PHYSICS 13 & 11A

GENERAL PHYSICS 1

Dynamics of Motion:

Application of Newton's Laws of Motion

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APPLICATION OF NEWTON'S LAWS OF MOTION

Friction

Friction f – refers to actual forces that are exerted to oppose motion

– a resistance that opposes every effort to slide or roll a body over another

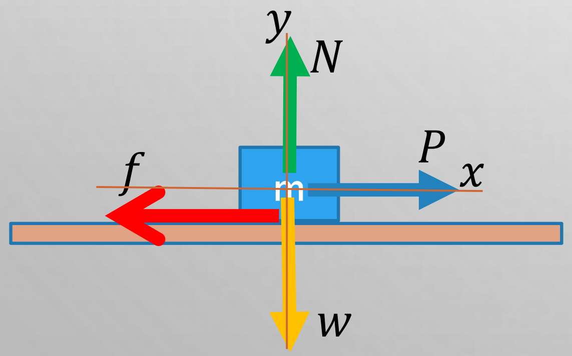
Kinds of Friction:

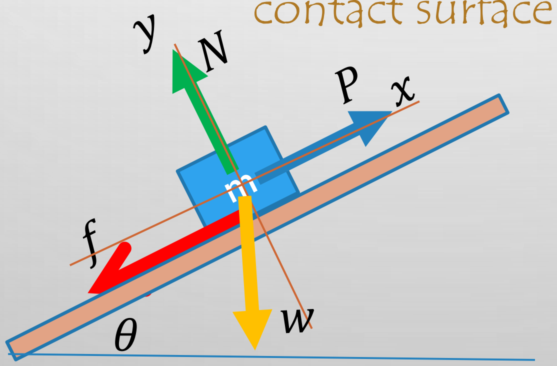
1. Static friction – force that will just start the body.
2. Kinetic friction – force that will pull the body uniformly.

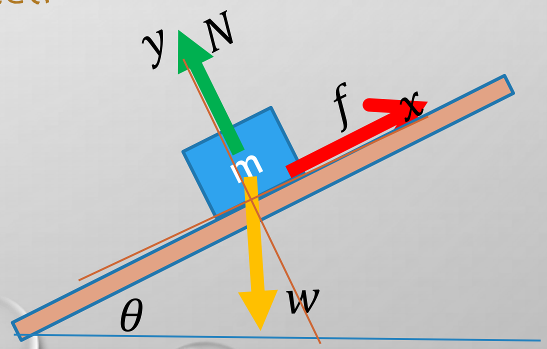
Coefficient of friction μ – the ratio of the force necessary to move one surface over the other with uniform velocity to the normal force pressing the two surfaces to other.

$$\mu = \frac{f}{N} \qquad f = \mu N$$

Where: N is the normal force exerted by the contact surface to the object.



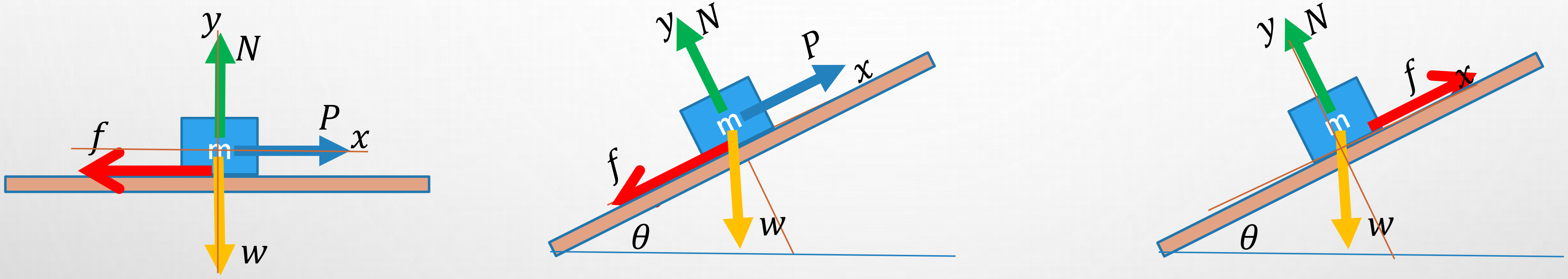




APPLICATION OF NEWTON'S LAWS OF MOTION

Free-Body Diagram (FBD)

FBD is a vectors diagram showing all forces acting on the body.



