Recitation Class

Chapter 2

[Problem 29] A car moving at a constant velocity of 46 m/s passes a traffic cop who is readily sitting on his motorcycle. After a reaction time of 1.0s, the cop begins to chase the speeding car with a constant acceleration of 4.0 m/s^2. How much time does the cop need to overtake the speeding car?

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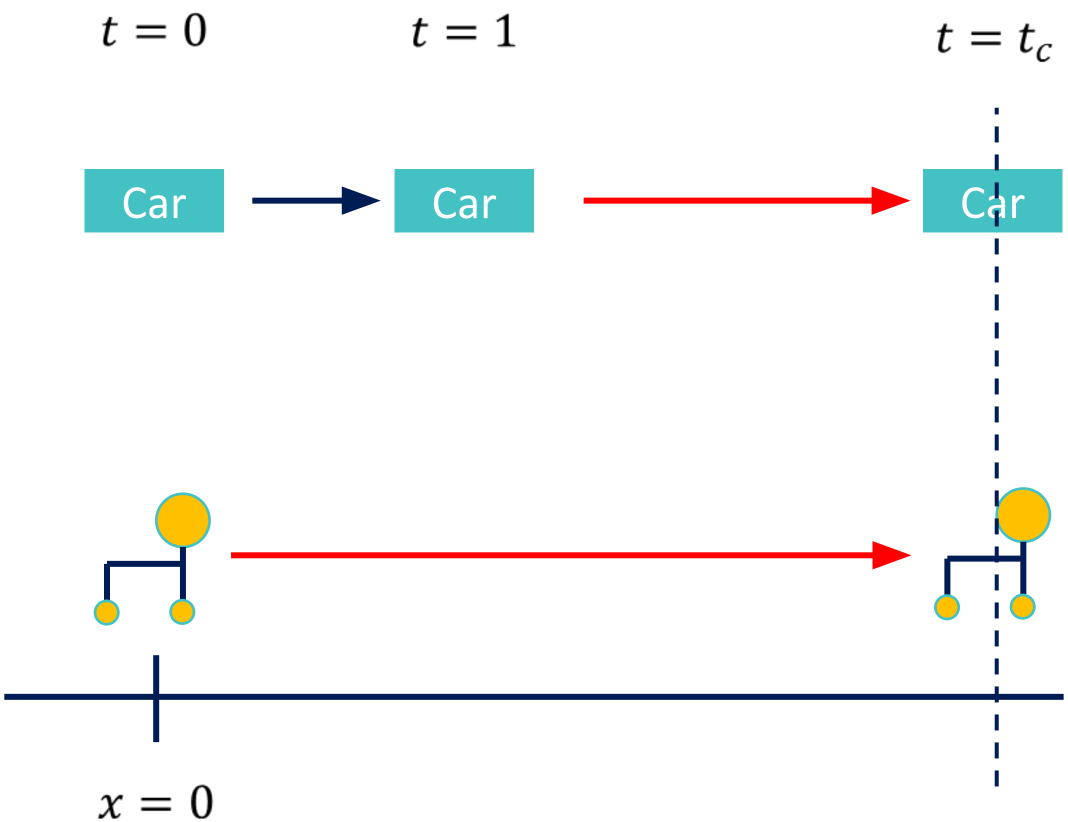

$$x_{\text{car}} - x_{\text{car},0} = v_{\text{car}}(t_f - 1)$$

$$x_{\text{cop}} - x_{\text{cop},0} = \frac{1}{2}a(t_f - 1)^2$$

$$x_{\text{car}} = x_{\text{cop}}, t_f - 1 \equiv X \Longrightarrow 2X^2 - 23X - 23 = 0 \Longrightarrow X = 24\ s$$

[Problem 58] An object falls a distance h from rest. If it travels 0.60h in the last 1.00 s, find (a) the time and (b) the height of its fall. (c) Explain the physically unacceptable solution of the quadratic equation in t that you obtain.?

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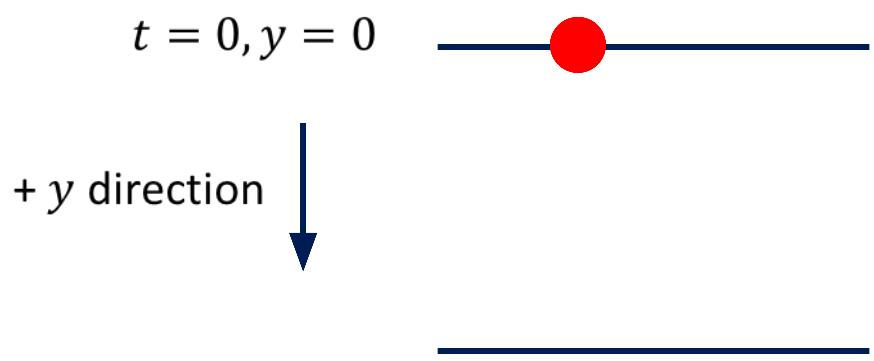

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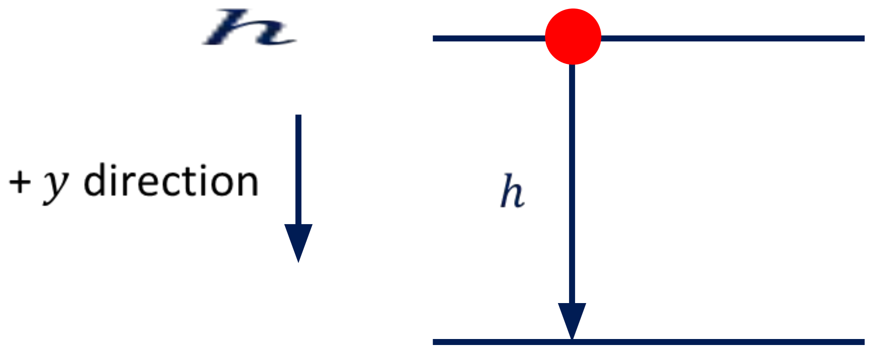

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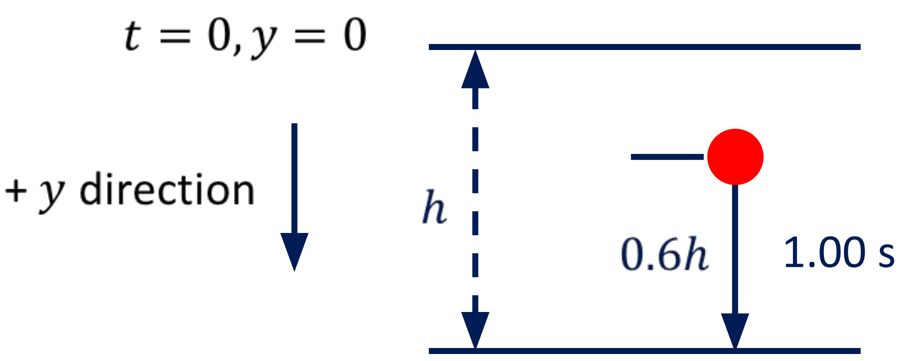

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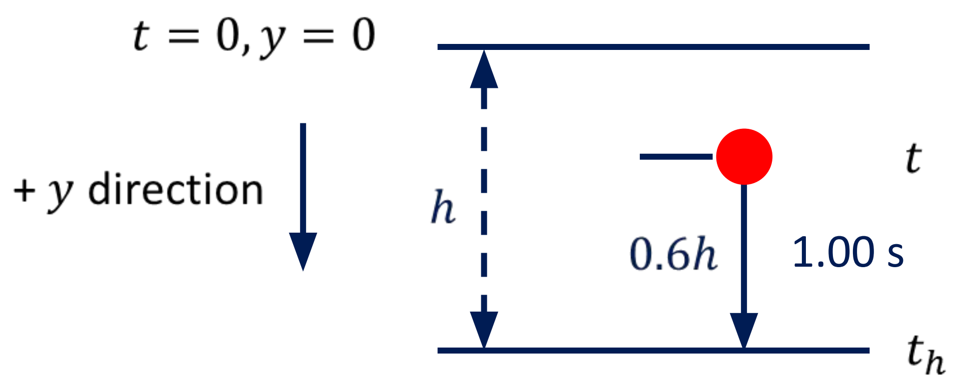

