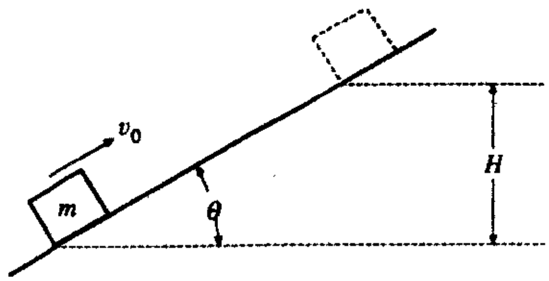
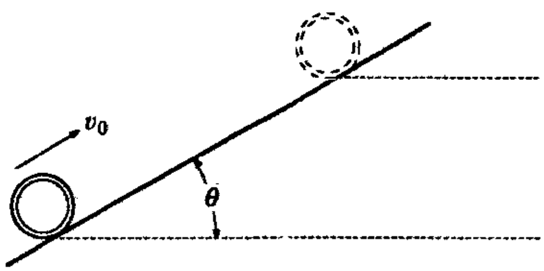
1990-C MECH-2



Mech. 2. A block of mass m slides up the incline shown above with an initial speed v_0 in the position shown.

(a) If the incline is frictionless, determine the maximum height H to which the block will rise, in terms of the given quantities and appropriate constants.

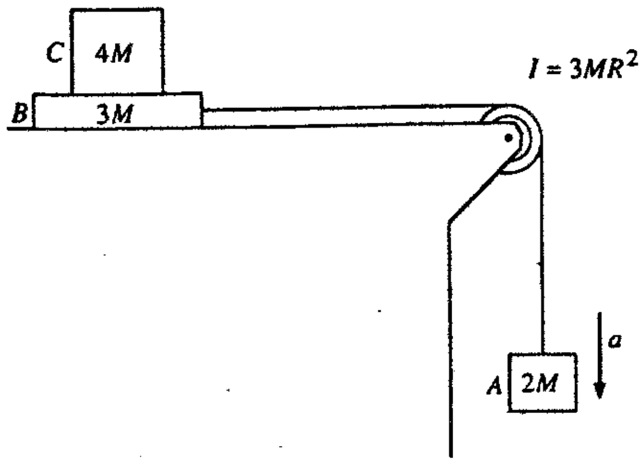
(b) If the incline is rough with coefficient of sliding friction μ, determine the maximum height to which the block will rise in terms of H and the given quantities.



A thin hoop of mass m and radius R moves up the incline shown above with an initial speed v_0 in the position shown.

(c) If the incline is rough and the hoop rolls up the incline without slipping, determine the maximum height to which the hoop will rise in terms of H and the given quantities.

(d) If the incline is frictionless, determine the maximum height to which the hoop will rise in terms of H and the given quantities.



Block A of mass $2M$ hangs from a cord that passes over a pulley and is connected to block B of mass $3M$ that is free to move on a frictionless horizontal surface, as shown above. The pulley is a disk with frictionless bearings, having a radius R and moment of inertia $3MR^2$. Block C of mass $4M$ is on top of block B. The surface between blocks B and C is NOT frictionless. Shortly after the system is released from rest, block A moves with a downward acceleration a, and the two blocks on the table move relative to each other.

In terms of M, g, and a, determine the

(a) tension T_v in the vertical section of the cord

(b) tension T_h in the horizontal section of the cord

If a = 2 meters per second squared, determine the

(c) coefficient of kinetic friction between blocks B and C

(d) acceleration of block C

KEY

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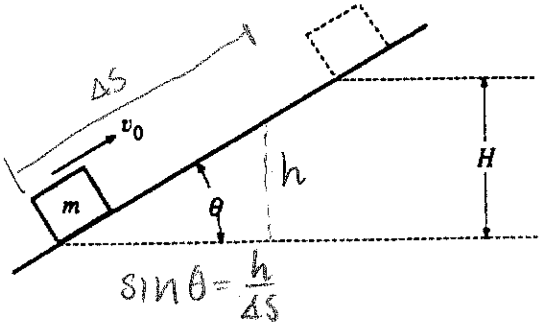
a) KE → GPE

$\frac{1}{2}mv_0^2 = mgH$

$H = \frac{v_0^2}{2g}$



b) KE − W_{F_f} = GPE

$W_{F_f} = F_f \Delta s$

$= \mu mg\cos\theta \cdot \frac{h}{\sin\theta}$ ($mg = w_\perp$)

