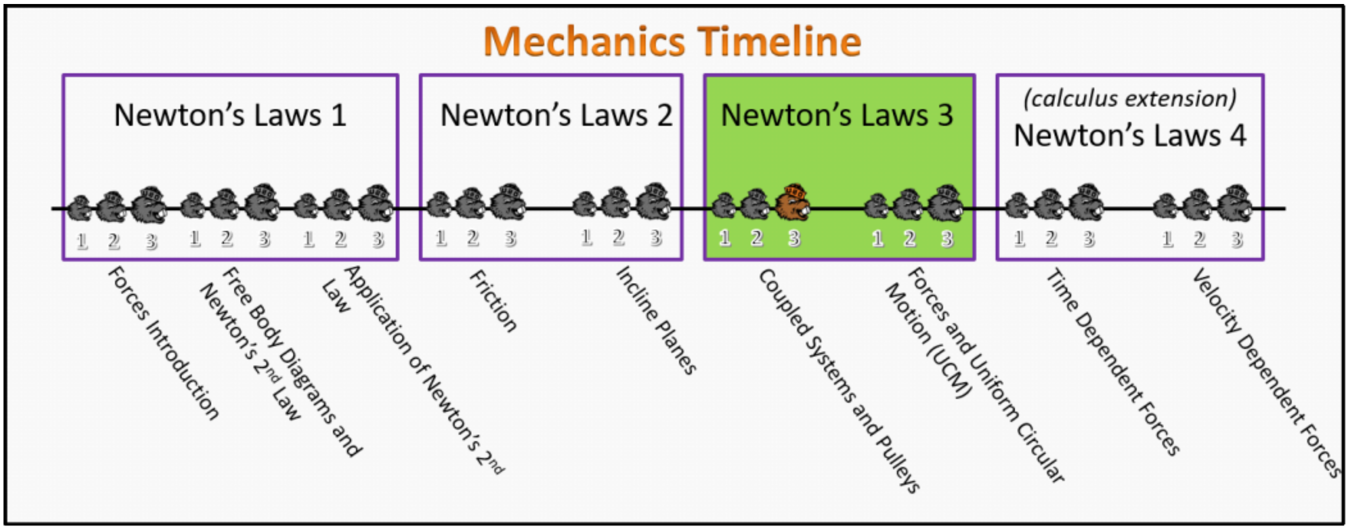
(N3.L1.3-sols) Practice Stage Solutions

Thursday, March 29, 2018 8:34 PM

Newton's Laws 3
Foundation Stage (N3.L1.3)

Post-Lecture 1
Coupled Systems and Pulleys



Questions

N3.L1.3-01

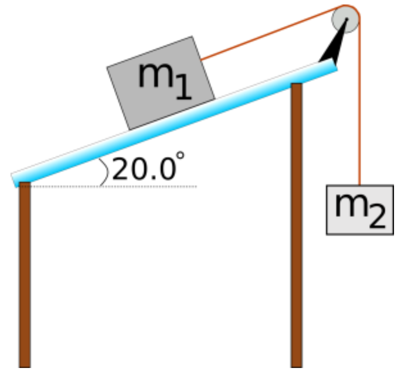
Description: Direction of kinetic friction.

Learning Objectives: [?]

Problem Statement: A box of $\mathbf{m_1}$ = 10.5 kg is on an incline plane with negligible friction between the box and the incline. The box $\mathbf{m_1}$ is attached via an ideal string and pulley to a hanging mass off $\mathbf{m_2}$ = 5.50 kg. The incline make an angle of 20.0° with respect to the horizontal. Use $\mathbf{g}$ = 9.80 m/s^2.

(a) Rank the magnitude of accelerations for $\mathbf{m_1}$ and $\mathbf{m_2}$.

(1) $|\vec{\mathbf{a}}_1| > |\vec{\mathbf{a}}_2|$
(2) $|\vec{\mathbf{a}}_1| < |\vec{\mathbf{a}}_2|$
(3) $|\vec{\mathbf{a}}_1| = |\vec{\mathbf{a}}_2|$



(b) Do we necessarily know the direction of acceleration of $\mathbf{m_1}$ without doing any calculations?