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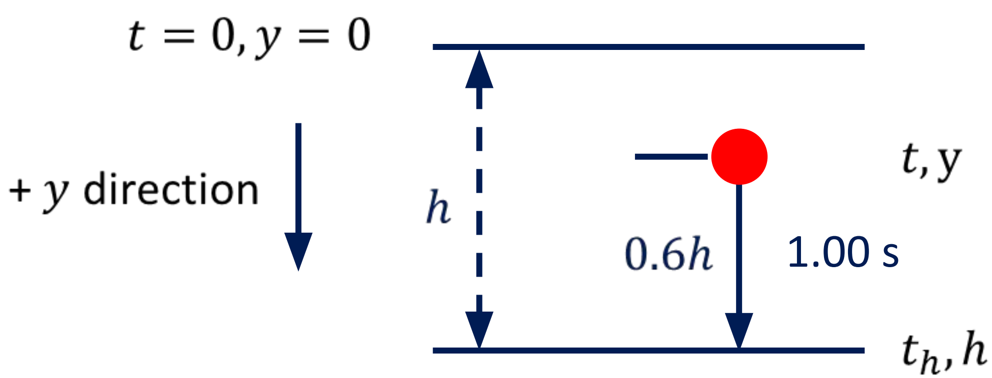

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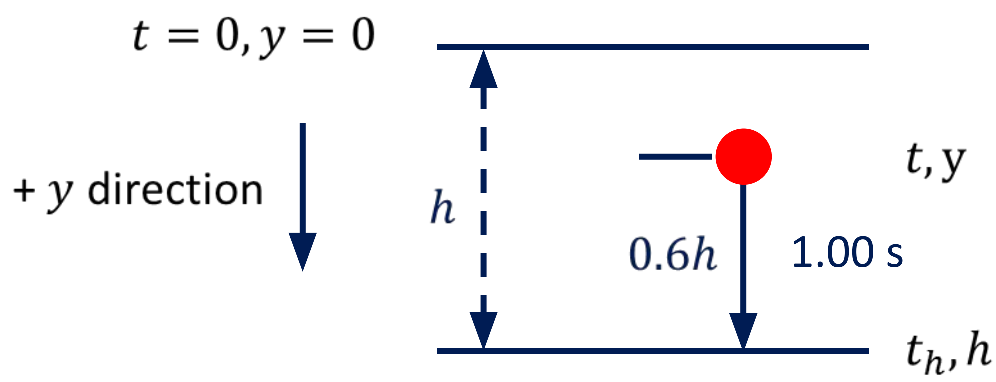

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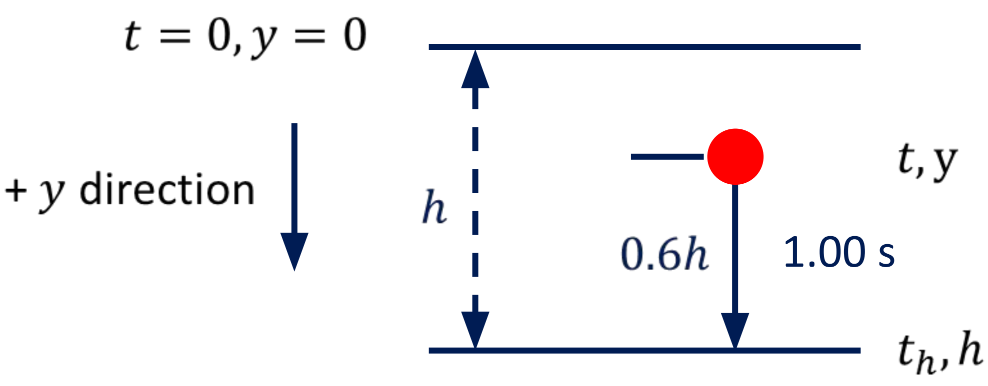

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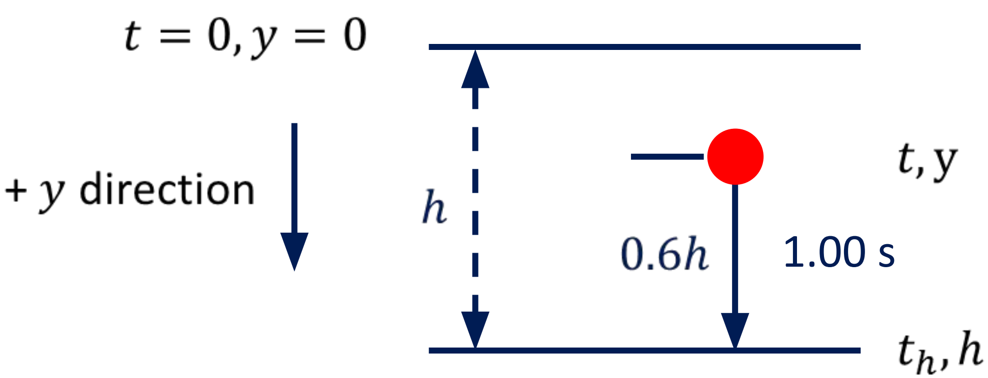

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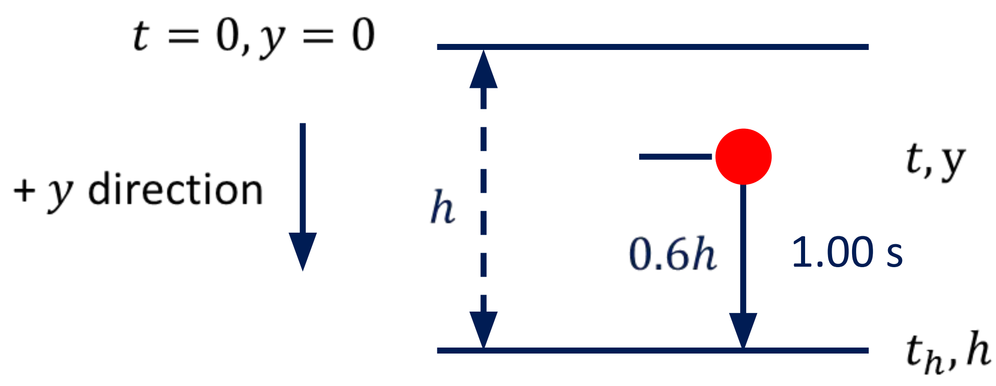

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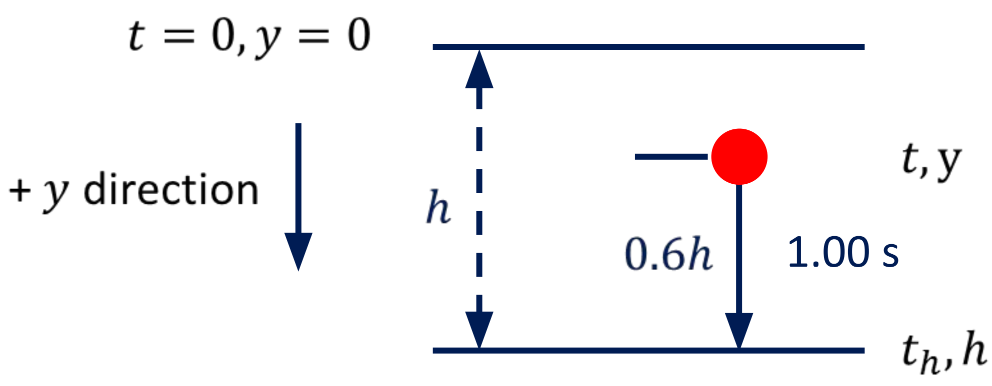

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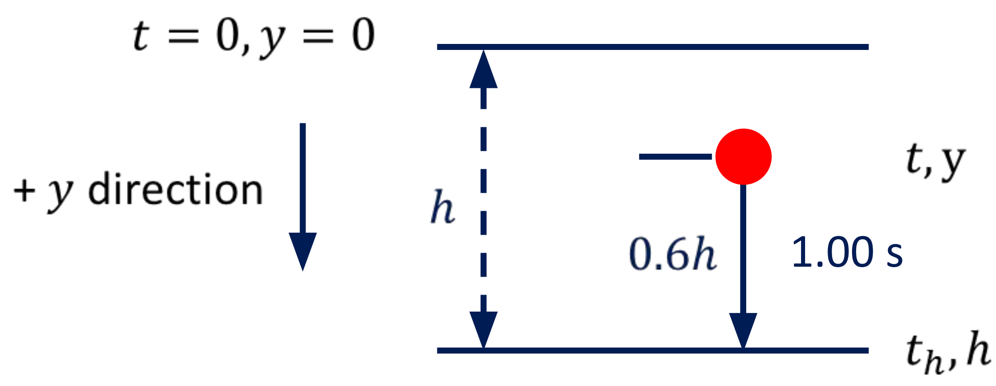

