

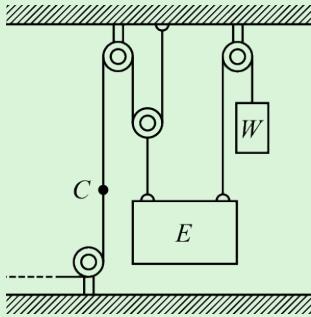
해설

2023-1 동역학(이동훈 교수님) 중간고사

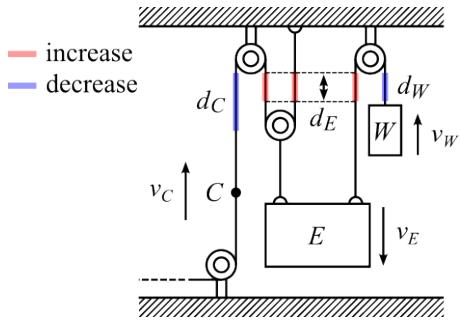
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Question 1



Knowing that the block E is moving downward with a speed of 2 m/s, determine (a) the velocities of C and W , (b) the relative velocity of C with respect to E and that of W with respect to E .



$$\text{given : } \mathbf{v}_E = 2 \text{ m/s} \downarrow$$

We can find some constraint equations.

$$d_C = 2d_E \Rightarrow v_C = 2v_E$$

$$d_W = d_E \Rightarrow v_W = v_E$$

$$v_C = 2v_E = 4 \text{ m/s}$$

$$v_W = v_E = 2 \text{ m/s}$$

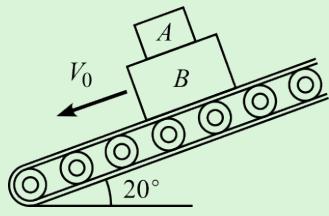
$$(a) \quad \mathbf{v}_C = 4.00 \text{ m/s} \uparrow; \mathbf{v}_W = 2.00 \text{ m/s} \uparrow \quad \blacktriangleleft$$

$$v_{C/E} = v_C - v_E = 6 \text{ m/s}$$

$$v_{W/E} = v_W - v_E = 4 \text{ m/s}$$

$$(b) \quad \mathbf{v}_{C/E} = 6.00 \text{ m/s} \uparrow; \mathbf{v}_{W/E} = 4.00 \text{ m/s} \uparrow \quad \blacktriangleleft$$

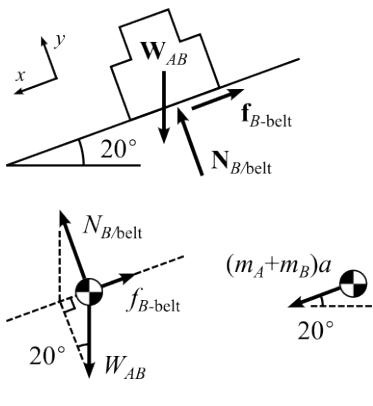
Question 2



A 10-kg box A and 20-kg box B is sliding down the inclined conveyer belt in the position shown with speed V_0 . Knowing that the coefficient of kinetic friction between B and the belt is 0.3, determine the minimum coefficient of static friction between A and B when A does not slip on B .

$$\text{given : } \mu_k = 0.3, \quad m_A = 10 \text{ kg}, \quad m_B = 20 \text{ kg}$$

In the system of A and B , the FBD and KD is



$$\sum F_y = 0$$

$$N_{B/\text{belt}} - W_{AB} \cos 20^\circ = 0$$

$$N_{B/\text{belt}} = (m_A + m_B)g \cos 20^\circ$$

$$f_{B-\text{belt}} = \mu_k N_{B/\text{belt}} = \mu_k (m_A + m_B)g \cos 20^\circ$$

$$\sum F_x = ma$$

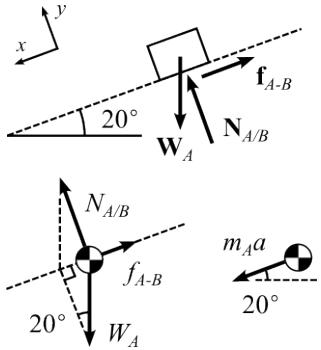
$$W_{AB} \sin 20^\circ - f_{B-\text{belt}} = (m_A + m_B)a$$

