Al-Mustaqbal University

College of Engineering & Technology

Biomedical Engineering Department

Subject Name: Dynamics

1st Class, Second Semester

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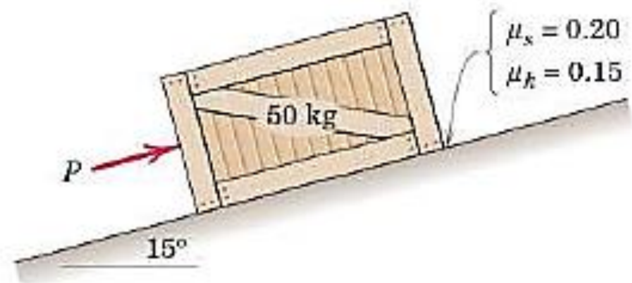
Lecture No.:- 7

Lecture Title: [Kinetics of Particles Problems]

Kinetics of Particles

3/2 The 50-kg crate is stationary when the force P is applied. Determine the resulting acceleration of the crate if (*a*) $P = 0$, (*b*) $P = 150$ N, and (*c*) $P = 300$ N.



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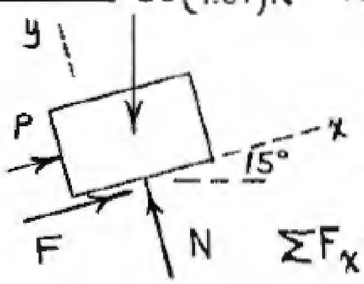


$\Sigma F_y = 0: \; N - 50(9.81)\cos 15° = 0$

$N = 474$ N throughout

(a) $P = 0$

Equilibrium check:

$\Sigma F_x = 0: \; F - 50(9.81)\sin 15° = 0$

$F = 127.0$ N

$F_{max} = \mu_s N = 0.2(474) = 94.8 \text{ N} < F$: motion ↙

$\Sigma F_x = ma_x: \; 0.15(474) - 50(9.81)\sin 15° = 50a_x$

$a_x = -1.118 \text{ m/s}^2$

(b) $P = 150$ N ; Equilibrium check:

$\Sigma F_x = 0: \; 150 + F - 50(9.81)\sin 15° = 0$

$F = -23.0$ N , $|F| < F_{max}$ so no motion: $a = 0$

(c) $P = 300$ N ; Equilibrium check yields $F = -173.0$ N

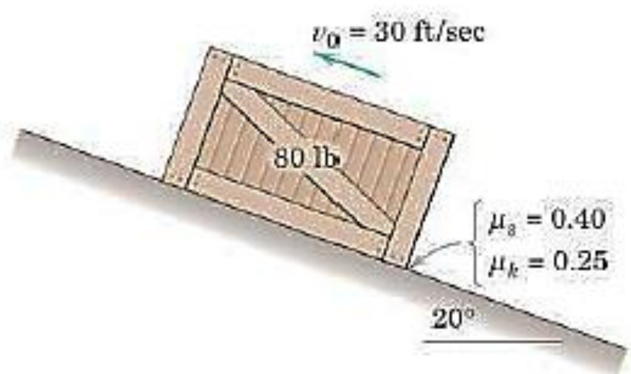
$|F| > F_{max}$, so motion ↗ , $F = F_k$ ↙ .

$\Sigma F_x = ma_x: \; 300 - 0.15(474) - 50(9.81)\sin 15° = 50a_x$

$a_x = 2.04 \text{ m/s}^2$

3/3 At a certain instant, the 80-lb crate has a velocity of 30 ft/sec up the 20° incline. Calculate the time t required for the crate to come to rest and the corresponding distance d traveled. Also, determine the distance d' traveled when the crate speed has been reduced to 15 ft/sec.

Ans. $t = 1.615$ sec, $d = 24.2$ ft, $d' = 18.17$ ft



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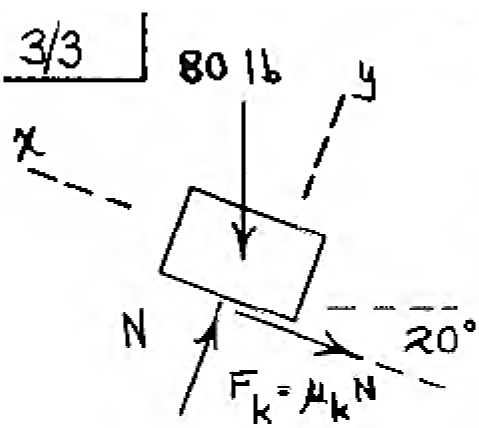


