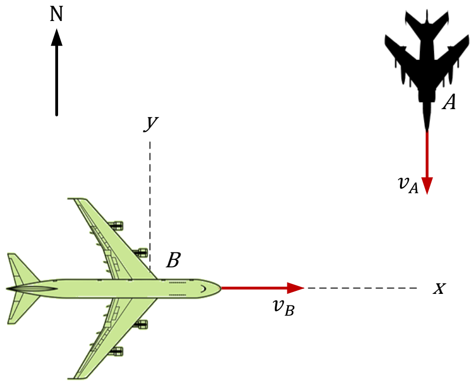
Question 8.9.

The passenger aircraft B is flying east with a velocity $v_B = 800$ km/hr. A military jet traveling south with a velocity $v_A = 1200$ km/hr passes under B at a slightly lower altitude. What velocity does A appear to have to a passenger in B, and what is the direction of that apparent velocity?



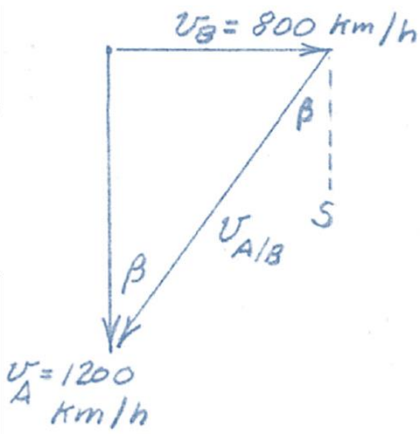
Solution

$v_A = v_B + v_{A/B}$

$v_{A/B} = \sqrt{(1200)^2 + (800)^2} = 1442$ km/h (Answer)

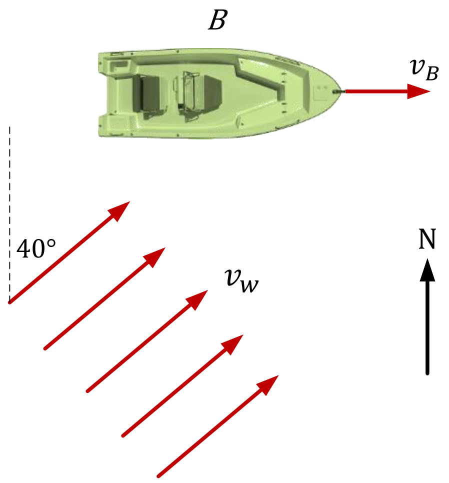
$\beta = \tan^{-1}\left(\frac{800}{1200}\right)$

$\beta = 33.7°$ (West of South) (Answer)

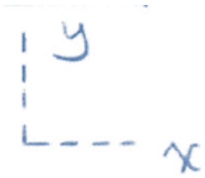


Question 8.10.

A boat is moving due east and encounters a southwest wind of speed $v_w = 10$ m/s as shown. The experienced boat captain wishes to minimize the effects of the wind on the passengers who are on the outdoor decks. At what speed v_B should they proceed?



Solution



$v_{w/B} = v_w - v_B$

$v_{w/B} = (10)(\sin 40°\ \mathbf{i} + \cos 40°\ \mathbf{j}) - v_B\ \mathbf{i}$

$v_{w/B} = (6.43 - v_B)\ \mathbf{i} + 7.66\ \mathbf{j}$

The captain can reduce the head/tail wind to zero

:

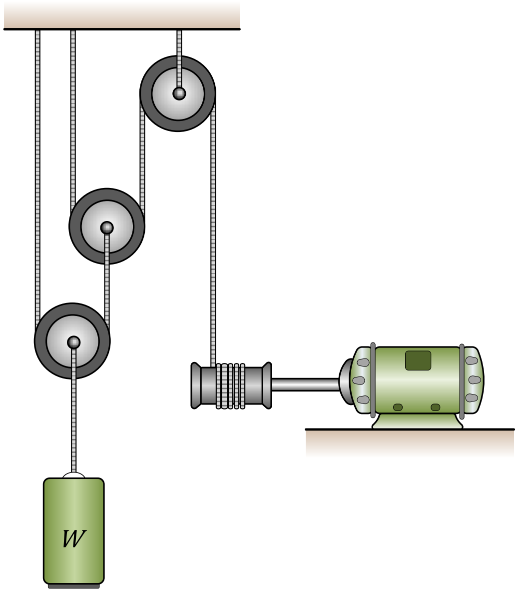
$6.43 - v_B = 0$

$v_B = 6.43$ m/s (Answer)

Note: The passengers will still feel a side wind of 7.66 m/s *from the South.*

Question 8.11.

