Particle Dynamics

Engineering Mechanics: Dynamics

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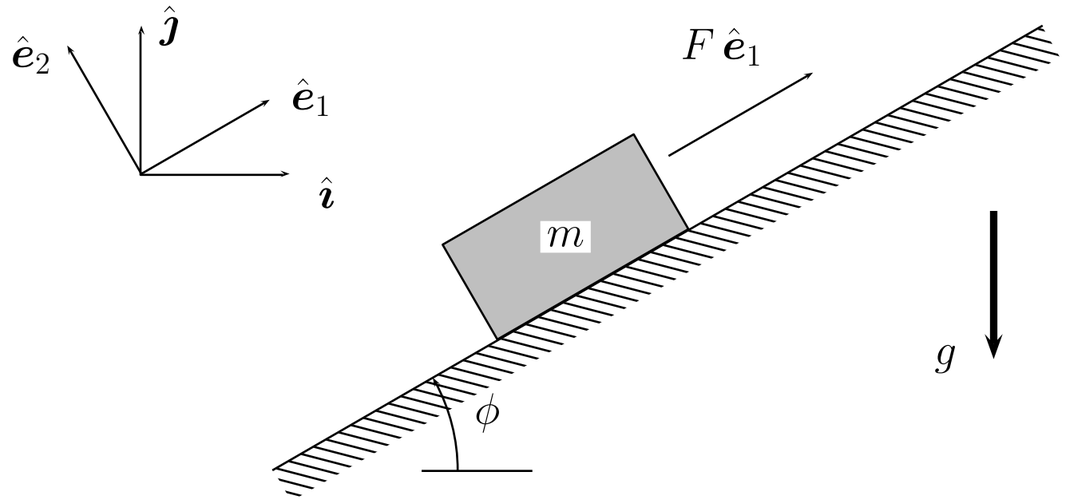
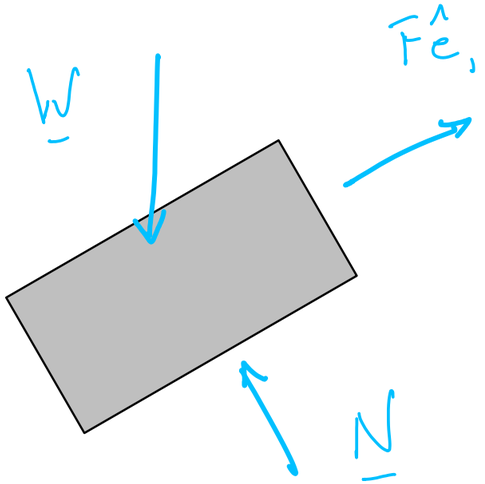
A block of mass m slides on a smooth surface inclined at an angle ϕ and is pulled by a force of magnitude F. Find the acceleration of the block.





IDENTIFY FORCES

- APPLIED LOAD
- WEIGHT
- NORMAL FORCE

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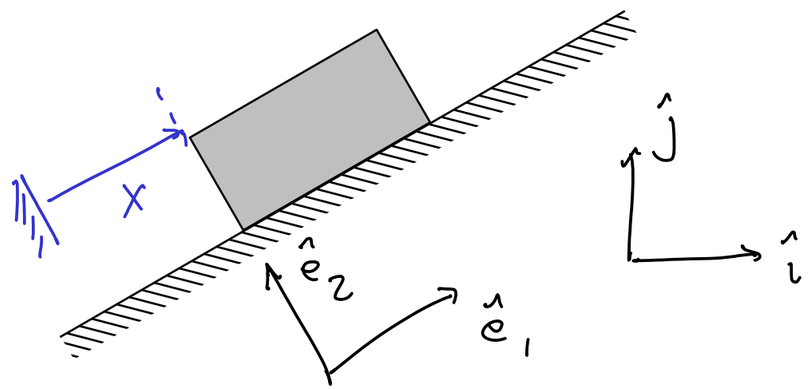
Coordinates and Directions



$$\hat{e}_1 = C_\phi \hat{i} + S_\phi \hat{j} \qquad \hat{i} = C_\phi \hat{e}_1 - S_\phi \hat{e}_2$$