$\Sigma F_y = 0: \quad N - 80\cos 20° = 0$

$N = 75.2$ lb

$\Sigma F_x = ma_x:$

$-0.25(75.2) - 80\sin 20° = \frac{80}{32.2}\,a$

$a = -18.58$ ft/sec^2

$v = v_0 + at: \quad 0 = +30 - 18.58t, \quad \underline{t = 1.615 \text{ sec}}$

$v^2 = v_0^2 + 2a(s - s_0): \quad 0^2 = 30^2 + 2(-18.58)\,d$

$\underline{d = 24.2 \text{ ft}}$

$v^2 = v_0^2 + 2a(s - s_0): \quad 15^2 = 30^2 + 2(-18.58)\,d'$

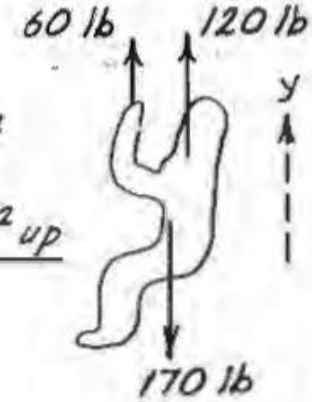
$\underline{d' = 18.17 \text{ ft}}$

3/8 The 170-lb man in the bosun's chair exerts a pull of 60 lb on the rope for a short interval. Find his acceleration. Neglect the mass of the chair, rope, and pulleys.

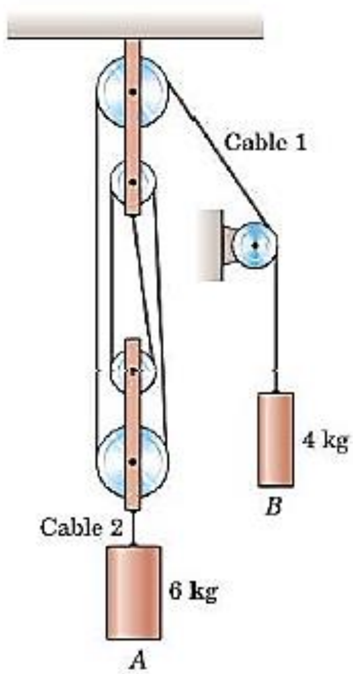
3/8

$$\Sigma F_y = ma_y: \; 180 - 170 = \frac{170}{32.2} a$$

$$\underline{a = 1.894 \text{ ft/sec}^2 \text{ up}}$$

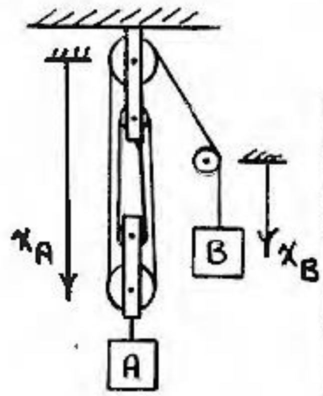


3/12 The block-and-tackle system is released from rest with all cables taut. Neglect the mass and friction of all pulleys and determine the acceleration of each cylinder and the tensions T_1 and T_2 in the two cables.

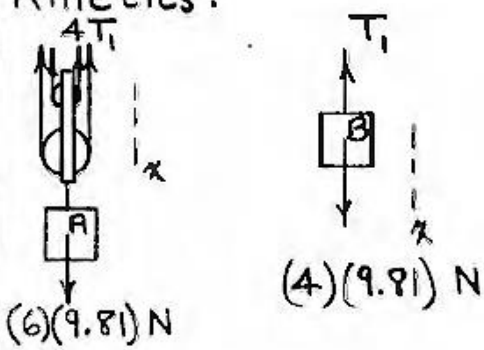


3/12 Kinematics: $4x_A + x_B = L_{rope} + \text{constant}$

$$\therefore \quad 4a_A + a_B = 0 \qquad (1)$$



Kinetics:



$$A: \Sigma F_x = ma_x: \quad 6(9.81) - 4T_1 = 6a_A \qquad (2)$$

$$B: \Sigma F_x = ma_x: \quad 4(9.81) - T_1 = 4a_B \qquad (3)$$

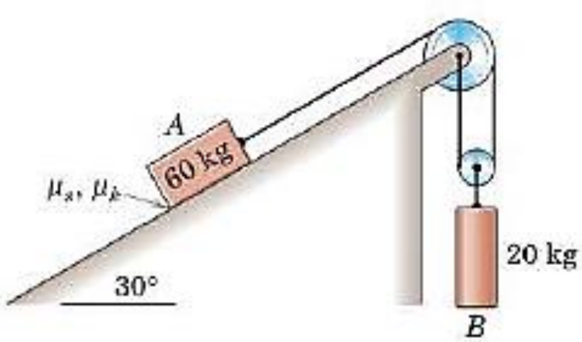
Solution of Eqs. (1)–(3): $\begin{cases} a_A = -1.401 \text{ m/s}^2 \\ a_B = 5.61 \text{ m/s}^2 \\ T_1 = 16.82 \text{ N} \end{cases}$

Tension in cable above A

$T_2 = 4T_1 = \underline{67.3 \text{ N}}$

3/27 The system is released from rest with the cable taut. For the friction coefficients $\mu_s = 0.25$ and $\mu_k = 0.20$, calculate the acceleration of each body and the tension T in the cable. Neglect the small mass and friction of the pulleys.