(1) Yes, up the incline.
(2) Yes, down the incline.
(3) No, but we can just guess a direction. For example, let's assume **m_1** accelerates up the ramp and if after our analysis we get a negative acceleration for **m_1**, then we picked the wrong direction, but the magnitude of our answer is correct.
(4) No, so we cannot proceeded any father with this problem. This system is unsolvable.

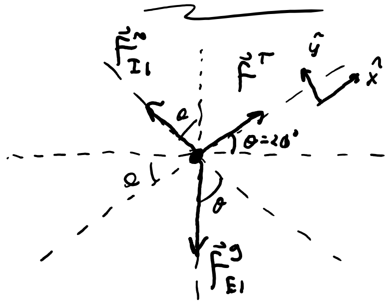
(c) Find the magnitude of acceleration for **m_1**.

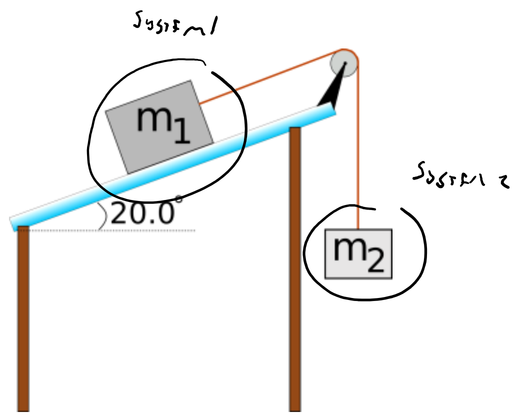
(1) 1.17 m/s^2
(2) 3.35 m/s^2
(3) 5.57 m/s^2
(4) 9.21 m/s^2
(5) 9.80 m/s^2

CONNECTIONS

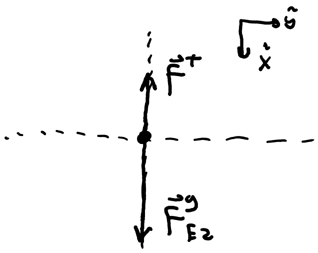
$a_{1x} = a_{2x} = a_x$

FBD System 1





FBD System 2



$\sum F_{1x} = m_1 a_{1x}$

$F^T - m_1 g \sin\theta = m_1 a_x$

$\sum F_{2x} = m_2 a_{2x}$

$m_2 g - F^T = m_2 a_x$

$F^T = m_2 g - m_2 a_x$

$m_2 g - m_2 a_x - m_1 g \sin\theta = m_1 a_x$

$m_1 a_x + m_2 a_x = m_2 g - m_1 g \sin\theta$

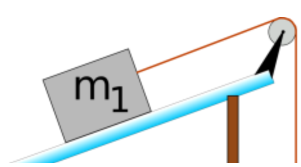
$$a_x = \frac{m_2 g - m_1 g \sin\theta}{(m_1 + m_2)}$$

$$= \frac{(55)(9.8) - (10.5)(9.8)\sin(20)}{10.5 + 55}$$

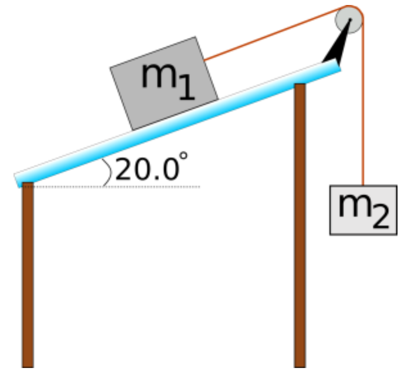
$a_x \approx 1.16913 \ m/s^2$

(d) What direction is the acceleration of **m_1**?

(1) Up the incline.
(2) Down the incline.
(3) Vertically upwards.
(4) Vertically downwards.



(1) Up the incline.
(2) Down the incline.
(3) Vertically upwards.
(4) Vertically downwards.



N3.L1.3-02

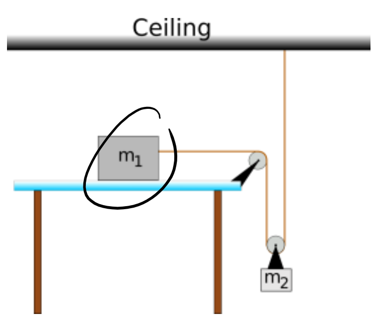
Description: Calculate push force on box sliding across a floor with non-negligible friction.

