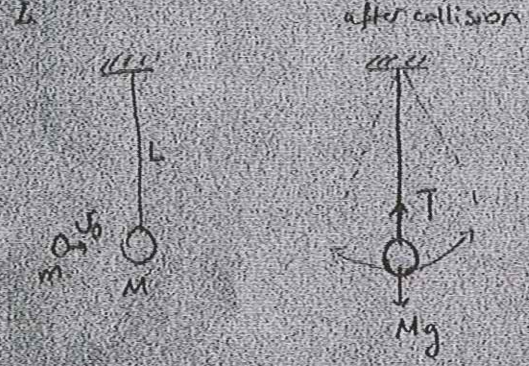
PHYS 101: General Physics | KOÇ UNIVERSITY College of Sciences Quiz 8 | Fall Semester 2014

Section 1 2014 | | 20 November

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

First Name: **Last name:** **Student ID:** **Signature:**

A ball with mass M that is hanged from the ceiling by a very light wire of length L, is struck in an elastic collision by another ball with mass m that is moving horizontally at speed v_0 just before the collision. Find the tension in the wire just after the collision in terms of M, m, v_0, g, L.



$\Sigma F = m a_{rad}$ $\left(a_{rad} = \frac{v^2}{R}\right)$

$T - Mg = M \frac{V'^2}{L}$

$$\boxed{T = Mg + \frac{M}{L}\left(\frac{2m}{m+M} v_0\right)^2}$$

For the collision, momentum conservation

elastic collision: energy also conserved

① $m v + M \underset{0}{V} = m v' + M V'$

$\frac{1}{2} m v_0^2 = \frac{1}{2} m v'^2 + \frac{1}{2} M V'^2$

$m v_0 = m v' + M V'$

② $m(v_0 - v') = M V'$

$m(v_0^2 - v'^2) = M V'^2$ ③

divide them

$\Rightarrow v_0 + v' = V'$ (insert this in eq ①)

$m v_0 = m v' + M v_0 + M v'$

$\Rightarrow v' = \frac{(m-M)}{(m+M)} v_0$

$\Rightarrow V' = \frac{2m}{m+M} v_0$

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College of Sciences

Section 2 | Quiz 8 | 20 November 2014

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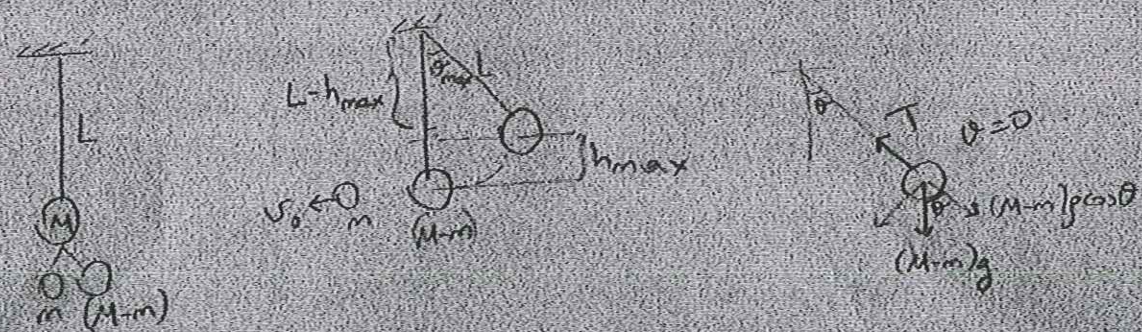
Quiz duration: 10 minutes
First Name: **Last name:** **Student ID:** **Signature:**

A ball with mass M that is hanged from the ceiling by a very light wire of length L undergoes an explosion and splits into two pieces. Just after the explosion one of the pieces with mass m is observed to move horizontally at speed v_0. Find the tension in the wire when the second piece is at its maximum height in terms of M, m, v_0, g, L.

inelastic



for explosion, momentum conservation

$$0 = m(-v_0) + (M-m)v$$

$$v = \frac{m v_0}{(M-m)}$$

to find h_{max}, use energy conservation

$$\frac{1}{2}(M-m)v^2 = (M-m)g\,h_{max}$$

$$h_{max} = \frac{v^2}{2g}$$

$$\Sigma F = m a_{rad} = m\frac{v^2}{L} = 0$$

at h_{max},

$$T - (M-m)g\cos\theta_{max} = 0$$

$$T = (M-m)g\cos\theta_{max}$$

$$\cos\theta_{max} = \frac{L-h_{max}}{L}$$

$$T = (M-m)g\left(\frac{L-h_{max}}{L}\right)$$

$$\Rightarrow T = (M-m)g\left(1 - \frac{v^2}{2gL}\right)$$

PHYS 101: General Physics — KOÇ UNIVERSITY — Fall Semester 2014

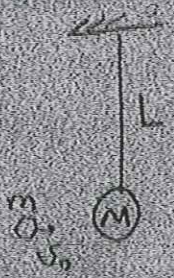
College of Sciences

Section 3 — Quiz 8 — 20 November 2014

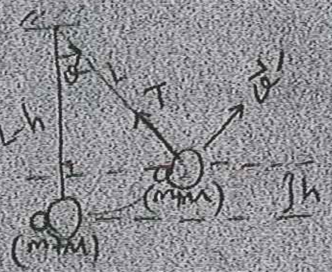
Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

First Name: Last name: Student ID: Signature:

A ball with mass M that is hanged from the ceiling by a very light wire of length L, is struck in a completely inelastic collision by another ball with mass m that is moving horizontally at speed v_0 just before the collision. Find the tension in the wire when mass M is at some height h in terms of M, m, v_0, g, L, h.



