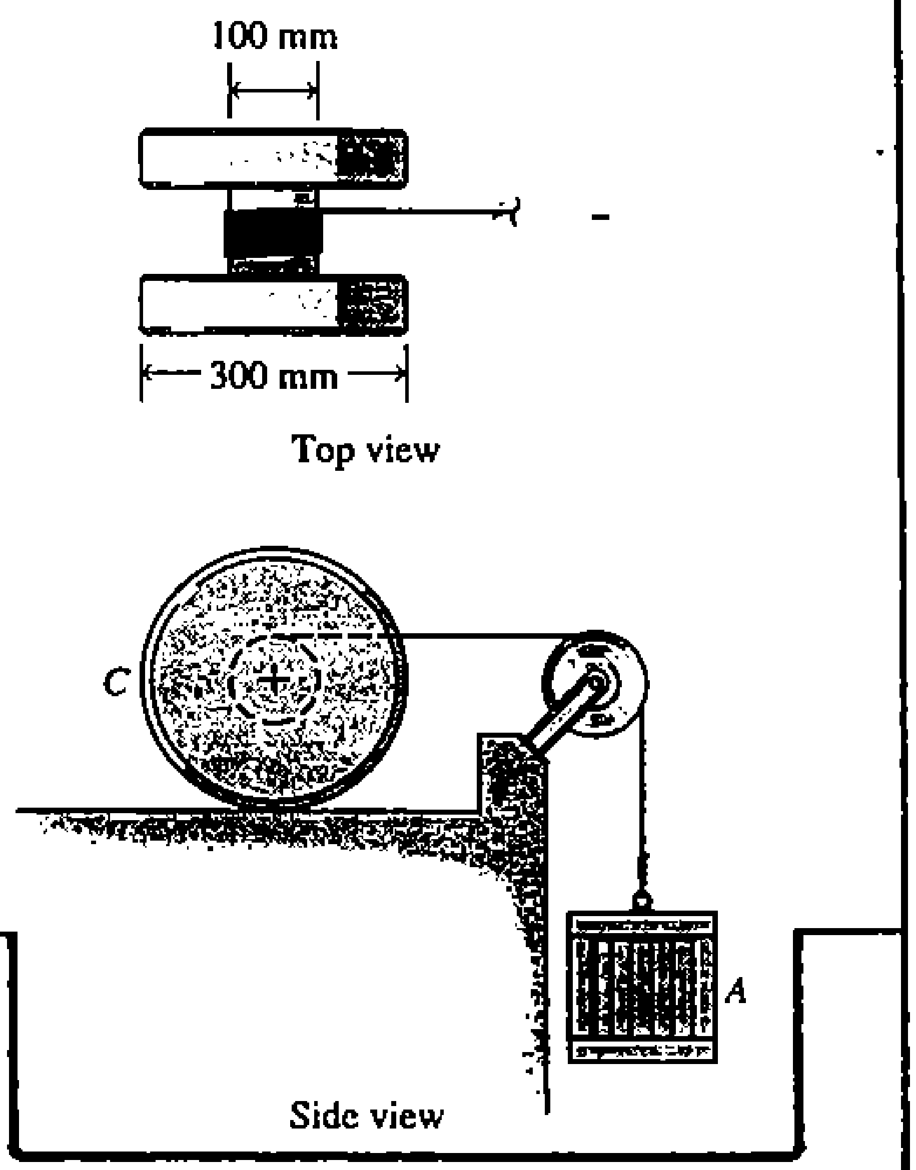
b) θ_2는? (**10 points**) $\boldsymbol{\theta_2 = 49.8°}$

(부분점수는 a)에서 나온 자신의 결과를 사용하여 $\boldsymbol{\theta_2}$를 제시하면 (**3~5 points**))

2. 번 채점 기준.
(a)
답 맞으면 15점
틀렸을 경우.
1. FBD그리면 5점
2.모멘트 평형과 힘 평형에 대한 식 2개를 만들면 4점(각2점)
3. 각 가속도 구하면 +1점
4. 가속도 = 거리 * 각 가속도 식 맞으면 +1점.