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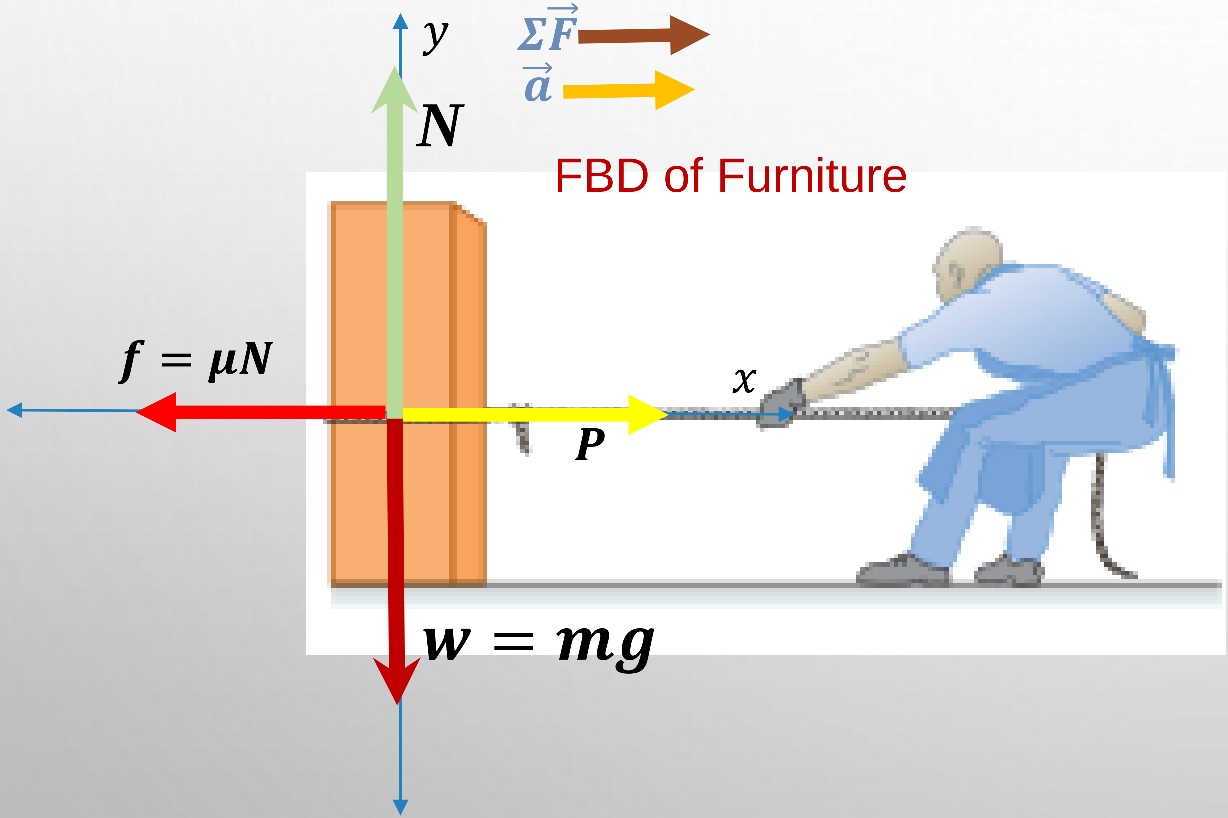


$\Sigma\vec{F}_y = N - w = 0$ (for static equilibrium)

$\Sigma\vec{F}_x = P - f$ (Net External force)