Determine the vertical rise h of the load W during 5 seconds if the hoisting drum wraps cable around it at the constant rate of 320 mm/s.



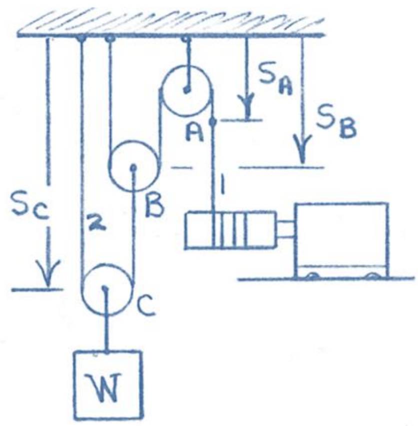
Solution

Let A be a point on cable 1:

$$L_1 = s_A + 2s_B + constants$$

Differentiate with respect to time:

$$0 = v_A + 2v_B \qquad \text{----- (1)}$$



$$L_2 = s_C + (s_C - s_B)$$

Differentiate with respect to time:

$$0 = 2v_C - v_B \qquad \text{----- (2)}$$

Combine (1) and (2) to obtain:

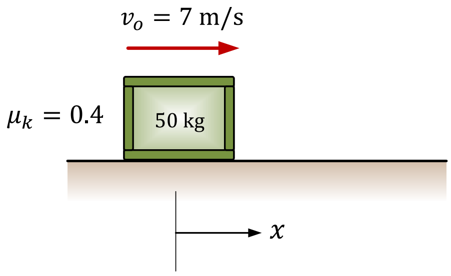
$$v_C = -\frac{v_A}{4} = -\frac{(320)}{4} = -80\ \text{mm/s}$$

Therefore, W rises:

$$h = 80(5) = 400\ \text{mm} \qquad \text{(Answer)}$$

Question 8.12.

The 50 kg crate is projected along the floor with an initial speed of 7 m/s at $x = 0$. The coefficient of kinetic friction is 0.40. Calculate the time required for the crate to come to rest and the corresponding distance x travelled.



Solution

$+\uparrow \sum F_y = 0$

$N - mg = 0$

$N = mg$

$+\rightarrow \sum F_x = ma_{Gx}$

$-\mu_k mg = ma_{Gx}$

$a_{Gx} = -\mu_k g = -(0.4)(9.81) = -3.92$ m/s

Kinematics:

$v^2 - v_o{}^2 = 2a(x - x_o)$

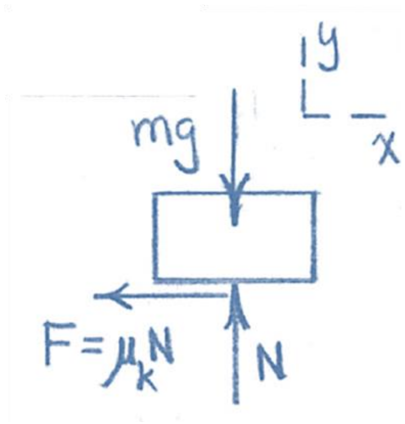
$0^2 - 7^2 = 2(-3.92)(x - 0)$

$x = 6.24$ m (Answer)

$v = v_o + at$

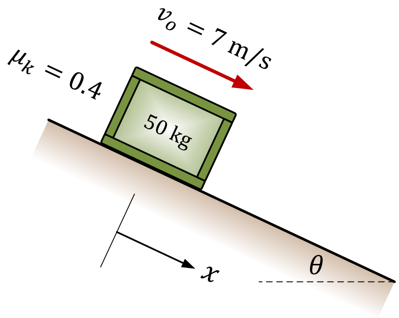
$0 = 7 - 3.92(t)$

$t = 1.784$ s (Answer)



Question 8.13.