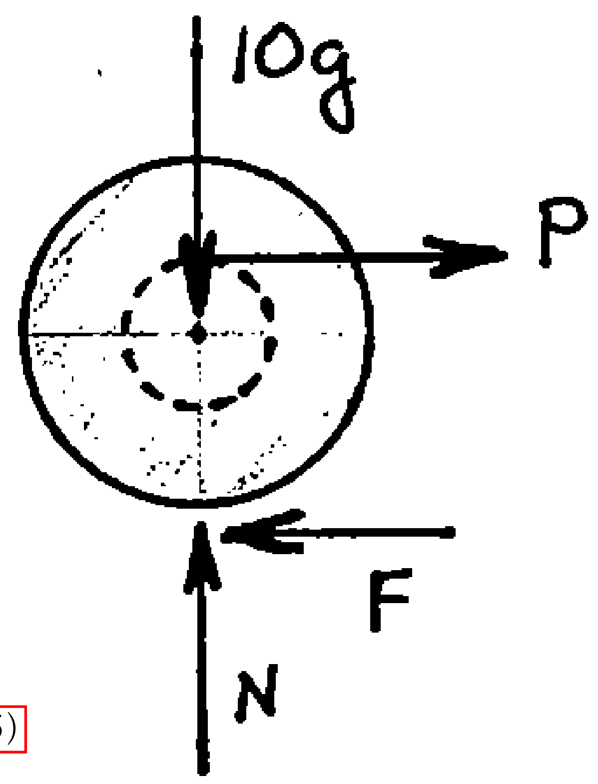
(b)
답 맞으면 15점
틀렸을 경우
1. 중심에서의 모멘트 평형=0 이용하면 +1점.
2. R2 값을 구하면 5점
3. FB= R2*cos45+(-R3)*cos45 식 맞으면 5점.

18-26* The 10-kg spool C has a centroidal radius of gyration of 75 mm. A cord is attached to the center of the spool, passes over a small frictionless pulley, and is attached to a 25-kg crate A. If the system is released from rest and the spool rolls without slipping, determine the speed v_C and angular velocity ω_C of the spool and the speed v_A of the crate after the crate has dropped 2 m.



Solution

Neither N, F, nor W_C do work. The rope tension is an internal force; its work will cancel out when the work-energy equations for the crate A and spool C are added together. The weight W_A has a potential; the zero of gravitational potential energy is set at the initial position. If the spool rolls without slipping, then



$$v_C = 0.150\omega \quad (5)$$

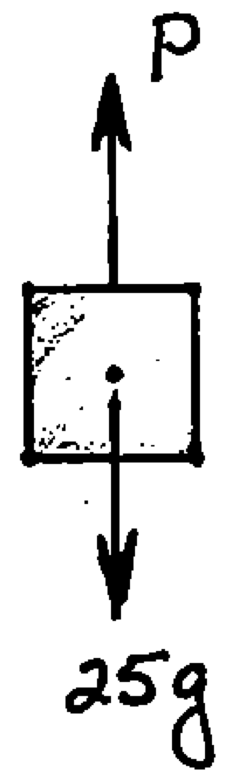
$$v_A = 0.200\omega \quad (5)$$

and the kinetic energy of the system is

$$T = \frac{1}{2} m_C v_C^2 + \frac{1}{2} I_C \omega^2 + \frac{1}{2} m_A v_A^2 \quad (5)$$