$\Sigma\vec{F} = P_x - f$

Net external force

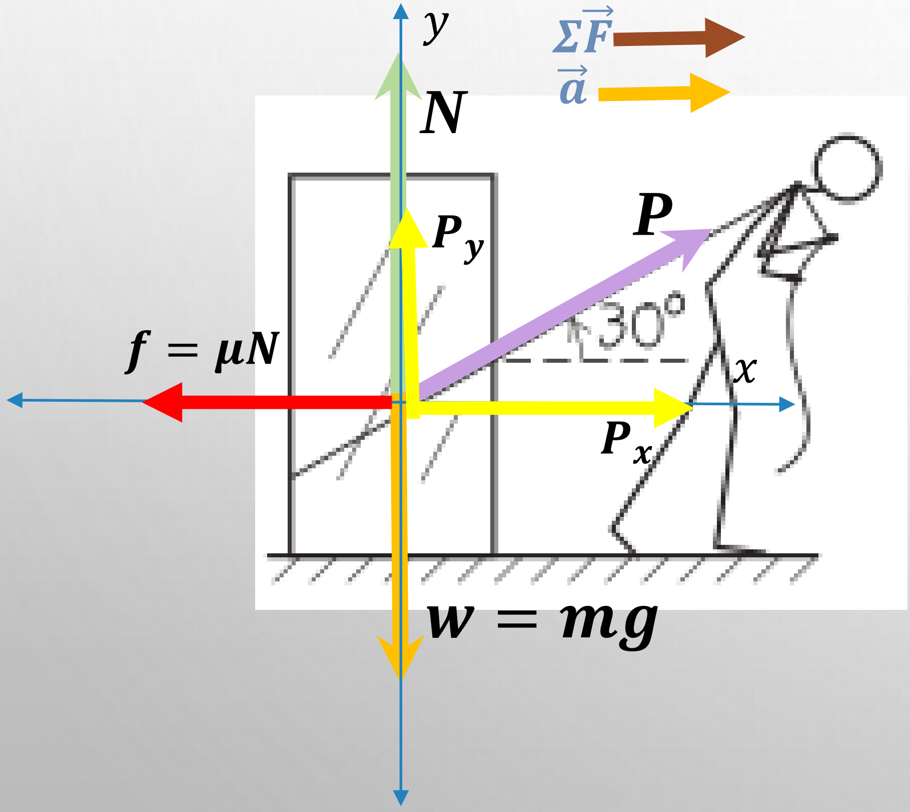
Note: If pulling force P is less than friction f then furniture is at rest otherwise it will move to the right..

APPLICATION OF NEWTON'S LAWS OF MOTION

Free-Body Diagram (FBD)

FBD is a vectors diagram showing all forces acting on the body.

FBD of box



$$\Sigma\vec{F}_y = N + P_y - w = 0$$ (for static equilibrium)

$$\Sigma\vec{F}_x = P_x - f$$ (Net External force)

$$\Sigma\vec{F} = P_x - f$$

Net external force

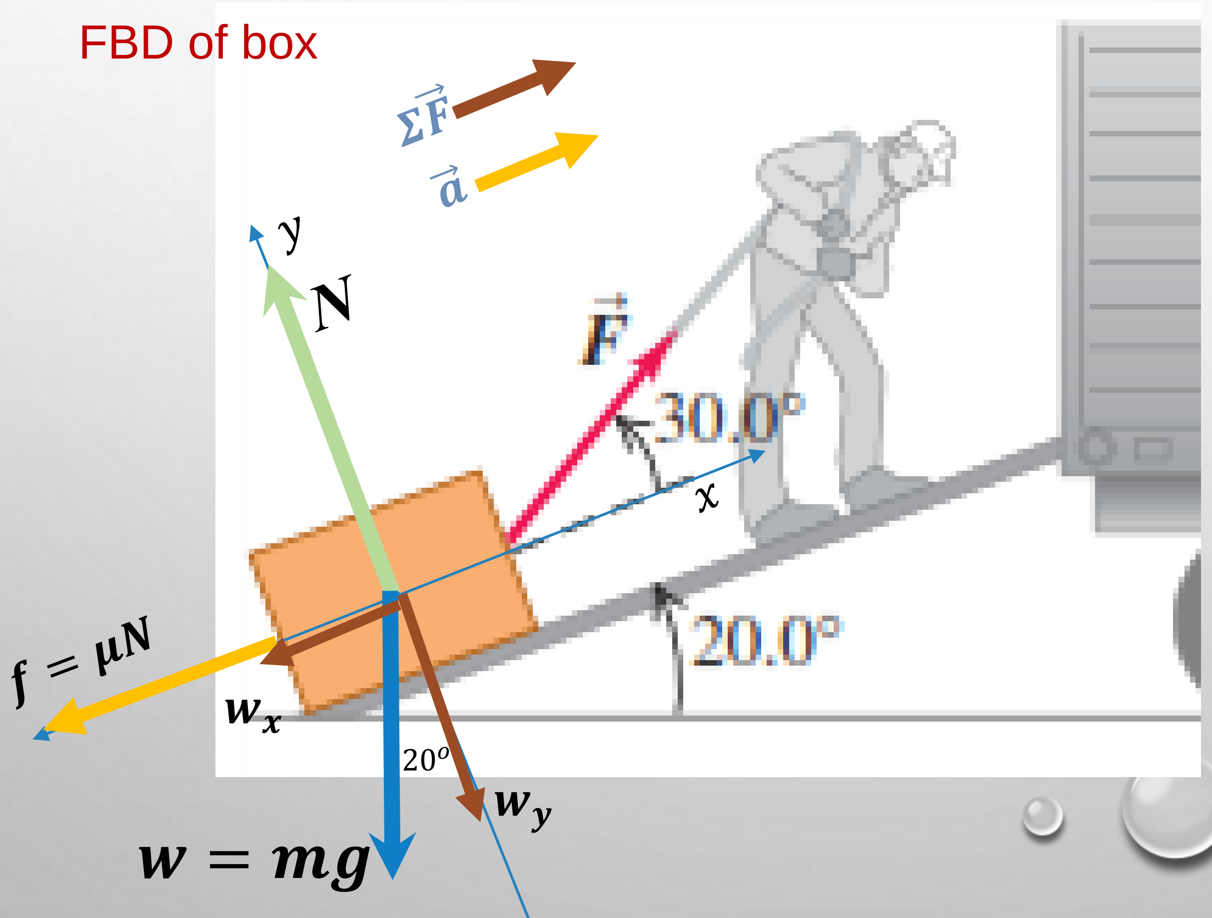
Note: If $\Sigma\vec{F}_y$ is not equal to zero then box didn't touch the ground surface. Therefore Net external force is not equal to $\Sigma\vec{F}_x$.

