PARTICLE KINETICS

KINETICS PROBLEMS

1] COORDINATE SYSTEM

2] FREE BODY DIAGRAMS

3] KINETICS EQUATIONS

if need be?
3] KINEMATICS

4] SOLVE FOR...

→ SOLUTION

Practice Problem

Example 4.A.6

Given: The system of blocks A and B shown below is initially at rest when a force F is applied to the free end of the cable.
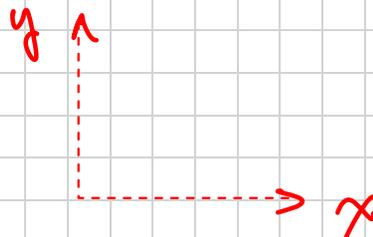
Find: Determine the accelerations of blocks A and B: (a) if the surface between A and B is smooth, and (b) if the surface between A and B is rough with a coefficient of kinetic friction being μ_k, and where it is known that block A slips on block B.

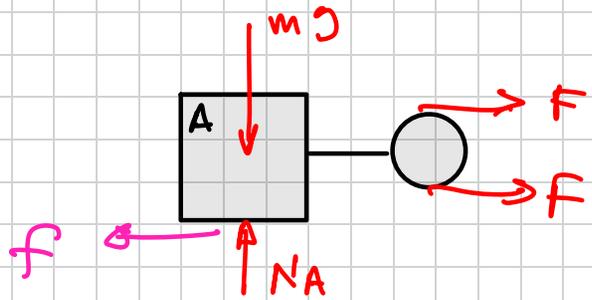Use the following parameters in your analysis: $F = 60$ N, $m = 20$ kg, $M = 100$ kg and $\mu_k = 0.5$.
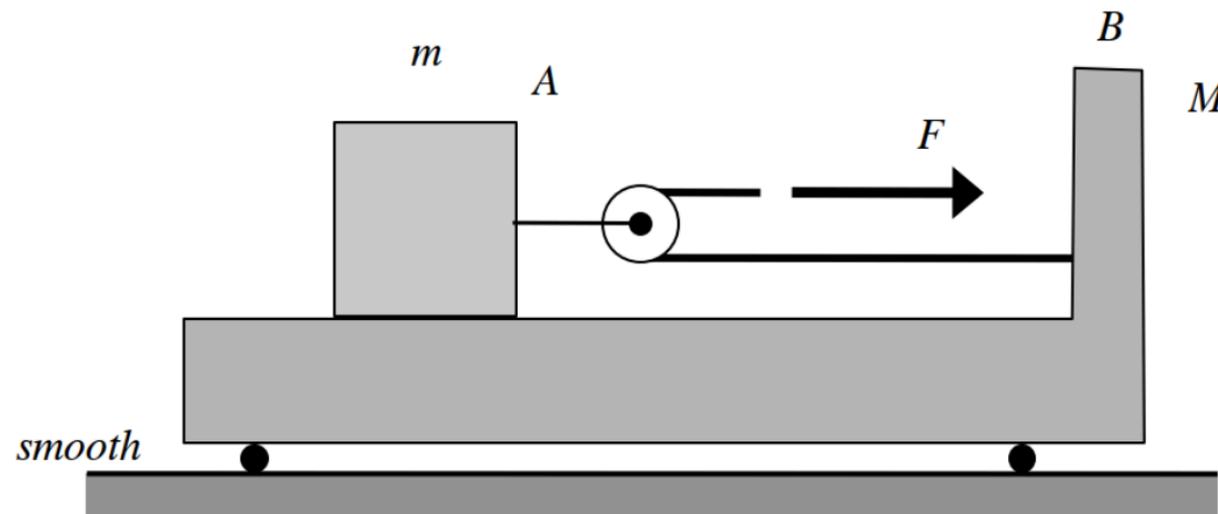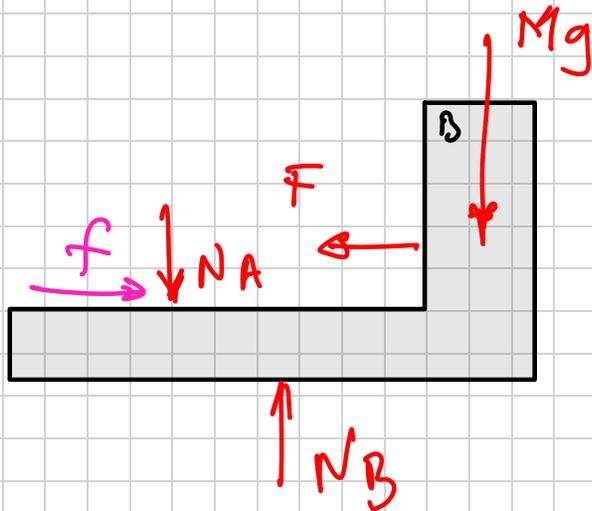