Ans. $a_A = 1.450$ m/s^2 down incline
$a_B = 0.725$ m/s^2 up
$T = 105.4$ N



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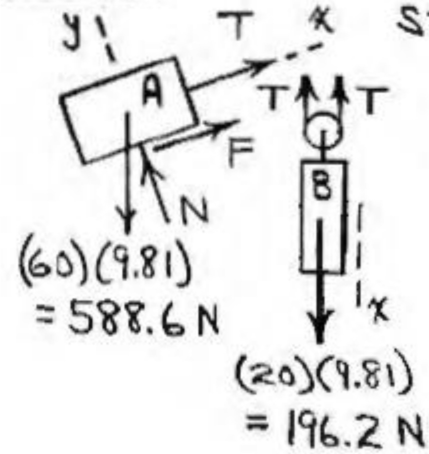
Check for motion by assuming static equilibrium.



B : $2T = 196.2$, $T = 98.1$ N

A : $\Sigma F_x = 0$: $98.1 - 588.6 \sin 30° + F = 0$, $F = 196.2$ N

$F_{max} = \mu_s N = (0.25)(588.6) \cos 30° = 127.4$ N

$F > F_{max} \Rightarrow$ motion (↙)

From kinematics, $a_A = 2a_B = 2a$

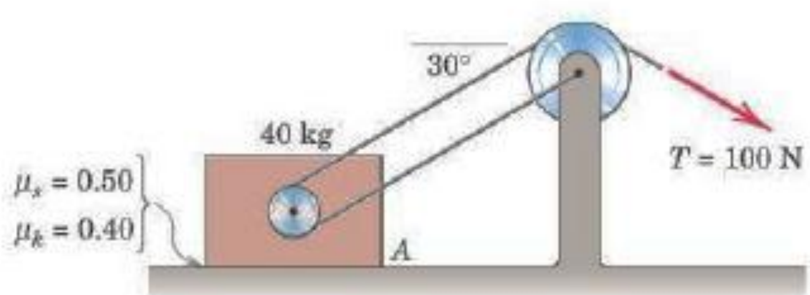
A : $\Sigma F_x = ma_x$: $T + 0.2(588.6 \cos 30°) - 588.6 \sin 30° = 60(2a)$

B : $\Sigma F_x = ma_x$: $-2T + 196.2 = 20a$

Solution : $\underline{a = -0.725 \text{ m/s}^2}$, $\underline{T = 105.4 \text{ N}}$

3/39 Compute the acceleration of block *A* for the instant depicted. Neglect the masses of the pulleys.

Ans. $a = 1.406$ m/s^2



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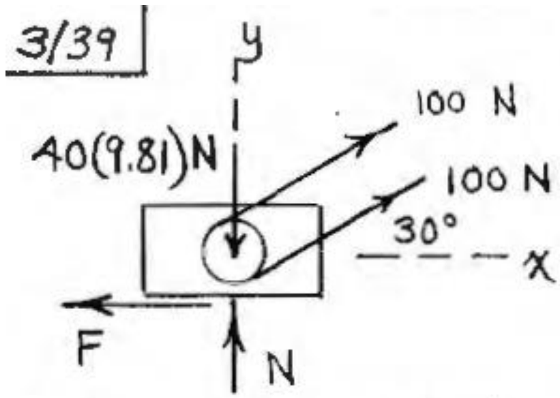

$$\begin{cases} \mu_s = 0.5 \\ \mu_k = 0.4 \end{cases}$$

$\Sigma F_y = 0: \quad N + 200 \sin 30° - 40(9.81) = 0$

$$N = 292 \text{ N}$$

Assume static equilibrium:

$\Sigma F_x = 0: \; -F + 200 \cos 30° = 0, \quad F = 173.2 \text{ N}$

$F_{max} = \mu_s N = 0.5(292) = 146.2 \text{ N} < F$

Assumption wrong, motion exists $\rightarrow$.

$F = \mu_k N = 0.4(292) = 117.0 \text{ N}$

$\Sigma F_x = ma_x: \; -117 + 200 \cos 30° = 40 a_x$

$$\underline{a_x = a = 1.406 \text{ m/s}^2}$$