APPLICATION OF NEWTON'S LAWS OF MOTION

Free-Body Diagram (FBD)

Exercise Problem: Construct the free-body diagram (FBD)

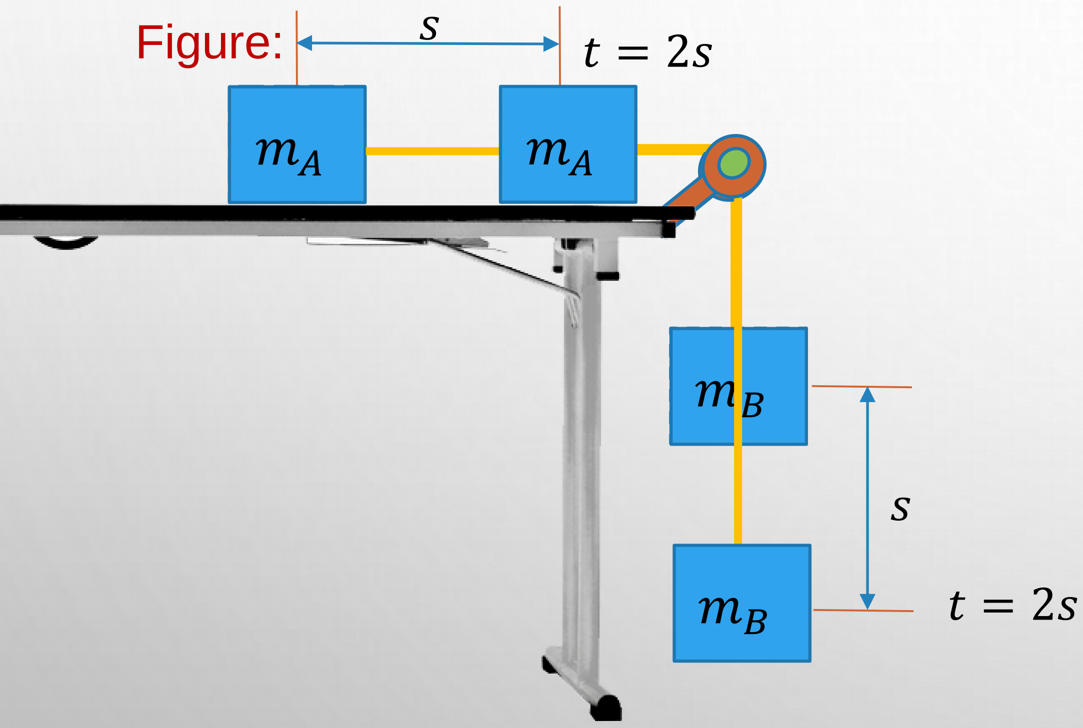
FBD of box



APPLICATION OF NEWTON'S LAWS OF MOTION

Problem: A horizontal cord is attached to a 6.0-kg body in a horizontal table. The cord passes over a pulley at the end of the table and to this end is hung a body of mass 8 kg. Find the distance the two bodies will travel after 2s, if they start from rest. What is the tension in the cord?