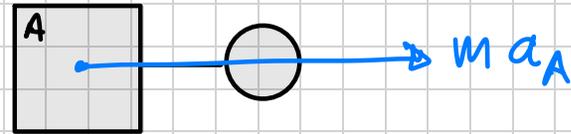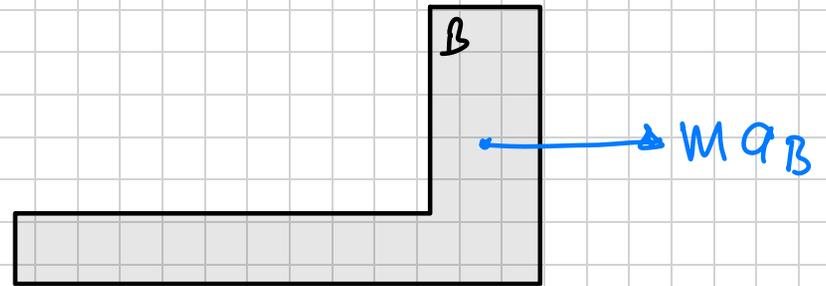**Solution:**

1.

2. Diagrams (smooth case):

3. Kinetics (w/o Friction)

A: $\sum F_x = m a_{Ax}$

$2F = m a_{Ax}$ ✓ ?

$\sum F_y = m a_{Ay}$

$N_A - mg = 0$

B: $\sum F_x = M a_{Bx}$

$-F = M a_{Bx}$?

$\sum F_y = 0$

$-Mg + N_B - N_A = 0$

④ solve

$$\vec{a}_{AX} = \frac{2F}{m}\hat{\imath} + 0\hat{\jmath} \quad \frac{m}{s^2} \qquad a_{AY} = 0$$

$$\vec{a}_{BX} = -\frac{F}{M}\hat{\imath} + 0\hat{\jmath} \quad \frac{m}{s^2} \qquad a_{BY} = 0$$

Step ③   Including   Friction.

$$\Sigma Fx = m\,a_{AX}$$

$$2F - f = m\,a_{AX}$$

$$\Sigma Fx = M\,a_{BX}$$

$$f - F = M\,a_{BX}$$

④   Solve

$$a_{AX} = \frac{1}{m}(2F - f) \qquad , \qquad N_A = mg$$

$$a_{BX} = \frac{1}{M}(f - F) \qquad \qquad N_B = (M+m)g$$

$$f = \mu_K \cdot N_A$$

$$\rightarrow \quad \vec{a}_A = \frac{1}{m}(2F - \mu_K mg)\,\hat{\imath} + 0\,\hat{\jmath} \quad {}^{m}\!/\!s^2 \; (Friction)$$

$$\vec{a}_B = \frac{1}{M}(\mu_K mg - F)\,\hat{\imath} + 0\,\hat{\jmath} \quad m/s^2$$

Cartesian, path and polar description can all be used in the right side of Newton's second law equation

(A) True

(B) False

Practice Problem

Example 4.A.8

Given: Blocks A and B (having masses of 10 kg and 5 kg, respectively) are constrained to move along smooth, vertical and horizontal guides, as shown in the figure. A and B are connected by a lightweight rod of length $L = 2.5$ m. A force of $F = 50$ N acts to the right on block B. At the position where $s_A = 1.5$ m, A is moving downward with a speed of 4 m/s.
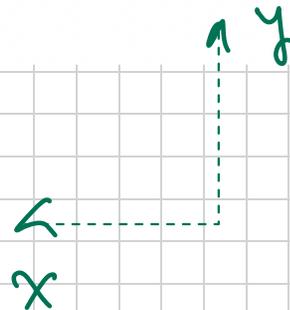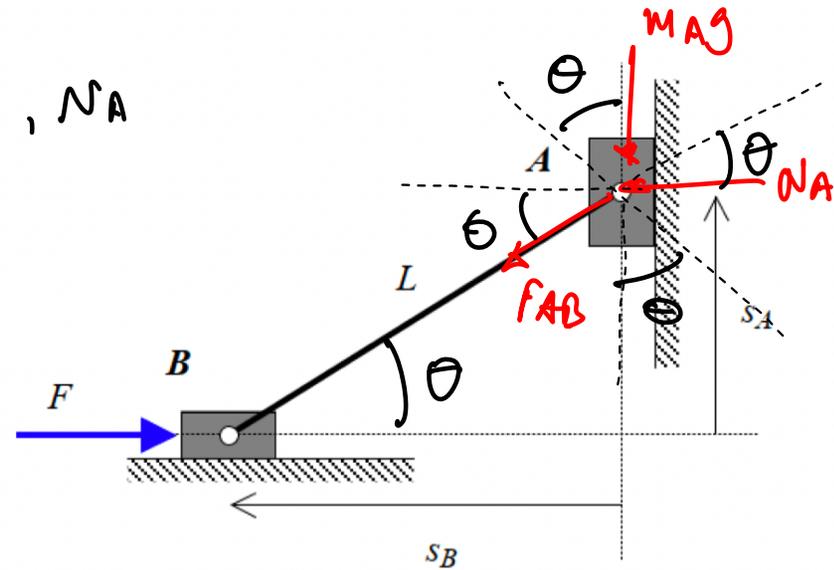
Find: Determine:
   (a) The acceleration of A and B at this instant; and
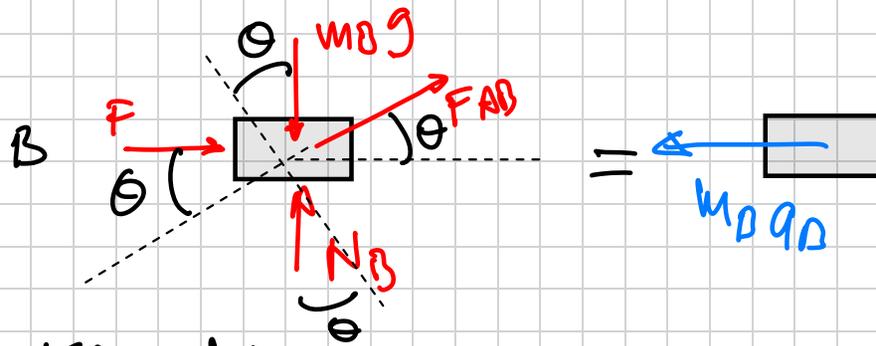   (b) The force in rod AB at this instant.