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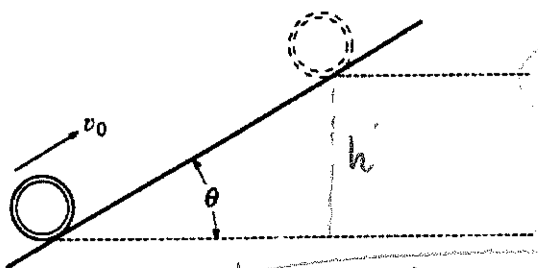
$\frac{1}{2}mv_0^2 - \mu mg\cot\theta \cdot h = mgh$

$\frac{1}{2}v_0^2 = \mu g\cot\theta \cdot h + gh$

$h = \frac{\frac{1}{2}v_0^2}{\mu g\cot\theta + g}$

BUT THIS IS NOT IN TERMS OF H !!



THAT'S H

so $h = \frac{v_0^2}{2g(\mu\cot\theta + 1)}$ ∴ $h = \frac{H}{\mu\cot\theta + 1}$

A thin hoop of mass m and radius R moves up the incline shown above with an initial speed v_0 in the position shown.

(c) If the incline is rough and the hoop rolls up the incline without slipping, determine the maximum height to which the hoop will rise in terms of H and the given quantities.

(d) If the incline is frictionless, determine the maximum height to which the hoop will rise in terms of H and the given quantities.

c) ($KE_{TRANS} + KE_{ROT}$) → GPE

$\frac{1}{2}mv_0^2 + \frac{1}{2}(mR^2)\left(\frac{v^2}{R^2}\right) = mgh$

$mv_0^2 = mgh$

$h = \frac{v_0^2}{g} = 2H$

d) w/o F_f ON INCLINE, THERE IS NO LOSS OF KE_{ROT} AS HOOP GOES UP INCLINE

∴ KE_{LIN} ONLY → GPH

$\frac{1}{2}mv_0^2 = mgh$

$h = \frac{v_0^2}{2g} = H$

SAME AS (a)

a) $\Sigma F: 2Mg - T_v = 2Ma \longrightarrow \boxed{T_v = 2M(g-a)}$ ← "GIVEN"

b) $\Sigma \tau: T_v R - T_h R = I\alpha = 3MR^2\left(\frac{a}{R}\right)$

$T_v - T_h = 3Ma \longrightarrow T_h = T_v - 3Ma$

$= 2Mg - 2Ma - 3Ma$

$\boxed{T_h = 2Mg - 5Ma}$

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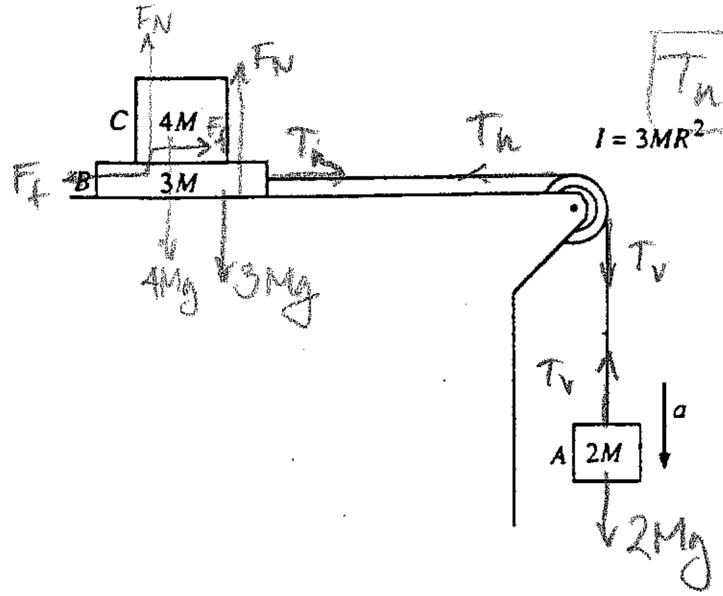

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c) BOX C WILL ACCEL TO RIGHT DUE TO F_f B/W BOXES

$\Sigma F_B: T_h - F_f = 3Ma$

$T_h - \mu F_N = 3Ma$ (F_N B/W BLOCKS WHICH = 4Mg)

SUB-IN FROM (b) → $T_h - \mu 4Mg = 3Ma$

$2Mg - 5Ma - \mu 4Mg = 3Ma$

$\mu = \frac{2g - 8a}{4g} = \boxed{0.1}$

d) $\Sigma F_C: F_f = 4Ma_{BLOCK C}$ ($\neq a_{SYS}$)

$4\mu Mg = 4Ma_{BLOCK C}$

$\boxed{a = \mu g = 1\,m/s^2}$