Figure:



APPLICATION OF NEWTON'S LAWS OF MOTION

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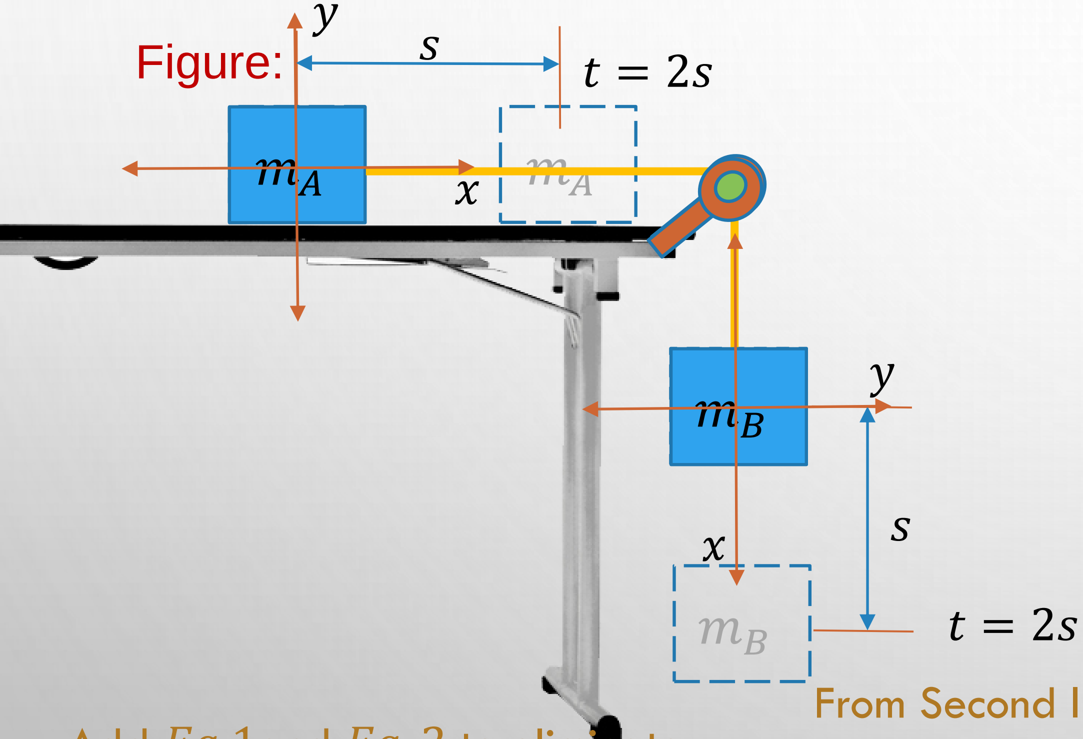
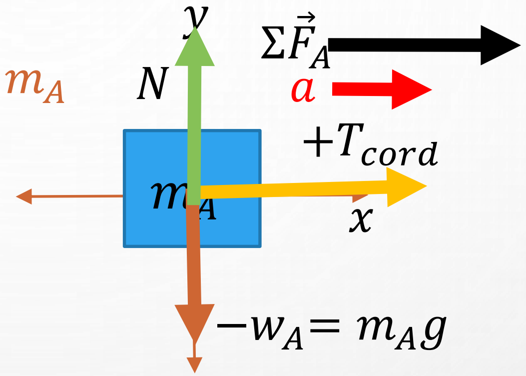


FBD of m_A



$\Sigma \vec{F}_y = N - w_A = 0$ (static equilibrium)

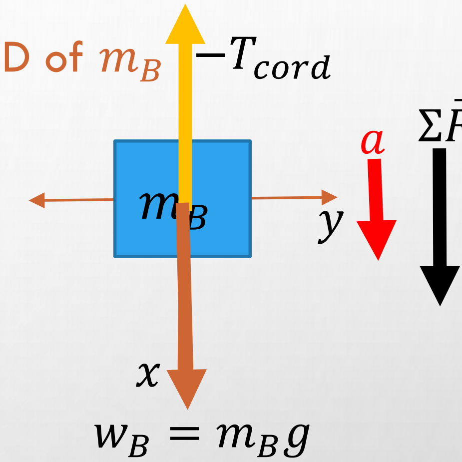
$\Sigma \vec{F}_x = +T_{cord}$

Net external force

From Second law $\Sigma \vec{F}_A = m_A a$

$T_{cord} = m_A a$ Eq.1

FBD of m_B



$\Sigma \vec{F}_y = 0$ (static equilibrium)