The 50 kg crate is projected down an incline as shown with an initial speed of 7 m/s. Investigate the time t required for the crate to come to rest and the corresponding distance x traveled if (a) $\theta = 15°$ and (b) $\theta = 30°$.

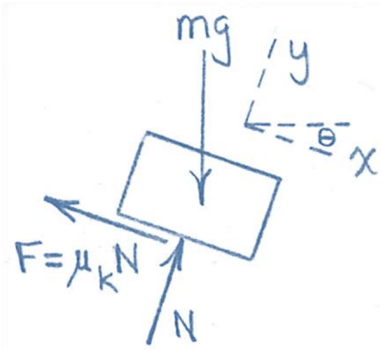


Solution

$+\uparrow \sum F_y = 0$

$N - mg\cos\theta = 0$

$N = mg\cos\theta$



$+\rightarrow \sum F_x = ma_{Gx}$

$mg\sin\theta - \mu_k mg\cos\theta = ma_{Gx}$

$a_{Gx} = g(\sin\theta - \mu_k\cos\theta)$

(a) at $\theta = 15°$

$a_{Gx} = 9.81(\sin 15° - 0.4\cos 15°) = -1.251\ \text{m/s}^2$

Kinematics:

$v^2 - {v_o}^2 = 2a(x - x_o)$

$0^2 - 7^2 = 2(-1.251)(x - 0)$

$x = 19.58$ m (Answer)

$v = v_o + at$

$0 = 7 - 1.251(t)$

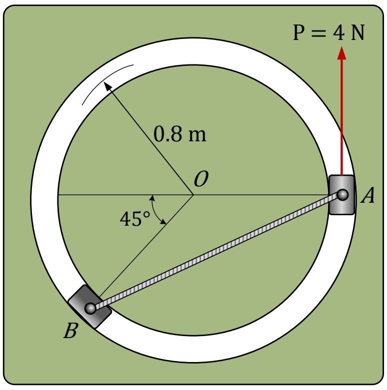
$t = 5.59$ s (Answer)

(b) at $\theta = 30°$

$a_{Gx} = 9.81(\sin 30° - 0.4\cos 30°) = 1.51\ \text{m/s}^2$

i.e. the crate does not come to rest (Answer)

Question 8.14.



The two 0.2 kg sliders A and B move without friction in the horizontal-plane circular slot. Determine the acceleration of each slider and the normal reaction force exerted on each when the system starts from rest in the position shown and is acted upon by the 4 N force P. Also find the tension in the inextensible connecting cord AB.

Solution

$\beta = 22.5°$

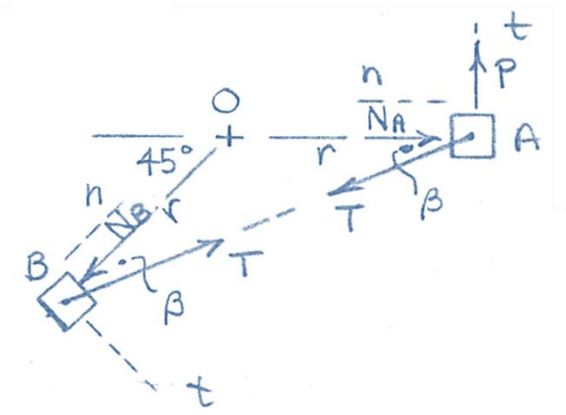
For slider A:

$+\uparrow \sum F_t = ma_t$

$P - T\sin\beta = 0.2a_t$ ----- (1)

$+\leftarrow \sum F_n = ma_n$

$-N_A + T\cos\beta = 0$ ----- (2)



For slider B:

$+\rightarrow \sum F_t = ma_t$

$T\sin\beta = 0.2a_t$ ----- (3)

$+\uparrow \sum F_n = ma_n$

$-N_B + T\cos\beta = 0$ ----- (4)

Note: a_t is common to both bodies

Solve Eqs. (1) – (4) with $P = 4$ N

$a_t = 10\ \mathrm{m/s^2}$ (Answer)

$N_A = 4.83$ N (Answer)

$N_B = 4.83$ N (Answer)

$T = 5.23$ N (Answer)