Given: m_A, m_B, L, F, s_A, N_A

Find: $\vec{a}_A, \vec{a}_B, \overline{F_{AB}}$

1) Coord system

② FBD & KD

For A: forces $m_A g$ (down), N_A (right), F_{AB} (down-left at angle θ), with angle θ markings. Equals $m_A a_A$ (up).

For B: forces F (right), $m_B g$ (down), F_{AB} (up-right at angle θ), N_B (up), with angle θ markings. Equals $m_B a_B$ (left).
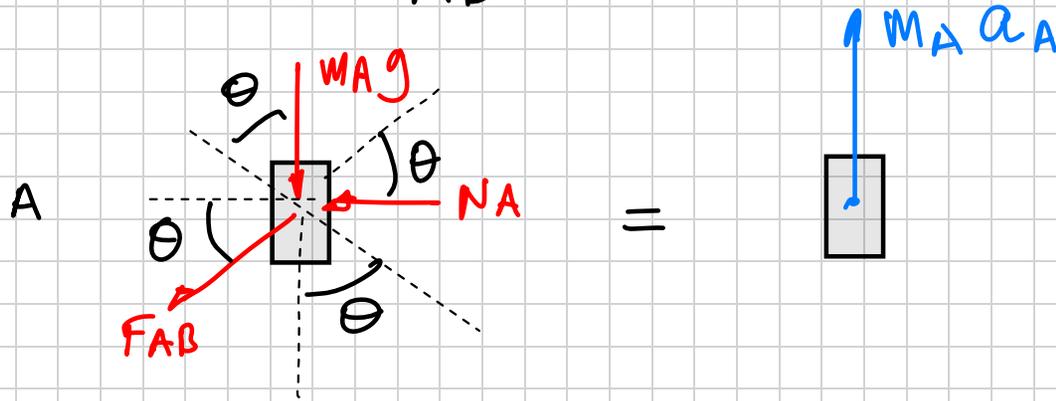
③ Kinetics

$$A: \quad \Sigma F_x = m_A a_{Ax}$$
$$+ N_A - F_{AB} \cos\theta = 0 \quad ①$$

$$\Sigma F_y = m_A a_{Ay}$$
$$- m_A g - F_{AB} \sin\theta = m_A a_{Ay} \quad ②$$

$$B: \quad \Sigma F_x = m_B a_{Bx}$$
$$- F - F_{AB} \cos\theta = m_B a_{Bx} \quad ③$$

$$\Sigma F_y = m_B a_{By}$$
$$- m_B g + N_B + F_{AB} \sin\theta = 0 \quad ④$$

Four equns, FIVE unknowns.

④ Kinematics

$$\frac{d}{dt}\left(L^2 = S_A^2 + S_B^2 \right) \quad ⑤ \qquad \text{Five equns, SIX unknowns!}$$

$$\frac{d}{dt}\left(0 = \cancel{2}S_A \dot{S}_A + \cancel{2}S_B \dot{S}_B \right) = S_A N_A + S_B N_B = 0 \quad ⑥$$

Six equns, SEVEN unknowns!

$$0 = \dot{S}_A \dot{S}_A + S_A \ddot{S}_A + \dot{S}_B \dot{S}_B + S_B \ddot{S}_B$$

$$0 = N_A^2 + S_A q_A + N_B^2 + S_B q_B \quad ⑦$$

SEVEN equations, SEVEN unknowns!