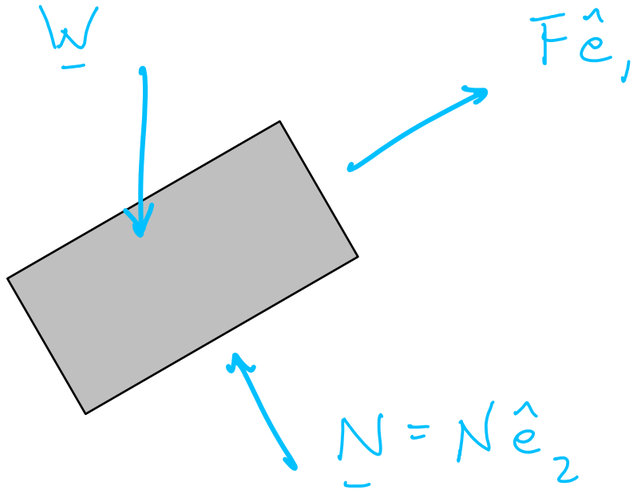
$$\hat{e}_2 = -S_\phi \hat{i} + C_\phi \hat{j} \qquad \hat{j} = S_\phi \hat{e}_1 + C_\phi \hat{e}_2$$

Kinematics/Free Body Diagram

ACCELERATION

$$\underline{a}_B = \ddot{x}\,\hat{e}_1$$

$$-mg\hat{j} = \underline{W}$$



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Equations of Motion

LINEAR MOMENTUM BALANCE

$$-mg\hat{j} + F\hat{e}_1 + N\hat{e}_2 = \sum \underline{F} = m\underline{a}_B = m\ddot{x}\hat{e}_1$$

$$\hat{j} = S_\phi \hat{e}_1 + C_\phi \hat{e}_2$$

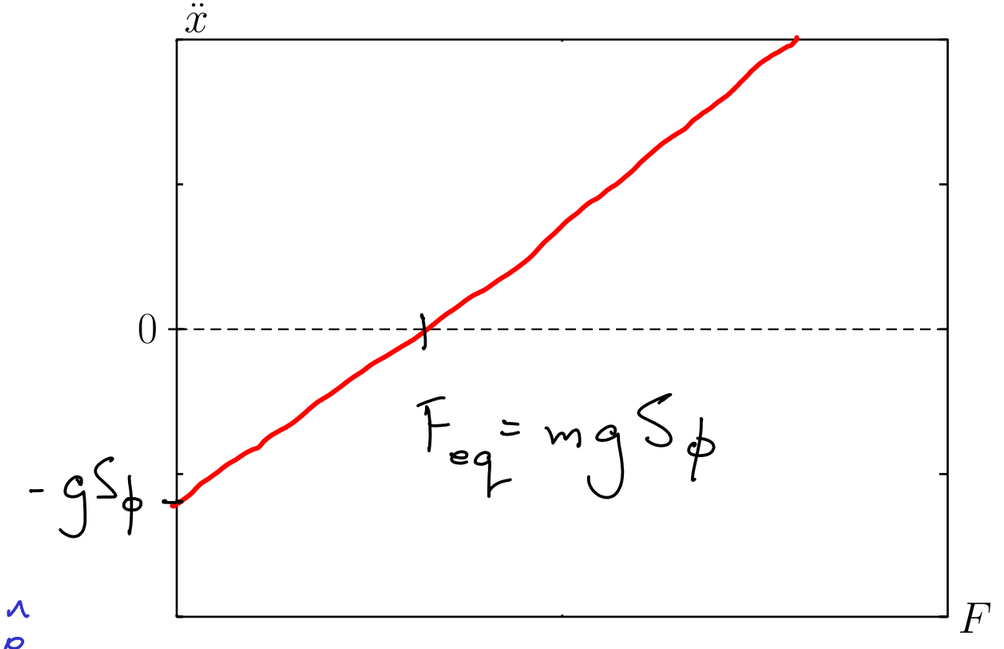
$\hat{e}_1$ DIR: $\quad -mgS_\phi + F = m\ddot{x}$

$\hat{e}_2$ DIR: $\quad -mgC_\phi + N = 0$

SOLVING

$$\ddot{x} = \frac{F}{m} - gS_\phi \longrightarrow \underline{a}_B = \ddot{x}\hat{e}_1 = \left(\frac{F}{m} - gS_\phi\right)\hat{e}_1$$

$$N = mgC_\phi$$



STATIC EQUILIBRIUM $\longrightarrow \ddot{x} = 0$

@ $F = F_{eq} = mgS_\phi$

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