$\Sigma \vec{F}_x = -T_{cord} + m_B g$

Net external force

From Second law $\Sigma \vec{F}_B = m_B a$

$-T_{cord} + m_B g = m_B a$ Eq.2

Add Eq 1and $Eq.2$ to eliminate T_{cord} then solve Acceleration a.

$$a = \frac{m_B g}{m_A + m_B}$$

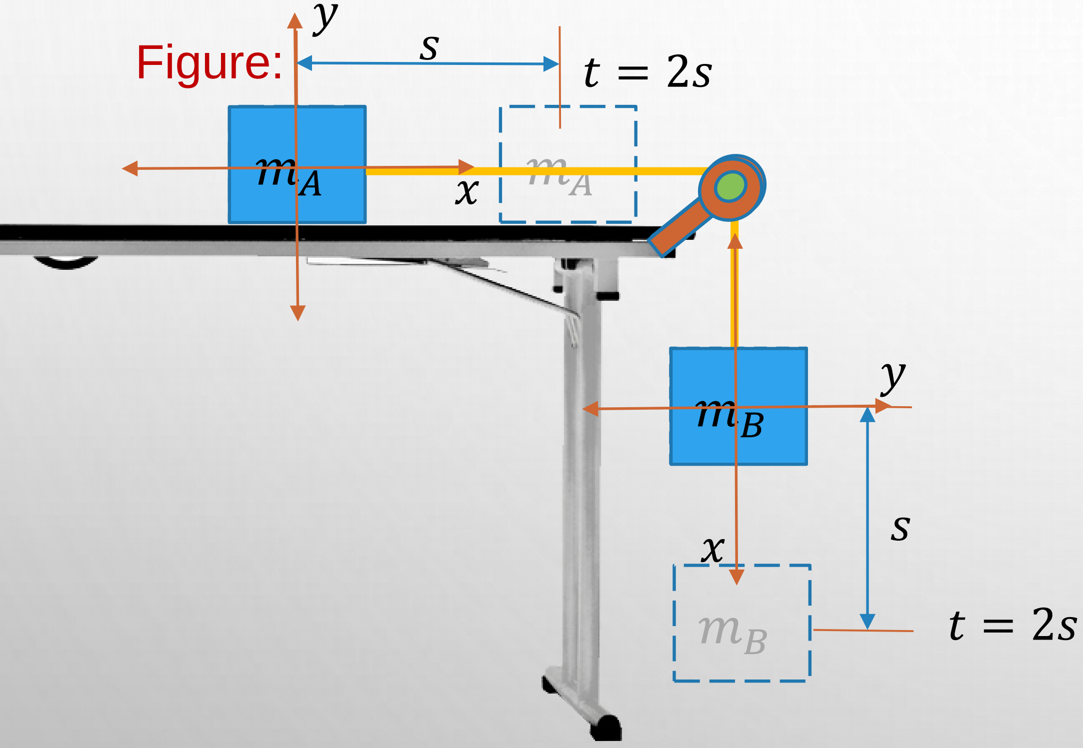
$$a = \frac{8(9.81)}{6+8} = 5.61 m/s^2$$

Cont'n

APPLICATION OF NEWTON'S LAWS OF MOTION

Problem: A horizontal cord is attached to a 6.0-kg body in a horizontal table. The cord passes over a pulley at the end of the table and to this end is hung a body of mass 8 kg. What is the tension in the cord? Find the distance the two bodies will travel after 2s, if they start from rest.

Figure:



a) Solve for tension in the cord T_{cord} using Eq.1

$T_{cord} = 6(5.61)$=33.66 N ANSWER

b) Solve for the distance s of two bodies after travelling 2 sec.