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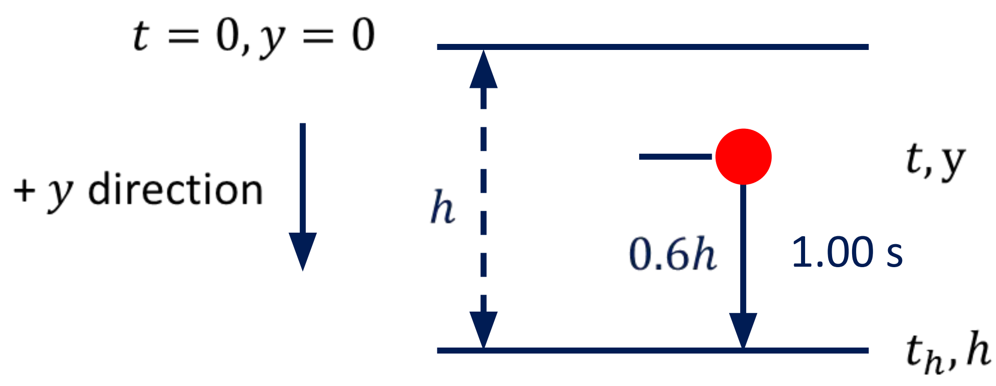

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Negative time indicates a time before the object was dropped

Answer of (c)

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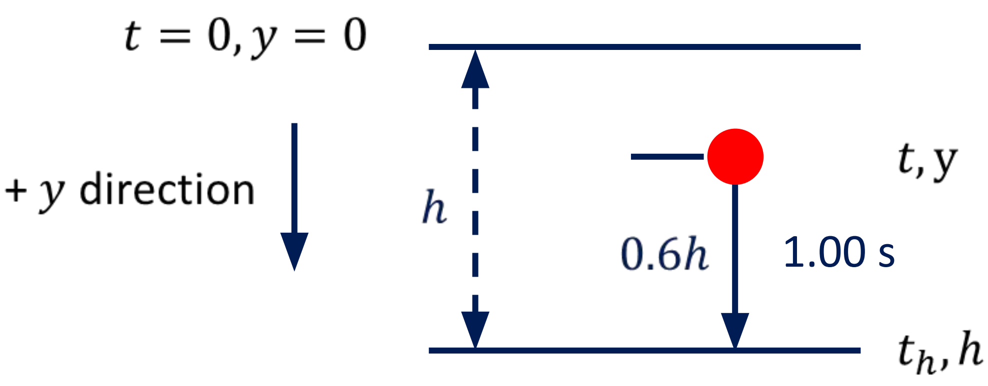

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(a) the time of the object's fall: t_h

$t_h - t = 1.00 \quad (1)$ $\qquad t = \sqrt{0.4}t_h \quad (3)$ $\qquad$ Plugging Eq. (3) into (1),

$$t_h - \sqrt{0.4}t_h = 1.00 \Longrightarrow t_h = \frac{1}{1-\sqrt{0.4}} = 2.72 \text{ s}$$

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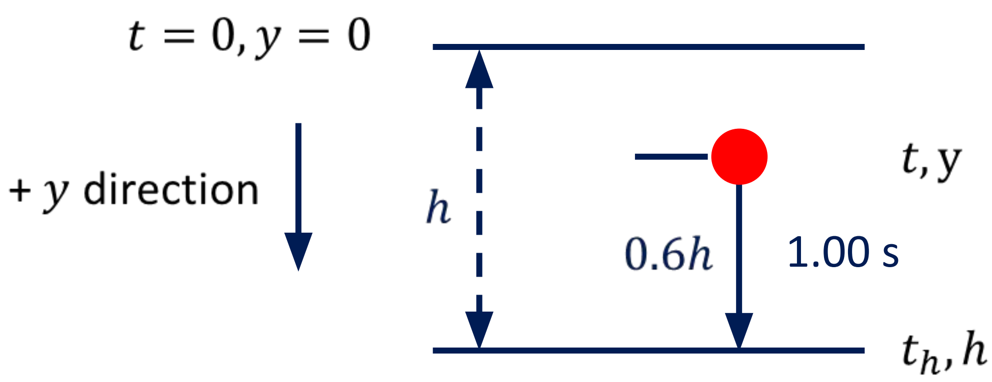

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(b) the height of the object's fall: h

$$h = \frac{1}{2} g t_h^2 = \frac{1}{2} \times 9.8\ \mathrm{m/s^2} \times (2.72\ \mathrm{s})^2 = 36.2\ \mathrm{m}$$

Chapter 4

[Problem 23] A shell, which is initially located at a distance of h above a horizontal plane, is fired horizontally with a muzzle velocity of v_0 to strike a target on the horizontal plane. (a) How long does the projectile remain in the air? (b) At what horizontal distance from the firing point does the shell strike the plane? What are the magnitudes of the (c) horizontal and (d) vertical components of its velocity as it strikes the ground?

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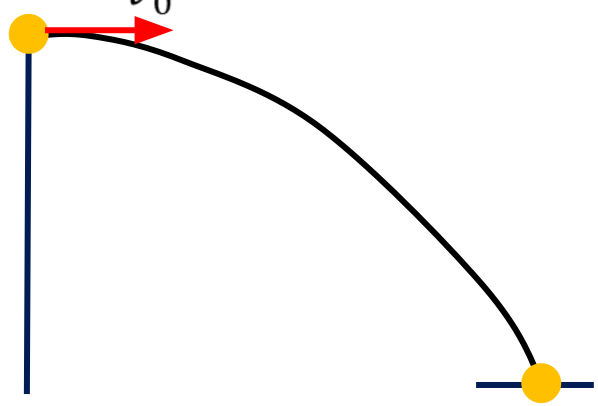
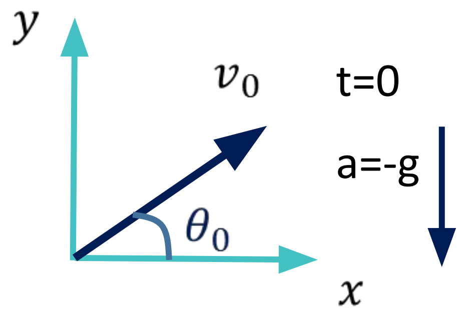




$$x - x_0 = (v_0 \cos\theta_0)t$$

$$y - y_0 = (v_0 \sin\theta_0)t - \frac{1}{2}gt^2$$

$$y_0 = h \qquad v_{0y} = 0$$

$$y = 0 \qquad v_{0x} = v_0$$

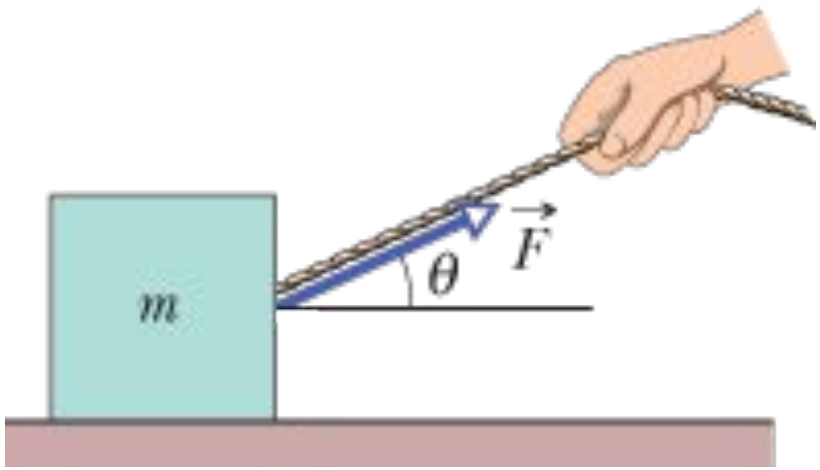
$$(a)\ h = \frac{1}{2}gt^2 \Longrightarrow t = \sqrt{\frac{2h}{g}}$$

$$(b)\ x - x_0 = v_0 t = v_0\sqrt{\frac{2h}{g}}$$

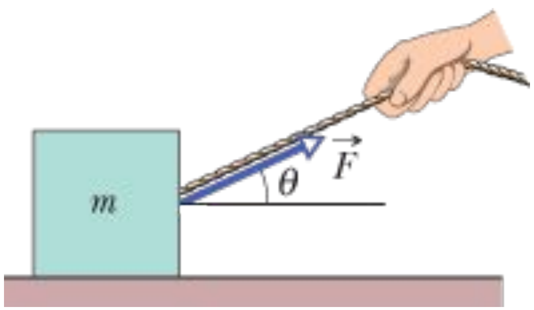
$$(c,d) v_{0x} = v_0, v_y = v_{0y} - gt = -\sqrt{2gh}$$

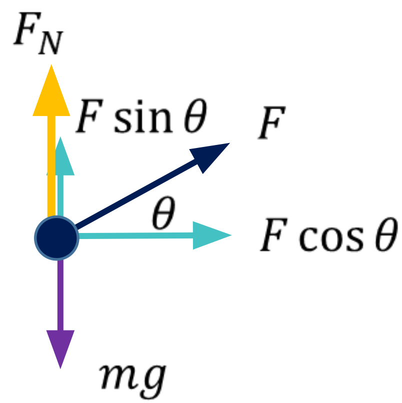
Chapter 5

[Problem 49] In the figure, a block of mass $m = 5.00$ kg is pulled along a horizontal frictionless floor by a cord that exerts a force of magnitude $F = 12.0$ N at an angle $\theta = 25.0°$. (a) What is the magnitude of the block's acceleration? (b) The force magnitude F is slowly increased. What is its value just before the block is lifted (completely) off the floor? (b) What is the magnitude of the block's acceleration just before it is lifted (completely) off the floor?