$$(m_A + m_B)g \sin 20^\circ - \mu_k (m_A + m_B)g \cos 20^\circ =$$

$$(m_A + m_B)a$$

$$a = g(\sin 20^\circ - \mu_k \cos 20^\circ) = 0.589702 \text{ m/s}^2$$

In the system of A , the FBD and KD is



$$\sum F_y = 0$$

$$N_{A/B} - W_A \cos 20^\circ = 0$$

$$N_{A/B} = m_A g \cos 20^\circ$$

$$\sum F_x = ma$$

$$W_A \sin 20^\circ - f_{A-B} = m_A a$$

$$m_A g \sin 20^\circ - f_{A-B} = m_A g (\sin 20^\circ - \mu_k \cos 20^\circ)$$

$$f_{A-B} = \mu_k m_A g \cos 20^\circ$$

$$f_{A-B} \leq \mu_s N_{A/B}$$

$$\mu_k m_A g \cos 20^\circ \leq \mu_s m_A g \cos 20^\circ$$

$$\mu_k \leq \mu_s$$

$$\mu_{s,\min} = \mu_k = 0.3$$

0.300

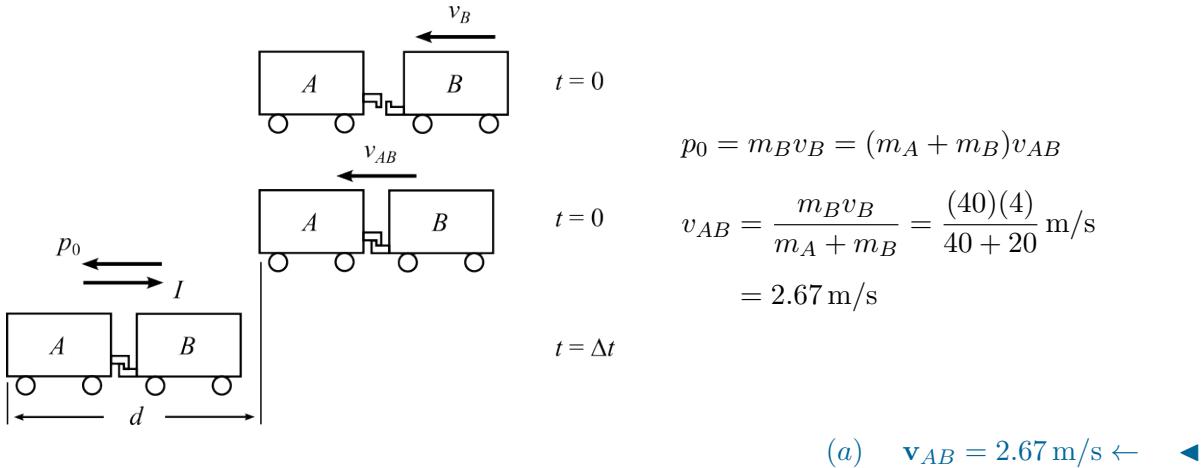


Question 3



A 40-Mg car B is moving to the left in this picture and combined with a 20-Mg car A that is at rest. Knowing that the coefficient of friction between the wheels and ground is 0.3 and the speed of B just before combination is 4 m/s, determine (a) the velocity of A and B just after combining and (b) the time taken for them to stop.

given : $v_B = 4 \text{ m/s}$, $\mu_k = 0.3$, $m_A = 20 \times 10^3 \text{ kg}$, $m_B = 40 \times 10^3 \text{ kg}$



$$F = \mu_k N = \mu_k g(m_A + m_B)$$

$$I = F \Delta t = \mu_k g(m_A + m_B) \Delta t$$

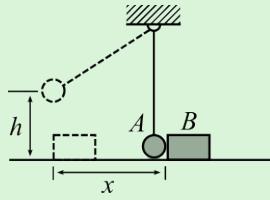
$$p_0 - I = 0$$

$$(m_A + m_B) v_{AB} - \mu_k g(m_A + m_B) \Delta t = 0$$

$$\Delta t = \frac{m_B v_B}{\mu_k g(m_A + m_B)} = \frac{(40)(4)}{(0.3)(9.81)(40 + 20)} \text{ s} = 0.906 \text{ s}$$

(b) $\Delta t = 0.906 \text{ s}$ ▶

Question 4



A 1-kg block B moving to the left with a speed 2 m/s strikes a 0.5-kg ball A that is hanging from a cord and is initially at rest. Knowing that the coefficient of kinetic friction between B and the ground is 0.6 and the coefficient of restitution between A and B is 0.8, determine (a) the maximum h , (b) x when B stops.

v_A , v_B , v'_A and v'_B are consumed as positive number when directions of velocities of them is left.

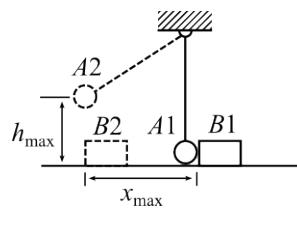
$$\begin{aligned} \text{given : } v_A &= 0, & v_B &= 2 \text{ m/s}, & m_A &= 0.5 \text{ kg}, & m_B &= 1 \text{ kg}, & \mu_k &= 0.6, & e &= 0.8 \\ v'_A - v'_B &= e(v_B - v_A) \\ v'_A - v'_B &= ev_B \end{aligned} \quad (1)$$

$$\begin{aligned} m_A v_A + m_B v_B &= m_A v'_A + m_B v'_B \\ m_B v_B &= m_A v'_A + m_B v'_B \end{aligned} \quad (2)$$

$$\begin{cases} v'_A - v'_B = ev_B \\ m_B v_B = m_A v'_A + m_B v'_B \end{cases} \quad (1) \quad (2)$$

$$v'_A = \frac{m_B(e+1)}{m_A+m_B} v_B = \frac{(1)(0.8+1)}{0.5+1} (2 \text{ m/s}) = 2.4 \text{ m/s}$$

$$v'_B = v'_A - ev_B = (2.4 \text{ m/s}) - (0.8)(2 \text{ m/s}) = -0.8 \text{ m/s}$$



we got : $v'_A = 2.4 \text{ m/s}$, $v'_B = 0.8 \text{ m/s}$

$$T_{A1} + V_{g,A1} = T_{A2} + V_{g,A2}$$

$$\frac{1}{2}m_A(v'_A)^2 + 0 = 0 + m_Agh$$

$$h = \frac{(v'_A)^2}{2g} = \frac{(2.4)^2}{2(9.81)} \text{ m} = 0.294 \text{ m}$$

$$(a) \quad h = 0.294 \text{ m} \quad \blacktriangleleft$$

$$T_{B1} + U_{B1 \rightarrow B2} = T_{B2}$$

$$\frac{1}{2}m_B(v'_B)^2 - \mu_k m_B g x = 0$$

$$x = \frac{(v'_B)^2}{2\mu_k g} = \frac{(-0.8)^2}{2(0.6)(9.81)} = 0.0544 \text{ m}$$

$$(b) \quad x = 0.0544 \text{ m} \quad \blacktriangleleft$$