Given:

$v_i = 0$

$t = 2\ s$

$a = 5.61\ m/s^2$

From kinematics: $s = v_1 t + \left(\frac{1}{2}\right) a t^2$

$s = 0(2) + \left(\frac{1}{2}\right)(5.61)2^2 = 11.22m$ ANSWER

ASSIGNMENT

. Given:

$m = 10$ kg

$h = 5$ m

$L = 10$m

$S_1 = 2$m

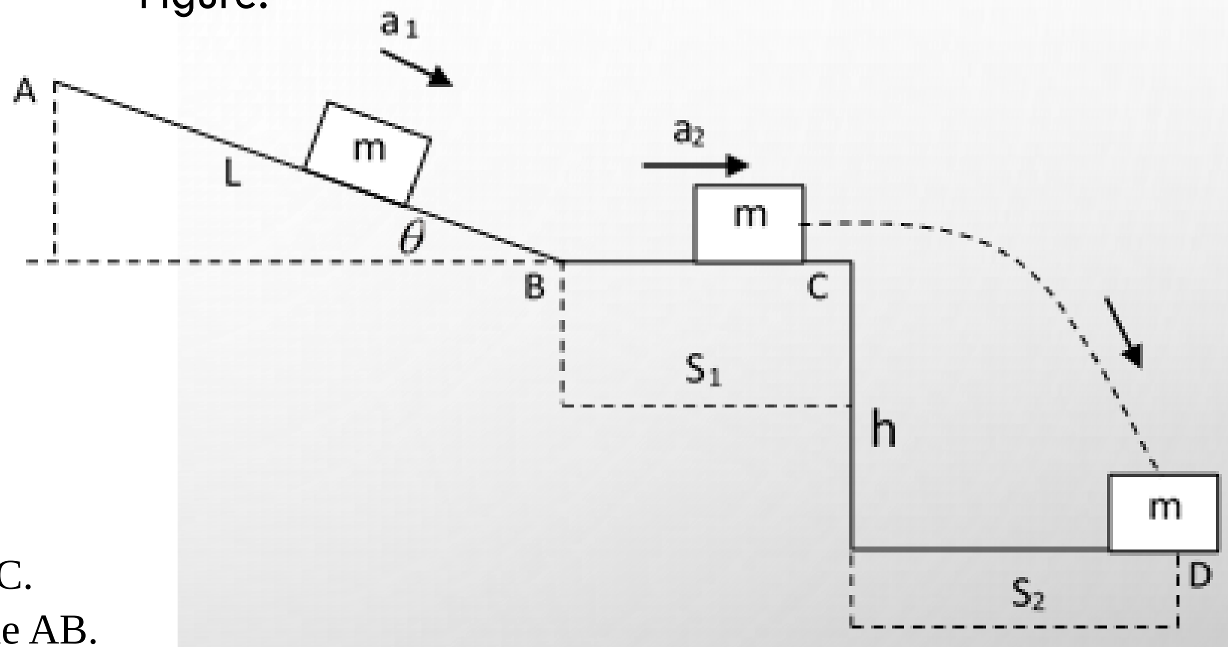
$Ø = 44^o$

$\mu = 0.06$ *coef. of kinetic friction*

Note:

- Particle "m" is release from rest at pt. A and moves to pt. B, then to pt.C, and finally to pt.D.
- Neglect the effect of the change in velocity direction at pt.B.
- The same value of coef. friction, from pt.A to pt.C.
- Projectile motion from pt.C to pt.D.

Figure:



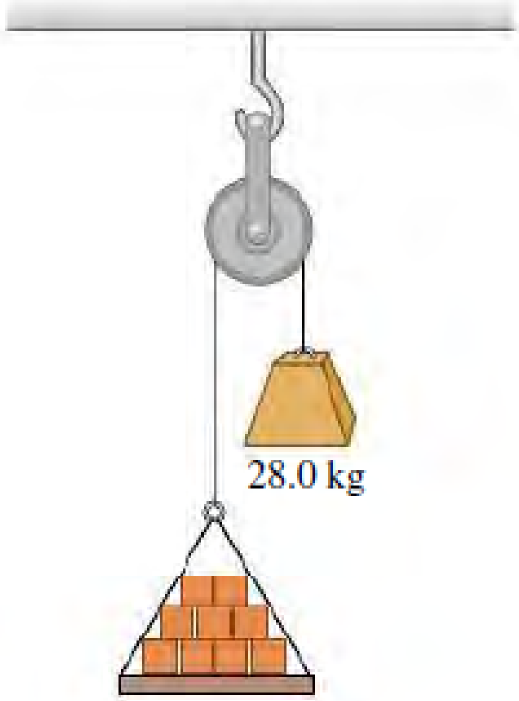
Required:

a. Free-body diagram of the particle at inclined plane AB.
b. Free-body diagram of the particle at horizontal plane BC.
c. Unbalanced force of the particle along the inclined plane AB.
d. Unbalanced force of the particle along the horizontal plane BC.
e. acceleration, a_1 of the particle along the inclined plane AB.
f. acceleration, a_2 of the particle along the horizontal plane BC.
g. velocity of the particle at pt.B.
h. velocity of the particle at pt.C.
i. Range, (S_2)
j. Total time of travel of particle from pt A to pt. D.