[Problem 49] In the figure, a block of mass m is pulled along a horizontal frictionless floor by a cord that exerts a force of magnitude F at an angle θ. (a) What is the magnitude of the block's acceleration? (b) The force magnitude F is slowly increased. What is its value just before the block is lifted (completely) off the floor? (b) What is the magnitude of the block's acceleration just before it is lifted (completely) off the floor?





(a) $ma_x = F_x = F\cos\theta$

$$a_x = \frac{F\cos\theta}{m}$$

(b) $F_N + F\sin\theta - mg = 0$

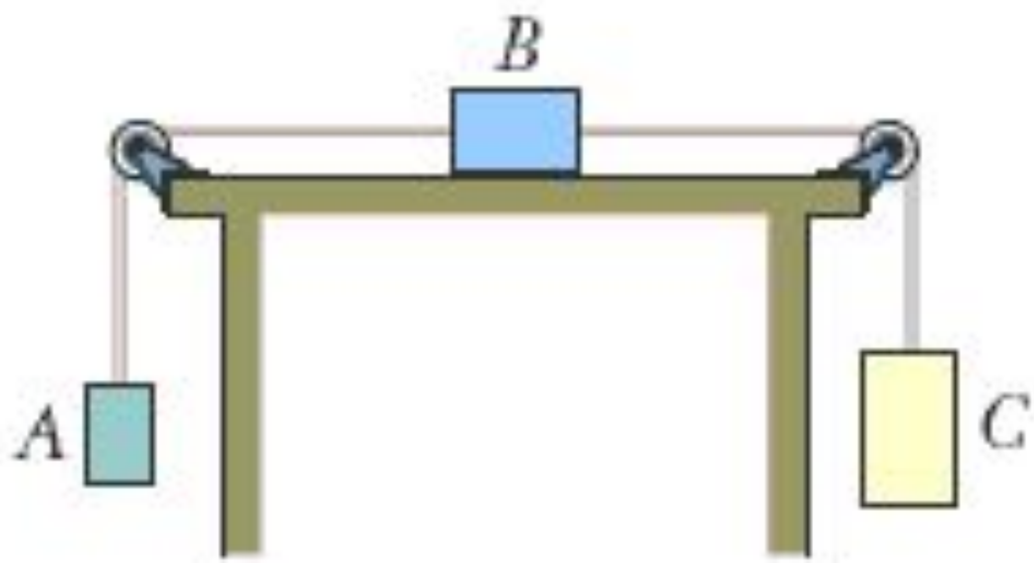
before the block is lifted off the floor

$$F_N = 0 \Longrightarrow F = \frac{mg}{\sin\theta}$$

(c) acceleration is still in the x axis

$$a = a_x = \frac{F\cos\theta}{m}$$

[Problem 67] The figure shows three blocks attached by cords that loop over frictionless pulleys. Block B lies on a frictionless table; the masses are mA = 6.00 kg, mB = 8.00 kg, and mC = 10.0 kg. When the blocks are released, what is the tension in the cord at the right?



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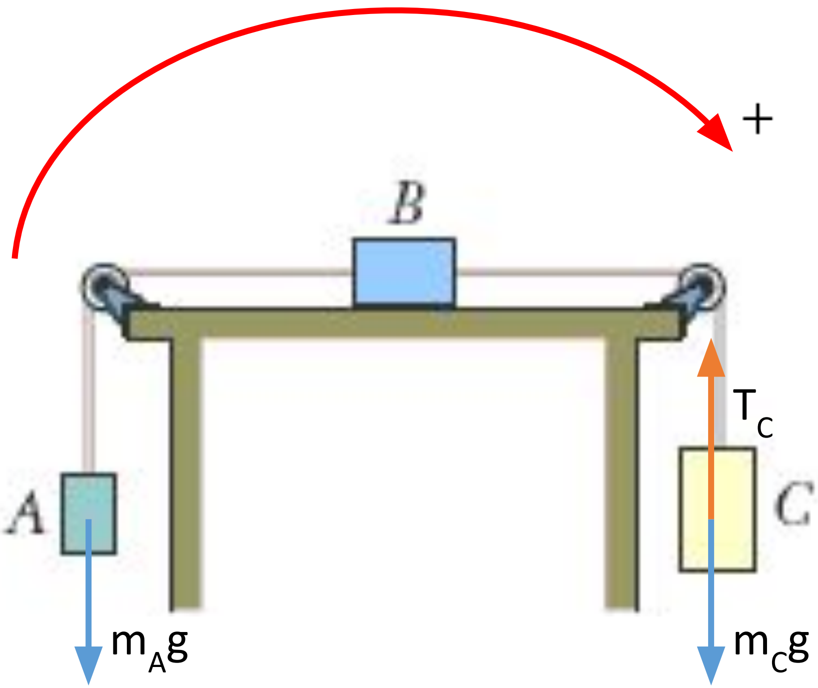

Assume a clockwise motion
(Downward is positive for block C,
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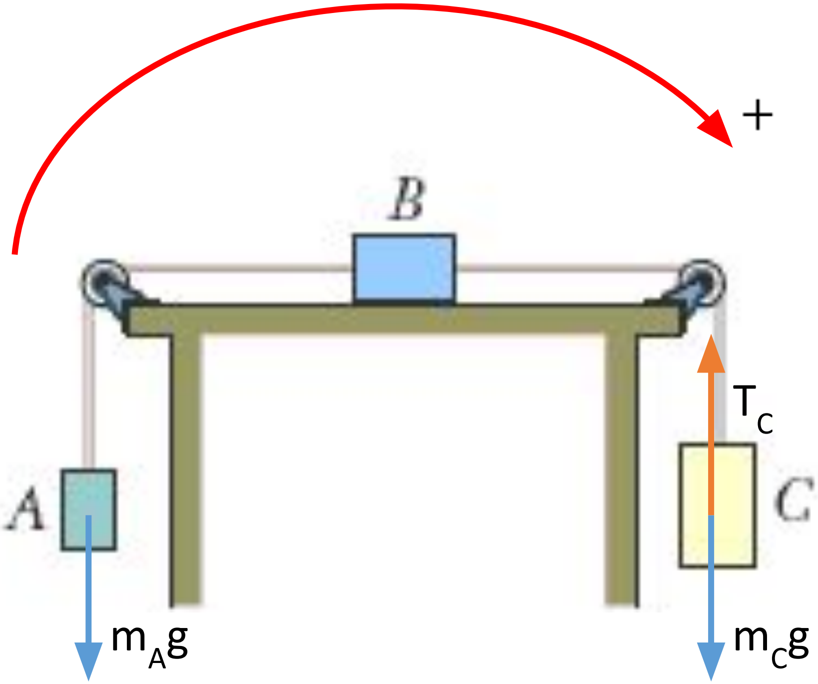

