

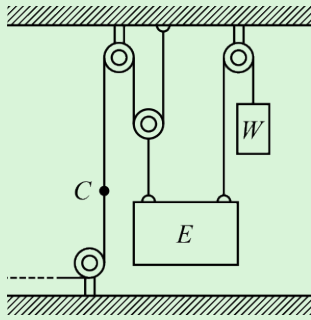
해설

2023-1 동역학(이동훈 교수님) 중간고사

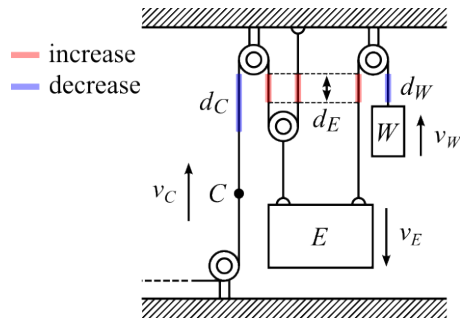
2025-12-30



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 .



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

We can find some constraint equations.

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

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

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

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

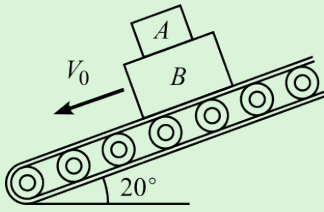
(a) $\mathbf{v}_C = 4.00 \text{ m/s} \uparrow$; $\mathbf{v}_W = 2.00 \text{ m/s} \uparrow$ ◀

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

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

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

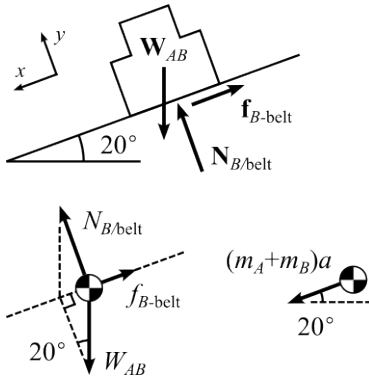
Question 2



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 .

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

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



$$\sum F_y = 0$$

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

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

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

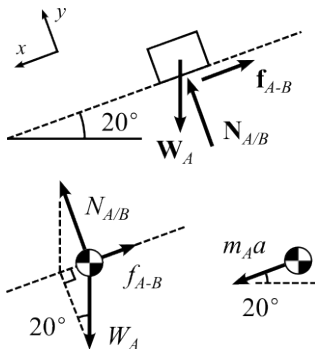
$$\sum F_x = ma$$

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

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

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

In the system of A , the FBD and KD is



$$\sum F_y = 0$$

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

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

$$\sum F_x = ma$$

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

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

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

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

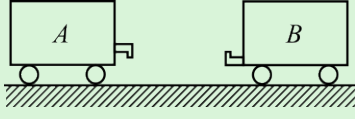
$$\mu_k m_A g \cos 20^\circ \leq \mu_s m_A g \cos 20^\circ$$

$$\mu_k \leq \mu_s$$

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

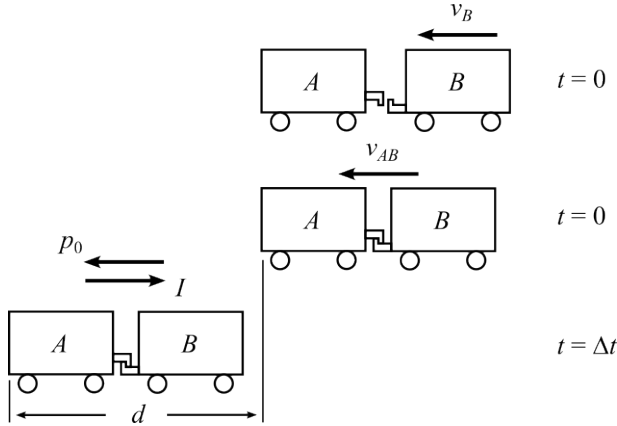
0.300 ◀

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



$$p_0 = m_B v_B = (m_A + m_B) v_{AB}$$

$$v_{AB} = \frac{m_B v_B}{m_A + m_B} = \frac{(40)(4)}{40 + 20} \text{ m/s} = 2.67 \text{ m/s}$$

(a) $v_{AB} = 2.67 \text{ m/s} \leftarrow$

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

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

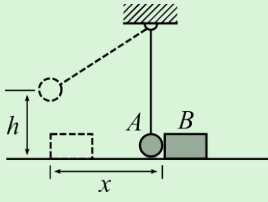
$$p_0 - I = 0$$

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

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

(b) $\Delta t = 0.906 \text{ s} \leftarrow$

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.

given : $v_A = 0$, $v_B = 2 \text{ m/s}$, $m_A = 0.5 \text{ kg}$, $m_B = 1 \text{ kg}$, $\mu_k = 0.6$, $e = 0.8$

$$v'_A - v'_B = e(v_B - v_A)$$

$$v'_A - v'_B = ev_B \quad (1)$$

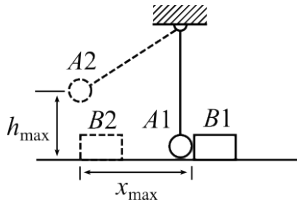
$$m_A v_A + m_B v_B = m_A v'_A + m_B v'_B$$

$$m_B v_B = m_A v'_A + m_B v'_B \quad (2)$$

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

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

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



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

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

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

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

(a) $h = 0.294 \text{ m}$ ◀

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

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

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

(b) $x = 0.0544 \text{ m}$ ◀