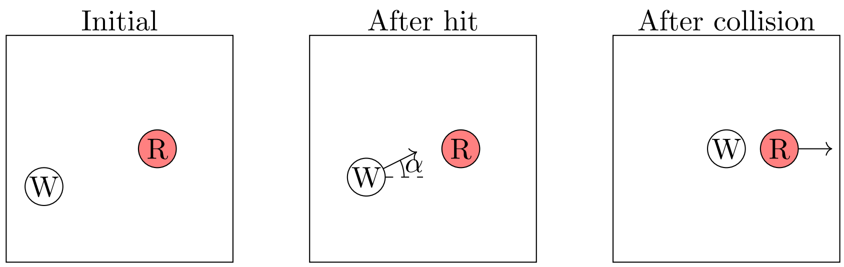
Quiz 3 (compiled : 2026/05/10 at 17:12; version 1)

Name: ______________________ **Student ID:** ______________________

Problem 1:

On a frictionless pool table, a white ball (W) and a red ball (R) of equal mass are initially stationary. A player hits the white ball such that it moves at an angle α relative to the horizontal. The white ball collides with the red ball such that the red ball moves horizontally and the white ball continues to move in an unspecified direction.



(a) Which of the following are *possible* directions for the white ball's velocity after the collision? Select all that apply.

- ☐ Directly up ($v_x = 0; v_y > 0$)
- ☐ Directly down ($v_x = 0; v_y < 0$)
- ☐ Up and to the right ($v_x > 0; v_y > 0$)
- ☐ Down and to the left ($v_x < 0; v_y < 0$)
- ☐ Directly right ($v_x > 0; v_y = 0$)
- ☐ Directly left ($v_x < 0; v_y = 0$)
- ☐ Down and to the right ($v_x > 0; v_y < 0$)
- ☐ Up and to the left ($v_x < 0; v_y > 0$)

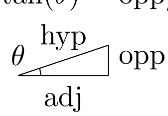
(b) Select the true statement:

- ◯ Suppose the player's hit force and time do not change; using a heavier white ball would make it move faster.
- ◯ Suppose the white ball missed the red ball instead of hitting it; then the momentum would not be conserved.
- ◯ It is possible for the angle α to be 90° without contradicting the rest of the description in the problem start.
- ◯ It is possible for the collision to be elastic without contradicting the rest of the description in the problem start.
- ◯ It is possible for the white ball's initial speed to be the same as the red ball's final speed.

(c) Suppose the player's hit force has magnitude $|\vec{F}|$ and is applied for a time Δt, and the mass of each ball is m. If the white ball moves vertically after the collision, what is the speed of each ball after the collision?

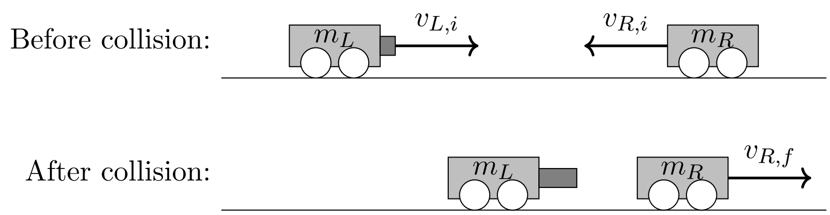
White ball : ◯ $|\vec{F}|\Delta t\sin(\alpha)$ ◯ $|\vec{F}|\Delta t\cos(\alpha)$ ◯ $\frac{|\vec{F}|\Delta t}{m}$ ◯ $\frac{|\vec{F}|\Delta t\sin(\alpha)}{m}$ ◯ $\frac{|\vec{F}|\Delta t\cos(\alpha)}{m}$ ◯ $\frac{|\vec{F}|\sin(\alpha)}{m}$ ◯ $\frac{|\vec{F}|\cos(\alpha)}{m}$