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$$m_C g - m_A g = Ma$$
$$(M = m_A + m_B + m_C)$$

$$a = \frac{(m_C - m_A)g}{M} = 1.63\, m/s^2$$

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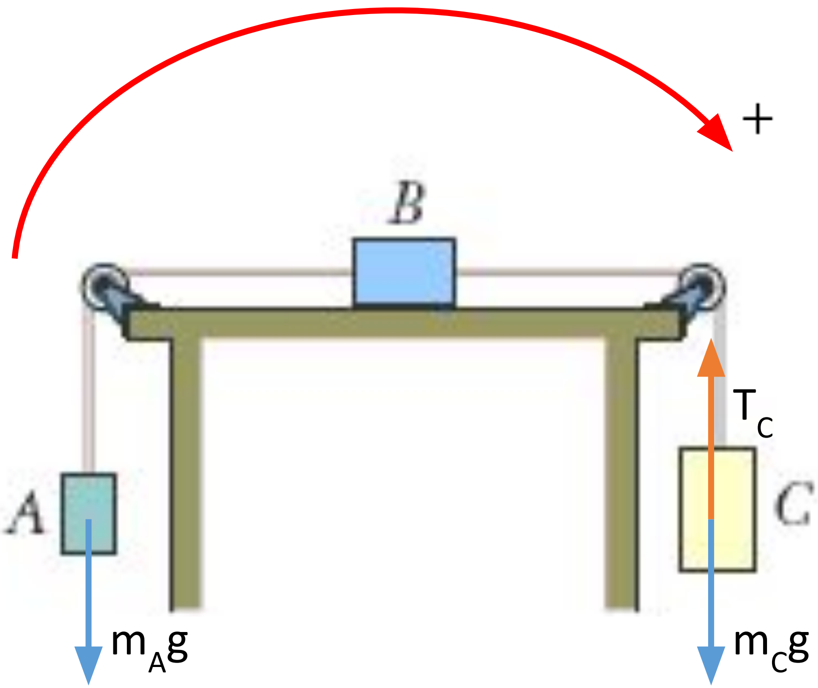

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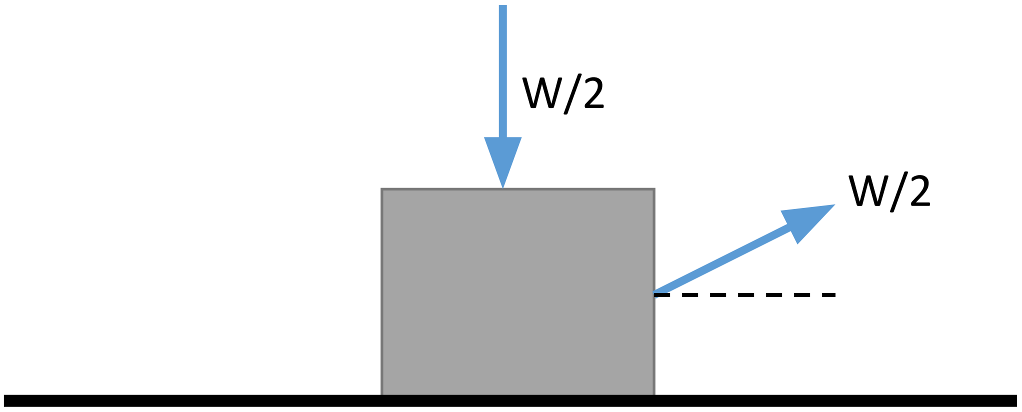
The force for just on block C:

$$m_C g - T_c = m_C a$$

$$T_C = \frac{m_C g(2m_A + m_B)}{M} = 81.7N$$

Chapter 6

[Problem 10] In the figure, a block of weight W experiences two applied forces, each of magnitude W/2. What coefficient for static friction between the block and the floor puts the block on the verge of sliding?



$$f_{s,\,\max} = \mu_s F_N$$

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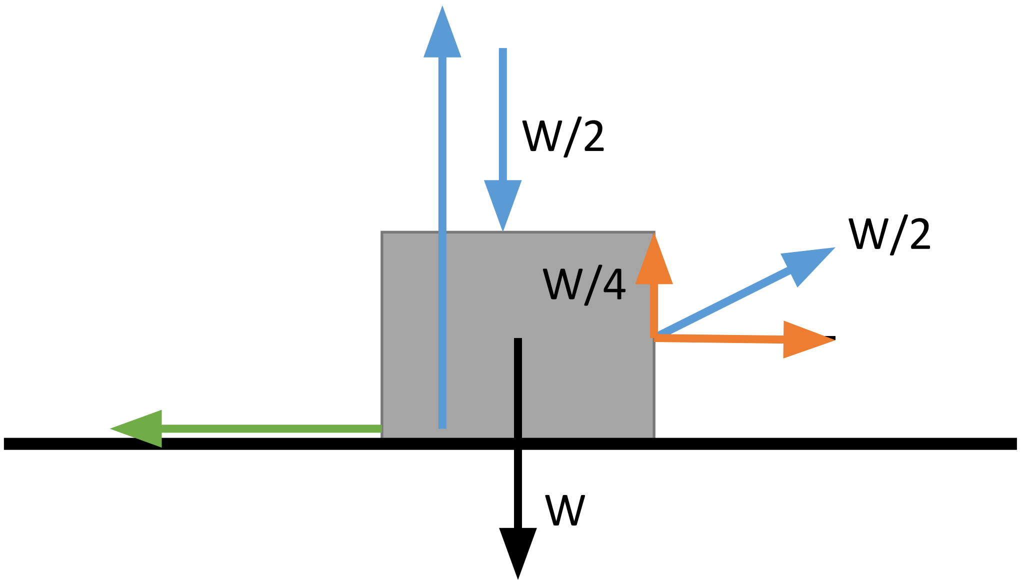

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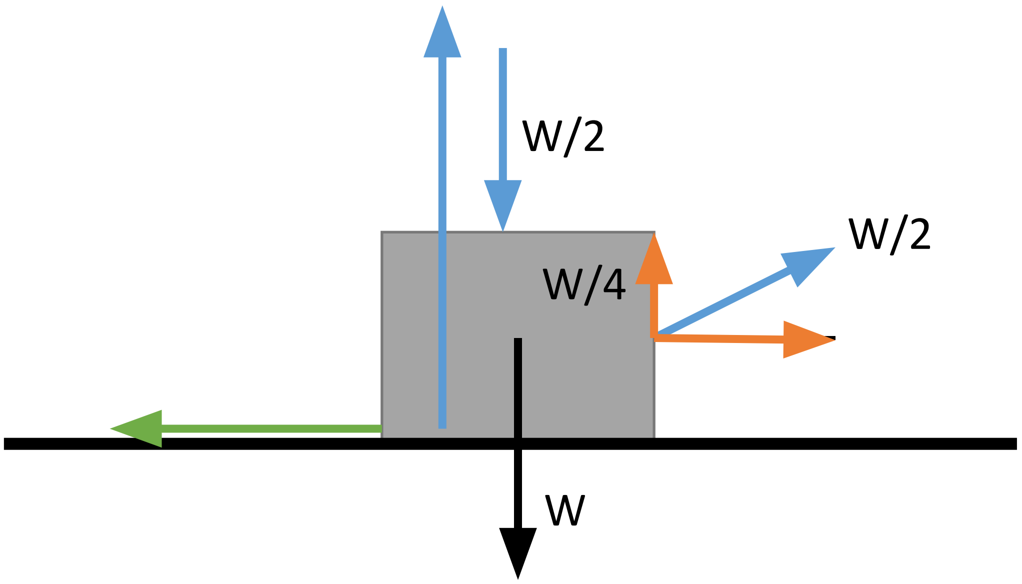
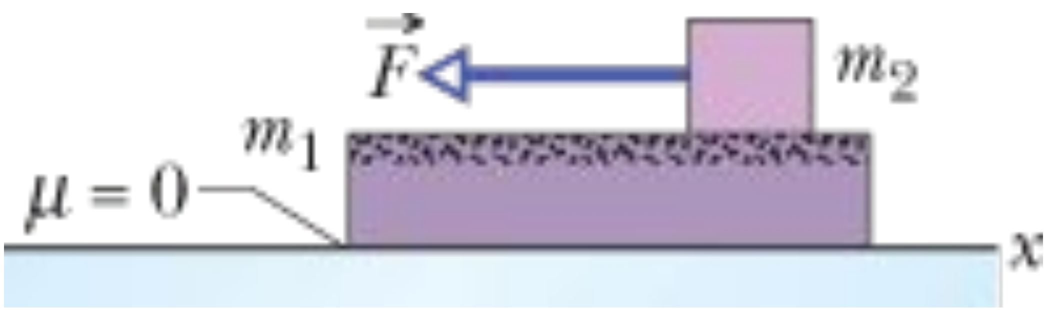


[Problem 34] In the figure, a slab of mass $m_1 = 40$ kg rests on a frictionless floor, and a block of mass $m_2 = 10$ kg rests on top of the slab. Between block and slab, the coefficient of static friction is 0.60, and the coefficient of kinetic friction is 0.40. A horizontal force $\vec{F}$ of magnitude 100 N begins to pull directly on the block, as shown. In unit-vector notation, what are the resulting accelerations of (a) the block and (b) the slab?



