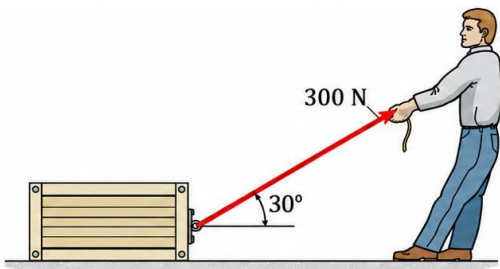
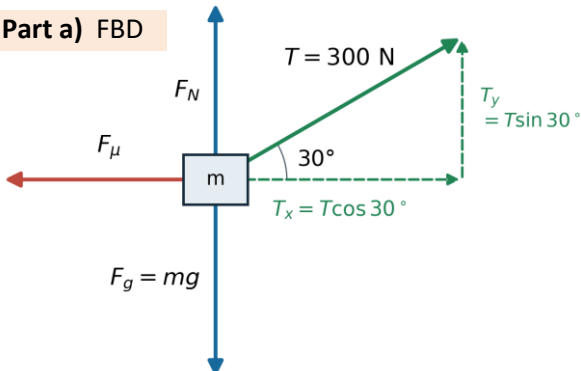


Harold's Physics

Forces with FBD

Cheat Sheet

1 October 2026

Forces on a Pulled Box		
Question	A man pulls a 50 kg box with a force of 300 N. As the box slides to the right on a horizontal floor and remains in contact with it, it experiences an opposing frictional force. As a result of the forces acting on it, the box accelerates to the right at 4.0 m/s^2. Diagram: - The pulling force is directed at 30° above the horizontal. - The positive x-axis points right, and the positive y-axis points upward. - Draw the free-body diagram (FBD) of the box. - Calculate the net force (F_{net}) acting on the box. - Write the equation expressing Newton's Second Law for the x-components of the forces acting on the box and use it to calculate the force of friction (F_μ) acting on the box. - Write the equation expressing Newton's Second Law for the y-components of the forces acting on the box and use it to calculate the normal force (F_N) acting on the box. - Calculate the coefficient of kinetic friction (μ_k) for the box on the floor.	
Diagrams	 Part a) FBD  Dashed green arrows represent components of T, not additional forces. Diagram not to scale.	
FBD Procedure	Identify the object, draw only external forces, choose axes, resolve components, and apply $\sum F_x = ma_x$, $\sum F_y = ma_y$.	
Givens	$m = 50 \text{ kg}$ $T = 300 \text{ N}$ $\theta = 30^\circ$ inclined from the horizontal $a = 4.0 \frac{m}{s^2}$ to the right	$\mu_k > 0$
Observations	$a_x = a$ $a_y = 0$ $g = 9.81 \frac{m}{s^2}$	$0 \leq F_{\mu_s} \leq \mu_s F_N$ $F_\mu = F_{\mu_k} = \mu_k F_N$

Part b)	Calculate the net force (F_{net}) acting on the box.
Equation	$F_{net} = ma$
Solution	$= (50 \text{ kg}) \left(4.0 \frac{\text{m}}{\text{s}^2} \right)$ $F_{net} = 200 \text{ N right}$
Part c)	Write the equation expressing Newton's Second Law for the x-components of the forces acting on the box and use it to calculate the force of friction (F_{μ_k}) acting on the box.
Equation	$F_{net,x} = \sum F_x = ma_x = T_x - F_{\mu_k}$
Solution	$F_{\mu_k} = T_x - F_{net,x}$ $F_{\mu_k} = T \cos 30^\circ - F_{net,x}$ $= (300 \text{ N}) \cos 30^\circ - 200 \text{ N}$ $= 259.8 \text{ N} - 200 \text{ N}$ $F_{\mu_k} = 59.8 \text{ N left}$
Part d)	Write the equation expressing Newton's Second Law for the y-components of the forces acting on the box and use it to calculate the normal force (F_N) acting on the box.
Equation	$\sum F_y = 0$ $F_N + T_y - F_g = 0$
Solution	$F_N = F_g - T_y$ $F_N = (50 \text{ kg}) \left(9.81 \frac{\text{m}}{\text{s}^2} \right) - (300 \text{ N}) \sin 30^\circ$ $= 490.5 \text{ N} - 150 \text{ N} = 340.5 \text{ N}$ $F_N \approx 340 \text{ N upward}$
Part e)	Calculate the coefficient of kinetic friction (μ_k) for the box on the floor.
Equation	$F_{\mu} = \mu_k F_N$
Solution	$\mu_k = \frac{F_{\mu}}{F_N}$ $\mu_k = \frac{59.8076 \text{ N}}{340.5 \text{ N}} = 0.17565$ $\mu_k \approx 0.18$ <i>The coefficient of kinetic friction is dimensionless.</i>

Sources

- Young, Hugh D. and Freedman, Roger A. (2015). University Physics with Modern Physics, 14th Edition, Section 4.6, Free-Body Diagrams. <https://www.amazon.com/University-Physics-Modern-14th/dp/0321973615>
- Numerade (n.d.). QUESTION 3. <https://www.numerade.com/ask/question/question-3-a-man-is-pulling-a-box-of-a-mass-of-50-kg-with-a-force-of-300-n-as-the-box-moves-across-the-surface-it-experiences-a-friction-force-as-a-result-of-the-forces-acting-on-it-the-box--57916/>

Acknowledgements

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