Red ball : ◯ $|\vec{F}|\Delta t\sin(\alpha)$ ◯ $|\vec{F}|\Delta t\cos(\alpha)$ ◯ $\frac{|\vec{F}|\Delta t}{m}$ ◯ $\frac{|\vec{F}|\Delta t\sin(\alpha)}{m}$ ◯ $\frac{|\vec{F}|\Delta t\cos(\alpha)}{m}$ ◯ $\frac{|\vec{F}|\sin(\alpha)}{m}$ ◯ $\frac{|\vec{F}|\cos(\alpha)}{m}$

Force and Momentum	**Trigonometry**
$\vec{p} = m\vec{v}$, $KE = \frac{1}{2}mv^2$ $\vec{J} = \vec{F}\Delta t = m\Delta\vec{v} = \Delta\vec{p}$ $\|F_g\| = mg$, $g = 10$ m/s^2	$\sin(\theta) = $ opp/hyp, $\cos(\theta) = $ adj/hyp $\tan(\theta) = $ opp/adj, adj^2 + opp^2 = hyp^2 

Problem 2:

Two carts are set up to collide on a track. Initially, the left cart of mass m_L is moving with a speed $v_{L,i}$ to the right, and the right cart of mass m_R is moving with a speed $v_{R,i}$ to the left. The left cart is equipped with a spring-loaded plunger that triggers when the carts collide; the effect is that the total kinetic energy actually increases after the collision, i.e. $\Delta KE_{\text{tot}} > 0$. After the collision, the left cart ends up stationary, and the right cart moves away with a speed $v_{R,f}$.



(a)

For each of the following pairs of quantities determine their relationship, or indicate it Cannot Be Determined (CBD).

- ○ $v_{L,i} > v_{R,i}$ ○ $v_{L,i} = v_{R,i}$ ○ $v_{L,i} < v_{R,i}$ ○ CBD
- ○ $v_{R,i} > v_{R,f}$ ○ $v_{R,i} = v_{R,f}$ ○ $v_{R,i} < v_{R,f}$ ○ CBD
- ○ $m_L v_{L,i} > m_R v_{R,i}$ ○ $m_L v_{L,i} = m_R v_{R,i}$ ○ $m_L v_{L,i} < m_R v_{R,i}$ ○ CBD
- ○ $m_L v_{L,i} > m_R v_{R,f}$ ○ $m_L v_{L,i} = m_R v_{R,f}$ ○ $m_L v_{L,i} < m_R v_{R,f}$ ○ CBD
- ○ $\frac{1}{2} m_L v_{L,i}^2 > \frac{1}{2} m_R (v_{R,f}^2 - v_{R,i}^2)$ ○ $\frac{1}{2} m_L v_{L,i}^2 = \frac{1}{2} m_R (v_{R,f}^2 - v_{R,i}^2)$ ○ $\frac{1}{2} m_L v_{L,i}^2 < \frac{1}{2} m_R (v_{R,f}^2 - v_{R,i}^2)$ ○ CBD

(b) With $m_L = 2m_R = 1.5\text{kg}$, and $v_{L,i} = 3v_{R,i} = 2.5\text{m/s}$, determine $v_{R,f}$ and ΔKE_{tot}, (Round to 2 decimal places)

$v_{R,f} =$ [ ] m/s

$\Delta KE_{\text{tot}} =$ [ ] J

(c) Imagine the experiment is set up with the exact same initial speeds, but with the piston already triggered. Without the piston's extra force, the magnitude of $|\vec{F}_{\text{by } L \text{ on } R} \Delta t|$ is reduced.
Which way do the carts end up moving after the collision in this setup?

○ L moves left and R moves right
○ Both move left
○ Both move right
○ L moves right and R moves left
○ Cannot be determined

Force and Momentum	**Trigonometry**
$\vec{p} = m\vec{v}$, $KE = \frac{1}{2}mv^2$ $\vec{J} = \vec{F}\Delta t = m\Delta\vec{v} = \Delta\vec{p}$ $\lvert F_g \rvert = mg$, $g = 10\ \text{m/s}^2$	$\sin(\theta) = \text{opp/hyp}$, $\cos(\theta) = \text{adj/hyp}$ $\tan(\theta) = \text{opp/adj}$, $\text{adj}^2 + \text{opp}^2 = \text{hyp}^2$