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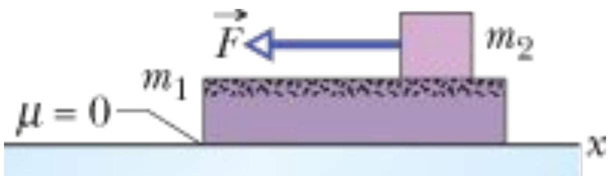

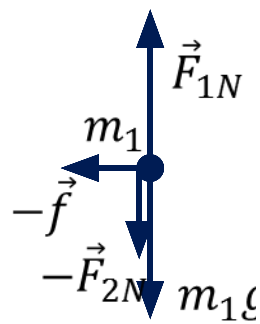

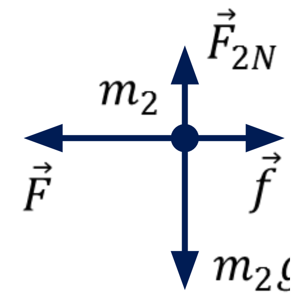

y: $F_{1N} - F_{2N} - m_1 g = 0$

x: $-f = m_1 a_1$

y: $F_{2N} - m_2 g = 0$

x: $-F + f = m_2 a_2$

Question: $a_1 = a_2$???

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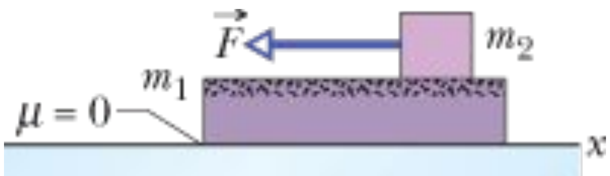
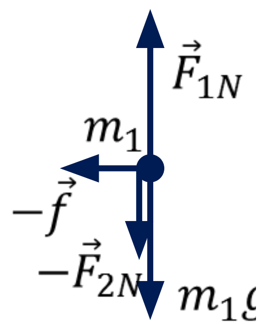
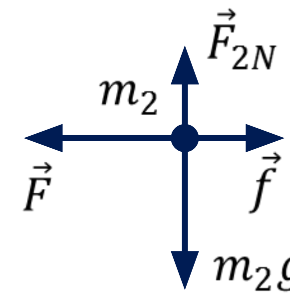






Question: $a_1 = a_2$???

$x: -f = m_1 a$

$x: -F + f = m_2 a$

Block does not stick together !!

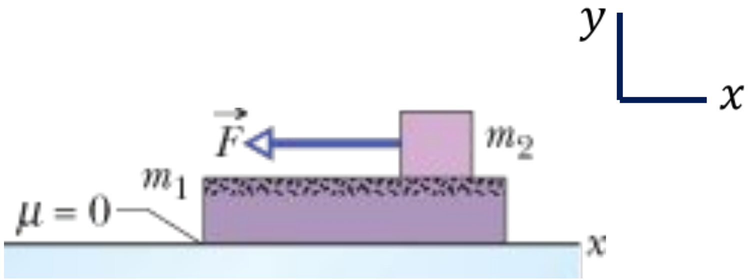
$$a = -\frac{f}{m_1}$$

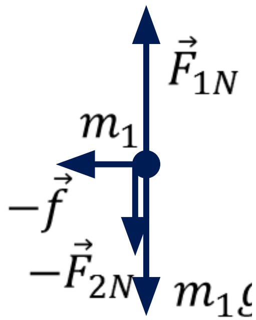
$a_1 \neq a_2$

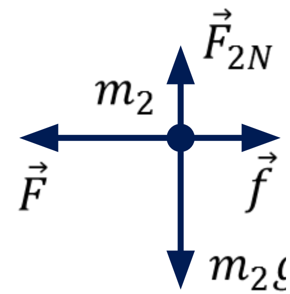
$$f = \frac{m_1 F}{m_1 + m_2} > f_{s,\max} = \mu_s m_2 g$$

80 N 59 N

[Problem 34] In the figure, a slab of mass $m_1 = 40$ kg rests on a frictionless floor, and a block of mass $m_2 = 10$ kg rests on top of the slab. Between block and slab, the coefficient of static friction is 0.60, and the coefficient of kinetic friction is 0.40. A horizontal force $\vec{F}$ of magnitude 100 N begins to pull directly on the block, as shown. In unit-vector notation, what are the resulting accelerations of (a) the block and (b) the slab?







(a) accelerations of the block

$$x: -F + f = m_2 a_2$$

$$y: \; F_{2N} - m_2 g = 0$$

$$f = \mu_k F_{2N} = \mu_k m_2 g$$

$$a_2 = \frac{-F + f}{m_2} = \frac{-F + \mu_k m_2 g}{m_2} = -6.1 \text{ m/s}^2$$

$$\vec{a}_2 = -(6.1 \text{ m/s}^2)\hat{\mathrm{i}}$$

(b) accelerations of the slab

$$x: -f = m_1 a_1$$

$$a_1 = -\frac{f}{m_1} = \frac{\mu_k m_2 g}{m_1} = -0.98 \, \text{m/s}^2$$

$$\vec{a}_1 = -(0.98 \text{ m/s}^2)\hat{\mathrm{i}}$$

[Problem 52] An amusement park ride consists of a car moving in a vertical circle on the end of a rigid boom of negligible mass. The combined weight of the car and riders is 6.0 kN, and the circles' radius is 10 m. At the top of the circle, what are the (a) magnitude F_B and (b) direction (up or down) of the force on the car from the boom if the car's speed is $v = 5.0\ m/s$? What are (c) F_B and (d) the direction if $v = 12\ m/s$

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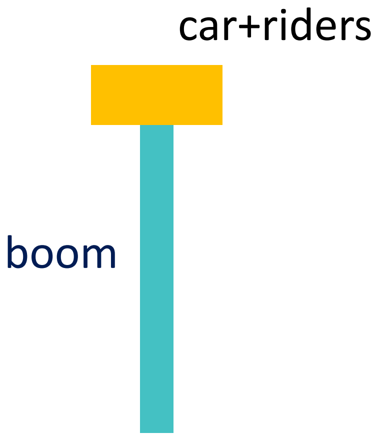

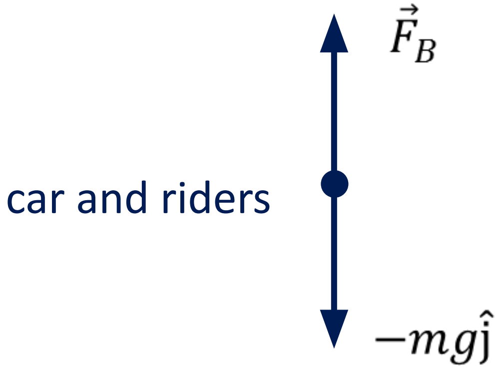

car is at rest at the top

$$F_B - mg = 0$$

F_B is upward

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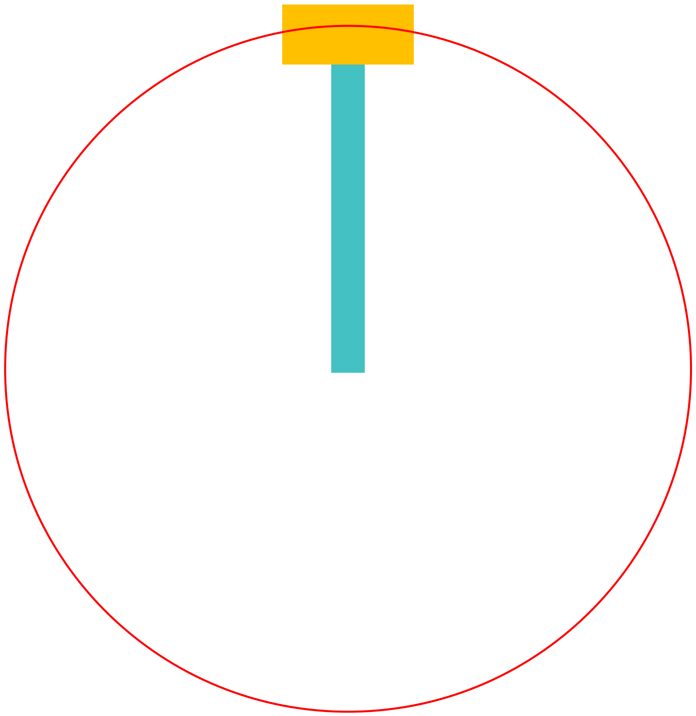