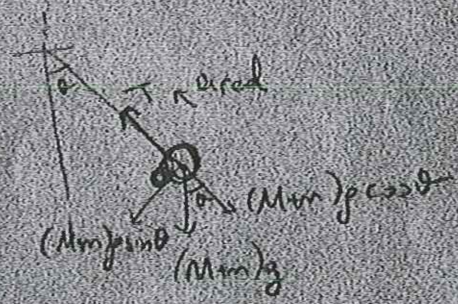
completely inelastic collision



momentum conservation

$$m v_0 + M v_i = (m+M)V \quad (v_i = 0)$$

$$V = \frac{m v_0}{(m+M)}$$



their velocity at some height h can be found by applying energy conservation:

$$K_1 + U_1 = K_2 + U_2$$

$$\frac{1}{2}(m+M)V^2 = (m+M)gh + \frac{1}{2}(m+M)V'^2$$

$$V' = \sqrt{V^2 - 2gh}$$

$$\Sigma F = m a_{rad}$$

$$T - (M+m)g\cos\theta = (M+m)a_{rad}$$

$$\cos\theta = \frac{L-h}{L}$$

$$a_{rad} = \frac{V'^2}{L} = \frac{V^2 - 2gh}{L}$$

$$a_{rad} = \frac{1}{L}\left[\left(\frac{m v_0}{m+M}\right)^2 - 2gh\right]$$

$$\Rightarrow T = \frac{(M+m)}{L}\left[g(L-h) - 2gh + \left(\frac{m v_0}{m+M}\right)^2\right]$$

PHYS 101: General Physics — Section 4, 2014

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Quiz 8

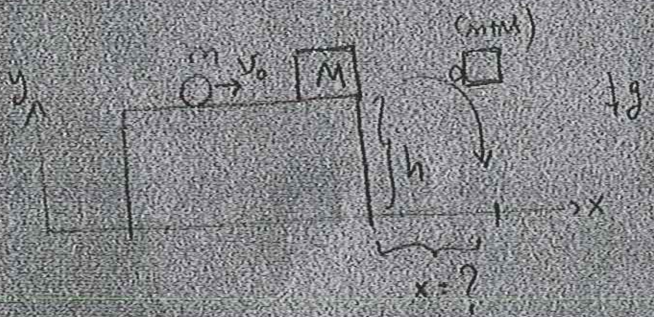
Fall Semester 2014
20 November

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

First Name: **Last name:** **Student ID:** **Signature:**

A block of wood with mass M sits at the edge of a frictionless table that is at a height h above the floor. A blob of clay with mass m slides along the length of the table with speed v_0, strikes the block of wood and sticks to it. The combined object leaves the edge of the table and travels to the floor. What horizontal distance has the combined object traveled when it reaches the floor in terms of M, m, v_0, g, h?

completely inelastic



time to take vertical distance h:

$$y - y_0 = \cancel{v_0 t}^{\,0} + \frac{1}{2} a t^2$$

$$-h = -\frac{1}{2} g t^2$$

$$t = \sqrt{\frac{2h}{g}}$$

for the collision, apply momentum conservation

$$m v_0 + \cancel{M v_i}^{\,0} = (m+M) v_f$$

$$v_f = \left(\frac{m v_0}{m+M}\right)$$

(v_f is in x-direction, combined object at height h after collision does not have any velocity in y-direction)

horizontal distance taken by the combined object when it reaches the floor is

$$x = v_f t$$

$$\boxed{x = \left(\frac{m v_0}{m+M}\right)\sqrt{\frac{2h}{g}}}$$

PHYS 101: General Physics | **KOÇ UNIVERSITY** | **Fall Semester 2014**

College of Sciences

Quiz 8

20 November

Section 3

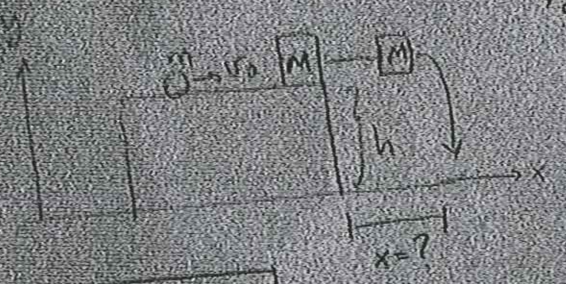
2014

Closed book. No calculators are to be used for this quiz.

Quiz duration: 10 minutes

First Name: **Last name:** **Student ID:** **Signature:**

A block of wood with mass M sits at the edge of a frictionless table that is at a height h above the floor. A ball with mass m slides along the length of the table with speed v_0, strikes elastically with the block of wood. The wood leaves the edge of the table and travels to the floor. What horizontal distance has the wood traveled when it reaches the floor in terms of M, m, v_0, g, h?



time to reach the floor:

$y - y_0 = v_{0y} t + \frac{1}{2} a t^2$

$h = \frac{1}{2} g t^2$

$t = \sqrt{\frac{2h}{g}}$

elastic collision; → momentum and energy conserved

① $m v_0 + M V_0 = m v + M V$ (with $V_0 = 0$)

② $m(v_0 - v) = M V$

$\frac{1}{2} m v_0^2 = \frac{1}{2} m v^2 + \frac{1}{2} M V^2$

③ $m(v_0^2 - v^2) = M V^2$

divide equation 2 by 3

$v_0 + v = V$ → put it into eq ①

$m v_0 = m v + M v_0 + M v$

$v = \frac{(m - M) v_0}{(m + M)}$ $V = \left(\frac{2m}{m+M}\right) v_0$

horizontal distance taken by M

$x = V t$

$x = \left(\frac{2m}{m+M}\right) v_0 \sqrt{\frac{2h}{g}}$