$$= \frac{1}{2}(10)(0.150\omega)^2 + \frac{1}{2}(10)(0.075)^2\omega^2$$

$$+ \frac{1}{2}(25)(0.200\omega)^2 = 0.64063\omega^2 \quad (5)$$



Therefore, the work-energy equation $T_i + V_i + U = T_f + V_f$ gives

$$0 + 0 + 0 = 0.64063\omega^2 + 25(9.81)y$$

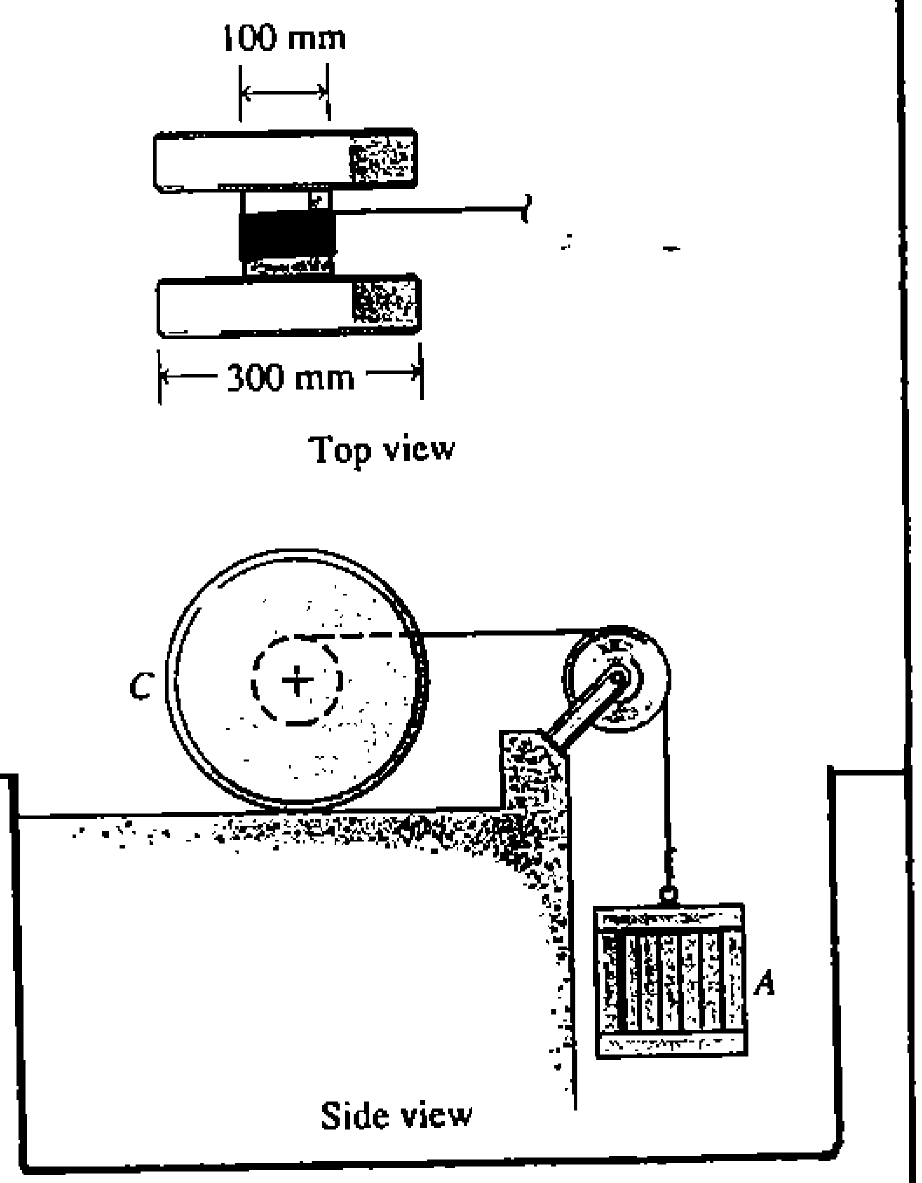
When the crate has dropped 2 m ($y = -2$ m)

$\omega_C = 27.7$ rad/s .... Ans. (10)

$v_C = 4.15$ m/s .... Ans. (5)

$v_A = 5.53$ m/s .... Ans. (5)

16-76 The 10-kg spool C has a centroidal radius of gyration of 75 mm. A cord connects the spool to a 25-kg crate. If the system is released from rest and the spool rolls without slipping, determine the speed v_C and the angular velocity ω_C of the spool and the speed v_A of the crate after the crate has dropped 2 m.