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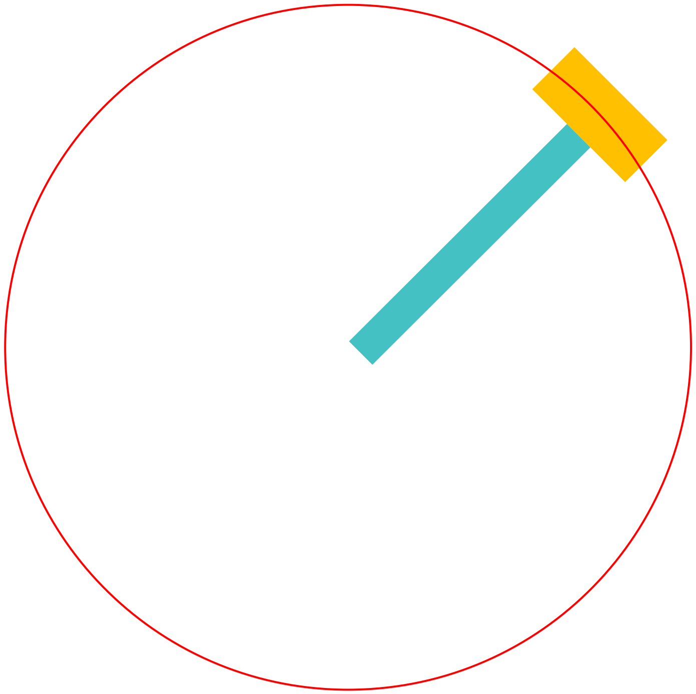

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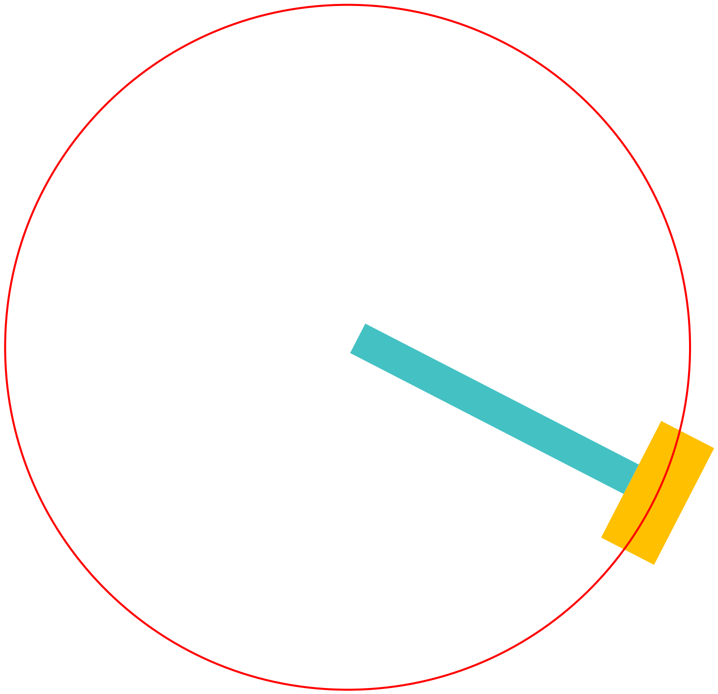

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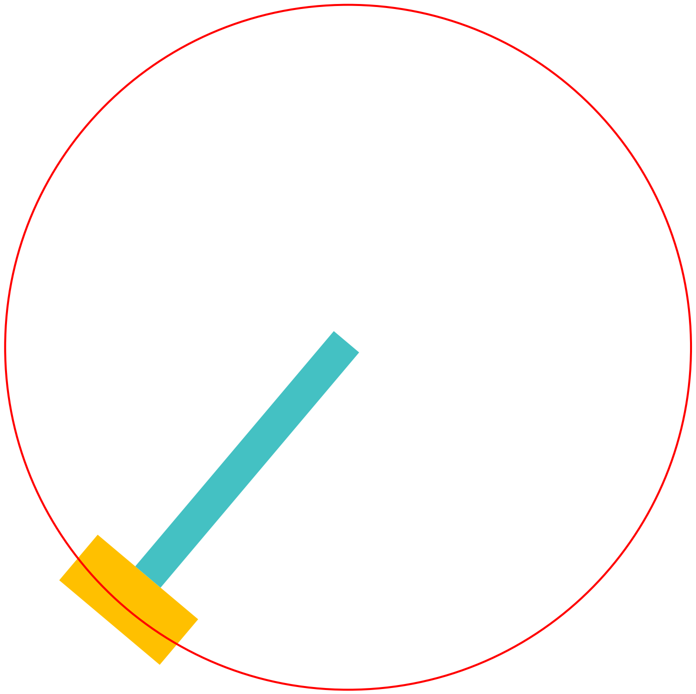

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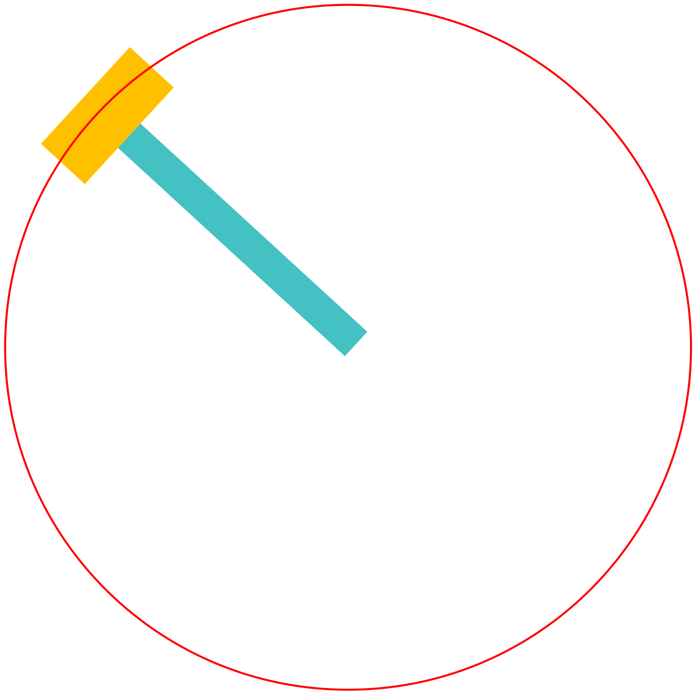

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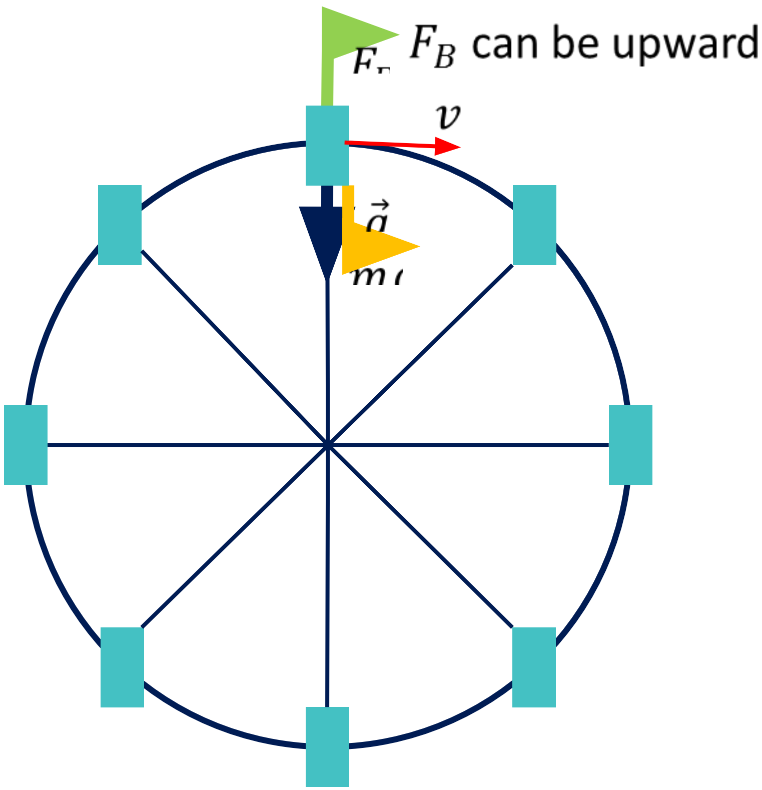