ASSIGNMENT

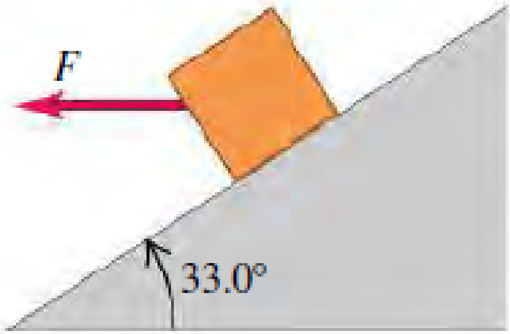
1. •• **Atwood's Machine.** A 15.0-kg load of bricks hangs from one end of a rope that passes over a small, frictionless pulley. A 28.0-kg counterweight is suspended from the other end of the rope (**Fig.**). The system is released from rest. (a) Draw two free-body diagrams, one for the load of bricks and one for the counterweight. (b) What is the magnitude of the upward acceleration of the load of bricks? (c) What is the tension in the rope while the load is moving? How does the tension compare to the weight of the load of bricks? To the weight of the counterweight?

Figure



2. An 8.00-kg box sits on a ramp that is inclined at 33.0° above the horizontal. The coefficient of kinetic friction between the box and the surface of the ramp is $\mu_k = 0.300$. A constant *horizontal* force $F = 26.0$ N is applied to the box (**Fig.**), and the box moves down the ramp. If the box is initially at rest, what is its speed 2.00 s after the force is applied?

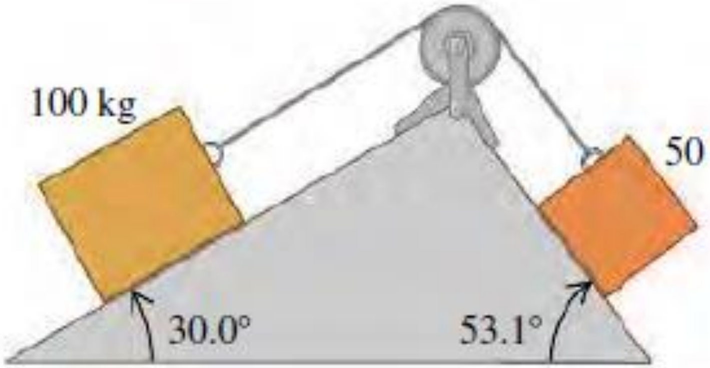
Figure



ASSIGNMENT

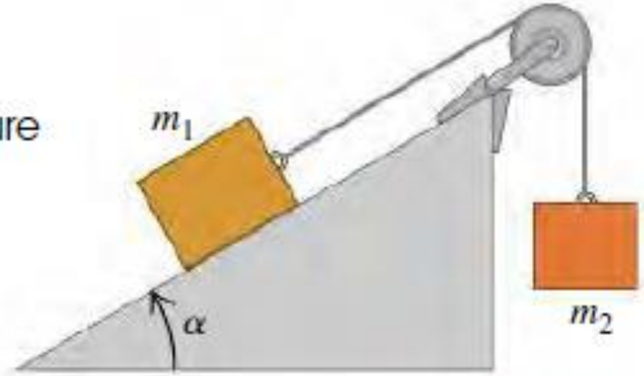
3. Two blocks connected by a cord passing over a small, frictionless pulley rest on frictionless planes (**Fig.**). (a) Which way will the system move when the blocks are released from rest? (b) What is the acceleration of the blocks? (c) What is the tension in the cord?

Figure



4. In **Fig.** , $m_1 = 20.0$ kg and $\alpha = 53.1°$. The coefficient of kinetic friction between the block of mass m_1 and the incline is $\mu_k = 0.40$. What must be the mass m_2 of the hanging block if it is to descend 12.0 m in the first 3.00 s after the system is released from rest?

Figure



ASSIGNMENT

5. A block is placed against the vertical front of a cart (**Fig.**). What acceleration must the cart have so that block *A* does not fall? The coefficient of static friction between the block and the cart is μ_s. How would an observer on the cart describe the behavior of the block?

Figure

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