Solution

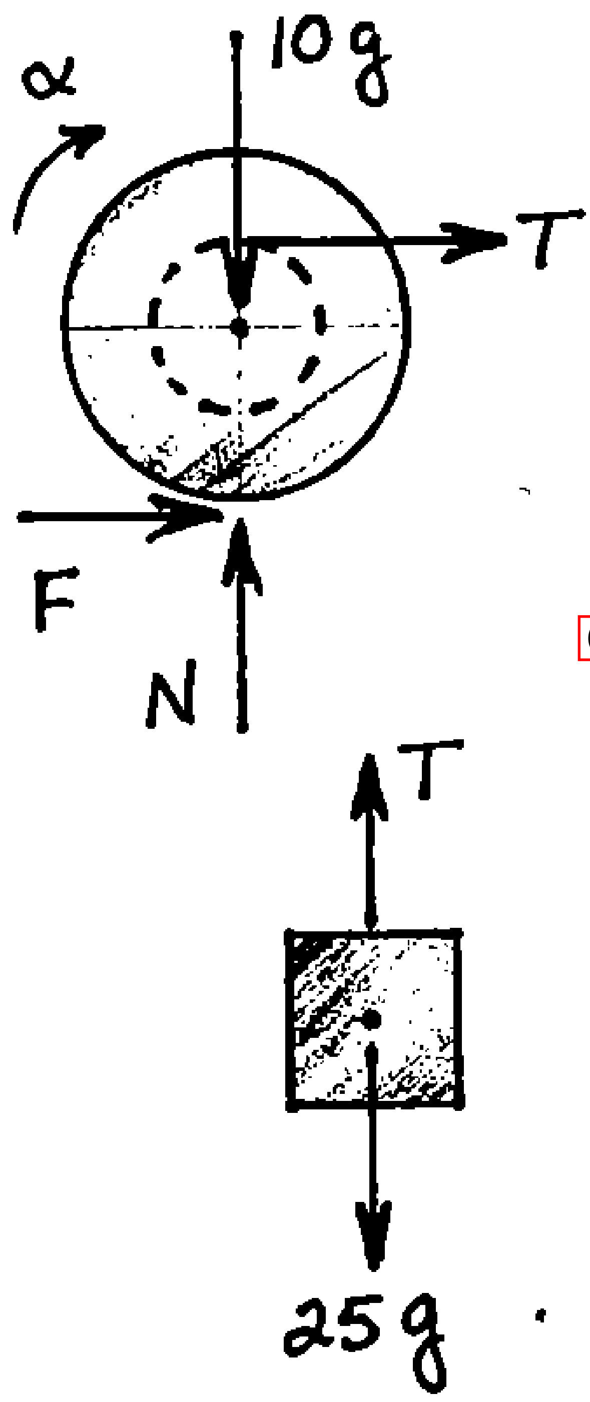
Separate free-body diagrams must be drawn of the spool and the crate since their motions are different. The equations of motion are

$$+\rightarrow \Sigma F_x = \quad F + T = 10a_{Gx} \qquad \text{(a)}$$

$$+\uparrow \Sigma F_y = \quad N - 10(9.81) = 0 \qquad \text{(b)}$$

$$\circlearrowright+ \Sigma M_G = 0.05T - 0.15F = I_G\alpha \qquad \text{(c)}$$

$$+\downarrow \Sigma F_y = \quad 25(9.81) - T = 25a_A \qquad \text{(d)}$$



where $a_{Gy} = 0$,

$$I_G = 10(0.075)^2 = 0.05625 \text{ kg}\cdot\text{m}^2$$

and the accelerations a_{Gx}, a_A, and α are related by

$$a_{Gx} = 0.15\alpha$$

$$a_A = 0.20\alpha$$

Therefore

$$N = 98.1 \text{ N}$$

and adding Eqs. *a* and *d* gives

$$245.25 + F = 10(0.15\alpha) + 25(0.20\alpha)$$

$$F = 6.500\alpha - 245.25 \qquad \text{(e)}$$

$$T = 245.25 - 5.00\alpha \qquad \text{(f)}$$

(Problem 16-76 continues ...)

(Problem 16-76 - cont.)

Then, combining Eqs. *c*, *e*, and *f* gives

$$0.05(245.25 - 5\alpha) - 0.15(6.5\alpha - 245.25) = 0.05625\alpha$$

$a = 38.28293 \text{ rad/s}^2$ ↻ = constant (5)

$F = 3.58902$ N ⟶

$T = 53.83537$ N

$a_{Gx} = 5.74244 \text{ m/s}^2$ ⟶ = constant (5)

$a_A = 7.65659 \text{ m/s}^2$ ↓ = constant (5)

Finally, integrating the (constant) acceleration of the crate with respect to time gives its velocity and position

$v_A = 7.65659t$ m/s ↓

$y_A = 3.82829t^2$

where y_A is positive downward (the same direction and a_A) and the constants of integration are both zero since the crate starts from rest when $y_A = 0$. Then the crate will have dropped 2 m when

$y_A = 3.82829t^2 = 2$ m

$t = 0.723$ s $V_A = 5.53$ m/s .... Ans. (5)

at which time

$v_{Gx} = 5.74244t = 4.15$ m/s ⟶ .... Ans. (5)

$\omega = 38.28293t = 27.7$ rad/s ↻ .... Ans. (5)