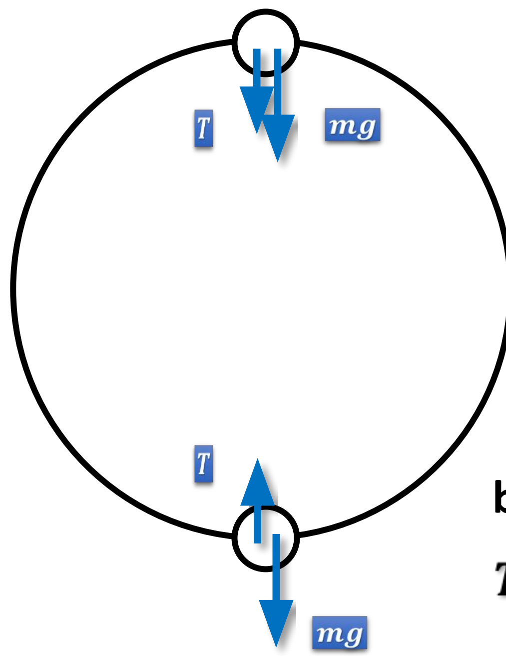

top:

$$mg + T = m\frac{v^2}{R}$$

$$T = m\frac{v^2}{R} - mg \geq 0$$

$$v \geq \sqrt{Rg}$$

bottom:

$$T - mg = m\frac{v^2}{R}$$

$$T = mg + m\frac{v^2}{R}$$

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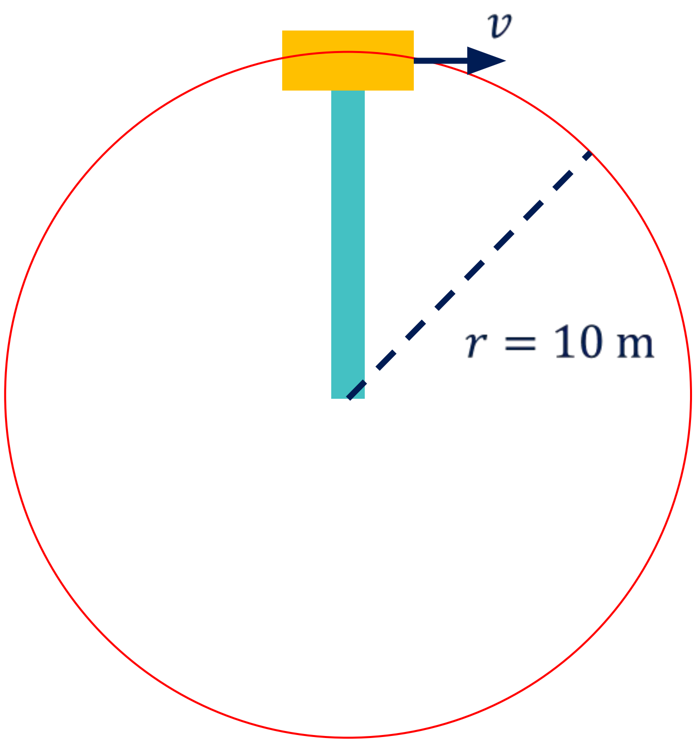

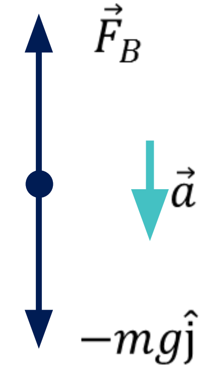

direction of F_B is able to be upward or downward (cf. loop-the-loop)

Assuming that F_B is upward, by Newton's second law

$$F_B - mg = m(-a) = -\frac{mv^2}{r}$$

$$\boxed{F_B = mg - \frac{mv^2}{r}}$$

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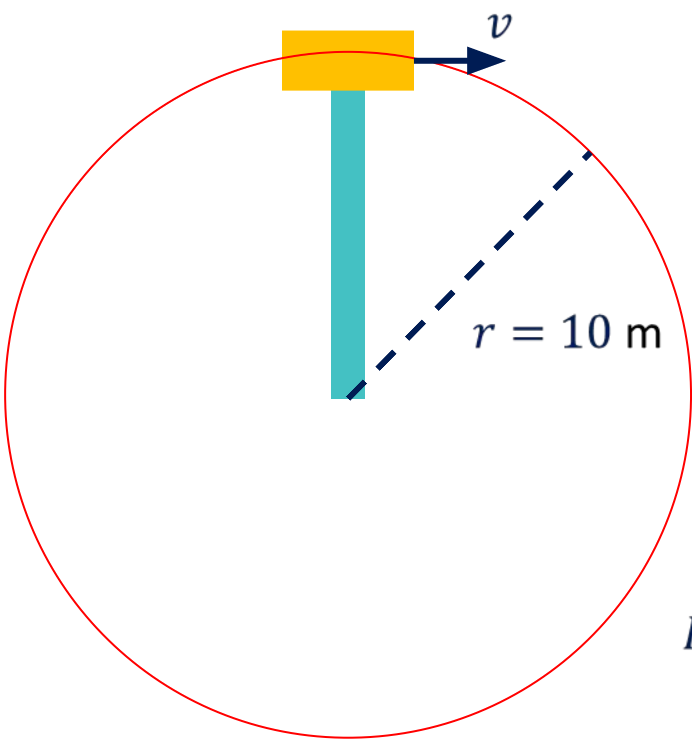
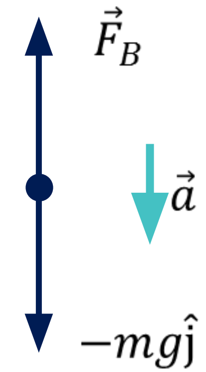


car and riders



(a), (b) $\quad v = 5.0\ m/s \quad m = \dfrac{6000}{g} = \dfrac{6000}{9.8\ m/s^2}$

$$F_B = mg - \frac{mv^2}{r} = 4.5\ \text{kN}$$

the direction of the force from the boom is upward

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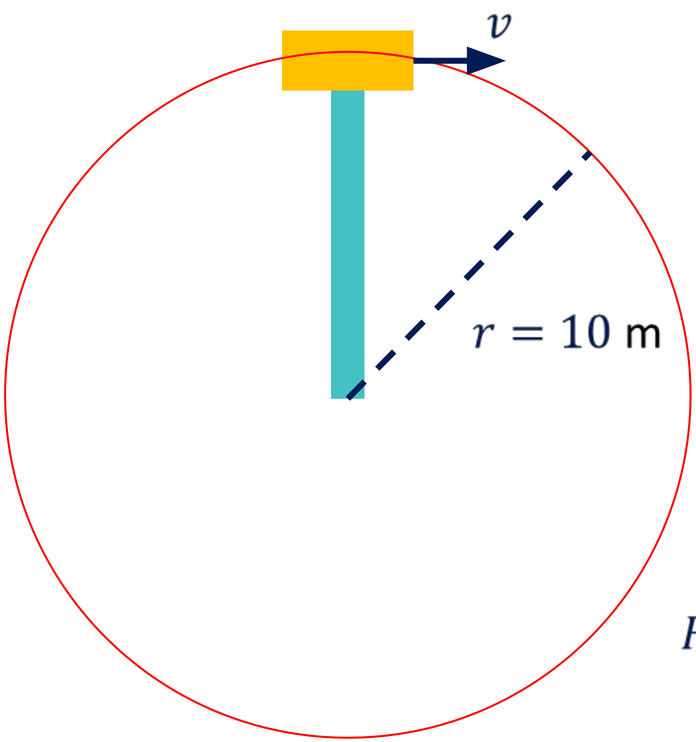

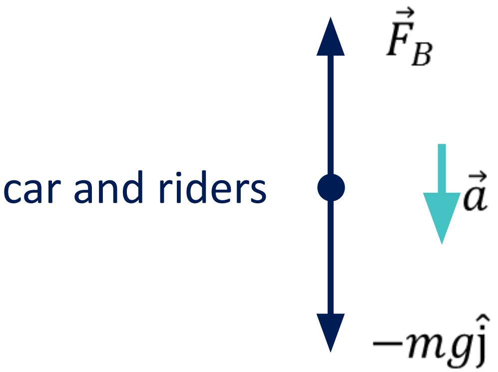

(c), (d) $v = 12.0\ m/s$ $m = \dfrac{6000}{g} = \dfrac{6000}{9.8\ m/s^2}$

$$F_B = mg - \frac{mv^2}{r} = -2.8\ \mathrm{kN}$$

the direction of the force from the boom is downward