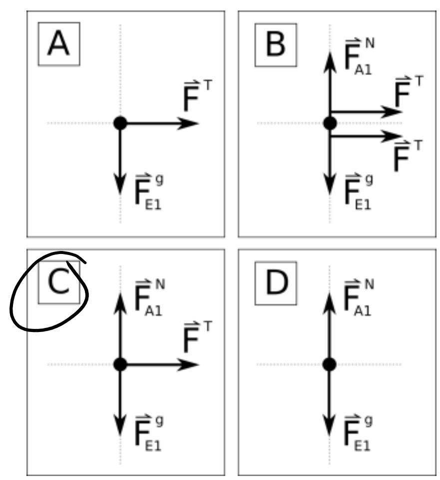
Learning Objectives: [?]

Problem Statement: Consider the scenario shown below. There is no friction between any surfaces, the rope is ideal, and the pulleys are ideal. The rope is also one continuous piece.

(a) Which of the free body diagrams below best represents the system of box $\mathbf{m_1}$?

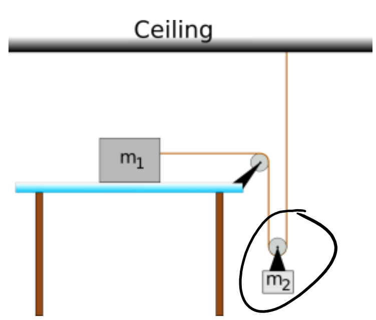
(1) A
(2) B
(3) C
(4) D

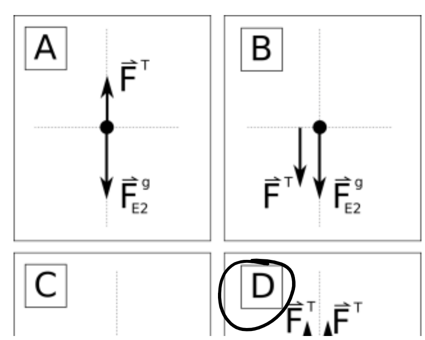


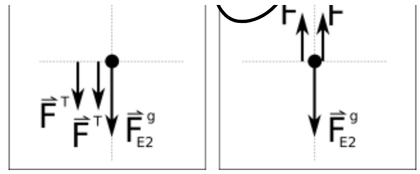


(b) Which of the free body diagrams below best represents the system of box $\mathbf{m_2}$?

(1) A
(2) B
(3) C
(4) D







N3.L1.3-03

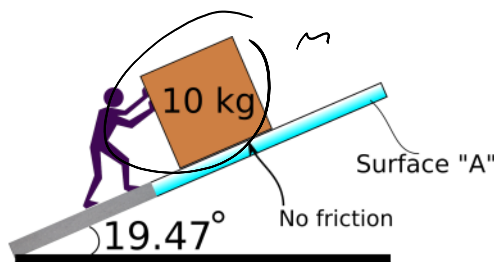
Description: Given mass, μ_s, μ_k, and magnitude of applied force with angle, determine the acceleration of the box on a horizontal surface.

Learning Objectives: [?]

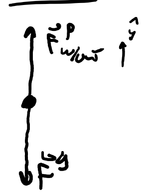
Problem Statement: A person needs to hold a 10.0 kg box vertically off the ground. If the person instead holds the box on an inclined plane as shown below, what is the mechanical advantage of the incline plane? The person is pushing parallel to the surface o f the incline.

(1) 1
(2) 2
(3) 3
(4) 0.5
(5) 0.333

$MA = \frac{F_{without}}{F_{with}}$



$F_{without}$

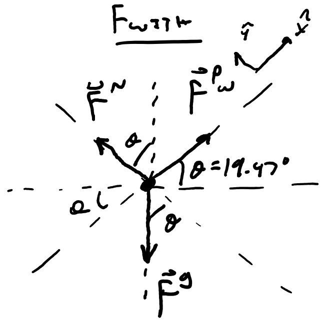


$\sum F_y = m a_y^0$

$F^P_{w/out} - mg = 0$

$F^P_{w/out} = mg$

F_{with}



$\sum F_x = m a_x^0$

$F^P_w - mg\sin\theta = 0$

$F^P_w = mg\sin\theta$

$MA = \frac{mg}{mg\sin\theta}$

$MA = \frac{1}{\sin\theta}$

$= \frac{1}{\sin(19.47)}$

$MA = 3$